Economics

Lecture Notes (Work in Progress)

May 12, 2025

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Preface

About the notes

A PDF version of these notes is available here.

Please note that while the PDF contains the same content, it has not been optimized for PDF format. Therefore, some parts may not appear as intended.

- These notes aims to support my lecture at the HS Fresenius but are incomplete and no substitute for taking actively part in class.
- This is work in progress and some sections are preliminary.
- I appreciate you reading it, and I appreciate any comments.
- This is work in progress so please check for updates regularly.
- For making an appointment, you can use the online tool that you find on my private homepage: https://hubchev.github.io/
- The logo of this book shown in Figure 1 represents ten important currencies.

Figure 1: Logo

About the author

I am a Professor of *International Economics and Data Science* at HS Fresenius, holding a Diploma in Economics from the University of Regensburg and a Doctoral Degree (summa cum laude) from the University of Trier. I completed postgraduate studies at the Interdisciplinary Graduate Center of Excellence at the Institute for Labor Law and Industrial Relations in the European Union (IAAEU) in Trier. Prior to

Figure 2: Prof. Dr. Stephan Huber

my current position, I worked as a research assistant to Prof. Dr. Dr. h.c. Joachim Möller at the University of Regensburg, a post-doc at the Leibniz Institute for East and Southeast European Studies (IOS) in Regensburg, and a freelancer at Charles University in Prague.

Throughout my career, I have also worked as a lecturer at various institutions, including the TU Munich, the University of Regensburg, Saarland University, and the Universities of Applied Sciences in Frankfurt and Augsburg. Additionally, I have had the opportunity to teach abroad for the University of Cordoba in Spain, the University of Perugia in Italy, and the Petra Christian University in Surabaya, Indonesia. My published work can be found in international journals such as the Canadian Journal of Economics and the Stata Journal. For more information, please visit my private homepage at hubchev.github.io and read my CV.

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Teaching principles

I believe in the ***K**eep **I**t **S**imple and **S**traightforward* principle (KISS), which emphasizes simplicity and clarity in all aspects of learning and teaching. This, however, does not imply that the content of the book easy to understand. Success still requires logical thinking and a strong work ethic. Those who struggle with this may find it difficult to pass my courses.

In the following sections, I will introduce various mathematical economic models and concepts that provide a structured framework for understanding economics. Familiarity with these concepts is necessary for understanding current literature and analyzing complex scenarios in international trade.

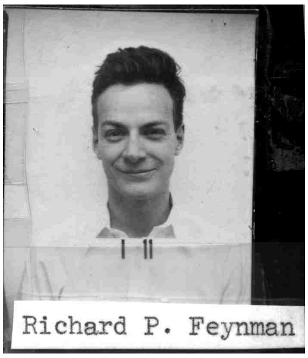
Economic models are based on transparent assumptions and usually consist of a set of equations that explain theories of economic behavior. A robust model should provide valuable insights into the behavior of rational actors and the workings of the economy.

Unfortunately, students sometimes feel overwhelmed by these models because of their reliance on math and rigorous logical reasoning. There is often a perception that there are simpler ways to convey these arguments. While this may occasionally be true, I firmly believe that the formal approach to introducing international economics is most beneficial in the long run. Allow me to back up this belief:

- The narrative method, characterized by storytelling and bullet points, is a quick way to convey information on a variety of topics. However, it also has its drawbacks: students can easily get caught up in intuitive anecdotes without developing critical thinking or recognizing the underlying driving forces. As a result, they memorize information only for exams and forget it shortly thereafter.
- Unlike anecdotes, formal models are not inherently true; however, they can provide deeper insights into a topic than narratives. In Huber (2025, p. 2.1 From anecdote to insight), I discuss the advantages and disadvantages of anecdotes from an epistemological perspective in greater detail.
- Compared to anecdotes, formal models usually offer more flexibility. Once students understand the underlying logic of a model and can interpret and evaluate its implications, they can apply their understanding to different circumstances or topics. In contrast, anecdotes often provide a narrow perspective on a problem, making it difficult to draw general conclusions.
- A mathematical economic model functions much like a proof of an argument in that it accurately describes the assumptions under which the argument holds. In contrast, narratives often obscure the underlying assumptions and premises of an argument.
- Formal argumentation is the norm in economic research. Familiarity with basic concepts therefore enables students to understand the current literature, conduct research and solve problems in their professional lives.
- Understanding an economic model means grasping the underlying relationships, which promotes retention. In essence, formal models promote students' independent thinking and reasoning rather than mere repetition of the teacher's words.

How to prepare for the exam

Figure 3: Richard P. Feynman's Los Alamos ID badge



Source: *https://en.wikipedia.org/wiki/File:Richard_Feynman_Los_Alamos_ID_badge.jpg*

Richard P. Feynman (1918-1988) was a team leader at the Manhattan Project (see Figure 4.1) and won the Nobel Prize in 1965 in physics. He once said:

> "I don't know what's the matter with people: they don't learn by understanding; they learn by some other way – by rote, or something. Their knowledge is so fragile!" (Feynman, 1985)

Of course, the key to learning is understanding. However, I believe that there is no understanding without practice, that is, solving problems and exercises by yourself with a pencil and a blank sheet of paper without knowing the solution in advance. Thus, I recommend the following:

- Attend lectures and and take the opportunity to ask questions and actively participate in class.

- Study the lecture notes and work on the exercises.
- Review the material regularly each week. Learning in small increments is more effective than last-minute cramming.
- Test yourself with past exams that you find in the appendix.
- If you have the opportunity to form a study group, make use of it. It is great to help each other, and it is very motivating to see that everyone has problems sometimes.
- If you have difficulties with some exercises and the solutions shown do not solve your problem, ask a classmate or contact me.

I am convinced that following my recommendations is the best method for students to

- maximize leisure time and minimize the time needed to prepare for the exam, respectively,
- getting long-term benefits out of the course,
- improve grades, and
- have more fun during lecture hours.

About the structure of these notes

I present international economics divided into three major branches:

Monetary international economics: This chapter explicitly considers the meaning of the international financial transaction.

International trade: This chapter is concerned with the determination of relative prices and real incomes in international trade abstracting from the intervention of money. That means trade is considered as an exchange of goods with no financial transactions involved. Of course, this assumption is unrealistic. However, it helps to understand the driving forces of real-world problems.

Trade policy: This chapter is about how international economics is taken into action to build the world we live in.

Moreover, in an appendix I offer solutions to the exercises, some microeconomic and mathematical preliminaries, and some past exams.

Recommended literature

My lecture notes are not a substitute for comprehensive textbooks. They are concise and may not fully explain all economic phenomena. To gain a deeper understanding, or if you're unfamiliar with the economic principles covered, I recommend reading a textbook for basic explanations of the concepts I use. Below, and within each chapter, are sources that might be helpful for further study.

Economic textbooks: Any major economics textbook can be used to complement this lecture. I personally recommend N. G. Mankiw (2024), Blanchard & Johnson (2013), and the open source textbook D. Shapiro et al. (2022) but you can also use Parkin (2012), Case et al. (2019), and Krugman & Wells (2018). While it is always nice to have a more recent textbook, basically older copies are just as fine (and much cheaper). Also, there are good books that are freely available online such as D. Shapiro et al. (2022), Anon (2020), Goodwin (2012), and Klein & Bauman (2010).

International economic textbooks: Of course, this lecture cannot cover all aspects of international economics. It os more like a curated collection of crucial concepts to grasp the fundamentals of global trade. For a deeper dive, I suggest exploring a standard international economics textbook of your preference. Here are some books, I recommend: Suranovic (2012), Suranovic (2016), Krugman et al. (2017), Feenstra & Taylor (2017), Pugel (2015), Carbaugh (2016), and Marrewijk (2012).

Part I

INTRODUCTION

Chapter 1

Scope

Recommended reading: D. Shapiro et al. (2022, ch. 1-3) or N. G. Mankiw (2024, pt. I)

Learning objectives:

Students will be able to:

- Define economics and distinguish between microeconomics and macroeconomics.
- Explain the scope and the big questions of economics.
- Differentiate between efficiency and effectiveness, analyzing how both concepts apply to economics and successful management.
- Identify contemporary economic topics, understanding the significant changes that shape the global economy and their relevance to the study of economics.
- Recognize the principles of scarcity and choice, exploring how these concepts underlie economic decision-making.
- Examine the key aspects that define perfect markets, recognizing the limitations of perfect competition in real-world contexts.
- Apply the rational economic way of thinking to recognize that all choices involve trade-offs, benefits, and costs.
- Investigate the role of the price system and Adam Smith's invisible hand in market operations and resource allocation.

1.1 What is economics?

It is important to note that economics encompasses a wide range of interpretations. There is no single definition that covers all facets. Nevertheless, there are certain aspects on which there is a certain consensus. This is the subject of the next chapter.

1.1.1 Production and productivity

Economics is the study of how to maximize welfare, production, consumption of goods and services, and whatever may be considered beneficial for an economy and the people that live therein.

> Wikipedia (2022): "An economy is an area of the production, distribution, and trade, as well as consumption of goods and services. In general, it is defined as a social domain that emphasizes the practices, discourses, and material expressions associated with the production, use, and management of scarce resources. Simplified, one can say that an economy is a system for providing livelihoods to people."

Exercise 1.1. Production and Productivity
Discuss the meaning of the terms production and productivity.

1.1.2 Efficiency and effectiveness

Economics and successful management revolves around two key concepts: Efficiency and Effectiveness.

Efficiency refers to the ability to achieve an intended result while minimizing waste in terms of time, effort, and resources. It emphasizes performing tasks in the most optimal manner, such as achieving results quickly or at the lowest cost. However, it's important to note that efficiency can sometimes be applied to the wrong activities, meaning that while the task may be done optimally, the outcome may not be the desired one.

Please keep in mind that efficiency is not an indicator of doing the right things. For example, if you are a business that provides a product that nobody wants to buy anymore, you can produce this product with the highest efficiency possible, but you will ultimately fail.

Effectiveness, on the other hand, is the capacity to produce better results that deliver greater value or achieve more favorable outcomes. It focuses on ensuring that the right tasks are carried out, completing activities successfully, and ultimately reaching one's goals.

Managers and individuals with goals should choose actions that are effective—meaning those actions allow them to achieve their intended objectives—and they should strive to execute these actions efficiently.

Exercise 1.2. Wisdom of the Dakota Indians
A well-known piece of wisdom from the Dakota Indians states: "If you realize that you are riding a dead horse, get off!"
Discuss what could that mean in a management context.

Solution

When managers are not doing the right thing they sometimes refuse to accept that they have the wrong business idea or the wrong strategy or product. Instead, they often tend to pursue the chosen strategy trying to do things more efficiency. To stay in the metapher:

- They procure a stronger whip.
- They change the rider.
- They argue, "That's how we've always ridden this horse!"
- They form a working group to analyze the dead horse.
- They visit other places to see how they handle dead horses there.
- They raise the quality standards for riding dead horses.
- They create a task force to revive the dead horse.
- They schedule a training session to learn how to ride better.
- They make comparisons between different dead horses.
- They change the criteria that determine whether a horse is dead.
- They hire external experts to ride the dead horse.
- They yoke several dead horses together to make them faster.
- They assert, "No horse can be so dead that it can't be beaten!"
- They allocate additional resources to improve the horse's performance.
- They commission a study to find out if there are cheaper consultants.
- They purchase something that claims to teach dead horses to run faster.
- They declare that our horse is better, faster, and cheaper when dead.
- They form a quality circle to find a use for dead horses.
- They revise the performance criteria for dead horses.
- They establish an independent cost center for dead horses.
- They have the horses certified as quickly as possible.
- They freeze the horses and wait for a new technology that will allow them to ride dead horses.

- They form a prayer group to pray for the horse's health.
- They place the horse in someone else's stable and claim it as theirs.
- They note that others are also riding dead horses and declare this the norm.
- They change the requirements for riding and movement and issue a new development mandate.
- They outsource the horse.
- They bet that the horse is just pretending to be dead.
- If you can't ride a dead horse, it can at least pull a cart.

1.1.3 Economic topics

You are studying economics at a time of **enormous change**. Some of these changes are for the better, while others are for the worse. Studying economics will help you to **understand the powerful forces that are shaping and changing our world**.

Recent topics in economics:

- COVID
- Protectionism/trade war
- Brexit
- Euro crisis
- Monetary policy
- Refugees
- Germany's trade surplus
- Greece's debt crisis
- Real estate crisis
- Global financial crisis in 2009
- Economics of the Corona Crisis
- Oil price fluctuations
- U.S. Dollar strength
- Economics of climate change

1.1.4 Definitions

- All economic questions arise because we want more than we can get.
- Our inability to satisfy all our wants is called **scarcity**.
- Because we face scarcity, we must make **choices**.
- The choices we make depend on the **incentives** we face. An incentive is a reward that encourages or a penalty that discourages an action.

Economics is a social science, and like all social sciences, many of the terms used in it are poorly defined. For example, the term *economy* can be understood differently, as the following quotes from Figure 1.1 to Figure 1.4 demonstrate:

> Colander (2006): "Economics is the study of how human beings coordinate their wants and desires, given the decision-making mechanisms, social customs, and political realities of society."

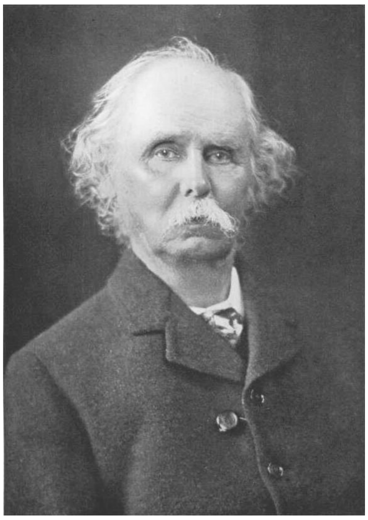
> Parkin (2012): "Economics is the social science that studies the choices that individuals, businesses, governments, and entire societies make as they cope with scarcity and the incentives that influence and reconcile those choices."

> Gwartney et al. (2006): "[E]conomics is the study of human behavior, with a particular focus on human decision making."

Figure 1.1: John Maynard Keynes (1883-1946)

Keynes (1921): The theory of economics does not furnish a body of settled conclusions immediately applicable to policy. It is a method rather than a doctrine, an apparatus of the mind, a technique of thinking, which helps its possessors to draw correct conclusions.

Figure 1.2: Alfred Marshall (1842-1924)



Marshall (2009): "Economics is a study of mankind in the ordinary business of life; it examines that part of individual and social action which is most closely connected with the attainment and with the use of the material requisites of well-being."

Figure 1.3: James Duesenberry (1918-2009)

Duesenberry (1960): "Economics is all about how people make choices. Sociology is about why there isn't any choice to be made."

Backhouse & Medema (2009): "[E]conomics is apparently the study of the economy, the study of the coordination process, the study of the effects of scarcity, the science of choice, and the study of human behavior."

Greenlaw & Shapiro (2022): "Economics seeks to solve the problem of scarcity, which is when human wants for goods and services exceed the available supply. A modern economy displays a division of labor, in which people earn income by specializing in what they produce and then use that income to purchase the products they need or want. The division of labor allows individuals and firms to specialize and to produce more for several reasons: a) It allows the agents to focus on areas of advantage due to natural factors and skill levels; b) It encourages the agents to learn and invent; c) It allows agents to take advantage of economies of scale. Division and specialization of labor only work when individuals can purchase what they do not produce in markets. Learning about economics helps you understand the major problems facing the world today, prepares you to be a good citizen, and helps you become a well-rounded thinker.

Backhouse & Medema (2009): "Perhaps the definition of economics is best viewed as a tool for the first day of principles classes but otherwise of little concern to practicing economists."

Although many textbook definitions are quite similar in many ways, the lack of agreement on a clear-cut definition of economics is not necessarily problematic, as Backhouse & Medema (2009) states:

> "[E]conomists are generally guided by pragmatic considerations of what works or by methodological views emanating from various sources, not by formal definitions."

1.2 Microeconomics vs. Macroeconomics

Parkin (2012): "**Microeconomics** is the study of the choices that individuals and businesses make, the way these choices interact in markets, and the influence of governments. [...] **Macroeconomics** is the study of the performance of the national economy and the global economy.''

Figure 1.4: Jacob Viner (1892-1970)

Jacob Viner: "Economics is what economists do." (see Backhouse & Medema, 2009)

Microeconomics and macroeconomics are two different perspectives on the economy. The microeconomic perspective focuses on parts of the economy:

- Individuals
- Firms
- Industries

Some examples of microeconomic questions are:

- Why are people downloading more movies?
- How would a tax on e-commerce affect eBay?

The term macro comes from the Greek word *makros*, meaning large. Thus, it studies groups or the entire economy using aggregate measures related to welfare and standards of living such as:

- National income
- Money
- Total (un)employment
- Aggregate demand and supply
- Total savings
- Inflation
- General price level
- International trade
- Balance of trade,
- ...

Macroeconomics employs two key policy approaches to pursue these objectives:

- Fiscal policy pertains to the regulation of government revenue, expenditures, and debt to generate positive impacts while averting negative effects on income, output, and employment.
- Monetary policy involves controlling money supply and credit to stimulate business activities, foster economic growth, stabilize price levels, attain full employment, and achieve balance of payments equilibrium.

Some examples of macroeconomic questions are:

- Why is the U.S. unemployment rate so high?
- Can the Federal Reserve make our economy expand by cutting interest rates?

Why separate micro and macroeconomics? Certainly, events occurring at the micro-level can provide insights into phenomena observed at the macro-level, and vice versa. Thus, there is an interdependence of these disciplines. Nevertheless, there remains value in distinguishing them because:

1. What is good at the micro level doesn't have to be good for the economy as a whole.
2. Macroeconomic problems can only be comprehended and solved through macro-level policy actions and programs.

Exercise 1.3. Read Krugman (1996), which is also available online: Harvard Business Review.

Figure 1.5: Krugman and Trump


Why businesspeople don't necessarily make great economists.

A Country Is Not a Company

by Paul Krugman

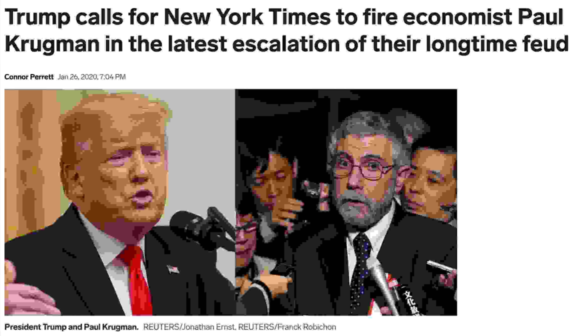
College students who plan to go into business often major in economics, but few believe that they will end up using what they hear in the lecture hall. Those students understand a fundamental truth: What they learn in economics courses won't help them run a business.

I am not claiming that business people are stupid or that economists are particularly smart. On the contrary, if the 100 top U.S. business executives got together with the 100 leading economists, the least impressive of the former group would probably outshine the most impressive of the latter. My point is that

seem particularly inclined to make false analogies between countries and corporations.

Exports and Jobs

Business executives consistently misunderstand two things about the relationship between international trade and domestic job creation.



Source: Krugman (1996) and www.businessinsider.com

Discuss why Trump may not like Krugman's expertise on international trade and comment on Krugman (1996)'s quote:

> "The next time you hear business people propounding their views about the economy, ask yourself: Have they taken the time to study this subject? Have they read what the experts write? If not, never mind how successful they have been in business. Ignore them, because they probably have no idea what they are talking about."

Discuss the following quote from the article *What Do Undergrads Need to Know About Trade?* by Nobel Laureate Paul Krugman (1993):

> "It should be possible to emphasize to students that the level of employment is a macroeconomic issue, depending in the short run on aggregate demand and depending in the long run on the natural rate of unemployment, with microeconomic policies like tariffs having little net effect. Trade policy should be debated in terms of its impact on efficiency, not in terms of phony numbers about jobs created or lost."

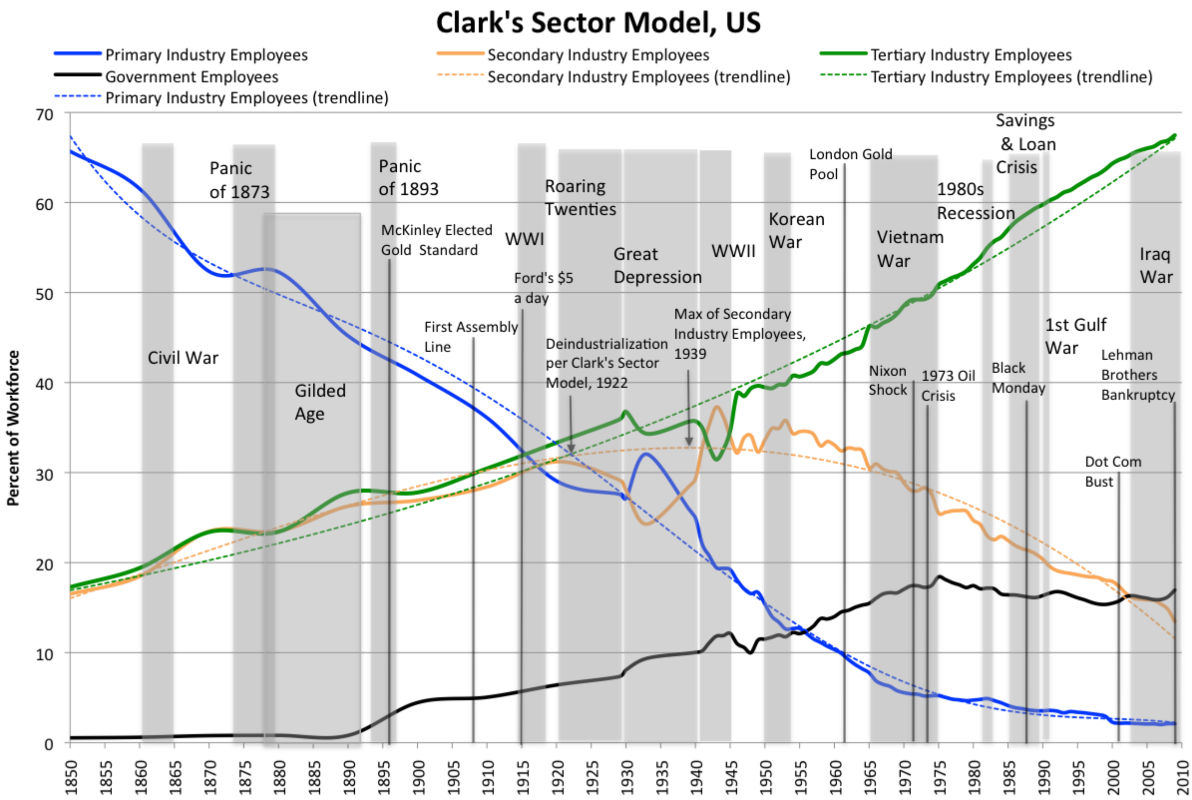
1.3 The scope of economics in five questions

- How do choices end up determining **what**, **where**, **how**, and **for whom** goods and services get produced?
- When do choices made in the pursuit of **self-interest** also promote the **social interest**?

1.3.1 What?

As demonstrated in Figure 1.6, what we produce changes over time.

Figure 1.6: Clark's Sector Model for US economy with current events highlighted.



Source: *www.63alfred.com*

1.3.2 How?

Goods and services are produced by using productive resources that economists call factors of production:

- **Land** (aka *natural resources*): These are the *gifts of nature* that we use to produce goods and services.
- **Labor**: This is the work time and effort that people devote to production. The quality of labor depends on *human capital*, which encompasses the knowledge and skill that people obtain from education, on-the-job training, and work experience.
- **Capital**: Refers to the tools, instruments, machines, buildings, and other constructions employed in the production process.
- **Entrepreneurship**: This is the human resource that organizes labor, land, and capital. Entrepreneurs come up with new ideas about what and how to produce, make business decisions, and bear the risks that arise from these decisions.

What determines the quantities of factors of production used to produce goods and services is a typical economic question.

1.3.3 For whom?

Who gets the goods and services depends on the incomes that people earn. People earn their incomes by selling the services of the factors of production they own:

- Land earns **rent**.
- Labor earns **wages**.
- Capital earns **interest**.
- Entrepreneurship earns **profit**.

Why is the distribution of income so unequal? Why do women and minorities earn less than white males?

1.3.4 Where?

We all know *the World is not flat*: The placement of land, labor, capital, and entrepreneurs in space is important. In particular, **Regional Science** considers that importance.

> "No other discipline can claim such a wide scope of interest and relevance to today's rapidly changing World. Thus, contrary to the claims of the 'end of geography', the process of globalization is making geography more important than ever." Sokol (2011)

Unfortunately, the main microeconomic and macroeconomic textbooks usually refrain from discussing the question "*Where?*". One reason for this could be that the introduction of space into the theory is not trivial. Ignoring the existence of regional differences and transport is accompanied by a lack of reality and may lead to wrong conclusions.

1.4 When is the pursuit of self-interest in the social interest?

7,800,000,000 people make economic choices every day that result in *What*, *How*, and *For Whom* goods and services get produced.

- Do we produce the right things in the right quantities?
- Do we use our factors of production in the best way?
- Do the goods and services go to those who benefit most from them?

Well, it depends on whether we consider self-interest or social interest:

- **Self-interest**: A choice is in your *self-interest* if you think that choice is the best one available for you. You use your time and other resources in the ways that make the most sense to you.
- **Social interest**: A choice is in the social interest if it leads to an outcome that is the best for society as a whole. The social interest has two dimensions: efficiency and equity (or fairness). What is best for society is an efficient and fair use of resources.

Exercise 1.4. Do you act in self-interest and who decides?

- Are you acting in your own interest or are you acting in the interest of a third party? And, do you have freedom of choice?
- Who decides *what*, *how*, and *for whom*? Discuss.
- Is it possible that when each of us makes decisions that are in our own best interest, it also turns out that those decisions are also in society's best interest?
- Do public ownership and central planning do a better job than private corporations and free markets?
- Don't corporate scandals show that large corporations work against society's interest?
- Should pharmaceutical companies be forced to provide HIV/AIDS drugs (or others) to poor people at low cost?
- Why are we destroying the environment?
- Why don't all people have jobs?

1.5 The economic way of thinking

The questions that economics attempts to answer tell us something about the scope of economics, but they do not tell us (1) how economists think and (2) how economists conduct research to find answers.

Exercise 1.5. TANSTAAFL

Figure 1.7: TANSTAAFL

A friend gifts you a shirt, as shown in Figure 1.7. You like it; however, you want to learn what the acronym TANSTAAFL means before you wear it. Take a moment to discover the message associated with the shirt's imprint. Do you think your friend's gift was truly altruistic?

Solution

See Wikipedia (2025d).

1.5.1 A choice is a tradeoff

Before discussing how economists do research, let's look at six key concepts that define the economic way of thinking:

1. A choice is a **tradeoff.**
2. People make **rational decisions** by comparing benefits and costs.
3. **Benefit** is what you get out of something.
4. **Cost** is what you have to give up to get something.
5. Most choices are *how-much* choices made **at the margin**.
6. Choices respond to **incentives**.

Due to scarcity, we are forced to make a choice. Whenever we make a decision, we choose from the available alternatives. It can be helpful to think of each choice as a trade-off - an exchange in which we give up one thing to get another.

The questions of what, how and for whom become clearer when we consider trade-offs:

- **What?** Trade-offs occur when individuals decide how to divide their income, when governments decide how to spend tax revenues, and when companies decide what products to make.
- **How?** Trade-offs occur when companies evaluate different production technologies to maximise efficiency.
- **For whom?** Trade-offs affect the distribution of purchasing power among citizens. Government redistribution of income from the wealthy to the less fortunate is an example of the great trade-off - the balance between equality and efficiency.

The production of goods and services—what is produced, how it is produced, and for whom it is produced—changes over time, leading to improvements in the quality of our economic lives, provided we make wise decisions. The quality of those decisions hinges on the tradeoffs we face.

Example

We encounter three significant tradeoffs between enjoying current consumption and leisure time versus increasing future production, consumption, and leisure time:

- By saving more today, we can invest in productive capital, such as machinery, which will enhance our production capacity in the upcoming time.
- By reducing our leisure time, we can focus on education and training, ultimately becoming more productive in the long run.
- If businesses choose to decrease current production and allocate resources to research and development of new technologies, they can boost future output.

The decisions we make in this area of conflict have a significant influence on the speed at which our economic conditions improve.

Exercise 1.6.

- Name choices that involve tradeoffs.
- Give some examples for choices without tradeoffs.

1.5.2 Rational choices

Economists view the choices that people make as **rational**. A rational choice is one that compares **costs and benefits** and achieves the greatest benefit over cost for the person making the choice.

Exercise 1.7. The businessman and the fisherman
A classic tale that exists in different versions goes like this:

> One day a fisherman was lying on a beautiful beach, with his fishing pole propped up in the sand and his solitary line cast out into the sparkling blue surf. He was enjoying the warmth of the afternoon sun and the prospect of catching a fish.
>
> About that time, a businessman came walking down the beach, trying to relieve some of the stress of his workday. He noticed the fisherman sitting on the beach and decided to find out why this fisherman was fishing instead of working harder to make a living for himself and his family.
>
> "You aren't going to catch many fish that way," said the businessman to the fisherman.
>
> "You should be working rather than lying on the beach!"
>
> The fisherman looked up at the businessman, smiled, and replied, "And what will my reward be?"
>
> "Well, you can get bigger nets and catch more fish!" was the businessman's answer. "And then what will my reward be?" asked the fisherman, still smiling.
>
> The businessman replied, "You will make money and you'll be able to buy a boat, which will then result in larger catches of fish!"
>
> "And then what will my reward be?" asked the fisherman again.
>
> The businessman was beginning to get a little irritated with the fisherman's questions. "You can buy a bigger boat, and hire some people to work for you!" he said.
>
> "And then what will my reward be?" repeated the fisherman.
>
> The businessman was getting angry. "Don't you understand? You can build up a fleet of fishing boats, sail all over the world, and let all your employees catch fish for you!"
>
> Once again the fisherman asked, "And then what will my reward be?"
>
> The businessman was red with rage and shouted at the fisherman, "Don't you understand that you can become so rich that you will never have to work for your living

again! You can spend all the rest of your days sitting on this beach, looking at the sunset. You won't have a care in the world!"

The fisherman, still smiling, looked up and said, "And what do you think I'm doing right now?"

Source: This version of the tale stems from theStorytellers.com (2025).
Who is acting rationally here? The fisherman or the businessman? What are the costs and benefits of both?

1.5.3 Benefit: What you gain

The utility of an item refers to the gain or pleasure it provides and is determined by **preferences**, that is, what a person likes or dislikes and the intensity of those feelings. Economists measure utility as the maximum amount a person **is willing to give up to obtain something**.

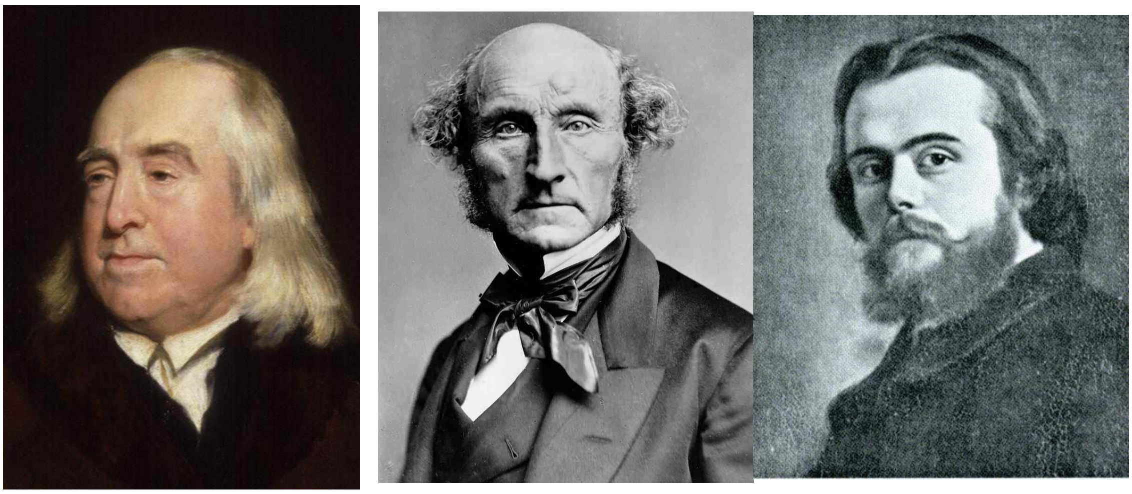
1.5.4 Cost: What you must give up

When considering a choice as a tradeoff, it is essential to emphasize cost as an opportunity foregone. The **opportunity cost** of something is the highest-valued alternative that must be sacrificed to get it.

Utility as a general measure

Figure 1.8: The concept of utility

(a) Jeremy Bentham (1748–1832) (b) John Stuart Mill (1806–1873) (c) Léon Walras (1834–1910)



The concept of utility within economics is used to model worth or value, and its usage has evolved significantly over time by many significant people including those shown in Figure 1.8. Initially introduced as a measure of pleasure or happiness within the theory of utilitarianism by moral philosophers such as Jeremy Bentham and John Stuart Mill, the concept was later developed and popularized by Léon Walras. In microeconomics, it typically represents the satisfaction or pleasure that consumers derive from consuming a bundle of goods and services.

1.5.5 Choosing at the margin

Choosing between studying or watching Netflix is rarely an **all-or-nothing** decision. Instead, you consider how many minutes to allocate to each activity. In making this decision, you compare the benefit of a bit more study time against its cost, effectively making your choice **at the margin**.

People often make choices at the margin, which means they evaluate the consequences of making incremental changes in the use of their resources.

The benefit derived from pursuing a small increase in activity is known as its marginal benefit, while the opportunity cost of that incremental increase is referred to as its marginal cost.

Our choices respond to **incentives**. For any activity, if the marginal benefit exceeds the marginal cost, people have an incentive to increase that activity. Conversely, if the marginal cost exceeds the marginal benefit, people have an incentive to reduce that activity.

> **Exercise 1.8.** Marginal analysis
> Watch this video and solve the associated problems.

1.6 International economics

International economics is covered in more detail in Chapter 29 to Chapter 37. However, let us briefly discuss the scope of this important area of economics.

1.6.1 What is international trade?

International trade is the exchange of capital, goods, and services across international borders or territories. Questions of international trade include:

- Why do nations trade?
- What do they trade?
- What is the effect of trade policies on trade and welfare?
- Can trade in goods substitute for factor mobility?
- Is free trade better than autarky?
- What are the effects of trade on income distribution?
- If there are winners and losers from trade liberalization, can the former compensate the latter?
- If nations gain from trade, how are the gains distributed?
- What are the welfare effects of various trade policies?

> **Exercise 1.9.** Trade and Putin
> Discuss the following quote in the context of the war between Russia and Ukraine.
>
> > "International trade and international capital flows link national economies. Although such links are considered to be beneficial for the most part, they produce an interdependence that occasionally has harmful effects. In particular, shocks that emanate in one country may negatively impact trade partners." (Helpman & Itskhoki, 2010)

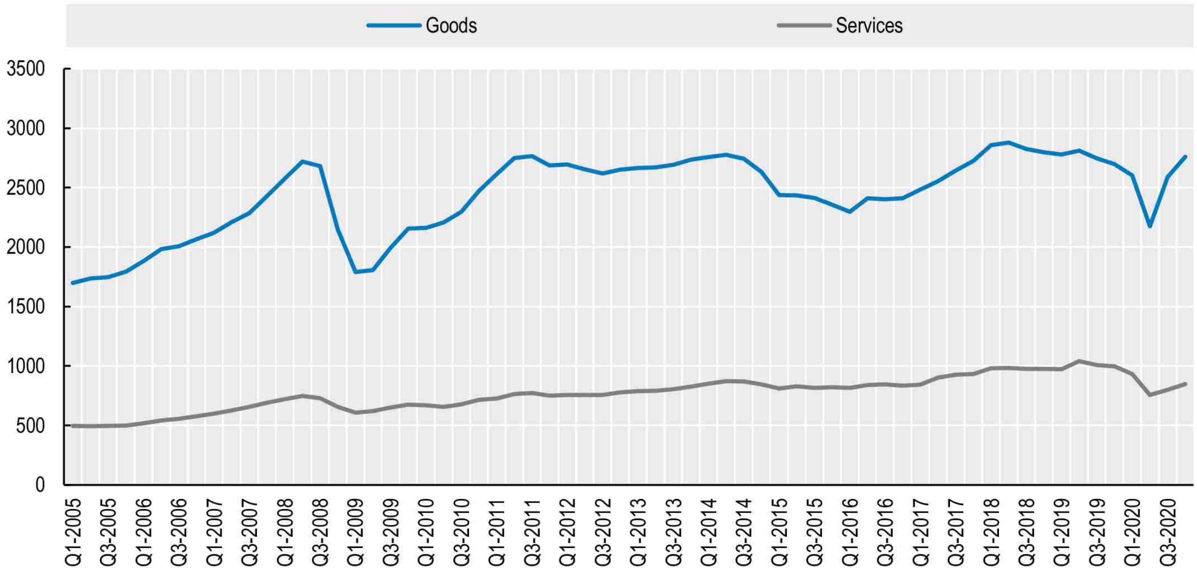
1.6.2 COVID and international economics: Stylized facts

See Figure 1.9 to Figure 1.11 and read Arriola et al. (2021) for further information.

1.6.3 What is international monetary economics?

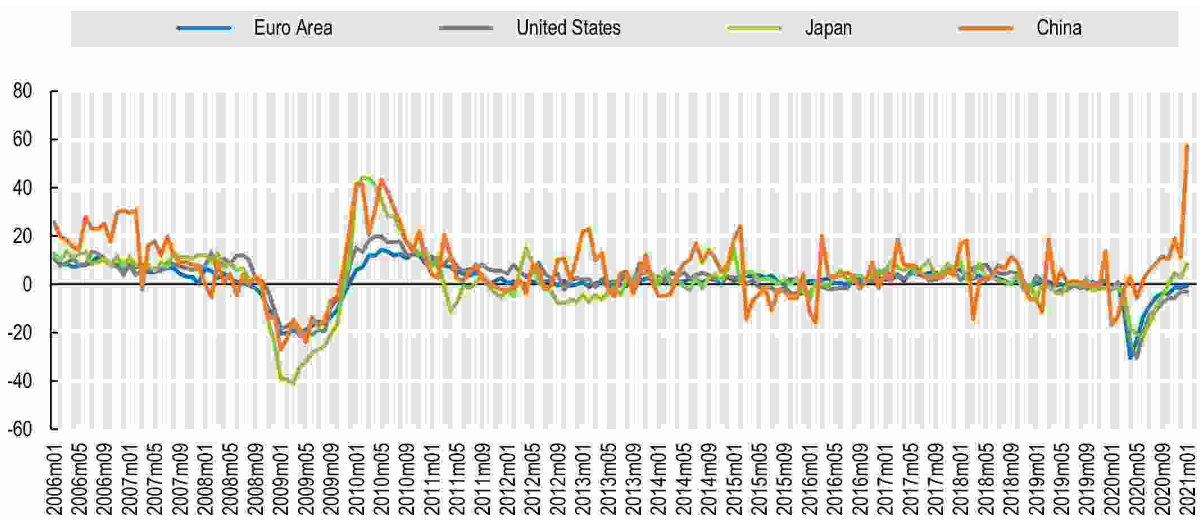
International monetary economics focuses on the financial aspects of international trade. It studies the flows of money across countries and their effects on economies as a whole.

Figure 1.9: Imports and exports in USD billion, OECD countries



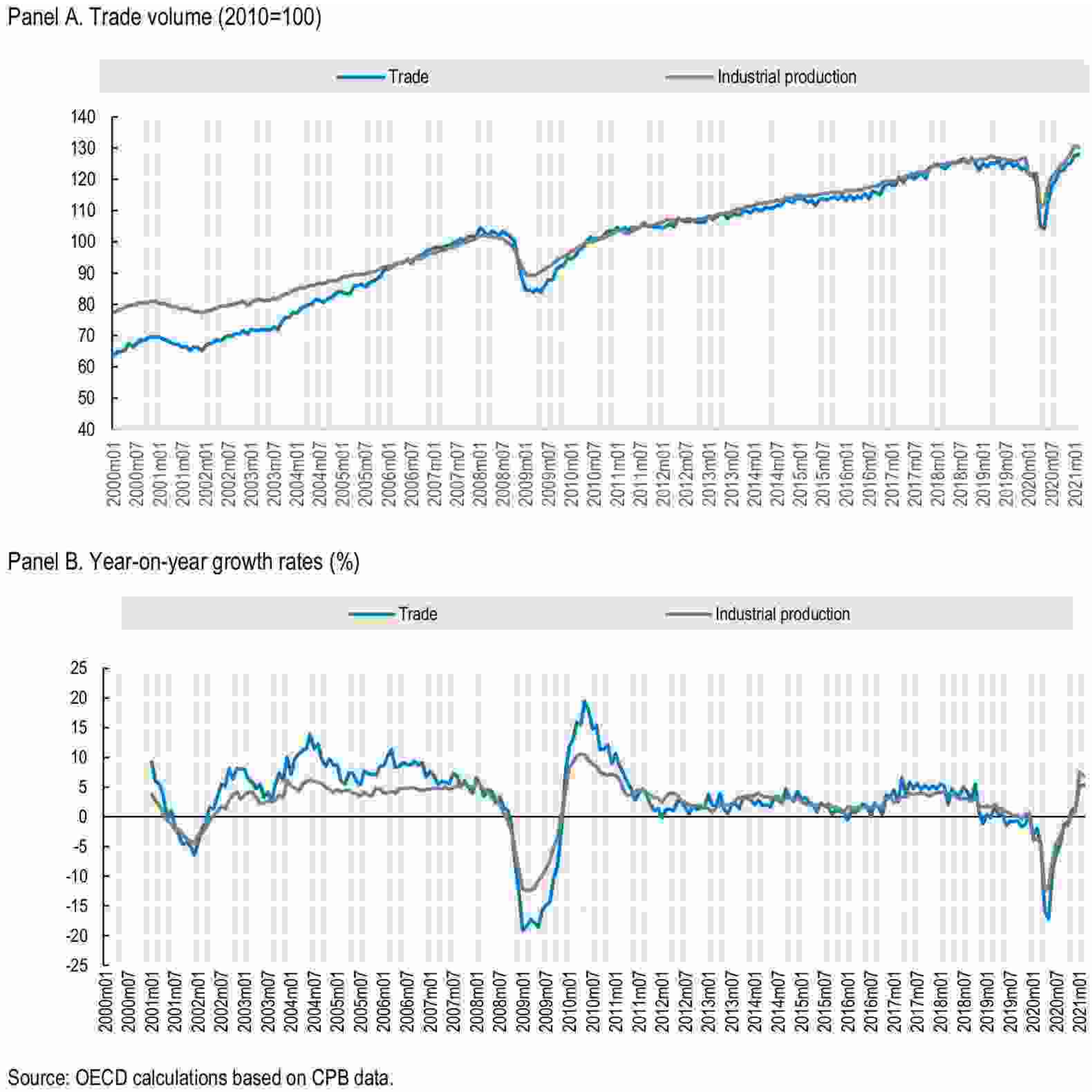
Source: Arriola et al. (2021)

Figure 1.10: Year-on-year growth rates of export volumes



Source: Arriola et al. (2021)

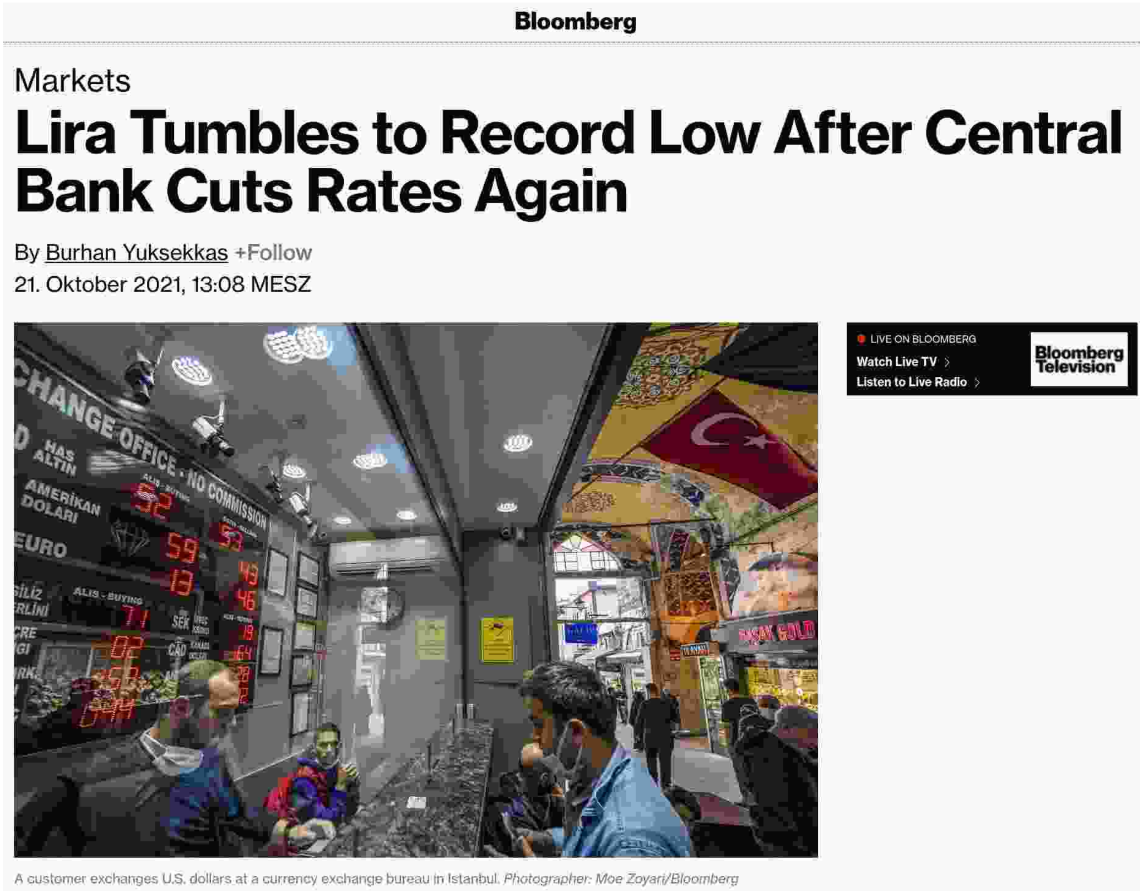
Figure 1.11: World merchandise trade and industrial production volumes



Source: Arriola et al. (2021)

Exercise 1.10. Discuss the content of Figure 1.12 to Figure 1.14.

Figure 1.12: Lira tumbles



Bloomberg

Markets

Lira Tumbles to Record Low After Central Bank Cuts Rates Again

By Burhan Yuksekkas +Follow

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A customer exchanges U.S. dollars at a currency exchange bureau in Istanbul. *Photographer: Moe Zoyari/Bloomberg*

Source: *Bloomberg.com*

Figure 1.13: Turkish lira hits record

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Turkish lira hits record low after Erdogan threatens foreign diplomats with ‘persona non grata’ status

PUBLISHED MON, OCT 25 2021·7:00 AM EDT | UPDATED MON, OCT 25 2021·1:22 PM EDT

Natasha Turak
@NATASHATURAK

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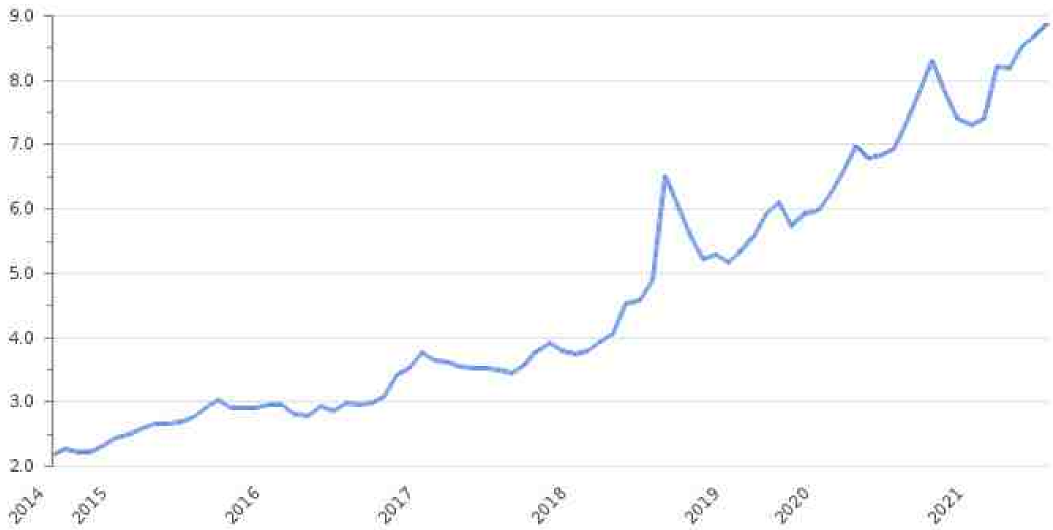
Source: *CNBC.com*

Figure 1.14: TRY to USD rate (₺/$)



1.7 What is international trade policy?

International trade policy encompasses the interplay of national interests affecting trade across borders. It is based on the assumption that a country's international trade policy serves its citizens' and companies' interests.

Exercise 1.11. Read euronews.com, see Figure 1.15.

Figure 1.15: Juncker responds on 03/03/2018

European Commission chief Jean-Claude Juncker has vowed to fight back against US President Donald Trump's threat of a 25% tariff on steel and 10% on aluminium imports (see Figure 1.15).

"So now we will also impose import tariffs. This is basically a stupid process, the fact that we have to do this. But we have to do it. We will now impose tariffs on motorcycles, Harley Davidson, on blue jeans, Levis, on Bourbon. We can also do stupid. We also have to be this stupid," he said in Hamburg on Friday evening.

While Trump may be comfortable with the idea of a trade war, it wasn't just across the Atlantic where the leader's plans ruffled feathers.

"We are impressing upon the American administration the unacceptable nature of these proposals that are going to hurt them every bit as much as they will hurt us," said Canadian Prime Minister Justin Trudeau.

The warnings from leaders around the world mirrored those of the International Monetary Fund, which said Trump's plan would cause damage both internationally and within America itself.

Trump, however, remains defiant, insisting that trade wars are good and easy to win.

Watch this video. Also see Figure 1.16.

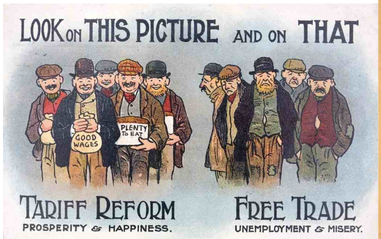
Figure 1.16: Trump and Juncker talk (7/25/2018)

Donald Trump and Jean-Claude Juncker talk trade tariffs

The leaders agreed to work toward "zero tariffs" between the US and the EU, which would decisively reverse the slew of trade tariffs imposed recently. The deal involves the EU purchasing natural gas from the US.

Source: dw.com

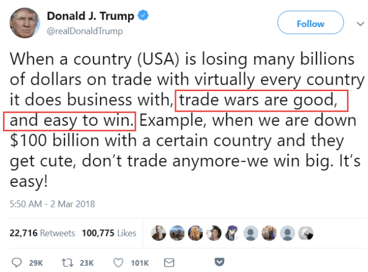
Exercise 1.12. Free trade: Good or bad?
Please consider the following subfigures of Figure **??** and discuss whether trade is something 'good' or 'bad'.



(a) *Source:* Link

(b) *Source:* Link

(c) *Source:* Link


Donald J. Trump @realDonaldTrump Follow

When a country (USA) is losing many billions of dollars on trade with virtually every country it does business with, trade wars are good, and easy to win. Example, when we are down $100 billion with a certain country and they get cute, don't trade anymore-we win big. It's easy!

5:50 AM - 2 Mar 2018

22,716 Retweets 100,775 Likes

(d) *Source:* Twitter

(e) *Source:* Link

(f) *Source:* Link

Some comments on a solution

The costs and benefits of international trade is a controversial topic in politics and academia. In academia, it is a widely shared belief that free trade can be (don't have to be!) a positive-sum game. Outside of academia, however, many people fear international trade because they might loose their competitive advantage in business or their jobs to foreign competitors. Nevertheless, it has to be stated that consumers decide to buy a lot of items from foreign suppliers without being forced to do so. Politicians take advantage of the topic to make popular statements.

Chapter 2

Rationality

Learning objectives:

Students will be able to:

- Describe the rational decision-making process and its components.
- Investigate the concept of bounded rationality and its implications for decision-making.
- Critique common heuristics and their impact on decision outcomes.
- Structure information effectively to facilitate better decision-making.
- Reflect on their own decision-making processes and discuss potential improvements.

2.1 The rational model

A choice can be considered as a rational one when a individual decides for the best alternative courses of action. That is, the alternative with the greatest benefit over cost for the individual making the choice. Whatever the benefits and the costs maybe, a decision maker has to consider all and make a decision. Of course, in reality it is often difficult if not impossible to sum up benefits and costs as the nature of both may be totally different. That is what makes decision often so difficult.

The nature of costs and benefits is manifold and emotions in general are hard to quantify and take as a basis for a decision. To deal with that economists use a theoretical concept that measures everything in **utility**. That is a general and abstract measure to model worth or value. Its usage has evolved significantly over time. The term was introduced initially as a measure of pleasure or happiness within the theory of utilitarianism. For example, it represents the satisfaction or pleasure that people receive for consuming a bundle of goods and services.

Definition: Rational decision

A rational decision is the result of a logical and systematic process in which the decision-maker evaluates

- all relevant and available information about
- all possible courses of action (a.k.a., alternatives) and
- all their potential outcomes,

aiming to choose the option that maximizes utility, where utility increases with benefits and decreases with costs.

The rational model assumes that actors always act in a way that maximizes their utility (as consumers) and profit (as producers) and that they are capable of arbitrarily complex considerations. This means that they consider all possible outcomes and choose the course of action that leads to the best result. In economics, this is known as the *homo economicus* assumption, which is a paraphrase of the assumption of perfect rationality. Of course, this assumption is highly idealized, and it is doubtful that any serious economist has ever believed it to be completely true in reality. It is important to understand the limitations of this assumption in order to make good decisions. Therefore, we will discuss the limitations in detail later. All in all, it is a useful assumption that is indispensable in theoretical research and simplifies many things in practical analysis. It makes it possible to make predictions and explain behavior to a certain extent.

Here is an example of a logical and systematic sequence of steps for making a decision, as outlined similarly by Fitzgerald (2002, p. 13):

1. **Clearly identify the problem**. A *problem* is defined as the perceived gap between the current situation and the desired outcome.
2. **Generate potential solutions**. For routine decisions, various alternatives can be easily identified using established decision rules. However, non-routine decisions require a creative process to discover new alternatives.
3. **Select a solution**. Using appropriate analytical approaches, choose the alternative with the highest expected value. In decision theory, this is referred to as **maximizing the expected utility** of the outcomes.
4. **Implement the solution**. Successful implementation requires ensuring that those responsible understand and accept their roles, and have the necessary motivation and resources for success.
5. **Evaluate and improve**. Assess the effectiveness of the decision and refine the process for future improvements.

Exercise 2.1. Poor and irrational decisions
People make poor decisions all the time. They smoke, take drugs, and harm themself in various ways, make seemingly stupid things that they regret instantaneously. Do all these people act irrational? And, what is a poor decision? What is a stupid thing? The more you think about all that the more challenging it becomes to stay within a logically consistent framework where the meaning of words doesn't change.
Discuss whether taking drugs can be considered a rational choice.

Solution

Taking drugs are usually considered to be a "stupid" idea because drugs (if not taken for medical purpose) usually don't solve problems and causes addiction and bad side effects. However they may give some sort of relieve for some short period of time. Thus, taking drugs can be considered as a rational choice for people that have strong time preferences (i.e., people that can't take the (emotional) pain now and want to postpone it), don't fear side effects, and have little or no hope that things will get better later or that taking any other alternative would help them solving their problem. For those people it is, at least from their perspective, a rational choice.

Overall, I would tend to argue that taking drugs can be a rational choice if these individuals consider all (!) alternative and all (!) information available and if they analyze all (!) relevant aspects without a bias.

If all that hold, we can disagree and we can try our best to convince these individuals that there are better alternative courses of action. Of course, we can and I believe, we should support those human beings not taking drugs. For example, we can teach them to be more optimistic and hence weight the chances that problems can be solved better. However, we cannot claim that their decision is irrational given the conditions mentioned above hold.

Often the conditions to not hold as desperate people are not capable to use all the information without a bias. This gives bystanders such as relatives, friends, and other authorities the legitimate to interfere. For example, doctors and national authorities can send people that are not capable to act rational to a psychological institute until they have the ability to rationally make a decision.

2.2 Irrationality

While the rational model is useful, it can also be criticized in a number of ways. One key misconception is that managers always optimize their decisions through rationality, consciously selecting and implementing the best alternatives. However, this belief rests on several questionable assumptions, as outlined by Fitzgerald (2002, p. 13):

- It is rarely possible to know in advance all possible alternative solutions and predict their specific outcomes.
- The assumption that there is always an optimal solution among the identified alternatives may not hold true.
- Accurately and numerically weighting the alternatives, their outcome probabilities, and the relative desirability of these outcomes is often impractical.
- Decision-makers are not always purely rational; emotions, biases, and organizational politics frequently influence the process.
- Business decisions are not exclusively driven by the desire to maximize profits.

The **rational model is considered normative** because it prescribes a strict, logical sequence of steps to follow in any decision-making process. It is based on the assumption that human behavior is logical and therefore predictable in certain conditions. However, this doesn't always reflect real-world decision-making. For example, findings from behavioral economics reveal that the concept of *homo economicus*, while useful, is flawed in several key aspects.

After all, what would happen if economics adopted the opposite extreme, assuming individuals act irrationally? If actors behaved randomly and unpredictably, we would struggle to make any predictions, and the future would resemble a random walk. Science itself would become meaningless and unnecessary.

Clearly, the extreme of irrationality isn't a viable alternative. So, what can we do? We can identify, explain, and account for the limitations of the *homo economicus* assumption in both theory and empirical analysis. Economists, and anyone applying or studying economic theories, should be aware of the pitfalls in human decision-making and recognize that our ability to act rationally is often limited.

2.3 Bounded rationality

Figure 2.1: Herbert A. Simon

Source: Picture is taken from Nobel Foundation archive.

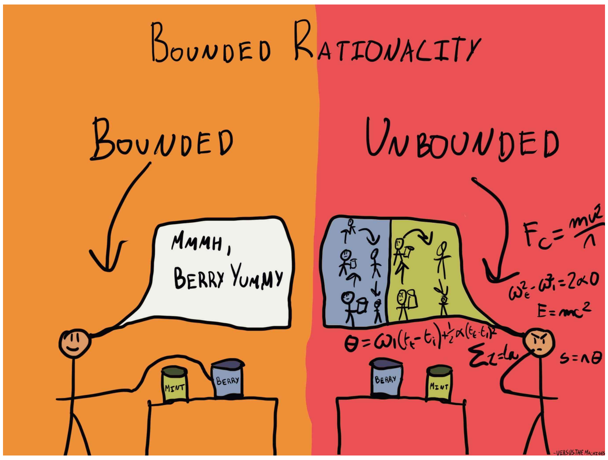
Herbert A. Simon (1916-2001) shown in figure Figure 2.1 received the Nobel Memorial Prize in Economic Sciences in 1978 and the Turing Award[1] in 1975. According to NobelPrize.org (2021), he

[1] The Turing Award is an annual prize given by the Association for Computing Machinery (ACM) for contributions of lasting and major technical importance to the computer field. It is generally recognized as the highest distinction in computer science and is known as or often referred to as 'Nobel Prize of Computing'.

> "combined different scientific disciplines and considered new factors in economic theories. Established economic theories held that enterprises and entrepreneurs all acted in completely rational ways, with the maximization of their own profit as their only goal. In contrast, Simon held that when making choices all people deviate from the strictly rational, and described companies as adaptable systems, with physical, personal, and social components. Through these perspectives, he was able to write about decision-making processes in modern society in an entirely new way".

In particular, he proposed **bounded rationality** as an alternative basis for the mathematical and neo-classical economic modelling of decision-making, as used in economics, political science, and related disciplines.

Figure 2.2: Bounded rationality



Source: https://thedecisionlab.com/wp-content/uploads/2019/08/Bounded-Rationality.jpg.

Bounded rationality proposes that decision making is constrained by managers' ability to process information, i.e., the rationally is *bounded* (see figure Figure 2.2). Managers use shortcuts and rules of thumb which are based on their prior experience with similar problems and scenarios. Given the constraints of managers in their position, they do not actually *optimize* their choice given the available information. It is more like finding a *satisfactory* solution, not necessarily the *best* or the *optimal* solution.

Exercise 2.2. Optimal vs. satisfactory solution
Use the pictures of Figure 2.3 to explain the idea of bounded rationality in the context of decision making.

Figure 2.3: The idea of bounded rationality

(a) Picture A

(b) Picture B

(c) Picture C

(d) Picture D

Solution

A) Collecting and analyzing the available information about a product is costly. It is also difficult to analyze the importance of product features for the intended purpose.
B) Individuals often use rules of thumb to make a satisfactory decision.
C) It is difficult to understand complex situations such as the market for financial products. For some people, it is simply not possible to find the best product in these complex markets.
D) Consumers are often confronted with many variants of a product. The differences are negligible and therefore it is not worthwhile for consumers to analyze the situation in detail. Thus, they make a decision that may not be optimal, but they are satisfied with it.

Exercise 2.3. Are we irrational?
Discuss the following statement:

> Since the rationality of individuals is bounded and it is obvious that individuals do not make optimal decisions, we can say that individuals act irrationally.

2.4 Heuristics

In real life, we frequently rely on heuristics to solve problems and make decisions. A **heuristic** is any approach to solving a problem that uses a practical method that is not guaranteed to be optimal, perfect, or rational. However, a heuristic should–at best–be sufficient to achieve an immediate, short-term goal or approximation. Overall, people use heuristics because they either cannot act completely rationally or want to act rationally but do not have the time it would take to compute the perfect solution. Moreover, the effort is probably not worth it or simply not possible given the time constraints under which the problem must be solved. A heuristic is a mental shortcut or rule of thumb to make decisions and solve problems quickly and efficiently. It helps individuals to arrive at a solution without extensive analysis or evaluation of all available information. Heuristics are usefull when time, resources, or information are limited.

While heuristics can be helpful in many situations, they can also lead to errors and biases, particularly when they are overused or misapplied. We will discuss some of these biases in Chapter 21 in greater detail.

2.5 System 1 and System 2 thinking

In fact, many studies have proven that people often do not act as predicted by theories that assume a home economicus. These behavioral economic research studies the effects of psychological, cognitive, emotional, cultural and social factors on the decisions of individuals and institutions and how those decisions vary from those implied by classical economic theory. While we will discover some more details about it in Chapter 21, I recommend watching the following video about the work of Tversky and Kahneman's shown in Figure 2.5.

The Nobel prize winner Daniel Kahneman (1934 - 2024) is probably the most well-known figure of behavioral economics (see Figure 2.4). One reason is his best-selling book *Thinking Fast and Slow* where he summarizes his work for a broader audience and introduced the modes of System 1 and System 2 thinking. These two modes are easy to understand and often helpful. Figure 2.6 shows a video where he describes these two modes in his own words.

System 1 thinking refers to our intuitive system, which is typically fast, automatic, effortless, implicit, and emotional. We make most decisions in life using this mode of thinking. For instance, we usually decide how to interpret verbal language or visual information automatically and unconsciously.

Figure 2.4: Kahneman and his bestseller

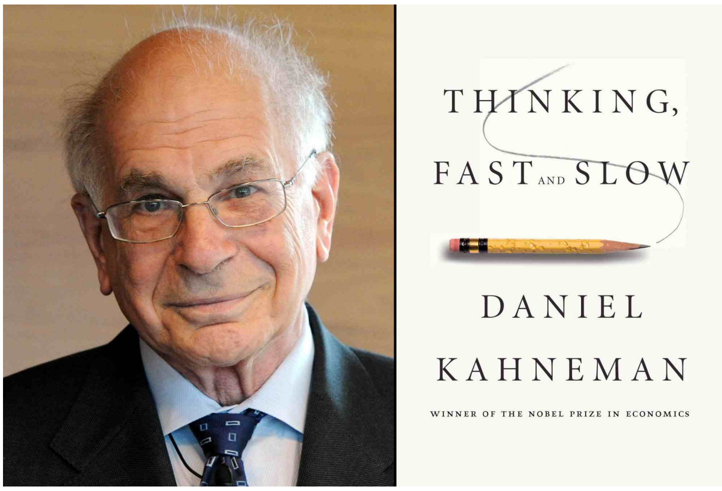


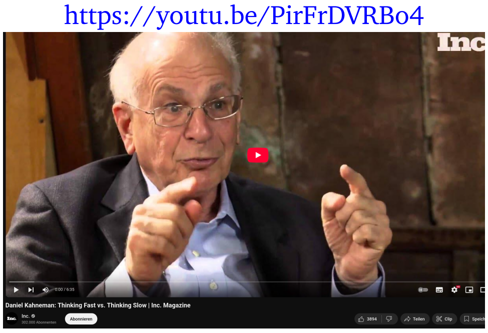
Figure 2.5: Kahneman and Tversky: How heuristics impact our judgment

https://youtu.be/3IjIVD-KYF4

Source: *Youtube*

Figure 2.6: Thinking fast and thinking slow

https://youtu.be/PirFrDVRBo4



Source: *Youtube*

By contrast, **System 2** refers to reasoning that is slower, conscious, effortful, explicit, and logical. In most situations, our System 1 thinking is quite sufficient; it would be impractical, for example, to logically reason through every choice we make while shopping for products in our daily life. But System 2 logic should preferably influence our most important decisions. The busier and more rushed people are, the more they have on their minds, and the more likely they are to rely on System 1 thinking. In fact, the pace of managerial life suggests that executives often rely on System 1 thinking. Although a complete System 2 process is not required for every managerial decision, a key goal for managers should be to identify situations in which they should move from the intuitively compelling System 1 thinking to the more logical System 2.

Exercise 2.4. Kahneman's examples
Kahneman describes the two different ways the brain forms thoughts in the first section of his book as follows:

- **System 1**: Fast, automatic, frequent, emotional, stereotypic, unconscious.
- **System 2**: Slow, effortful, infrequent, logical, calculating, conscious.

Below is a list of things that System 1 and System 2 can do. How do you perform these tasks? Do you use more of System 1 or System 2 thinking? Mark each number with a *1* or a *2* accordingly.

1. Determine that an object is at a greater distance than another
2. Localize the source of a specific sound
3. Complete the phrase "war and . . . "
4. Display disgust when seeing a gruesome image
5. Solve 2+2=?
6. Read text on a billboard
7. Drive a car on an empty road
8. Come up with a good chess move (if you're a chess master)
9. Understand simple sentences
10. Connect the description 'quiet and structured person with an eye for details' to a specific job
11. Brace yourself before the start of a sprint
12. Direct your attention toward the clowns at the circus
13. Direct your attention toward someone at a loud party
14. Look out for the woman with the gray hair
15. Dig into your memory to recognize a sound
16. Sustain a higher than normal walking rate
17. Determine the appropriateness of a particular behavior in a social setting
18. Count the number of A's in a certain text
19. Give someone your phone number
20. Park in a tight parking space
21. Determine the price/quality ratio of two washing machines
22. Determine the validity of complex logical reasoning
23. Solve 17 x 24

Chapter 3

Perfect markets

Recommended readings: Anon (2020, ch. 9)

Learning objectives:

Students will be able to:

- Describe the key characteristics and assumptions of perfect markets and perfect competition.
- Explain the implications of the price system on supply, demand, and the allocation of resources.
- Develop insights into the conditions necessary for achieving Pareto efficiency in markets.

3.1 Pencil parable

Figure 3.1: Milton Friedman's pencil parable

https://youtu.be/67tHtpac5ws

Source: *Youtube*

Milton Friedman (1912–2006), nobel prize winner and one of the great economists (and teachers) of the 20th century, had a 10-hour PBS broadcast series in 1980 called *Free to Choose*. In this show, he presented his vision of how free markets work. In a clip from the show (see Figure 3.1), he distills his arguments into a parable about a pencil. Please watch this video or read the transcript of the video:

> "Look at this lead pencil. There's not a single person in the world who could make this pencil. Remarkable statement? Not at all. The wood from which it is made, for all I know, comes from a tree that was cut down in the state of Washington. To cut down that tree, it took a saw. To make the saw, it took steel. To make steel, it took iron ore. This black center—we call it lead but it's really graphite, compressed graphite—I'm not sure where it comes from, but I think it comes from some mines in South America. This red top up here, this eraser, a

> bit of rubber, probably comes from Malaya, where the rubber tree isn't even native! It was imported from South America by some businessmen with the help of the British government. This brass ferrule? [Self-effacing laughter.] I haven't the slightest idea where it came from. Or the yellow paint! Or the paint that made the black lines. Or the glue that holds it together. Literally thousands of people co-operated to make this pencil. People who don't speak the same language, who practice different religions, who might hate one another if they ever met! When you go down to the store and buy this pencil, you are, in effect, trading a few minutes of your time for a few seconds of the time of all those thousands of people. What brought them together and induced them to cooperate to make this pencil? There was no commissar sending out orders from some central office. It was the magic of the price system: the impersonal operation of prices that brought them together and got them to cooperate, to make this pencil, so you could have it for a trifling sum. That is why the operation of the free market is so essential. Not only to promote productive efficiency but even more to foster harmony and peace among the peoples of the world."

By the way, the parable actually goes back to Leonard E. Read as you can read here.

3.2 Invisible hand

> Smith (1776): "It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own interest"

Figure 3.2: Adam Smith (1723-1790)

In perhaps the most influential book in economics ever written, *An Inquiry into the Nature and Causes of the Wealth of Nations*, Adam Smith (1776) (see Figure 3.2) argued that the pursuit of self-interest in a marketplace would promote the general interest. He said resources would be guided, as if by an **invisible hand**, to their best uses. That invisible hand was the **marketplace**. In particular, he wrote:

> "Every individual necessarily labours to render the annual revenue of the society as great as he can [. . .] He is in this, as in many other ways, led by an invisible hand to promote an end which was no part of his intention [. . .] By pursuing his own interest he frequently promotes that of the society more effectually than when he really intends to promote it."

3.3 Allocation of resources

Markets use prices as signals to allocate resources to their highest valued uses. Consumers will pay higher prices for goods and services that they value more highly. Producers will devote more resources to the production of goods and services that have higher prices, other things being equal. And, other things being equal, workers will provide more hours of labor to jobs that pay higher salaries.

This allocation principle applies to both product markets, such as those for cars, houses, and haircuts, and resource markets, including labor, land, and equipment. Individuals and households play two crucial roles in the economy: they demand goods and services and supply resources. Similarly, businesses also have dual roles; they supply goods and services while demanding resources. The interaction of demand and supply in both product and resource markets generates prices, which help allocate items to their highest valued alternatives.

The question of how resources can and should be allocated is a normative issue, and economists require normative criteria to make decisions. A widely accepted criterion is the Pareto principle (see Note 1).

Note 1: Pareto concept

An allocation of resources is considered **Pareto efficient** (or Pareto optimal) when no reallocation can make at least one individual better off without making someone else worse off. In other words, it is a state where resources are allocated in such a way that it is impossible to improve one person's situation without disadvantaging another.
A change in allocation that benefits at least one individual without harming anyone else is known as a Pareto improvement. This improvement is often used by economist that aim to give policy advice.

When economists discuss an optimal allocation of resources, they typically imply that the Pareto efficiency criterion is met, which defines optimal resource allocation as a state where no further improvements can be made without harming someone.

Factors that disrupt the functioning of a competitive market lead to an inefficient allocation of resources, ultimately diminishing society's overall well-being. This disruption is referred to as market failure. We will explore several forms of market failure later in the notes.

Exercise 3.1. Read and watch:

> **Milton Friedman**: "There was no commissar sending out orders from some central office. It was the magic of the price system: the impersonal operation of prices that brought them together and got them to cooperate, to make this pencil, so you could have it for a trifling sum."

Further explanations can be found in Figure 3.3 and Figure 3.4:

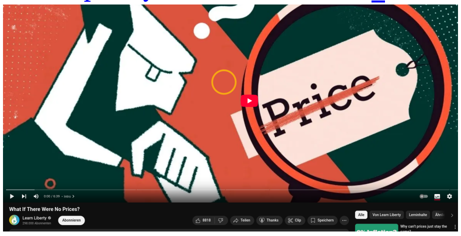
Figure 3.3: Coordination Through Prices

https://youtu.be/j_awx6F6z-U

Source: Youtube

Figure 3.4: What if there were no prices?

https://youtu.be/zkPGfTEZ_r4



Source: Youtube

Exercise 3.2. Magic of the price system
Explain in your own words what Friedman means when he talks about the *magic of the price system*. Why is this different from Adam Smith's *invisible hand*? Can you think of situations where the *magic of the price system* does not work properly? Can you think of necessary conditions that must be met for the "magic" to become reality?

Solution

The magic of the price system actually requires markets to be *perfect*. See Section 3.4.

3.4 Assumptions

The assumptions of perfect markets and perfect competition are as follows:

1. **Many buyers and sellers**: In a perfectly competitive market, there are numerous buyers and sellers, none of whom have a significant influence over market price. Each participant is a price taker, meaning they have no control over the price at which goods or services are exchanged.

2. **Homogeneous products**: The products offered by all firms in a perfectly competitive market are identical or homogeneous. Consumers perceive no differences between the goods or services provided by different sellers. As a result, buyers base their purchase decisions solely on price.

3. **Perfect information**: All buyers and sellers in a perfectly competitive market have complete and accurate information about prices, quality, availability, and other relevant factors. This assumption ensures that market participants can make rational decisions and respond efficiently to changes in market conditions.

4. **Free entry and exit**: Firms can freely enter or exit the market in response to profits or losses. There are no barriers to entry or exit, such as legal restrictions or substantial costs, that prevent new firms from entering the market or existing firms from leaving it.

5. **Perfect mobility of factors of production**: The resources used in production, such as labor and capital, can move freely between different firms and industries. There are no constraints on the mobility of factors of production, allowing firms to allocate resources efficiently.

6. **Profit maximization**: All firms in a perfectly competitive market are profit maximizers. They aim to maximize their profits by adjusting their output levels based on prevailing market conditions. If firms can increase their profits, they will expand production, and if they incur losses, they will reduce output or exit the market.

7. **No externalities and no transaction costs**: There are assumed to be no externalities, meaning no external costs or benefits to third parties not involved in the transaction.

These assumptions collectively define perfect competition. When all conditions are met, there is no need for government regulation, as welfare is maximized, resources are allocated optimally, and no Pareto improvement can be achieved.

While perfect competition is never fully realized in the real world, it serves as a valuable theoretical model that acts as a benchmark for analyzing actual markets. This model provides insights into market functioning and helps inform policymakers on how to address instances of market failure, where at least one assumption of perfect markets is not met.

It is important to note that the fact that real markets are usually imperfect does not imply that such imperfect markets necessarily fail or perform worse than centrally planned economies, for example.

Theory would predict that if firms in an industry would make some profits, new firms will enter the market or existing firms would produce more which both yields an increase in supply. That, in turn, will drive down market prices until all firms earn zero profits and no more firms would have an incentive to enter the market. In the equilibrium, total revenue equals total cost. Thus, firms do not make profits. Firms can only make profits if they have some sort of competitive advantage and hence are not price takers which would be against assumption 1. The most extreme form of competitive advantage is a monopoly. It describes that one firm is the only provider of a certain good or service. This firm can set prices and the supply of the good and service completely. We will discuss that extreme case in Chapter 14.

Chapter 4

Methods

Recommended reading: N. G. Mankiw (2024, ch. 2: Thinking Like an Economist), Huber (2025)

Learning outcomes:

Students will be able to:

- Understand the distinction between economic models and theories, recognizing their roles in analyzing economic problems,
- Apply scientific thinking in the construction of economic models, identifying and justifying the assumptions made in their development.
- Analyze positive statements, which can be tested through empirical observation, and normative statements, which reflect subjective opinions and values.
- Comprehend the reasons behind disagreements among economists, including differences in values and interpretations of positive theories.
- Appreciate the context in which economists operate, understanding that differing perspectives may arise from various interpretations of economic theory.

4.1 Theory and models

Economists utilize models and theories to analyze various problems. Distinguishing between these two concepts can be challenging, and practitioners often use the terms interchangeably.

A theory is a set of assumptions that aims to explain a particular phenomenon in nature. It must be possible to prove a theory true or false. In contrast, a model is a purposeful representation of reality. Models typically simplify the complexities of the real world by focusing only on the features that are relevant to the specific purpose at hand. Their goal is to reduce complexity, thereby facilitating a better understanding of the world. Furthermore, models assist in identifying key variables that can be empirically examined.

The art of scientific thinking and the construction of a theory or model lies in deciding which assumptions to make. Once we grasp the foundational model or theory, we can begin to relax or modify some of those assumptions.

For example, to understand how consumers make purchasing decisions, it may be helpful to start with the assumption that there are only two distinct goods and that the sole determinant of consumers' decisions is price. When we test our model against real data, we will likely find that while price accounts for a significant portion of consumer behavior, it does not explain everything. We can then refine our theory to enhance the explanatory power of our model.

A model typically includes endogenous variables, whose values are determined within the model, and exogenous variables, whose values are set externally by the researcher.

In the words of Nobel laureate Robert Solow:

> "All theory depends on assumptions which are not quite true. That is what makes it theory. The art of successful theorizing is to make the inevitable simplifying assumptions in such a way that the final results are not very sensitive."
> — Robert M. Solow (1956, p. 65)

4.2 A didactical note on models

In these note, I introduce some mathematical economic models. I strongly believe that these models are useful for thinking about economics in a structured way. Familiarity with them will enable you to engage with contemporary textbooks and literature. The models including their formulas and their graphical visualizations, can assist in understanding, analyzing, and memorizing the more complex facets of economics.

Economic models are built on transparent assumptions. Often these assumptions are formulated in a set of equations. A good model should provide valuable insights into how rational agents behave and how the economy functions. Unfortunately, students often feel overwhelmed by these models, as the application of mathematics and hence rigorous logical thinking is sort of new to them. I frequently hear that there are simpler ways to convey the argument. While there may be some truth to this, I firmly believe that formally introducing international economics is the most effective approach in the medium and long term. Allow me to justify my conviction:

1. The narrative method, such as telling stories and listing bullet points, efficiently informs about different topics but also has its drawbacks. Students can easily get lost in intuitive anecdotes without learning to think critically or identify underlying driving forces. They often cram the presented information only for exams and forget it shortly afterward.
2. Compared to anecdotes, formal models are not necessarily true, yet they provide deeper insights into topics than anecdotal storytelling.
3. A formal model is usually more flexible than stories or anecdotes. Once students grasp the underlying logic of a model and can interpret and evaluate its meaning, they can apply their findings to various circumstances or problems. In contrast, an anecdote is merely a story that offers a limited perspective. Drawing general conclusions and analogies from anecdotal evidence is problematic.
4. A mathematical economic model represents a proof of an argument, precisely stating the assumptions under which the argument holds true. In a narrative, the underlying assumptions and premises of an argument are often obscured.
5. Formal reasoning is the standard in economic research. By understanding the basic concepts, students can read and comprehend current literature, allowing them to conduct research and solve problems in their professional lives.
6. Once students understand an economic model, they grasp the underlying relationships, making it less likely for them to forget. In other words, **a formal model ensures that students are not merely repeating the teacher's words but are capable of thinking and reasoning independently.**

4.3 Feynman on scientific method

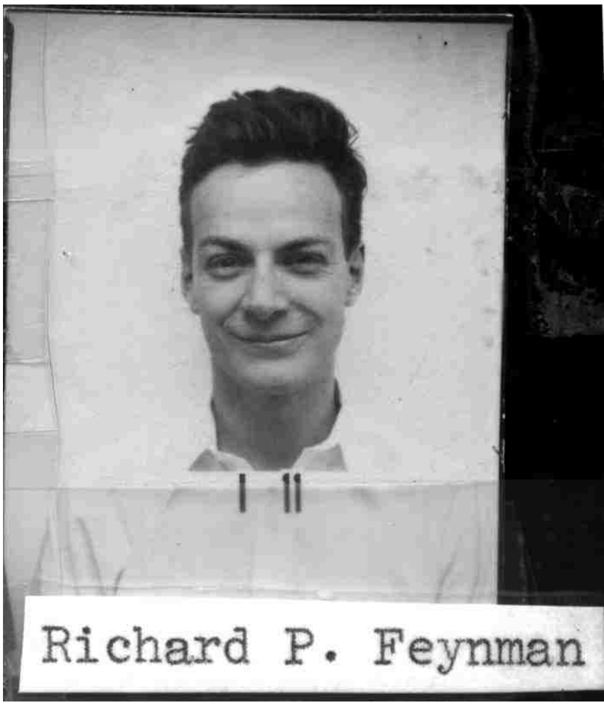
Richard P. Feynman was an American theoretical physicist. At the age of 25, he became a group leader of the Manhattan Project in Los Alamos, received the Nobel Prize in Physics in 1965, authored one of the most famous science books of our time (*Surely You're Joking, Mr. Feynman!*) (Feynman, 1985), and remains a hero for many enthusiasts, educators, and nerds (see Figure 4.1). In 1964, more than half a century ago, he gave a good description of scientific method which is still worth considering.

Watch the video *Feynman on scientific method*:

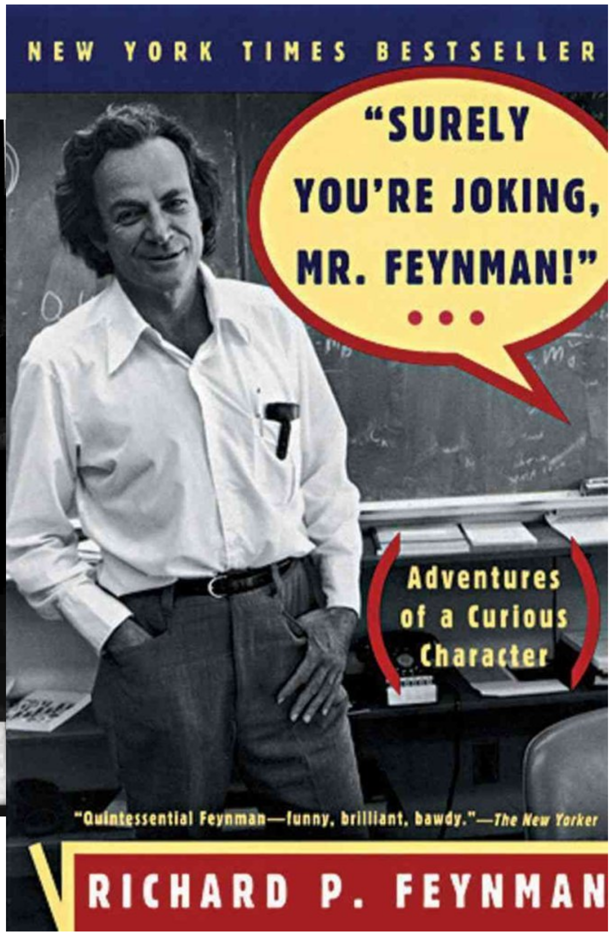
Here is a transcript of his lecture:

Figure 4.1: Richard P. Feynman (1918 - 1988)

(a) ID badge in Los Alamos



(b) Feynman's best seller



(c) Feynman's bus

(d) The Big Bang Theory

Figure 4.2: Feynman on scientific method

https://youtu.be/EYPapE-3FRw

Source: Youtube

"Now, I'm going to discuss how we would look for a new law. In general, we look for a new law by the following process. First, we guess it.

Then we—well, don't laugh. That's really true. Then we compute the consequences of the guess to see if this law that we guessed is right. We check what it would imply and compare those computed results to nature. Or we compare it to experiments or experiences, comparing it directly with observations to see if it works.

If it disagrees with experiment, it's wrong. And that simple statement is the key to science. It doesn't matter how beautiful your guess is. It doesn't matter how smart you are, who made the guess, or what his name is; if it disagrees with experiment, it's wrong. That's all there is to it.

It's therefore not unscientific to take a guess, although many people outside of science think it is. For instance, I had a conversation about flying saucers a few years ago with laymen.

Because I'm a scientist, I said, 'I don't think there are flying saucers.' Then my antagonist said, 'Is it impossible that there are flying saucers? Can you prove that it's impossible?' I said, 'No, I can't prove it's impossible. It's just very unlikely.'

They replied, 'You are very unscientific. If you can't prove something is impossible, then how can you say it's unlikely?' Well, that's how science works. It's scientific to say what's more likely or less likely, rather than attempting to prove every possibility and impossibility.

To clarify, I concluded by saying, 'From my understanding of the world around me, I believe it's much more likely that the reports of flying saucers are the result of the known irrational characteristics of terrestrial intelligence rather than the unknown rational efforts of extraterrestrial intelligence. It's just more likely, that's all. And it's a good guess. We always try to guess the most likely explanation, keeping in the back of our minds that if it doesn't work, we must consider other possibilities.

[. . .]

Now, you see, of course, that with this method, we can disprove any specific theory. We can have a definite theory or a real guess from which we can compute consequences that could be compared to experiments, and in principle, we can discard any theory. You can always prove any definite theory wrong. Notice, however, we never prove it right.

Suppose you invent a good guess, calculate the consequences, and find that every consequence matches the experiments. Does that mean your theory is right? No, it simply has not been proved wrong. Because in the future, there could be a wider range of experiments, and you may compute a broader range of consequences that could reveal that your theory is actually incorrect.

That's why laws, like Newton's laws of motion for planets, have lasted for such a long time. He guessed the law of gravitation, calculated various consequences for the solar system, and it took several hundred years before the slight error in the motion of Mercury was discovered.

[. . .]

I must also point out that you cannot prove a vague theory wrong. If the guess you make is poorly expressed and rather vague, and if the method you use to compute the consequences is also vague—you aren't sure. You might say, 'I think everything is due to [INAUDIBLE], and [INAUDIBLE] does this and that,' more or less. Thus, you can explain how this works. However, that theory is considered 'good' because it cannot be proved wrong.

If the process for computing the consequences is indefinite, then with a little skill, any experimental result can be made to fit—at least in theory. You're probably familiar with that in other fields. For example, A hates his mother. The reason is, of course, that she didn't show him enough love or care when he was a child. However, upon investigation, you may find that she actually loved him very much and everything was fine. Then the explanation changes to say she was overindulgent when he was [INAUDIBLE]. With a vague theory, it's possible to arrive at either conclusion.

[APPLAUSE]

Now, wait. The cure for this is the following: it would be possible to specify ahead of time how much love is insufficient and how much constitutes overindulgence precisely, enabling a legitimate theory against which you can conduct tests. It's often said that when this is pointed out regarding how much love is involved, you're dealing with psychological matters, and such things can't be defined so precisely. Yes, but then you can't claim to know anything about it. [APPLAUSE]

Now, I want to concentrate for now on—because I'm a theoretical physicist and more fascinated with this end of the problem—how you make guesses. It is irrelevant where the guess originates. What matters is that it agrees with experiments and is as precise as possible.

But, you might say, that's very simple. We just set up a machine—a great computing machine—with a random wheel that makes a succession of guesses. Each time it guesses hypotheses about how nature should work, it computes the consequences and compares them to a list of experimental results at the other end. In other words, guessing is a task for simpletons.

Actually, it's quite the opposite, and I will try to explain why. [. . .]

4.4 The economic way of doing research

Economics is a social science. When economists are trying to . . .

- . . . change the world, they act as **policy advisors**.
- . . . explain the world, they are **scientists**.

Economists distinguish between two types of statements:

1. A **positive** statement attempts to describe the world as it is and can be tested by checking it against facts. In other words, a positive statement deals with assumptions about the state of the world and some conclusions. The validity of the statement is verifiable or testable in principle, no matter how difficult it might be.
2. A **normative** statement claims how the world should be and cannot be tested. Normative statements often contain words such as *have to*, *ought to*, *must*, *should*, or non-quantifiable adjectives like *important*, which cannot be objectively measured. Consequently, normative statements cannot be verified or falsified by scientific methods.

Exercise 4.1. Positive or normative

1. An increase in the minimum wage will cause a decrease in employment among the least-skilled.
2. Higher federal budget deficits will cause interest rates to increase.

3. Nobody should be paid less due to their gender, race, age, or religion.

The task of economic science is to discover positive statements that align with our observations of the world and enable us to understand how the economic world operates. This task is substantial and can be broken into three steps:

1. **Observation and measurement:** Economists observe and measure economic activity, tracking data such as quantities of resources, wages and work hours, prices and quantities of goods and services produced, taxes and government spending, and the volume and price of traded goods.
2. **Model building**
3. **Testing models**

Research methodologies in economics often blend the inductive and deductive approaches. Inductive reasoning builds theories, while deductive reasoning tests existing ones. It's a methodical interplay between creation and scrutiny in the realm of economic research.

When scientists want to act as political advisors, they are often asked to make normative statements. From an ethical point of view, however, it is difficult to make normative statements without including subjective judgments, which can make such statements unscientific. Therefore, scientists should rely on moral criteria to justify their judgments and normative statements.

Among these criteria, the Pareto criterion is one of the best known and most widely used. It states that only changes that benefit at least one individual without harming others can be considered improvements. This concept is often used in economics to discuss the distribution of resources, welfare economics and policy making.

4.5 Cause and effect

Economists seek to unscramble cause and effect. They are particularly interested in positive statements concerning causal relationships. For example, are computers becoming cheaper because people are purchasing them in greater quantities, or are consumers buying more computers because prices are falling? Alternatively, could a third factor be influencing both the price of computers and the quantity sold? To address these questions, economists develop and test economic and econometric models.

Unfortunately, conducting experiments can be challenging for economists, and most economic behaviors are influenced by multiple simultaneous factors. To isolate the effect of interest, they employ various logical and econometric tools, including the ceteris paribus assumption, which means other things being equal. This approach enables economists to delineate cause-and-effect relationships by varying only one variable at a time while keeping all other relevant factors constant.

Reading tip: @Huber2023Quantitative

My lecture notes on quantitative methods covers these concepts in detail.

4.6 Common causal and predictive fallacies

1. The **fallacy of composition** asserts that what is true for the parts is true for the whole, or vice versa.

2. The **post hoc fallacy** is the error of reasoning that a first event causes a second event merely because the first occurs before the second.

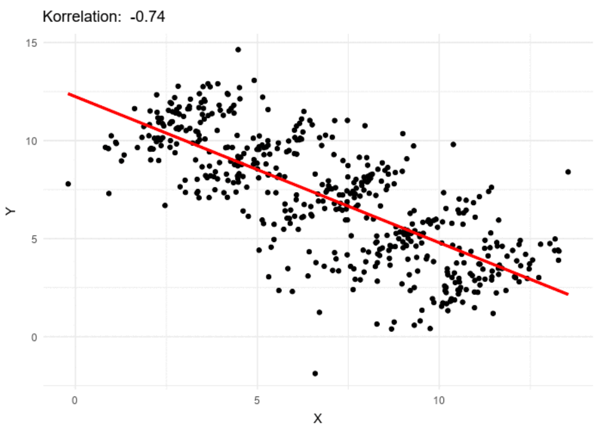
3. **Simpson's Paradox** is a phenomenon in probability and statistics where a trend appears in several groups of data but disappears or reverses when the groups are combined.

Figure 4.3: Fallacy of composition

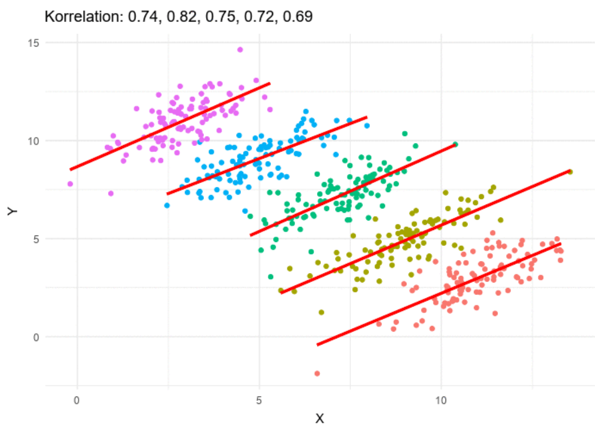
Figure 4.4: Post hoc fallacy

Figure 4.5: Simpson's paradox

(a) Without controls



(b) With controls



4. Correlation does not imply causation.

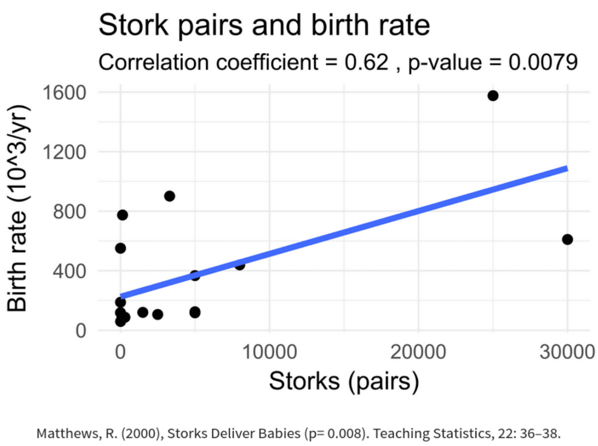
Correlation refers to a statistical relationship between two variables, where one variable tends to increase or decrease as the other variable also increases or decreases. However, just because two variables are correlated does not necessarily mean that one variable causes the other. This is known as the *correlation does not imply causation* principle.

For example, across many areas the number of storks is correlated with the birth rate of babies (see Matthews (2000) and Figure 4.6). However, this does not mean that the presence of storks causes an increase in the birth rate. It is possible that both the number of storks and the number of babies born are influenced by other factors, such as the overall population density or economic conditions in the area.

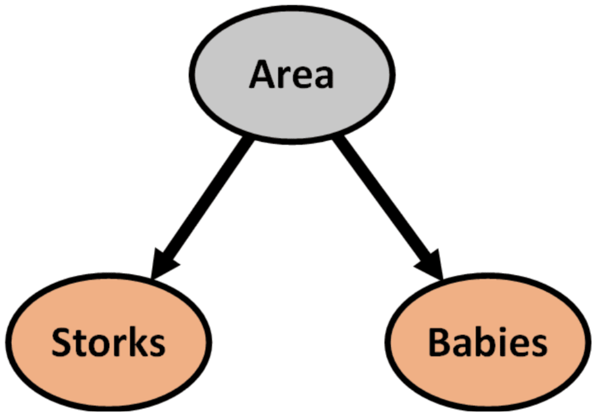
Therefore, it is important to carefully consider all possible explanations (confounders) for a correlation and to use data to disentangle the true cause-and-effect relationship between variables.

Figure 4.6: Storks and babies

(a) a)



(b) b)



4.7 Why economists disagree

Economists are often accused of contradicting each other. Contrary to popular belief, they find much common ground on a wide range of issues. Nevertheless, economists may:

1. Disagree about the validity of alternative positive theories regarding how the world works.
2. Have different values and, therefore, differing normative views about which policies should be implemented.

> "As a new graduate student, you are at the beginning of a new stage of your life. In a few months, you will be overloaded with definitions, concepts, and models. Your teachers will guide you into the wonders of economics and will rarely have time to pause and raise fundamental questions about what these models are supposed to mean. It is not unlikely that you will be brainwashed by the professional-sounding language and hidden assumptions. I am afraid I am about to initiate you into this inevitable process. Still, I want to take this opportunity to pause for a moment and alert you to the fact that many economists have strong and conflicting views about what economic theory is. Some see it as a set of theories that can (or should) be tested. Others view it as a set of tools for economic agents, while yet others perceive it as a framework through which professional and academic economists interpret the world." (Rubinstein, 2006, p. ix)

Part II

BASICS

Chapter 5

GDP

Required readings: D. Shapiro et al. (2022, ch. 19), N. G. Mankiw (2024, ch. 24)

Recommended readings: D. Shapiro et al. (2022, ch. 22, 23), N. G. Mankiw (2024, pt. VIII, ch. 32)

Learning objectives:

Students will be able to:

- Understand the importance of gross domestic product (GDP) and how it is measured.
- Analyze the composition of GDP and how it has changed over time.
- Recognize that GDP is the sum of consumption, investment, government spending, inventory investment, and exports minus imports.

5.1 Gross Domestic Product (GDP)

> William D. Nordhaus (2002): "While the GDP and the rest of the National Income and Product Accounts (NIPA) may seem to be arcane concepts, they are truly among the great inventions of the twentieth century. Much like a satellite in space can survey the weather across an entire continent, GDP provides an overall picture of the state of the economy. Since its initial construction by Simon Kuznets, who won the Nobel Prize in Economics for his contributions to national income accounting, significant strides have been made in developing and improving indexes of economic welfare."

The **Gross Domestic Product (GDP)** "is the market value of all final goods and services produced within a country in a given period of time" (N. G. Mankiw, 2024, ch. 24).

This definition consists of four parts:

- **Market value:** The items in GDP are valued at their market prices.
- **Final goods and services:** A final good is an item purchased by its final user. It contrasts with an intermediate good, which is produced by one firm, bought by another firm, and used as a component of a final good or service. To avoid double counting, GDP includes only final goods and services.
- **Produced within a country:** Only goods and services produced within a country are counted.
- **In a given period of time:** GDP is measured over a specified time frame, typically a quarter or a year.

5.2 Three equivalent ways to measure the GDP

GDP can be quantified through three methods, each expected to yield equivalent outcomes. The circular flow diagrams of Figure 5.2 visualize the concept.

1. Total spending on domestic products and services (expenditure approach)
2. Total domestic income (income approach)
3. Total domestic production (production approach)

All three approaches theoretically should arrive at the same result, that is, measuring the value that was added within an economy over the course of time.

Figure 5.1: Two circular flow diagrams

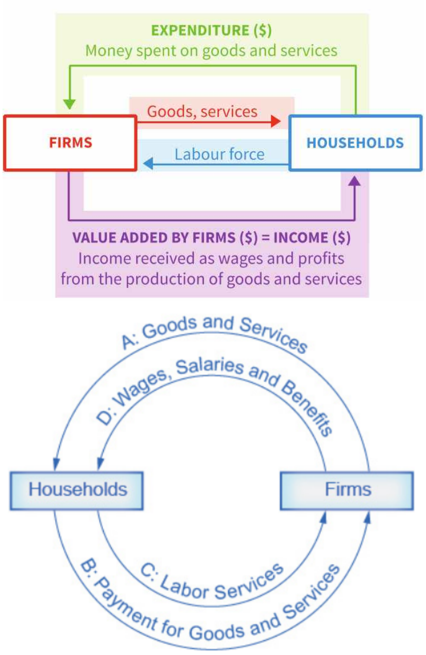
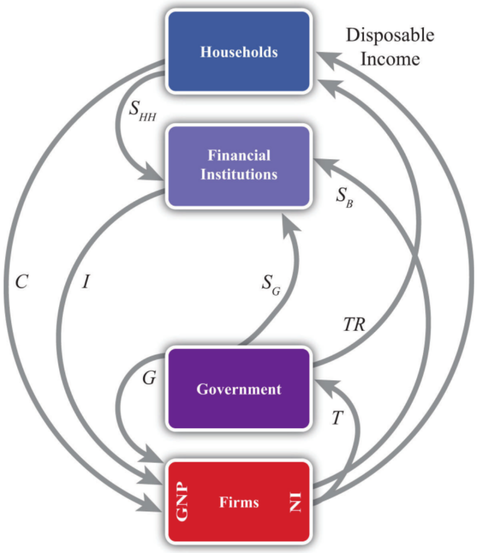


Figure 5.2: The circular flow in a closed economy



Note: The diagram was taken from Suranovic (2016), p. 54.

Watch the videos of Figure 5.3.

5.2.1 The expenditure approach

The expenditure approach measures GDP as the sum of consumption expenditure, C, investment, I, government expenditure on goods and services, G, and net exports of goods and services, $(X - M)$.

Figure 5.3: What is Gross Domestic Product (GDP)?

https://youtu.be/mjJmo5mN5yA

Source: Youtube

Therefore, the equation - which is often called the *GDP decomposition* - is:

$$GDP = C + I + G + (X - M),$$

where

- C denote the expenditure on all consumer goods,
- I denotes the expenditure on newly produced capital goods,
- G denotes government expenditure on goods and services (excluding transfers),
- X denotes the exports, and M the imports. The difference $X - M$ stands for the net exports, also known as the trade balance. For example, for the USA in 2020, this amounts to:

  $$\$14,145 + \$3,605 + \$3,831 + (-\$645) = \$20,936.$$

  Aggregate expenditure equals GDP because all goods and services produced are sold to households, firms, governments, or foreigners. Please note, goods and services that are not sold are included in investment as inventories and thus are "sold" to the producing firm.

Please consider Figures Figure 5.4, Figure 5.5, and Figure 5.6. They illustrate various aspects of GDP composition.

Figure 5.4: Decomposition of GDP in 2013 for the US, the Eurozone, and China.

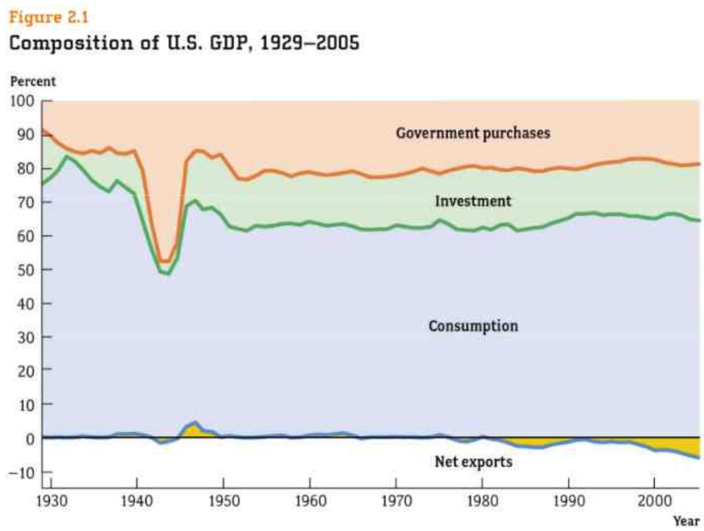
	US	**Eurozone (19 countries)**	**China**
Consumption (*C*)	68.4%	55.9%	37.3%
Government spending (*G*)	15.1%	21.1%	14.1%
Investment (*I*)	19.1%	19.5%	47.3%
Change in inventories	0.4%	0.0%	2.0%
Exports (*X*)	13.6%	43.9%	26.2%
Imports (*M*)	16.6%	40.5%	23.8%

Source: World Bank (2015). Adapted from Core Economics

5.2.2 The income approach

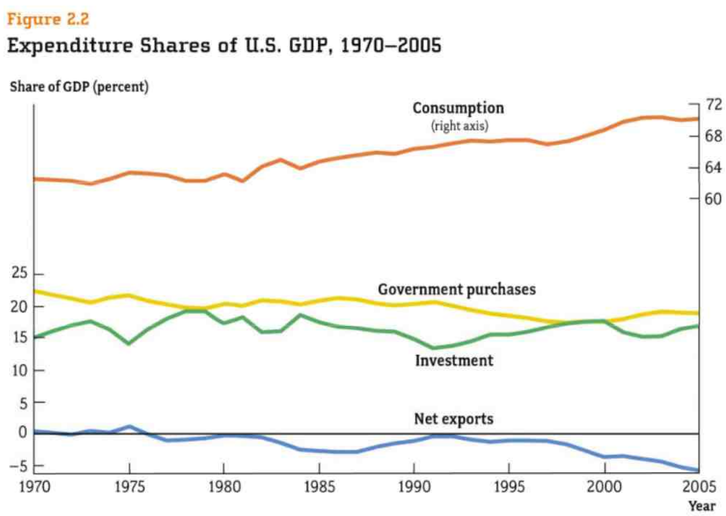
The income approach measures GDP as the sum of compensation of employees, net interest, rental income, corporate profits, and proprietors' income. This sum equals net domestic income at factor costs. To

Figure 5.5: Composition of US GDP, 1929-2005



Source: Jones (2008)

Figure 5.6: Expenditure Shares of U.S. GDP, 1970-2005



Source: Jones (2008)

obtain GDP, indirect taxes (taxes paid by consumers when they buy goods and services) minus subsidies are included along with depreciation. Finally, any discrepancy between the expenditure approach and the income approach is included in the income approach as a statistical discrepancy.

5.2.3 The production approach

The production approach calculates how much value is contributed at each stage of production. (Gross value added = gross value of output - value of intermediate consumption.)

FAQ

- **Are government transfer payments part of the GDP?**
  Government transfer payments, such as Social Security payments, are **not** included in government expenditures because they do not involve the government buying goods or services.

- **How do we account for international transactions?**
  For example, foreign production is domestic consumption (imports), while domestic production is foreign consumption (exports).
  We include exports and exclude imports, so that GDP reflects value added, income from, or consumption of, domestic production.

- **How do we incorporate government?**
  Treat it as another producer where public services are *bought* via taxes.

- **Why "domestic" and why "gross"?**

  – Depreciation refers to the decrease in the stock of capital due to wear and tear and obsolescence. The total spent on new capital purchases and replacing depreciated capital is termed **gross investment**. The increase in capital stock is termed **net investment**.
    * Net investment = gross investment - depreciation.

  – The term "gross" in gross domestic product signifies that the investment in GDP is gross investment, part of which replaces depreciating capital. Net domestic product subtracts depreciation from GDP.

Exercise 5.1. How to measure GDP Explain in one sentence the three equivalent ways to measure GDP.

Solution

1. In the *expenditure approach*, GDP is calculated as the sum of all expenditure on final products.
2. In the *income approach*, GDP is calculated as the sum of all income.
3. In the *value-added approach*, GDP is calculated as the sum of all value added in all production units.

Exercise 5.2. Part of GDP?
State which of the following are a part of the GDP and which are not:

1. Social security payments received by a retired factory worker.
2. Unpaid services of a family member in painting the family home.
3. The income of a butcher.
4. The monthly allowance a college student receives from home.
5. Rent received on an apartment.

6. A €2 million increase in business inventories.
7. Interest on a BMW bond.
8. The purchase of an insurance policy.

Solution

1. Social security payments received by a retired factory worker.
   ☐ Part of GDP

   ☒ Not Part of GDP
2. Unpaid services of a family member in painting the family home.
   ☐ Part of GDP

   ☒ Not Part of GDP
3. The income of a butcher.
   ☒ Part of GDP

   ☐ Not Part of GDP
4. The monthly allowance a college student receives from home.
   ☐ Part of GDP

   ☒ Not Part of GDP
5. Rent received on an apartment.
   ☒ Part of GDP

   ☐ Not Part of GDP
6. A €2 million increase in business inventories.
   ☒ Part of GDP

   ☐ Not Part of GDP
7. Interest on a BMW bond.
   ☒ Part of GDP

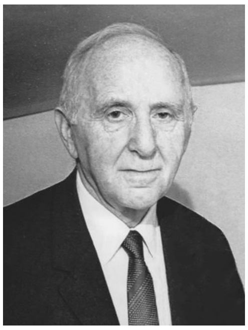
   ☐ Not Part of GDP
8. The purchase of an insurance policy.
   ☒ Part of GDP

   ☐ Not Part of GDP

5.3 Limitations of the nominal GDP

The GDP as a single measure for economic activity and production, respectively, was pioneered and developed by a Russian-born American economist, Simon Kuznets (1901-1985), see Figure 5.7. He received the Nobel Prize in economics in 1971 for his contributions. While he was convinced about the valuable uses of national income measurements, he was very much aware of the limitations and the risks of the measures to be abused. In an report to the U.S. Senate where he explains the possibilities of a national income measure, he warns in the section "Uses and Abuses of National Income Measurements" (Kuznets, 1934, pp. 5–8) that the GDP needs to be "interpreted with a full realization of the definition of national income assumed"Kuznets (1934, p. 6). Otherwise it is abused. Please read here his carefull warning:

Figure 5.7: Simon Kuznets (1901-1985)



Source: Public domain taken from Wikipedia (2025g)

"The valuable capacity of the human mind to simplify a complex situation in a compact characterization becomes dangerous when not controlled in terms of definitely stated criteria. With quantitative measurements especially, the definiteness of the result suggests, often misleadingly, a precision and simplicity in the outlines of the object measured. Measurements of national income are subject to this type of illusion and resulting abuse, especially since they deal with matters that are the center of conflict of opposing social groups where the effectiveness of an argument is often contingent upon oversimplification.

From the definition of national income presented and discussed above it is obvious that a measure of income produced sheds a good deal of light on the productivity of the nation; that income received measures the same productivity as reflected in the flow of means of purchase to the nation's members; and that when total income paid out is adjusted for changes in the value of money and apportioned per capita, the result is illuminating of movements in the nation's economic welfare. Comparison of such income measurements for different nations, or for the same nation for different years, yields valuable indications of spatial and temporal differences in national productivity and economic welfare. Moreover, various single groups of services or drafts may be compared with the country's total to indicate their relative weight in or draft upon the latter.

These constitute highly valuable uses of national income measurements, but only if the results are interpreted with a full realization of the definition of national income assumed, either explicitly or implicitly, by the measurement. Thus, the estimates submitted in the present study define income in such a way as to cover primarily only efforts whose results appear on the market place of our economy. A student of social affairs who is interested in the total productivity of the nation, including those efforts which, like housewives' services, do not appear on the market, can therefore use our measures only with some qualifications. Secondly, the present study's measures of national income, like all such studies, estimates the value of commodities and direct services at their market price. But market valuation of commodities and especially of direct services depends upon the personal distribution of income within the nation. Thus in a nation with a rich upper class, the personal services to the rich are likely to be valued at a much higher level than the very same services in another nation, characterized by a more equitable personal distribution of income. A student of social affairs who conceives of a nation's end-product as undistorted by the existing distribution of income, yould again have to qualify and change our estimates, possibly in a marked fashion. Thirdly, the present study's estimate of national income produced is based in part, like most existing estimates, upon the prevalent legal and accounting distinction between gross and net income of business enterprises. To a student of social affairs whose concept of net productivity does not agree with the prevailing practices of separating net from gross income, especially by corporations, our estimates will obviously present a somewhat distorted picture of the nation's net product.

All these qualifications upon estimates of national income as an index of productivity are just as important when income measurements are interpreted from the point of view of economic welfare. But in the latter case additional difficulties will be suggested to anyone who wants to penetrate below the surface of total figures and market values. Economic welfare cannot be adequately measured unless the personal distribution of income is known. And no income

> measurement undertakes to estimate the reverse side of income, that is, the intensity and unpleasantness of effort going into the earning of income. The welfare of a nation can, therefore, scarcely be inferred from a measurement of national income as defined above.
>
> The abuses of national income estimates arise largely from a failure to take into account the precise definition of income and the methods of its evaluation which the estimator assumes in arriving at his final figures. Notions of productivity or welfare as understood by the user of the estimates are often read by him into the income measurement, regardless of the assumptions made by the income estimator in arriving at the figures. As a result we find all too commonly such inferences that a decline of 30 percent in the national income (in terms of "constant" dollars) means a 30 percent decline in the total productivity of the nation, and a corresponding decline in its welfare. Or that a nation whose total income is twice the size of the national income of another country is twice "as well off", can sustain payments abroad twice as large or can carry a debt burden double in size. Such statements can obviously be true only when gualified by a host of "ifs."
>
> A similar failure to take into account the investigator's basic assumptions underlies another widely prevalent abuse of national income measures, involved in estimating the draft or "burden" which this or that particular type of expenses (e.g., government expenses, payments on bonded debt, etc.) constitutes ot the country's total end-product. Every payment included in the national income is ipso facto a draft or a "burden" upon national income. For example, net receipts by physicians from medical practice, are both an addition to national income and a draft upon individual incomes from which such receipts originate. Since we estimate the value of personal services or commodities at their market value it follows that any payment for productive services contributes just as much to the national income total as it takes away from it. No items included in national income can, therefore, be conceived as "pure" draft.
>
> The full meaning of a statement that such payments as interest on bonds or taxes for government services are a " burden" or draft upon national income is that actually no services are being rendered in return for these payments. That an increasing weight in the national income of payments on fixed debt or of salaries of government officials is not hailed as an increased contribution to national income lies in the implicit assumption, not always true, that the services contributed by creditors or government officials have not increased proportionately, and that, therefore, a heavier burden was added upon other income recipients without an increased benefit.
>
> Such assumptions are accepted all too easily because they are based upon a natural but erroneous identification of national income with business or personal income. From the standpoint of a business firm or person, the income of employees, private or public, is likely to appear as a draft. But from the vantage point of national economy as a whole, which is used by a national income investigator, no payment that is included in national income can be considered as a pure draft upon the country's end-product. This can be true only of payments not included, such as charity, earnings from illegal pursuits, and the like. All that the national income estimator can say is that this or the other part of the national total has increased or declined more than the others. That this rise or decline implies a larger or smaller burden upon the national economy can be established only on the basis of such additional assumptions as have been formulated above, assumptions which arc not a proper part of the national income estimate and which are far from being self-evident."

In a nutshell, GDP is an imperfect measure of production as it overlooks significant parts of economic activity. For example, it does not account for black market activity, private production, and production that occurs outside formal markets. While GDP is often used to gauge a country's welfare or the well-being and happiness of its citizens, it neglects factors considered essential to these concepts, which are inherently difficult to define.

Exercise 5.3. GDP as an imperfect measure
Watch the video Robert F. Kennedy challenges Gross Domestic Product or read the speech of Robert Kennedy below and discuss what factors influencing the standard of living are not included in GDP and how that may impact GDP:

> "Gross National Product counts air pollution and cigarette advertising, and ambulances

to clear our highways of carnage. It counts special locks for our doors and the jails for the people who break them. It counts the destruction of the redwood and the loss of our natural wonder in chaotic sprawl. It counts napalm and counts nuclear warheads and armored cars for the police to fight the riots in our cities. It counts Whitman's rifle and Speck's knife, and the television programs which glorify violence in order to sell toys to our children. Yet the gross national product does not allow for the health of our children, the quality of their education or the joy of their play. It does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of our public officials. [...] it measures everything in short, except that which makes life worthwhile."
– Senator Robert F. Kennedy (1925-1968) (see Kennedy, 1968)

Solution: Factors omitted from GDP

Some aspects that influence the standard of living are not part of GDP. These include:

- **Non-market transactions:** Household production, such as childcare services, is excluded from GDP. As more services, including childcare, are provided in the marketplace, the measured growth rate might overstate the development of overall economic activity.
- **Black-market activities:** Although the level of GDP may be underestimated if the underground economy is a stable proportion of total economic activity, the growth rate itself should remain accurate.
- **Leisure Time:** An increase in leisure time may lower the economic growth rate, but individuals may value their leisure and feel better off as a result.
- **Environmental Quality:** Pollution does not directly diminish the economic growth rate, even though it may lower living standards.
- **Inequality:** GDP fails to account for income inequality within society.
- **Sustainability:** GDP does not reflect the sustainability of economic growth.
- **Health and environment:** GDP overlooks the health of individuals and the environment in general.
- **Depreciation replacement:** GDP does not consider how much capital (tangible goods) has depreciated. For example, while GDP measures the construction of new bridges, it does not account for bridges that have been decommissioned. It is not a balance sheet of prosperity but a measure of the inflow of new production.

5.4 Nominal and real GDP

Please watch the video of Figure 5.8.

Figure 5.8: Nominal vs. Real GDP

https://youtu.be/rGqhTQyY6g4

Source: Youtube

Nominal GDP reflects the value of final goods and services produced in a specific year, valued at the prices prevalent during that year. The overall market value of production and thus GDP can rise either through increased output of goods and services or through higher prices. In contrast, the **real GDP** enables the comparison of production quantities across different time periods, as it represents the value of final goods and services produced in a year, valued at the prices of a reference base year. This relationship is expressed as:

$$GDP^{\text{real}} = \frac{GDP^{\text{nominal}}}{P}$$

While nominal GDP is the commonly reported figure and does not account for price adjustments, real GDP provides somehow a more accurate reflection of the actual quantity of goods and services produced. The real GDP is an inflation-adjusted measure that captures the value of all goods and services produced by an economy in a given year, expressed in base-year prices. It is often referred to as constant-price GDP, inflation-corrected GDP, or constant dollar GDP. A clear definition can be found on Wikipedia (2020):

> “Real gross domestic product (real gdp for short) is a macroeconomic measure of the value of economic output adjusted for price changes (i.e., inflation or deflation). This adjustment transforms the money-value measure, nominal GDP, into an index for quantity of total output.”

To clarify the concept of the real GDP, consider the two following examples where we suppose the economy produces only one product.

Example A: Prices change

Production and prices are as shown in Table 5.1:

Table 5.1: No quantity changes

Year	Number	Price in Euro
2010	500	1
2011	500	1.1
2012	500	1.2

Nominal GDP:

$$GDP_{2010}^{nominal} = 500 \cdot 1€ = 500€ \quad (5.1)$$
$$GDP_{2011}^{nominal} = 500 \cdot 1.1€ = 550€ \quad (5.2)$$
$$GDP_{2012}^{nominal} = 500 \cdot 1.2€ = 600€ \quad (5.3)$$

Real GDP with a base year 2010:

$$GDP_{2010}^{real,base=2010} = 500 \cdot 1€ = 500€ \quad (5.4)$$
$$GDP_{2011}^{real,base=2010} = 500 \cdot 1€ = 500€ \quad (5.5)$$
$$GDP_{2012}^{real,base=2010} = 500 \cdot 1€ = 500€ \quad (5.6)$$

Example B: Prices and quantity change

The production and prices are as shown in Table 5.2:

Table 5.2: Price and quantity changes

Year	Number	Price in Euro
2010	500	1
2011	600	1.1
2012	700	1.2

Nominal GDP:

$$GDP_{2010} = 500 \cdot 1€ = 500€ \tag{5.7}$$
$$GDP_{2011} = 600 \cdot 1.1€ = 660€ \tag{5.8}$$
$$GDP_{2012} = 700 \cdot 1.2€ = 840€ \tag{5.9}$$

Real GDP with a base year of 2010:

$$GDP_{2010}^{base=2010} = 500 \cdot 1€ = 500€ \tag{5.10}$$
$$GDP_{2011}^{base=2010} = 600 \cdot 1€ = 600€ \tag{5.11}$$
$$GDP_{2012}^{base=2010} = 700 \cdot 1€ = 700€ \tag{5.12}$$

The examples above simplify reality by assuming that only one item is being produced in the economy, while, in fact, many goods and services are produced. Despite this limitation, the examples illustrate two important points. First, it is crucial to identify a representative basket of goods produced in an economy. Second, it is essential to measure the prices of this basket accurately. Both of these aspects will be discussed in Chapter 6. Afterward, we will return to evaluating GDP as a measure of welfare in Chapter 7.

Exercise 5.4. Various GDP

a) To estimate GDP, you add the value of all goods and services produced, both final and intermediate goods. Is this procedure correct? Why?
b) What is the relationship between aggregate income and aggregate production? Why does this relationship exist?
c) Does my purchase of a domestically produced Ford automobile that was manufactured in 2020 add to the current U.S. GDP? Why? How about my purchase of a domestically produced, newly produced Ford? Why?
d) Does my purchase of 100 shares of stock in Meta add to the nation's GDP? Why?
e) If a homeowner cuts their lawn, is the value of this work included in real GDP? Suppose the homeowner hires a neighborhood kid to cut the lawn. Is this activity included in real GDP? Comment on your answers.
f) In 1900, the average work week was 65 hours; today it is approximately 35 hours. How did this change affect real GDP within the United States? How did it affect the standard of living within the United States? Comment on your answers.
g) In the United States, many children receive daycare from commercial providers. In Africa, this is uncommon; children are almost all cared for by relatives. How would this difference affect comparisons of GDP per person?

Solution

a) Adding the value of all goods and services produced is incorrect because it leads to significant double counting. Intermediate goods and services will be counted multiple times; for example, a CPU produced by Intel and then used in a Dell computer could be counted as both a CPU from Intel and as part of the computer from Dell.

b) Aggregate income equals aggregate production. The circular flow shows this result: the flow of production out of business firms equals the flow of expenditure into business firms, which equals the flow of costs out of business firms, which is the same as the flow of aggregate income to households.

c) The purchase of the used Ford does not add to current U.S. GDP as it was not produced in the current year; however, a new Ford automobile is counted in current U.S. GDP because it was produced during the current year.

d) Purchasing shares of stock does not add to the nation's GDP, as GDP measures production. Shares of stock are not the production of a good or service and, therefore, are not included in GDP.

e) The homeowner's work around their home is not included in GDP because home production is excluded. Hiring a neighborhood kid to cut the lawn is included in GDP because it is a service that has been sold in a market. This illustrates a flaw in GDP computation; the same lawn is mowed regardless of payment, yet GDP is unaffected in one case and increases in the other.

f) The decrease in the average work week will likely decrease real GDP, as less time is spent producing goods and services. This could imply a lower standard of living. However, the increase in leisure time can lead to a higher standard of living for many individuals who value their leisure more than the goods and services they could produce. Thus, relying solely on changes in real GDP to measure standard of living is inadequate.

g) This difference suggests that U.S. GDP per person is biased higher than GDP per person in African countries, as the same service—childcare—produced in both regions is included in GDP in the U.S. due to market transactions, while in Africa it is omitted due to being performed as household production.

Exercise 5.5. What counts as GDP?
By how much does GDP rise in each of the following scenarios? Explain.

1. You spend 8000 € on college tuition this semester.
2. You buy a used computer from a friend for 500€.
3. The government spends 300€ million to build a bridge.
4. Foreign graduate students work as teaching assistants at the local university and earn 2000€ each.

Solution

1. GDP rises by the $4,000 amount of your tuition payment. This is a purchase of a service (education) produced this semester.
2. The purchase of used goods does not involve new production. This is simply a transfer of an existing good, so GDP is unchanged. If you bought the used car from a dealer, the service of selling the car would represent new production, so something like $200 of the $2,500 might be included in GDP.
3. The new dam represents new production, and the government spending of $100 million is counted as GDP. If the spending were spread over several years, the flow of new production (and GDP) would also occur over time.
4. Foreign graduate students working in the United States contribute to production that occurs within the country, and this is included in GDP. So GDP increases by $5,000 for each student.

Chapter 6

Inflation

Recommended readings: CORE Econ (2025b, ch. 4)

Learning objectives:

Students will be able to:

- Discuss the concept of an aggregate measure for inflation.
- Assess the consequences of inflation for an economy.

In this section, we will explore the concept of inflation. We will begin by defining inflation and explaining how it can be measured. Then, we'll address the challenges associated with measuring inflation and discuss why it is a potential threat to economic prosperity.

6.1 Measuring inflation

Prices can change over time. They can rise, fall or remain stable. Inflation refers specifically to a situation in which the price level is rising, while deflation describes a fall in prices. The inflation rate quantifies this change by indicating the percentage difference in the prices from one period to the next. But what is meant when we speak about the "prices" or the "price level"?

To accurately calculate the price level and the real GDP of a country that includes multiple goods, respectively, it is essential to determine the **Consumer Price Index (CPI)**. The CPI measures the average prices paid by consumers for a fixed basket of consumer goods and services, providing insight into the overall price level in the economy.

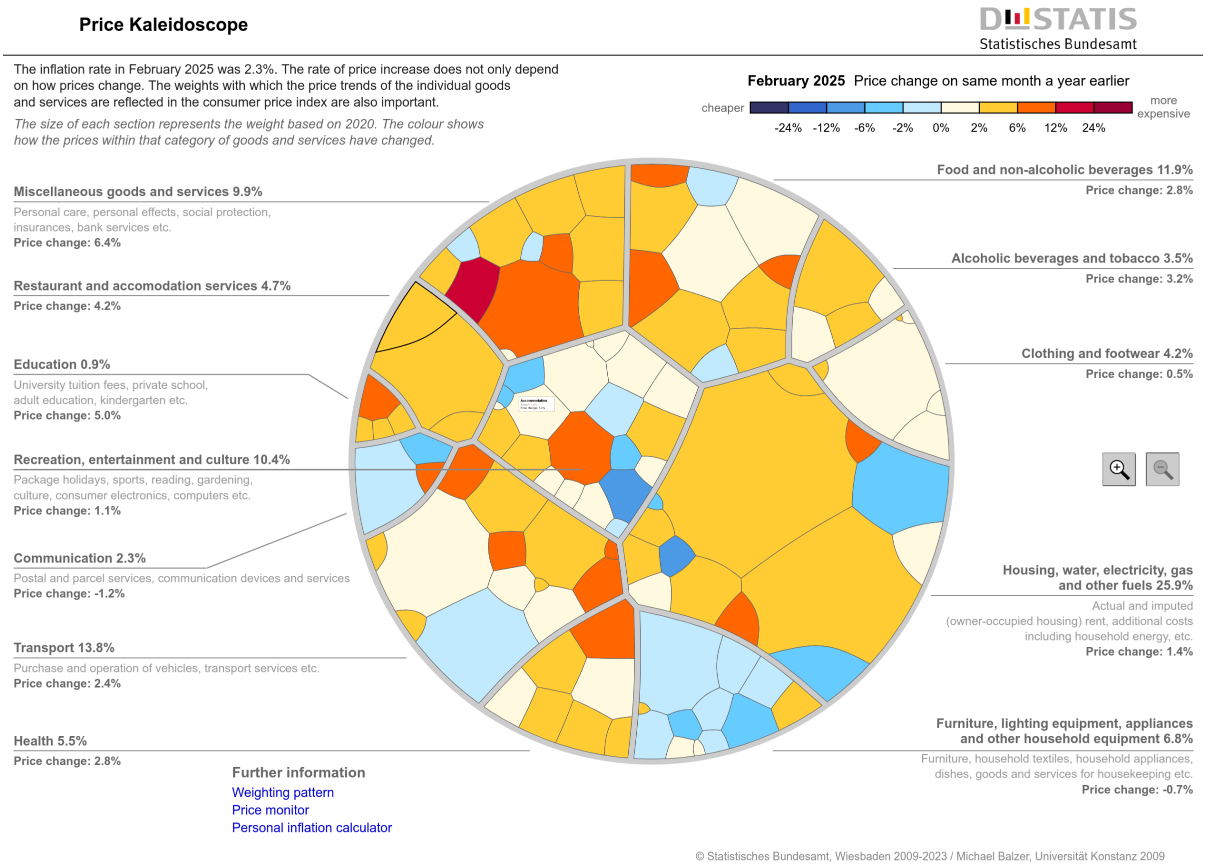
Typically, the CPI is normalized to equal 100 in a reference base period. For example, if the reference base period is set between 1982 and 1984, with an average CPI of 100, then an observed CPI of 269.2 in May 2021 indicates a substantial price increase of 169.2 percent since that period.

6.1.1 The Consumer Price Index (CPI) in 5 steps

1. **Fix basket:** Identify the prices that are most relevant to the typical consumer. National statistics agencies establish a market basket of goods and services commonly purchased by consumers and conduct regular surveys to determine the weights for these prices. For a visual representation of the various goods commonly purchased by typical consumers in Germany, you can refer to the informative Price Kaleidoscope as shown in Figure 6.1. For a discussion on the challenges to define a basket, see Section 6.1.2.

2. **Find prices:** Gather data on the prices of each good and service in the basket for each designated time period.

Figure 6.1: Price kaleidoskop



Source: Destatis (2025)

3. **Compute basket's cost:** Use the price data to calculate the total cost of the basket of goods and services at various times.

4. **Choose a base year and compute:**

   - Designate one year as the base year, serving as the benchmark for comparison.
   - Compute the index by dividing the basket's price in one year by the basket's price in the base year, then multiplying by 100.

$$CPI = \frac{\text{cost of basket in current year}}{\text{cost of basket in base year}} \cdot 100$$

5. **Compute the inflation rate:** The inflation rate is the percentage change in the price index from the previous period. It is determined by the percentage change of the CPI from one year to the next. The formula is given by

$$h_t = \left(\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}} \cdot 100 \right),$$

   where h_t denotes the inflation rate at time t (this year), while CPI_t and CPI_{t-1} represent the CPI for time t and $t-1$ (previous year), respectively.
   For example, in May 2021, the CPI was 261.0, and in May 2020, it was 257.9. Using the formula, we find that the inflation rate between 2021 and 2020 was 1.2%.

Example: CPI calculation

Step 1: Consider a basket containing 4 salads and 2 hamburgers.
Step 2: Table 6.1 shows the prices of salads and hamburgers over several years:

Table 6.1: Prices and quantities over time

Year	Price of salads	Price of hamburgers
2016	1	2
2017	2	3
2018	3	4

Step 3: The total basket cost for each year are shown in Table 6.2:

Table 6.2: Basket costs over time

Year	Basket cost
2016	8
2017	14
2018	20

Steps 4 and 5: Using 2016 as the base year, we can calculate the CPI and inflation rate as shown in Table 6.3:

Table 6.3: Inflation over time

Year	CPI	Inflation Rate
2016	100	na
2017	175	75%
2018	250	43%

6.1.2 Challenges of the CPI

While the CPI accurately reflects the prices of selected goods that comprise the typical basket, it is not a flawless measure of the cost of living. Several key issues can lead the CPI to overstate the true cost of living when the basket is held fixed over time including the following:

Substitution bias: Substitution bias occurs when the basket used to calculate the CPI does not adjust to reflect consumer responses to changes in relative prices. Consumers tend to substitute goods that have become relatively less expensive, which can lead the index to overstate the increase in the cost of living by not accounting for these substitution patterns.

Introduction of new goods: The introduction of new goods further complicates the CPI measurement, as the basket does not incorporate the changes in purchasing power that result from new products entering the market. With the addition of new goods, consumers experience a greater variety of options, which makes each euro more valuable. Consequently, consumers require less money to maintain a given standard of living as new products are introduced.

Unmeasured quality changes: Unmeasured quality changes also pose a challenge for accurately capturing the cost of living. If the quality of a good improves from one year to the next, the real value of a euro increases, even if the price of the good remains the same. Conversely, if the quality of a good declines, the value of a euro falls, regardless of whether its price remains constant. Although the Office for National Statistics (ONS) attempts to adjust prices for constant quality, accurately measuring these quality changes can be quite difficult.

Exercise 6.1. Relative weights
Examine the weighting schemes employed by the Federal Statistics Office of Germany (Destatis) and the U.S. Bureau of Labor Statistics to see how they prioritize housing and energy in their consumer price indices. For reference, here are the links to the relevant data:

- U.S. Bureau of Labor Statistics (2025): Relative Importance and Weight Information for the Consumer Price Indexes
- Destatis (2019): Weighting Scheme (2015)

6.2 High inflation and deflation

Unexpected fluctuations in inflation or deflation pose considerable challenges for society as they lead to a redistribution of income and wealth. For example, unexpected inflation usually benefits employees and borrowers, as their income can increase, reducing the real burden of their debt. Conversely, unexpected deflation usually favours employers and lenders as the value of money increases, making it more difficult for borrowers to meet their obligations.

These unexpected changes can force individuals and businesses to shift their focus from productive activities to predicting and protecting against economic volatility. In particular, unexpected deflation can cause indebted businesses and households to cut back on spending, which can ultimately lead to recession and higher unemployment rates.

In extreme cases, hyperinflation occurs, that is usually the how inflation rates of more than 50 per cent per month are called. This can seriously destabilise an economy. Thus, central banks and politicians seek to maintain low and stable inflation due to its various negative implications for the economy. Here is an summary of the most important implications:

Menu costs: High inflation forces businesses to frequently change their prices, resulting in lost time and increased costs.

Purchasing power loss: Inflation impacts individuals unevenly, with low-wage earners and those on fixed nominal incomes experiencing a loss of purchasing power.

Redistribution of wealth and income: As discussed in the section on real and nominal interest rates, rising inflation leads to decreasing real interest rates. Consequently, borrowers benefit from lower real interest payments, while lenders receive reduced real returns. This wealth redistribution occurs because debt is usually expressed in nominal terms, and inflation diminishes the actual value of fixed monetary sums.

Distorted price signals: Inflation disrupts the clarity of prices as indicators for resource allocation. Typically, prices provide critical information regarding supply and demand, aiding informed decision-making. Inflation blurs these signals, complicating the ability to differentiate between actual changes in value and overall price increases, thereby undermining the price mechanism that guides markets.

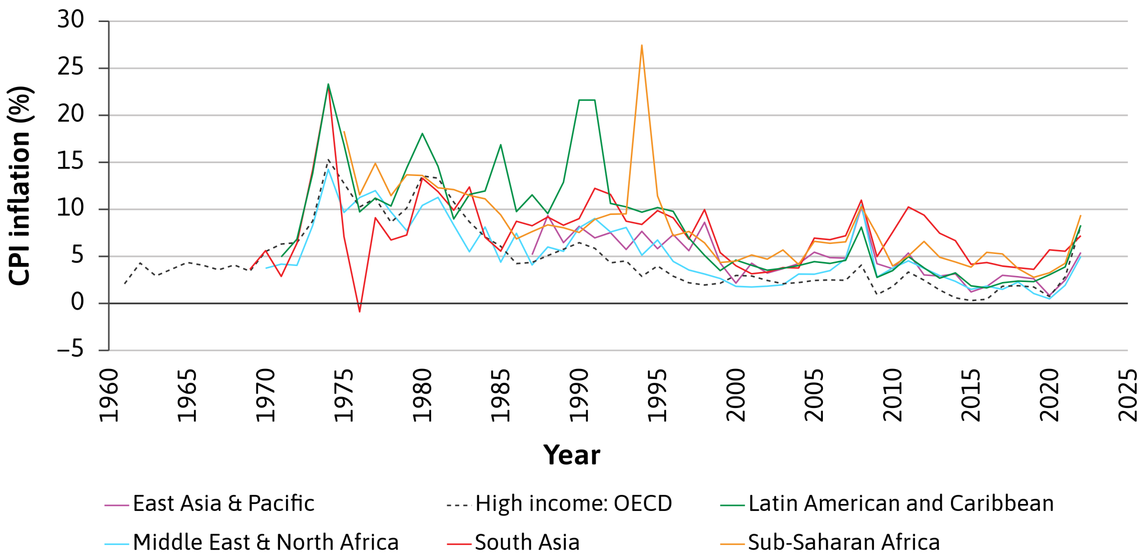
Uncertainties: High and volatile inflation creates uncertainty surrounding future prices. This uncertainty can prevent businesses and consumers from accurately assessing the real value of money, hampering long-term planning, saving, and investment, which can ultimately lead to economic instability.

Exercise 6.2. Global inflation

a) Investigate the inflation rates of selected countries online to grasp international differences and global trends. Tip: OECD Inflation Data

b) Discuss Figure 6.3.

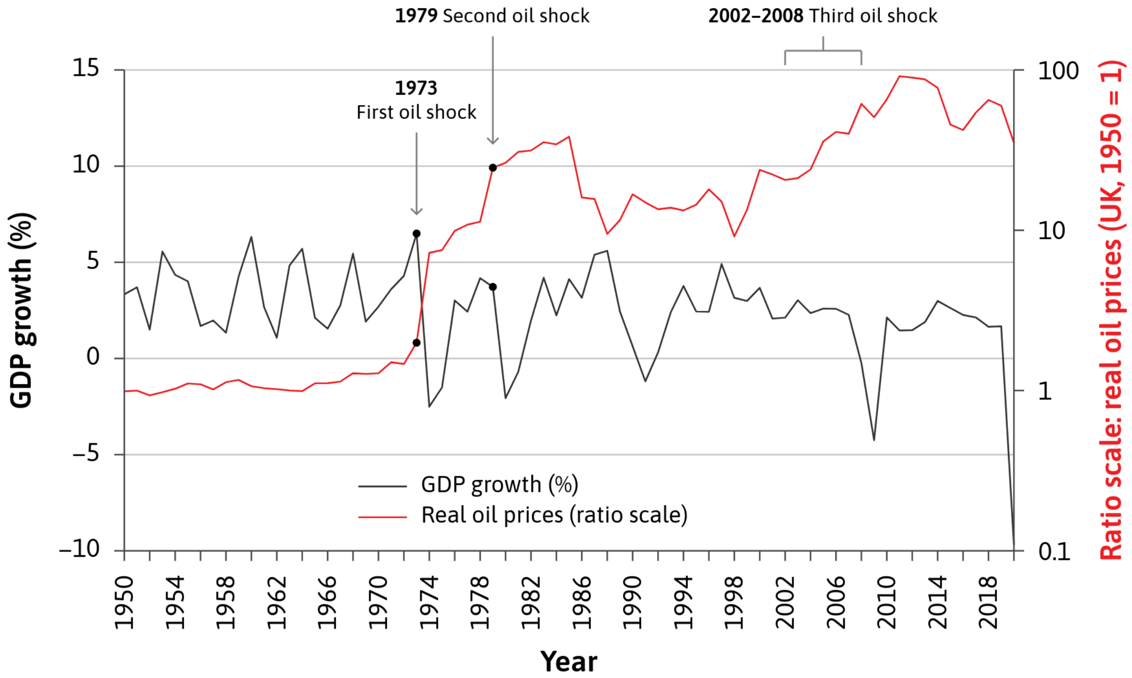
Figure 6.2: Inflation levels and volatility in high- and low-income economies



Source: CORE Econ (2025b, ch. 4.1)

c) Discuss the two time series shown in Figure 6.3.

Figure 6.3: UK GDP growth and real oil prices (1950–2020)



Source: CORE Econ (2025a, ch. 15.7)

Exercise 6.3. Salary over time
In 1947, teachers earned €1,000. By 2015, their salary had increased to €74,000, which means that nominally, they earned 74 times as much in 2015 as they did in 1947. However, to determine whether teachers can buy more or less today compared to 1947, we need to consider the impact of rising prices over time. Given the CPI values of $CPI_{t=1947} = 28.9$ and $CPI_{t=2015} = 1018.6$ calculate the real difference in purchasing power from 1947 to 2015.

Solution

To convert teachers' salaries from 1947 to 2015 values, we can use the following formula:

$$\text{salary}_{2015}^{\text{real}} = \text{salary}_{1947} \cdot \frac{CPI_{2015}}{CPI_{1947}} = €1,000 \cdot \frac{1018.6}{28.9} = €35,246$$

This calculation shows that €1,000 in 1947 had the same purchasing power as €35,246 in 2015. Since teachers earned €74,000 in 2015, they can indeed buy more with their salary than they could in 1947.

Chapter 7

Welfare

Required readings:

D. Shapiro et al. (2022, ch. 19)

Learning objectives:

Students will be able to:

- Utilize GDP to assess the evolution of living standards over time.
- Utilize GDP to compare living standards across countries.
- Discuss how other measures can be utilized to complement the GDP as a measure for wellfare.

7.1 Real and nominal numbers in economics

In economics, understanding the distinction between real and nominal values is crucial for analyzing wage levels and currency measurements. Nominal wages refer to the monetary amount received by workers, unadjusted for inflation. For example, if a worker is paid €50,000 per year, that figure represents their nominal wage. However, nominal wages do not account for changes in purchasing power over time due to inflation.

Real wages, on the other hand, provide a more accurate reflection of a worker's purchasing power by adjusting nominal wages for changes in prices. To compute real wages, economists typically use the CPI. For example, in case of inflation, the real wage controls for the worker can actually afford fewer goods and services than before.

Similarly, this distinction extends to other economic metrics, such as gross domestic product (GDP). Real GDP is adjusted for inflation, providing a clearer picture of an economy's growth by reflecting the true value of goods and services produced over time. In contrast, nominal GDP represents the raw monetary value without an inflation adjustment.

Exercise 7.1. Nominal vs. real GDP and CPI In this exercise, you calculate nominal and real GDP for a simple economy. You then calculate real GDP growth using two base years and discuss the differences. Suppose an economy consists of only two types of products: computers and automobiles. Sales and price data for these two products for two different years are shown Table 7.1:

Table 7.1: Prices and quantities of cars and PC over time

Year	No. of PCs	Price per PC (in €)	No. of cars sold	Price per car (in €)
1990	500,000	6,000	1,000,000	12,000
2000	5,000,000	2,000	1,500,000	20,000

a) Nominal GDP in any year is calculated by multiplying the quantity of each final product sold by its price and summing over all final goods and services. Assuming that all computers and automobiles are final goods, calculate nominal GDP in 1990 and 2000.

b) Real GDP in any year is calculated by multiplying that year's quantities of goods and services by their prices in some base year. Calculate real GDP in 1990 and 2000, using 1990 as the base year.

c) Calculate the percentage change in real GDP between 1990 and 2000 using 1990 as the base year.

d) Calculate real GDP in 1990 and 2000, using 2000 as the base year.

e) Calculate the percentage change in real GDP between 1990 and 2000 using 2000 as the base year.

f) Explain why your answers to parts 3 and 5 are different. Do you feel there is one that more accurately measures the true growth in GDP? Which one, and why?

g) Calculate the Consumer Price Index (CPI) and inflation for the economy using 1990 as the base year.

h) Calculate the Consumer Price Index (CPI) and inflation for the economy using 2000 as the base year.

i) Compare the CPI results from above. Can you explain the results?

Solution

a) 1990: €15,000,000,000
2000: €40,000,000,000

b) 1990: €15,000,000,000
2000: €48,000,000,000

c) 220% increase

d) 1990: €21,000,000,000
2000: €40,000,000,000

e) 90% increase

f) Answers differ because base-year prices are different. Neither measure is clearly superior, but real GDP growth is significantly different. There are ten times as many computers in 2000 compared to 1990 and 50% more cars. Thus, something between 50% and 1000% is appropriate, but how to weight each increase is where prices come in.

g)

$$500,000 \cdot 6,000 + 1000,000 \cdot 12,000 = 15,000,000,000$$
$$500,000 \cdot 2,000 + 1000,000 \cdot 20,000 = 21,000,000,000$$
$$CPI_{base=1990} = 1.4$$

Prices increased from 1990 to 2000 by 40% using 1990 as the base year.

h)

$$5000,000 \cdot 6,000 + 1500,000 \cdot 12,000 = 48,000,000,000$$
$$5000,000 \cdot 2,000 + 1500,000 \cdot 20,000 = 40,000,000,000$$
$$CPI_{base=2000} \approx 0.8\bar{3}$$

Prices decreased from 1990 to 2000 by approximately $16\frac{2}{3}\%$ using 2000 as the base year.

i) The contradictory CPI results arise from the use of distinct baskets of goods. With 2000 as the base year, considerable weight is given to PCs, which have declined in price. Conversely, when using 1990 as the base year, greater emphasis is placed on cars, which have risen in price.

7.2 Welfare comparisons

To compare living standards across countries using real GDP, we face several challenges as discussed in greater detail in D. Shapiro et al. (2022, ch. 19). Let me emphasize two things:

First, the real GDP of one country must be converted into the **same currency** unit as the real GDP of another country. This process is straightforward once we have the exchange rates; however, these rates often fluctuate significantly, which can lead to misleading interpretations of GDP when assessed during periods of exchange rate peaks. Additionally, if the prices of goods and services vary considerably between countries, differences in GDP may not solely reflect disparities in living standards.

Second, it is essential that the goods and services in both countries are valued at the **same prices**. Relative prices can differ across countries, so goods and services should be weighted appropriately. For instance, if prices are generally lower in China than in the United States, this would undervalue China's production when using its domestic prices. Therefore, if we value all goods and services produced in China using U.S. prices, we can achieve a more accurate comparison of real GDP between the two countries. This comparison, made using consistent pricing, is referred to as purchasing power parity (PPP) prices. The PPP principle is based on the idea that, in the absence of transportation costs and other barriers, identical goods should have the same price when expressed in a common currency.

To calculate PPP-adjusted GDP for a more accurate cross-country comparison, the following steps are typically taken:

1. Select a representative basket of goods and services for each country.
2. Determine the respective prices that apply to **all** countries.
3. Calculate the exchange rate based on the selected baskets and prices. This rate is known as the *PPP exchange rate* and reflects the relative price levels between the two countries.
4. Convert the real GDP of each country into a common currency using the PPP exchange rate.

The resulting adjusted GDP values allow for a more accurate comparison of living standards and play a significant role in international economic analysis and policy formulation.

It is important to note that while the concept of PPP is useful, it is a simplification that does not fully capture the complexities of international trade, market imperfections, and non-tradable goods.

Example: Germany and Indonesia

Let us compare the GDP in PPP for two countries, Germany and Indonesia, using a simplified scenario that assumes a basket of only two goods: bread and milk. Prices are given in local currencies, i.e., Euros for Germany and Rupiah for Indonesia. For this example, let's say one bread in Germany costs €2 and a liter of milk costs €1.5. In Indonesia, one bread costs 12,000 Indonesian Rupiah (IDR) and a liter of milk costs 10,000 IDR.

Step 1: Basket of goods and services

- Bread price in Germany: €2
- Milk price in Germany: €1.5
- Bread price in Indonesia: 12,000 IDR
- Milk price in Indonesia: 10,000 IDR

Step 2: Price comparison

- Bread price ratio: €2 / 12,000 IDR = 0.00016667
- Milk price ratio: €1.5 / 10,000 IDR = 0.00015

Step 3: Exchange rate calculation

- Average price ratio: (0.00016667 + 0.00015) / 2 = 0.000158335
- PPP exchange rate: 1 Euro = 0.000158335 IDR

Now, using the PPP exchange rate, we can convert GDP figures between the two countries to facilitate a more accurate comparison of their economies.
Please note that this is a simplified example for illustrative purposes. Actual PPP calculations involve more comprehensive baskets of goods, data collection, adjustments for non-traded goods, and more sophisticated methods. Real-world PPP calculations are conducted by organizations such as the International Comparison Program (ICP) to provide accurate comparisons of living standards across countries.

7.3 Alternative measures of welfare

Despite its weaknesses the GDP is one of the best measures we have to indicate living standards. Please watch the video of Figure 7.1. However, we should try to also look out for other measures that can complement the GDP.

Figure 7.1: Real GDP per capita and the standard of living

https://youtu.be/Z0qHA93oOSc

Source: Youtube

Disposable income:
Disposable income is defined as total income minus taxes plus government transfers. It represents the

income that households and non-corporate businesses have available after fulfilling their obligations to the government. While GDP includes the value of goods and services produced by the government, such as education, national defense, and law enforcement—factors that contribute to well-being—these are not reflected in disposable income. Thus, GDP per capita can serve as a better measure of living standards than disposable income itself.

Gross National Product (GNP):
The GNP refers to the total income earned by a nation's citizens, whether generated domestically or abroad. This measure captures the economic contributions of citizens, regardless of location.

Net National Product (NNP)
The NNP is calculated as the total income of a nation's residents (GNP) minus losses due to depreciation. Depreciation accounts for the decline in value of the economy's stock of equipment and structures, such as aging vehicles and obsolete computers.

World Happiness Report:
The World Happiness Report primarily utilizes data from the Gallup World Poll, which surveys individuals in over 150 countries (see: World Happiness Report). Each variable measured reflects a population-weighted average score on a scale from 0 to 10 that is tracked over time and compared against other countries. Current variables in the report include:

- Real GDP per capita
- Social support
- Healthy life expectancy
- Freedom to make life choices
- Generosity
- Perceptions of corruption

Human Development Index (HDI)
The HDI is a composite index that incorporates life expectancy, education (mean years of schooling completed and expected years of schooling), and per capita income indicators. Countries are ranked into four tiers of human development based on these metrics. A country attains a higher HDI when it achieves greater longevity, higher education levels, and a higher gross national income (GNI) per capita at purchasing power parity (PPP) (see: Human Development Index).

Exercise 7.2. OECD Better Life Index
Visit the OECD Better Life Index to create your own index by weighting the factors that are important to you. Then, explore what aspects of life matter most, on average, for people in your home country.

7.4 Questions

7.4.1 Single choice questions

Choose the one alternative that best completes the statement or answers the question.

1. Economics is best defined as the study of...

how to run a business most profitably

how to predict inflation, unemployment, and stock prices

how the government can stop the harm from unchecked self-interest

how society manages its scarce resources

2. Your opportunity cost of going to a movie is...

the price of the ticket

the price of the ticket plus the cost of any soda and popcorn you buy at the theater

zero, as long as you enjoy the movie and consider it a worthwhile use of time and money

the total cash expenditure needed to go to the movie plus the value of your time

3. A marginal change is one that...

is not important for public policy

incrementally alters an existing plan

makes an outcome inefficient

does not influence incentives

4. Adam Smith's *invisible hand* refers to...

the subtle and often hidden methods that businesses use to profit at consumer's expense

the ability of free markets to reach desirable outcomes, despite the self-interest of market participants

the ability of government to benefit consumers, even if the consumers are unaware of the regulations

the way in which producers or consumers in unregulated markets impose costs on innocent bystanders

5. The US Federal government enacted regulation in the 1960s requiring people to wear seatbelts. All of the following resulted from this regulation, EXCEPT:

overall deaths due to car accidents changed very little

fewer deaths occurred per accident

fewer pedestrians were killed in car accidents

the frequency of accidents increased

6. In a market economy, the decisions of what and how much to produce are made by:

voters in elections.

all producers and consumers.

the government only.

non-governmental agencies.

7. Even though markets do a great job in organizing economic activity, governments are needed to do all of the following EXCEPT:

establish and enforce property rights.

intervene when markets fail due to externalities.

intervene when markets fail due to market power.

decide what and how much should be produced.

8. Economics is best defined as the study of how people, businesses, governments, and societies:

make choices to cope with scarcity.
attain wealth.
choose abundance over scarcity.
use their infinite resources.

9. Economists point out that scarcity confronts:

the rich but not the poor.
the poor but not the rich.
both the poor and the rich.
neither the poor nor the rich.

10. Scarcity requires that people must:

trade.
compete.
cooperate.
make choices.

11. As an economic concept, scarcity applies to:

neither time nor money.
both money and time.
time but not money.
money but not time.

12. Which is the most accurate definition of the study of economics? Economics is the study of:

the distribution of surplus goods to those in need.
affluence in a morally bankrupt world.
ways to reduce wants to eliminate the problem of scarcity.
the choices we make because of scarcity.

13. Which of the following is a macroeconomic topic?

why plumbers earn more than janitors.
the reasons for the rise in average prices.
whether the army should buy more tanks or more rockets.
the reasons for a rise in the price of orange juice.

14. Which of the following is a microeconomic topic?

the reasons for a decline in average prices.
the reasons why Kathy buys less orange juice.
the cause of why total employment may decrease.
the effect of the government budget deficit on inflation.

15. Which of the following topics would be studied in a microeconomics course?

how a tax rate increase will impact total production.

comparing inflation rates across countries.

how a trade agreement between the United States and Mexico affects both nations' unemployment rates.

how rent ceilings impact the supply of apartments.

16. When an economy produces more houses and fewer typewriters, it is answering the what question.

where.

for whom.

how.

what.

17. When firms in an economy start producing more computers and fewer televisions, they are answering the what question.

where.

when.

what.

for whom.

18. The question "Should cars or motorbikes be produced?" is an example of the:

how question.

who question.

where question.

what question.

19. The opportunity cost of any action is:

the time required but not the monetary cost.

all the possible alternatives forgone.

the highest-valued alternative forgone.

the monetary cost but not the time required.

20. The statement that _______ is a positive statement:

the price of gasoline is too high.

too many people in the United States have no health care insurance.

the price of sugar in the United States is higher than the price in Australia.

more students should study economics.

7.4.2 Multiple choice questions

Choose the alternative(s) that best completes the statement or answers the question. All or just one answer can be correct.

1. Which of the following activities are typically excluded from GDP calculations?
   a) Household services like childcare.
   b) Market-based services such as healthcare.
   c) Public infrastructure development.
   d) Industrial production of goods.

Solution

a

2. How does the presence of a black market impact GDP calculations?
   a) It leads to an overestimation of GDP levels.
   b) It might cause GDP levels to be lower than actual economic activity.
   c) It leads to an underestimation of GDP levels.
   d) It doesn't affect GDP calculations in any way.

Solution

b) and c)

3. How can increased leisure time affect the economic growth rate and well-being?
   a) It might lead to a lower economic growth rate but enhance well-being.
   b) It always results in higher economic growth and well-being.
   c) It has no impact on either economic growth or well-being.
   d) It leads to lower well-being without influencing economic growth.

Solution

a)

4. How does pollution influence economic growth and living standards?
   a) Pollution directly decreases economic growth.
   b) Pollution might not impact economic growth but can reduce living standards.
   c) Pollution has no effect on either economic growth or living standards.
   d) Pollution enhances both economic growth and living standards.

Solution

b)

5. How is Gross Domestic Product (GDP) typically measured?
    a) By calculating the total monetary value of all imports and exports.
    b) By summing up the value of all assets owned by a country's citizens.
    c) By computing the total market value of all goods and services produced within a country's borders during a specific period.
    d) By evaluating the total amount of money circulating within the country's financial system.

Solution

c)

6. What is the income approach to calculating GDP based on?
    a) The total number of hours worked by the population.
    b) The total value of goods and services produced by households.
    c) The total monetary value of all income earned by individuals in a country.
    d) The average wage rate divided by the number of employed individuals.

Solution

c)

7. How does nominal GDP differ from real GDP?
    a) Nominal GDP does not account for prices, while real GDP does.
    b) Real GDP is measured in current prices, while nominal GDP is adjusted for inflation.
    c) Nominal GDP includes government spending, while real GDP does not.
    d) Real GDP is the total value of goods and services produced, while nominal GDP is adjusted for population growth.

Solution

a

8. What aspect of societal well-being is not addressed by GDP?
    a) Human health and well-being.
    b) Political stability and governance.
    c) Global trade relationships.
    d) The depreciation of goods.

Solution

a, b, and d

9. What aspect of societal well-being is not addressed by GDP?
    a) Economic growth rate fluctuations.
    b) Income inequality within a society.
    c) Equal distribution of public resources.
    d) Long-term sustainability of economic growth.

Solution

b, c, and d

Chapter 8

Production and utility

Required readings:

D. Shapiro et al. (2022, ch. 2, appendix A and B)

Learning objectives:

In this section, I cover some basic concepts that are crucial for understanding the upcoming sections. In particular, students will be able to:

- Identify and explain the key features of production functions.
- Interpret the Production Possibility Frontier (PPF) curve to visualize production and growth in firms and countries.
- Analyze indifference curves to understand how they represent different bundles of goods that provide equal satisfaction to consumers.
- Understand how isoquants illustrate different levels of production achievable with varying combinations of input factors.
- Graphically sketch and apply budget constraints to inform consumer decision-making.

8.1 Production functions

A firm or a company is a productive unit. In particular, it is an organization that produces goods and services. In short, it can be called *output*. To do so, it uses inputs called *factors of production*, that is, labor, capital, land, skills, etc. The relationship between the inputs and the output is the production function. The goal of the firm is to achieve whatever goal its owner(s) decide to achieve through the firm. Usually, it is (and in Germany for example it has to be the case by law) to generate profits, that is, total revenue minus total cost for the level of production.

A production function (PF) is a mathematical representation of the process that transforms inputs into output.

- When factors of production are **perfect substitutes** the PF can be written like this:

$$q = f(K, L) = L + K$$

- When factors of production are **perfect complements** the PF can be written like this:

$$q = f(K, L) = \min(L, K)$$

- A special and often used function is the Cobb-Douglas PF:

$$q = f(K, L) = K^{\alpha} L^{1-\alpha} \quad \text{with} \quad 0 < \alpha < 1$$

The **returns to scale** describes the increase in output when a firm multiples all of its inputs by some factor. Let $\lambda > 1$, then, with two factors K and L, we can define that for

$$f(cK, cL) = c^{\lambda} f(K, L),$$

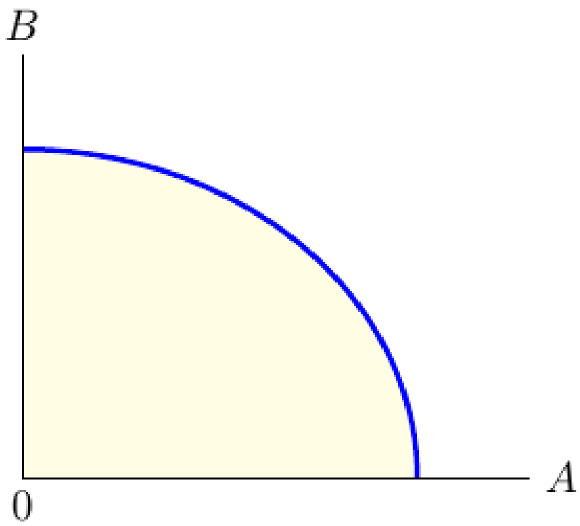
- $\lambda > 1$ the PF has increasing returns to scale,
- $\lambda = 1$ the PF has constant returns to scale,
- $\lambda < 1$ the PF has decreasing returns to scale.

The marginal product is the change in the total output when the input varies of one infinitesimal small unit. Graphically, the marginal product is the slope of the total product function at any point. The slope of the total product function, that is, the marginal product, is generally not constant. The marginal product to an input is assumed to decrease beyond some level of input. This is called the *law of diminishing marginal returns*. In particular, we can distinguish:

- positive marginal returns when $f' > 0$ and
- diminishing marginal returns when $f'' < 0$ and
- increasing marginal returns when $f'' > 0$.

8.2 Production possibility frontier curve

Figure 8.1: The production possibility frontier curve



The production possibilities frontier (PPF) curve shown in Figure 8.1 provides a graphical representation of all possible production options for two products when all available resources and factors of production are fully and efficiently utilized within a given time period. The PPF serves as a boundary between combinations of goods and services that can be produced and those that cannot.

The PPF is an invaluable tool for illustrating the effects of scarcity as it provides insights into production efficiency, opportunity costs and the trade-offs between different choices. In general, the PPF exhibits concavity, as not all factors of production can be used equally productively in all activities.

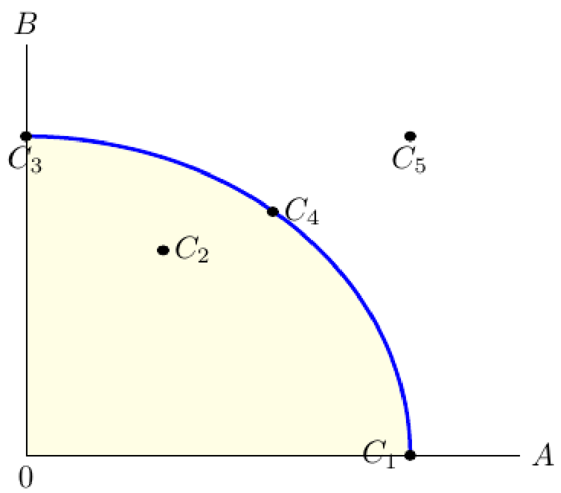
Economic growth refers to the continuous expansion of production possibilities. An economy experiences growth through technological advances, improvements in the quality of labor or an increase in the factors of production (labor, capital). When the resources of an economy increase, the production possibilities also expand, shifting the PPF outwards. It is worth noting that PPF can be used to explain production in an economy or company.

Production efficiency occurs when it is impossible to produce more of one good or service without producing less of another. If production takes place directly on the PPF, this means efficiency. If, on the other hand, production takes place within the PPF (yellow shaded area of Figure 8.1), it is possible to produce more goods without sacrificing existing goods, which indicates inefficiency. If production is on the PPF, there is a trade-off, as obtaining more of one good requires sacrificing a certain amount of another good. This trade-off is associated with costs called *opportunity costs*.

Exercise 8.1. Understanding production (Solution 8.1)

a) Figure 8.2 shows a PPF and five conceivable production points, C_i, where $i \in \{1, \ldots, 5\}$. Explain the figure using the following terms: _attainable point; available resources, unattainable, inefficient, efficient point.

Figure 8.2: Production and different consumption points



b) What would happen to the PPF if the technology available in a country and needed for the production process became better?

c) What would happen to the PPF if the resources available in a country and needed in the production process of both goods shrank?

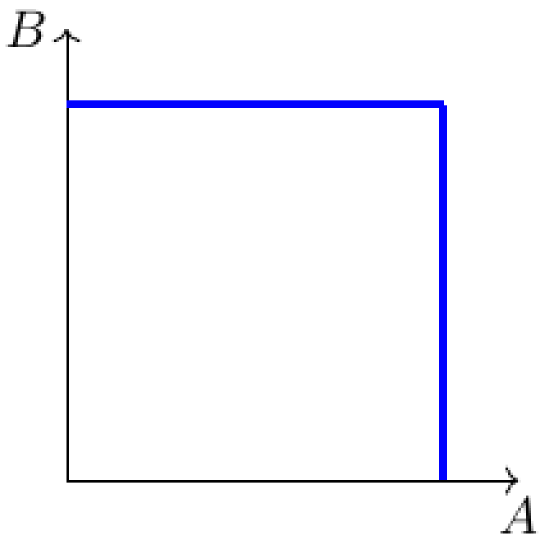
d) What would happen to the PPF if the resources (technology) available in a country that are needed in the production process...

   i) ...for both goods increased (improved)?
   ii) ...for good A shrank (got worse)?
   iii) ...for good B increased (improved)?

e) Does the shape of the PPF tell us anything about economies of scale in the production process?

f) Figure 8.3 shows an extreme PPF. How can such a PPF be explained?

Figure 8.3: Extreme production possibility frontier curve



Solution 8.1. Understanding production (Exercise 8.1)

a) Any point that lies either on the production possibilities curve or to the left of it is said to be an attainable point: it can be produced with currently available resources. Production points that lie in the yellow shaded area are said to be unattainable because they cannot be produced using currently available resources. These points represent an inefficient production, because existing resources would allow for production of more of at least one good without sacrificing the production of any other good. An efficient point is one that lies on the production possibilities curve. At any such point, more of one good can be produced only by producing less of the other.

b) The PPF would shift outwards.

c) The PPF would shift inwards.

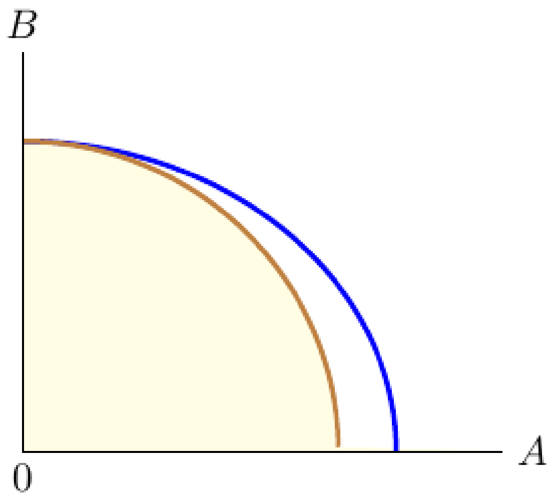
d) The PPF would shift…

   i) …outwards for both goods.
   ii) …inwards for good A, see Figure 8.4.
   iii) …outwards for good B.

e) With economies of scale, the PPF would curve inward, with the opportunity cost of one good falling as more of it is produced. A straight-line (linear) PPF reflects a situation where resources are not specialized and can be substituted for each other with no added cost. With constant returns to scale, there are two opportunities for a linear PPF: if there was only one factor of production to consider or if the factor intensity ratios in the two sectors were constant at all points on the production-possibilities curve.

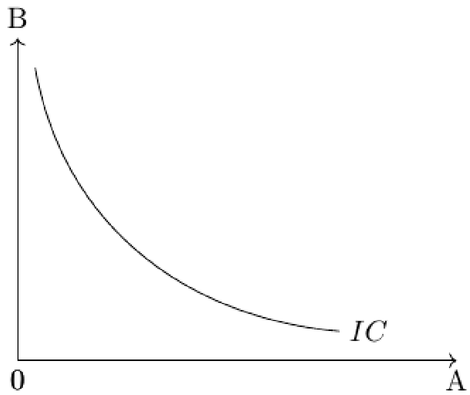
f) Here is one example: Suppose a country that is endowed with two factors of production and that one factor can only be used for producing good A and the other factor can only be used to produce good B.

Figure 8.4: Shrinking production possibilities in good A



8.3 Indifference curves and isoquants

Figure 8.5: Indifference curve



Combinations of two goods that yield the same level of utility for consumers are represented by indifference curves, see figure Figure 8.5. These curves illustrate the various bundles of goods where consumers are equally satisfied. That means all points on an indifference curve represent the same level of utility. The shape of the indifference curve is determined by the underlying utility function, which captures the preferences of consumers for consuming different combinations of the two goods.

The slope of an indifference curve indicates the rate at which the two goods can be substituted while maintaining the same level of utility for the consumer. Technically, the slope represents the marginal rate of substitution, which is equal to the absolute value of the slope. It measures the maximum quantity of one good that a consumer is willing to give up in order to obtain an additional unit of the other good.

It is assumed that consumers aim to attain the highest possible indifference curve because a higher curve, located further to the right on a coordinate system, represents a higher level of utility. In Figure 8.6, for example, (IC_1) represents a lower level of utility than (IC_2).

Similar to the concept of indifference curves, an isoquant shows the combinations of factors of production that result in the same quantity of output.

Figure 8.6: Indifference curve

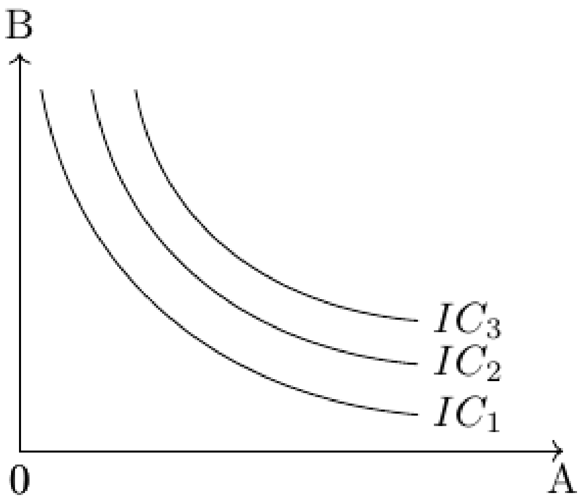
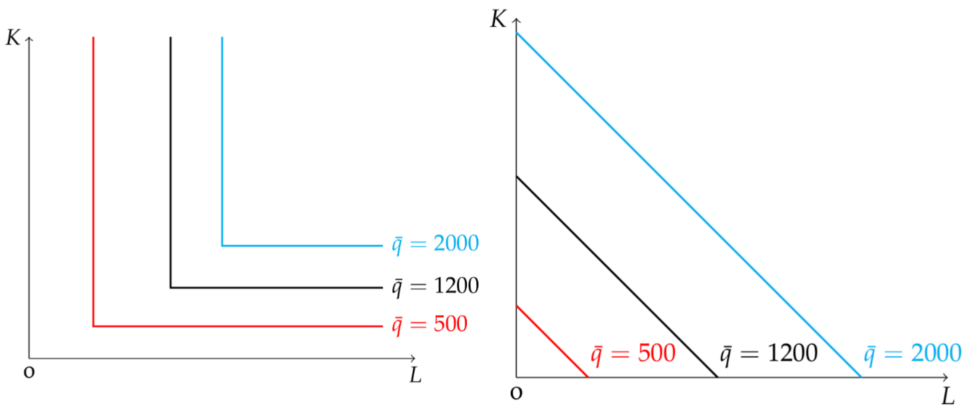


Figure 8.7: Perfect complements or substitutes



Exercise 8.2. Isoquants

- Which of the two plots of Figure 8.7 show isoquants when factors of production are **perfect complements** and **perfect substitutes**, respectively?
- Discuss the features of a Cobb-Douglas PF with respect to returns to scale and marginal product of production for both inputs. Sketch the total output curve in an output-(K) and an output-(L) quadrant. Sketch the isoquants for different levels of production.

Chapter 9

Supply and demand

Recommended readings:

D. Shapiro et al. (2022, ch. 3), Emerson (2019, ch. 11)

Learning objectives:

Students will be able to:

- Distinguish between quantity demanded and demand, and explain what determines demand.
- Distinguish between quantity supplied and supply, and explain what determines supply.
- Explain how demand and supply determine price and quantity in a market, and discuss the effects of changes in demand and supply.

9.1 What is a market?

A market is any arrangement that brings buyers and sellers together. A market might be a physical place or a group of buyers and sellers spread around the world who never meet. In this chapter, we study a competitive market that has so many buyers and sellers that no individual buyer or seller can influence the price. Quantity demanded is the amount of a good, service, or resource that people are willing and able to buy during a specified period at a specified price. The quantity demanded is expressed as an amount per unit of time, for example, the amount per day or per month. Supply and demand are the forces that make market economies work because they determine prices in a market economy. Prices, in turn, allocate the economy's scarce resources. The model of the market based on supply and demand, like any other model, is based on a series of assumptions.

Exercise 9.1. The problem of value: The Water-Diamond Paradox

> "Water is clearly important. We literally can't live without it. Yet you can get water in your apartment in New York without paying for it. On modern Roman streets you can wash your hands or bathe your dog at any old fire hydrant. In the office and in the dorm you can drink water from the fountain down the hall.
>
> Diamonds are different. You can live without diamonds. Yet they are very expensive, valued extremely highly per ounce in the marketplace.
>
> Notice how strange this is - how a good such as a diamond, which is beautiful but inessential, could be so much more expensive per ounce than an essential and not necessarily beautiful good, such as water. The case is called 'the water/diamond paradox.' It is the first and the deepest question of value. What, after all, determines the value of things?" (Klamer et al., 2015, ch. 5.1)

Discuss the water-diamond paradox. Can you think of similar examples of goods that have a high price but no *real value*? Also discuss what the *value of a good* is when it is not based on price.

9.2 Demand

9.2.1 The law of demand

Other things remaining the same, if the price of the good rises, the quantity demanded of that good decreases. Conversely, if the price of the good falls, the quantity demanded of that good increases.

9.2.2 Demand schedule and demand curve

Demand is the relationship between the quantity demanded and the price of a good when all other influences on buying plans remain the same. Demand is illustrated by a demand schedule and a demand curve. The demand curve shows the relationship between price and quantity demanded. In Table 9.1 you see an example of a demand schedule for two individuals, A and B. This schedule is visualized in Figure 9.1.

Market demand refers to the sum of all individual demands for a particular good or service. Graphically, individual demand curves are summed horizontally to obtain the market demand curve. The aggregated demand is visualized in Figure 9.2.

Table 9.1: Demand schedule of persons A and B

Price of a per Unit (Euro)	Quantity Demanded by Person 1 (litres per month)	Quantity Demanded by Person 2 (units per period)	Total Quantity Demanded (units per period)
0.00	20	10	30
0.10	18	9	27
0.20	16	8	24
0.30	14	7	21
0.40	12	6	18
0.50	10	5	15
0.60	8	4	12
0.70	6	3	9
0.80	4	2	6
0.90	2	1	3
1.00	0	0	0

9.2.3 Changes and shifts of demand

Movements along the demand curve are caused by a change in the price of the product. For example, if the price of a specific good changes, the quantity demanded will typically be altered by two effects: the income effect and the substitution effect:

- **The income effect**: Assuming that consumers' incomes remain constant, a decrease in the price of a good allows them to purchase more of it with their available income.
- **The substitution effect**: If the price of one good is lower compared to other similar products, some consumers will choose to substitute the more expensive options with the now cheaper alternative, such as milk.

In section Section 11.2.5, I will discuss both the income and substitution effects in greater detail.

In contrast, changes in other factors that influence demand can result in a shift of the demand curve in a price-quantity diagram. A shift in the demand curve—either to the left or right—occurs when there is a change that affects the quantity demanded at every price level. Below is an incomplete list of factors that can cause demand curves to shift:

Figure 9.1: Demand curve

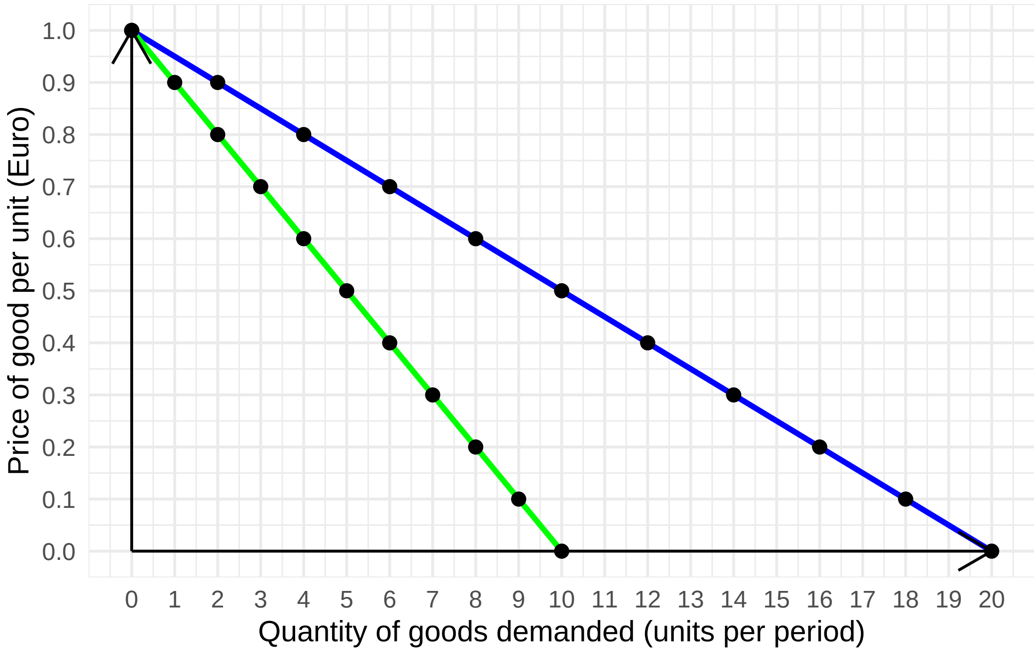
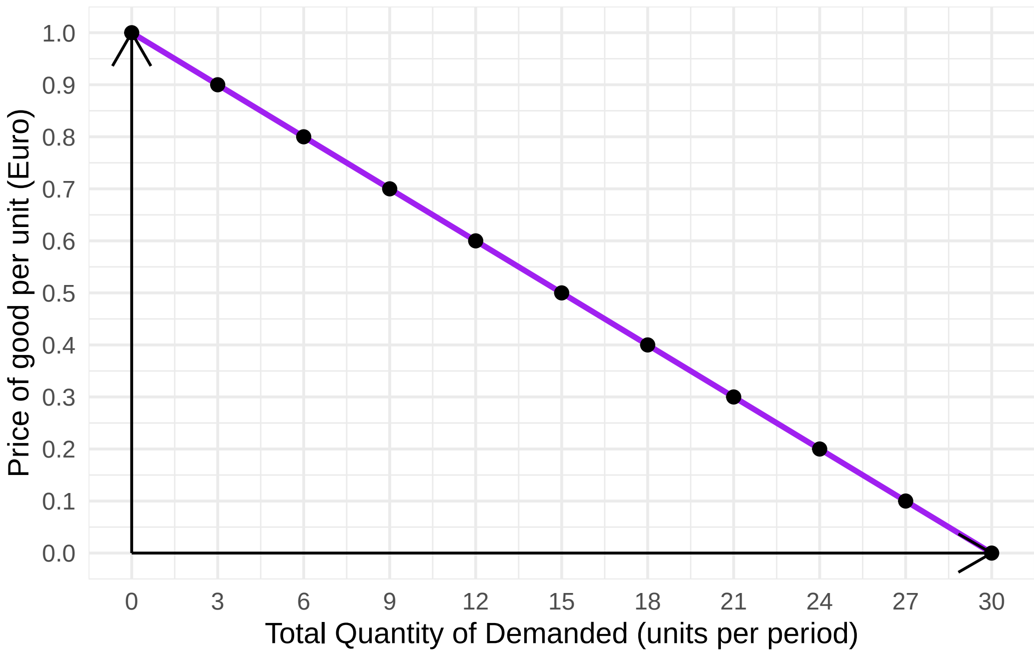


Figure 9.2: Aggregate demand



Income: The overall income of consumers greatly impacts their purchasing power. For normal goods, as income rises, the demand increases. Conversely, for inferior goods, demand decreases as income increases. For example, when consumers have higher incomes, they are less likely to purchase instant noodles (an inferior good) and may instead buy higher-quality meals.

Tastes and preferences: Changes in consumer preferences can shift demand. If health trends favor plant-based foods, demand for these products may rise, while demand for red meat may decline.

Consumer expectations: Expectations about future prices can influence current demand. If consumers expect that prices will rise in the future, they are more likely to purchase now, increasing current demand. Conversely, if they expect prices to drop, they may delay purchases, decreasing current demand.

Population and demographics: Changes in the number of consumers or their demographics can impact demand. For example, an aging population might increase the demand for healthcare products and services, while a growing youth demographic might boost demand for technology and entertainment products.

Price of related goods: When the price of a good rises, consumers may switch to other goods that offer similar benefits, known as substitutes. A substitute is a product that can be consumed in place of another. For example, apples and oranges are substitutes. If the price of butter increases, consumers may opt for margarine instead. In this scenario, the demand for margarine increases, while the demand for butter decreases. Conversely, demand can also be affected by changes in the prices of complementary goods—products that are often consumed together. A **complement** is a good that pairs well with another. For instance, sausages and mustard, or fish and chips are common complements. If the price of printers drops, the demand for ink cartridges might increase as more people purchase printers. Or, if the price of hot dogs rises, the demand for hot dog buns may decrease.

9.3 Types of goods

Goods can be classified based on how their demand reacts to changes in prices and consumer income. Here are some relevant types of goods:

9.3.1 Normal goods

A normal good is defined as a good for which the demand increases as income increases. Conversely, demand decreases when income decreases.

Examples of normal goods include luxury items, branded clothing, and high-quality food products. As consumers' incomes rise, they are more likely to purchase these goods, reflecting their preference for higher-quality or more luxurious items.

9.3.2 Inferior goods

An inferior good is one for which the demand decreases as incomes rise and increases when incomes fall.

Examples of inferior goods include budget brands, instant noodles, and second-hand clothing. When consumers have lower incomes, they may opt for these less expensive options, but as their income increases, they tend to switch to more expensive alternatives.

9.3.3 Giffen goods:

A giffen good is a special type of good that increase in demand when its price rises, violating the basic law of demand. This phenomenon typically occurs because the good is so essential that the consumer constitutes a significant portion of its budget and they buy even more if it when the price increases as their inability to afford more expensive alternatives.

9.3.4 Veblen goods:

A Veblen good is a type of luxury good for which demand increases as the price increases, contrary to the law of demand. These goods serve as a status symbol. The higher price makes them more desirable to certain consumers who view these goods as markers of wealth or prestige. Examples include designer handbags and high-end cars.

> **Tip**
>
> Read the two Wikipedia entries for giffen and veblen goods: Wikipedia (2025b) and Wikipedia (2025f).

Understanding these classifications is important in microeconomics as they help economists analyze consumer behavior, market trends, and the overall economy's response to changes in income levels.

Exercise 9.2.

a) Fill in the blanks:

The demand for a good __________ (increases/decreases) if the price of one of its substitutes rises.
The demand for a good __________ (increases/decreases) if the price of one of its substitutes falls.
The demand for a good __________ (increases/decreases) if the price of one of its complements rises.
The demand for a good __________ (increases/decreases) if the price of one of its complements falls.
A rise in the expected future price of a good __________ (increases/decreases) the current demand for that good.
A fall in the expected future price of a good __________ (increases/decreases) the current demand for that good.

b) Can you give examples of normal and inferior goods?

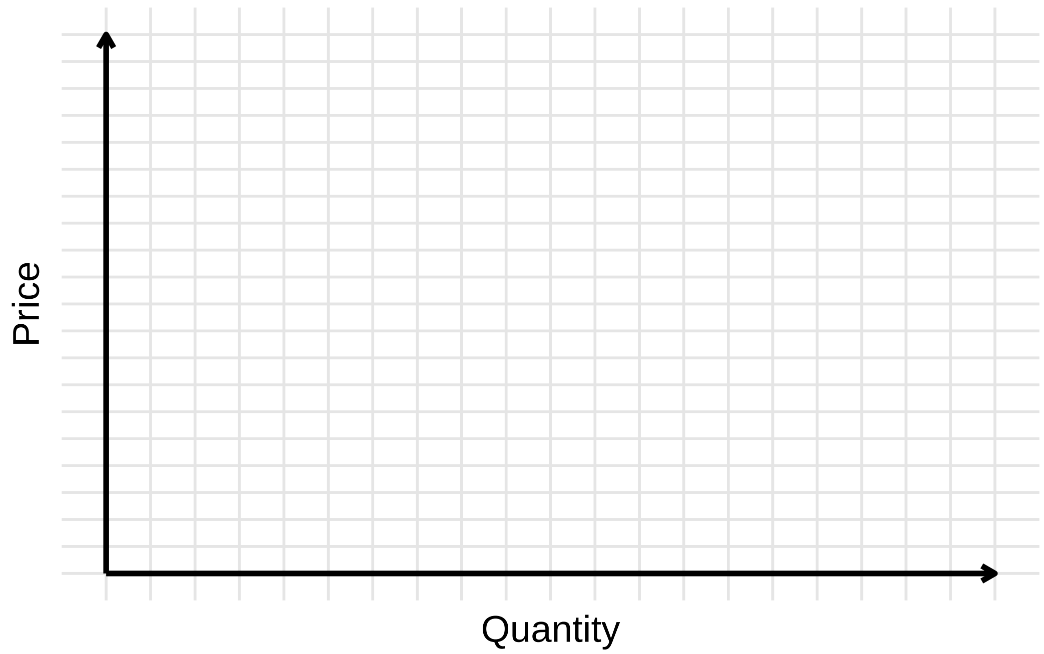
c) Fill in the blanks:

When income is expected to increase in the future, or when credit is easy to get and the cost of borrowing is low, the demand for some goods __________ (increases/decreases).
When income is expected to decrease in the future, or when credit is hard to get and the cost of borrowing is high, the demand for some goods __________ (increases/decreases).

d) Is the following statement true or false: Changes in expected future income and the availability and cost of credit have the greatest effect on the demand for big-ticket items such as homes and cars?

Exercise 9.3. Three demand curves
Use Figure 9.3 to draw a plot with three demand curves. Explain everything you show. One curve should represent an economy in an economic boom, one in an economic downturn, and one in between.

Figure 9.3: Sketch of demand in three different economic states



9.4 Supply

The **law of supply** states that, all else being equal: When the price of a good rises, the quantity supplied of that good increases and vice versa.

The quantity supplied is the amount of a good that sellers are willing and able to sell at a given price. In Table 9.2 an example of a supply schedule is shown that illustrates the relationship between the price of a good and the corresponding quantity supplied. The graphical representation of the relationship between the price of a good and the quantity supplied is visualized in Figure 9.4.

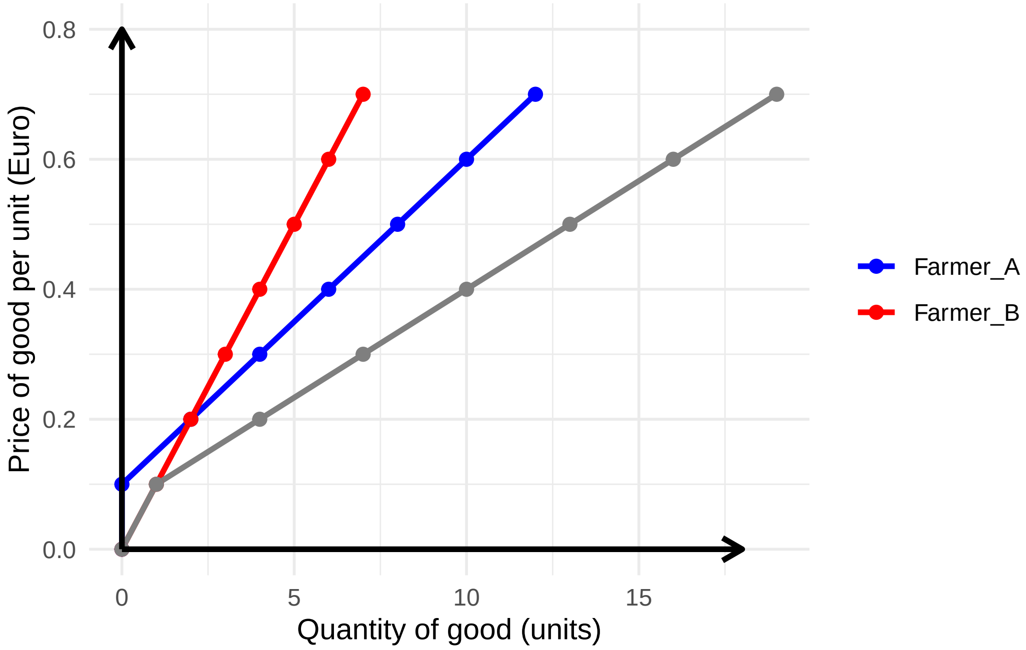
Table 9.2: Example: supply schedule

Price of good per unit (Euro)	producer A	+	producer B	=	Market
0.00	0	+	0	=	0
0.10	0	+	1	=	1
0.20	2	+	2	=	4
0.30	4	+	3	=	7
0.40	6	+	4	=	10
0.50	8	+	5	=	13
0.60	10	+	6	=	16
0.70	12	+	7	=	19

9.4.1 Changes and shifts of supply

The supply curve illustrates the quantities that producers are willing to offer for sale at various prices, while assuming that all other factors affecting their selling decisions remain constant. Any alteration in these additional factors—excluding price changes—results in a shift of the supply curve either to the left or the right.

Figure 9.4: Supply curves



Several key factors can cause shifts in the supply curve. These include the profitability of alternative goods in production and the prices of goods produced jointly. Advancements in technology can also influence supply, as can changes in the number of sellers in the market. Natural and social factors, such as weather conditions and evolving public attitudes, play a significant role as well. Furthermore, input prices—the costs associated with the factors of production—affect the supply. As production costs rise, the quantity supplied typically decreases. Expectations regarding future market conditions can also impact supply decisions, as can changes in resource prices. Higher resource and input prices generally elevate production costs, resulting in a reduced quantity supplied. Additionally, improvements in productivity—defined as output per unit of input—can lower costs and lead to an increase in supply.

A change in the price of one good can impact the supply of another good. This relationship occurs particularly in the context of goods that can be produced in place of one another, known as **substitutes in production**. These are goods that can be manufactured using similar resources, allowing producers to switch between them based on price fluctuations and market demands.

Overall, these dynamics illustrate the complex interplay of various factors that can influence how supply responds to changes in the market environment.

Exercise 9.4. Prices of related goods in production
Fill in the blanks:

a) The quantity supplied of a good ______________ (increases/decreases) if the price of one of its substitutes in production falls.

b) The quantity supplied of a good ______________ (increases/decreases) if the price of one of its substitutes in production rises.

c) The quantity supplied of a good ______________ (increases/decreases) if the price of one of its complements in production rises.

d) The quantity supplied of a good ______________ (increases/decreases) if the price of one of its complements in production falls.

Solution

a) decreases

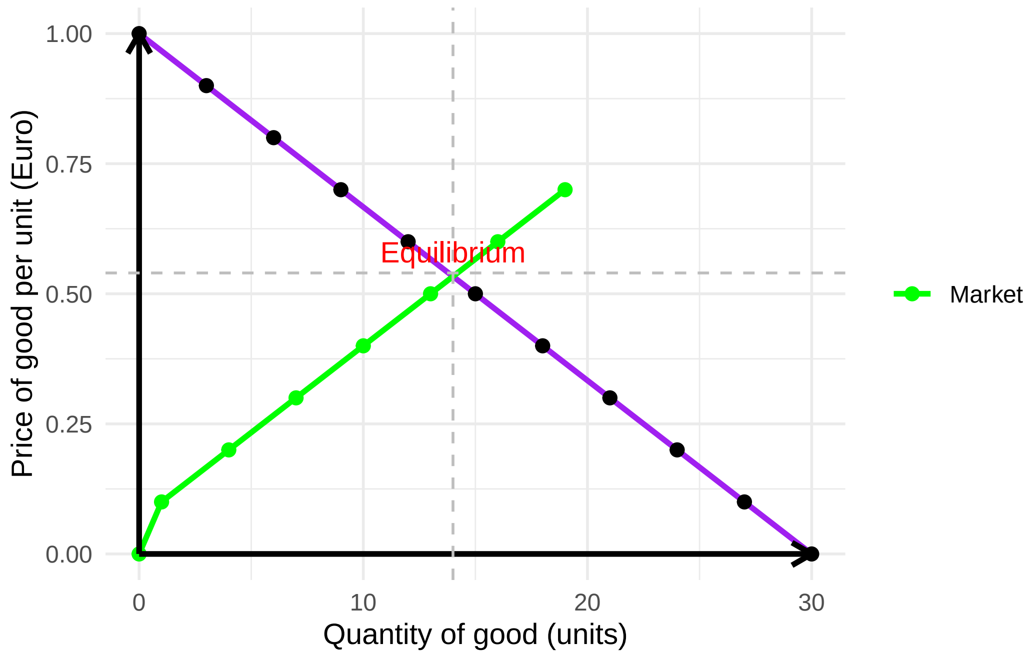
b) increases
c) decreases
d) increases

9.4.2 Market equilibrium

In economics, equilibrium refers to a situation where economic forces such as supply and demand are balanced. In the absence of external influences, the equilibrium values of economic variables remain unchanged.

The price that balances quantity supplied and quantity demanded is called the **equilibrium price**. Graphically, this is the price at which the supply and demand curves intersect. The quantity that comes along the equilibrium price is called the **equilibrium quantity**. That is visualized in Figure 9.5.

Figure 9.5: Market equilibrium of supply and demand



Exercise 9.5. After the visual determination of the equilibrium market price and quantity, calculate the equilibrium market price and quantity assuming the demand function:

$$x(p) = -\frac{3}{4}p + 300$$

and the supply function

$$x_S(p) = \frac{5}{4}p - 100.$$

Addtionally, draw the two functions and mark the equilibrium.

Solution

To formally calculate the equilibrium market price and quantity using the given demand and supply functions, you can set the two equations equal to each other and solve for the price (p). Here's how it can be represented mathematically:

At equilibrium, the quantity demanded equals the quantity supplied:

$$x(p) = x_S(p)$$

Soving both functions for x and setting the two functions equal gives:

$$-\frac{3}{4}p + 300 = \frac{5}{4}p - 100$$

Now, solve for (p):

$$p = 200.$$

Substituting $p = 200$ back into either the demand or supply equation yields

$$x(200) = -\frac{3}{4}(200) + 300,$$

or

$$x(200) = -150 + 300.$$

Thus, the equilibrium quantity is

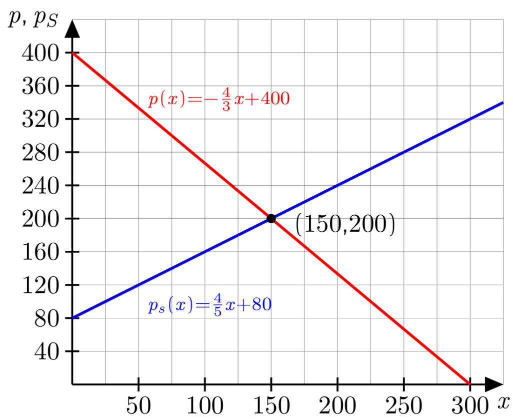
$$x^* = 150$$

and the equilibrium market price is

$$p^* = 200$$

The graphical solution is shown in Figure 9.6.

Figure 9.6: The equilibrium with supply and demand



Supply > demand (surplus / excess)

If price > equilibrium price, then quantity supplied > quantity demanded. There is excess supply or a surplus. Suppliers will lower the price to increase sales, thereby moving towards equilibrium.

Supply < demand (shortage)

If price < equilibrium price, then quantity demanded > quantity supplied. There is excess demand or a shortage. Suppliers will raise the price due to too many buyers chasing too few goods, thereby moving toward equilibrium.

Three steps to analyzing changes in equilibrium

1. Decide whether the event shifts the supply or demand curve (or both).
2. Determine whether the curve(s) shift to the left or to the right.
3. Use the supply and demand diagram to see how the shift affects equilibrium price and quantity.

Exercise 9.6. Supply and demand for coffee
Suppose you are observing the market for coffee. Assume the initial equilibrium price of coffee is €3 per cup, and the equilibrium quantity is 100 cups.

1. Increase in demand:

a) Describe a scenario that could cause an increase in demand for coffee.
b) Draw a demand and supply graph showing the initial demand and supply curves, with the equilibrium price and quantity marked.
c) Illustrate the new demand curve after the increase in demand.
d) Discuss how the increase in demand affects the equilibrium price and quantity. What happens to the original equilibrium price and quantity? Why?

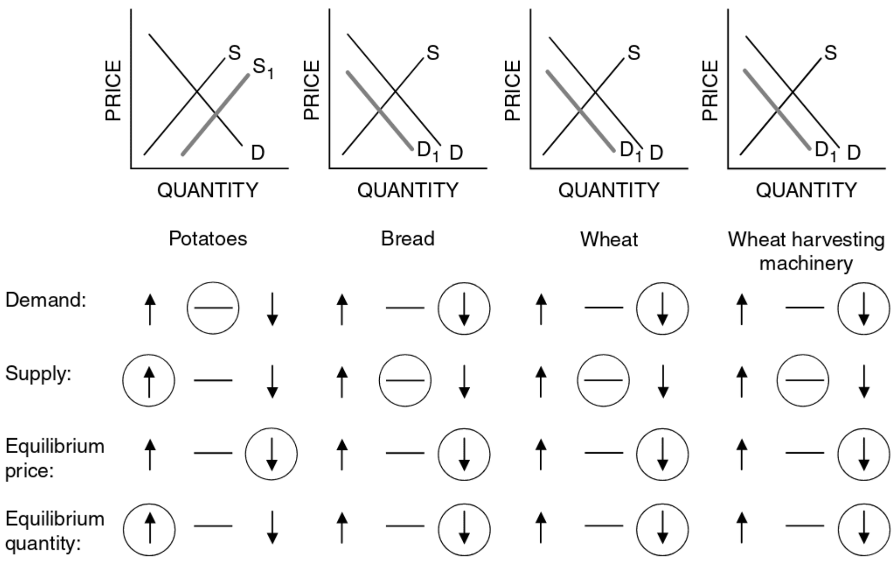
2. Increase in supply:

a) Describe a scenario that could cause an increase in supply for coffee.
b) Draw a demand and supply graph showing the initial demand and supply curves, with the equilibrium price and quantity marked.
c) Illustrate the new demand curve after the increase in supply.
d) Discuss how the increase in supply affects the equilibrium price and quantity. What happens to the original equilibrium price and quantity? Why?

Exercise 9.7. Effects of a new fertilizer
Assume that a new fertilizer dramatically increases the number of potatoes that can be harvested with no additional labor or machinery. Also assume that this fertilizer does not affect wheat farming and that people are satisfied to eat either potatoes or bread made from wheat flour.
Illustrate for both markets, potato and bread, how demand, supply, the equilibrium prices, and quantities change due to the new fertilizer.

Solution

Figure 9.7: Effects of a new fertilizer

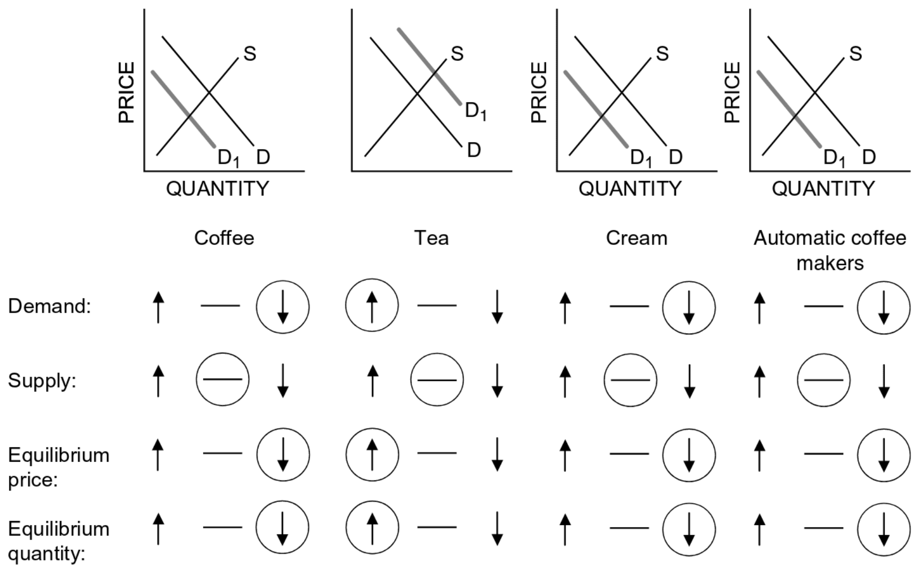


Source: Morton & Goodman (2003, p. 83)

Exercise 9.8. Effects of a study on coffee
Assume new studies show that coffee is worse for people's health than tea and that more people use cream in coffee than in tea.
Illustrate the changes in the markets of coffee, tea, and cream.

Solution

Figure 9.8: Effects of a reputation loss of coffee



Source: Morton & Goodman (2003, p. 85)

Exercise 9.9. Housing market

1. Which of the following factors cause an increase in the demand for houses in Berlin:
   a) An increase in the annual income of many citizens of Berlin.
   b) A reduced rate of immigration into Berlin.
   c) Lower interest rates on loans to buy houses.
2. The demand for cement in Berlin would (increase / decrease), which would result in (higher / lower) prices for cement in Berlin.
3. Employment of workers who build houses would (increase / decrease) and their wages would (increase / decrease).

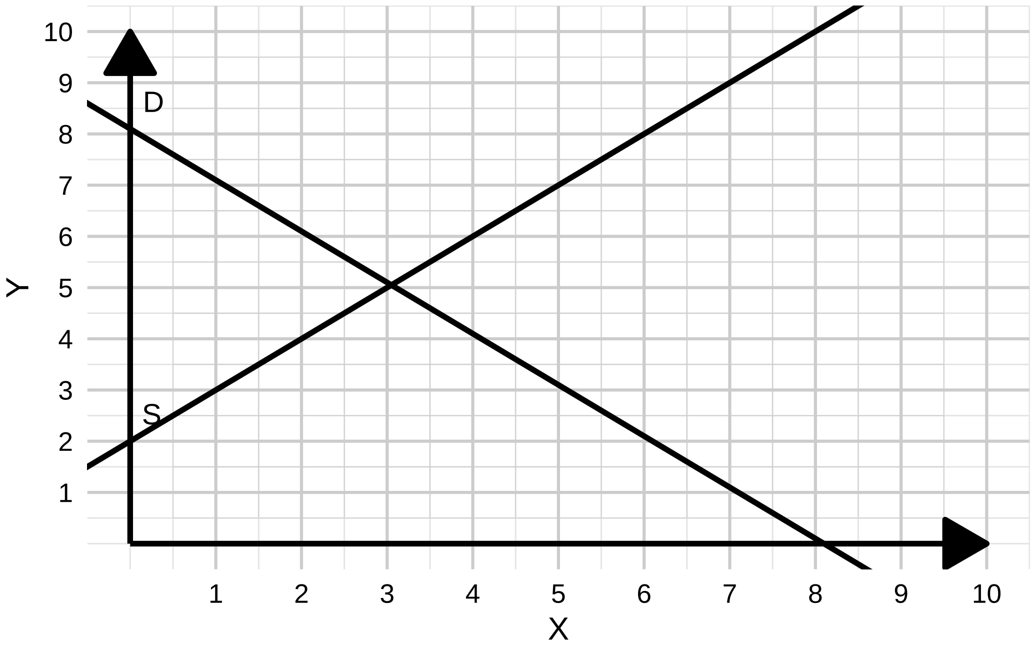
Solution

1. a, c
2. increase; higher
3. increase; increase

Exercise 9.10. Supply and demand analysis
The diagram of Figure 9.9 shows the supply and demand schedule for a given good in a closed economy. The supply function is labeled with S and the demand function is labeled with D.

1. What will be the equilibrium market price?
2. How many items are traded?

Figure 9.9: Supply and demand curve



Chapter 10

Allocation

Required readings: Emerson (2019, ch. 10 and 11),

Recommended readings: Anon (2020, ch. 6)

Learning outcomes:

Students will be able to:

- Explain what is meant by an efficient allocation of resources in an economy and describe the market conditions that must exist to achieve this goal.
- Define consumer and producer surplus.

10.1 How markets allocate resources

Markets use prices as signals to allocate resources to their highest valued uses. More specifically, it is the interaction of demand and supply in markets that generates prices that serve to allocate items to their highest valued alternatives. Consumers will pay higher prices for goods and services that they value more highly. Producers will devote more resources to the production of goods and services that have higher prices, all else being equal. Similarly, workers will provide more hours of labor to jobs that pay higher salaries.

This allocation principle applies to all free and well functioning markets such as product markets for items such as cars, houses, and haircuts, as well as to resource markets for items such as labor, land, and equipment. Factors that interfere with the workings of a competitive market result in an inefficient allocation of resources, leading to a reduction in society's overall well-being.

10.2 Efficient allocation of resources

Remember Milton Friedman's words:

> There was no commissar sending out orders from some central office. It was the magic of the price system: the impersonal operation of prices that brought them together and got them to cooperate, to make this pencil, so you could have it for a trifling sum.
>
> Literally thousands of people cooperated to make this pencil. [...] It was the **magic of the price system**—the impersonal operation of prices that brought them together and got them to cooperate to make this pencil so that you could have it for a trifling sum.

Also, recall Adam Smith, who wrote in perhaps the most influential book in economics, *An Inquiry into the Nature and Causes of the Wealth of Nations* (Smith, 1776), that the pursuit of self-interest in a marketplace would promote the general interest. He stated that resources would be guided, as if by an **invisible hand**, to their best uses. That invisible hand was the **marketplace**.

1. When the net benefits of all economic activities are maximized, economists say the allocation of resources is **efficient**.
2. The concept of an efficient allocation of resources incorporates production, but it also includes efficiency in the consumption of goods and services.

The 'magic' (usually) only happens if the assumptions of the classical model and perfect markets, respectively, hold.

In the upcoming sections, we will discuss some examples where markets are not efficient and welfare is suboptimal. Before that, however, we need to introduce a way to measure welfare.

Exercise 10.1. Greed
Watch Gordon Gekko's "Greed is good" speech from the movie *Wall Street* (see Figure 10.1).

Figure 10.1: The movie Wall Street

Source: IMDb.com

Figure 10.2: Wall Street: Greed is good (1987)

https://youtu.be/VVxYOQS6ggk

Source: Youtube

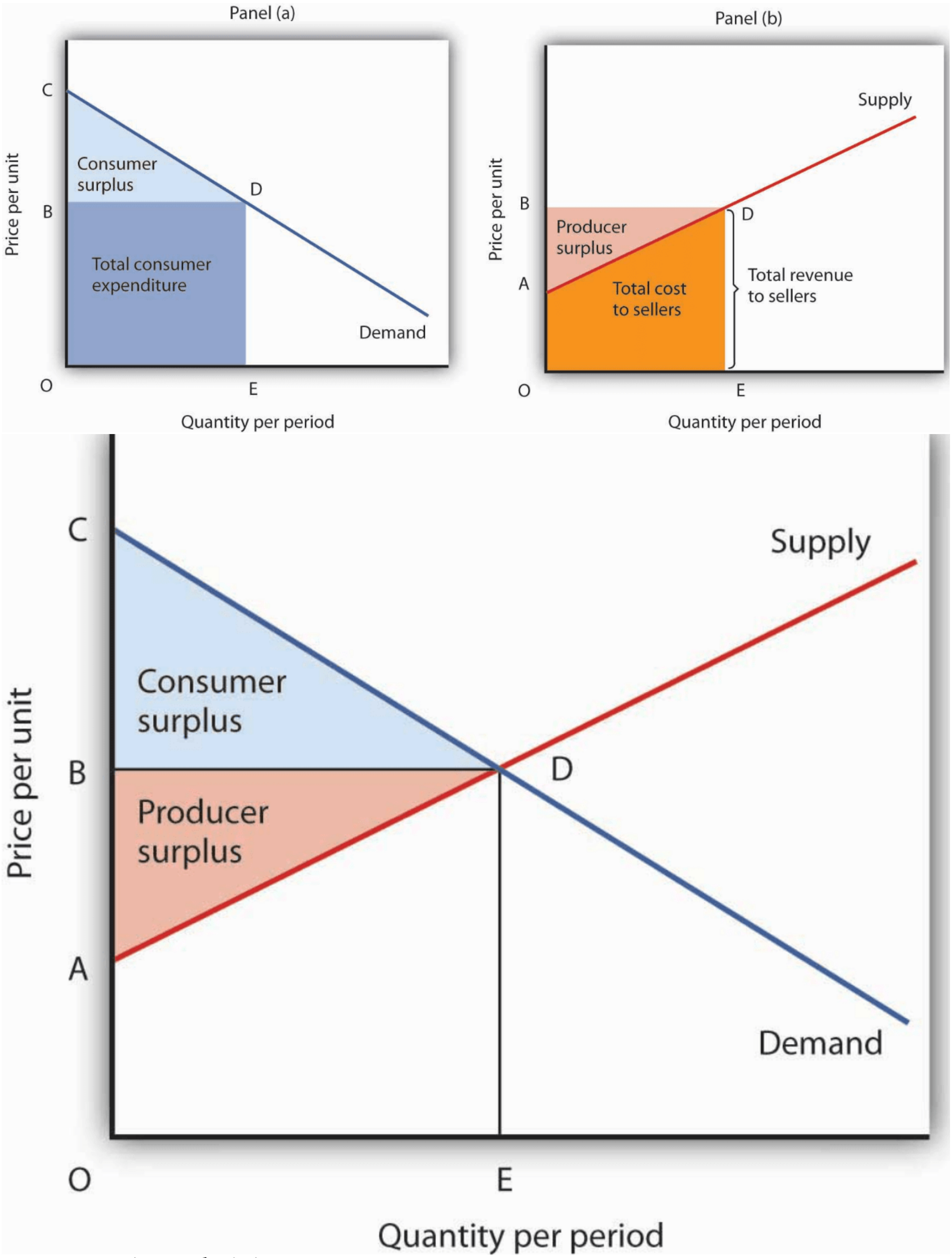
Discuss the relationship between greed, the law of demand, and perfect markets.

10.3 Consumer and producer surplus

In our discussions, we've gained an understanding of market dynamics, exploring how the interplay of supply and demand shapes prices. Now, we explore whether the equilibrium achieved in the market is truly optimal for both consumers and suppliers. Consumer surplus and producer surplus are helpful concepts in economics for welfare analysis. They help us understand the benefits that consumers and producers gain from participating in a market exchange.

Consumer surplus refers to the additional value that consumers receive beyond what they actually pay for a product or service in the market. It is essentially the difference between what consumers are willing

Figure 10.3: Consumer and producer surplus



Source: Anon (2020, ch. 6.2)

to pay for a good or service (their willingness to pay) and the actual price they pay.

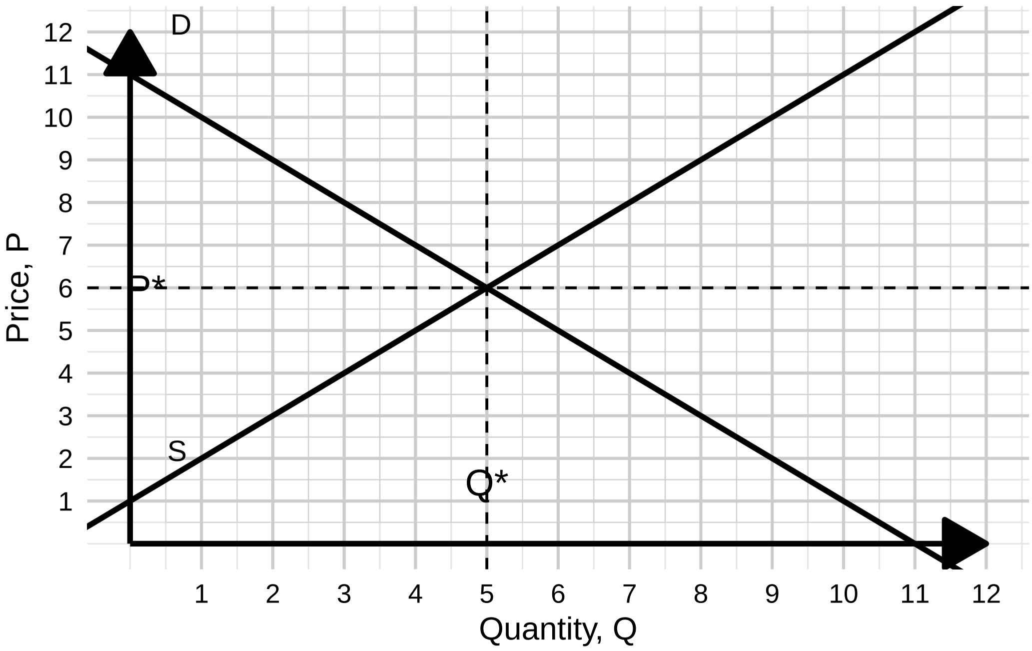
On the other side, producer surplus pertains to the benefit that producers receive from market transactions. It's the difference between the price at which producers are willing to supply a good or service and the actual price they receive. This surplus highlights the additional revenue that producers gain beyond what they need to cover their production costs.

Both consumer surplus and producer surplus contribute to the overall economic welfare in a market. Maximizing both surpluses ensures that resources are allocated efficiently, benefiting both sides of the exchange and contributing to societal well-being. The equilibrium point where these surpluses are maximized is the point where the demand and supply curves intersect. Figure 10.3 visualizes the explained concepts.

Exercise 10.2. Welfare and taxes

1. The following diagram shows the supply and demand schedule for a given good in a closed economy, where $P^* = 6$ denotes the equilibrium market price and $Q^* = 5000$ denotes the equilibrium quantity traded in the market. Calculate producer surplus, consumer surplus, and total welfare, and sketch them in the diagram below.

Figure 10.4: Where is the consumer and producer surplus?

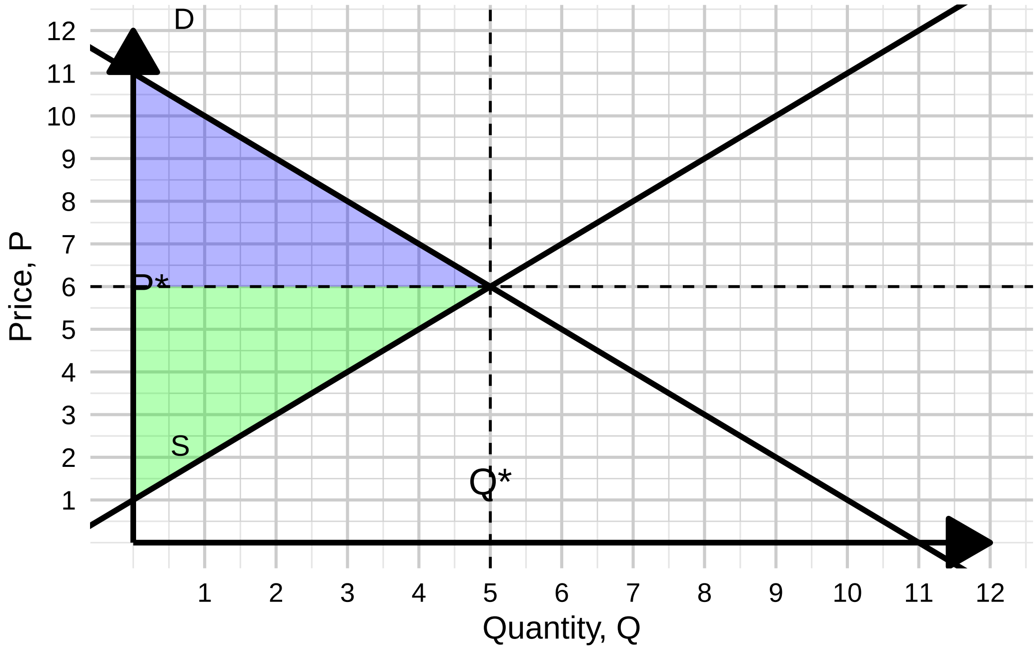


2. Using the diagram above, discuss the impact of a 16.6% value-added tax per unit sold (the price consumers now have to pay is 7 €) on the quantity traded. Calculate producer surplus, consumer surplus, and total welfare.

Solution

1. As shown in Figure 10.5, the blue triangle represents consumer surplus, while the green triangle represents producer surplus. Both surpluses summed together give total welfare.
   - Consumer Surplus (CS) = 12,500
   - Producer Surplus (PS) = 12,500
   - Total Welfare (TW) = 25,000

Figure 10.5: Consumer and producer surplus



2. After the introduction of a 16.6% value-added tax:
    - Consumer Surplus (CS) = 8,000
    - Producer Surplus (PS) = 8,000
    - Tax Revenue = 8,000
    - Total Welfare (TW) = 24,000

10.4 Price ceilings and floors

Study Emerson (2019, ch. 11.3).

10.5 Taxes and subsidies

Study Emerson (2019, ch. 11.4).

10.6 Summary

- Economists use the model of supply and demand to analyze competitive markets.
- In a competitive market, there are many buyers and sellers, each of whom has little or no influence on the market price.
- The demand curve shows how the quantity of a good depends on the price.
    - According to the law of demand, as the price of a good falls, the quantity demanded rises. Therefore, the demand curve slopes downward.
    - In addition to price, other determinants of how much consumers want to buy include income, the prices of complements and substitutes, tastes, expectations, and the number of buyers.
    - If one of these factors changes, the demand curve shifts.

- The supply curve shows how the quantity of a good supplied depends on the price.
  - According to the law of supply, as the price of a good rises, the quantity supplied rises. Therefore, the supply curve slopes upward.
  - In addition to price, other determinants of how much producers want to sell include input prices, technology, expectations, and the number of sellers.
  - If one of these factors changes, the supply curve shifts.
- To analyze how any event influences a market, we use the supply and demand diagram to examine how the event affects the equilibrium price and quantity.
- In market economies, prices are the signals that guide economic decisions and thereby allocate resources.
- The equilibrium price is the price at which the quantity demanded equals the quantity supplied. It is determined by the intersection of the demand and supply curves.
- A surplus exists if the quantity of a good or service supplied exceeds the quantity demanded at the current price; it causes downward pressure on price. A shortage exists if the quantity of a good or service demanded exceeds the quantity supplied at the current price; it causes upward pressure on price.
- An increase in demand, all other things unchanged, will cause the equilibrium price to rise; quantity supplied will increase. A decrease in demand will cause the equilibrium price to fall; quantity supplied will decrease.
- An increase in supply, all other things unchanged, will cause the equilibrium price to fall; quantity demanded will increase. A decrease in supply will cause the equilibrium price to rise; quantity demanded will decrease.
- To determine what happens to equilibrium price and equilibrium quantity when both the supply and demand curves shift, you must know the direction each of the curves shifts and the extent to which each curve shifts.

Chapter 11

Constraints

Recommended readings: Emerson (2019, ch. 4), Huber (2023)

Subjects such as consumers and producers often face decisions with specific goals while dealing with various constraints. This process is referred to as **decision-making and optimization under constraints**. Specifically, we encounter problems related to maximization or minimization within these constraints.

For example, consumers may have a fixed budget to allocate among various items, or consumers have identified a specific basket of items they wish to purchase and now they seek to minimize the costs for that basket. The first is represents a maximization problem and the latter a minimization problem. Similarly, producers typically aim to maximize their profits given a limited amount of production factors, or they seek to minimize costs for a certain level of production.

This section will explore how to approach these optimization problems rationally. We will revisit the concept of utility before discussing two mathematical techniques that can provide solutions: the Lagrangian Multiplier method and Linear Programming.

11.1 Budget constraint

In microeconomics, the concept of a budget constraint plays a vital role in understanding consumer decision-making and helps to analyze consumer choices and trade-offs. The budget constraint represents the limitations faced by consumers in allocating their limited income across different goods and services. The budget constraint indicates that the total expenditure on goods and services, calculated by multiplying the prices of each item by its corresponding quantity, must be less than or equal to the consumer's income. Mathematically, the budget constraint can be expressed as:

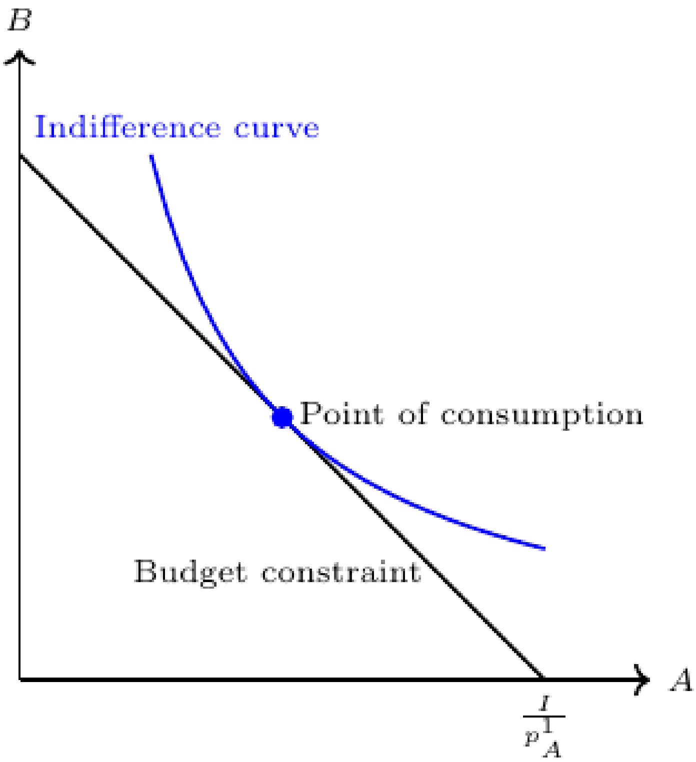
$$P_1 \cdot Q_1 + P_2 \cdot Q_2 + \ldots + P_n \cdot Q_n \leq I$$

where (P_n) represent the prices of goods, (Q_n) denote the quantities of goods (n) consumed. (I) denotes the consumer's income or their budget.

Consumers strive to maximize their utility by selecting the optimal combination of goods and services within the constraints imposed by their limited income. This involves making decisions about how much of each good to consume while staying within the budgetary limits. The graphical representation of the ideal consumption point is depicted in Figure Figure 11.1.

By studying the budget constraint, economists can gain insights into consumer behavior, price changes, and the impact of income fluctuations on consumption patterns.

Figure 11.1: Optimal consumption choice



11.2 Consumption and production choices

11.2.1 Decision making at the margin

To understand how households and individuals, respectively, make choices, economists examine what consumers can afford, illustrated by a budget constraint line, along with the total utility or satisfaction derived from those choices. In a budget constraint, the quantity of one good is represented on the horizontal axis and the quantity of the other good on the vertical axis. The budget constraint line illustrates various combinations of two goods that are affordable based on consumer income.

To introduce the basic concept of how consumers make decisions, consider a situation where a consumer

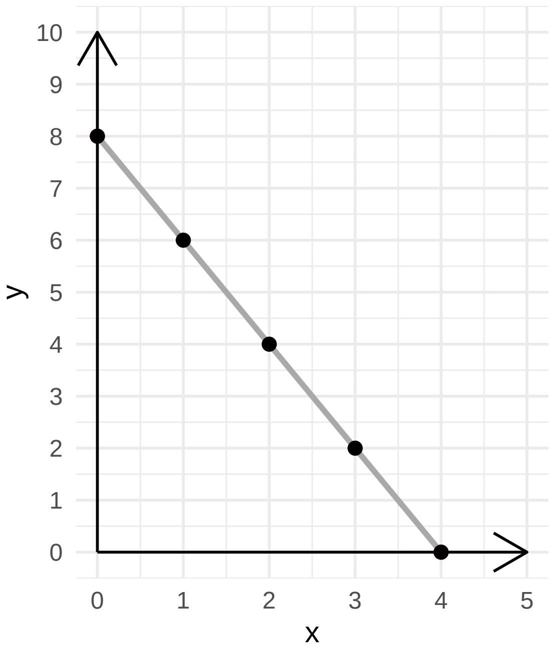
- can buy two different products, x and y.
- Good y costs €14 per unit, while
- good x costs €7 per unit.
- Each unit of consumption comes with a certain level of pleasure, or utility.
- Suppose the consumer's budget is €56 and
- the utilities are specified in Table 11.1, with the possible points of consumption visualized in Figure 11.2. The points on the budget constraint line indicate the combinations of goods that the consumer can afford.

The consumer aims to choose the combination that maximizes utility, which economists use to describe an individual's level of satisfaction or happiness with their decisions. In this scenario, five different options are possible, assuming that fractions of goods cannot be consumed. Thus, we simply calculate the overall utility for each option and select the highest value. It is important to note that marginal utility diminishes as additional units are consumed, meaning that each subsequent unit of a good provides less additional utility. This phenomenon exemplifies the law of diminishing marginal utility, which states that additional utility decreases with each unit consumed.

Table 11.1: Marginal utility and consumers' decision

Good y (Quantity)	Total Utility	Marginal Utility	Marginal Utility per Dollar	Good x (Quantity)	Total Utility	Marginal Utility	Marginal Utility per Dollar
1	22	22	**1.57**	1	16	16	**2.29**
2	43	21	1.50	2	31	15	**2.14**
3	63	20	1.43	3	45	14	**2.00**
4	81	18	1.29	4	58	13	**1.86**
5	97	16	1.14	5	70	12	**1.71**
6	111	14	1.00	6	81	11	**1.57**
7	123	12	0.86	7	91	10	1.43
8	133	10	0.71	8	100	9	1.29

Figure 11.2: Total utility and diminishing marginal utility



Another perspective is to focus on utility per Euro. In this context, marginal utility per Euro quantifies the additional utility a consumer receives relative to the price of the product.

$$\text{Marginal Utility per Euro} = \frac{\text{Marginal Utility}}{\text{Price}}$$

The general equation for marginal utility is:

$$\text{Marginal Utility} = \frac{\text{Change in Total Utility}}{\text{Change in Quantity}}$$

The consumer's first purchase will be a unit of good x because it offers the highest marginal utility per Euro and is within his budget. He will continue purchasing units of good x until the utility gained from the sixth unit of good x is equal to that of one unit of good yf.

This method for determining the optimal choice can be summarized by a general rule: the utility-maximizing choice between consumption goods occurs where the marginal utility per Euro ("Bang for the Buck") is equal for both goods:

$$\text{Marginal Utility per Euro of Good 1} = \text{Marginal Utility per Euro of Good 2}$$

$$\frac{22}{14} = \frac{11}{7}$$

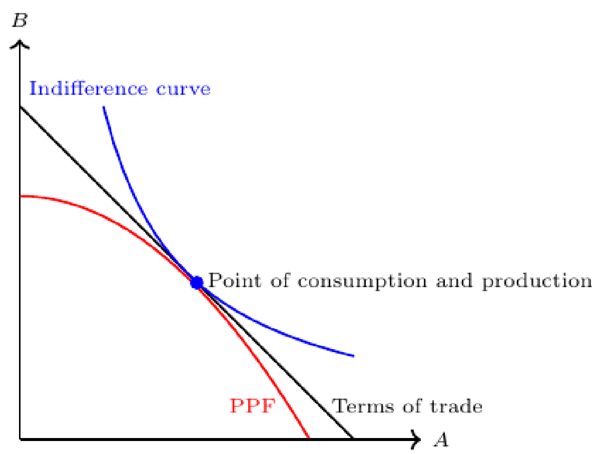
$$1.57 = 1.57$$

11.2.2 Utility maximization

In microeconomics, utility maximization (in its simplest form when having just two goods) involves selecting a combination of two goods that satisfies two essential conditions, see Figure 11.3:

1. The chosen point of utility maximization must fall within the attainable region defined by the Production Possibility Frontier (PPF) or be affordable within the constraints of a given budget.
2. The selected point of utility maximization must lie on the highest indifference curve that is consistent with the first condition.

Figure 11.3: Optimal consumption



These conditions ensure that the consumer selects the optimal bundle of goods that maximizes their utility while taking into account the constraints imposed by production capabilities or budget limitations.

By analyzing production possibilities and individual preferences, economists gain insights into how consumers make choices, allocate resources, and achieve utility maximization. Understanding these concepts helps economists explore the trade-offs and decision-making processes that influence consumer behavior and shape market dynamics.

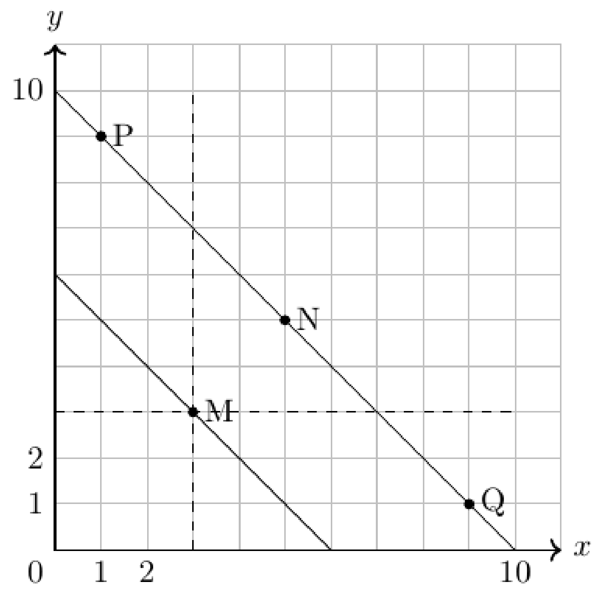
If you are not familiar with the basic principles of the production possibility frontier curve, indifference curves, and budget constraints, I recommend referring to Chapter 8 for a comprehensive overview. This section provides a detailed explanation and exploration of these concepts.

11.2.3 The role of income and budget

If income increases the budget constraint curve shifts outwards (to the right) as shown in Figure 11.4.

The utility-maximizing choice on the original budget constraint is M. The dashed horizontal and vertical lines extending through point M allow you to see at a glance whether the quantity consumed of goods on the new budget constraint is higher or lower than on the original budget constraint. On the new budget constraint, a choice like N will be made if both goods are *normal goods*. If good x is an *inferior good*, a choice like P will be made. If good y is an *inferior good*, a choice like Q will be made.

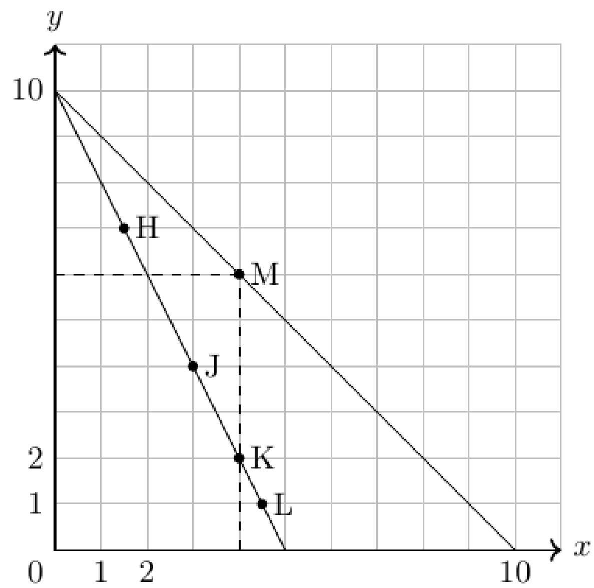
Figure 11.4: Impact of income change on consumption



11.2.4 The role of prices

If price of one good increases then the budget constraint curve. When the price rises, the budget constraint shifts in to the left for that good.

Figure 11.5: Impact of price change on consumption

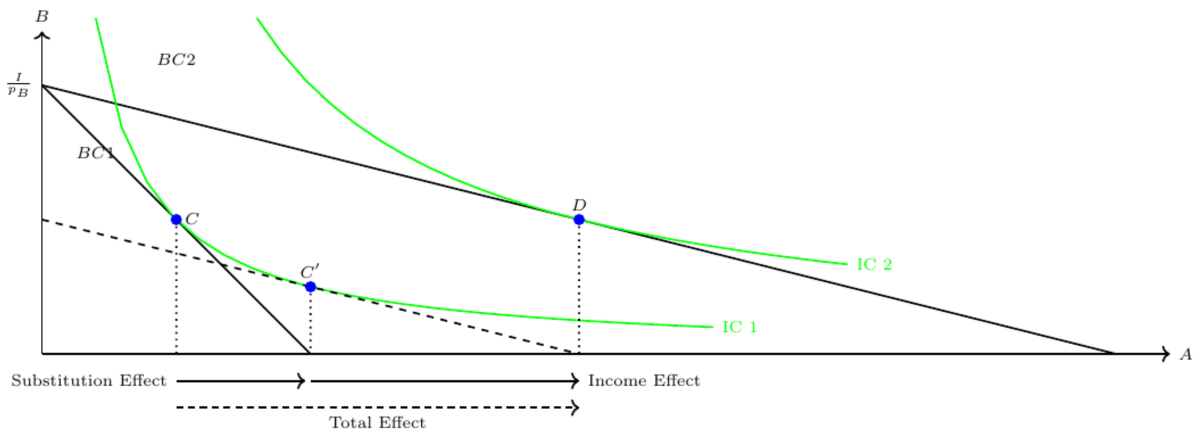


The dashed lines make it possible to see at a glance whether the new consumption choice involves less of both goods, or less of one good and more of the other. The new possible choices would be good x's and more good y's, like point H, or less of both goods, as at point J. Choice K would mean that the higher price of good x led to exactly the same quantity of good x being consumed, but fewer of good y. Choices like L are theoretically possible (if good x are giffen goods) but highly unlikely in the real world, because they would mean that a higher price for goods x means a greater quantity consumed of good x.

11.2.5 Substitution and income effect

When prices increase, individuals typically respond by reducing their consumption of the product with the higher price. This reaction is driven by two factors, both of which can occur simultaneously.

Figure 11.6: Impact of income change on consumption



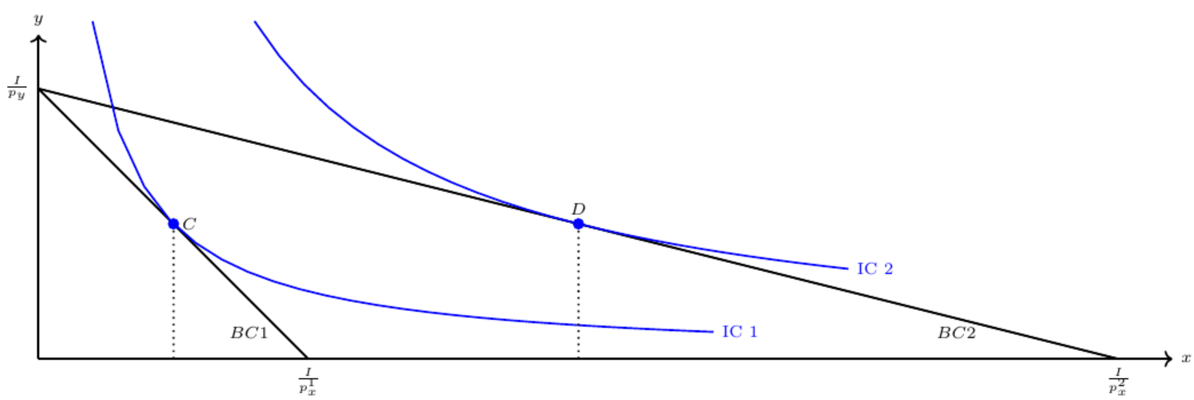
The *substitution effect* occurs when a price change incentivizes consumers to consume less of a good with a relatively higher price and more of a good with a relatively lower price.

The *income effect* stems from the fact that a higher price effectively reduces the purchasing power of income (even if actual income remains the same). This reduction in purchasing power leads to a decrease in the consumption of the good, particularly when the good is considered normal.

Figure 11.6 illustrates the Hicksian decomposition for a price reduction of good A, which affects the consumption of goods A and B, shifting the consumption point from C to D. The point C' represents the hypothetical consumption point resulting from a rotated budget constraint that reflects the new price relationship.

Exercise 11.1. The graphical foundations of demand curves
A shift in the budget constraint means that when individuals are seeking their highest utility, the quantity that is demanded of that good will change. In this way, the logical foundations of demand curves—which show a connection between prices and quantity demanded—are based on the underlying idea of individuals seeking utility.
In Figure 11.7, two points of consumption are displayed, illustrating the optimal choices made by customers when faced with prices $p_x^1 > p_x^2$. The objective of this exercise is to graphically derive the demand function for good x. To accomplish this, please provide a second two-dimensional plot below the existing graph, with the price of good x, p_x, represented on the y-axis.

Figure 11.7: Graphical derivation of the demand function



11.2.6 Consumption, production, and terms of trade

Market prices in a closed economy: The price relation of two goods, the so-called terms of trade, is determined by the slope of the Production Possibility Frontier (PPF) at the point where it is tangent to the indifference curve. This relationship highlights the trade-off between the two goods and their relative scarcity within a closed economy.

Utility maximizing production: The production point that maximizes utility is where the PPF is tangent to the price relation, that is, the *terms of trade*. This principle applies not only in a closed economy (autarky) but also under free trade (open economy). It implies that producers should allocate resources in a way that balances the trade-off between producing more of one good at the expense of another, while considering consumer preferences. Figure 11.3 depicts this.

Exercise 11.2. Understanding indifference curves and budget constraints

a) Which indifference curve in Figure 11.8 represents the highest utility level? Explain your decision.
b) Suppose two goods are perfect substitutes. Two goods are substitutes if they can be used for the same purpose or provide the same utility to the consumer. Draw the indifference curves for perfect substitutes.
c) Suppose two goods are perfect complements. Two goods are complements if they go well together and the demand for one good is related to the demand for another good. A perfect complement is a good that must be consumed together with another good. Draw the indifference curves for perfect complements.
d) Suppose you have a fixed income $I = 10$ that you can spend on consuming two goods x, y at certain prices $p_x = 1, p_y = 1$. Draw the budget line consisting of all possible combinations of two goods that a consumer can buy at certain market prices by allocating his income. Using indifference curves, sketch what each consumer should consume to maximize utility.

Solution

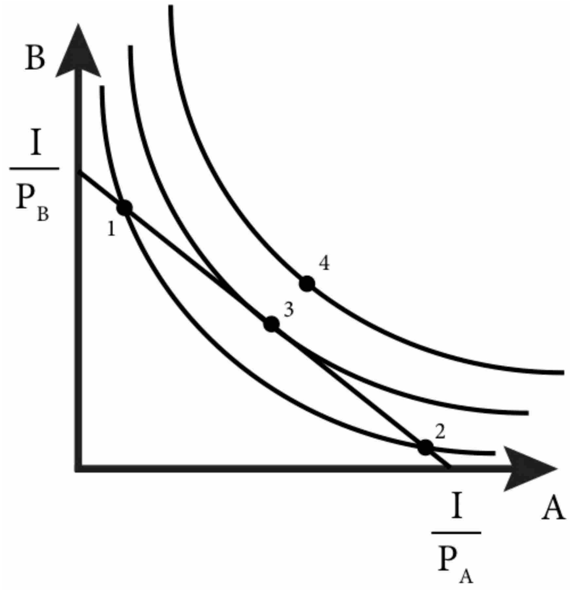
a) The IC that goes through points 1 and 2 represent the lowest utility. The IC that goes through 4 the highest.

b) Task solved in class.
c) Task solved in class.
d) The budget line can be sketched into a y-x plot by solving $p_x x + p_y y = I$ for y:

$$y = \frac{I}{p_y} - \frac{p_x}{p_y} x$$

Exercise 11.3. Utility maximization

Figure 11.8: Utility maximization



Source: Emerson (2019, ch. 4)

Assign the following words to the respective points in Figure 11.8.

- Optimal bundle.
- Can do better by trading some B for some A.
- Can do better by trading some B for some A.
- Unaffordable.

Please find solutions to the exercise in Emerson (2019, ch. 4).

11.3 Linear programming

Linear Programming is a common technique for decision making under certainty. It allows to express a desired benefit (such as profit) as a mathematical function of several variables. The solution is the set of values for the independent variables (decision variables) that serves to maximize the benefit or to minimize the negative outcome under consideration of certain limits, a.k.a. constraints. The method usually follows a four step procedure:

1. state the problem;
2. state the decision variables;
3. set up an objective function;
4. clarify the constraints.

Example: Consider a factory producing two products, product X and product Y. The problem is this: If you can realize \$10.00 profit per unit of product X and \$14.00 per unit of product Y, what is the production level of x units of product X and y units of product Y that maximizes the profit P each day? Your production, and therefore your profit, is subject to resource limitations, or constraints. Assume in this example that you employ five workers—three machinists and two assemblers—and that each works only 40 hours a week.[1]

- Product X requires three hours of machining and one hour of assembly per unit.

[1] The example is taken from Morse et al. (2014, p. 134f).

- Product Y requires two hours of machining and two hours of assembly per unit.

1. *State the problem:* How many of product X and product Y to produce to maximize profit?
2. *Decision variables:* Suppose x denotes the number of product X to produce per day and y denotes number of product Y to produce per day
3. *Objective function:* Maximize
$$P = 10x + 14y$$
4. *Constraints:*

- machine time=120h
- assembling time=80h
- hours needed for production of one good:

machine time: $x \to 3h$ and $y \to 2h$

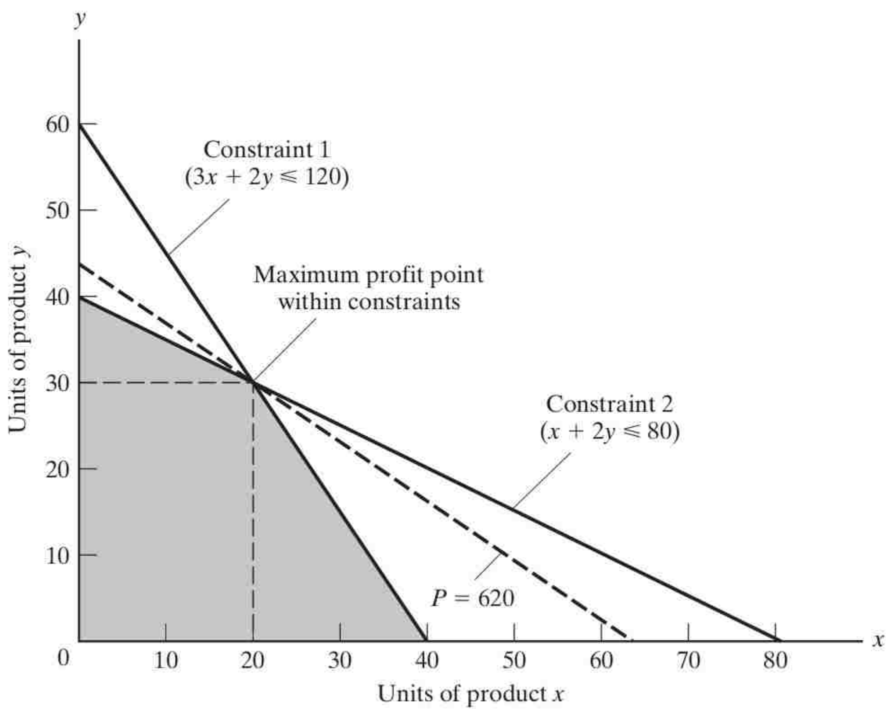
assembling time: $x \to 1h$ and $y \to 2h$

Thus, we get:

$$3x + 2y \leq 120 \quad \Leftrightarrow y \leq 60 - \frac{3}{2}x \quad \text{(hours of machining time)}$$
$$x + 2y \leq 80 \quad \Leftrightarrow y \leq 40 - \frac{1}{2}x \quad \text{(hours of assembly time)}$$

Since there are only two products, these limitations can be shown on a two-dimensional graph Figure 11.9. Since all relationships are linear, the solution to our problem will fall at one of the corners.

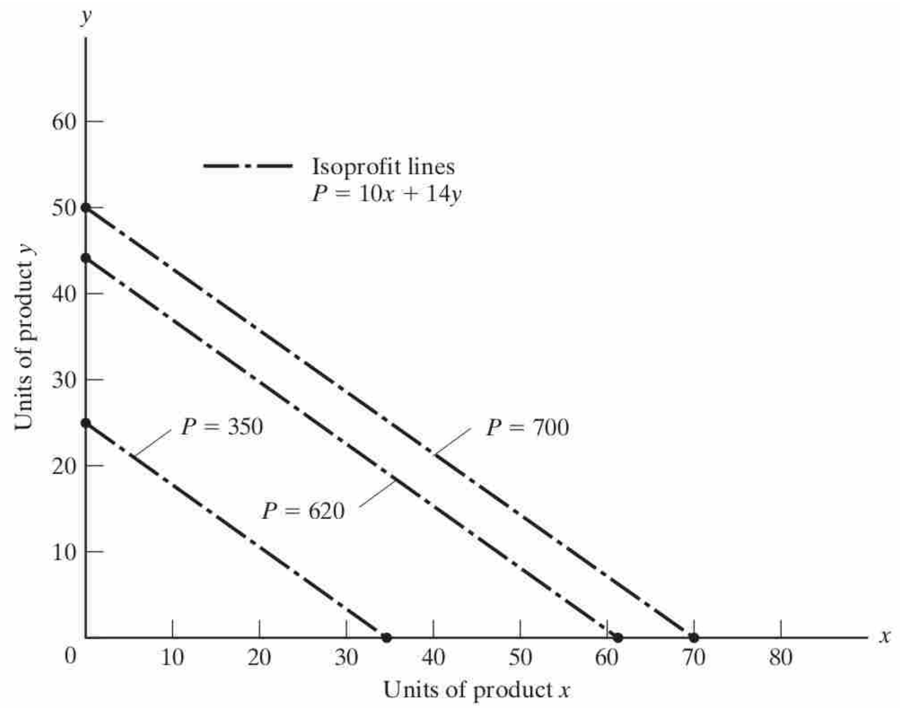
Figure 11.9: Linear program example: Constraints and solution



To draw the isoprofit function in a plot with the good y on the y-axis and good x on the x-axis, we can re-arrange the objective function to get
$$y = \frac{1}{14}P - \frac{10}{14}x$$
To illustrate the function let us consider some arbitrarily chosen levels of profit in Figure 11.10:

- \$350 by selling 35 units of X or 25 units of Y

Figure 11.10: Linear program example: Isoprofit lines



- \$700 by selling 70 units of X or 50 units of Y
- \$620 by selling 62 units of X or 44.3 units of Y.

To find the solution, begin at some feasible solution (satisfying the given constraints) such as $(x, y) = (0, 0)$, and proceed in the direction of *steepest ascent* of the profit function (in this case, by increasing production of Y at \$14.00 profit per unit) until some constraint is reached. Since assembly hours are limited to 80, no more than 80/2, or 40, units of Y can be made, earning $40 \cdot \$14.00$, or \$560 profit. Then proceed along the steepest allowable ascent from there (along the assembly constraint line) until another constraint (machining hours) is reached. At that point, (x,y) = (20,30) and profit P = (20 * +10.00) + (30 * +14.00), or \$620. Since there is no remaining edge along which profit increases, this is the optimum solution.

11.4 Lagrange multiplier method

The method outlined below requires an understanding of how to take derivatives of functions and solve systems of equations. If readers feel they need a refresher on these topics, I recommend consulting the lecture notes *Calculus and Linear Algebra* from Huber (2023).

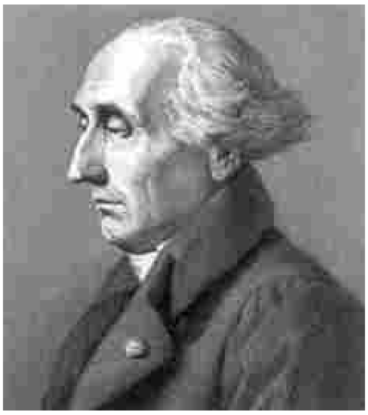
The decision-making process of consumers and producers lies at the core of microeconomic research and is of significant importance for managers. I will not go into detail here, but I will show some examples of how to come to a decision when certain information is given.

For a deeper understanding of the microeconomic preliminaries related to this topic, please read section Chapter 8 of the appendix.

The Lagrange multiplier method, named after Joseph-Louis Lagrange (see Figure 11.11), is a strategy for finding the local maxima and minima of a function subject to constraints. The red curve in Figure 11.12 represents the constraint $g(x, y) = c$, while the blue curves depict contours of $f(x, y)$. The point where the red constraint tangentially intersects a blue contour represents the maximum of $f(x, y)$ along the constraint, as $d1 > d2$.

For a detailed visual explanation of the method, you can watch Dr. Trefor Bazett's YouTube video, see Figure 11.13.

Figure 11.11: Joseph-Louis Lagrange (1736-1813)



Source: *history.mcs.st*

Figure 11.12: Contours of the function and the constraint in red

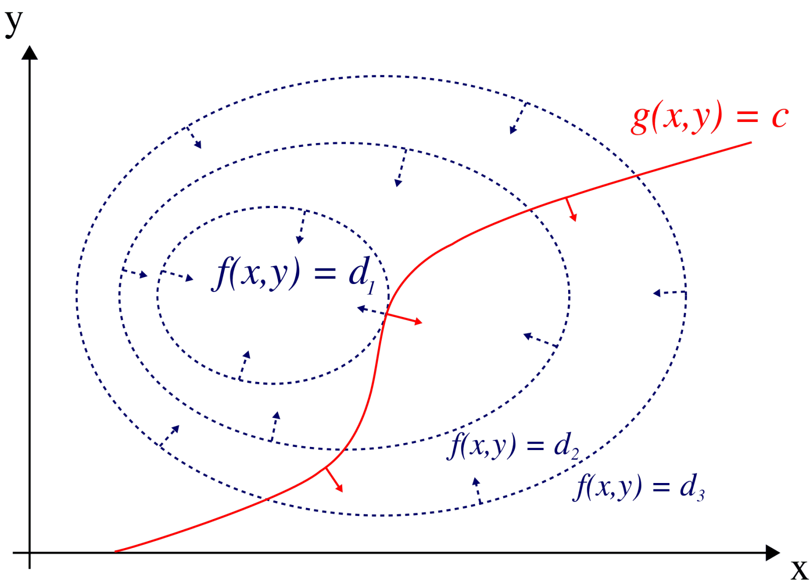


Figure 11.13: Lagrange Multiplier graphically explained

https://youtu.be/8mjcnxGMwFo

Source: *Youtube*

The Lagrange multiplier method, named after Joseph-Louis Lagrange, is a powerful technique for solving optimization problems with constraints.It allows us to find the local maxima and minima of a function subject to certain conditions. The method involves four key steps:

Step 1: Formulate the Problem

Define the problem you want to solve in mathematical terms. This includes specifying the objective function to be maximized or minimized and the constraints that need to be satisfied.

The problem that we want to solve can be written in the following way,

$$\begin{array}{ll} \max_{x,y} & F(x,y) \\ \text{s.t.} & g(x,y)=0 \end{array}$$

where $F(x,y)$ is the function to be maximized and $g(x,y)=0$ is the constraint to be respected. Notice that $\max_{x,y}$ means that we must solve (maximize) with respect to x and y.

Step 2: Construct the Lagrangian

Create a new function called the Lagrangian by combining the objective function and the constraints using Lagrange multipliers. The Lagrangian introduces new variables, known as Lagrange multipliers, to account for the constraints. The Lagrangian, $\mathcal{L}$, is a combination of the functions that explain the problem: The λ is called the *Lagrange Multiplier*.

$$\mathcal{L}(x,y,\lambda)=F(x,y)-\lambda g(x,y)$$

Step 3: Determine the First-Order Conditions

Differentiate the Lagrangian with respect to the variables of the problem (e.g., x and y) and the Lagrange multipliers. Set the partial derivatives equal to zero to obtain the first-order conditions. These conditions represent the necessary conditions for optimality.

Differentiate $\mathcal{L}$ w.r.t. x, y, and λ and equate the partial derivatives to 0:

$$\begin{aligned} \frac{\partial\mathcal{L}(x,y,\lambda)}{\partial x}&=0\Leftrightarrow\frac{\partial F(x,y)}{\partial x}-\lambda\frac{\partial g(x,y)}{\partial x}=0\\ \frac{\partial\mathcal{L}(x,y,\lambda)}{\partial y}&=0\Leftrightarrow\frac{\partial F(x,y)}{\partial y}-\lambda\frac{\partial g(x,y)}{\partial y}=0\\ \frac{\partial\mathcal{L}(x,y,\lambda)}{\partial\lambda}&=0\Leftrightarrow g(x,y)=0 \end{aligned}$$

Step 4: Solve the System of Equations

Solve the system of equations obtained from the first-order conditions to find the values of the variables and Lagrange multipliers that satisfy the optimality conditions. The solutions represent the optimal quantities that maximize or minimize the objective function subject to the given constraints.

By following these four steps, you can effectively apply the Lagrange multiplier method to various optimization problems with constraints. It provides a systematic approach to finding the optimal solutions while incorporating the necessary trade-offs imposed by the constraints.

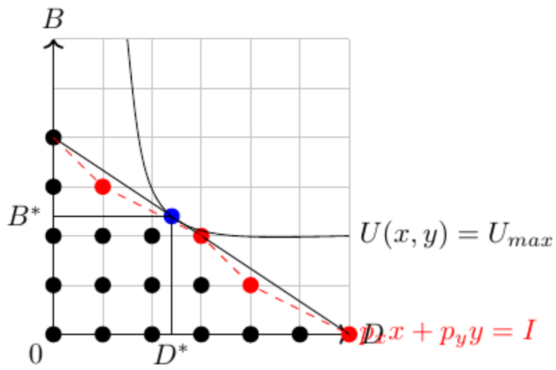
Exercise 11.4. Burgers and drinks
Suppose you are in a fast food restaurant and you want to buy burgers and some drinks. You have €12 to spend, a burger costs €3 and a drink costs €2.

a) Assume that you want to spend all your money and that you can only buy complete units of each products. What are the possible choices of consumption?
b) Given your utility function $U(x,y)=B^{0.6}D^{0.4}$ calculate for each possible consumption point your overall utility. How will you decide?
c) Assume that you want to spend all your money and that both products can be bought on a metric scale where one burger weights 200 grams and a drink is 200 ml. How much of both goods would you consume now? Hint: Use the Lagrangian multiplier method that is explained in Wainwright (2012).

Solution

In Figure 11.14, I marked all 19 possible bundles of burger and drinks of consumption. The budget constraint is shown by the solid line.

Figure 11.14: Possible consumption choices



- We now should calculate the utility of all 19 points, but only the red dots denote choices that may yield an optimal utility. The best utility is achieved when we buy 2 burgers and 3 drinks:

$$U = 2^{0.6}3^{0.4} = 2.35$$

- Solve:

$$\mathcal{L} = B^{0.6}D^{0.4} + \lambda(3B + 2D - 12)$$

FOC:

$$\begin{aligned} 3B + 2D - 12 &= 0 \\ 0.6B^{-0.4}D^{0.4} + 3\lambda &= 0 \\ 0.4B^{0.6}D^{-0.6} + 2\lambda &= 0 \end{aligned}$$

Solving the second and third FOC for λ and substituting λ gives:

$$B = D$$

which we can plug into the first FOC to obtain:

$$B^* = 2.4 \quad \text{and} \quad D^* = 2.4$$

Exercise 11.5. Labor and machines

Suppose you rent a factory for a month to produce as many masks as possible. After you have paid the rent, you need to decide how many machines to buy and how many workers to hire for the given month.

What is the optimal amount of workers and machines to employ for the given month, if you assume the following:

- L denotes the number of workers
- K denotes the number of machines
- Q denotes the number of masks produced
- p_L denotes the price of a worker for a month

- p_K denotes the price of a machine for a month
- B denotes the money you can invest in the production of masks for the next month
- $B = 216$
- The production of masks can be explained by the following Cobb-Douglas production function: $Q = K^{0.4}L^{0.6}$
- $p_L = 2$
- $p_K = 8$

Solution

1. Set up Lagrangian:

$$\mathcal{L} = K^{0.4}L^{0.6} - 216\lambda + 2\lambda L + 8\lambda K$$

2. FOC:

$$\begin{aligned} 0 &= 0.4K^{-0.6}L^{0.6} - 8\lambda \quad (*) \\ 0 &= 0.6K^{0.4}L^{-0.4} - 2\lambda \quad (**) \\ 0 &= 216 - 2L - 8K \quad (***) \end{aligned}$$

3. Solving (*) and (**) for λ and substituting λ gives us:

$$\frac{1}{6}L = K \quad (****)$$

4. Plugging (****) into (***) yields:

$$0 = 216 - 2L - 8 \cdot \left(\frac{1}{6}L\right) \Rightarrow L = 64\frac{4}{5}$$

5. Using that result in (***) again, we get:

$$216 - 2 \cdot 64\frac{4}{5} + 8K \Rightarrow K = 10\frac{4}{5}$$

Thus, the optimal combination of inputs is $L = 64\frac{4}{5}$ and $K = 10\frac{4}{5}$.

Exercise 11.6. Consumption choice
Suppose you want to spend your complete budget of €30,

$$I = 30,$$

on the consumption of two goods, A and B. Further assume good A costs €6,

$$p_A = 6,$$

and good B costs €4,

$$p_B = 4$$

and that you want to maximize your utility that stems from consuming the two goods. Calculate how much of both goods to buy and consume, respectively, when your utility function is given as

$$U(A, B) = A^{0.8}B^{0.2}$$

Solution

$$
\begin{aligned}
\mathcal{L} &= A^{0.8}B^{0.2} + \lambda(6A + 4B - 30) \\
FOC: \frac{\partial \mathcal{L}}{\partial \lambda} &= 6A + 4B - 30 = 0 \qquad (*) \\
\frac{\partial \mathcal{L}}{\partial A} &= 0.8A^{-0.2}B^{0.2} + 6\lambda = 0 \qquad (**) \\
\frac{\partial \mathcal{L}}{\partial B} &= 0.2A^{0.8}B^{-0.8} + 4\lambda = 0 \qquad (***)
\end{aligned}
$$

System of 3 equation with 3 unknowns can be solved in various ways. The easiest way is to solve **() and (*)** for λ and substitute it out:

- solve for λ

$$
\begin{aligned}
-\frac{2}{15}A^{-0.2}B^{0.2} &= \lambda \qquad (**') \\
-\frac{1}{20}A^{0.8}B^{-0.8} &= \lambda \qquad (***')
\end{aligned}
$$

- set both equations equal by substituting λ and solve for B

$$
\begin{aligned}
\frac{2}{15}A^{-0.2}B^{0.2} &= \frac{1}{20}A^{0.8}B^{-0.8} \\
B &= 0.375A \qquad (****)
\end{aligned}
$$

- Now, plug in $(****)$ into $(*)$ to get a number for A

$$
\begin{aligned}
30 &= 6A + 4 \cdot 0.375A \\
\Leftrightarrow 30 &= 7.5A \\
\Leftrightarrow A &= 4
\end{aligned}
$$

- Use $A = 4$ in $(*)$ to get a number for B

$$
\begin{aligned}
30 &= 6 \cdot 4 + 4B \\
\Leftrightarrow 6 &= 4B \\
B &= \frac{6}{4} = 1.5
\end{aligned}
$$

Thus, we'd consume 4 units of good A and 1.5 of good B.

Exercise 11.7. Cost-minimizing combination of factors
Using two input factors r_1 and r_2, a firm wants to produces a fixed quantity of a product, that is $x = 20$. Given the production function

$$x = \frac{5}{4} r_1^{\frac{1}{2}} r_2^{\frac{1}{2}}$$

and the factor prices

$$p_{r_1} = 1 \quad \text{and } p_{r_2} = 4.$$

calculate the cost-minimizing combination of factors (r_1, r_2).

Solution

$$\mathcal{L} = r_1 + 4r_2 + \lambda\left(\frac{5}{4} r_1^{\frac{1}{2}} r_2^{\frac{1}{2}} - 20\right)$$

Taking the FOC we get

$$r_1 = 4r_2$$

using that in the constraint, we get $r_1 = 32$ and $r_2 = 8$.

Also see https://t1p.de/huber-lagr1 which uses this tool: https://www.emathhelp.net/calculators/calculus-3/lagrange-multipliers-calculator/

Exercise 11.8. Lagrange with n-constraints
Write down the Lagrangian multiplier for the following minimization problem:
Minimize $f(\mathbf{x})$ subject to:

$$\begin{aligned} g_1(\mathbf{x}) &= 0 \\ g_2(\mathbf{x}) &= 0 \\ &\vdots \\ g_n(\mathbf{x}) &= 0, \end{aligned}$$

where n denotes the number of constraints.

Solution

$$\mathcal{L}(x_1, \ldots, x_m, \lambda_i, \ldots, \lambda_n) = f(\mathbf{x}) + \lambda_1 g_1(\mathbf{x}) + \lambda_2 g_2(\mathbf{x}) + \ldots + \lambda_n g_n(\mathbf{x})$$

The points of local minimum would be the solution of the following equations:

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial x_j} &= 0 \quad \forall j = 1 \ldots m \\ g_i(\mathbf{x}) &= 0 \quad \forall i = 1 \ldots n \end{aligned}$$

Exercise 11.9. Derivation of demand function using the Lagranian multiplier
A representative consumer has on average the following utility function: $U = xy$, and faces a budget constraint of $B = P_x x + P_y y$, where B, P_x and P_y are the budget and prices, which are given. Solve the following choice problem:
Maximize $U = xy$ s.t. $B = P_x x + P_y y$.

Solution

The Lagrangian for this problem is

$$Z = xy + \lambda \left(P_x x + P_y y - B\right)$$

The first order conditions are

$$\begin{aligned} Z_x &= y + \lambda P_x = 0 \\ Z_y &= x + \lambda P_y = 0 \\ Z_\lambda &= -B + P_x x + P_y y = 0 \end{aligned}$$

Solving the first order conditions yield the following solutions

$$x^M = \frac{B}{2P_x} \quad y^M = \frac{B}{2P_y} \quad \lambda = \frac{B}{2P_x P_y}$$

where x^M and y^M are the consumer's demand functions.

Exercise 11.10. Cobb-Douglas and demand
A consumer who has a Cobb-Douglas utility function $u(x, y) = Ax^\alpha y^\beta$ faces the budget constraint $px + qy = I$, where A, α, β, p, and q are positive constants. Solve the problem:

$$\max Ax^\alpha y^\beta \quad \text{subject to} \quad px + qy = I$$

Solution

The Lagrangian is

$$\mathcal{L}(x,y) = Ax^{\alpha}y^{\beta} + \lambda(px + qy - I)$$

Therefore, the first-order conditions are

$$\begin{aligned} \mathcal{L}'_x(x,y) &= A\alpha x^{\alpha-1}y^{\beta} + \lambda p = 0 \qquad (*) \\ \mathcal{L}'_y(x,y) &= Ax^{\alpha}\beta y^{\beta-1} + \lambda q = 0 \qquad (**) \\ px + qy - I &= 0 \qquad (***) \end{aligned}$$

Solving $(*)$ and $(**)$ for λ yields

$$\lambda = \frac{A\alpha x^{\alpha-1}y^{\beta-1}y}{p} = \frac{Ax^{\alpha-1}x\beta y^{\beta-1}}{q}$$

Canceling the common factor $Ax^{\alpha-1}y^{\beta-1}$ from the last two fractions gives

$$\frac{\alpha y}{p} = \frac{x\beta}{q}$$

and therefore

$$qy = px\frac{\beta}{\alpha}$$

Inserting this result in $(***)$ yields

$$px + px\frac{\beta}{\alpha} = I$$

Rearranging gives

$$px\left(\frac{\alpha+\beta}{\alpha}\right) = I$$

Solving for x yields the following *demand function*

$$x = \frac{\alpha}{\alpha+\beta}\frac{I}{p}$$

Inserting

$$px = qy\frac{\alpha}{\beta}$$

in $(***)$ gives

$$qy\frac{\partial}{\beta} + qy = I$$

and therefore the _demand function}

$$y = \frac{\beta}{\alpha+\beta}\frac{I}{q}$$

Chapter 12

Elasticity

Required reading: D. Shapiro et al. (2022, ch. 5)

Learning objectives:

Students will be able to:

- Explain the concept of price elasticity of demand and how to calculate it.
- Describe what it means for demand to be price inelastic, unit price elastic, price elastic, perfectly price inelastic, and perfectly price elastic.
- Explain how and why the value of price elasticity of demand changes along a linear demand curve.
- Understand the relationship between total revenue and price elasticity of demand.

12.1 How to measure an elasticity

Elasticity is the measurement of the percentage change of one economic variable in response to a change in another. Here, elasticity refers to the degree to which individuals, consumers, or producers change their demand or the amount supplied in response to price or income changes. Elasticity is a normalized measure, meaning the units of measurement of the variables (€, cent, kg, g) do not play a role, enabling comparisons of how different goods react to price changes, for example.

The **price elasticity of demand (PED)** is computed as the percentage change in the quantity demanded divided by the percentage change in price:

$$\text{PED} = \frac{\text{Percentage change in quantity demanded}}{\text{Percentage change in price}} = \frac{\frac{q_{t=\text{today}} - q_{t=\text{yesterday}}}{q_{t=\text{yesterday}}}}{\frac{p_{t=\text{today}} - p_{t=\text{yesterday}}}{p_{t=\text{yesterday}}}}$$

Exercise 12.1. How Rachel's demand reacts to changes in price
Rachel's demand curve is linear. Her demand decreases from **10 to 6** liters of milk if the price increases from **50 to 70** cents. Suppose you know that Rachel's demand curve for cookies is also linear and that her demand decreases from **3 to 1** cookie if the price increases from **20 to 40** cents. As the prices changed in both cases by 20 cents, can we say that she reacts more sensitively to prices of milk compared to cookies because she buys 4 units more of milk and just 2 units less of cookies?

Solution

No, we cannot conclude this without discussing elasticities. We would be **comparing apples with pears**, or in this case, cookies with milk, as the units of measurement are different.
Let's calculate the elasticities:
Example milk: If the price of a liter of milk increases from €0.50 to €0.70, and the amount demanded falls from 10 to 6 liters, then the price elasticity of demand (PED) for milk is calculated as:

$$PED^*_{milk} = \frac{\frac{6-10}{10} \cdot 100}{\frac{(€0.70-€0.50)}{€0.50} \cdot 100} = -1$$

Example cookie: If the price of a cookie increases from €0.20 to €0.40 and the amount demanded falls from 3 to 1 cookie, then the price elasticity of demand (PED) for cookies is:

$$PED^*_{cookie} = \frac{\frac{1-3}{3} \cdot 100}{\frac{(€0.40-€0.20)}{€0.20} \cdot 100} = -\frac{2}{3}$$

This means if the price increases by 1%, Rachel will demand 1% less of milk and $\frac{2}{3}$% less of cookies. Thus, we can conclude that she is more price-sensitive to milk.

Exercise 12.2. Check for units of measurement and direction of change

a) Assume a cookie weighs 100g and we use $ as currency, with one dollar equal to €0.86. Recalculate the PED_{cookie} using grams as the unit of measurement.

b) You may have heard that the problem with the *simple* method of calculation is that the precise magnitude of the elasticity depends on the direction of change. Thus, calculate the elasticities if the prices decrease from €0.70 to €0.50 and from €0.20 to €0.40, respectively. In other words, assume that quantities and prices from the earlier example change in the opposite direction.

Solution

- **Check: Units of Measurement**
  To convert €0.20 to $, calculate:

$$€0.40 \cdot \frac{\$1}{€0.86} = \$0.465116279$$

and hence €0.20 = 0.23255814$. Then,

$$PED^*_{cookie} = \frac{\frac{100g-300g}{300g} \cdot 100}{\frac{(\$0.465116279-\$0.23255814)}{\$0.23255814} \cdot 100} = -\frac{2}{3}$$

Check: it remains the same.

- **Check: Direction of Change**

$$PED^*_{milk} = \frac{\frac{10-6}{6} \cdot 100}{\frac{(€0.50-€0.70)}{€0.70} \cdot 100} = \frac{\frac{2}{3}}{\frac{2}{7}} = -\frac{7}{3}$$

$$PED^*_{cookie} = \frac{\frac{3-1}{1} \cdot 100}{\frac{(€0.20-€0.40)}{€0.40} \cdot 100} = -4$$

The result is significantly different. Thus, this method of calculation is inadequate.
Solution: Midpoint Method, see Section 12.2.

12.2 Midpoint method

The midpoint formula computes percentage changes by dividing the change by the average value (i.e., the midpoint) of the initial and final value. It is independent of the direction of change and hence is preferable to the basic method. For example, when a change in price from *P_1* to *P_2* comes along with a change in demand from *Q_1* to *Q_2*, the formula can be written like this:

$$\text{Price Elasticity of Demand (PED)} = \frac{\frac{Q_2 - Q_1}{\left(\frac{(Q_2+Q_1)}{2}\right)}}{\frac{(P_2-P_1)}{\left(\frac{(P_2+P_1)}{2}\right)}} = \frac{\triangle Q/\bar{Q}}{\triangle P/\bar{P}}$$

Notice that the formula can be simplified by using the $\triangle$ symbol to represent a change in values, and using a bar over the quantities to indicate the average of the two values.

Exercise 12.3. Midpoint method and the direction of change
Check if applying the midpoint method is really a solution, i.e., the elasticities of milk and cookies are direction of change.

Solution

$$PED_{milk} = \frac{\frac{10-6}{\frac{(10+6)}{2}}}{\frac{(€0.50-€0.70)}{\frac{(€0.50+€0.70)}{2}}} = -\frac{3}{2} = -1.5$$

$$PED_{milk} = \frac{\frac{6-10}{(6+10)/2}}{\frac{(0.70-0.50)}{(0.70+0.50)/2}} = -1.5$$

$$PED_{cookie} = \frac{\frac{1-3}{4}}{\frac{(0.40-0.20)}{0.30}} = -0.375$$

$$PED_{cookie} = \frac{\frac{3-1}{4}}{\frac{(0.20-0.40)}{0.30}} = -0.375$$

Thus, a 1% increase in price will lead to a drop in quantity demanded of 1.5% for milk and 0.375% for cookies.

12.3 Point elasticity

More generally, we can use differential calculus to get the the elasticity of two variables, *x* and *y*:

$$\epsilon_{y,x} = \frac{dQ}{dP} \cdot \frac{P}{Q}$$

12.4 Elasticity and demand

Price elasticity of demand (PED) has various classifications that help us understand how quantity demanded responds to price changes. It is termed **perfectly elastic** when $|PED| \to \infty$, indicating that quantity responds infinitely to even the smallest price change. Conversely, it is labeled **perfectly inelastic** when $PED = 0$, signifying that quantity does not respond at all to price changes.

In less extreme cases, we refer to **price inelastic demand** when $0 < |PED| < 1$, meaning that quantity demanded does not respond significantly to changes in price. On the other hand, **price elastic demand** occurs when $|PED| > 1$, indicating a strong responsive relationship between quantity demanded and price.

Understanding PED is crucial as it measures the sensitivity of quantity demanded to price changes and is closely related to the slope of the demand curve. However, it is important to note that the slope alone does not provide the complete picture of PED.

Exercise 12.4. Sketch demand curves

- Sketch demand curves for
  - Normal goods with price inelastic demand
  - Normal goods with perfect price inelastic demand
  - Normal goods with price elastic demand
  - Normal goods with perfect price elastic demand
- Do the same for a *Giffen good*.

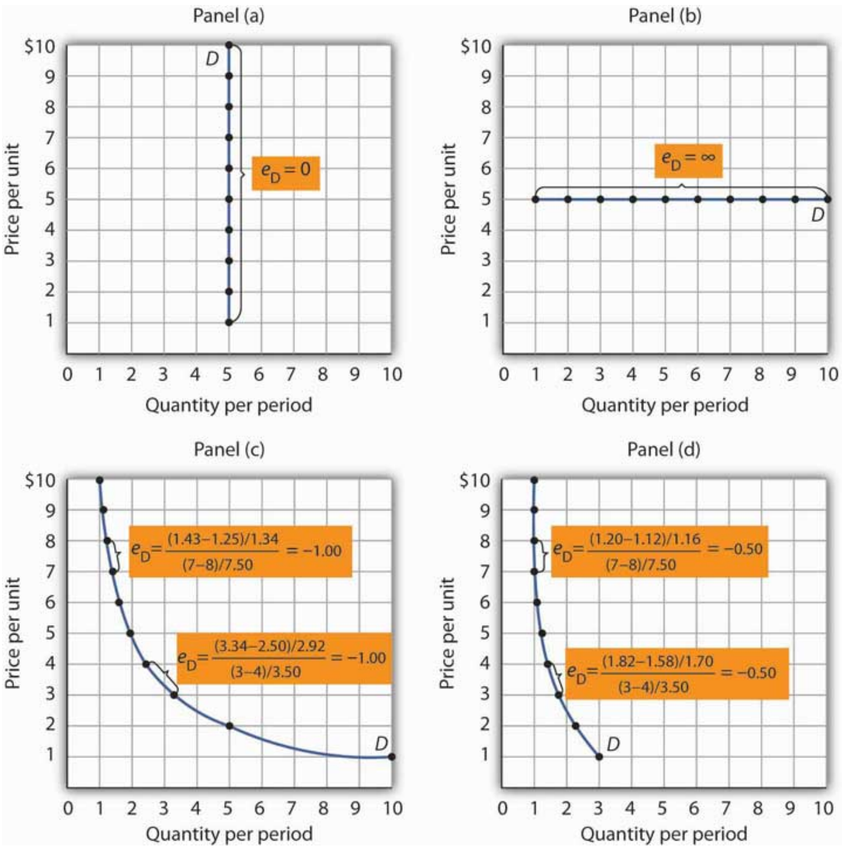
Determinants of PED: Several factors influence the price elasticity of demand. The availability of close substitutes plays a significant role, as does the classification of goods into necessities versus luxuries. Additionally, the time horizon can impact elasticity.

Price elasticity of a linear demand curve:

When examining the price elasticity of a linear demand curve, it is essential to recognize that while the slope remains constant, elasticity does not! Demand is typically inelastic at points with low prices and high quantities, whereas it becomes elastic at points with high prices and low quantities. This is demonstrated in Figure 12.1 and Figure 12.2.

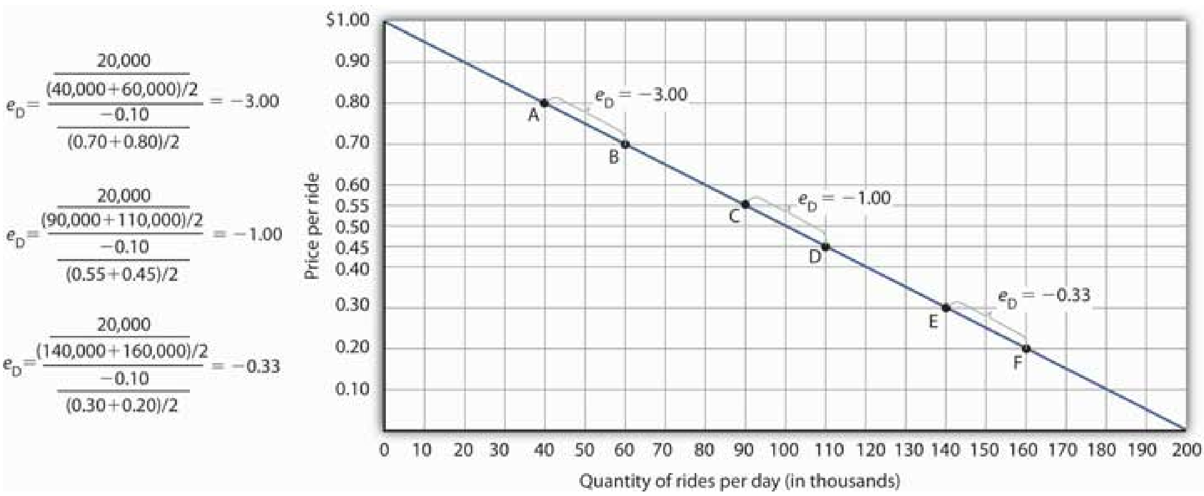
Moreover, total revenue varies at each point along the demand curve. Demand curves with a constant price elasticity are referred to as *iso-elastic*. An iso-elastic demand curve is shown in panel (c) of Figure 12.1.

Figure 12.1: Representations of different PEDs



Source: Anon (2020, p. 154)

Figure 12.2: Price elasticities of demand for a linear demand curve



Source: Anon (2020, p. 148)

Part III

MARKET FAILURE

Chapter 13

Imperfect

Required readings: Emerson (2019, ch. 10 and 11),

Recommended readings: Anon (2020, ch. 6)

In earlier chapters, we looked at how free markets efficiently allocate resources. We stressed that this magic of the price system needs perfect markets to function. Although perfect competition isn't found in reality, it's a useful theoretical model. It helps us analyze markets and guide policymakers in dealing with market failures, where perfect market conditions aren't met.

Sections Section 10.4 and Section 10.5 covered the welfare losses from price controls, taxes, and subsidies. Upcoming sections will come back to that and we will explore more sources of market failure, their effects, and how to counteract them.

It is important to note that, despite the absence of perfect market conditions in practice, centrally planned economies do not inherently outperform market-based systems. Historical experience suggests that a free-market-oriented capitalist approach is the most effective, albeit imperfect, system for economic organization.

Theory suggests that when firms make profits, new firms enter or existing firms expand. This increases supply, lowers prices, and eventually firms earn zero profit. At equilibrium, total revenue equals total cost, and firms don't profit. Profits come from competitive advantages, which means firms aren't price takers. This contradicts one of the assumptions of perfect competition. The most extreme competitive advantage is a monopoly, where one firm controls the entire supply and pricing of a good or service. We will discuss this further in the next section.

13.1 Theorems of welfare economics

There are two fundamental theorems of welfare economics. The first states that a market in equilibrium under perfect competition will be Pareto optimal in the sense that no further exchange would make one person better off without making another worse off. The requirements for perfect competition are as follows:

1. There are no externalities and no transaction costs, and each actor has perfect information.
2. Any efficient allocation of resources can be achieved through competitive markets, given the right redistribution of resources.

> Metaphor: Runners
>
> In a scenario where the first theorem applies, the competitive market equilibrium is fair. When thinking of a race where runners compete, all runners give their best effort, and the fastest runner wins. This outcome is efficient because each runner is motivated to perform their best to achieve their individual goals, which collectively leads to an optimal overall result. Each runner receives a

fair price.
If the race starts with an uneven advantage, the market (or race) isn't efficient initially. However, the second theorem suggests that by redistributing starting positions or providing compensation to less advantaged runners, an efficient outcome can still be achieved. In the economic context, this means that with appropriate policies (taxes, subsidies, etc.), markets can be used to attain efficient outcomes even when the initial distribution is unequal.
In summary, the example of runners in track and field helps illustrate how the two fundamental theorems of welfare economics emphasize the efficiency achieved by competitive markets and the possibility of achieving efficient outcomes through redistribution. Just as runners compete to achieve their best, competitive markets can lead to optimal resource allocation, and policies can ensure fairness and efficiency in the allocation process.

13.2 Types of imperfect market structures

To develop principles and make predictions about markets and how producers will behave in them, economists have developed numerous models of market structure, including the following:

- **Monopolistic competition**: also called competitive market, where there are a large number of firms, each having a small proportion of the market share and slightly differentiated products.
- **Oligopoly**: a market dominated by a small number of firms that together control the majority of the market share.
- **Duopoly**: a special case of an oligopoly with two firms.
- **Monopsony**: when there is only one buyer in a market.
- **Monopoly**: where there is only one provider of a product or service.
- **Natural monopoly**: a monopoly where economies of scale cause efficiency to increase continuously with the size of the firm. A firm is a natural monopoly if it can serve the entire market demand at a lower cost than any combination of two or more smaller, more specialized firms.
- **Perfect competition**: a theoretical market structure featuring no barriers to entry, an unlimited number of producers and consumers, and a perfectly elastic demand curve.

As one assumption of the perfect free market is that there is competition, it is evident that if there is just one or a few competitors, this assumption is not fulfilled. In the following, we discuss what happens to markets that don't have perfect competition.

13.3 Price controls

13.3.1 Maximum price

A legal maximum price, set to protect consumers, establishes an upper limit for the sale of a good. One example is price fixing in rental apartments. It is ineffective if set above the equilibrium price (see Figure 13.1); it becomes binding when placed below the equilibrium price (see Figure 13.2). This can lead to deadweight loss due to missed mutually beneficial transactions.

13.3.2 Minimum price

A legal minimum price is a rule that sets the lowest price for a product, protecting sellers. For example, minimum wage protects the seller of labor time. Only when this minimum price is higher than the normal price is it binding and affects the market.

Figure 13.1: Non-binding maximum price

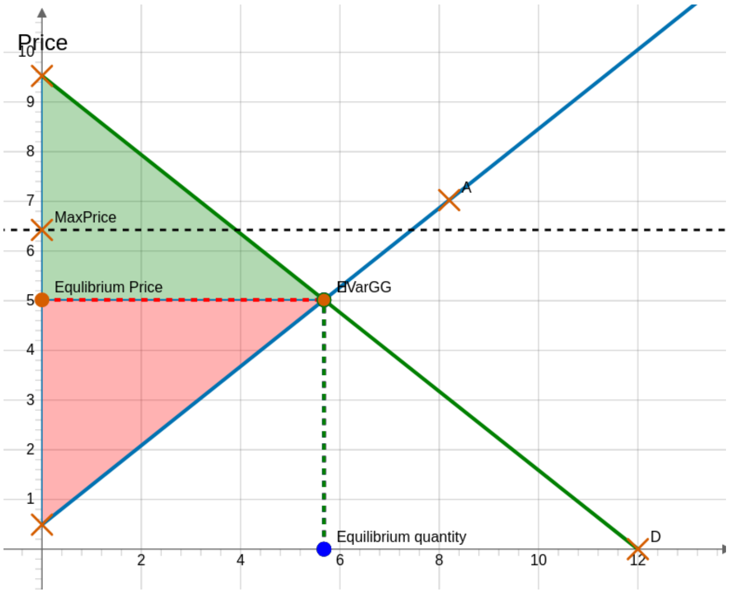
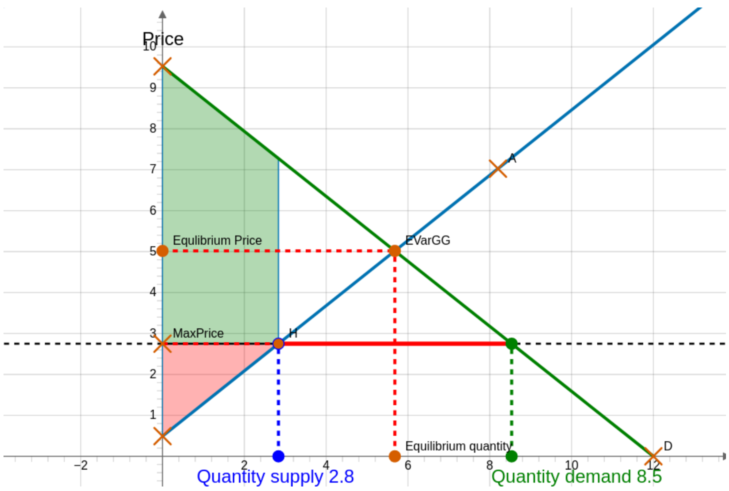


Figure 13.2: Binding maximum price



13.3.3 Price controls

Analyze the two scenarios above. Can you sketch in both plots consumer and producer surplus? Who is better off? Who is worse off? And does overall welfare increase or decrease?

13.3.4 Taxes

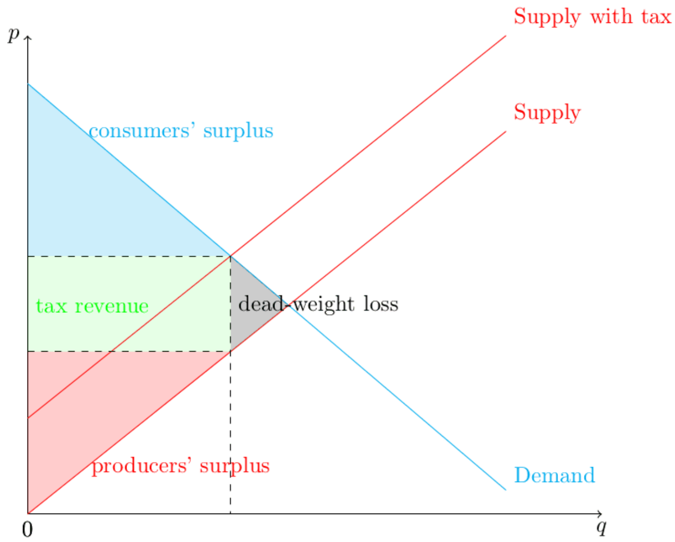
Taxes change how things are bought and sold. When there's a tax, people who buy things pay more, and people who sell things receive less money, no matter who the tax is on. Tax incidence shows how the burden of the tax is divided between buyers and sellers.

The tax has several effects:

- Quantity of goods sold decreases.
- Sales decrease after the tax is applied.
- The tax burden is shared between buyers and sellers, no matter who the tax is imposed on.
- There is a loss of welfare (deadweight loss).

Exercise 13.1. Tax consumer
Figure 13.3 illustrates the consequences of a fixed excise tax and its implied deadweight loss when the producers have to pay the tax (an excise tax is a tax imposed by the government that applies when a producer makes a sale. A fixed excise tax is an amount that the seller must return to the government for each unit sold to a customer).

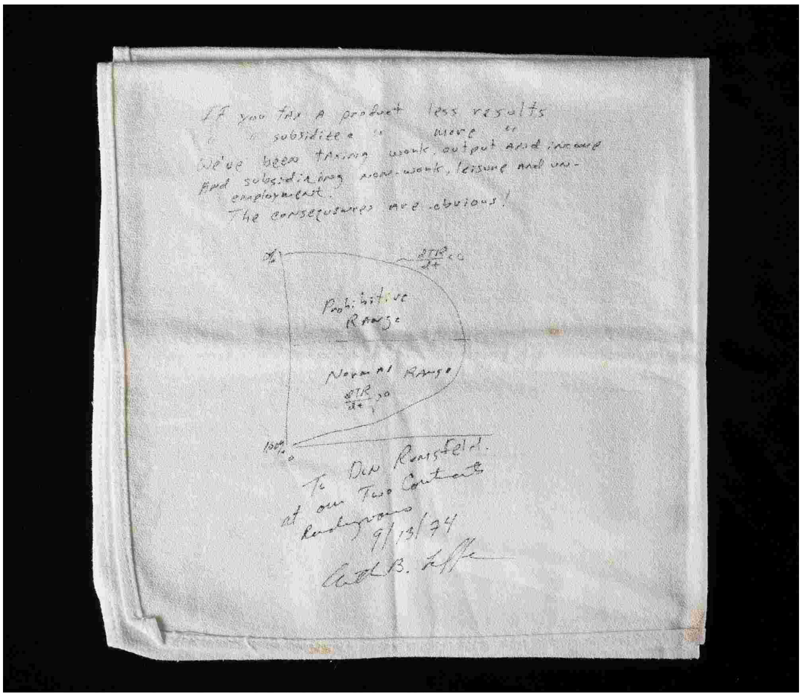
Figure 13.3: Welfare implications of a tax



Sketch a similar figure: - When the consumer has to pay the tax. - When there is a price ceiling (a market where exchanges are not permitted above a certain price). - When there is a price floor (a market where exchanges are not permitted under a certain price).

Exercise 13.2. Laffer curve
The so-called Laffer curve is an economic concept that illustrates the relationship between tax rates and tax revenue. It is named after economist Arthur Laffer, who sketched the curve in 1974 on a napkin while talking to Dick Cheney and Donald Rumsfeld, two former important US politicians. The curve suggests that there exists a tax rate that maximizes government revenue. At very low and very high tax rates, the government revenue generated may be relatively low, as taxpayers either have little incentive to work (at very high rates) or can evade taxes (at very low rates).

Figure 13.4: Laffer's napkin



Source: National Museum of American History, see: Link.

Now, visit this interactive graph and consider the Laffer curve. What is the impact of the supply and demand elasticity? Can you always spot consumer surplus, producer surplus, tax revenue, and deadweight loss?

13.4 Subsidies

Subsidies are like negative taxes, producing the opposite impacts of taxes, which include:

- More quantity being bought and sold.
- A boost in total sales due to the subsidy.
- The benefits are shared between buyers and sellers, regardless of who receives the subsidy.

Exercise 13.3. Minimum wage
Analyze the welfare effects of a minimum wage that is above the market clearing equilibrium wage.

Exercise 13.4. Social surplus
The demand and supply functions in a competitive market are given by

$$p = 20 - \frac{1}{2}q$$

and

$$p = 5 + q$$

a. What is the equilibrium quantity in this market?
b. What is the equilibrium price in this market?
c. If the price was 10% higher than the market equilibrium, what would be the excess supply?

d. If the price was 20% lower than the market equilibrium, what would be the amount of shortage?
e. What is the consumers' surplus in this market?
f. What is the social surplus in this market?

Solution

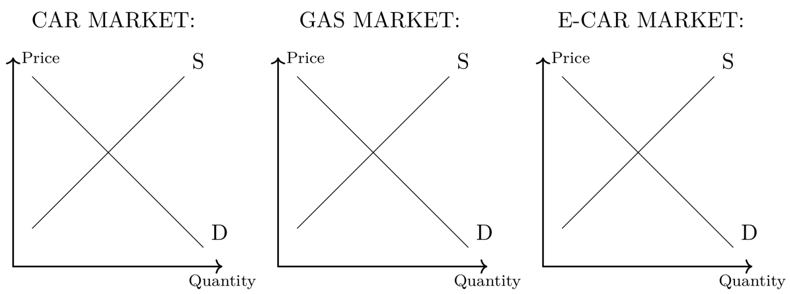
a. 10
b. 15
c. 4.5
d. 9
e. 25
f. 75

Exercise 13.5. Markets are connected
Read section Emerson (2019, ch. 11.1) and solve the following tasks.
Consider the following goods: gasoline powered cars (*cars*), electricity powered cars (*e-cars*), and gasoline (*gas*).

1. Are the goods *cars* and *gas* more likely to be substitutes or complements? Explain your decision.
2. Indicate whether the following pairs of goods are more likely to be substitutes or complements: (1) cars and e-cars (2) e-cars and gas.
3. Suppose a new, easily accessible, and large oil field is found. As a consequence, you expect that the price for gasoline will fall. Analyze the impact of this exogenous shock on the three markets in further detail. Assume that the price of gasoline does not alter the production of *cars* and *e-cars*.

The three plots in Figure 13.5 represent the three markets where the supply function S and demand functions $D $ refer to the market circumstances before the exogenous shock has happened.
Sketch in the three plots — for each market — shifts of the supply function and/or the demand function that may happen due to the exogenous shock. Discuss the new equilibrium prices and quantities in the respective markets.

Figure 13.5: Demand and supply in three markets



Chapter 14

Monopoly

Recommended reading:

Emerson (2019, ch. 15), Anon (2020, ch. 10)

Learning objectives:

Students will be able to:

- Describe the characteristics and implications of a monopolistic market structure.
- Identify the relationship between price, marginal revenue, and marginal cost in a monopoly.
- Judge the market power of firms using concepts such as the Lerner index and price elasticity of demand.
- Investigate the effects of monopolistic pricing on consumer welfare and total welfare in a market.
- Discuss real-world examples of monopolies and the challenges they face in terms of competition and regulation.

14.1 Introduction

A monopolist is a firm that is the only provider of a good or service. There is no close substitute to it. The ability of a monopolist to raise its price above the competitive level by reducing output is known as *market power*. This implies a loss of total welfare. In contrast with a perfectly competitive firm which faces a perfectly elastic demand (taking price as given), a monopolist faces the market demand. As a consequence, a monopolist has the power to set the market price. While we can consider a competitive firm as a *price taker*, a monopolist is price decision-maker or *price setter*. Firms that have to face fierce competition are more like price takers as they cannot set the price above the market price. If firms in perfect competition would set the price higher, all consumers would simply stop buying from that particular firm. That is not the case for a firm with market power, that is, a firm that has a product with unique features no other competitor has to offer.

In real markets, it is challenging to find a 100% clear monopoly, as there is usually some form of substitute available—even if imperfect. Nonetheless, several sectors in Germany are characterized by natural or legal monopolies. Deutsche Bahn (DB), the state-owned railway company, holds a near-monopoly on long-distance rail infrastructure and many regional routes, with only limited competition from private operators. Deutsche Post (DHL Group), although officially deregulated since 2008, continues to dominate traditional mail delivery, particularly for letters and official documents, and maintains a strong position in logistics. The Federal Printing Office (Bundesdruckerei) holds a monopoly on the production of sensitive government documents such as passports, ID cards, and tax labels. Additionally, municipal utilities (Stadtwerke) in many German towns operate as local monopolies for electricity, water, and gas supply, even though the energy market itself is open to alternative providers.

14.2 Revenue and price relationship

There are two types of constraints that restrict the behavior of a monopolist (and any other firm):

- Technological constraints summarized in the cost function $C(x)$.
- Demand constraints: $x(p)$.

Thus, we can write the revenue (or profit) function of the monopolist in two alternative ways:

1. Either by using the demand function:

$$\pi(p) = px(p) - C(x(p))$$

2. Or by using the inverse demand function:

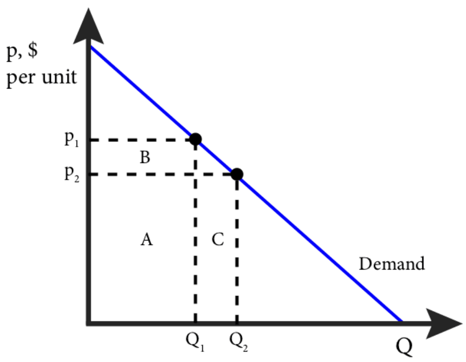
$$\pi(x) = p(x)x - C(x)$$

The demand, $x(p)$, and the inverse demand, $p(x)$, represent the same relationship between price and demanded quantity from different points of view. The demand function is a complete description of the demanded quantity at each price, whereas the inverse demand gives us the maximum price at which a given output x may be sold in the market.

Thus, an increase in production by a monopolist has two opposing effects on revenue:

- A **quantity effect**: one more unit is sold, increasing total revenue by the price at which the unit is sold.
- A **price effect**: in order to sell the last unit, the monopolist must cut the market price on all units sold. This decreases total revenue.

Figure 14.1: Price effects and revenue



Source: Graph is taken from Emerson (2019).

The two effects are shown in figure Figure 14.1: At price p_1, the total revenue is $p_1 \cdot Q_1$, which is represented by the areas A+B. At price p_2, the total revenue is $p_2 \cdot Q_2$, which is represented by the areas A+C. Area A is the same for both, so the marginal revenue is the difference between B and C or C-B. Note that area C is the price, p_2, times the change in quantity, $Q_2 - Q_1$, or $p\Delta Q$; and area B is the quantity, Q_1, times the change in price, $p_2 - p_1$, or $\Delta p \cdot Q$. Since $p_2 - p_1$ is negative, the change in total revenue is C-B or: $\Delta TR = p\Delta Q + \Delta p \cdot Q$. Dividing both sides by ΔQ gives us an expression for marginal revenue:

$$MR = \frac{\Delta TR}{\Delta Q} = \underbrace{p}_{\text{quantity effect}} + \underbrace{Q\frac{\Delta p}{\Delta Q}}_{\text{price effect}}$$

14.3 Profit maximization

To find the profit-maximizing price and quantity, respectively, we should look at the first-order conditions:

$$\begin{aligned}\max_p \pi(p) \equiv \max_p \quad & px(p) - C(x(p)) \\ \frac{\partial \pi(p)}{\partial p} = & \pi'(p) = x(p) + px'(p) - C'(x(p))x'(p) \stackrel{!}{=} 0\end{aligned}$$

or

$$\begin{aligned}\max_p \pi(x) \equiv \max_x \quad & p(x)x - C(x) \\ \frac{\partial \pi(x)}{\partial x} = & \pi'(p) = \underbrace{p(x)}_{\text{quantity effect}} + \underbrace{xp'(x)}_{\text{price effect}} - C'(x) \stackrel{!}{=} \qquad 0 \\ \Rightarrow \underbrace{p(x) + xp'(x)}_{\text{marginal revenue}} = & \underbrace{C'(x)}_{\text{marginal costs}} \\ \Rightarrow MR = & MC\end{aligned}$$

At the profit-maximizing level of output, **marginal revenue equals marginal cost**, that is, an infinitesimal change in the level of output changes revenue and cost equally. In other words, an infinitesimal increase in the level of output increases revenue and cost by the same amount, and an infinitesimal decrease in the level of output reduces revenue and cost by the same amount.

Thus, we can determine a monopoly firm's profit-maximizing price and output by following three steps:

1. Determine the demand, marginal revenue, and marginal cost curves.
2. Select the output level at which the marginal revenue and marginal cost curves intersect.
3. Determine from the demand curve the price at which that output can be sold.

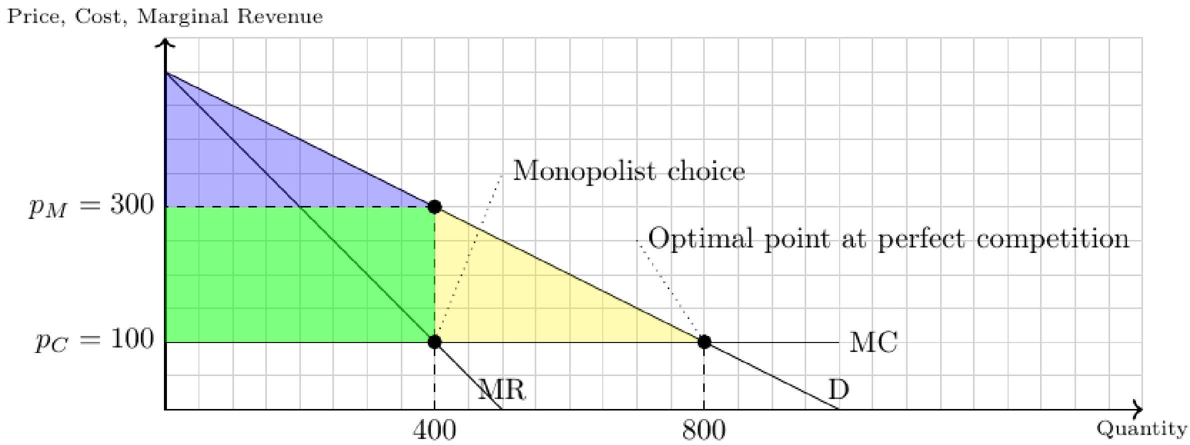
14.4 Price effect

Due to the price effect of an increase in output, the marginal revenue curve of a firm with market power always lies below its demand curve. So, a profit-maximizing monopolist chooses the output level at which marginal cost is equal to marginal revenue—not equal to price. As a result, the monopolist **produces less and sells its output at a higher price than a perfectly competitive industry would**. It earns a profit in the short run and the long run.

14.5 Welfare loss

As illustrated in Figure Figure 14.2, the price-setting behavior of a monopolist typically leads to a reduction in overall welfare: The shaded green area represents the *monopoly profit*, and the blue area denotes the *consumer surplus*, the sum of both constitute the total welfare. The yellow triangle represents the deadweight loss, indicating the welfare that is lost due to the monopolist producing fewer goods at a higher price than in a competitive market. The horizontal line at $p = 100$ represents the marginal costs (MC).

Figure 14.2: Price setting of a monopolist



14.6 Market power

We know that the demand elasticity of price can be measured with:

$$\frac{\triangle p/\bar{p}}{\triangle x/\bar{x}}.$$

Using differential calculus, the point-price elasticity of demand (PPD) can be written as:

$$PPD = \frac{\partial p(x)}{\partial x} \cdot \frac{x}{p(x)}$$

This can also be expressed as:

$$PPD = p'(x)\frac{x}{p(x)} = x\frac{p'(x)}{p(x)}$$

Thus, if $PPD = 0$, the price does not change if a single firm increases its quantity sold on the market. That means the firms are price takers, and their quantity sold has no impact on the price. If firms, however, have market power, $PPD < 0$, which means that if a firm increases the quantity on the market, the price must fall. **The PPD can hence be interpreted as an indicator of the market power of firms.**

14.7 Marginal revenue

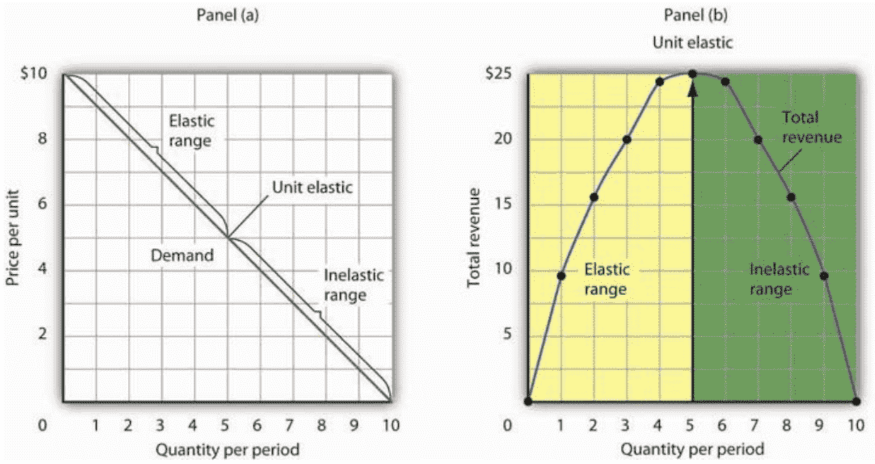
Now, plugging the PPD into the MR function, we can show that MR is equal to zero when we have a unit demand elasticity, PPD, of -1:

$$MR = p(x) + xp'(x) = p(x)\left(1 + x\frac{p'(x)}{p(x)}\right) = p(x)\,(1 + PPD)$$

Also see figure Figure 14.3. In the monopoly output, marginal revenue and marginal cost are equal:

$$MC = p(x) \cdot (1 + PPD)$$

Figure 14.3: Price setting of a monopolist



Suppose a monopolist faces the downward-sloping demand curve shown in Panel (a). In order to increase the quantity sold, it must cut the price. Total revenue is found by multiplying the price and quantity sold at each price. Total revenue, plotted in Panel (b), is maximized at $25, when the quantity sold is 5 units and the price is $5. At that point on the demand curve, the price elasticity of demand equals −1.

Source: Anon (2020, p. 344)

14.8 Lerner index

The Lerner index is a measure of monopoly power, which equals the markup over marginal cost as a percentage of price. To obtain the Lerner index of monopoly power (or market power), let us rearrange $MC = p(x) \cdot (1 + PPD)$ as follows:

$$\frac{MC - p(x)}{p(x)} = PPD = \text{Lerner Index}$$

If a firm does not have market power ($PPD = 0$), its price equals the marginal cost. When a firm's market power is high (up to $|PPD| = \infty$), the higher the markup that a firm sets. In perfect competition, since p and MC are equal, the Lerner Index is 0. A pure monopolist, on the other hand, can theoretically charge an infinite markup, which leads us to a Lerner index of 1.

Exercise 14.1. Marginal revenue and total revenue
Show the relationship between a linear demand curve and the marginal revenue curve in one panel and the relationship of the quantity sold and the total revenue in another panel. What characterizes the price of a profit maximizing monopolist?

Solution

See: Emerson (2019, ch. 15.2): *15.2 Profit Maximization for Monopolists*, which is available here.

Exercise 14.2. How to maximize profits
A company sold a quantity of 750 goods ($Q_{t=1} = 750$) in January ($t = 1$), at a price of 45 Euro ($P_{t=1} = 45$). In February ($t = 2$), they reduced the price to 40 Euro ($P_{t=2} = 40$) and sold 800 goods ($Q_{t=2} = 800$). Now answer the following questions knowing that the total costs had been 26,500 € in January and 28,000 € in February.

1. Derive the (linear) demand function.
2. Derive the cost function.
3. Derive the revenue function.

4. Derive the marginal revenue function.
5. Derive the marginal cost function.
6. Calculate the profit-maximizing price and output.
7. Calculate the amount of profit in January, February, and what the company can expect by setting the prices profit-maximizing.

Solution

1. The demand function can be derived using the point-slope formula[1] and one sales point:

$$P - 40 = -\frac{1}{10}(Q - 800) \tag{14.1}$$
$$\Leftrightarrow P = 120 - \frac{1}{10}Q \tag{14.2}$$
$$\Leftrightarrow Q = 1200 - 10P \tag{14.3}$$

2. Total costs (TC) are given by fixed costs (FC) and variable costs (VC):

$$TC = FC + \underbrace{VC}_{MC \cdot Q} = FC + MC \cdot Q.$$

MC denotes marginal costs. Solving the system of equations:

$$26500 = FC + 750 \cdot MC$$
$$28000 = FC + 800 \cdot MC$$

we find that ($MC = 30$) and ($FC = 4000$). The cost function is:

$$TC = 4000 + 30 \cdot Q.$$

3. The revenue function is given by:

$$TR = P \cdot Q(P).$$

Plugging the demand function in gives:

$$TR(Q) = 120Q - \frac{1}{10}Q^2.$$

4. The marginal revenue function is:

$$\frac{\partial TR(Q)}{\partial Q} = 120 - \frac{2}{10}Q.$$

5. The marginal cost function is:

$$MC = 30$$

(as found in step 3).
6. Setting ($MC = MR$), we find the optimal quantity:

$$30 = 120 - \frac{2}{10}Q \Rightarrow Q^* = 450.$$

Plugging (Q^) into the demand function, we find the optimal price:

$$P^{=}120 - \frac{1}{10} \cdot 450 = 75.$$

7. Profit (π) is given by $\pi = TR - TC$:

$$\pi_{t=1} = 1200 \cdot 75 - 10 \cdot 75^2 - 4000 - 30 \cdot 750 = 7250$$
$$\pi_{t=2} = 1200 \cdot 75 - 10 \cdot 75^2 - 4000 + 30 \cdot 800 = 4000$$
$$\pi_{t=3} = 12$$

14.9 Price discrimination

Discrimination is the practice of treating people differently based on some (irrelevant) characteristic, such as race or gender. It is important to actively fight discrimination whenever it is observed. However, the concept of discrimination takes a different form when it comes to *price discrimination*, which is a business practice involving the sale of the same goods at different prices to different buyers. This practice can be commonly seen in special offers tailored for students or retired individuals.

One of the key factors utilized in price discrimination is the willingness to pay (WTP) of individuals. By charging a higher price to buyers with a higher WTP, a firm can maximize its profit. Moreover, and that is kind of surprising, it also comes with a increase in social welfare as is shown in figure Figure 14.5 and figure Figure 14.5. In Figure 14.5, the monopolist charges the same price (PM) to all buyers. A deadweight loss results. In Figure 14.5, however, the monopolist produces the competitive quantity but charges each buyer his or her WTP. This is called perfect price discrimination. The monopolist captures all consumer surplus as profit. But there is no deadweight loss.

Figure 14.4: Monopoly without price discrimination and welfare

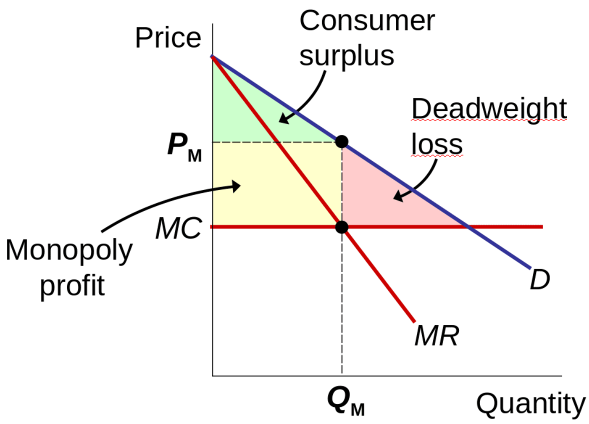
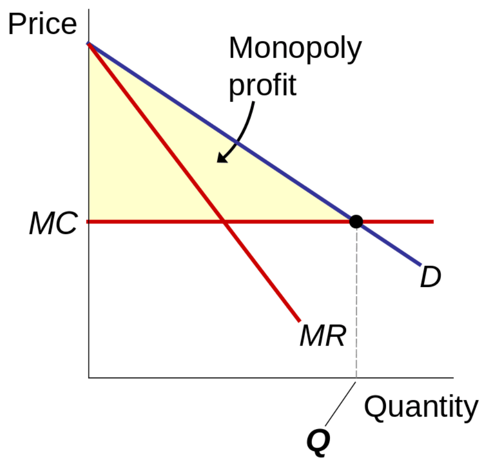


Figure 14.5: Monopoly with price discrimination and welfare



In the real world, price discrimination is a common phenomenon, but achieving perfect price discrimination is highly challenging. This is primarily because no firm possesses complete knowledge of every buyer's willingness to pay (WTP), and buyers typically do not disclose this information to sellers. Consequently, firms often divide customers into groups based on observables that are likely correlated with their WTP.

Exercise 14.3. Name and discuss examples of price discrimination in real markets.

[1] $y_2 - y_1 = m(x_2 - x_1)$

Chapter 15

Externalities

An externality is an uncompensated impact of one economically active unit's (person or firm) actions on the well-being of a bystander. It arises when a person engages in an activity that affects the well-being of a bystander and yet neither pays nor receives any compensation for that effect.

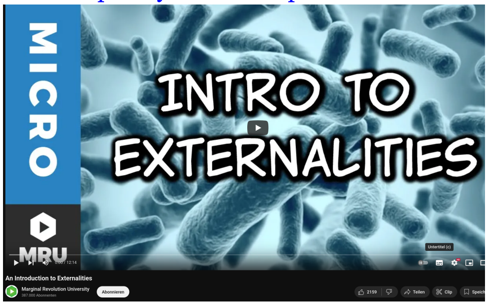
When the impact on the bystander is adverse, the externality is called a **negative externality**. When the impact on the bystander is beneficial, the externality is called a **positive externality**. Externalities cause markets to be inefficient and thus fail to maximize total surplus. Buyers/consumers and sellers/producers neglect the external effects of their actions. (Otherwise, the effects wouldn't be considered to be *external*.)

15.1 Positive and negative externalities

Watch the video shown in Figure 15.1.

Figure 15.1: Intro to externalities

https://youtu.be/CpVf11f09Pk



Source: Youtube

Example: Aluminum industry

Background: Aluminum factories emit pollution (a negative externality). For each unit of aluminum produced, a certain amount of smoke enters the atmosphere. The smoke poses a health risk for innocent bystanders who breathe the air.

How does a negative externality affect the efficiency of the market outcome?

- The cost to society of producing aluminum is larger than the cost to the aluminum producers.
- The social cost includes the private costs of the aluminum producers plus the costs of the bystanders impacted by the pollution.
- The social-cost curve is above the supply curve (because it adds the external costs of aluminum production).

- The socially optimal equilibrium (intersection of social-cost curve and demand curve) is different from the actual equilibrium (where externalities are not considered).

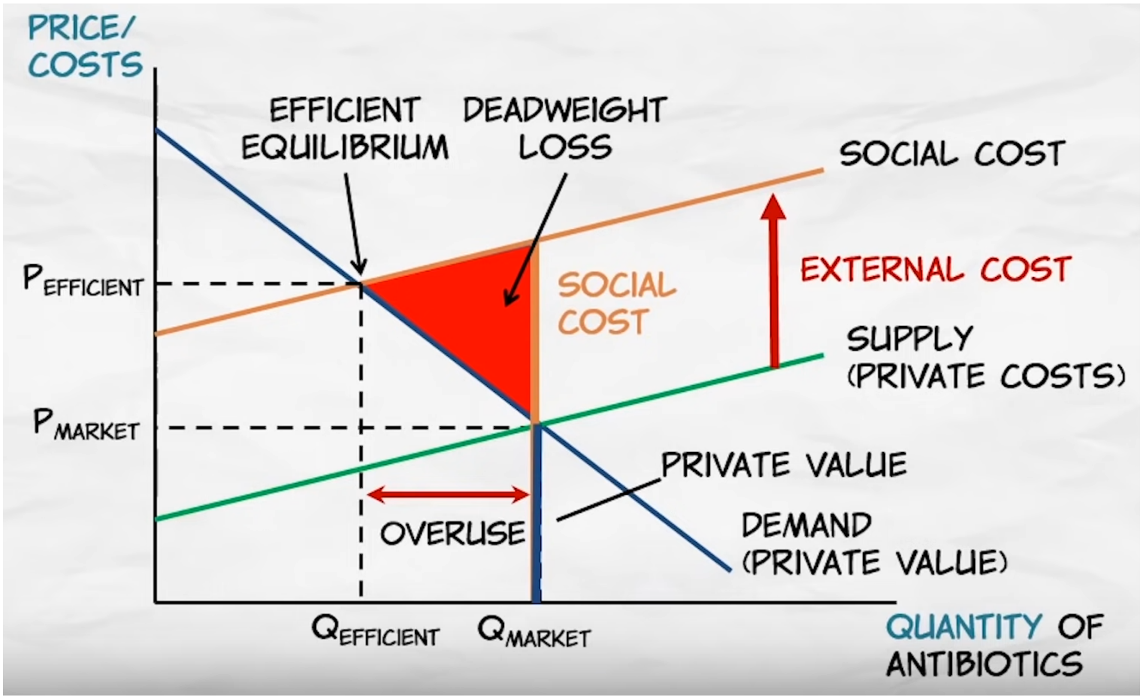
One solution: Policymakers can tax aluminum producers for each ton of aluminum sold. The tax shifts the supply curve upward by the size of the tax. The tax should reflect the external cost of pollutants released into the atmosphere (in order to match the social-cost curve). The new market equilibrium would result in the socially optimal quantity of aluminum.

Another solution: Internalizing the externality: Altering incentives so that people and firms account for the external effects of their actions.

Alternatives: If property rights were clearly defined, we would have a (theoretical) chance of a market solution. However, the transaction costs are probably simply too high, as all people are harmed, necessitating that all people bargain with the polluting firms.

Exercise 15.1. Give examples of positive and negative externalities. Distinguish whether the externalities stem from consumption or production. Discuss the visualization shown in Figure 15.2.

Figure 15.2: External cost



Source: Taken from the video of Figure 15.1.

15.2 Production externalities

Production externalities refer to a side effect from an industrial operation, such as a paper mill producing waste that is dumped into a river. They are usually unintended, and their impacts are typically unrelated to and unsolicited by anyone. They can have economic, social, or environmental side effects. Production externalities can be measured in terms of the difference between the actual cost of production of the good and the real cost of this production to society at large. The impact of production externalities can be positive or negative or a combination of both.

Examples of production externalities:

- (+) The construction and operation of an airport will benefit local businesses because of increased accessibility.

- (+) An industrial company providing first aid classes for employees to increase workplace safety. This may also save lives outside the factory.
- (+) A foreign firm that demonstrates up-to-date technologies to local firms and improves their productivity.
- (+) Many sectors participate in technological innovation that happens in one sector (technological spillovers).
- (-) Noise pollution produced by a productive unit.
- (-) Increased usage of antibiotics propagates increased antibiotic-resistant infections.
- (-) The development of ill health, notably early-onset Type II diabetes and metabolic syndrome, as a result of companies over-processing foods including the addition of (too much) sugar.

Formally

Production externalities happen because the output of one productive unit (unit 1) is a function of the amount of output of another productive unit (unit 2).

$$y_1 = f_1(L_1, K_1, y_2) \tag{15.1}$$
$$y_2 = f_2(L_2, K_2). \tag{15.2}$$

If $\frac{\partial y_1}{y_2} < 0$, it indicates a negative external effect; if $\frac{\partial y_1}{y_2} > 0$, it indicates a positive external effect. In the case of positive (negative) external effects, the welfare optimum would require more (less) production of productive unit 2.

15.3 Consumption externalities

Examples of consumption externalities:

- (+) Going to university. Your education benefits the rest of society (you can teach others).
- (+) Taking medicine or a vaccine which prevents the spread of infectious disease.
- (-) Consuming fireworks causes damage to the environment and to the health of other people.
- (-) Driving a car pollutes the environment and injures people.
- (-) Smoking and eating unhealthily may cause costs for other people.

Formally

Consumption externalities occur because the utility of one individual is determined by the consumption of good $z_1 $ but also by the amount another individual is consuming from good $z_2 $:

$$u_1 = f_1(z_1, z_2) \tag{15.3}$$
$$u_2 = f_2(z_2). \tag{15.4}$$

If $\frac{\partial u_1}{z_2} < 0$, it indicates a negative external effect; if $\frac{\partial u_1}{z_2} > 0$, it indicates a positive external effect. Alternatively, the utility of an individual can be determined by the utility level of another individual:

$$u_1 = f_1(z_1, u_2)u_2 = f_2(z_2).$$

If $\frac{\partial u_1}{u_2} < 0$, it indicates a negative external effect; if $\frac{\partial u_1}{u_2} > 0$, it indicates a positive external effect. In the case of positive (negative) external effects, the welfare optimum would require more (less) of the consumption of good $z_2 $.

15.4 Government interventions

Governments can manage externalities in two ways:

1. **Command-and-control policies** which regulate behavior directly. Regulations that require or forbid certain behaviors or subsidize good behavior. Example: Making it a crime to dump hazardous chemicals into the water supply.
2. **Market-based policies** which provide incentives so that firms can determine the best way to solve a problem.
    - **Corrective tax:** A tax designed to induce private decision-makers to take into account the social costs that arise from a negative externality.
    - **Tradable permits** (aka "Cap and Trade"): For example, voluntary transfer of the right to pollute from one firm to another. The government, in effect, creates a scarce resource ("pollution permits"). The result is the creation of a market governed by supply and demand. Permits end up in the hands of firms that value them most highly. *Tradable green certificates* of the EU are financial assets issued to producers of certified green electricity and can be regarded as a market-based environmental subsidy.

15.5 Private solutions to externalities

In some cases, government intervention is not necessarily needed to address externalities and to coordinate the behavior of market participants. For instance, if your neighbor plays loud music, you can talk to him and bargain for a good solution that leaves both parties better off.

Some types of private solutions include: - Moral codes and social sanctions. - Charitable and private organizations that aim to help and bring people together.

15.6 The Coase theorem

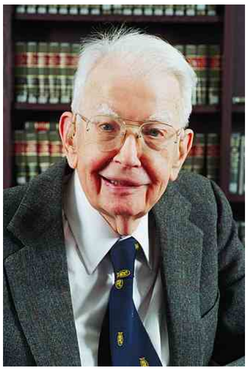
The Coase Theorem is named after Ronald Coase, a Nobel laureate of 1991 (see Figure 15.3). It states that if property rights exist and transaction costs are low, private transactions are efficient. In other words, with property rights and low transaction costs, there are no externalities. All costs and benefits are taken into account by the transacting parties. Thus, it doesn't matter how the property rights are assigned as long as they are assigned. The theorem posits that if private parties can bargain without cost over the allocation of resources, they can solve the problem of externalities on their own. However, the theorem only works when the relevant parties can come to an agreement and are able to enforce that agreement. This is often not the case.

Transaction costs, in this respect, refer to the costs that parties incur during the process of agreeing to and following through on a bargain. Efficient bargaining becomes increasingly difficult when the number of interested parties is large. Coordinating more people is costly, and the more individuals involved, the less likely it is that private transactions yield a successful, efficient market outcome.

15.7 Imperfect information

In previous sections, we assumed that households and firms have perfect information on products and inputs. For example, to make good choices among goods and services available in the market, consumers must have full information on product quality, availability, and price. To make sound judgments about what inputs to use, producers must have full information on input availability, quality, and price. If this information is not available, consumers and producers are likely to make mistakes.

Figure 15.3: Ronald H. Coase (1910-2013)



15.8 Moral hazard

An information problem that arises in insurance markets is **moral hazard**. Often, people enter into contracts in which the outcome of the contract depends on one of the parties' future behavior. A **moral hazard** problem arises when one party to a contract passes the cost of his or her behavior onto the other party to the contract. In other words, **moral hazard** is a situation in which one party engages in risky behavior or fails to act in good faith because it knows the other party bears the economic consequences of their behavior.

15.9 Information asymmetry

When participants in an economic transaction have different information about the transaction, information is spread asymmetrically. This often causes inefficient markets. For example, in the healthcare market, there is a significant amount of information asymmetry, as doctors and suppliers of medical products and services possess much more knowledge on the topic and may use that informational advantage to offer overpriced and possibly unnecessary products and treatments.

15.10 Adverse selection

This sort of imperfect information occurs when a buyer or seller enters into an exchange with another party who has more information. For example, suppose there are two types of workers: lazy workers and hard workers. Each worker knows which they are, but employers cannot tell. If there is only one wage rate, lazy workers will be overpaid and hard workers will be underpaid relative to their productivity.

Another example is the secondhand car market. Suppose buyers cannot distinguish between a high-quality car (a cherry) and a low-quality car (a lemon), but sellers know the quality of their cars. Buyers would be willing to pay €6000 for a good car and €2000 for a bad car. If half of the cars for sale are good and half are bad, the market price of a car would be €4000.

Moreover, the asymmetric information yields a so-called **adverse selection** problem. That is, used car sellers know they are getting far more than their cars are worth by selling at €4000, while owners of good cars know they are getting far less than their cars are really worth. Thus, more lemon owners are attracted into selling their cars than are cherry owners. This sort of market is known as a **market for lemons**, named after the article *The Market for Lemons: Quality Uncertainty and the Market Mechanism* by George Akerlof (1970) (see Figure 15.4), the Nobel laureate of 2001.

Exercise 15.2. Market failure review

1. What is an external effect? Explain in detail and define the terms **external benefit** and **external cost**.

Figure 15.4: George A. Akerlof (*1940)

2. What does it mean **to internalize an external effect**?
3. What is a public good? Define briefly.
4. What is the free-rider problem and how does government help to overcome it?
5. Why is it so important to have a monopoly control commission?
6. What do property rights have to do with externalities? What are the conditions that must hold so that private market transactions can eliminate external effects?
7. What are good reasons for the government to tax people and restrict civil rights and liberties?

Solution

1. An **externality** is a cost or benefit of a production or consumption activity that spills over to affect people other than those who decide the scale of the activity.
   An **external cost** is the cost of producing a good or service that is not borne by its consumers or producers but by other people.
   An **external benefit** is the benefit of consuming a good or service that does not accrue to its consumers or producers but to other people.

2. In order to eliminate market failures caused by externalities, it is necessary to intervene in the market in a way to encourage consumers and producers to change their rational choices so that they produce or purchase quantities that are closer to the social optimum, correcting efficiency deviations of externalities. This correction process is called **internalization of externalities**. In other words, when a person considers the consequences of his market transactions on individuals that are not part of the market transaction itself, we say he has **internalized the external effects** of his actions.

3. A **public good** is a good or service that can be consumed simultaneously by everyone and from which no one can be excluded. Public goods are **non-rival** in consumption, meaning one person's consumption of the good does not affect the quantity available for anyone else. Public goods are **non-excludable** if it is impossible to prevent someone from benefiting from a good without having paid for it.

4. Public goods create a **free-rider problem**. A free-rider is a person who consumes a good without paying for it. Markets fail to supply a public good because no one has an incentive to pay for it. The government can provide the public good and finance the costs with taxes and other duties. The challenge here is to find the optimal level of provision for public goods.

5. The rent-seeking behavior of a monopolist prevents the allocation of resources from being efficient. Markets fail when monopoly power exists, as a monopolist increases profit by restrict-

ing output and increasing price. A major activity of government is to regulate monopolies and enforce laws that prevent cartels and other restrictions on competition.

6. If property rights are assigned, externalities can be eliminated by private parties bargaining for a jointly optimal solution. This holds only if there are no transaction costs or other market imperfections, like imperfect information, and if enforcement is possible.

7. Any sort of market failure can act as a legitimate reason for the government to intervene in the market. Economists, however, have different viewpoints regarding whether or not (and how) government should intervene. An often-mentioned criterion is the Pareto criterion: If an intervention yields a Pareto improvement, meaning a change that harms no one and helps at least one person, most economists would support the policy intervention. However, it is hard to think of any real-world market intervention that actually does not harm anybody. Thus, it is often – to some extent – a normative judgment whether to support a market intervention or not. The main argument for market interventions in the case of market failure is that the intervention can improve overall welfare; hence it is **just** a matter of redistributing endowments and output, respectively. In other words, when the overall output increases due to government action, those who were harmed by the intervention can be compensated so that nobody is worse off due to the government action, while at least some are better off. While this may be theoretically clear and true, it may be practically hard to implement because it is challenging to identify losers and to calculate their loss. Thus, any market intervention and government activity should be discussed transparently (especially with respect to normative views), with an open mind and by protecting minorities that may be the losers of a government action.

Exercise 15.3. Externalities examples
For each of the examples below, the following questions will be answered:

1. Does an externality exist? If so, classify the externality as positive/negative (or both).
2. If an externality exists, determine whether the Coase theorem applies (i.e., is it possible or reasonably feasible to assign property rights and solve the problem?).
3. If an externality exists and the Coase Theorem does not apply, argue which of the government's tools are best suited to address the issue: quantity regulation, taxes/subsidies, tradable permits, or something else.

Examples:

1. **British Petroleum drills for oil in the Gulf Coast**

   Solution

   - a) Yes. You can either think of there being a negative externality (accidents on oil rigs cause spills, which negatively affect other inhabitants of the Gulf states) or a positive externality (identifying where oil is allows other companies to drill for oil more effectively because they know where it is).
   - b) If oil spills only damage property, and these property owners can costlessly recoup costs in the legal system, then the drillers will internalize the impact of their drilling on the social cost of the oil spill. However, if it is hard to determine the true costs from an oil spill (e.g., it may be hard to figure out whether someone lost their job because of an oil spill or some other reason), then the Coase Theorem may not apply. In the positive externality case, it may be difficult to assign property rights to an oil field after it is identified, so the Coase Theorem may not apply.
   - c) Quantity regulation on the amount of safety/advanced drilling technology investments seems feasible. One could also argue for subsidies for safer drilling technologies (or taxes on less safe technologies). Tradable permits seem difficult to implement here.

2. **Carbon emissions from vehicles**

Solution

- a) Yes. I drive my car which emits gases that harm others, whose harm I do not pay for.
- b) The Coase Theorem is difficult to apply since it would require assigning property rights to those who are harmed. Since many of the harmed are dispersed (e.g., driving in Charlotte theoretically harms everyone in the world a small amount) and in some cases involves the "unborn" (future generations facing global warming), the feasibility of negotiated private contracts is highly questionable.
- c) If we believe that the social marginal benefit curve is flat (horizontal), we would want to price the carbon using a tax. Quantity regulation would require different quantities for each producer of carbon, but each individual has different marginal costs, making this difficult. Perhaps we can also do quantity regulation with tradable permits to address the issue of not knowing the costs.

3. **Your upstairs neighbors throwing an awesome but loud party**

   Solution

   - a) Yes, an externality exists, but it may be positive or negative depending on your tastes and preferences.
   - b) The Coase Theorem would require the neighbors to own rights to holding the party. Then the neighbors would pay other neighbors to have (or not have) the party. This could work (so an answer of "yes" is fine). However, in reality, there are likely many different people affected by the party (e.g., multiple neighbors hate the noise). Bargaining with all parties may allow one party to "hold-up" the others, rendering the Coase theorem inapplicable.
   - c) The best solution may be a community agreement or regulation regarding noise levels during certain hours.

4. **Buying a car with added safety features that prevent drivers/passengers' deaths in the event of an accident**

   Solution

   - a) It depends. If people drive more recklessly as a result of having a safer car, then buying the safety feature imposes a negative externality on other drivers. If having a safety feature does not change the likelihood of an accident or the impact on other cars, then there is no externality.
   - b) The Coase Theorem does not apply: it would be incredibly difficult to write a contract with those with whom you may eventually be engaged in a car accident.
   - c) Quantity regulation (e.g., regulating the safety feature, or preventing it) or taxation would potentially correct the externality. It seems strange, but theoretically we would want to tax the safety feature if it leads to more reckless driving.

5. **Bringing crying babies on a plane**

   Solution

   - a) Yes, obviously negative.
   - b) The Coase Theorem does not apply.
   - c) One solution could be to tax parents who bring babies on the plane and redistribute that tax to those who are exposed to the crying around the baby on the plane. Airlines could also potentially intervene and lower the ticket price for everyone seated nearby who has to listen to the baby crying (or serve free drinks/snacks when a baby starts crying).

Exercise 15.4. Tax a market failure
The private marginal benefit (PMB) associated with a product's consumption is given by:

$$PMB = 360 - 4Q$$

The private marginal cost (PMC) associated with its production is:

$$PMC = 6Q$$

Furthermore, the marginal (external) damage (MD) associated with this good's production is:

$$MD = 2Q$$

Questions:

1. Calculate how much private production and hence consumption is in a free market.
2. Calculate the social optimal quantity consumed.
3. As there is an external effect, the government decides to intervene and correct the externality by imposing a tax of T per unit consumed. What tax should it set to achieve the social optimum?
4. Can you think of other ways for the government to intervene?

Solution

1. **Private production and consumption in a free market:**
   To find the quantity produced and consumed in a free market, set PMB equal to PMC:

$$PMB = PMC$$

$$360 - 4Q = 6Q$$

   Solving this equation:

$$360 = 10Q$$

$$Q_F^* = 36$$

   Answer: In a free market, 36 units are produced and consumed.

2. **Social optimal quantity consumed:**
   To determine the socially optimal quantity, we must account for the marginal external damage (MD) by adding it to PMC. The equation becomes:

$$MD + PMC = PMB$$

$$2Q + 6Q = 360 - 4Q$$

   Simplifying this gives:

$$8Q = 360 - 4Q$$

   Solving for (Q_S^*):

$$12Q = 360$$

$$Q_S^* = 30$$

Answer: The social optimum quantity of consumption would be 30 units.

3. **Tax to achieve the social optimum:**
   To determine the required tax (T), set PMB equal to PMC plus tax:

$$PMB = PMC + T$$

   Substituting (Q = 30):

$$360 - 4Q = 6Q + T$$

   Plugging in (Q = 30):

$$360 - 4 \cdot 30 = 6 \cdot 30 + T$$

$$360 - 120 = 180 + T$$

$$T = 60$$

   Answer: A tax of 60 per unit of consumption would ensure that the social optimum quantity of 30 is consumed.

4. **Other regulations:**
   Other government interventions could include:
   - Imposing a direct restriction on the quantity produced or consumed.
   - Implementing subsidies for more environmentally friendly production methods.
   - Establishing tradeable permits for emissions related to the production of this good.
   - Promoting public awareness campaigns about the negative externalities involved.

15.11 Public goods (preliminary)

There are many goods that have no market price. These goods include things like nature (e.g., rivers, mountains, beaches, lakes) or government amenities and events (playgrounds, parks, parades). These goods face a different set of economic problems since the normal market forces that provide efficient allocation are absent.

Economic goods can be grouped according to the following characteristics:

- **Excludability:** The property of a good whereby a person can be prevented from using it.
- **Rivalry in consumption:** The property of a good whereby one person's use diminishes other people's use.

Using the above characteristics, it is possible to categorize goods into four categories:

1. **Private goods:** Goods that are both excludable and rival in consumption.
   - **Example:** An ice cream cone. It is excludable because you can prevent someone from eating one. It is rival in consumption because if someone eats an ice cream cone, another person cannot eat the same cone.
2. **Public goods:** Goods that are neither excludable nor rival in consumption.

  - **Example:** A tornado siren in a small town. It is not excludable because it is impossible to prevent any single person from hearing it when the siren sounds. It is not rival in consumption because when one person benefits from the warning, it does not reduce the benefit to others. Other important public goods are national defense, basic research, and fighting poverty.

3. **Common resources:** Goods that are rival in consumption but not excludable.
   - **Example:** Fish in the ocean. It is rival in consumption because when one person catches a fish, there are fewer fish for the next person to catch. It is not excludable because it is difficult to stop fishermen from catching fish from a large ocean.
4. **Club goods:** Goods that are excludable but not rival in consumption.
   - **Example:** Fire protection in a small town. It is excludable because the fire department can decide not to save a building from a fire. It is not rival in consumption because once paid for, the additional cost of protecting one more house is small.

Figure 15.5: Matrix of economic goods with examples

	Excludable	Non-excludable
Rivalrous	**Private goods** food, clothing, cars, parking spaces	**Common-pool resources** fish stocks, timber, coal
Non-rivalrous	**Club goods** cinemas, private parks, satellite television	**Public goods** free-to-air television, air, national defense

Whether governments should provide public goods or not must be the result of a cost-benefit analysis that compares the costs and benefits to society of providing a public good.

Common resources

- Common resources are not excludable (like public goods). Unlike public goods, common resources are rival in consumption: one person's use degrades the resource for others.
- **Tragedy of the Commons:** A parable that illustrates why common resources are used more than is desirable from the standpoint of society as a whole.
  - Social and private incentives differ.
  - Government can solve the problem through regulation or taxes to reduce consumption.
  - Government can also solve the problem by turning the common resource into a private good.
- Some important common resources:
  - Clean air and water.
  - Congested roads.
  - Fish, whales, and other wildlife.

Switching between public and private goods

- Some goods switch between public and private goods depending on circumstances.
  - **Example:** A fireworks display performed in a town can be a public good. A fireworks display at a private amusement park (e.g., Disneyland) is a private good.
  - **Example:** A lighthouse operated by the government is a public good. A privately owned lighthouse that charges adjacent ports for operation is a private good.

The boundaries between goods are not always clear

- The characteristics of being excludable and rival in consumption can be a matter of degree.
- **Example:** Fish in an ocean may not be excludable because of practical challenges in managing ocean stocks. However, government restrictions and a large coast guard can make fish partially excludable.
- Public goods and common resources are closely related to externalities; both these goods and externalities result from something valuable having no associated price.
  - **Example:** If an individual builds and operates a tornado siren in a town, the neighbors will benefit from the siren without paying for it (positive externality).
  - **Example:** If an individual uses a common resource such as fish in the ocean, others are worse off because there are fewer fish to catch (negative externality).
- Private decisions about consumption and production can lead to an inefficient allocation of resources, and government intervention can potentially raise economic well-being.

15.12 The free-rider problem

- **Example:** A fireworks display. This good is not excludable (you cannot prevent someone from seeing fireworks) and it is not rival in consumption (because one person's enjoyment does not reduce another's enjoyment).
- **Free rider:** A person who receives the benefit of a good but avoids paying for it.
- The free-rider problem prevents the private market from supplying public goods.
- Government is one solution to this problem. If the total benefit exceeds the costs, a government can finance a public good with tax revenue.

15.13 The importance of property rights

- There are some goods that the market does not adequately address or provide for (clean air, for example).
- Governments are relied on to provide necessary common goods.
- Markets cannot allocate resources efficiently without property rights.
- Goods that do not have well-established owners lack similar incentives for firms and individual actors.
- Well-planned and necessary policies can make the allocation of resources more efficient and raise economic well-being.

Part IV

DECISION MAKING

Chapter 16

Decision making basics

Required readings: Section 11.2 of Saylor Academy (2002).

Learning objectives:

Students will be able to:

- Make informed decisions with a clear understanding of their nature and purpose.
- Identify and explain the trade-offs involved in decision-making processes.
- Describe the different characteristics of various types of decisions.
- Utilize a range of decision-making strategies effectively.
- Explain the rational decision-making model and the concept of homo economicus.
- Discuss the concept of bounded rationality and its impact on human decision-making.
- Apply heuristics to enhance decision-making in practical situations.

16.1 Definition: Decision

The statement of Eilon (1969) still holds true:

> "An examination of the literature reveals the somewhat perplexing fact that most books on management and decision theory do not contain a specific definition of what is meant by a decision. One can find detailed descriptions of decision trees, discussions of game theory and analyses of various statistical treatments of payoffs matrices under conditions of uncertainty, but the definition of the decision activity itself is often taken for granted and is associated with making a choice between alternative courses of action."

The word *decision* stems from the latin verb *decidere* which can have different meanings including

- make explicit,
- put an end to,
- bring to conclusion,
- settle/decide/agree (on),
- die,
- end up,
- fail,
- fall in ruin,
- fall/drop/hang/flow down/off/over,
- sink/drop,
- cut/notch/carve to delineate,
- detach,
- cut off/out/down,

- fell.

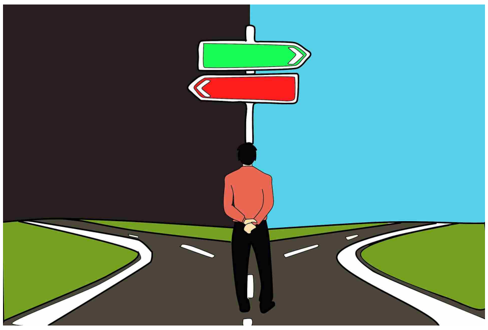
Wikipedia (2024) defines **decision making** as follows:

> "In psychology, decision-making [...] is regarded as the cognitive process resulting in the selection of a belief or a course of action among several alternative possibilities. Decision-making is the process of identifying and choosing alternatives based on the values, preferences and beliefs of the decision-maker. Every decision-making process produces a final choice, which may or may not prompt action. [...] Decision-making can be regarded as a problem-solving activity yielding a solution deemed to be optimal, or at least satisfactory. It is therefore a process which can be more or less rational or irrational..."

Let's agree on the following working definition that is symbolized in Figure 16.1:

> Fitzgerald (2002, p. 8): "A decision is the point at which a choice is made between alternative—and usually competing—options. As such, it may be seen as a stepping-off point—the moment at which a commitment is made to one course of action to the exclusion of others."

Figure 16.1: Decision-making



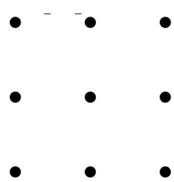
Source: Picture is taken from https://pixabay.com

Exercise 16.1. Why are you studying here?
There are probably many personal reasons why you have chosen your study program. Take a moment to think about the decisions that led you to choose this program. Think back to the moment you signed the contract - was it a difficult decision? What factors influenced your choice? Perhaps you had several options; why did you ultimately choose this degree program? Think about your decision-making process and write a short summary of how you came to this decision.

Exercise 16.2. Solve the puzzles

a) **The nine dots problem** Connect the dots shown in figure Figure 16.2 with no more than 4 straight lines without lifting your hand from the paper.

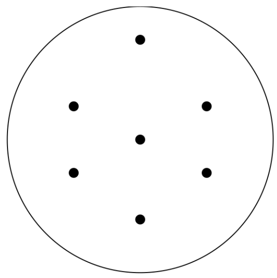
Figure 16.2: The nine dots problem



b) **The tasty cake puzzle** In figure Figure 16.3 you see a tasty cake with the nine dots representing strawberries. Cut this cake up with exactly four straight cuts so that each portion of the cake contains just one strawberry on the top.

Reflect on how you tried to solve the puzzles. Did you have a problem solving strategy? How did you come to the right decision? Think of restrictions you imposed on yourself which was not inherent to the problem.

Figure 16.3: The tasty cake puzzle

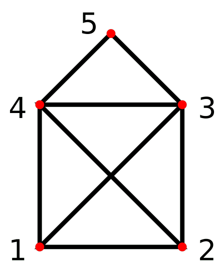


c) **The house of Santa Claus** The house of Santa Claus is an old German drawing game. It goes like this: You have to draw a house in one line where you

(1) must start at bottom left (point 1),
(2) you are not allowed to lift your pencil while drawing and
(3) it is forbidden to repeat a line.

During drawing you say: "Das ist das Haus des Nikolaus". What do you think is the success-rate of kids who play this game for the first time?

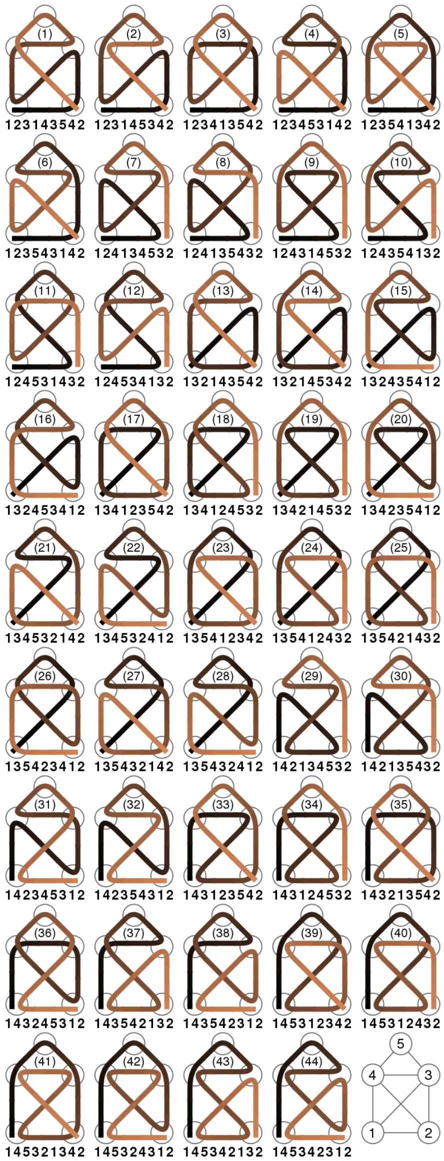
Figure 16.4: The house of Santa Claus



Solution

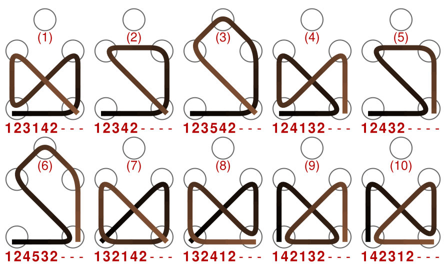
There are 44 solutions (see Figure 16.5) and only 10 different ways to fail (see Figure 16.6). Thus, the probability to fail is about 18.5% and hence the probability to succeed is about 81.5%.

Figure 16.5: Forty-four ways to solve the puzzle



Taken from wikipedia.org.

Figure 16.6: Ten ways to fail in the puzzle



Taken from wikipedia.org.

16.2 How to characterize decisions

Decision making is a process of investing time and effort to make a decision that leads to a results. Before we talk about the results, let's discuss some (stereo) types of decisions that can help to design an appropriate decision making process. Using stereotypes and categorizations can be beneficial as they simplify complexities and provide guidance. For example, we often employ stereotypes to appropriately engage with others. When encountering a person dressed formally, it is generally advisable to approach them in a professional manner, even when uncertain of their preferences. In this case, our prior experiences help guide our behavior based on stereotypes.

According to Fitzgerald (2002, p. 9f) decisions can be roughly divided into two generic types:

- **Routine decisions**: Decisions that must be made at regular intervals.
- **Non-routine**: Unique, random, non-recurring decision situations.

Another common method of dividing decisions into two categories is as follows:

- **Operative decisions**: This type of decision usually involves day-to-day business operations. There is a lot of overlap with the routine category here. Examples of this type of decision include
  - setting production levels,
  - determining employee work shifts for the upcoming week to ensure adequate coverage,
  - coordinating daily delivery routes for distributing products to customers,
  - deciding to stop production or fix a problem if quality standards are not met during routine inspections, or, when it comes to decisions in our daily lives,
  - where, what, when, and what to eat for lunch.
- **Strategic decisions**: These decisions typically concern long-term company policies and direction. Examples include
  - entering a new market or exiting an industry,
  - choosing a corporate design, or
  - acquiring a competitor.
  - In our personal lives, a strategic decision might be choosing between renting an apartment near the university or commuting from our parents' home.

People often distinguish between **decisions at work** and **private decisions**. Private decisions affect fewer people on average, but usually the people involved are closer to you personally. However, both types of decisions involve the same things such as people (human resources), money (budgeting), buying and selling (marketing), how we do something (operations) or how we want to do it in the future (strategy and planning).

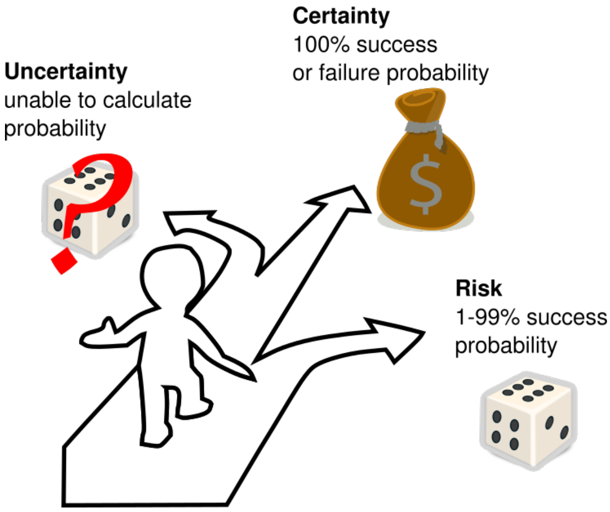
Some decisions are more important than others because the potential impact of a decision varies, that is, the **scope of a decision**. For example, decisions can affect one person or millions, one pound/dollar or millions, one product/service or an entire market, one day or ten years, etc.

However, it is not entirely clear how to validate the scope. It depends heavily on the perspective of the decision-maker. For a small company, for example, an investment of 10,000 euros may be a big decision, while for a multinational cooperation it is a drop in the ocean. So the scope for decisions is relative, not absolute. It depends entirely on the context in which the decision is made and on the characteristics of the person(s) making it.

There are three general conditions (see Figure 16.7) that determine the design of the optimal decision making process:

1. **Certainty:** A condition under which taking a decision involves reasonable degree of certainty about its result, what are the opportunities and what conditions accompany this decision.
2. **Risk:** A condition under which taking a decision involves reasonable degree of certainty about its result, what are the opportunities and what conditions accompany this decision.
3. **Uncertainty:** A condition in which decision maker does not know all the choices, as well as risks associated with each of them and possible consequences.

Figure 16.7: Conditions of decision making



Source: CEOpedia (2021)

16.3 Decision making strategies

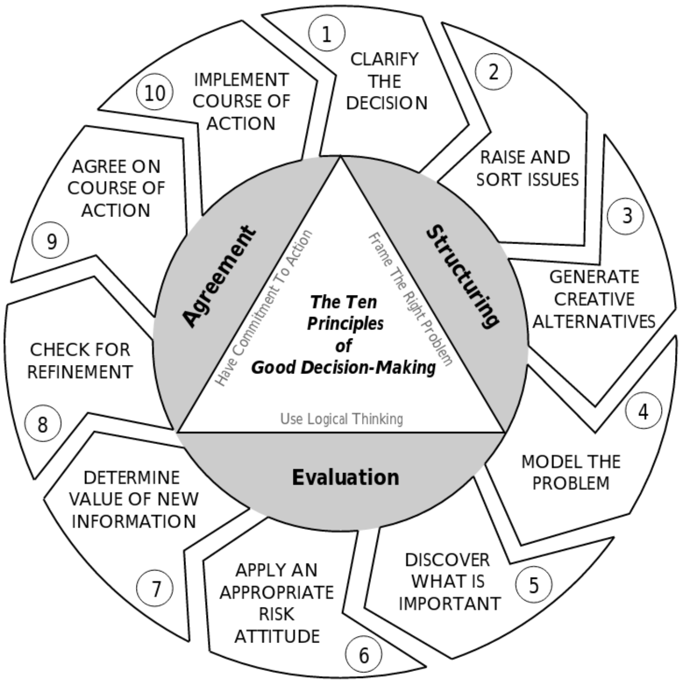
Exercise 16.3. Different schemes of a decision making process

a) Google for *"decision making strategies"* and look at the images that Google suggests you.

b) Read Indeed Editorial Team (2023) and discuss the twelve decision making strategies. The article can be found here.

c) Compare these strategies to the scheme shown in Figure 16.8.

Figure 16.8: Decision-making



Source: https://pixabay.com

d) Choose a problem of your choice and try to solve the problem using the two illustrations above by making a good decision.

e) Discuss in class whether the diagram or the strategies in Indeed Editorial Team (2023) are helpful in making a wise decision or solving a problem.

f) Watch https://youtu.be/pPIhAm_WGbQ and answer the following questions: How is the nature of decisions discussed here? Does it contain a rational model of problem solving? Reflect on which ways to solve a problem and come to a decision, respectively, have been addressed.

Exercise 16.4. The businessman and the fisherman
A classic tale that exist in different version^[This one stems from thestorytellers.com. A famous version stems from Paulo Coelho^[See https://paulocoelhoblog.com and it goes like this:

> One day a fisherman was lying on a beautiful beach, with his fishing pole propped up in the sand and his solitary line cast out into the sparkling blue surf. He was enjoying the warmth of the afternoon sun and the prospect of catching a fish.
>
> About that time, a businessman came walking down the beach, trying to relieve some of the stress of his workday. He noticed the fisherman sitting on the beach and decided to find out why this fisherman was fishing instead of working harder to make a living for himself and his family. "You aren't going to catch many fish that way", said the businessman to the fisherman.
>
> "You should be working rather than lying on the beach!" The fisherman looked up at the businessman, smiled and replied, "And what will my reward be?" "Well, you can get bigger nets and catch more fish!" was the businessman's answer. "And then what will my reward be?" asked the fisherman, still smiling. The businessman replied, "You will make money and you'll be able to buy a boat, which will then result in larger catches of fish!" "And then what will my reward be?"" asked the fisherman again.
>
> The businessman was beginning to get a little irritated with the fisherman's questions. "You can buy a bigger boat, and hire some people to work for you!" he said. "And then what will my reward be?" repeated the fisherman. The businessman was getting angry. "Don't you understand? You can build up a fleet of fishing boats, sail all over the world, and let all your employees catch fish for you!"
>
> Once again the fisherman asked, "And then what will my reward be?" The businessman was red with rage and shouted at the fisherman, "Don't you understand that you can become so rich that you will never have to work for your living again! You can spend all the rest of your days sitting on this beach, looking at the sunset. You won't have a care in the world!"
>
> The fisherman, still smiling, looked up and said, "And what do you think I'm doing right now?"

Define the cost and benefits of both persons. Who do you think has a better life overall. Who is acting rationally here? In other words, who is maximizing utility here? The fishermen or the businessmen? Both? None?

Review

- Decision analysis is about using information in order to come to a decision.
- A structured and rational process can help improve the chances of receiving good decision outcomes.
- As decision problems are often (too) complex to fully capture or solve rationally. Thus, a good decision analysis should try to use the available information and the existing understanding of the problem as transparent, consistent, and logical as possible.
- A complex decision problem should be simplified and hence decomposed into its basic and

most important components.

- There are hundred of different *schemes* or *strategies* how to make decisions in certain circumstances. Many heuristics exist how to think, behave, and calculate to come to a wise decision.
- Mostly decisions are based on subjective expectations. These expectations are difficult to validate.
- Articulating exact expectation and preferences is a difficult task and the information that stems from these articulation is full of biases. Decision analytic tools need to take that into consideration.

Chapter 17

Decision theory

Learning objectives:

Students will be able to:

- Distinguish different theories of decision making.
- Calculate the optimal decision under certainty, uncertainty, and under risk.
- Describe and use various criteria of decision making.
- Simplify complex decision making situations and use formal approaches of decision making to guide the decision making behavior of managers.

Required readings: Finne (1998)

Recommended readings: Bonanno (2017, sec. 3)

17.1 Payoff table

Every decision has consequences. While these consequences can be complex, economists often simplify decision analysis using the concept of utility. In this framework, anything positive is regarded as utility, and anything negative is viewed as disutility. Ultimately, these outcomes can be represented by a single value, which we will refer to as the "payoff."

In this sense, decision-making becomes straightforward: we simply choose the alternative that provides the highest payoff. For example, if you know the weather will be sunny, you might choose to wear a T-shirt and shorts. On a cold day, however, you would opt for warmer clothing. But since the state of nature (the weather) is not completely certain, your decision involves some degree of risk, assuming you have some idea of the likelihood of sunshine or cold weather. If you have no information about the weather at all, your decision is made under uncertainty.

In the following, I introduce the payoff table as a tool to stylize a situation in which a decision must be made. Specifically, I will describe three modes of decision-making: under certainty, under uncertainty, and under risk.

A payoff table, also known as a decision matrix, can be a helpful tool for decision making, as shown in the table below. It presents the available alternatives denoted by A_i, along with the possible future states of nature denoted by N_j. A state of nature (or simply "state") refers to the set of external factors (he has no direct power in it) that are relevant to the decision maker.

The payoff or outcome depends on both the chosen alternative and the future state of nature that occurs. For instance, if alternative A_i is chosen and state of nature N_j occurs, the resulting payoff is O_{ij}. Our goal is to choose the alternative A_i that yields the most favorable outcome O_{ij}.

The payoff is a numerical value that represents either profit, cost, or more generally, utility (benefit) or disutility (loss).

Table 17.1: Payoff matrix

State of nature (N_j)	N_1	N_2	...	N_j	...	N_n
Probability (p)	p_1	p_2	...	p_j	...	p_n
Alternative (A_i)						
A_1	O_{11}	O_{12}	...	O_{1j}	...	O_{1n}
A_2	O_{21}	O_{22}	...	O_{2j}	...	O_{2n}
...	...	...	...	...	...	...
A_i	O_{i1}	O_{i2}	...	O_{ij}	...	O_{in}
...	...	...	...	...	...	...
A_m	O_{m1}	O_{m2}	...	O_{mj}	...	O_{mn}

If we assume that all states are independent from each other and that we are certain about the state of nature, the decision is straightforward: just go for the alternative with the best outcome for each state of nature. However, most real-world scenarios are not that simple because most states of nature are more complex and needs further to be considered.

Decision making under **un**certainty assumes that we are fully **un**aware of the future state of nature.

If a decision should be made under risks, then we have some information about the probability that certain states appear. A decision under uncertainty simple means we have no information, that is, no probabilities.

> ⚠ Warning
>
> Unless stated otherwise, the outputs in a payoff table represent utility (or profits), where a higher number indicates a better outcome. However, the outputs could also represent something negative, such as disutility (or deficits). In such cases, the interpretation—and the decision-making process—changes significantly. Please keep this in mind.

17.2 Certainty

When a decision must be made under certainty, the state of nature is fully known, and the optimal choice is to select the alternative with the highest payoff. However, determining this payoff can be complex, as it may be the result of a sophisticated function involving multiple variables.

For example, imagine you need to choose between four different restaurants (a_1, a_2, a_3, a_4). Each restaurant offers a unique combination of characteristics, such as the quality of the food (k_1), the quality of the music played (k_2), the price (k_3), the quality of the service (k_4), and the overall environment (k_5). The corresponding payoff Table 17.2 assigns a numerical value to each characteristic, with higher numbers indicating better quality.

In this scenario, a_i represents the different restaurant options, k_i refers to specific characteristics of each restaurant, and the numbers in the table indicate the payoffs associated with each characteristic.

Please note that the characteristics k_j of the scheme in Table 17.2 do not represent different states of nature but represent characteristics and its corresponding utility (whatever that number may mean in particular) of one particular characteristics if we choose a respective alternative.

Table 17.2: Weighting scheme

	k_1	k_2	k_3	k_4	k_5
a_1	3	0	7	1	4
a_2	4	1	4	2	1
a_3	4	0	3	2	1
a_4	5	1	2	3	1

Domination

To arrive at an overall outcome for each alternative and make an informed decision, the first step is to determine whether any alternatives are dominated by others. An alternative is considered dominated if it is not superior in any characteristic compared to at least one other alternative.

Dominated alternatives can be excluded from consideration. For example, in Table 17.3, we can see that alternative 2 outperforms alternative 3. This makes it unnecessary to consider alternative 3 in the decision-making process.

Table 17.3: Alternative 3 is dominated by alternative 2

	k_1	k_2	k_3	k_4	k_5
a_1	3	0	7	1	4
a_2	4	1	4	2	1
a_3	~~4~~	~~0~~	~~3~~	~~2~~	~~1~~
a_4	5	1	2	3	1

Weighting

No preferences

Still, we have three alternative left. How to decide? Well, we need to become clear what characteristics matter (most). Suppose you don't have any preferences than you would go for restaurant a_1 because it offers the best average value, see Table 17.4.

Table 17.4: Alternative 1 is the best on average

	k_1	k_2	k_3	k_4	k_5	Overall
a_1	3	0	7	1	4	14/5
a_2	4	1	4	2	1	12/5
a_4	5	1	2	3	1	12/5

Clear preferences

Suppose you have a preference for the first three characteristics, that are quality of the food (k_1), the quality of the music played (k_2), and the price (k_3). Specifically, suppose that your preference scheme is as follows:

$$g_1 : g_2 : g_3 : g_4 : g_5 = 3 : 4 : 3 : 1 : 1$$

This means, for example, that you value music (k_2) four times more than the quality of the service (k_4) and the overall environment (k_5). The weights assigned to each characteristic are:

$$w_1 = 3/12; w_2 = 4/12; w_3 = 3/12; w_4 = w_5 = 1/12.$$

To determine the best decision, you can calculate the aggregated expected utility for each alternative as follows:

$$\Phi(a_i) = \sum_c w_p \cdot u_{ic} \rightarrow max,$$

where u_{ic} represents the utility (or value) of alternative i for a given characteristic c. The results of this calculation are shown in Table 17.5.

Table 17.5: Results with preferences given

	k_1	k_2	k_3	k_4	k_5	$\Phi(a_i)$
a_1	3	0	7	1	4	35/12
a_2	4	1	4	2	1	31/12
a_4	5	1	2	3	1	29/12

Thus, alternative a_1 offers the best value given the preference scheme outlined above. In summary, we express the choice as follows:

$$a_1 \succ a_2 \succ a_4 \succ a_3,$$

where $\succ$ represents the preference relation (that is, "is preferred to"). If two alternatives offer the same value and we are indifferent between them, we can use the symbol $\sim$ to represent this indifference.

Maximax (go for cup)

If you like to *go for cup*, that is, you search for a great experience in at least one characteristic, then, you can choose the alternative that gives the maximum possible output in any characteristic. The choice would in our example be (see Table 17.6):

$$a_1 \succ a_4 \succ a_2 \sim a_3,$$

Table 17.6: Results with maximax

	k_1	k_2	k_3	k_4	k_5	Overall
a_1	3	0	7	1	4	7
a_2	4	1	4	2	1	4
a_3	4	0	3	2	1	4
a_4	5	1	2	3	1	5

Minimax (best of the worst)

The Minimax (or maximin) criterion is a conservative criterion because it is based on making the best out of the worst possible conditions. The choice would in our example be (see Table 17.7):

$$a_2 \sim a_4 \succ a_1 \sim a_3,$$

Table 17.7: Results with maximax

	k_1	k_2	k_3	k_4	k_5	Overall
a_1	3	0	7	1	4	0
a_2	4	1	4	2	1	1
a_3	4	0	3	2	1	0
a_4	5	1	2	3	1	1

Körth's Maximin-Rule

According to this rule, we compare alternatives by the worst possible outcome under each alternative, and we should choose the one which maximizes the utility of the worst outcome. More concrete, the procedure consists of 4 steps:

1. Calculate the utility maximum for each column c of the payoff matrix (see Table 17.8):

$$\overline{O}_c = \max_{i=1,\dots,m} O_{ic} \qquad \forall c.$$

Table 17.8: Best utility per alternative

	k_1	k_2	k_3	k_4	k_5
a_1	3	0	7	1	4
a_2	4	1	4	2	1
a_3	4	0	3	2	1
a_4	5	1	2	3	1
$\overline{O}_c$	5	1	7	3	4

2. Calculate for each cell the relative utility (see Table 17.9),

$$\frac{O_{ij}}{\overline{O}_j}.$$

Table 17.9: Best relative utility

	k_1	k_2	k_3	k_4	k_5
a_1	3/5	0/1	7/7	1/3	4/4
a_2	4/5	1/1	4/7	2/3	1/4
a_3	4/5	0/1	3/7	2/3	1/4
a_4	5/5	1/1	2/7	3/3	1/4

3. Calculate for each row i the minimum (see Table 17.10):

$$\Phi(a_i) = \min_{j=1,\dots,p} \left(\frac{O_{ij}}{\overline{O}_j} \right) \qquad \forall i.$$

Table 17.10: Relative minimum for each alternative

	k_1	k_2	k_3	k_4	k_5	$\Phi(a_i)$
a_1	3/5	0/1	7/7	1/3	4/4	0
a_2	4/5	1/1	4/7	2/3	1/4	1/4
a_3	4/5	0/1	3/7	2/3	1/4	0
a_4	5/5	1/1	2/7	3/3	1/4	1/4

4. Set preferences by maximizing $\Phi(a_i)$:

$$a_2 \sim a_4 \succ a_1 \sim a_3,$$

Exercise 17.1. Körth
For the following payoff-matrix, calculate the order of preferences based on Körth's Maximin-Rule.

O_{ij}	k_1	k_2	k_3	k_4	k_5
a_1	3	0	7	1	4
a_2	4	0	4	2	1
a_3	4	-1	3	2	1

a_4	5	1	3	3	1

Solution

$\overline{O}_1 = 5; \overline{O}_2 = 1; \overline{O}_3 = 7; \overline{O}_4 = 3; \overline{O}_5 = 4$

O_{ij}	k_1	k_2	k_3	k_4	k_5	$\Phi(a_i)$
a_1	3/5	0	1	1/3	1	0
a_2	4/5	0	4/7	2/3	1/4	0
a_3	4/5	-1	3/7	2/3	1/4	-1
a_4	1	1	3/7	1	1/4	1/4

$a_4 \succ a_1 \sim a_2 \succ a_3$

Exercise 17.2. Given the following payoff table Table 17.13 where high numbers indicate high utility, ranging from 0 (no utility) to 10 (high utility).

Table 17.13: Payoff table

	z1	z2	z3	z4	z5
a1	1	2	3	4	3
a2	4	3	2	1	4
a3	4	5	0	5	6
a4	1	5	1	5	6
a5	2	2	2	1	3
a6	3	4	0	5	3

a) State which alternatives can be excluded because they are dominated by other alternatives.

b) Suppose your preference scheme is as follows:

$$g_1 = \frac{1}{2}; \quad g_2 = 1; \quad g_3 = 2; \quad g_4 = 1; \quad g_5 = 1.$$

Find the order of preference based on the aggregated expected utility.

17.3 Uncertainty

When a decision must be made under **un**certainty, the state of nature is fully **un**known. That is, different possible states of nature exist but no information on their probability of occurrences are given. The optimal rational choice can't be made without a criterion that reflect preferences such as risk aversion. In the following, I discuss some popular criteria.

Laplace criterion

The Laplace criterion assigns equal probabilities to all possible payoffs for each alternative, then selects the alternative with the highest expected payoff. An example can be found in Finne (1998). In Table 17.14 are the data for another example. According to the expected average utility, the decision should be

$$a_2 \succ a_1 \succ a_3.$$

Table 17.14: Example data for uncertainty

Alternatives	N_1	N_2	N_3	Laplace	Maximax	Minimax
a_1	30	40	50	120/3	50	30
a_2	25	70	30	125/3	70	25
a_3	10	20	80	110/3	80	10

Maximax criterion (go for cup)

If you're aiming for the best possible outcome without regard for the potential worst-case scenario, you would choose the alternative with the highest possible payoff. This "go for cup" approach focuses on maximizing the best-case outcome.

In the example of Table 17.14, the decision applying the Maximax strategy is

$$a_3 \succ a_2 \succ a_1.$$

Minimax criterion (best of the worst)

The Minimax (or Maximin) criterion is a conservative approach, aimed at securing the best outcome under the worst possible conditions. This approach is often used by risk-averse decision-makers. For examples on how to apply this criterion, see Finne (1998).

In the example of Table 17.14, the decision applying the Maximax strategy is

$$a_1 \succ a_2 \succ a_3.$$

Savage Minimax criterion

The Savage Minimax criterion minimizes the worst-case regret by selecting the option that performs as closely as possible to the optimal decision. Unlike the traditional minimax, this approach applies the minimax principle to the regret (that is, the difference or ratio of payoffs), making it less pessimistic. For more details, see Finne (1998).

Using the example data of Table 17.14, the regret table is constructed by subtracting the maximum payoff in each state from the payoffs in that state, see Table 17.15.

Table 17.15: Savage regret table

Alternatives	Regret for N_1	Regret for N_2	Regret for N_3	Maximum Regret
a_1	$30 - 30 = 0$	$70 - 40 = 30$	$80 - 50 = 30$	30
a_2	$30 - 25 = 5$	$70 - 70 = 0$	$80 - 30 = 50$	50
a_3	$30 - 10 = 20$	$70 - 20 = 50$	$80 - 80 = 0$	50

Based on the Savage Minimax criterion, the alternative with the smallest maximum regret should be chosen and the decision is

$$a_1 \succ a_2 \sim a_3.$$

Hurwicz criterion

The Hurwicz criterion allows the decision-maker to calculate a weighted average between the best and worst possible payoff for each alternative. The alternative with the highest weighted average is then chosen.

For each decision alternative, the weight α is used to compute Hurwicz the value:

$$H_i = \alpha \cdot \overline{O}_i + (1 - \alpha) \cdot \underline{O}_i$$

where

$$\overline{O}_i = \max_{j=1,\dots,p} O_{ij} \quad \forall i$$

and

$$\underline{O}_i = \min_{j=1,\dots,p} O_{ij} \qquad \forall i,$$

that is, the respective maximum and minimum output for each alternative, i.

This formula allows for flexibility in decision-making by adjusting the value of α, which reflects the decision-maker's optimism (with $\alpha = 1$ representing complete optimism and $\alpha = 0$ representing complete pessimism).

The Hurwicz criterion calculates a weighted average between the best and worst payoffs for each alternative. Using the data of Table 17.14 once again, we need to assume an optimism index. Let's say we are slightly optimistic and willing to take some risks by setting $\alpha = 0.6$.

In a_1, the maximum payoff is 50 and the minimum payoff is 30.

$$H_1 = 0.6 \cdot 50 + (1 - 0.6) \cdot 30 = 30 + 12 = 42$$

In a_2, the maximum payoff is 70 and the minimum payoff is 25.

$$H_2 = 0.6 \cdot 70 + (1 - 0.6) \cdot 25 = 42 + 10 = 52$$

In a_3, the maximum payoff is 80 and the minimum payoff is 10.

$$H_3 = 0.6 \cdot 80 + (1 - 0.6) \cdot 10 = 48 + 4 = 52$$

Thus, the decision is

$$a_2 \sim a_3 \succ a_1.$$

Exercise 17.3. Use the data of Table 17.14 to make a decision for a complete pessimist ($\alpha = 0$) and an optimist ($\alpha = 1$)

Solution

When $\alpha = 0$:

- a_1: (H_1 = 30)
- a_2: (H_2 = 25)
- a_3: (H_3 = 10)

Thus, the decision is

$$a_1 \succ a_2 \succ a_3.$$

When $\alpha = 1$:

- a_1: (H_1 = 50)
- a_2: (H_2 = 70)
- a_3: (H_3 = 80)

Thus, the decision is

$$a_3 \succ a_2 \succ a_1.$$

Error in @Finne1998three

The example that is shown in Figure 7 of Finne (1998, p. 401) contains some errors. Here is the *correct table* including the Hurwicz-values (we assume a $\alpha = .5$):

O_{ij}	$min(\theta_1)$	$max(\theta_2)$	H_i
a_1	36	110	73
a_2	40	100	70
a_3	58	74	66
a_4	61	66	63.5

Thus, the order of preference is $a_4 \succ a_3 \succ a_1 \succ a_2$.

Three categories
Read Finne (1998) and answer the following questions:

a) Explain the three categories of decision making.
b) Give examples of the three categories of decision making.
c) Explain the four criteria for decision making under uncertainty.

Exercise 17.4.

Table 17.17: Payoff table

	z1	z2	z3
a1	0	9	8
a2	8	5	9
a3	1	10	1
a4	4	5	2
a5	9	10	10

In Table 17.17 you see a payoff table where high numbers indicate high disutility, ranging from 0 (no disutility) to 10 (high disutility).

a) Using this payoff table, indicate which alternatives can be excluded because they are dominated by other alternatives. (Hint: Exclude dominated alternatives in the calculations of the following questions).

b) Using the *Laplace criterion*, calculate the complete order of preferred alternative(s), a_i.
c) Using the *Maximax criterion*, calculate the complete order of preferred alternative(s), a_i.
d) Using the *Minimax criterion*, calculate the complete order of preferred alternative(s), a_i.

17.4 Risk

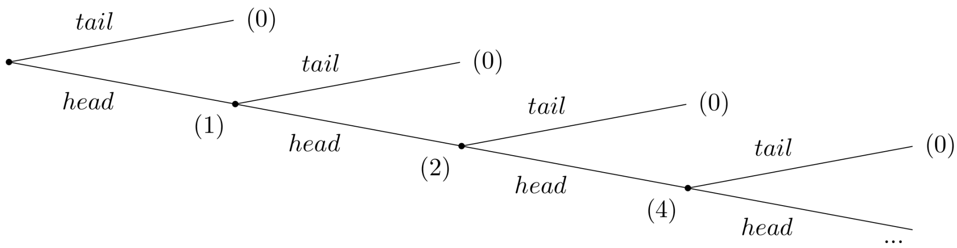
When some information is given about the probability of occurrence of states of nature, we speak of *decision-making under risk*. The most straight forward technique to make a decision here is to maximize the expected outcome for each alternative given the probability of occurrence, p_j.

However, the expected utility hypothesis states that the subjective value associated with an individual's gamble is the statistical expectation of that individual's valuations of the outcomes of that gamble, where these valuations may differ from the Euro value of those outcomes. Thus, you should better look on the utility of a respective outcome rather than on the outcome itself because the utility and outcome do not have to be linked in a linear way. The St. Petersburg Paradox by Daniel Bernoulli in 1738 is considered the beginnings of the hypothesis.

Infinite St. Petersburg lotteries

Suppose a casino offers a game of chance for a single player, where a fair coin is tossed at each stage. The first time head appears the player gets $1. From then onwards, every time a head appears, the stake is doubled. The game continues until the first tails appears, at which point the player receives $\$2^{k-1}$, where k is the number of tosses (number of heads) plus one (for the final tails). For instance, if tails appears on the first toss, the player wins $0. If tails appears on the second toss, the player wins $2. If tails appears on the third toss, the player wins $4, and so on. The extensive form of the game is given in Figure 17.1.

Figure 17.1: Extensive form of the St. Petersburg paradox



Given the rules of the game, what would be a fair price for the player to pay the casino in order to enter the game?

To answer this question, one needs to consider the expected payout: The player has a 1/2 probability of winning $1, a 1/4 probability of winning $2, a 1/8 probability of winning $4, and so on. Thus, the overall expected value can be calculated as follows:

$$E = \frac{1}{2} \cdot 1 + \frac{1}{4} \cdot 2 + \frac{1}{8} \cdot 4 + \frac{1}{16} \cdot 8 + \dots$$

This can be simplified as:

$$E = \frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \dots = +\infty.$$

That means the expected win for playing this game is an infinite amount of money. Based on the expected value, a risk-neutral individual should be willing to play the game at any price if given the opportunity. The willingness to pay of most people who have given the opportunity to play the game deviates dramatically from the objectively calculable expected payout of the lottery. This describes the apparent paradox.

In the context of the St. Petersburg Paradox, it becomes evident that relying solely on expected values is inadequate for certain games and for making well-informed decisions. Expected utility, on the other hand, has been the prevailing concept used to reconcile actual behavior with the notion of rationality thus far.

Finite St. Petersburg lotteries

Let us assume that at the beginning, the casino and the player agrees upon how many times the coin will be tossed. So we have a finite number I of lotteries with $1 \leq I \leq \infty$.

To calculate the expected value of the game, the probability $p(i)$ of throwing any number i of consecutive head is crucial. This probability is given by

$$p(i) = \underbrace{\frac{1}{2} \cdot \frac{1}{2} \cdot \dots \cdot \frac{1}{2}}_{i \text{ factors}} = \frac{1}{2^i}$$

The payoff $W(I)$ is, if head appears I-times in a row by

$$W(I) = 2^{I-1}$$

The expected payoff $E(W(I))$ if the coin is flipped I times is then given by

$$E(W(I)) = \sum_{i=1}^{I} p(i) \cdot W(i) = \sum_{i=1}^{I} \frac{1}{2^i} \cdot 2^{i-1} = \sum_{i=1}^{I} \frac{1}{2} = \frac{I}{2}$$

Thus, the expected payoff grows proportionally with the maximum number of rolls. This is because at any point in the game, the option to keep playing has a positive value no matter how many times head has appeared before. Thus, the expected value of the game is infinitely high for an unlimited number of tosses but not so for a limited number of tosses. Even with a very limited maximum number of tosses of, for example, $I = 100$, only a few players would be willing to pay $50 for participation. The relatively high probability to leave the game with no or very low winnings leads in general to a subjective rather low evaluation that is below the expected value.

In the real world, we understand that money is limited and the casino offering this game also operates within a limited budget. Let's assume, for example, that the casino's maximum budget is $20,000,000. As a result, the game must conclude after 25 coin tosses because $2^{25} = 33,554,432$ would exceed the casino's financial capacity. Consequently, the expected value of the game in this scenario would be significantly reduced to just $12.50. Interestingly, if you were to ask people, most would still be willing to pay less than $12.50 to participate. How can we explain this? Well, it is not the expected outcome that matters but the utility that stems from the outcome.

The impact of output on utility matters

Daniel Bernoulli (1700 - 1782) worked on the paradox while being a professor in St. Petersburg. His solution builds on the conceptual separation of the expected payoff and its utility. He describes the basis of the paradox as follows:

> "Until now scientists have usually rested their hypothesis on the assumption that all gains must be evaluated exclusively in terms of themselves, i.e., on the basis of their intrinsic qualities, and that these gains will always produce a utility directly proportionate to the gain.'' (Bernoulli, 1954, p. 27)

The relationship between gain and utility, however, is not simply directly proportional but rather more complex. Therefore, it is important to evaluate the game based on expected utility rather than just the expected payoff.

$$E(u(W(I))) = \sum_{i=1}^{I} p(i) \cdot u(W(i)) = \sum_{i=1}^{I} \frac{1}{2^i} \cdot u\left(2^{i-1}\right)$$

Daniel Bernoulli himself proposed the following logarithmic utility function:

$$u(W) = a \cdot \ln(W),$$

where a is a positive constant. Using this function in the expected utility, we get

$$E(u(W(I))) = \sum_{i=1}^{I} \frac{1}{2^i} \cdot a \cdot \ln\left(2^{i-1}\right) = a \cdot \sum_{i=1}^{I} \frac{i-1}{2^i} \ln 2 = a \cdot \ln 2 \cdot \sum_{i=1}^{I} \frac{i-1}{2^i}.$$

The infinite series, $\sum_{i=1}^{I} \frac{i-1}{2^i}$, converges to 1 ($\lim_{I \to \infty} \sum_{i=1}^{I} \frac{i-1}{2^i} = 1$). Thus, given an ex ante unbounded number of throws, the expected utility of the game is given by

$$E(u(W(\infty))) = a \cdot \ln 2.$$

In experiments in which people were offered this game, their willingness to pay was roughly between 2 and 3 Euro. Thus, the suggests logarithmic utility function seems to be a pretty realistic specification. The main reason is mathematically that the increasing expected payoff has decreasing marginal utility and hence the utility function reflects the risk aversion of many people.

Exercise 17.5. Rationality and risk
There are 90 balls in an box. It is known that 30 of them are red, the remaining 60 are blue or green. An individual can choose between the following lotteries:

	Payoff	probability
Lottery 1	100 Euro if a red ball is drawn 0 Euro else	$p = \frac{1}{3}$
Lottery 2	100 Euro if a blue ball is drawn 0 Euro else	$0 \leq p \leq \frac{2}{3}$

In a second variant it has the choice between the following lotteries:

	Payoff	probability
Lottery 3	100 Euro if a red or green ball is drawn or 0 Euro else	$\frac{1}{3} \leq p \leq 1$
Lottery 4	100 Euro if a blue or green ball is drawn or 0 Euro else	$p = \frac{2}{3}$

a) Which of the lotteries does the individual choose on the basis of expected values (risk neutral)?
b) Which of the lotteries does the individual choose on the basis of expected utility if the utility of a payoff of x is given by $u(x) = x^2$?
c) Empirical studies, e.g. **?**, show, however, that most individuals will usually choose lotteries 1 and 4. will. Discuss: Is this consistent with rational behavior?

Solution

Read the Wikipedia entry about the Ellsberg paradox (2024):

> "In decision theory, the Ellsberg paradox (or Ellsberg's paradox) is a paradox in which people's decisions are inconsistent with subjective expected utility theory. John Maynard Keynes published a version of the paradox in 1921. Daniel Ellsberg popularized the paradox in his 1961 paper,"Risk, Ambiguity, and the Savage Axioms". It is generally taken to be evidence of ambiguity aversion, in which a person tends to prefer choices with quantifiable risks over those with unknown, incalculable risks.
>
> Ellsberg's findings indicate that choices with an underlying level of risk are favored in instances where the likelihood of risk is clear, rather than instances in which the likelihood of risk is unknown. A decision-maker will overwhelmingly favor a choice with a transparent likelihood of risk, even in instances where the unknown alternative will likely produce greater utility. When offered choices with varying risk, people prefer choices with calculable risk, even when those choices have less utility."

Chapter 18

Conditional events

Learning objectives:

Students will be able to:

- Understand and use the terminology of probability.
- Determine whether two events are mutually exclusive and whether two events are independent.
- Calculate probabilities using the addition rules and multiplication rules.
- Calculate with conditional probabilities using Bayes Theorem.
- Construct and interpret venn and tree diagrams.
- Apply their knowledge of probability theory to decision making in business.

18.1 Introduction

When dealing with probabilities, especially conditional probabilities, relying on intuition and gut feeling often leads to poor decision-making. Our judgments are biased, and the choices we make are usually less rational than we may believe. Exercise 18.1 provides some evidence for my claim. Before I discuss how conditional probabilities can be considered in a rational decision making process, I repeat the essential basics of stochastics in Section 18.2

Exercise 18.1. Lisa is pregnant
The following question stems from a study carried out by Kahneman & Tversky (1972): Lisa is thirty-three and is pregnant for the first time. She is worried about birth defects such as Down syndrome. Her doctor tells her that she need not worry too much because there is only a 1 in 1,000 chance that a woman of her age will have a baby with Down syndrome. Nevertheless, Lisa remains anxious about this possibility and decides to obtain a test, known as the Triple Screen, that can detect Down syndrome. The test is moderately accurate: When a baby has Down syndrome, the test delivers a positive result 86 percent of the time. There is, however, a small 'false positive' rate: 5 percent of babies produce a positive result despite not having Down syndrome. Lisa takes the Triple Screen and obtains a positive result for Down syndrome.
Given this test result, what are the chances that her baby has Down syndrome?

a) 0-20 percent chance
b) 21-40 percent chance
c) 41-60 percent chance
d) 61-80 percent chance
e) 81-100 percent chance

Think about the question and put your answer here:
https://pingo.coactum.de/ Code: 666528

Solution

At the beginning of the *Inferential Statistics* course at summer 2020, I also asked student this question. Here are the results of the 16 students who participated:

Option	Frequency of answers	Percentage
a)	3	19%
b)	2	13%
c)	2	13%
d)	3	19%
e)	6	38%

How did they reach their answers? Like most people, they decided that Lisa has a substantial chance of having a baby with Down syndrome. The test gets it right 86 percent of the time, right? That sounds rather reliable, doesn't it? Well it does, but we should not rely on our feelings here and better do the math because the correct result would be that there is **just a 1.7 percent chance of the baby having a Down syndrome**.

Now, let us proof the result that there is just a 1.7 percent chance of the baby having a Down syndrome using *Bayesian Arithmetic* which is explained in the following videos:

Also, consider this interactive tool here: https://www.skobelevs.ie/BayesTheorem/

Let A be the event of the Baby has a Down syndrom and B the test is positive. Then,

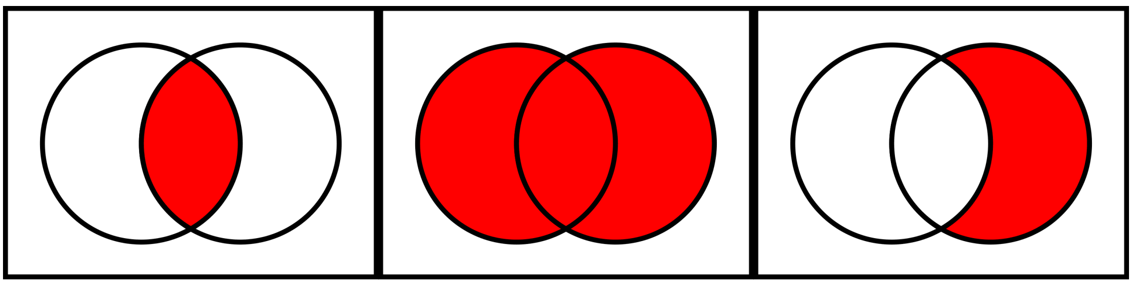
$$\begin{aligned}
P(A) &= 0.001\\
P(B \mid A) &= 0.86\\
P(B \mid \neg A) &= 0.05\\
P(B) &= \frac{999 \cdot 0.05}{1000} + \frac{1 \cdot 0.86}{1000} = \frac{50.81}{1000} = 0.05081\\
P(A \mid B) &= \frac{P(B \mid A)P(A)}{P(B)} = \frac{0.86 \cdot 0.001}{0.05081} = 0.016925802
\end{aligned}$$

18.2 Terminology: $P(A)$, $P(A|B)$, Ω, $\cap$, $\neg$, ...

Exercise 18.2.

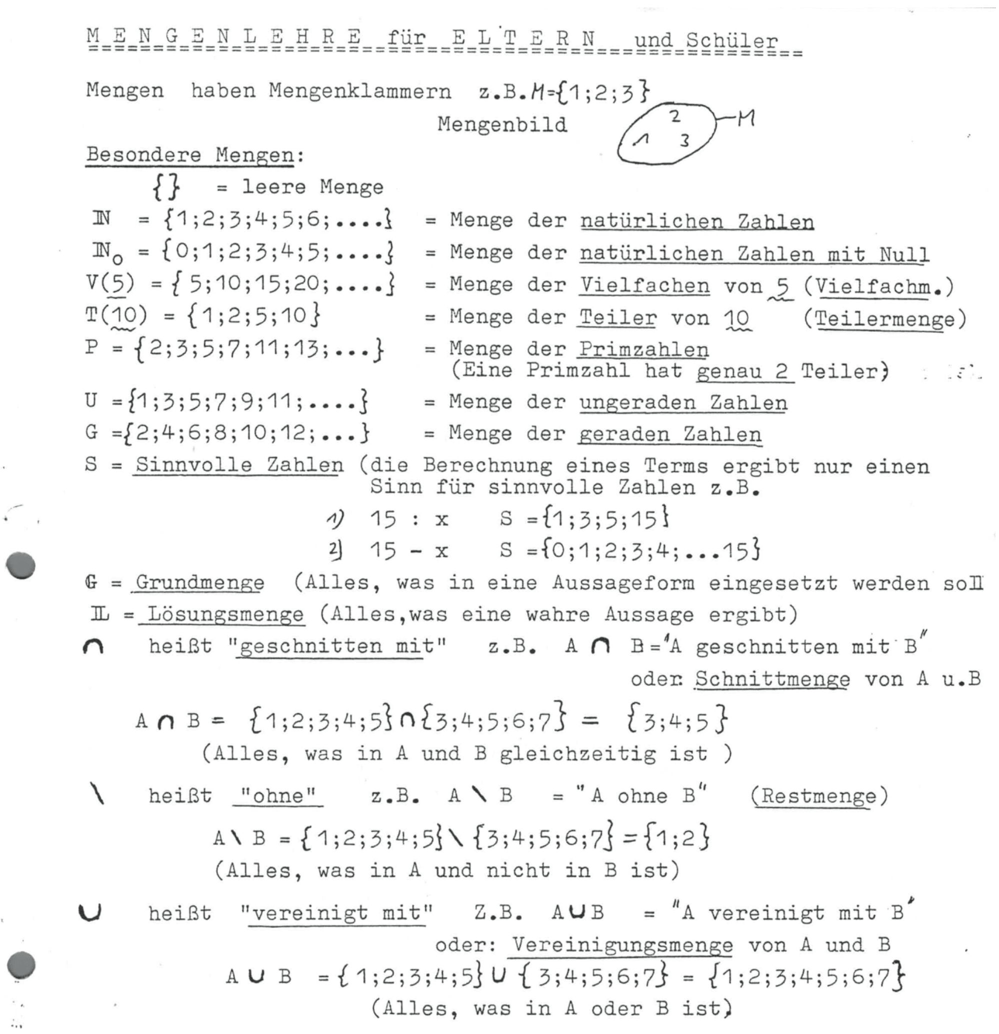
Figure 18.1: Set theory visualized

(a) Intersection: $A \cap B$ (b) Union: $A \cup B$ (c) Relative complement: $\neg A \cup B$



The next chapter will deal with stochastics, probabilities, and set theory. I guess you are somehow familiar with graphical visualization like shown in Figure 18.1. In Germany and most other countries, that is taught in school. When I moved to Cologne in 2020, I found the page shown in Figure 18.2 that I had received back then from my high school math teacher. It was September 1993 and I was a struggling fifth grader in my fourth week. Perhaps you'd like to share your experiences with stochastics?

Figure 18.2: Relative complement: $\neg A \cup B$



MENGENLEHRE für ELTERN und Schüler

Mengen haben Mengenklammern z.B. $M = \{1;2;3\}$

Mengenbild

Besondere Mengen:

$\{\}$ = leere Menge

$\mathbb{N} = \{1;2;3;4;5;6;....\}$ = Menge der natürlichen Zahlen

$\mathbb{N}_0 = \{0;1;2;3;4;5;....\}$ = Menge der natürlichen Zahlen mit Null

$V(5) = \{5;10;15;20;....\}$ = Menge der Vielfachen von 5 (Vielfachm.)

$T(10) = \{1;2;5;10\}$ = Menge der Teiler von 10 (Teilermenge)

$P = \{2;3;5;7;11;13;...\}$ = Menge der Primzahlen (Eine Primzahl hat genau 2 Teiler)

$U = \{1;3;5;7;9;11;....\}$ = Menge der ungeraden Zahlen

$G = \{2;4;6;8;10;12;...\}$ = Menge der geraden Zahlen

S = Sinnvolle Zahlen (die Berechnung eines Terms ergibt nur einen Sinn für sinnvolle Zahlen z.B.

1) $15 : x$ $S = \{1;3;5;15\}$

2) $15 - x$ $S = \{0;1;2;3;4;...15\}$

$\mathbb{G}$ = Grundmenge (Alles, was in eine Aussageform eingesetzt werden soll)

$\mathbb{L}$ = Lösungsmenge (Alles, was eine wahre Aussage ergibt)

$\cap$ heißt "geschnitten mit" z.B. $A \cap B$ = "A geschnitten mit B" oder Schnittmenge von A u.B

$A \cap B = \{1;2;3;4;5\} \cap \{3;4;5;6;7\} = \{3;4;5\}$

(Alles, was in A und B gleichzeitig ist)

$\setminus$ heißt "ohne" z.B. $A \setminus B$ = "A ohne B" (Restmenge)

$A \setminus B = \{1;2;3;4;5\} \setminus \{3;4;5;6;7\} = \{1;2\}$

(Alles, was in A und nicht in B ist)

$\cup$ heißt "vereinigt mit" z.B. $A \cup B$ = "A vereinigt mit B" oder: Vereinigungsmenge von A und B

$A \cup B = \{1;2;3;4;5\} \cup \{3;4;5;6;7\} = \{1;2;3;4;5;6;7\}$

(Alles, was in A oder B ist)

18.2.1 Sample space

A result of an **experiment** is called an **outcome**. An experiment is a planned operation carried out under controlled conditions. Flipping a fair coin twice is an example of an experiment. The **sample space** of an experiment is the set of all possible outcomes. The Greek letter Ω is often used to denote the sample space. For example, if you flip a fair coin, $\Omega = \{H, T\}$ where the outcomes heads and tails are denoted with H and T, respectively.

Exercise 18.3. Sample space
Find the sample space for the following experiments:

a) One coin is tossed.
b) Two coins are tossed once.
c) Two dices are tossed once.
d) Picking two marbles, one at a time, from a bag that contains many blue, B, and red marbles, R.

Solution

a) $\Omega = \{head, tail\}$

b) $\Omega = \{(head, head), (tail, tail), (head, tail), (tail, head)\}$
c) Overall, 36 different outcomes: $\{(1,1),(1,2),(1,3),(1,4),(1,5),(1,6),(2,1),(2,2),\ldots,(6,6)\}$
d) $\Omega = \{(B,B),(B,R),(R,B),(R,R)\}$.

Overall, there are three ways to represent a sample space:

1. to list the possible outcomes (see Exercise 18.3),
2. to create a tree diagram (see Figure 18.3), or
3. to create a Venn diagram (see Figure 18.4).

Figure 18.3: Tree diagramm

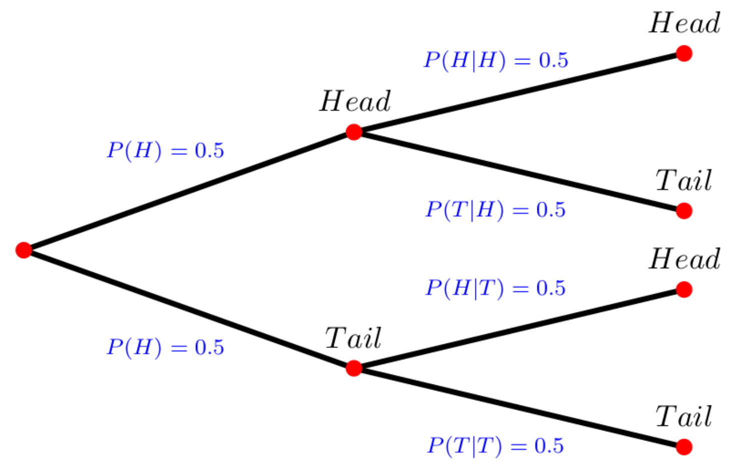
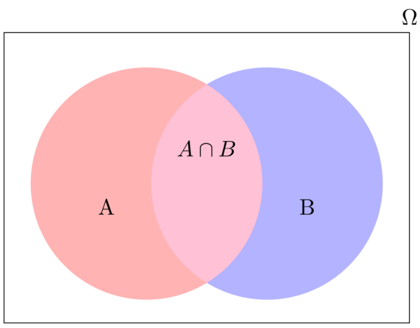


Figure 18.4: Venn diagramm



18.2.2 Probability

Probability is a measure that is associated with how certain we are of outcomes of a particular experiment or activity. The probability of an event A, written $P(A)$, is defined as

$$P(A) = \frac{\text{Number of outcomes favorable to the occurrence of } A}{\text{Total number of equally likely outcomes}} = \frac{n(A)}{n(\Omega)}$$

For example, A dice has 6 sides with 6 different numbers on it. In particular, the set of *elements* of a dice is $M = \{1,2,3,4,5,6\}$. Thus, the probability to receive a 6 is 1/6 because we look for one wanted outcome in six possible outcomes.

Exercise 18.4. Probability
When a fair dice is thrown, what is the probability of getting

a) the number 5,
b) a number that is a multiple of 3,
c) a number that is greater than 6,
d) a positive number that is less than 7.

Solution

A fair dice is an unbiased dice where each of the six numbers is equally likely to turn up. The sample space is $\Omega = \{1, 2, 3, 4, 5, 6\}$.

a) Let A be the event of getting the number 5, $A = \{5\}$. Then, $P(A) = \frac{1}{6}$.
b) Let B be the event of getting a multiple of 3, $B = \{3, 6\}$. Then, $P(B) = \frac{1}{3}$.
c) Let C be the event of getting a number greater than 6, $C = 7, 8, \ldots$. Then, $P(C) = 0$ as there is no number greater than 6 in the sample space $\Omega = \{1, 2, 3, 4, 5, 6\}$. A probability of 0 means the event will never occur.
d) Let D be the event of getting a number less than 7, $D = \{1, 2, 3, 4, 5, 6\}$. Then, $P = 1$ as the event will always occur.

18.2.2.1 The complement of an event ($\neg - Event$)

The complement of event A is denoted with a $\neg A$ or sometimes with a superscript ‘c’ like A^c. It consists of all outcomes that are *not* in A. Thus, it should be clear that $P(A) + P(\neg A) = 1$. For example, let the sample space be

$$\Omega = \{1, 2, 3, 4, 5, 6\}$$

and let

$$A = \{1, 2, 3, 4\}.$$

Then,

$$\neg A = \{5, 6\};$$
$$P(A) = \frac{4}{6};$$
$$P(\neg A) = \frac{2}{6};$$

and

$$P(A) + P(\neg A) = \frac{4}{6} + \frac{2}{6} = 1.$$

18.2.2.2 Independent events (AND-events)

Two events are independent when the outcome of the first event does not influence the outcome of the second event. For example, if you throw a dice and a coin, the number on the dice does not affect whether the result you get on the coin. More formally, two events are independent if the following are true:

$$P(A|B) = P(A)$$
$$P(B|A) = P(B)$$
$$P(A \cap B) = P(A)P(B)$$

To calculate the probability of two independent events (X and Y) happen, the probability of the first event, $P(X)$, has to be multiplied with the probability of the second event, $P(Y)$:

$$P(X \text{ and } Y) = P(X \cap Y) = P(X) \cdot P(Y),$$

where $\cap$ stands for “and”.

For example, let A and B be $\{1, 2, 3, 4, 5\}$ and $\{4, 5, 6, 7, 8\}$, respectively. Then $A \cap B = \{4, 5\}$.

Exercise 18.5. Three dices
Suppose you have three dice. Calculate the probability of getting three times a 4.

Solution

The probability of getting a 4 on one dice is 1/6. The probability of getting three 4 is:

$$P(4 \cap 4 \cap 4) = \frac{1}{6} \cdot \frac{1}{6} \cdot \frac{1}{6} = \frac{1}{216}$$

18.2.2.3 Dependent events (|-Events)

Events are dependent when one event affects the outcome of the other. If A and B are dependent events then the probability of both occurring is the product of the probability of A and the probability of A *after* B has occurred:

$$P(A \cap B) = P(A) \cdot P(B|A)$$

where $|A$ stands for “after A has occurred”, or “given A has occurred”. In other words, $P(B|A)$ is the probability of B given A.

Of course, the equation above can also be written as

$$\Leftrightarrow P(B|A) = \frac{P(A \cap B)}{P(A)} \cdot .$$

For example, suppose we toss a fair, six-sided die. The sample space is $\Omega = \{1, 2, 3, 4, 5, 6\}$. Let A be 2 and 3 and let B be even (2, 4, 6). To calculate $P(A|B)$, we count the number of outcomes 2 or 3 in the sample space $B = \{2, 4, 6\}$. Then we divide that by the number of outcomes B (rather than Ω).

We get the same result by using the formula. Remember that Ω has six outcomes.

$$P(A \mid B) = \frac{P(B \cap A)}{P(B)} = \frac{\frac{\text{number of outcomes that are 2 or 3 AND even}}{6}}{\frac{\text{number of outcomes that are even}}{6}} = \frac{\frac{1}{6}}{\frac{3}{6}} = \frac{1}{3}$$

Exercise 18.6. Purse
A purse contains four € 5 bills, five € 10 bills and three € 20 bills. Two bills are selected randomly without the first selection being replaced. Find the probability that two € 5 bills are selected.

Solution

There are four € 5 bills. There are a total of twelve bills. The probability to select at first a € 5 bill then is $P(€5) = \frac{4}{12}$. As the the result of the first draw affects the probability of the second draw, we have to consider that there are only three € 5 bills left and there are a total of eleven bills left. Thus,

$$P(€5|€5) = \frac{3}{11}$$

and

$$P(€5 \cap €5) = P(€5) \cdot P(€5|€5) = \frac{4}{12} \cdot \frac{3}{11} = \frac{1}{11}.$$

The probability of drawing a € 5 bill and then another € 5 bill is $\frac{1}{11}$.

18.3 Bayes' theorem

The conditional probability of A given B is written $P(A|B)$. $P(A|B)$ is the probability that event A will occur given that the event B has already occurred. A conditional reduces the sample space. We calculate the probability of A from the reduced sample space B. The formula to calculate $P(A|B)$ is

$$P(A|B) = \frac{P(A \cap B)}{P(B)}$$

where $P(B)$ is greater than zero. This formula is also known as **Bayes' Theorem**, which is a simple mathematical formula used for calculating conditional probabilities, states that

$$P(A)P(B|A) = P(B)P(A|B)$$

This is true since $P(A \cap B) = P(B \cap A)$ and due to the fact that $P(A \cap B) = P(B \mid A)P(A)$, we can write Bayes' Theorem as

$$P(A \mid B) = \frac{P(B \mid A)P(A)}{P(B)}.$$

The box below summarizes the important facts w.r.t. Bayes' Theorem.

Bayes' Theorem

The theorem states that

$$P(A \mid B) = \frac{P(B \mid A)P(A)}{P(B)}$$

if $P(B) \neq 0$ and A and B are events. It simply uses the following logical facts:

$$P(B \cap A) = P(A \cap B),$$

$$P(A \mid B) = \frac{P(A \cap B)}{P(B)}, \text{ and}$$

$$P(B \mid A) = \frac{P(A \cap B)}{P(A)},$$

or, to put it in one line:

$$P(A \cap B) = P(B \cap A) = P(A \mid B)P(B) = P(B \mid A)P(A).$$

Sometimes, it is helpful to re-write the Theorem as follows:

$$P(A) = P(A|B)P(B) + P(A|\neg B)P(\neg B), \text{ and}$$

$$P(B) = P(B|A)P(A) + P(B|\neg A)P(\neg A),$$

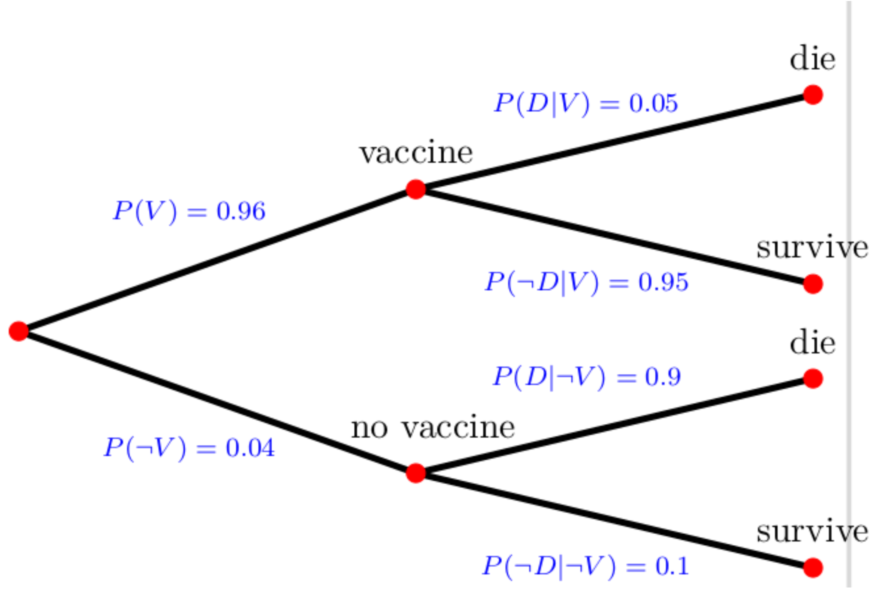
For a deeper understanding of Bayes theorem, I recommend watching the following videos:

- Bayes theorem and
- The quick proof of Bayes' theorem

Moreover, this interactive tool can be helpful.

Exercise 18.7. To be vaccinated or not to be

Figure 18.5: Tree diagramm (Exercise 18.7)



The tree diagram in Figure 18.5 shows probabilities of people to have a vaccine for some disease. Moreover, it shows the conditional probabilities of people to die given the fact they were vaccinated or not. D denotes the event of *die* and $\neg D$ denotes *not die*, i.e., survive; V denotes the event of *vaccinated* and $\neg V$ *not vaccinated*.

a) Calculate the overall probability to die, $P(D)$
b) Calculate the probability that a person that has died was vaccinated, $P(V|D)$.

Disclaimer: The case presented here is fictitious. The data given here are purely fictitious and serve only to practice the method.

Solution

a)

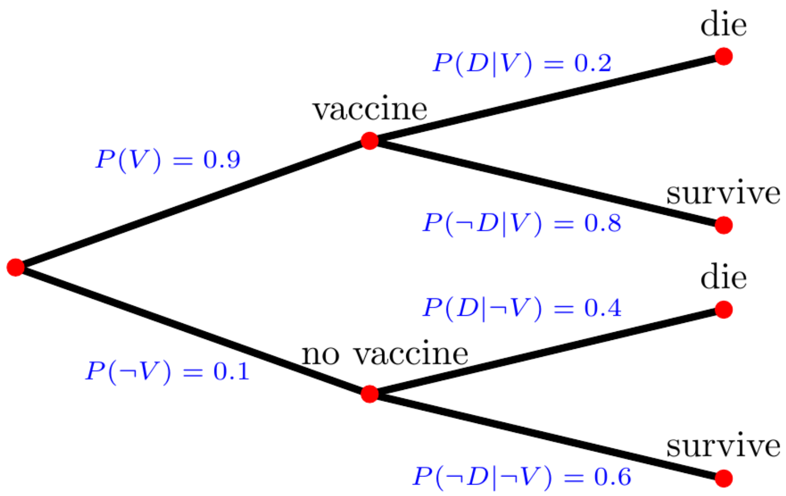
$$\begin{aligned} P(D) &= P(V) \cdot P(D|V) + (P(\neg V) \cdot P(D|\neg V)) \\ &= .96 \cdot .05 + .04 \cdot .09 \\ &= 0.048 + 0.036 \\ &= 0.084 \end{aligned}$$

b)

$$P(V \mid D) = \frac{P(D \mid V)P(V)}{P(D)} = \frac{.05 \cdot .96}{.084} \approx .5714285$$

Exercise 18.8. To die or not to die
You read on Facebook that in the year 2021 about over 80% of people that died were vaccinated. You are shocked by this high probability that a dead person was vaccinated, $P(V|D)$. You decide to check this fact. Reading the study to which the Facebook post is referring, you find out that the study only refers to people above the age of 90. Moreover, you find the following *Tree Diargram*. It allows checking the fact as it describes the vaccination rates and the conditional probabilities of people to die given the fact they were vaccinated or not. In particular, D denotes the event of *die* and $\neg D$ denotes *not die*, i.e., survive; V denotes the event of *vaccinated* and $\neg V$ *not vaccinated*.

Figure 18.6: Tree diagramm (Exercise 18.8)



a) Calculate the overall probability to die, $P(D)$
b) Calculate the probability that a person that has died was vaccinated, $P(V|D)$.
c) Your calculations shows that the fact used in the statement on Facebook is indeed true. Discuss whether this number should have an impact to get vaccinated or not.

Disclaimer: The case presented here is fictitious. The data given here are purely fictitious and serve only to practice the method.

Solution

a)
$$P(D) = 0.9 \cdot 0.2 + 0.1 \cdot 0.4 = 0.22$$

b)
$$P(V \mid D) = \frac{P(D \mid V)P(V)}{P(D)} = \frac{0.2 \cdot 0.90}{0.22} = \frac{0.036}{0.22} \approx 0.8181$$

%

$$P(\neg V \mid D) = \frac{P}{(}D \mid \neg V)P(\neg V)P(D) = \frac{0}{.}4 \cdot 0.40.028 = \frac{0}{.}020.028 \approx 0.71428$$

c) ...

Exercise 18.9. Corona false positive
Suppose that Corona infects one out of every 1000 people in a population and that the test for it comes back positive in 99% of all cases if a person has Corona. Moreover, the test also produces some false positive, that is about 2% of uninfected patients also tested positive.
Now, assume you are tested positive and you want to know the chances of having the disease. Then, we have two events to work with:
A: you have Corona
B: your test indicates that you have Corona
and we know that

$$\begin{aligned} P(A) &= .001 & &\rightarrow \text{one out of 1000 has Corona} \\ P(B|A) &= .99 & &\rightarrow \text{probability of a positive test, given infection} \\ P(B|\neg A) &= .02 & &\rightarrow \text{probability of a false positive, given no infection} \end{aligned}$$

As you don't like to go into quarantine, you are interested in the probability of having the disease given a positive test, that is $P(A|B)$?

> Disclaimer: The case presented here is fictitious. The data given here are purely fictitious and serve only to practice the method.

Solution to Exercise 18.9

In order to come to an answer, lets draw a table of the probabilities that may be of interest:

	A	$\neg A$	$\sum$
B	$P(A \cap B)$	$P(\neg A \cap B)$	$P(B)$
$\neg B$	$P(A \cap \neg B)$	$P(\neg A \cap \neg B)$	$P(\neg B)$
	$P(A)$	$P(\neg A)$	1

Please note, the symbol $\neg$ simply abbreviates "NOT" and the symbol $\cap$ stands for "AND". The probability of you having both the disease and a positive test, $P(A \cap B)$, is easy to calculate:

$$\underbrace{P(A \cap B) = P(B|A)P(A)}_{\text{a.k.a. multiplication rule}} = .99 \cdot .001 = .00099$$

Also, it is straight forward to calculate the probability of having both, no infection and a positive test:

$$P(\neg A \cap B) = P(B|\neg A)P(\neg A) = .02 \cdot .999 = .01998$$

Knowing that, it is clear that the overall probability of being diagnosed with Corona is

$$P(B) = .00099 + .0199 = .02097$$

That means, out of 1000 people about 21 are on average diagnosed with Corona while only one person actually is infected with Corona. Thus, your probability of having Corona once your test came out to be positive, $P(A|B)$, is approximately

$$P(A|B) \approx \frac{1}{21} = 0,047619048$$

and more precisely

$$P(A|B) = \frac{P(A \cap B)}{P(B)} = \frac{.00099}{.02097} = 0,0472103.$$

In other words, with a probability of more than 95%, you may go into quarantine without infection:

$$P(\neg A|B) = \frac{P(\neg A \cap B)}{P(B)} = \frac{.01998}{.02097} = 0,9527897 \quad (= 1 - P(A|B))$$

Given the accuracy of the test, this number appears to be rather high to many people. The high test accuracy of 99% and the rather low number of 2% false positives, however, is misleading. This is sometimes called the **false positive paradox**. The source of the fact that many people think $P(A|B)$ is much lower is that they don't consider the impact of the low probability of having the disease, $P(A)$, on $P(A|B)$, $P(B|A)$, and $P(B|\neg A)$ respectively (also, see the *Linda case*). Moreover, many people don't understand the false positive rate correctly.
To summarize, we know

	A	¬A	$\sum$
B	.00099	.01998	.02097
¬B	P(A ¬B)	P(¬A ¬B)	P(¬B)
—	.001	P(¬A)	1

The four remaining unknowns can be calculated by subtracting in the columns and adding across the crows, so that the final table is:

	A	¬A	$\sum$
B	.00099	.01998	.02097
¬B	.00001	.97902	.97903
—	.001	.999	1

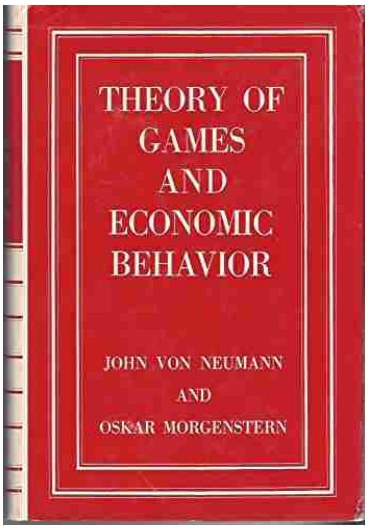
Chapter 19

Games

Game theory is the study of mathematical models that describe strategic interactions among rational decision-makers. Specifically, it analyzes how two or more players make decisions in situations where their choices affect one another's outcomes. In these scenarios, each player's actions influence the payoffs of others, and vice versa, creating interdependence. As in the models discussed earlier, game theory assumes that players act rationally, seeking to maximize their own benefits. This framework allows for economic research through laboratory experiments or real-world field studies.

Game theory is not just an academic exercise; it has practical applications in real market situations and various human interactions. It is used across all fields of science including social science and computer science. In the 21st century, game theory has expanded to cover a wide range of behavioral relationships and is now an umbrella term for the study of logical decision-making in humans, animals, and machines.

Figure 19.1: The book of Von Neumann & Morgenstern (1947)



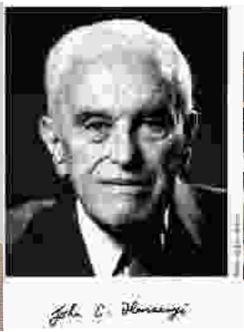
Modern game theory began with the idea of mixed-strategy equilibria in two-person zero-sum games and its proof by John von Neumann. His work and in particular his jointly written with Oskar Morgenstern from 1944 *Theory of Games and Economic Behavior* (see Figure 19.1) which considered cooperative games of several players was the beginning of modern game theory. The second edition of this book provided an axiomatic theory of expected utility, which allowed mathematical statisticians and economists to treat decision-making under uncertainty.

Game theory has been widely recognized as an important tool in many fields. As of 2014, with the *Nobel Memorial Prize in Economic Sciences* going to game theorist Jean Tirole, eleven game theorists have won the economics Nobel Prize including Reinhard Selten from Germany together with John Harsanyi and John Nash in 1994, see Figure 19.2.

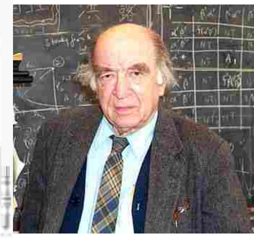
Figure 19.2: Nobel price winners that contributed to game theory

(a) Reinhard Selten

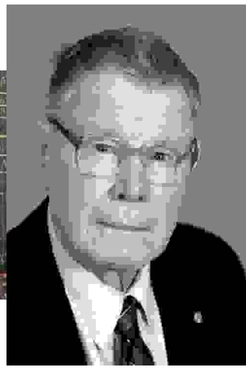
(b) John Harsanyi



(c) Leonid Hurwicz



(d) Thomas Schelling



(e) Jean Tirole

Exercise 19.1. The dissertation of John Nash

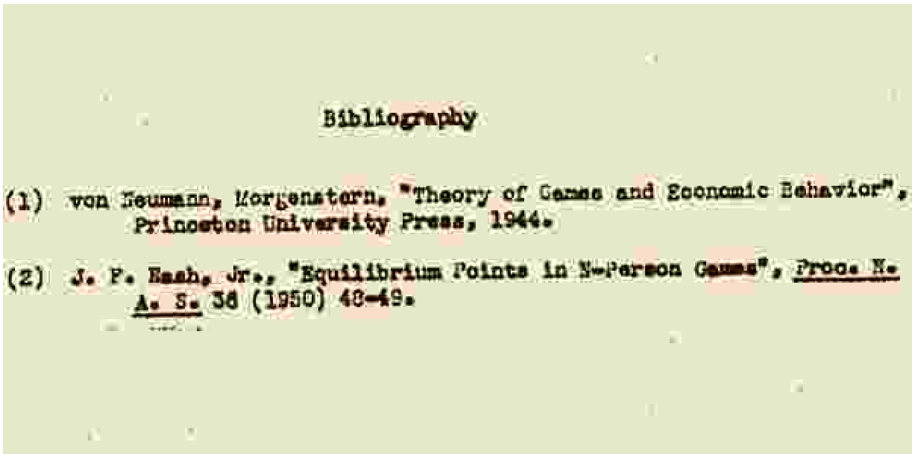
a) Discuss: How many citations does a good academic work require?

b) Read Nash (1950) and discuss the question once again. The dissertation is available here.

Solution

The reference list in John Nash's doctoral thesis Nash (1950) contains only two entries (see Figure 19.3): the book by Von Neumann & Morgenstern (1947) and a short note from his own publication. His thesis, along with several other works, earned him the Nobel Prize, the Abel Prize, and other prestigious honors.

Figure 19.3: Reference list of Nash (1950)



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(1) von Neumann, Morgenstern, "Theory of Games and Economic Behavior", Princeton University Press, 1944.

(2) J. F. Nash, Jr., "Equilibrium Points in N-Person Games", Proc. N. A. S. 36 (1950) 48-49.

19.1 Structure of games

19.1.1 Elements

The elements of a game include several key components that define its structure and dynamics. First, there is the **number of players**, which indicates how many individuals or entities are involved in the game. Each player has a specific set of **strategies** and **alternative actions** available to them, which can significantly influence the game's outcome.

Additionally, the **payoff functions** determine the rewards or penalties that players receive based on the actions taken, reflecting their preferences and objectives. The **state of information** is also crucial, as it outlines what each player knows about the game, including the actions of other players. Lastly, the **timing of actions and information** plays a vital role, as it affects the decisions made by players and the overall flow of the game. Understanding these elements is essential for analyzing strategic interactions effectively.

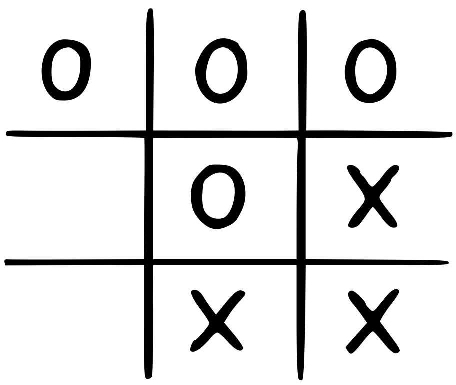
19.1.2 Classes

Games can be categorized into various classes based on their characteristics:

- **Cooperative vs. Non-cooperative**: Cooperative games allow players to form binding commitments, while non-cooperative games do not.
- **Static vs. Dynamic**: Static games are played in a single time period, whereas dynamic games unfold over multiple periods, with players potentially adapting their strategies over time.
- **One-shot vs. Repeated**: One-shot games are played once, while repeated games involve the same players playing multiple rounds, allowing for strategy adjustments based on previous outcomes.
- **Non-zero-sum vs. Zero-sum**: In zero-sum games, one player's gain is another's loss, while non-zero-sum games allow for outcomes where all players can benefit or suffer together.
- **Perfect Information vs. Non-perfect Information**: Perfect information games allow players to know all previous actions, whereas non-perfect information games involve some level of uncertainty about other players' actions.
- **Symmetric Information vs. Asymmetric Information**: In symmetric information games, all players have access to the same information, while asymmetric information games involve players having different information.
- **Deterministic vs. Non-deterministic Payoffs (Random)**: Deterministic payoffs yield consistent outcomes for given strategies, while non-deterministic payoffs involve randomness and variability in outcomes.

Exercise 19.2. Tic Tac Toe
Tic Tac Toe is a simple yet classic game that can be analyzed through various game theory classifications. Discuss the classes of the game Tic Tac Toe (see Figure 19.4).

Figure 19.4: Tic Tac Toe



Solution

Here's how it fits into the categories mentioned:

Cooperative vs. Non-cooperative:
Non-cooperative: Tic Tac Toe is a non-cooperative game because players cannot form binding agreements or commitments. Each player independently decides their move without collaboration.

Static vs. Dynamic:
Dynamic: The game is dynamic because it occurs in various rounds, with players taking turns one after another and they have the chance to respond on the moves made by the opponent.

One-shot vs. Repeated:
One-shot: A typical game of Tic Tac Toe is a one-shot game, meaning it is played once with no subsequent rounds. However, players may play multiple games in sequence, which can lead to a repeated game scenario, but each individual game remains one-shot.

Non-zero-sum vs. Zero-sum:
Zero-sum: Tic Tac Toe is a zero-sum game because one player's gain (winning the game) results in an equal loss for the other player.

Perfect Information vs. Non-perfect Information:
Perfect Information: The game has perfect information as both players are fully aware of all previous moves made by their opponent. There is no hidden information; each player can see the entire game board and all actions taken.

Symmetric Information vs. Asymmetric Information:
Symmetric Information: The game exhibits symmetric information, where both players have access to the same information regarding the game's state. They both see the same board and the same moves, and neither player has an informational advantage over the other.

Deterministic vs. Non-deterministic Payoffs:
Deterministic: The payoffs in Tic Tac Toe are deterministic, as the outcome (win, loss, or draw) is solely determined by the players' moves without any random elements involved. Each strategic decision directly influences the final result.

19.1.3 Representations

19.1.3.1 Normal form

The normal form of a game is a matrix representation that captures the strategic interactions between players who choose their strategies simultaneously. It lists each player's possible strategies and the resulting payoffs for each combination of strategies. This format helps identify dominant strategies and Nash equilibria, making it useful for analyzing static games.

The matrix provided in Table 19.1 is a normal-form representation of a game in which players move simultaneously (or at least do not observe the other player's move before making their own) and receive the payoffs as specified for the combinations of actions played.

Table 19.1: Example of a normal-form representation

	Person B - work	Person B - shirk
Person A - work	10 ; 10	5 ; 11
Person A - shirk	11 ; 5	6 ; 6

In the example of Table 19.1, two workers, A and B, have to make the choice to shirk or to work hard. In the following, I describe how to solve the decision for each person. The trick is to find the best answer of each person in whatever the other one is doing.

To solve the game represented in the normal-form table, follow these steps:

1. **Identify strategies**: Each player (Person A and Person B) has two strategies: "work" or "shirk."
2. **Payoff matrix**: The matrix shows the payoffs for both players based on their chosen strategies:
   - If both work, the payoffs are (10, 10).
   - If A works and B shirks, the payoffs are (5, 11).
   - If A shirks and B works, the payoffs are (11, 5).
   - If both shirk, the payoffs are (6, 6).

3. **Determine dominant strategies**: A dominant strategy is one that yields a higher payoff regardless of the other player's action.

For Person A:

- If B works, A gets 10 by working and 11 by shirking (so shirking is better).
- If B shirks, A gets 5 by working and 6 by shirking (so again, shirking is better).
- Thus, A's dominant strategy is to shirk.

For Person B:

- If A works, B gets 10 by working and 11 by shirking (so shirking is better).
- If A shirks, B gets 5 by working and 6 by shirking (so again, shirking is better).
- Thus, B's dominant strategy is to shirk.

4. **Nash Equilibrium**: The Nash equilibrium occurs when both players choose their dominant strategies. In this case, both will choose to shirk: Payoffs at this equilibrium are (6, 6).

5. **Conclusion**: Both players have a strong incentive to shirk, leading to a Nash equilibrium with both receiving a payoff of 6.

This analysis shows how rational decision-making can lead to outcomes that may not be optimal for either player collectively, highlighting the potential for suboptimal outcomes in strategic interactions.

Exercise 19.3. Matching pennies (random and simultaneous version)
Write down the following game in the normal form:
Matching pennies (random and simultaneous version) is a game with two players (1, 2). Both players flip a penny simultaneously. Each penny falls down and shows either heads up or tails up. If the two pennies match (either both heads up or both tails up), player 2 wins and player 1 must pay him a Euro. If the two pennies do not match, player 1 wins and player 2 must pay him a Euro. Additionally, describe the elements of the game and the class of this game.

Solution

The normal form of the game is shown in Table 19.2.

Table 19.2: Normal form of the random and simultaneous version

		Person 2 - Head	Person 2 - Tail
Person 1 - Head	-1 ; 1	1 ; -1	
Person 1 - Tail	1 ; -1	-1 ; 1	

It is a game that belongs to the following classes:

- non-cooperative
- static
- one-shot
- zero-sum
- perfect information
- symmetric information
- non-deterministic payoffs

Elements of the game:

- Number of players: 2
- Number of strategies: No strategies as whether heads or tails shows up is random
- Payoff functions:

$$\text{Player 1} = \begin{cases} 1, & \text{if } (T,T) \text{ or } (H,H) \\ -1, & \text{otherwise} \end{cases}$$

$$\text{Player 2} = \begin{cases} 1, & \text{if } (H,T) \text{ or } (T,H) \\ -1, & \text{otherwise} \end{cases}$$

- State of information: Everybody knows the rules and is perfectly informed
- Timing of actions and information: both throw the coin at the same time and see the result at the same time

19.1.4 Extensive form

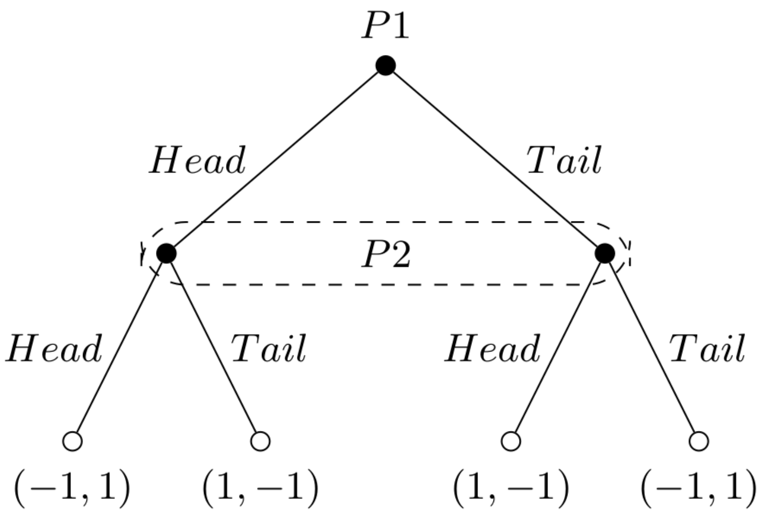
The extensive form in game theory is a way to represent games that captures the sequence of moves by players, their available choices at each point, and the information they have when making decisions. Unlike the normal form, which shows all strategies and payoffs in a matrix, the extensive form uses a tree diagram to show how a game unfolds over time. Each branch represents a possible action, and the endpoints show the payoffs for different outcomes. This format also accounts for chance events and imperfect information, making it useful for analyzing dynamic, sequential decision-making scenarios.

Exercise 19.4. Matching pennies (random version)
Write down the following game in the extensive form:
Matching pennies (random version) is a game with two players (1, 2). Player 1 starts by flipping a fair penny high, catches it, and then turns it over into the other hand so that the result is hidden from the other player. Then, player 2 flips the coin. If the two pennies match (either both heads up or both tails up), player 2 wins and player 1 must pay him a Euro. If the two pennies do not match, player 1 wins and player 2 must pay him a Euro.

Solution

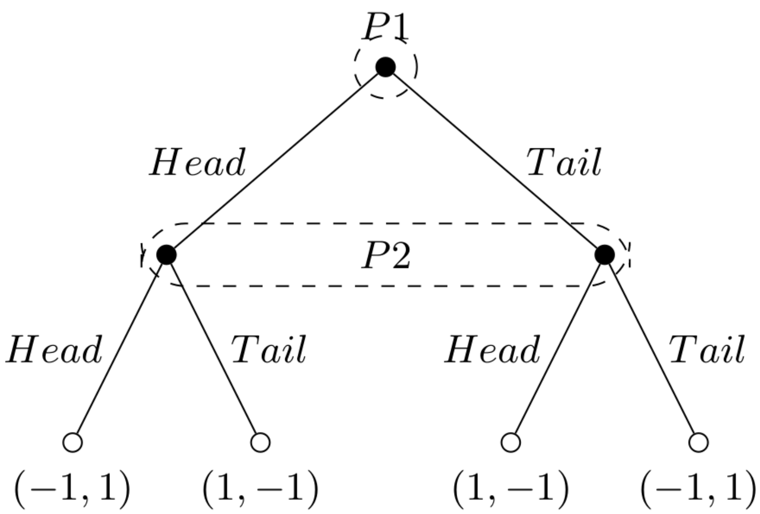
As player 2 has no idea what player 1 has chosen, he cannot come up with any strategy that increases his winning rate. The extensive

Figure 19.5: Extensive form of the random version



The dashed circled line indicates that player 2 is not informed about whether P1 decided head or tail. As we have now introduced how to graphically show that some players have a restricted information set, we can draw the extensive form also for the random and simultaneous version of the matching pennies game. Please note that the dashed circle around player 1 is redundant and hence it is a convention not to draw it sometimes.

Figure 19.6: Extensive form of the random and simultaneous version

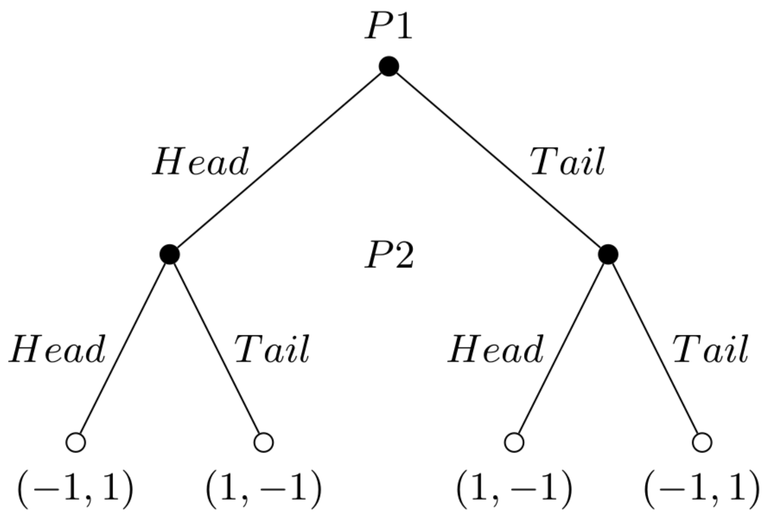


Exercise 19.5. Matching pennies (strategic version)
Write down the following game in the extensive form and discuss the strategies of both:
Matching pennies (strategic version) is a game with two players (1, 2). Player 1 starts and decides whether to put a coin with either heads up or tails up onto a table. Player 2 can see the decision of player 1. Then, player 2 decides whether to put a coin with heads or tails on the table. If the two pennies match (either both heads up or both tails up), player 2 wins and player 1 must pay him a Euro. If the two pennies do not match, player 1 wins and player 2 must pay him a Euro.

Solution

As player 2 has complete information about the decision of player 1, he can always come up with the choice that makes him win. That is, if player 1 chooses head(/tail) player one will also choose head(/tail).

Figure 19.7: Extensive form of the strategic version



19.2 Nash equilibrium

19.2.1 John Forbes Nash Jr. (1928-2015)

John Forbes Nash Jr. (1928-2015) had an extraordinary life which ended tragically in a car accident after having received the Abel Prize. In Figure 19.8 you see the real John Nash as well as actor Russel Crowe who plays him in the movie *A Beautiful Mind*. To get known to John Nash and his contributions, read his Wikipedia entry, watch the following videos, and read the Nobel prize award ceremony speech below.

Nash Equilibrium (taken from *A Beautiful Mind*)

Dr. John Nash on his life before and after the Nobel Prize

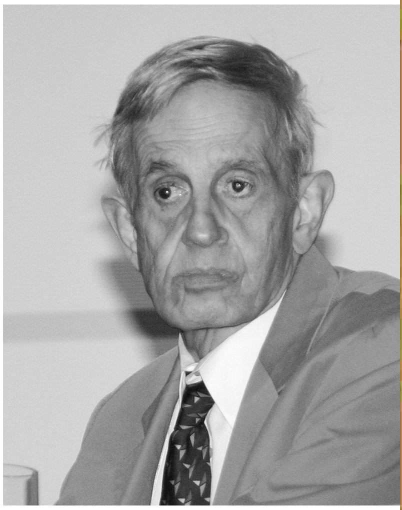
Nobel Prize Award ceremony speech of 1994

Presentation Speech by Professor Karl-Göran Mäler of the Royal Swedish Academy of Sciences taken from Nobel Prize Speech):

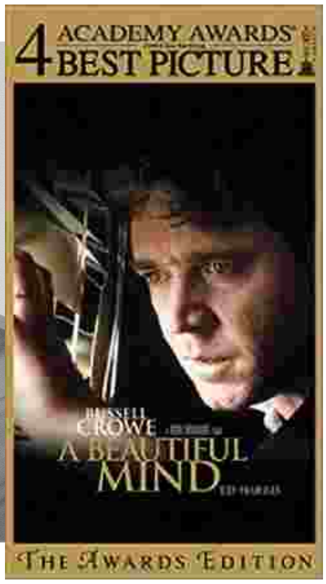
> Many situations in society, from everyday life to high-level politics, are characterized by what economists call strategic interactions. When there is strategic interaction, the outcome for one agent depends not only on what that agent does, but also very largely on how other agents act or react. A firm that decreases its price to attract more customers will not succeed in this strategy if the other major firms in the market use the same strategy. Whether a political party will be successful in attracting more votes by proposing lower taxes or increased spending will depend on the proposals from other parties. The success of' a central bank which is trying to fight inflation by maintaining a fixed exchange rate depends – as we know – on decisions on fiscal policy, and also on reactions in markets for labor and commodities.
>
> A simple economic example of strategic interaction is where two firms are competing with identical products on the same market. If one firm increases its production, this will make the market price fall and therefore reduce profits for the other firm. The other firm will obviously try to counteract this, for example by increasing its production and so maintaining its market share but at the cost of further reduction in market

Figure 19.8: John Nash and movie The Beautiful Mind

(a) The real John Nash



(b) The movie: A Beautiful Mind



(c) Excerpt: “Adam Smith needs revision”

price. The first company must therefore anticipate this countermove and possible further countermoves when it makes its decision to increase production. Can we predict how the parties will choose their strategies in situations like this?

As early as the 1830s the French economist Auguste Cournot had studied the probable outcome when two firms compete in the same market. Many economists and social scientists subsequently tried to analyze the outcome in other specific forms of strategic interaction. However, prior to the birth of game theory, there was no toolbox that gave scholars access to a general but rigorous method of analyzing different forms of strategic interaction. The situation is totally different now. Scientific journals and advanced textbooks are filled with analyses that build on game theory, as it has been developed by this year’s Laureates in economics, John Nash, John Harsanyi and Reinhard Selten.

Non-cooperative game theory deals with situations where the parties cannot make binding agreements. Even in very complicated games, with many parties and many available strategies, it will be possible to describe the outcome in terms of a so-called Nash equilibrium – so named after one of the Laureates. John Nash has shown that there is at least one stable outcome, that is an outcome such that no player can improve his own outcome by choosing a different strategy when all players have correct expectations of each other’s strategy. Even if each party acts in an individually rational way, the Nash equilibrium shows that strategic interaction can quite often cause collective irrationality: trade wars or excessive emission of pollutants that threaten the global environment are examples in the international sphere. One should also add that the Nash equilibrium has been important within evolutionary ecology – to describe natural selection as a strategic interaction within and between species.

In many games, the players lack complete information about each other’ ‘s objective. If the government, for example, wants to deregulate a firm but does not know the cost situation in the firm, while the firm’s management has this knowledge, we have a game with incomplete information. In three articles published toward the end of the 1960s, John Harsanyi showed how equilibrium analysis could be extended to handle this difficulty, which game theorists up to that time had regarded as insurmountable. Harsanyi’s approach has laid an analytical basis for several lively research areas including information economics which starts from the fact that different decision makers, in a market or within an organization, often have access to different information. These areas cover a broad range of issues, from contracts between shareholders and a company’s management to institutions in developing countries.

One problem connected with the concept of Nash equilibrium is that there may be several equilibria in non-cooperative games. It may thus be difficult – both for the players and an outside analyst – to predict the outcome. Reinhard Selten has, through his "perfection'' concepts, laid the foundations for the research program that has tried to exclude improbable or unreasonable equilibria. Certain Nash equilibria can, in fact, be such that they are based on threats or promises intended to make other players choose certain strategies. These threats and promises are often empty because it is not in the player's interest to carry them out if a situation arises in which he has threatened to carry them out. By excluding such empty threats and promises Selten could make stronger predictions about the outcome in the form of socalled perfect equilibria.

Selten's contributions have had great importance for analysis of the dynamics of strategic interaction, for example between firms trying to reach dominant positions on the market, or between private agents and a government that tries to implement a particular economic policy.

Professor John Harsanyi, the analysis of games with incomplete information is due to you, and it has been of great importance for the economics of information.

Dr John Nash, your analysis of equilibria in non-cooperative games, and all your other contributions to game theory, have had a profound effect on the way economic theory has developed in the last two decades. Professor Reinhard Selten, your notion of perfection in the equilibrium analysis has substantially extended the use of non-cooperative game theory.

It is an honour and a privilege for me to convey to all of you, on behalf of the Royal Swedish Academy of Sciences, our warmest congratulations. I now ask you to receive your prizes from the hands of his Majesty the King.

19.2.2 Nash equilibrium

To find a Nash equilibrium in a normal form game as shown in Table 19.3, we can look for the best responses for both players in a game. We do so by putting a star next to the payoff attained by the best response of a player for all the strategies of the other player. For example, we put a star next to the 4 because S1 is the best response by Player B to the action S1 of Player A.

Notice that the bottom right corner box has a particular feature: it shows that the strategies played by all the (two) players and resulting in that outcome are best responses to the others' players best responses. That defines a **Nash equilibrium**.

Table 19.3: An example for a game with a Nash equilibrium

		Person B		
		S1	S2	S3
Person A	S1	0 ; 4*	4* ; 0	5 ; 3
	S2	4* ; 0	0 ; 4*	5 ; 3
	S3	3 ; 5	3 ; 5	6* ; 6*

Nash equilibrium

The Nash equilibrium is a concept of game theory where the optimal outcome of a game is one where no player has an incentive to deviate from their chosen strategy after considering the opponent's choice.
Please watch the video: What is Nash Equilibrium?

19.2.3 The prisoner's dilemma

The prisoner's dilemma is the most well-known example of game theory. It shows why two completely rational individuals might not cooperate, even if it appears that it is in their best interests to do so.

Consider the example of two criminals arrested for a crime. Prosecutors have no hard evidence to convict them. However, to gain a confession, officials remove the prisoners from their solitary cells and question each one in separate chambers. Neither prisoner has the means to communicate with each other. The criminals are now confronted by the officials with four possible scenarios:

1. If both confess, they will each receive an eight-year prison sentence.
2. If Prisoner 1 confesses, but Prisoner 2 does not (he aims to *cooperate* with Prisoner 1), Prisoner 1 will go free and Prisoner 2 will get twenty years.
3. If Prisoner 2 confesses, but Prisoner 1 does not (he aims to *cooperate* with Prisoner 1), Prisoner 1 will get twenty years, and Prisoner 2 will go free.
4. If neither confesses, each will serve two years in prison.

The corresponding normal form of the game is shown in Table 19.4.

Table 19.4: Example for a prisoner's dilemma

		Person B	
		Confess	**Cooperate**
Person A	Confess	8 years ; 8 years	0 years ; 20 years
	Cooperate	20 years ; 0 years	2 years ; 2 years

The scenario is also explained in this video

Let us now look at how individuals would rationally decide what to do:

- If A assumes that B confesses, A would also confess.
- If A assumes that B cooperates, A would still confess.

Since the same logic applies for B, we can conclude that the strategy of choice is to confess, even though the most favorable strategy for both would be to cooperate. The game-theoretical equilibrium (both confess) in this game can be called a **Nash equilibrium** because it suggests that both players will make the move that is best for them individually, even if it is worse for them collectively.

Exercise 19.6.

a) Define briefly what is meant by a *Nash equilibrium*.
b) Analyze whether the *normal form* of the given game has a Nash equilibrium. Please notice that high numbers indicate high utility, ranging from 0 (no utility) to 10 (high utility).

Table 19.5: Normal form of a game

		Player 2	
		P	V
Player 1	P	2, 4	2, 6
	V	7, 1	3, 3

Solution

a) The Nash equilibrium is a concept of game theory where the optimal outcome of a game is one where no player has an incentive to deviate from his chosen strategy after considering an opponent's choice.

b) In the game above the point where both play V with (3,3) is a Nash-Equilibrium Nash equilibrium.

Chapter 20

Finance

You are financially literate if you understand and manage personal finances effectively. It involves having a basic understanding of financial concepts, such as budgeting, saving, investing, and managing debt. Financial literacy also includes knowledge of financial products and services, such as bank accounts, credit cards, loans, and insurance. Being financially literate means having the skills and knowledge to make informed financial decisions, and being able to assess risks and opportunities when it comes to managing money. It is an important life skill that can help individuals achieve their financial goals, build wealth, and avoid financial pitfalls.

Being better-educated was always associated with having more financial knowledge (Figure 1) across the countries we examined,3 yet we also found that education is not enough. That is, even well-educated people are not necessarily savvy about money.

Unfortunately, financial illiteracy is widespread. While being better-educated is associated with making better financial decisions on average, "even well-educated people are not necessarily savvy about money" (Mitchell & Lusardi, 2015, p. 3).

There are various attempts to assess the levels of financial literacy, for example: OECD (2025).

Exercise 20.1. S&P Global FinLit Survey
One example of a comprehend way to measure financial literacy stems from the *Standard & Poor‘s Ratings Services Global Financial Literacy Survey* (see Klapper & Lusardi, 2020). They ask the following multiple-choice questions:

1. Suppose you have some money. Is it safer to put your money into one business or investment, or to put your money into multiple businesses or investments?
   a) One business or investment
   b) Multiple businesses or investments
   c) Don‘t know
   d) Refused to answer
2. Suppose over the next 10 years the prices of the things you buy double. If your income also doubles, will you be able to buy less than you can buy today, the same as you can buy today, or more than you can buy today?
   a) Less
   b) The same
   c) More
   d) Don‘t know
   e) Refused to answer
3. Suppose you need to borrow $100. Which is the lower amount to pay back: $105 or $100 plus 3%?
   a) $105
   b) $100 plus 3%

c) Don‘t know
d) Refused to answer

4. Suppose you put money in the bank for 2 years and the bank agrees to add 15% per year to your account. Will the bank add more money to your account the second year than it did the first year, or will it add the same amount of money both years?

    a) More
    b) The same
    c) Don‘t know
    d) Refused to answer

5. Suppose you had $100 in a savings account and the bank adds 10% per year to the account. How much money would you have in the account after 5 years if you did not remove any money from the account?

    a) More than $150
    b) Exactly $150
    c) Less than $150
    d) Don‘t know
    e) Refused to answer

These questions cover four fields of financial literacy, i.e., risk diversification, inflation and purchasing power, numeracy (simple calculations related to interest rates), and compound interest (interest payments increase exponentially over time). Knowledge in these concepts is important to make good financial decisions and to manage risk.
Try to answer these quesions and compare your performance with the results shown in Klapper & Lusardi (2020).

Solution

Correct answers are:

1. b)
2. b)
3. b)
4. a)
5. a)

Exercise 20.2. The three questions
Referring to Mitchell & Lusardi (2015), only 21.7% of individuals in Germany with a lower secondary education and 72% of those with tertiary education can correctly answer all three of the following questions. Try it yourself!

1. Suppose you had $100 in a savings account and the interest rate was 2% per year. After 5 years, how much do you think you would have in the account if you left the money to grow?

    a) More than $102
    b) Exactly $102
    c) Less than $102
    d) Do not know
    e) Refuse to answer

2. Imagine that the interest rate on your savings account was 1% per year and inflation was 2% per year. After 1 year, how much would you be able to buy with the money in this account?

    a) More than today
    b) Exactly the same
    c) Less than today
    d) Do not know
    e) Refuse to answer

3. Please tell me whether this statement is true or false: *"Buying a single company's stock usually provides a safer return than a stock mutual fund."*

   a) True
   b) False
   c) Do not know
   d) Refuse to answer

These three questions are designed to measure Lusardi & Mitchell (2014) reports that in many countries the financial illiteracy is considerably high as the following table shows:

Table 20.1: Financial literacy around the World

	% all correct	% none correct
Germany	57	10
Netherlands	46	11
United States	35	10
Italy	28	20
Sweden	27	11
Japan	27	17
New Zealand	27	4
Russia	3	28

Solution

Correct answers are:

1. a)
2. c)
3. b)

20.1 Simple financial mathematics

I discuss financial mathematics in the following chapter just briefly. If you want to gather a deeper understanding, I recommend the open textbook of Dahlquist et al. (2022) or the respective chapters of Wilkinson (2022).

20.1.1 Simple Interest

Suppose r denotes annual interest rates, P denotes the initial deposit which earns the interest, A denotes the value of the deposit at the end of an investment. Then, the relationship of these for a single year is

$$A = P + Pr = P(1 + r)$$

and for many years, t, it is

$$A = P(1 + rt)$$

which is the simple interest formula. It gives the amount due when the annual interests does not become part of the deposit P.

20.1.2 Compound interest

If the annual interest, $P(1+r)$, is added to P, we need a formula that takes this into account, and for two periods this is

$$A = P \cdot [(1+r) \cdot (1+r)] = P(1+r)^2$$

and for t periods

$$A = P(1+r)^t.$$

Compound interest is the addition of interest to the principal sum of a loan or deposit, or in other words, interest on principal plus interest. It is the result of reinvesting interest, or adding it to the loaned capital rather than paying it out, or requiring payment from borrower, so that interest in the next period is then earned on the principal sum plus previously accumulated interest.

$$A = P\left(1 + \frac{r}{n}\right)^{nt}$$

Example

Suppose a principal amount of \$1,500 is deposited in a bank paying an annual interest rate of 4.3%, compounded quarterly. Then the balance after 6 years is found by using the formula above, with $P = 1500$, $r = 0.043$ (4.3%), $n = 4$, and $t = 6$:

$$A = 1500 \times \left(1 + \frac{0.043}{4}\right)^{4\times 6} \approx 1938.84$$

So the amount A after 6 years is approximately \$1,938.84.

Subtracting the original principal from this amount gives the amount of interest received: $1938.84 - 1500 = 438.84$

20.1.3 Continuously compounded interest

As n, the number of compounding periods per year, increases without limit, the case is known as continuous compounding, in which case the effective annual rate approaches an upper limit of $e^r - 1$, where e is a mathematical constant that is the base of the natural logarithm.

Continuous compounding can be thought of as making the compounding period infinitesimally small, achieved by taking the limit as n goes to infinity. The amount after t periods of continuous compounding can be expressed in terms of the initial amount P as

$$A = Pe^{rt}$$

20.1.4 Present value

The present is the value of an expected income stream determined as of the date of valuation. The present value is usually less than the future value because money has interest-earning potential, a characteristic referred to as the time value of money, except during times of zero- or negative interest rates, when the present value will be equal or more than the future value. Time value can be described with the simplified phrase, "A dollar today is worth more than a dollar tomorrow'‘. Here, 'worth more' means that its value is greater than tomorrow. A dollar today is worth more than a dollar tomorrow because the dollar can be invested and earn a day's worth of interest, making the total accumulate to a value more than a dollar by tomorrow.

$$P = Ae^{-rt}$$

20.2 Net present value and internal rate of return

When making decisions about financial products such as investments or loans, it is important to consider their long-term impact on your finances. *Net Present Value* (NPV) and *Internal Rate of Return* (IRR) are two key indicators that can help guide decision making and determine whether a financial product is a good investment.

Net Present Value (NPV) is the difference between the present value of all cash inflows and the present value of all cash outflows over a given time period. The formula to calculate NPV is:

$$NPV = \sum_{n=1}^{N} \frac{C_n}{(1+r)^n} - C_0$$

where C_n denotes net cash inflow during the period n, r the discount rate, or the cost of capital, n the number of periods, and C_0 the initial investment.

In other words, NPV helps determine the current value of future cash flows, adjusted for the time value of money. A positive NPV indicates that an investment is expected to generate a return greater than the cost of capital, while a negative NPV suggests that the investment is likely to result in a loss.

Internal Rate of Return (IRR), on the other hand, is the discount rate that makes the NPV of all cash inflows equal to the NPV of all cash outflows. The formula to calculate IRR is:

$$0 = \sum_{n=0}^{N} \frac{C_n}{(1+IRR)^n}$$

where C_n denotes the net cash inflow during the period n, IRR the internal rate of return, n the number of periods, and C_0 the initial investment.

IRR can be thought of as the rate of return an investment generates over time, taking into account the time value of money. When comparing different investment opportunities, a higher IRR generally indicates a more profitable investment.

Both NPV and IRR are important tools to help individuals make informed decisions about financial products. By comparing the NPV and IRR of different investment options, individuals can determine which investments are likely to generate the greatest returns over time, and which products may not be worth the initial investment.

It is worth noting that while NPV and IRR are useful indicators for decision making, they are not the only factors to consider. Individuals should also consider other important factors such as risk, liquidity, and diversification when evaluating different financial products. By taking a holistic approach and considering all relevant factors, individuals can make informed decisions that are best suited to their financial goals and circumstances.

Exercise 20.3. Investment case
You deposit 1,000 euros today into a savings account with an annual interest rate of 5% for 2 years. What is the balance after 2 years with annual, semi-annual (4 interest payments per year), and continuous compounding?

Solution

- Annual compounding:

$$1,000€ \cdot (1+0.05)^2 = 1,102.50€$$

- Semi-annual compounding:

$$1,000€ \cdot \left(1 + \frac{0.05}{4}\right)^{2 \cdot 4} = 1,104.49€$$

- Continuous compounding:

$$1,000€ \cdot e^{0.05 \cdot 2} = 1,105.17€$$

Exercise 20.4. Present value
You want to have 100,000 in 10 years, and you can save money with an interest rate of 5% p.a. How much do you need to invest today for annual, semi-annual (4 interest periods), and continuous compounding to achieve your goal?

Solution

- Annual compounding:

The formula for the future value of a present amount with annual compounding is:

$$V_{\text{future}} = V_{\text{present}} \cdot (1 + i)^t$$

To calculate the present value, we need to rearrange the above formula for Present Value:

$$V_{\text{present}} = \frac{V_{\text{future}}}{(1 + i)^t}$$

$$V_{\text{present}} = \frac{100,000}{(1 + 0.05)^{10}} \approx 61,391$$

- Semi-annual compounding (4 interest periods per year):

The formula for the future value of a present amount with semi-annual compounding is:

$$V_{\text{future}} = V_{\text{present}} \cdot \left(1 + \frac{i}{p}\right)^{p \cdot t}.$$

To calculate the present value, we need to rearrange the above formula for Present Value:

$$V_{\text{present}} = \frac{V_{\text{present}}}{\left(1 + \frac{i}{p}\right)^{p \cdot t}}$$

$$\frac{100,000}{(1 + \frac{0.05}{4})^{4 \cdot 10}} \approx 60,841$$

- Continuous compounding:

The formula for the future value of a present amount with continuous compounding is:

$$V_{\text{future}} = V_{\text{present}} \cdot e^{i \cdot t}$$

To calculate the present value, we need to rearrange the above formula for present value:

$$V_{\text{present}} = \frac{V_{\text{future}}}{e^{i \cdot t}}$$

$$V_{\text{present}} = \frac{100,000}{e^{0.05 \cdot 10}} \approx 60,653$$

Exercise 20.5. Invest in A or B
You are considering investing in project A or B.
Project A: It costs 50,000 today and is expected to generate cash flows of 20,000 per year for the next 5 years. You have a required rate of return of 8%.
Project B: It costs 50,000 today and you get 100,000 back in 5 years.
Calculate the value of your invest after five years. Which investment is the better one?

Solution

$$V_A^{t=5} \approx 117,332$$
$$V_B^{t=5} = 100,000$$

Thus, we should prefer project A.

Exercise 20.6. Net present value
You are considering investing in project A or B.
Project A: It costs 50,000 today and is expected to generate cash flows of 20,000 per year for the next 5 years. You have a required rate of return of 8%.
Project B: It costs 50,000 today and you get 100,000 back in 5 years.
Calculate the net present value of both projects and decide where to invest.

Solution

Assuming that the cash flows occur at the end of each year, we can use the following formula to calculate the NPV of the project:

$$NPV = \sum_{n=1}^{N} \frac{C_n}{(1+r)^n} - C_0$$

$$NPV_A = -50,000 + \frac{20,000}{(1+0.08)^1} + \frac{20,000}{(1+0.08)^2} + \frac{20,000}{(1+0.08)^3} + \frac{20,000}{(1+0.08)^4} + \frac{20,000}{(1+0.08)^5}$$

$$NPV_A = -50,000 + 18,518.52 + 17,146.77 + 15,876.64 + 14,700.59 + 13,611.66 \approx 29,854$$

$$NPV_B = -50,000 + \frac{100,000}{(1+0.08)^5} = -50,000 + 68058,31 \approx 18058$$

Since the $NPV_A > NPV_B$, we should invest in project A.

Exercise 20.7. Internal rate of return
You are considering investing in project A or B.
Project A: It costs 50,000 today and is expected to generate cash flows of 20,000 per year for the next 5 years. You have a required rate of return of 8%.
Project B: It costs 50,000 today and you get 100,000 back in 5 years.
Calculate the internal rate of return of both projects with the help of a software package such as *Excel* or *Libre Calc* and decide where to invest.

Solution

Assuming that the cash flows occur at the end of each year, we can use the following formula to calculate the IRR of the project:

$$0 = \sum_{n=0}^{N} \frac{C_n}{(1+IRR)^n}$$

$$0 = -50,000 + \frac{20,000}{(1+IRR)^1} + \frac{20,000}{(1+IRR)^2} + \frac{20,000}{(1+IRR)^3} + \frac{20,000}{(1+IRR)^4} + \frac{20,000}{(1+IRR)^5}$$

Solving for IRR is not that easy. Using a spreadsheet program, we get $IRR_A \approx 28.68$ and $IRR_B \approx 14.87$. Thus, project A seems to be better.

Exercise 20.8. Rule of 70
The *Rule of 70* is often used to approximate the time required for a growing series to double. To understand this rule calculate how many periods it takes to double your money when it growth at a constant rate of 1% each period.

Solution

What is the time required for a growing variable to double?

Let X be the initial value of a growing variable, and Y denote the terminal value at time $t+n$. The relationship between the two is given by

$$Y = X(1+g)^n$$

where g is the annual growth rate. As we are interested in the time span required for X to double, $Y = 2$, and

$$2 = (1+g)^n$$

Taking natural logarithms (logarithm to the base of e), we get

$$\ln 2 = n \ln(1+g)$$

and hence

$$n = \frac{\ln 2}{\ln(1+g)} \quad (*).$$

This is the exact number of time periods required for a growing variable to double its size.

One can approximate n using the definition of e^x:

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots + \frac{x^n}{n!} + R_n$$

where the remainder term $R_n \to 0$ as $n \to \infty$. Ignoring high-order terms, for small x, it may be approximated by

$$e^x \approx 1 + x$$

Taking logarithms of both sides, we get

$$x \approx \ln(1+x) \quad (**).$$

Using (**), equation (*) may be approximated as

$$n \approx \frac{\ln 2}{g} = \frac{0.693147}{g} \approx \frac{70}{g\%}$$

This is the origin of the Rule of 70.

Using the number e right away is simpler:

$$\begin{aligned}
(e^r)^t &= 2 \\
\ln e^{rt} &= \ln 2 \\
rt &= \ln 2 \\
t &= \frac{\ln 2}{r} \\
t &\approx \frac{0.693147}{r}
\end{aligned}$$

20.3 A note on growth rates and the logarithm

20.3.1 Log approximation of growth rates

Most data are recorded for discrete periods of time (e.g., quarters, years). Consequently, it is often useful to model economic dynamics in discrete periods of time. A good linear approximation to a growth rate from time $t = 0$ to $t = 1$ in x is

$$g = \frac{x_1 - x_0}{x_0} \approx \ln x_1 - \ln x_0$$

Let us prove that with the a small change from 1000 to 1002. The exact calculation would be:

$$\frac{1002 - 1000}{1000} = 0.002.$$

The approximate calculation is

$$g \approx \ln(1002) - \ln(1000) = 0.00199800266267314.$$

The approximation is close because the change is small.

Let us consider now changes considering some numbers of per capita real GDP for the US and Japan in 1950 and 1989 given in Table 20.2.

Table 20.2: GDP over time

Year	US	Japan
1950	8611	1563
1989	18317	15101

For these large changes the said approximation does not give us close results. The exact calculation for the US would be:

$$g = \frac{18317 - 8611}{8611} = 1.1271629311346.$$

The approximate calculation is

$$g \approx \ln(18317) - \ln(8611) = 0.754789134664051.$$

20.3.2 Annual average growth rates

What are the annual average growth rates over this period for the US and Japan? Here is one way to answer this question:

$$Y_{1989} = (1+g)^{39} \cdot Y_{1950} \tag{20.1}$$
$$\Leftrightarrow \frac{Y_{1989}}{Y_{1950}} = (1+g)^{39} \tag{20.2}$$
$$\Leftrightarrow g = \left(\frac{Y_{1989}}{Y_{1950}}\right)^{\frac{1}{39}} - 1. \tag{20.3}$$

Yielding $g = 0.019542$ for the US and $g = 0.0598822$ for Japan. The US grew at an average growth rate of about 2% annually over the period, while Japan grew at about 6% annually.

Let us now do the calculation using the natural log of both sides of:

$$\frac{Y_{1989}}{Y_{1950}} = (1+g)^{39}$$

to get:

$$\ln(Y_{1989}) - \ln(Y_{1950}) = 39 \cdot \ln(1+g)$$

which rearranges to:

$$\ln(1+g) = \frac{\ln(Y_{1989}) - \ln(Y_{1950})}{39}.$$

Calculating that now for the US and China, we get $g \approx 0.0195420$ for the US and $g \approx 0.05988224$ for Japan.

20.3.3 Plotting growth using the logarithm

Recall that, with a constant growth rate g and starting from time 0, output in time t is:

$$Y_t = (1+g)^t \cdot Y_0$$

Taking natural logs of both sides, we have:

$$\ln Y_t = \ln Y_0 + t \cdot \ln(1+g)$$

We see that log output is linear in time. Thus, if the growth rate is constant, a plot of log output against time will yield a straight line. Consequently, plotting log output against time is a quick way to **eyeball** whether growth rates have changed over time.

In Figure 20.1 and Figure 20.2 you see a semi-logarithmic plot that has one axis on a logarithmic scale and the other on a linear scale. It is useful for data with exponential relationships, where one variable covers a large range of values, or to zoom in and visualize that what seems to be a straight line in the beginning is, in fact, the slow start of a logarithmic curve that is about to spike, and changes are much bigger than thought initially.

Exercise 20.9. Investments over time
Describe the formulas to describe the growth process of an investment over time when time is discrete and when time is continuous.

Figure 20.1: Log plot

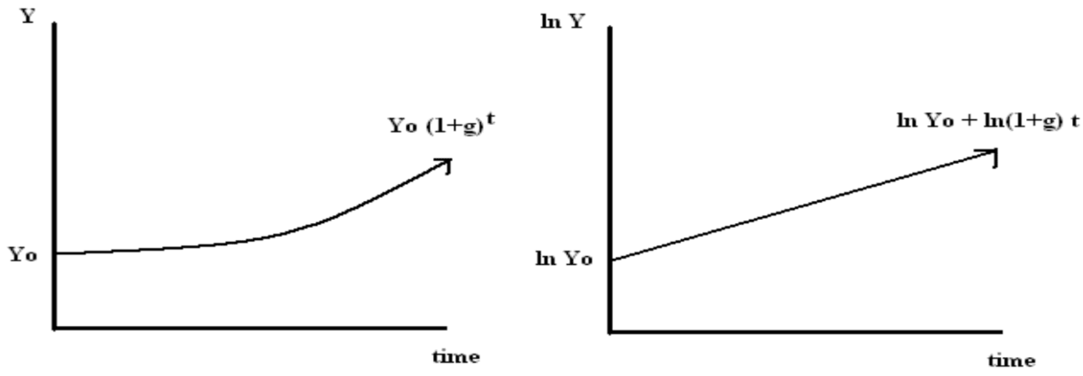
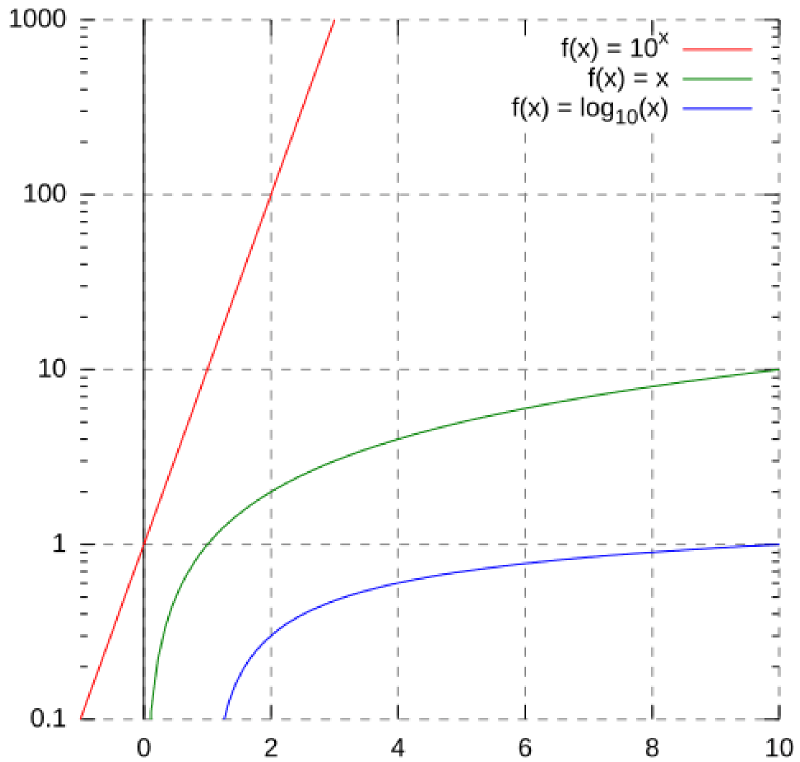


Figure 20.2: Log-Lin scale



Solution

The formula under discrete time is:

$$Y_t = Y_0 \cdot (1+g)^t$$

The formula under continuous time is:

$$Y_t = Y_0 \cdot e^{gt}$$

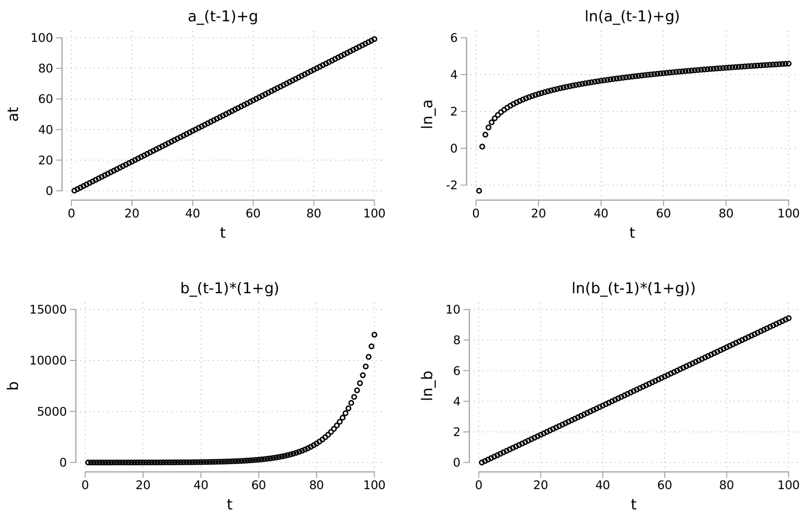
Exercise 20.10. Exponential growth
Sketch a timeline for each of the following series:

- $a_t = a_{t-1} + g$
- $\ln(a_t)$
- $b_t = b_{t-1} \cdot (1+g)$
- $\ln b_t$

Solution

Figure Figure 20.3 provides the solution.

Figure 20.3: Various growth functions



Exercise 20.11. COVID and how to plot it
I downloaded the complete **Our World in Data COVID-19** dataset from ourworldindata.org. I created some graphs which I will show you below in Figure 20.4 to Figure 20.9. Can you discuss the scaling and how to interpret them? What is your opinion on these graphs? Are some of them a bit misleading (at least if you don't look twice)?

Figure 20.4: Total cases

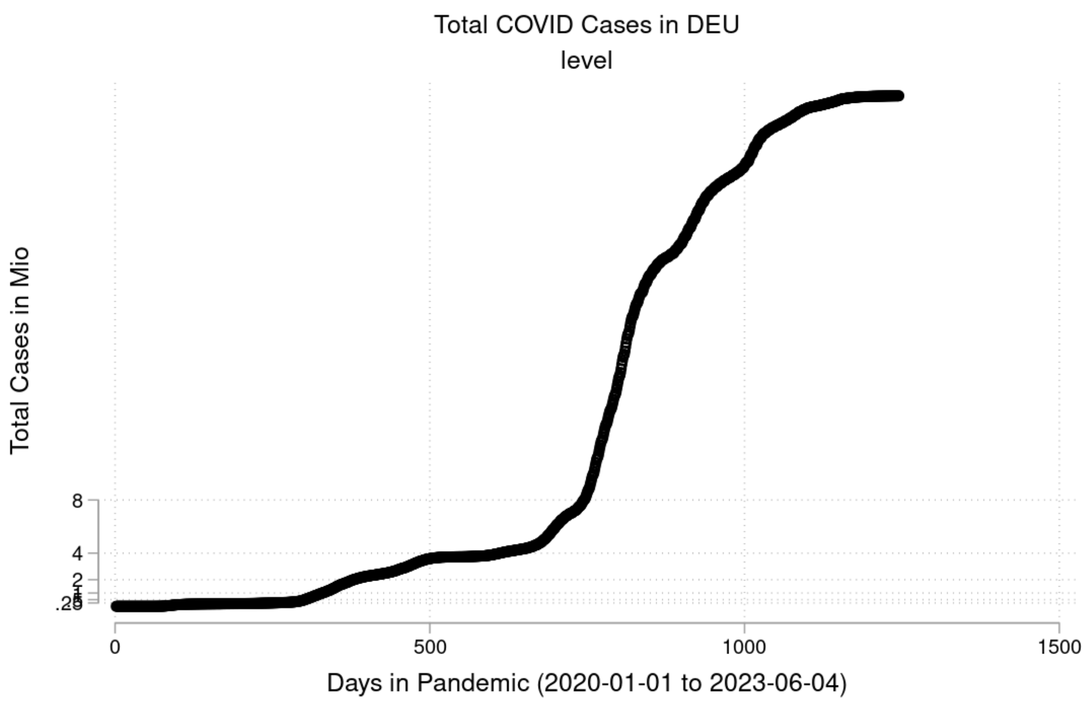


Figure 20.5: Total cases 2

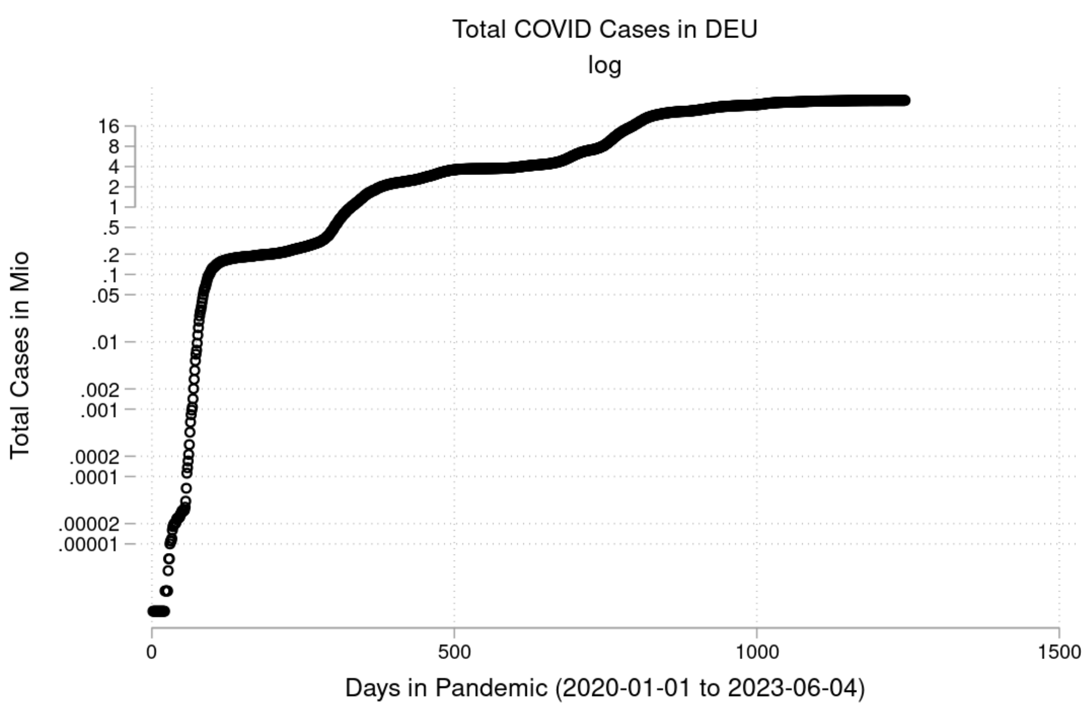


Figure 20.6: Total cases 3

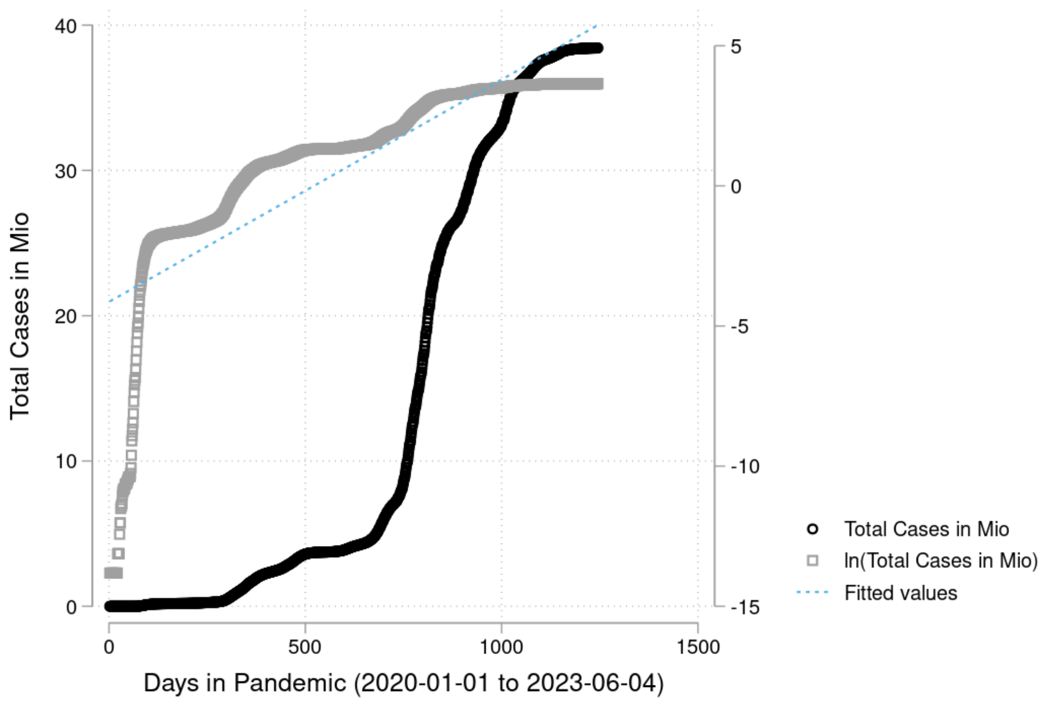


Figure 20.7: New cases

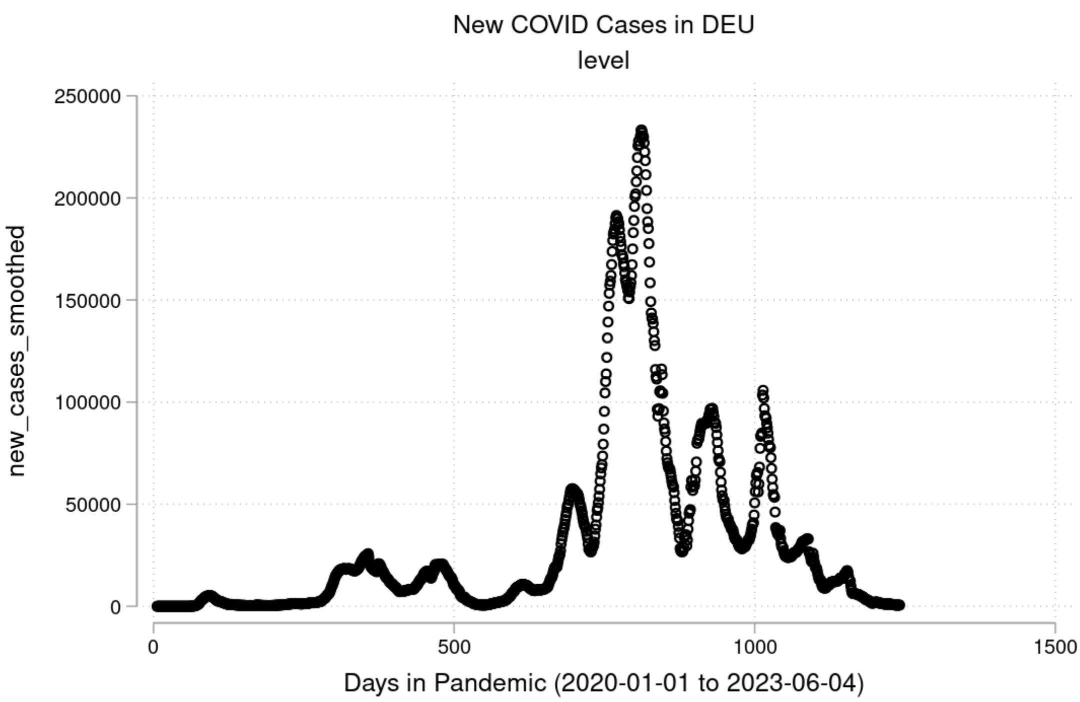


Figure 20.8: New cases 2

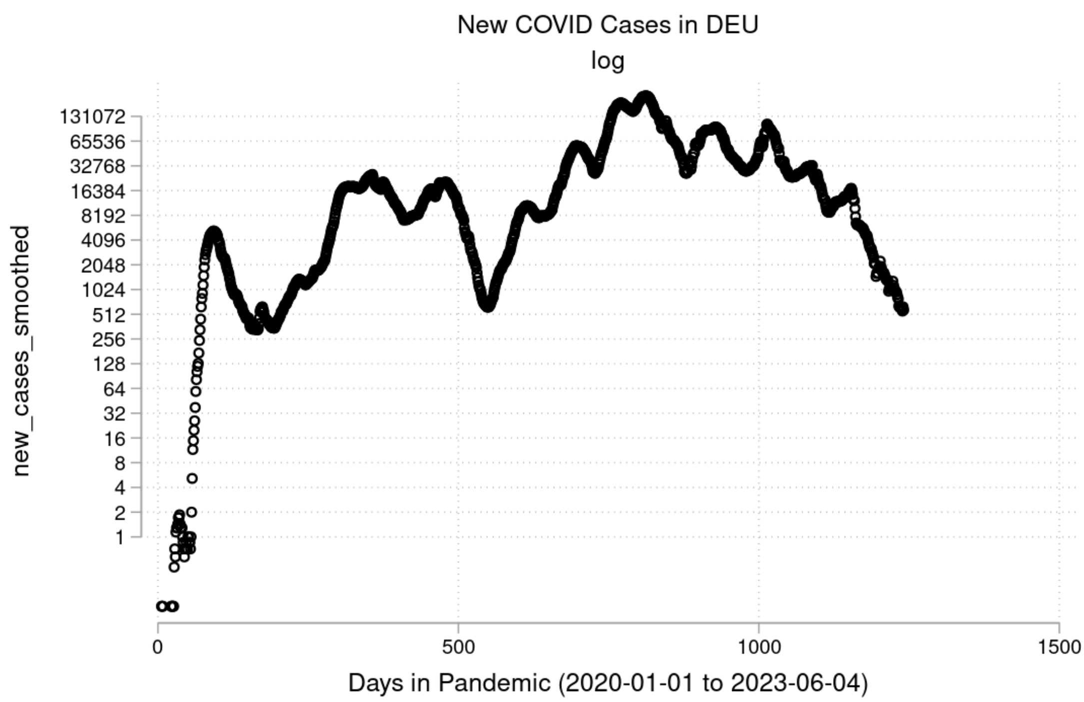
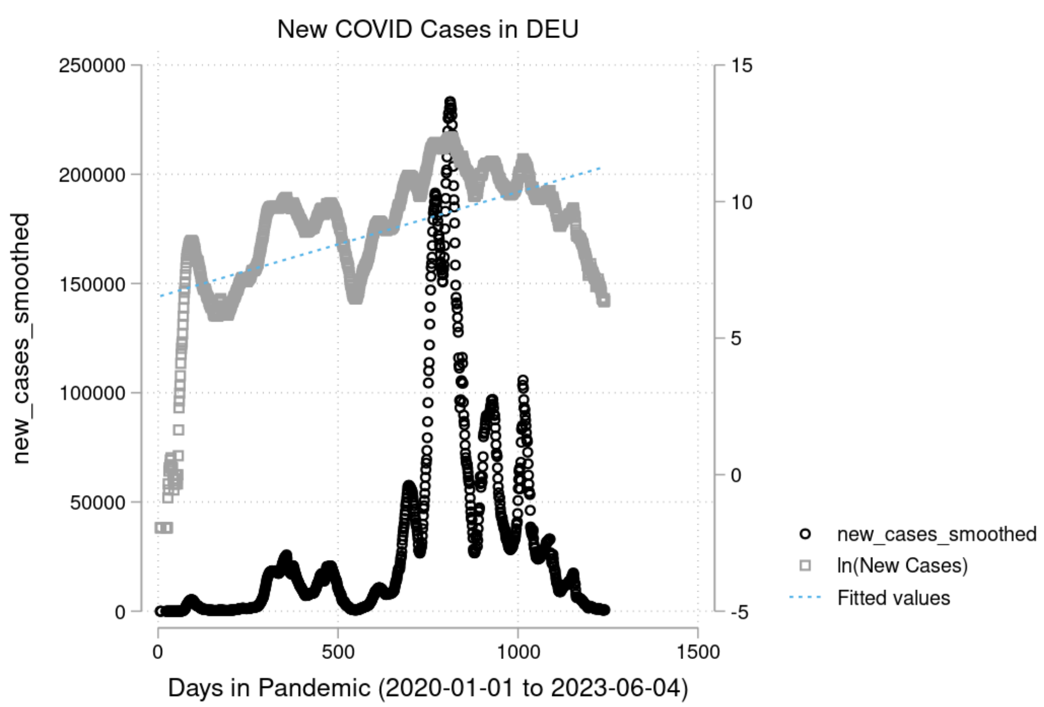


Figure 20.9: New cases 3



Chapter 21

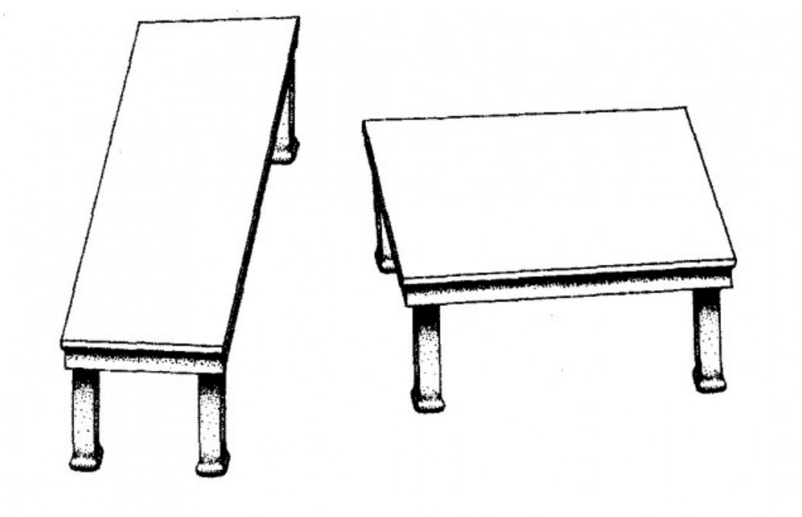
Cognitive biases

Required readings: Bazerman & Moore (2012, ch. 1-2)

In section Section 2.3, we discussed how human beings have limited cognitive abilities to arrive at optimal solutions. Behavioral economics, pioneered by Amos Tversky (1937-1996) and 2002 Nobel Prize winner Daniel Kahnemann (*1934), has identified several biases that explain why and when people fail to act perfectly rationally. In the following sections, we will explore some of the most prominent biases that arise from humans relying on heuristics in decision-making. Specifically, we will describe biases result from the use of availability, representative, and confirmation heuristics and can lead to flawed decision-making and negative outcomes for individuals and organizations. By recognizing and accounting for these biases, we can make better decisions.

Exercise 21.1. Shepard Tabletop Illusion

Figure 21.1: Shepard tabletop illusion



Look at the two table shwon in Figure 21.1. Which one is larger, and which one looks more like a square?

Solution

Watch Shepard Tabletop Illusion

21.1 Availability heuristic

The **availability heuristic** refers to our tendency to make judgments or decisions based on information that is easily retrievable from memory. For example, if someone hears a lot of news about a particular stock or investment, they may be more likely to invest in it, even if there are other better investment options available. This bias can also lead individuals to overestimate the frequency of certain events, such as the likelihood of a market crash, based on recent media coverage.

21.2 Representative heuristic

The **representative heuristic** refers to our tendency to make judgments based on how similar something is to a stereotype or preconceived notion. For example, an investor might assume that a company with a flashy website and marketing materials is more successful than a company with a more low-key image, even if the latter is actually more profitable. This bias can also lead to assumptions about the performance of certain investment strategies based on their resemblance to other successful strategies.

21.3 Confirmation heuristic

The **confirmation heuristic** refers to our tendency to seek out information that confirms our existing beliefs and ignore information that contradicts them. For example, an investor who strongly believes in the potential of a particular investment might only read news and analysis that supports their belief and ignore any information that suggests otherwise. This can lead to a failure to consider potential risks and downsides of an investment.

21.4 Investment mistakes

Investing can be a daunting task, but avoiding some common investment mistakes can help set you on the right path to financial success. The following list list shows according to Stammers (2016) the *Top 20 common investment mistakes* without the explanations provided in the paper:

- **Expecting too much or using someone else's expectations:** Nobody can tell you what a reasonable rate of return is without having an understanding of you, your goals, and your current asset allocation.
- **Not having clear investment goals:** Too many investors focus on the latest investment fad or on maximizing short-term investment return instead of designing an investment portfolio that has a high probability of achieving their long-term investment objectives.
- **Failing to diversify enough:** The best course of action is to find a balance. Seek the advice of a professional adviser.
- **Focusing on the wrong kind of performance:** If you find yourself looking short term, refocus.
- **Buying high and selling low:** Instead of rational decision making, many investment decisions are motivated by fear or greed.
- **Trading too much and too often:** You should always be sure you are on track. Use the impulse to reconfigure your investment portfolio as a prompt to learn more about the assets you hold instead of as a push to trade.
- **Paying too much in fees and commissions:** Look for funds that have fees that make sense and make sure you are receiving value for the advisory fees you are paying.
- **Focusing too much on taxes:** It is important that the impetus to buy or sell a security is driven by its merits, not its tax consequences.
- **Not reviewing investments regularly:** Check in regularly to make sure that your investments still make sense for your situation and that your portfolio doesn't need rebalancing.
- **Taking too much, too little, or the wrong risk:** Make sure that you know your financial and emotional ability to take risks and recognize the investment risks you are taking.

- **Not knowing the true performance of your investments:** Many investors do not know how their investments have performed in the context of their portfolio. You must relate the performance of your overall portfolio to your plan to see if you are on track after accounting for costs and inflation.
- **Reacting to the media:** Using the news channels as the sole source of investment analysis is a common investor mistake. Successful investors gather information from several independent sources and conduct their own proprietary research and analysis.
- **Chasing yield:** High-yielding assets can be seductive, but the highest yields carry the highest risks. Past returns are no indication of future performance. Focus on the whole picture and don't get distracted while disregarding risk management.
- **Trying to be a market timing genius:** Market timing is very difficult and attempting to make a well-timed call can be an investor's undoing. Consistently contributing to your investment portfolio is often better than trying to trade in and out in an attempt to time the market.
- **Not doing due diligence:** Check the training, experience, and ethical standing of the people managing your money. Ask for references and check their work on the investments they recommend. Taking the time to do due diligence can help avoid fraudulent schemes and provide peace of mind.
- **Working with the wrong adviser:** An investment adviser should share a similar philosophy about investing and life in general. The benefits of taking extra time to find the right adviser far outweigh the comfort of making a quick decision.
- **Letting emotions get in the way:** Investing can bring up significant emotional issues that can impede decision-making. A good adviser can help construct a plan that works no matter what the answers to important financial questions are.
- **Forgetting about inflation:** It's important to focus on real returns after accounting for fees and inflation. Even if the economy is not in a massive inflationary period, some costs will still rise, so it's important to focus on what you can buy with your assets, rather than their value in dollar terms.
- **Neglecting to start or continue:** Investment management requires continual effort and analysis to be successful. It's important to start investing and continue to invest over time, even if you lack basic knowledge or have experienced investment losses.
- **Not controlling what you can:** While you can't control what the market will bear, you can control how much money you save. Continually investing capital over time can have as much influence on wealth accumulation as the return on investment and increase the probability of reaching your financial goals.

21.5 Heuristics can fail

Respond to the following problems which are taken from Bazerman & Moore (2012, p. 15f). In class, we will discuss your answers and how they match with the mathematically correct solutions to these problems.

Exercise 21.2. Problem 1
Please rank the following causes of death in the United States between 1990 and 2000. Place a 1 next to the most common cause, 2 next to the second, and so on. - Tobacco - Poor diet and physical inactivity - Motor vehicle accidents - Firearms (guns) - Illicit drug use
Now, estimate the number of deaths caused by each of these five causes between 1990 and 2000.

Solution

According to Mokdad et al. (2004, p. 1240), the answer is the following order:

- Tobacco
- Poor diet and physical inactivity
- Motor vehicle accidents
- Firearms (guns)
- Illicit drug use

Exercise 21.3. Problem 2 and 3
Estimate the percentage of words in the English language that begin with the letter "a."
Estimate the percentage of words in the English language that have the letter "a" as their third letter.

Solution

Most people estimate that there are more words beginning with "a" than words in which "a" is the third letter. In fact, the latter are more numerous than the former. Words beginning with "a" constitute roughly 6 percent of English words, whereas words with "a" as the third letter make up more than 9 percent of English words.

Exercise 21.4. Problem 4
Lisa is thirty-three and pregnant for the first time. She is worried about birth defects like Down syndrome. Her doctor tells her there is only a 1 in 1,000 chance that a woman of her age will have a baby with Down syndrome. However, Lisa remains anxious and decides to get a test called the Triple Screen, which detects Down syndrome. The test is moderately accurate: when a baby has Down syndrome, the test gives a positive result 86% of the time. However, 5% of babies who don't have Down syndrome also get a false positive. Lisa takes the test and gets a positive result. What are the chances that her baby has Down syndrome?

a) 0-20%

b) 21-40%

c) 41-60%

d) 61-80%

e) 81-100%

Solution

Most people think that Lisa has a substantial chance of having a baby with Down syndrome. The test gets it right 86 percent of the time, right? That sounds rather reliable, doesn't it? Well, it does, but we should not rely on our *feelings* here. It's better to do the math, because the correct result would show that there is just a 1.7 percent chance of the baby having Down syndrome. Here is the proof for that small number:

Let A be the event of the baby having Down syndrome and B the event of a positive test result. Then,

$$\begin{aligned}
P(A) &= 0.001 \\
P(B \mid A) &= 0.86 \\
P(B \mid \neg A) &= 0.05 \\
P(B) &= \frac{999 \cdot 0.05}{1000} + \frac{1 \cdot 0.86}{1000} = \frac{50.81}{1000} = 0.05081 \\
P(A \mid B) &= \frac{P(B \mid A)P(A)}{P(B)} = \frac{0.86 \cdot 0.001}{0.05081} = 0.01693
\end{aligned}$$

Exercise 21.5. Problem 5
A town is served by two hospitals. In the larger hospital, about 45 babies are born each day. In the smaller hospital, about 15 babies are born daily. About 50% of all babies are boys. For a year, each hospital recorded days when more than 60% of the babies born were boys. Which hospital recorded more such days?

a) The larger hospital

b) The smaller hospital

c) About the same (within 5%)

Solution

Most individuals choose C, expecting the two hospitals to record a similar number of days on which 60 percent or more of the babies born are boys. However, statistics tell us that we are much more likely to observe 60 percent of male babies in a smaller sample than in a larger sample. Think about which is more likely: getting more than 60 percent heads in 3 flips of a coin or in 3,000 flips of a coin? Half of the time, 3 flips will produce more than 60 percent heads. But with 3,000 flips, it happens about 0.0001 percent of the time. Most people ignore sample size when judging probabilities.

Exercise 21.6. Problem 6
You and your spouse have had three daughters. Now expecting a fourth child, you wonder about the odds of having a boy. What is the best estimate of your chances of having another girl?

a) 6.25% (1 in 16), because the odds of getting four girls in a row is 1 in 16

b) 50% (1 in 2), because there is an equal chance of getting each gender

c) Somewhere between 6.25% and 50%

Solution

Many assume that after having three girls, the probability of having another girl must be lower. However, the gender determination of each baby is independent; the chance remains 50 percent for each child, regardless of previous children.

Exercise 21.7. Problem 7
You manage a Major League Baseball team, and the 2005 season has just ended. Your job is to predict future player performance. You must estimate 2006 batting averages for nine players. Fill in your guesses in the right column:

Player	2005 Batting Average	Estimated 2006 Batting Average
1	.215	
2	.242	
3	.244	
4	.258	
5	.261	
6	.274	
7	.276	
8	.283	
9	.305	

Solution

Most people predict that a player's 2006 performance will be almost identical to their 2005 performance. However, statistics show the correlation between Major League Baseball players' batting averages from one year to the next is only 0.4. This tendency is known as "regression to the mean"—the worst performers tend to improve, and the best tend to decline.

Exercise 21.8. Problem 8
Linda is 31, single, outspoken, and very smart. She majored in philosophy and was deeply concerned with issues of discrimination and social justice. Rank the following descriptions in order of how likely they are to describe Linda:

a) Linda is a teacher in an elementary school.

b) Linda works in a bookstore and takes yoga classes.

c) Linda is active in the feminist movement.

d) Linda is a psychiatric social worker.

e) Linda is a member of the League of Women Voters.

f) Linda is a bank teller.

g) Linda is an insurance salesperson.

h) Linda is a bank teller who is active in the feminist movement.

Solution

Examine your rank orderings of descriptions C, F, and H. Most people rank C as more likely than H, and H as more likely than F. However, a conjunction (being both a bank teller and a feminist) cannot be more probable than being a bank teller alone. This is a fundamental law of probability, but it's commonly misunderstood due to representativeness bias.

Exercise 21.9. Problem 9
Take the last three digits of your phone number. Add a "1" to the front to form a four-digit number. Now, estimate whether the Taj Mahal was completed before or after this year.
___ Before ___ After
Now, make your best estimate of the actual year in which the Taj Mahal was completed: ___

Solution

Most people are influenced by irrelevant information, such as their phone number. If your phone number resulted in a year like 1978 or 1040, your estimate might change. In reality, the Taj Mahal was completed in 1648, but people with high phone numbers tend to give more recent estimates.

Exercise 21.10. Problem 10
Which of the following instances seems most likely? Which is the second most likely?

a) Drawing a red marble from a bag containing 50% red marbles and 50% white marbles.

b) Drawing a red marble seven times in succession (with replacement) from a bag containing 90% red marbles and 10% white marbles.

c) Drawing at least one red marble in seven tries (with replacement) from a bag containing 10% red marbles and 90% white marbles.

Solution

The most common order of likelihood chosen is $B > A > C$. However, the correct order is C (52 percent), A (50 percent), and B (48 percent). This illustrates a bias where people overestimate the probability of conjunctive events (where multiple events must happen together) and underestimate disjunctive events (where only one of many events needs to happen).

Exercise 21.11. Problem 11
Ten uncertain quantities are listed below. For each, write down your best estimate. Then, put a lower and upper bound around your estimate so you're 98% confident the range includes the actual value.

Estimate	Lower Bound	Upper Bound
a. Wal-Mart's 2006 revenue		
b. Microsoft's 2006 revenue		
c. World population (July 2007)		
d. Market cap of Best Buy (July 2007)		
e. Market cap of Heinz (July 2007)		
f. McDonald's rank in 2006 Fortune 500		
g. Nike's rank in 2006 Fortune 500		
h. US motor vehicle fatalities (2005)		
i. US national debt (July 2007)		
j. US federal budget (FY 2008)		

Solution

The correct answers are:
(a) $351 billion,
(b) $44 billion,
(c) 6.6 billion people,
(d) $23 billion,
(e) $15 billion,
(f) 108,
(g) 158,
(h) 43,443,
(i) $8.8 trillion,
(j) $2.9 trillion.

Most people are overconfident, estimating too narrow a range for these quantities. Despite claiming a 98 percent confidence, many fail to surround more than 30–70 percent of the actual values.

Exercise 21.12. Problem 12
Which best describes the relationship between a baseball player's batting average in one season and the next?

a) Zero correlation

b) Weak correlation (about .4)

c) Strong correlation (about .7)

d) Perfect correlation (1.0)

Solution

The correct answer is a correlation of about 0.4 between batting averages from one season to the next.

Exercise 21.13. Twelve cognitive biases
In the textbook of Bazerman & Moore (2012) twelve cognitive biases that are described. Read chapter 2 of the book and summarize the twelve biases in a sentence.
Moreover, watch the video of Figure 21.2.

Figure 21.2: Twelve cognitive biases explained

https://youtu.be/wEwGBIr_RIw

Source: Youtube

Solution

1. **Ease of Recall:** Individuals tend to consider events that are more easily remembered to be more frequent, regardless of their actual frequency.
2. **Retrievability:** Individuals' assessments of event frequency are influenced by how easily information can be retrieved from memory.
3. **Insensitivity to Base Rates:** Individuals tend to ignore the frequency of events in the general population and focus instead on specific characteristics of the events.
4. **Insensitivity to Sample Size:** Individuals often fail to take sample size into account when assessing the reliability of sample information.
5. **Misconceptions of Chance:** Individuals expect random processes to produce results that look "random" even when the sample size is too small for statistical validity.
6. **Regression to the Mean:** Individuals fail to recognize that extreme events tend to regress to the mean over time.
7. **Conjunction Fallacy:** Individuals often judge that the occurrence of two events together is more likely than the occurrence of either event alone.
8. **Confirmation Trap:** Individuals tend to seek out information that confirms their existing beliefs and ignore information that contradicts them.
9. **Anchoring:** Individuals often make estimates based on initial values, and fail to make sufficient adjustments from those values.
10. **Conjunctive- and Disjunctive-Events Bias:** Individuals tend to overestimate the likelihood of conjunctive events (two events occurring together) and underestimate the likelihood of disjunctive events (either of two events occurring).
11. **Overconfidence:** Individuals tend to be overconfident in the accuracy of their judgments, particularly when answering difficult questions.
12. **Hindsight and the Curse of Knowledge:** After learning the outcome of an event, individuals tend to overestimate their ability to have predicted that outcome. Additionally, individuals often fail to consider the perspective of others when making predictions.

Part V

MACRO

Chapter 22

Long-run growth

Required readings:
Blanchard & Johnson (2013, ch. 11)

Recommended readings:
Blanchard & Johnson (2013, ch. 10-12) and Romer (2006, pp. 5–29)

Learning objectives:

Students will be able to:

- Understand how capital accumulates over time and its implications for economic growth.
- Analyze the impact of the diminishing marginal product of capital on differing growth rates across countries.
- Describe the principle of transition dynamics, where countries farther below their steady state experience faster growth.
- Identify the limitations of capital accumulation and recognize areas of economic growth that remain unexplained.

22.1 Preface

This chapter focuses on the determinants of economic growth **in the long run**. We present a growth model developed independently by Solow (1956) and Swan (1956) known as the *Solow-Swan growth model*, the *neoclassical growth model*, or simply the *Solow model*. Robert Solow (see Figure 22.1) received in 1987 Nobel Memorial Prize in Economic Sciences for his contributions.

Figure 22.1: Robert M. Solow (1924-2023)

Long run refers to long-term trajectories spanning decades, not cyclical movements. These models consider real income or real output and disregard factors significant in the short run, like inflation or demand.

Exercise 22.1. Visualization of welfare

Figure 22.2: Hans Rosling's 200 Countries, 200 Years, 4 Minutes

https://youtu.be/jbkSRLYSojo

Source: *Youtube*

Watch the video of Figure 22.2 and study Livingcost - Germany vs Indonesia and World Bank GDP per Capita Data.
Discuss what led to Indonesia's impressive catch-up growth and speculate when this rapid growth might slow down. Additionally, consider if Indonesia could achieve a GDP per capita similar to that of a Mid-European country like Germany.

22.2 Stylized facts

22.2.1 Hockey-stick growth

In Figure 22.3, it's evident that numerous countries have witnessed a form of *hockey-stick* growth. Growth take-off occurred at different points in time for various countries: Britain was the first country to experience sustained economic growth, starting around 1650. In Japan, it occurred around 1870. The kink for China and India happened in the second half of the 20th century. Some economies only saw substantial improvements in living standards after gaining independence from colonial rule.

The Industrial Revolution, also called the Technological Revolution, was a transformative era from the late 18th to 19th centuries. It introduced advances, like machinery and steam power, that transformed manufacturing and led to urbanization, reshaping economies, labor, and society.

Technology is the process that uses inputs to produce outputs. For example, a cake recipe outlines the combination of inputs (e.g., flour, energy) and activities (e.g., stirring) needed to make the cake. Technological changes significantly reduced work time needed in production, allowing increased living standards. Figures Figure 22.4, Figure 22.5, and Figure 22.6 demonstrate rapid technological advancements impacting welfare.

Exercise 22.2. Discuss the data of Figure 22.4, Figure 22.5, and Figure 22.6 and their interelationship with economic growth.

22.2.2 Population

Population growth displays a hockey-stick pattern, as shown in Figure 22.7. The figure illustrates the link between economic development and population growth. Although growth is slowing due to changing demographics, with birth rates falling faster than death rates, an annual growth rate of 1% still results in the world population doubling roughly every 70 years.

Figure 22.3: GDP per capita over time

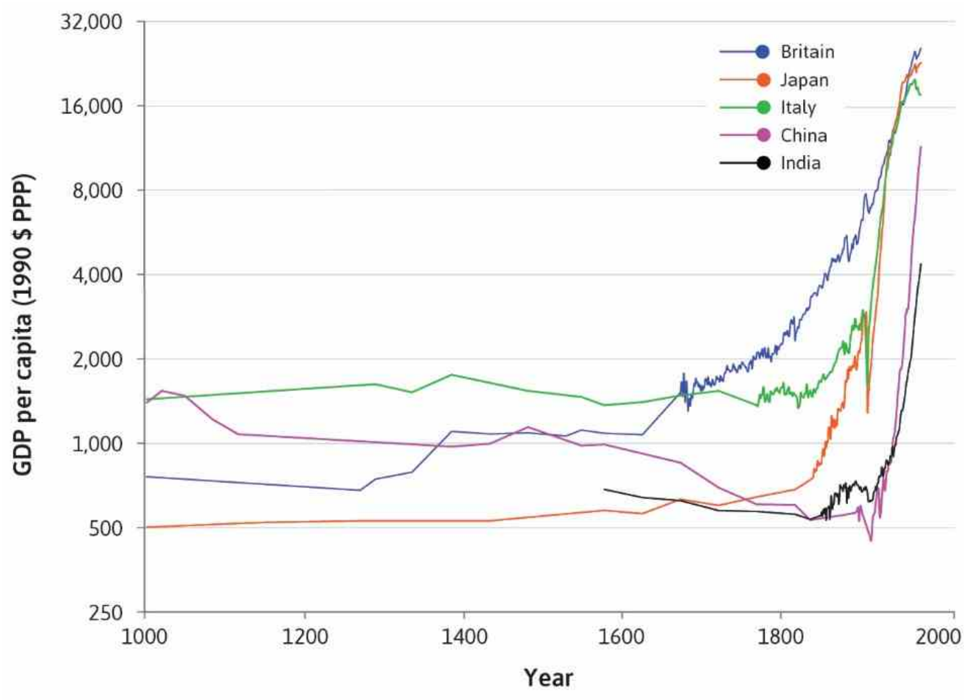
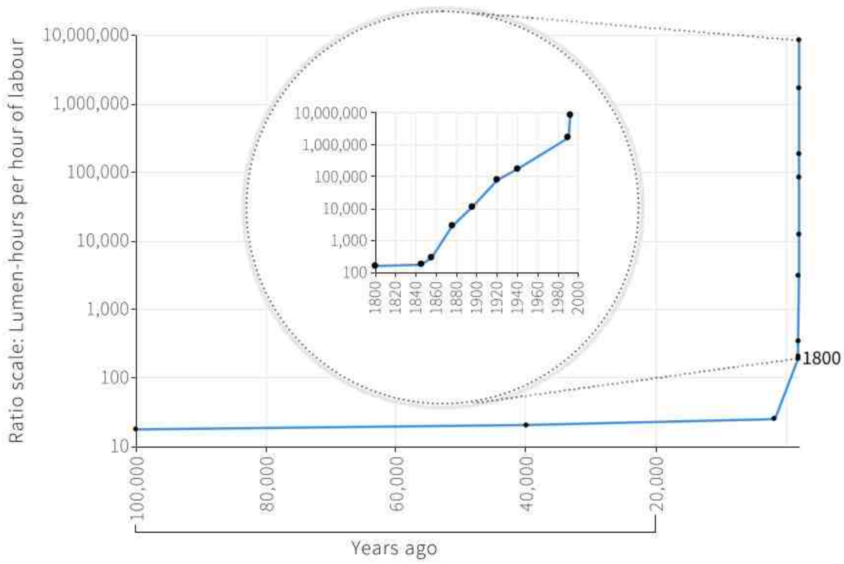
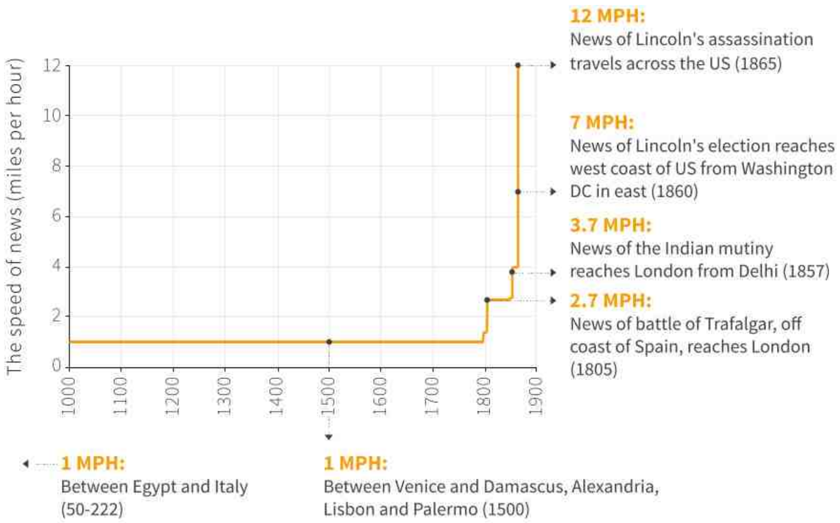


Figure 22.4: Lumen-hours per hour of labor



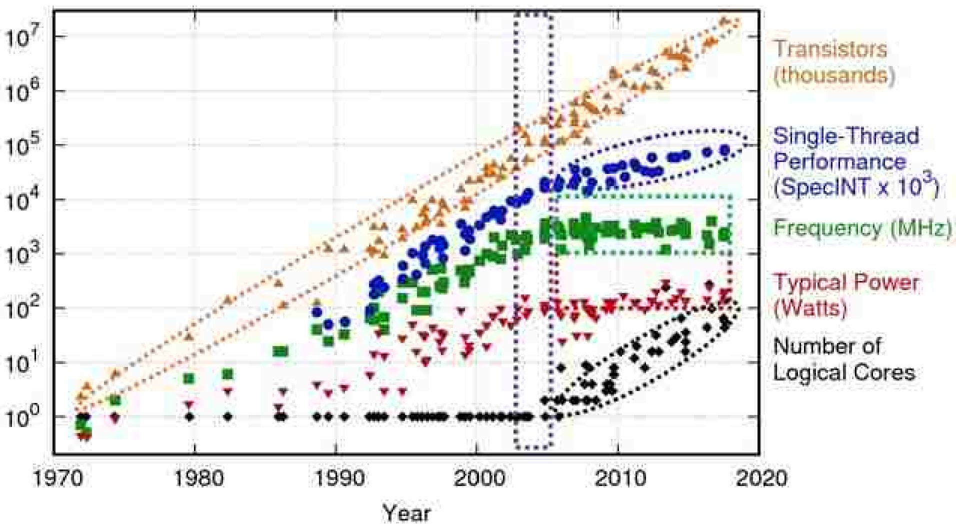
Source: CORE Econ (2025a)

Figure 22.5: A connected world



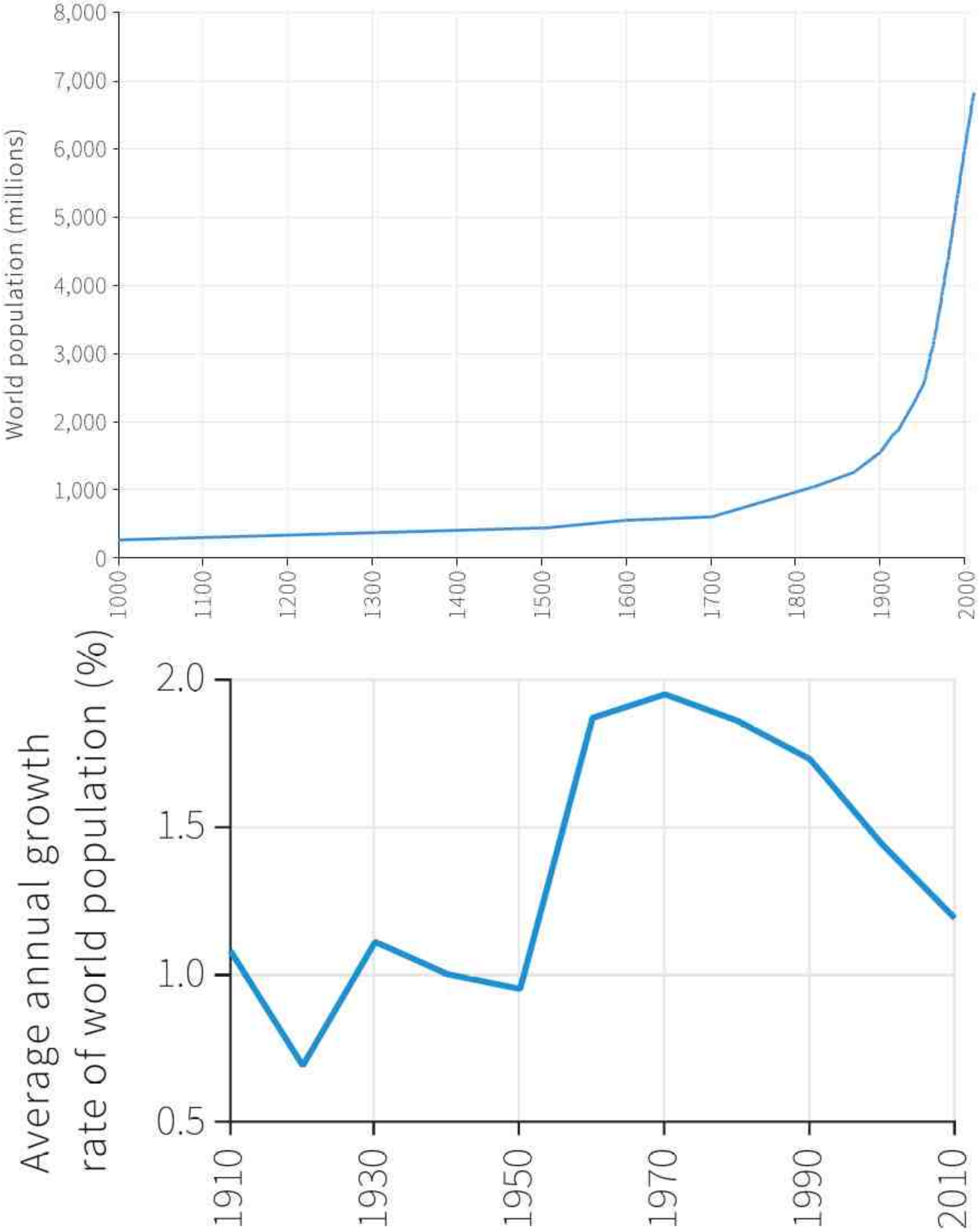
Source: CORE Econ (2025a)

Figure 22.6: 42 years of microprocessor trend data



Source: Rusanovsky et al. (2019)

Figure 22.7: World population over time

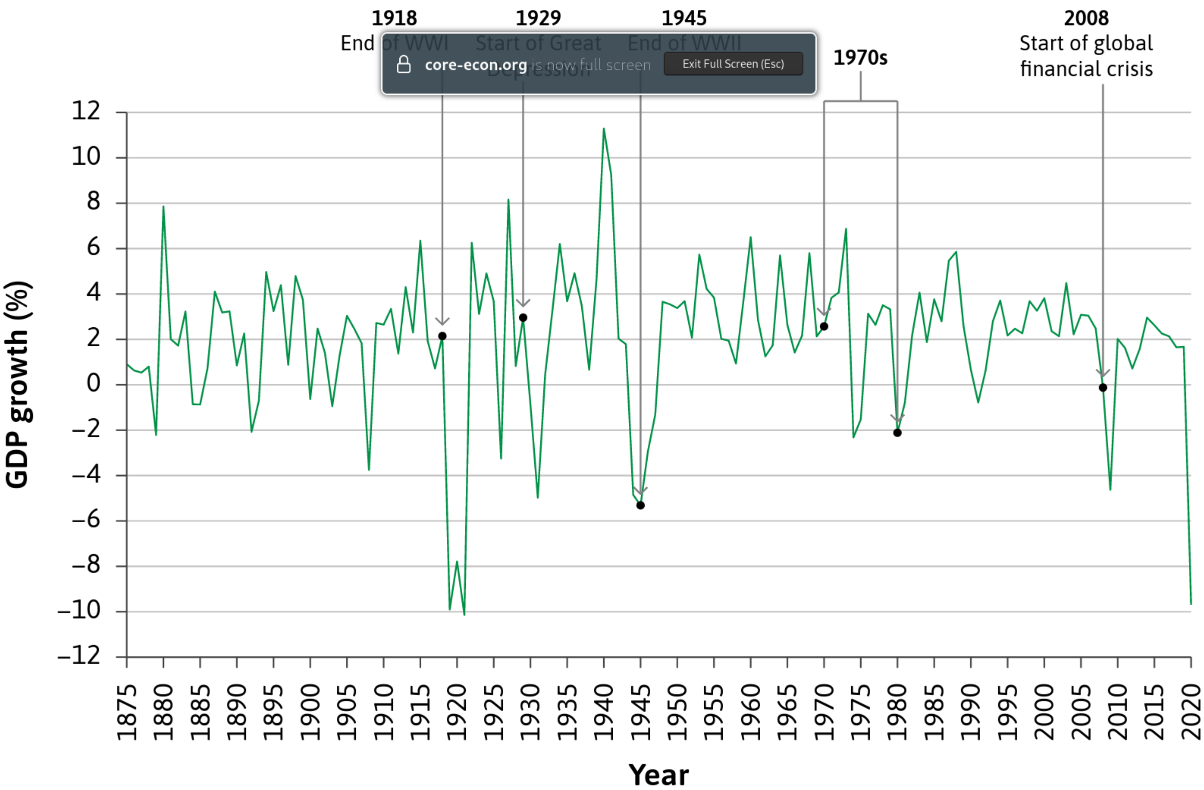


Source: CORE Econ (2025a)

22.2.3 Fluctuations

Figure 22.8 illustrates long-term GDP growth in the UK, highlighting fluctuations and severe crises.

Figure 22.8: UK GDP growth (1875–2020)



Source: *www.core-econ.org*

22.2.4 Nature

Environmental consequences arise from increased production and population growth, impacting global climate change and local pollution, deforestation. New technologies may offer potential solutions. Figure 22.9 illustrates significant environmental measures.

22.3 Solow model

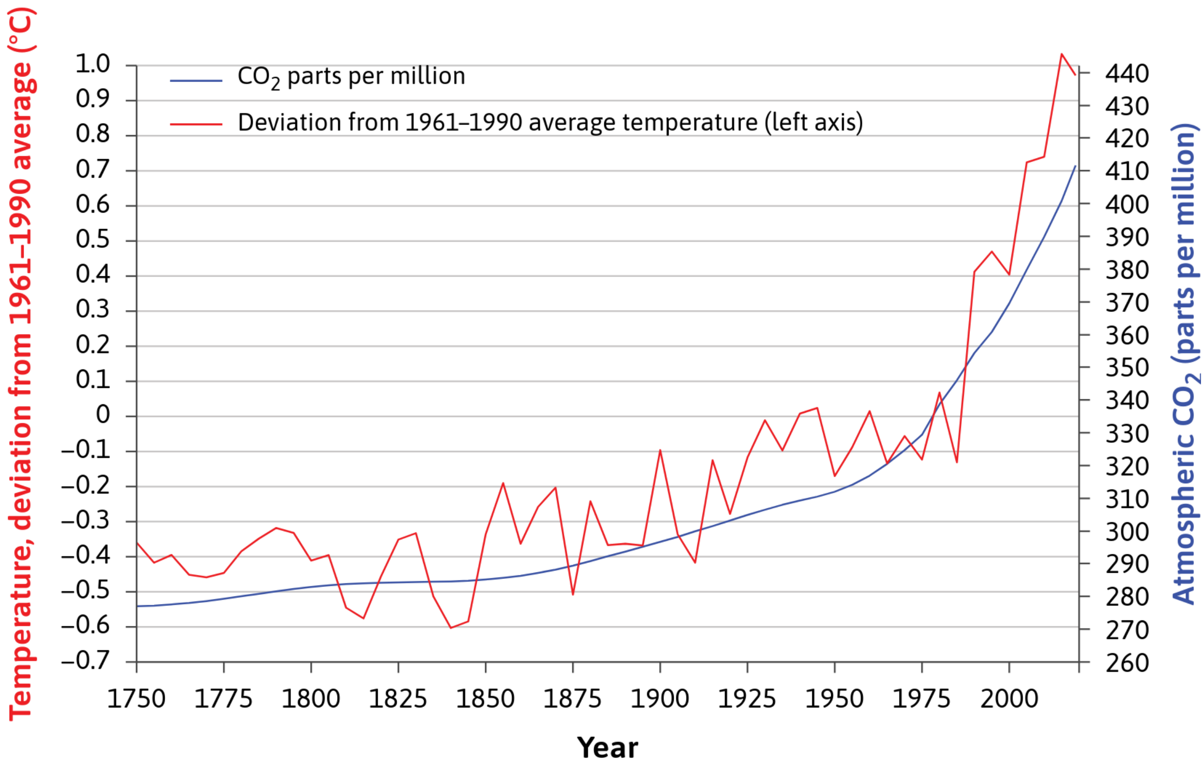
22.3.1 Introduction

The nicely animated video of Figure 22.10 discusses unexpected economic growth situations and presents two puzzles: Germany and Japan's rapid growth after World War II despite heavy losses, and China's astonishing growth compared to advanced economies which have better institutions and more capital. The Solow Model of Economic Growth is introduced to help understand these dynamics and distinguish between "catching up" and "cutting-edge" growth. The model simplifies growth factors: labor (L), human capital ($L \cdot e$), physical capital (K), and ideas (A). These inputs work together in a production function to generate output. The abstraction of the production function will be further simplified in upcoming videos, starting with an exploration of how capital contributes to economic growth.

Here is a transcript of the video:

> *Here's a fact about economic growth that might seem counterintuitive. During World War II, Germany and Japan suffered heavy losses. Millions of people were killed. Entire cities were*

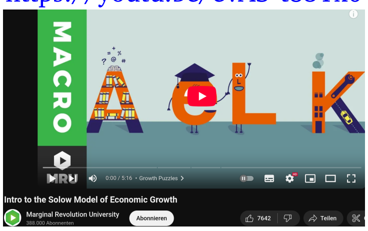
Figure 22.9: Global atmospheric concentration of carbon dioxide and global temperatures (1750–2019)



Source: *www.core-econ.org*

Figure 22.10: Intro to the Solow model of economic growth

https://youtu.be/eVAS-t83Tx0



Source: *Youtube*

flattened. Roads, bridges, factories, and other resources critical to an economy were destroyed. Yet, following World War II, Germany and Japan both grew quickly. In fact, they grew much faster than did the United States. Many people wondered what was going on. Why were the losers of the war growing faster than the winners? Here's another puzzle. In the past several decades, China has been growing at astonishing rates of growth – 7 to 10% per year. Remember, at those rates, the standard of living – it's doubling every 7 to 10 years. In contrast, in the advanced economies, like the United States, Canada, or France, they're growing around 2% per year, doubling only once every 35 years. So here's the puzzle. In the previous talks, we said that the way to get a high standard of living and economic growth is to have good institutions, like property rights, honest government, political stability, a dependable legal system, and competitive and open markets. But in each one of these cases, there's no question that the advanced economies have better institutions than does China. Plus, the advanced economies – they've got more human and physical capital. So if the advanced economies have got better institutions and more capital, why are they growing slower than China? To solve these puzzles, we're going to be drawing on an important economic model: the Solow Model of Economic Growth, named for Robert Solow, who won the Nobel Prize. The Solow Model will help us to better understand the dynamics of growth. The Solow Model is also going to help us to draw a distinction between two types of growth: catching-up growth and cutting-edge growth. As we'll see, catching up can be much faster than growing on the cutting edge. Now, you might ask, "What's an economic model?" An economic model is a simplified framework that helps us to understand a more complex reality. We're going to be using a super simple version of the Solow Model that boils economic growth down to just a few key variables and some basic mathematics. Now, although it's simple, the Solow Model can provide us with some deep insights into the causes of growth. A key part of the model is a production function – a simplified description of how resources, inputs, are used to produce output. So let's take a look at some of the inputs into our production function. The first key input is us, people. We use the letter L to represent labor. The more educated people are, the more effective their labor. So we can multiply L by e for education. Together, these two variables represent human capital. Next is physical capital, represented by the letter K. K is all of our factories, and tools, and so forth. Last, but certainly not least, is ideas, represented by the letter A. A represents all of our knowledge about how to combine capital and labor to produce valuable output. Everything from how to transport stuff without carrying it on your back, to how to keep diseases from spreading, to how to add up numbers in a fraction of a second. A is ideas, and better ideas mean that we can get more bang for our buck, more output from the same inputs of capital and labor. We can think of human capital, physical capital, and ideas being used together to produce output. That's the idea of our production function. Now, right now our production function is very abstract. But in future videos, we're going to boil it down even more and make our production function concrete. We're going to start in the next video by taking a closer look at how capital – machines, factories, roads, and so forth – how capital contributes to economic growth. Let's dig in.

22.3.2 Steady state

Figure 22.11: The Solow model and the steady state

https://youtu.be/LQR7rO-I96A

Source: Youtube

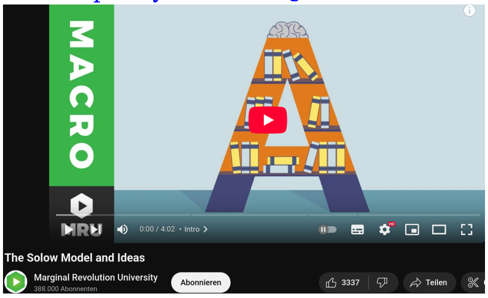
Study the video of Figure 22.11 and the transcript of the video:

Let's continue our exploration of the Solow Growth Model. In our last video, we covered how physical capital faces the iron logic of diminishing returns. Now let's turn to another unfortunate aspect of physical capital: capital rusts. Roads get potholes and need to be repaired, tools wear out, trucks break down. In short, we say that capital depreciates. Now let's put the amount of capital on the horizontal axis and the amount of depreciation on the vertical axis. We can then model the relationship like this. Depreciation increases at a constant rate as the capital stock increases. The more capital you have, the more capital depreciation you have. Now let's add a new aspect to our model. Where does the money for capital accumulation come from? From savings and investment. When we create economic output, we can either consume it or save it. What we don't consume can be saved and invested in new capital. So suppose we invest a constant fraction of our output. Let's say we devote 30% of output to investment. We can now add an investment curve to our graph. It'll mimic the shape of the output line since investment is just a constant fraction of output. Notice that our first units of capital – they're very productive and so they create a lot of output and thus also a lot of investment. But as we add more and more units of capital, we get less output and also less investment. That's the iron logic of diminishing returns once again. Now let's put investment and depreciation on the same graph. Depreciation is growing at the same rate as the capital stock grows. Each new unit of capital creates an equal amount of depreciation. Now notice that when investment is greater than depreciation, that means the capital stock must be growing. We're adding more units of capital than are depreciating. But as the capital stock grows – investment and depreciation – they're on a crash course to intersect. When this happens, we've reached what is called the Steady-State Level of Capital. The steady-state is the key to understanding the Solow Model. At the steady-state, investment is equal to depreciation. That means that all of investment is being used just to repair and replace the existing capital stock. No new capital is being created. Now remember, we've assumed that all the other variables in the model – they're not changing. So if the capital stock isn't growing, nothing is growing. In other words, when we reach the Steady-State Level of Capital we've also reached the Steady-State Level of Output. Now suppose you ended up on the other side of the steady-state point – over here. You'd find that depreciation is greater than investment. That means some of the capital stock needs repair, but there isn't enough investment to do all of the needed repairs, so the capital stock shrinks, pushing you back towards the steady state. So to the left of the steady-state we have investment greater than depreciation and the capital stock is growing. To the right of the steady-state we have the opposite – depreciation is greater than investment, and the capital stock – it's shrinking. Either way, we always end up moving towards the steady-state. Let's go back to our earlier example of Germany after the end of World War II. Since the capital stock is low, it's also very productive and we get a lot of output from the first new roads and factories after the war. We've already mentioned that point. But in addition, we now see that when the capital stock is very productive and producing a lot of output, we will also be producing a lot of investment. So in the next period the capital stock will be even bigger than before and we'll get even more output. Plus, since the capital stock is low, we don't have much depreciation to take care of. So with the investment, it will mostly be generating new capital, not replacing old capital. Now over time, however, both of these forces - they weaken. The returns to capital diminish and depreciation eats up more and more of investment. A country with a lot of roads, and bridges and factories - it's doing well, but it also has to invest a lot just to maintain all those roads and bridges and factories. And this is exactly what we saw in Germany and Japan after World War II. Growth rates started out very high, but as those countries caught up, growth rates declined. Now perhaps our friend K *still has one more trick up his sleeve to get the economy growing. What if we started to save more of our output? A higher savings rate shifts the investment curve up like this. Now investment is higher than depreciation, so we're adding to the capital stock and the economy is back to growing. However, you can see that the same dynamic exists as before. The iron logic of diminishing returns means that we'll again end up at a new steady-state level of capital. The higher savings rate - it spurs growth for a time and it does increase the steady-state level of output. But, at the new steady-state, investment once again equals depreciation and we get zero economic growth. Accumulation of physical capital can only generate temporary growth. In our next video, we'll take a look at how human capital influences growth.*

22.3.3 Technological progress

Figure 22.12: The Solow model and ideas

https://youtu.be/LQR7rO-I96A



Source: Youtube

Study the video of Figure 22.12 and the transcript of the video:

> We've covered a lot of the Super Simple Solow Model. We've looked at the dynamics of capital accumulation, how changes in savings rates influence growth, and we've looked at some of the predictions of the Solow Model. One thing we've learned is that the model seems to inevitably predict that we end up in a steady state with no growth. Now, however, we're going to turn to the last of our variables: ideas. Can ideas keep us growing? Better ideas mean that we get more bang for our buck, more output from the same inputs of capital and labor. Alternatively, we can think about this as increasing our productivity. Henry Ford, for example, took ideas from lots of other industries, like meatpacking, bicycle making, and brewing, and he combined them in a way that had never before been used in the manufacturing of automobiles. This novel combination of ideas sparked a dramatic increase in productivity that transformed the world. The same types of processes – they're continuing today, and in all industries, increasing output per worker across the economies. So let's go back to our previous graph of capital and output. We can now add ideas as a multiplier. Better ideas multiply the output from the same capital stock. So, if A increases from 1 to 2, that's a doubling of our productivity. And that shifts the output curve up. When output doubles, so does investment. Now, once again, investment is greater than depreciation. So we begin accumulating capital once again. And that further boosts our output. So better ideas spur more output, which creates more investment, which leads to capital accumulation. So better ideas lead to growth in two ways: the increased productivity of a given capital stock, and the increased investment, which increases capital accumulation. Now imagine that ideas are constantly improving. You'd have continual shifts upward of the output curve. And that means continual shifts upward of the investment curve. We'd always stay to the left of the steady state, and there, we'd continually grow. So growth at the cutting edge – it's determined by how fast new ideas are formed, and how much those new ideas increase our productivity. So that's our super simple Solow Model. It combines a model of catching up growth due to capital accumulation, with a model of cutting-edge growth due to idea accumulation._

22.3.4 Solow's central question

Question: Can capital accumulation lead to long-term growth and perpetual improvements in living standards? Formally speaking, can the following circular relationship last forever and lead to sustainable growth in production:

$$Y \uparrow \rightarrow S \uparrow \rightarrow I \uparrow \rightarrow K \uparrow \rightarrow Y \uparrow \dots$$

Robert M. Solow's answer is: No, capital accumulation can boost growth only for some time. The only long-term key to growth is technological progress.

> "Whether you like it or not, history is on our side. We will bury you!" This quote is from Soviet First Secretary Nikita Khrushchev while addressing Western ambassadors at a reception at the Polish embassy in Moscow on November 18, 1956 (Time Magazine, 1956).

In the 1950s, the Soviet Union launched a growth offensive with extremely high investments, primarily in heavy industry. History was not really on his side as far as we can judge that.

22.4 The formal Solow model

There are many different versions of the Solow model. Each has its unique way of writing things down, which might puzzle newcomers trying to understand it.

To make your reading of research easier, let me introduce you to the approach taken by (Romer, 2006, pp. 5–29). In his widely-recognized book for graduate students, he presents the classic form of the model. Despite its challenging aspects, it's designed to be quite comprehensible.

22.4.1 Production

The heart of any theory of growth is a production function (PF) as it describes how output is made from different factors of production. Production in the Solow model takes the form:

$$Y(t) = f(K(t), A(t)L(t))$$

where Y is output, K is the input of physical capital (buildings and machines), $L$is the input of labor, and A is knowledge or the effectiveness of labor. Time$t$does not enter production directly but only through A, K, and L. As A and L enter multiplicatively, AL is usually interpreted jointly as effective labor.

For convenience, the time argument (t) will be dropped, and the PF can be rewritten:

$$Y = F(K, AL)$$

22.4.2 Constant returns to scale

If output changes by the factor c when every production factor is multiplied by c, then the production function has constant returns to scale (CRS). Production in the Solow model is assumed to take place at constant returns to scale:

$$f(c \cdot K, c \cdot AL) = c \cdot f(K, AL) \qquad \text{for all } c \geq 0$$

22.4.3 Intensive form

CRS allows us to work with the PF in intensive form. Setting c to be $\frac{1}{AL}$:

$$f\left(\frac{1}{AL} \cdot K, \frac{1}{AL} \cdot AL\right) = \frac{1}{AL} \cdot \underbrace{f(K, AL)}_{Y} \tag{22.1}$$

$$\Leftrightarrow f\left(\underbrace{\frac{K}{AL}}_{k}, 1\right) = \underbrace{\frac{Y}{AL}}_{y} \tag{22.2}$$

$$F(k) = y \tag{22.3}$$

where k is defined as $\frac{K}{AL}$ and denotes the amount of capital per unit of effective labor, and y is defined as $\frac{Y}{AL}$ and denotes the output per unit of effective labor.

22.4.4 Inada conditions

The intensive form production function (PF) is assumed to satisfy the following conditions:

$$\begin{aligned} f(0) &= 0, \\ f'(k) &> 0, \\ f''(k) &< 0. \end{aligned}$$

A PF satisfying these assumptions is shown in panel a) of Figure 22.13. A nice series of lecture units explaining the Solow model can be found here.

22.4.5 Cobb-Douglas function

The function

$$f(K, AL) = K^{\alpha}(AL)^{1-\alpha}$$

is a well-received production function named after Cobb & Douglas (1928) which

1. can be written in the intensive form by dividing both inputs byAL:

$$f(k) = f\left(\frac{K}{AL}, 1\right) = \left(\frac{K}{AL}\right)^{\alpha} = k^{\alpha}$$

2. satisfies the Inada conditions:

$$\begin{aligned} f(0) &= 0 \\ f'(k) &= \alpha k^{\alpha-1} > 0, \\ f''(k) &= -(1-\alpha)\alpha k^{\alpha-2} < 0, \end{aligned}$$

3. has constant returns to scale (CRS):

$$\begin{aligned} f(cK, cAL) &= (cK)^{\alpha}(cAL)^{1-\alpha} \\ &= c^{\alpha}c^{1-\alpha}K^{\alpha}(AL)^{1-\alpha} \\ &= c\,\underbrace{K^{\alpha}(AL)^{1-\alpha}}_{f(K,AL)} \\ &= cY \end{aligned}$$

22.4.6 Evolution of production factors

L and A

Assume the initial levels of K and L are given and that they continuously change over time.

$$\begin{aligned} \frac{dL(t)}{dt} &= \dot{L}(t) \\ \frac{dA(t)}{dt} &= \dot{A}(t). \end{aligned}$$

Further assume that labor grows constantly with rate n and knowledge with rate g:

$$\begin{aligned} \dot{L}(t) = nL(t) &\Leftrightarrow n = \frac{\dot{L}(t)}{L(t)} \\ \dot{A}(t) = gA(t) &\Leftrightarrow g = \frac{\dot{A}(t)}{A(t)}. \end{aligned}$$

As the evolution of labor and knowledge are assumed to be exogenous, we should analyze the evolution of K.

K

Changes in the capital stock are explained with

$$\dot{K}(t) = sY(t) - \delta K(t), \tag{22.4}$$

where sY is the fraction of output that is devoted to investment and δ is the capital depreciation rate. All output that is not invested in the capital stock, $(1-s)Y$, is consumed, assuming a closed economy. Both s and δ are exogenous and constant parameters.

22.4.7 Evolution of$k$

To see the dynamics of$k$, that is,$\dot{k}$, we need to consider $\frac{d\left(\frac{K}{AL}\right)}{dt}$. It involves using two derivative rules:

$$\left(\frac{w}{h}\right)' = \frac{w' \cdot h - w \cdot h'}{h^2}$$

and

$$(ab)' = a' \cdot b + a \cdot b'.$$

By dropping the time argument t, we derive:

$$\begin{aligned}
\dot{k} &= \frac{d\left(\frac{K}{AL}\right)}{dt} \\
&= \frac{\overbrace{\dot{K}}^{w'} \cdot \overbrace{AL}^{h} - \overbrace{K}^{w} \cdot \overbrace{(\overbrace{A\dot{L}}^{a'\cdot b} + \overbrace{L\dot{A}}^{a\cdot b'})}^{h'}}{\underbrace{(AL)^2}_{h^2}} \\
&= \frac{\dot{K}}{AL} - \frac{K}{(AL)^2}\left[A\dot{L} + L\dot{A}\right] \\
&= \frac{\dot{K}}{AL} - \frac{K\dot{L}}{ALL} - \frac{K\dot{A}}{AAL} \\
&= \frac{\dot{K}}{AL} - \underbrace{\frac{K}{AL}}_{k} \cdot \underbrace{\frac{\dot{L}}{L}}_{n} - \underbrace{\frac{K}{AL}}_{k} \cdot \underbrace{\frac{\dot{A}}{A}}_{g} \\
&= \frac{\dot{K}}{AL} - kn - kg \\
&= \frac{\dot{K}}{AL} - k(n+g)
\end{aligned}$$

Using $\dot{K} = sY - \delta K$ from Equation 22.4 in the above equation yields:

$$\begin{aligned}
\dot{k} &= \frac{sY - \delta K}{AL} - k(n+g) \\
&= s \underbrace{\frac{Y}{AL}}_{y \equiv f(k)} - \delta \underbrace{\frac{K}{AL}}_{k} - k(n+g) \\
&= sf(k) - \delta k - k(n+g) \\
\dot{k} &= sf(k) - k(\delta + n + g)
\end{aligned}$$

This is the key equation of the Solow model. The change in the capital stock per effective unit of labor, which is the only factor of production that can cause growth in our model, is determined by$sf(k)$, the actual investment per effective unit of labor, and$k(\delta+n+g)$, the break-even investment. In other words, it describes why$\frac{K}{AL}$ decreases without investments over time:

- $\delta k \rightarrow$ capital depreciates (gets less over time),
- $nk \rightarrow$ quantity of labor is growing,
- $gk \rightarrow$ effectiveness of labor is growing.

22.4.8 Steady-state k^*

The steady-state equilibrium capital, k^*, is the point where:

$$\dot{k} = 0.$$

At this point, growth is zero as capital per effective labor unit k remains the same over time. Since output per effective unit of labor y depends on k through the production function, it is also unchanging. This point is described further in Table 22.1 and Figure 22.13.

Table 22.1: Steady-state growth rates in the Solow model

Variable	Symbol	Steady-state growth rate
Labor	L	n
Knowledge	A	g
Total output	$Y = yAL$	$n + g$
Capital per effective unit of labor	$k = \frac{K}{AL}$	0
Output per effective unit of labor	$y = \frac{Y}{AL} = f(k)$	0
Output per unit of labor	$\frac{Y}{L} = yA$	g

22.4.9 Consumption

In the Solow model, $sf(k)$ represents the proportion of output a country saves and invests. $k(\delta + n + g)$ refers to the necessary investment to keep k stable. Thus, the thick blue line denotes the fraction of overall production, $f(k)$, that goes to consumption, c:

$$c = f(k) - sf(k)$$

The dashed line represents the proportion that is reinvested. In the steady-state, actual investments equal break-even investment, $(n + g + \delta)k^*$. Therefore, steady-state consumption is given by:

$$c^* = f(k^*) - (n + g + \delta)k^*$$

22.4.10 Golden rule of consumption

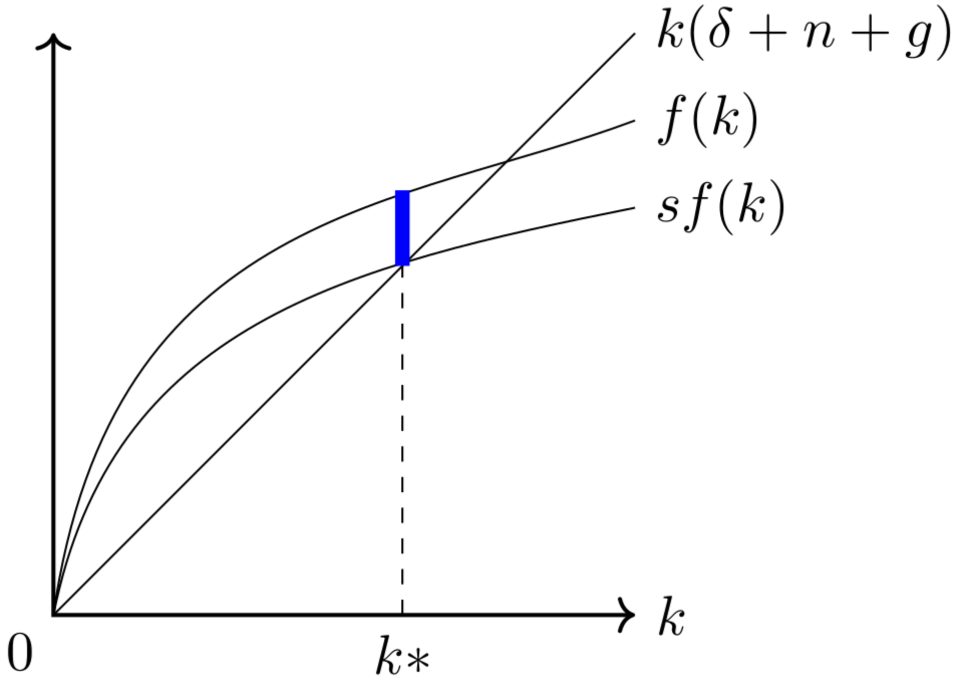
Increased investment in the capital stock can only boost growth until the steady state is reached. Thus, the question arises: How much should we invest in the capital stock? The only variable we should consider in the long run when deciding how much to invest from the output, $sf(k)$, is consumption. The reason is that consumption, not output, defines welfare. Maximal steady-state consumption, C^*, is given by:

$$\frac{\partial C^*}{\partial s} = \underbrace{[f'(k^*) - (n + g + \delta)]}_{\text{Golden Rule}} \frac{\partial k^*}{\partial s}$$

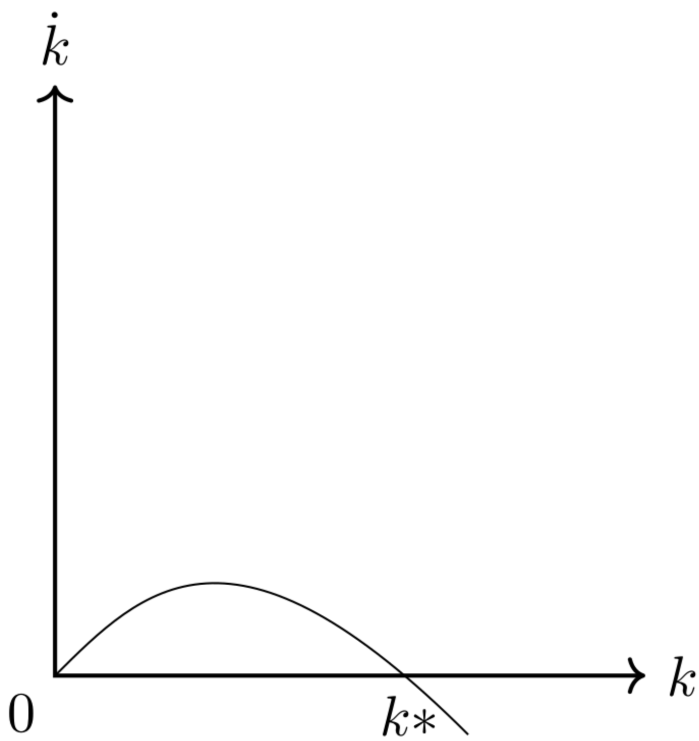
The **golden rule** states that consumption is maximized at the point when the slope of the output function, $f(k)$, equals $n + g + \delta$ as shown in the upper panel of Figure 22.13.

Figure 22.13: Balanced growth in the Solow model

(a) a)



(b) b)



22.4.11 Long-run growth rates

In the steady state, there is a balanced growth path where all variables grow at a constant rate, as shown in Table 22.1. Sustained growth requires technological progress, evident because output per worker is only driven by g.

22.5 Summary

- The steady-state equilibrium is the point where investment spending equals spending on depreciation, and the capital-output ratio remains constant; at this point, growth is zero.
- The Solow model provides a framework to understand the transition of economies over time.
- Less developed economies have lower capital-output ratios; with accumulating capital, they can experience catch-up growth.
- Investment is determined by the domestic savings ratio and by capital inflow from abroad.
- Investment in capital increases capital per worker and leads to growth.
- As the stock of capital rises, the extra output from an additional unit of capital falls; this characteristic is called diminishing returns.
- In the long run, growth requires technological progress, meaning output per worker is only driven by g (ideas).

Exercise 22.3. Technological progress
In the long run, capital per effective unit of labor is constant, and hence the only way that the capital per worker and, in turn, output per worker increases is through technological progress. Show this formally.

Solution

Y grows at $n + g$ and L grows at n, so the quotient grows at the difference: g. This implies that in the steady state, living standards (output per person) grow at the rate of technological progress.
In the long run, capital per effective unit of labor is constant, and thus the only way that capital per worker and output per worker increase is via technological progress.
In the steady state, $\dot{k} = 0$, which means:

$$\frac{Y_t}{A_t L_t} = \frac{Y_{t-1}}{A_{t-1} L_{t-1}}$$

This assumes that in the steady state, the output per effective unit of labor is constant, not changing from period $t - 1$ to period t. Note that while the output per effective unit of labor is constant, the output per unit of labor is not.

$$\begin{aligned} \frac{Y_t}{A_t L_t} &= \frac{Y_{t-1}}{A_{t-1} L_{t-1}} \\ \Leftrightarrow \frac{\frac{Y_t}{L_t}}{\frac{Y_{t-1}}{L_{t-1}}} &= \frac{A_t}{A_{t-1}} \\ \Leftrightarrow \underbrace{\frac{\frac{Y_t}{L_t}}{\frac{Y_{t-1}}{L_{t-1}}} - 1}_{\text{growth rate of } \frac{Y}{L}} &= \underbrace{\frac{A_t}{A_{t-1}} - 1}_{g} \end{aligned}$$

Thus, in the steady state, it is only technological progress, i.e., g, that determines per capita growth.[a]

[a] For simplicity, this was shown in discrete times. However, it also holds true in continuous times.

Exercise 22.4. Solow simplified
Consider a Solow growth model as introduced in the lecture. Further assume that population (or labor force) does not grow, $n = 0$, and that there is no technological change, $g = 0$. The parameters of the model are given by $s = 0.2$ (savings rate) and $\delta = 0.05$ (depreciation rate).

1. **Main assumptions of the Solow model:**
   - List the main assumptions that underlie the Solow model.
2. **Production functions for the Solow model:**
   Which of the following production functions could be used in the Solow model?
   - $Y = K^{0.5}L^{0.5}$
   - $Y = K^{0.4}L^{0.7}$
   - $Y = K^{1/3}L^{2/3}$
3. **Importance of constant returns to scale and concavity:**
   Why is it important to assume that the production function has constant returns to scale and is concave, meaning the marginal returns for the inputs are positive $\frac{\partial f(K)}{\partial K} > 0$ but diminishing $\frac{\partial^2 f(K)}{\partial K^2} < 0$?
4. **Rewrite production function:**
   Rewrite the production function $Y = K^{1/3}L^{2/3}$ in terms of output per effective unit of labor.
5. **Steady-state level of capital stock:**
   Find the steady-state level of the capital stock. What is the growth rate of capital per effective unit of labor in the steady-state?
6. **Steady-state output per labor:**
   Calculate the steady-state output per labor.
7. **Sketch steady-state level of capital stock:**
   Sketch the steady-state level of the capital stock in a graph with output per labor and capital per labor on the axes. Mark on the plot how much of the output goes into capital services and how much remains for consumption.
8. **Impact of increased saving rate:**
   Assume the saving rate increases to $s = 0.3$. Calculate the new steady-state level of the capital stock and the corresponding steady-state output per labor. What would be the output-maximizing savings rate?
9. **Desirability of a saving rate of 1:**
   Discuss whether a saving rate of 1 would be a desirable goal. Can you think of an optimal saving rate? What is the *Golden Rule* of Capital Accumulation in the Solow Model?
10. **Golden Rule level of the capital stock:**
    Calculate which capital stock would maximize consumption per worker in the steady-state.
11. **Associated savings rate for maximum consumption:**
    What is the associated savings rate that must be imposed by a benevolent social planner to maximize consumption per worker?
12. **Comparison with consumption-maximizing savings rate:**
    Compare your result with the consumption-maximizing savings rate. Do citizens need to save more or less? Discuss economic policies that could help the social planner implement this in real-world situations.

Chapter 23

Unemployment and business cycles

Required readings:
D. Shapiro et al. (2022, ch. 14)

Learning objectives:

Students will be able to:

- that the gap between actual GDP and potential GDP is a key measure of the economy's performance in the short run.
- the causes of unemployment.
- what the reverse multiplier effect is.
- the role of wage-setting for the aggregate economy.

23.1 Unemployment

Unemployment poses a significant challenge both personally and socially, leading to the loss of income for individuals and a reduction in national production. The individual costs of unemployment are multifaceted and include the loss of earnings, increased risk of falling into poverty, and deterioration of health. Furthermore, unemployment can result in negative social behaviors, such as drug and alcohol abuse, crime, and the de-skilling of workers who become disconnected from evolving work practices and technology. Persistently high unemployment can severely undermine an individual's future job prospects by depleting their human capital.

For an economy unemployment simply means that there are production factors, that is, labor, unutilized. That comes along with lower tax revenues and increased welfare payments. Additionally, unemployment contributes to a range of social costs, including deteriorating health, rising crime rates, social unrest, and political repercussions.

In any economy, adults fall into one of three categories: they can be employed, unemployed, or not participating in the labor force. Unemployment is usually defined as the condition of being jobless while being willing and able to work. It's important to note that this definition can vary from country to country and among different federal statistical agencies.

To combat unemployment, various government programs can be implemented to help unemployed workers find new jobs more efficiently. These programs include active labor market policies often run by employment agencies such as training and educational initiatives. Other passive labor market policies such as wage subsidies, public employment schemes, and unemployment benefits can also help to improve the labor market. Each of these measures aims to reduce the duration and impact of unemployment, fostering a more robust and productive workforce.

23.1.1 Explanations for unemployment

In a perfect labor market, wages would adjust so that the quantity of labor supplied equals the quantity of labor demanded. At equilibrium, there is no unemployment, and wage rate adjustments ensure that all workers are fully employed. However, the reality is that labor markets do not clear instantaneously.

> **Exercise 23.1.** Perfect labor market
> Draw a two-way plot with labor supply and demand, which economists often use to illustrate a market (equilibrium) of full employment and unemployment, respectively.

Job losses within specific industries may result from technological change, which forces workers whose knowledge, skills, and experience have become redundant to seek new employment. Additionally, structural changes in the economy can affect its makeup over time. Such changes may stem from competition from abroad, technological advancements, or shifts in societal norms and trends. Consequently, workers who lose their jobs in one industry often encounter available positions that require skills they do not possess, a situation commonly referred to as occupational immobility. They may also find that potential job opportunities are located outside their immediate region, known as geographic immobility.

Furthermore, wages may be set too high for labor demand to absorb all available labor supply. This scenario can occur due to several factors that create above-equilibrium wages, including minimum wage laws, the influence of unions, and efficiency wages.

When wages exceed the equilibrium level, the quantity of labor supplied surpasses the quantity of labor demanded, resulting in unemployment as workers wait for job openings to become available. There are three rational explanations for wages above the market-clearing level.

Minimum wage

When the minimum wage is set above the level that balances supply and demand, it creates unemployment. Minimum wages often have the most significant impact on the least skilled and least experienced members of the labor force, such as teenagers.

Unions

Figure 23.1: Unions fight for higher wages

Source: Labor Union Report

A union is a worker association that bargains with employers over wages and working conditions, see Figure 23.1. In the early 1980s, over half of the UK labor force was unionized; however, this figure rapidly fell to a union coverage of 25.4% in 2013. The process where unions and firms agree on the terms of employment is called collective bargaining. Economists have found that union workers typically earn significantly more than similar workers who do not belong to unions. A strike may be organized if the union and the firm cannot reach an agreement; this refers to the union organizing a withdrawal of labor from the firm.

Are unions good or bad for the economy?

Critics argue that unions cause an inefficient and inequitable allocation of labor. Wages above the competitive level reduce the quantity of labor demanded, resulting in unemployment where some workers benefit at the expense of others. On the other hand, advocates contend that unions are a necessary antidote to the market power of firms hiring workers, especially in the presence of local monopsonies. Furthermore, they argue that unions play a critical role in helping firms respond efficiently to workers' concerns.

Exercise 23.2. Unions as the source of market failure
Unions aim to protect workers. However, what about the unemployed? Do unions care about them, considering they are usually not members? If unions do not care about the unemployed, how can that lead to labor market failure? This leads us to explore the insider-outsider theory of labor economics.

Solution

The insider-outsider theory explains how firm behavior, national welfare, and wage negotiations are affected by a group in a more privileged position. Insiders, those employed by a firm, and employers are the primary negotiators over wages. Because insiders are already employed, they possess power and are often uninterested in expanding job availability for outsiders. Their focus tends to be on maximizing their own wages, which results in holding wages steady and limiting opportunities for outsiders. Firms are incentivized to bargain with insiders due to the high costs of replacing workers, known as labor turnover costs, which include severance pay, hiring expenses, and firm-specific training. Because the rate of unemployment is irrelevant to the union's and employer's wage-setting monopoly, the natural rate of unemployment rises in tandem with the actual rate. Consequently, outsiders (the unemployed) become increasingly irrelevant in wage negotiations. Insiders often use their power to prevent outsiders from underbidding their current wage, resulting in a labor market that does not experience wage underbidding, even with many unemployed workers willing to accept lower wages. This leads to a market failure, where wages are not set according to the labor market's needs or preferences.

Efficiency wages

Efficiency wages are above-equilibrium wages paid by firms with the aim of increasing worker productivity. The theory of efficiency wages posits that firms operate more efficiently if wages are set above the equilibrium level. Nobel Prize-winning economist Joseph E. Stiglitz, recognized for his work on asymmetric information and efficiency wages, has contributed significantly to this theory (C. Shapiro & Stiglitz, 1984). A firm may prefer to offer higher than equilibrium wages for several reasons. First, higher wages can lead to improved worker health, as better-paid employees tend to maintain a healthier diet, which can enhance productivity. Second, higher wages reduce worker turnover because employees earning more are less likely to seek alternative job opportunities. Third, better pay motivates workers to exert more effort, leading to increased productivity. Lastly, higher wages attract a more qualified pool of applicants, fostering a stronger workforce.

Wage increases can cut costs

On January 5, 1914, Henry Ford shocked the world by announcing that the Ford Motor Company would double its workers' wages to five dollars a day. He later claimed this was the best cost-cutting decision he could have made. This scenario, which may initially appear paradoxical, can be explained by the role of efficiency wages in enhancing productivity and employee retention.

Marx and the reserve army

Karl Marx shown in Figure 23.2 argued that unemployment is a necessary condition for capitalism, as it keeps wages low and intimidates workers, preventing them from revolting against the market power of industrialists. He referred to the unemployed as the *reserve army of labor.* This reserve army consists of various groups of people, including the long-term unemployed and those who intermittently enter and exit the labor market for different reasons. Individuals in this reserve army gain employment only when there is a significant shortage in the labor market. This group provides a readily available pool of potential workers that firms can tap into when there is a need to rapidly increase output to meet demand.

Figure 23.2: Non existing Karl-Marx-University

Note: The Karl Marx University of Trier has never existed. However, there have been several attempts to rename the university. So far, they have all failed. Can you imagine why?

23.1.2 Types of unemployment

Frictional unemployment

Frictional unemployment arises from normal labor turnover. These workers are searching for jobs. The unemployment related to this search process is a permanent phenomenon in a dynamic, growing economy. Frictional unemployment increases when more people enter the labor market or when unemployment compensation payments increase.

- It takes time for workers to search for jobs that best suit their tastes and skills.
- Search unemployment is inevitable because the economy is always changing.
- Workers in declining industries will find themselves looking for new jobs, and firms in growing industries will be seeking new workers.
- If job search takes time, this means there must always be some unemployment.

Structural unemployment

Structural unemployment arises when changes in technology or international competition change the skills needed to perform jobs or change the locations of jobs. Sometimes there is a mismatch between skills demanded by firms and skills provided by workers, especially when there are great technological changes in an industry. Structural unemployment generally lasts longer than frictional unemployment. Minimum wages and efficiency wages create structural unemployment.

Voluntary and involuntary unemployment

Voluntary unemployment occurs if people choose to remain unemployed rather than taking jobs that are available. Involuntary unemployment occurs if people want to work at prevailing market wages but cannot find employment.

Cyclical unemployment

Cyclical unemployment is the fluctuating unemployment over the business cycle. It increases during a recession and decreases during an expansion.

Natural unemployment

Natural unemployment arises from frictions and structural change when there is no cyclical unemployment—when all the unemployment is frictional and structural. As a percentage of the labor force, it is called the natural unemployment rate.

Full employment

Full employment is defined as a situation in which the unemployment rate equals the natural unemployment rate.

Exercise 23.3. Can unemployment be good?

> Getting laid off is usually bad for the individual, but may be good long term for society.

Discuss that statement by analyzing each type of unemployment, considering whether it is good or bad for society.

Solution

Frictional? Good because a healthy, dynamic economy needs new entrants to the labor force, such as college graduates, and freedom for people to quit a job they don't like.

Structural? Good because a healthy, growing economy incorporates technological changes that render some jobs obsolete.

Cyclical? Bad because unemployment strictly due to economic cycles is unfortunate. If it were possible to maintain consistent growth with fewer fluctuations, there would be less cyclical unemployment and higher welfare. Can and should the cycle be managed? This is a major question in Macroeconomics we will continue to explore.

Natural? From an individual's perspective, when they have not yet found their desired job, unemployment is bad and not truly *natural*. However, a certain level of unemployment can benefit society by creating more productive matches between firms and workers and facilitating technological changes that contribute to growth.

Exercise 23.4. Unemployment in Niger and Qatar

Figure 23.3: Unemployment rate comparison by country

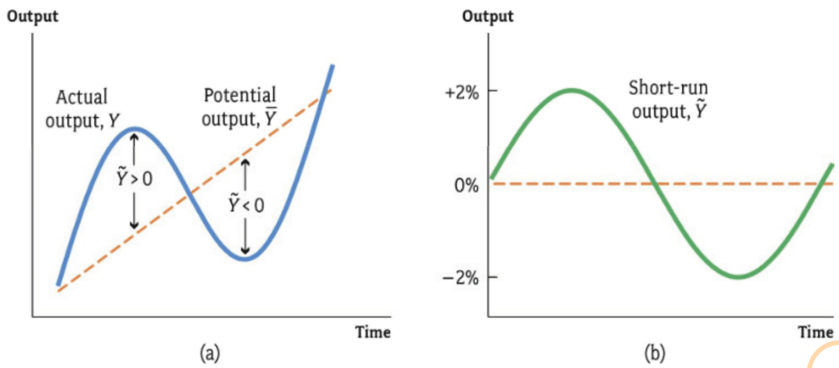
https://youtu.be/6QgD4GfyFmU

Source: Youtube

Watch the video of Figure 23.3 and discuss why such different countries like Niger and Qatar have similar and low unemployment rates.

23.2 Business cycles

Figure 23.4: Economic fluctuations and short-run output



Source: Jones (2008, p. 220)

Actual output in an economy is the sum of the long-run trend and short-run fluctuations (see Figure 23.4):

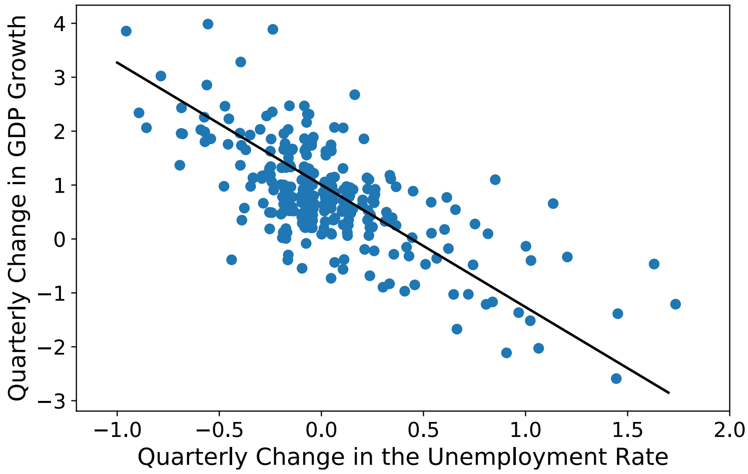
$$\underbrace{\text{actual output}}_{Y_t} = \underbrace{\text{long-run trend}}_{\bar{Y}_t} + \underbrace{\text{short-run fluctuation}}_{\tilde{Y}_t}$$

Here, $\bar{Y}_t$ represents the potential output that follows the general trend of GDP, while $\tilde{Y}_t$ captures short-run fluctuations. The difference between real GDP and potential GDP is known as the output gap.

23.2.1 Okun's Law

Okun's law is an empirically observed relationship between unemployment and short-run fluctuations in countries' production. It is named after Arthur Melvin Okun (1928-1980), who first proposed the relationship in 1962 (see Figure 23.5).

Figure 23.5: Okun's law



Source: Wikimedia Commons

23.2.2 The reverse multiplier effect

When people experience unemployment, they: - Cut back on their spending on luxuries. - Goods with a relatively high income elasticity of demand are likely to be affected more significantly. - These businesses may reduce orders and lay off workers. - As a result, an increase in unemployment can impact economic activity as a whole, creating further unemployment, with negative effects often varying locally. - Switch their spending to substitute goods, which may be considered inferior goods. This change might lead some firms to experience an increase in demand, such as budget supermarkets.

Exercise 23.5. The great depression vs. COVID crisis
John Maynard Keynes (1883-1946):

> "In the long run, we are all dead."

Figure 23.6: Political theory - John Maynard Keynes

https://youtu.be/qtAeINU3FKM

Source: Youtube

Watch the video in Figure 23.6, read Wikipedia (2025c), and Falk et al. (2021). Compare the Great Depression with the recent COVID crisis, specifically in terms of unemployment.

Chapter 24

Aggregate demand

Required readings: @Blanchard2013Blanchard.

Learning objectives:

Students will be able to:

- Understand that demand determines production in the short run.
- Recognize that increases in consumer confidence, investment demand, government spending, or decreases in taxes can increase equilibrium output in the short run.
- Learn how to derive the building blocks of our short-run model: the IS curve.

24.1 Stylized facts

Exercise 24.1. Figure 24.1 to Figure 24.5 show some stylized facts.
Discuss these figures and compare the financial market crisis of 2009 and the Corona crisis of 2020.

24.2 How to fight an economic crisis

In times of economic crisis, people reduce their spending. Businesses cut back on orders and lay off workers, which further reduces consumption. This vicious cycle is illustrated in Figure 1. How can we break this cycle of reduced consumption and job loss? The answer is straightforward: boost aggregate demand. The upcoming section will elaborate and justify that answer further.

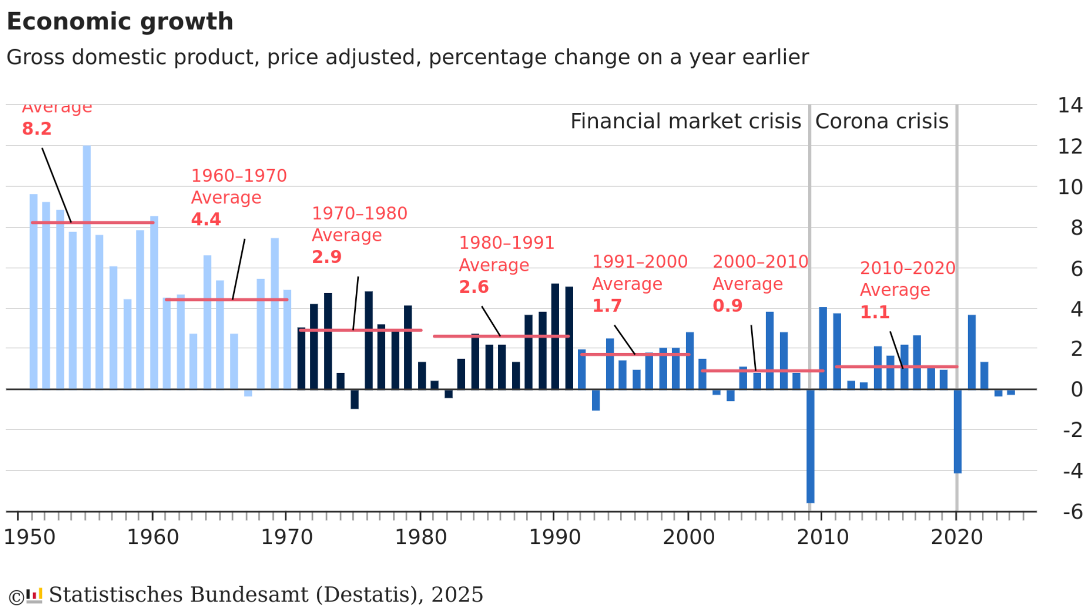
The coronavirus pandemic has slowed global commerce to a crawl. However, many large economies are taking significant actions to move through the crisis. How have national governments acted to lessen the economic impact of the pandemic?

To aid EU citizens, businesses, and countries in recovering from the COVID-19 economic downturn, EU leaders have developed a recovery plan for Europe. On 23 April 2020, they decided to establish an EU recovery fund to mitigate the crisis's effects. By 21 July 2020, EU leaders approved a €1.824 trillion budget for 2021-2027. This package, which includes the Multiannual Financial Framework and Next Generation EU, will help rebuild post-pandemic and invest in green and digital transitions. Besides these measures, three safety nets totaling €540 billion are already in place to support workers, businesses, and countries. On 25 September 2020, the Council sanctioned €87.4 billion in financial aid to 16 member states via the EU's emergency unemployment program, SURE.

The **IMF Policy tracker** summarizes the key economic responses governments are taking to limit the human and economic impact of the COVID-19 pandemic. The tracker includes 196 economies. See: IMF Policy Responses to COVID-19.

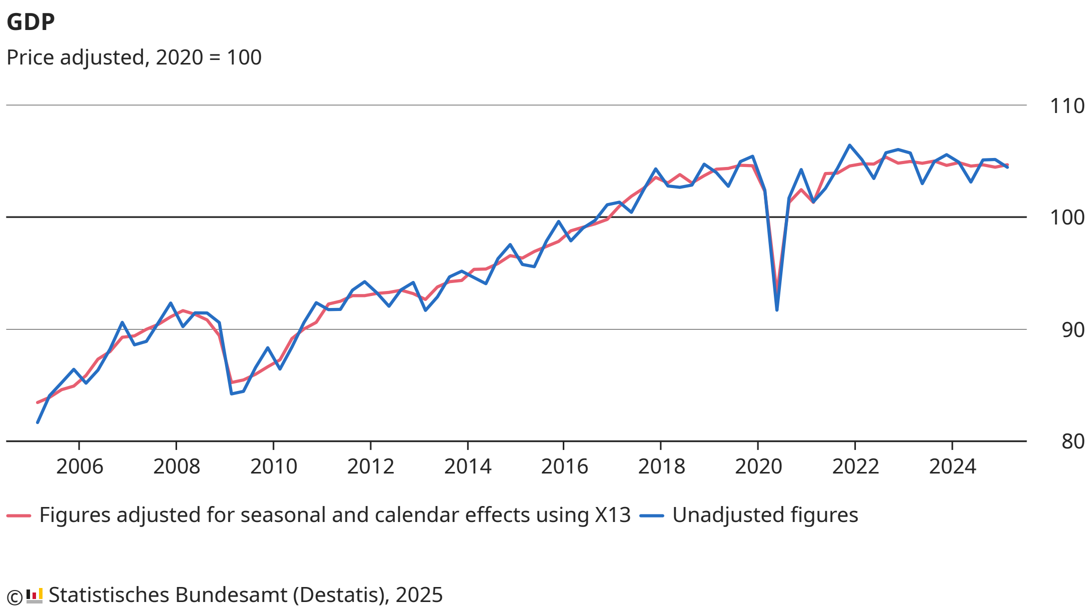
Germany's federal government has adopted two supplementary budgets to tackle the COVID-19 crisis:

Figure 24.1: Germany's GDP from 1950 to 2025, price adjusted, percentage change on a year earlier



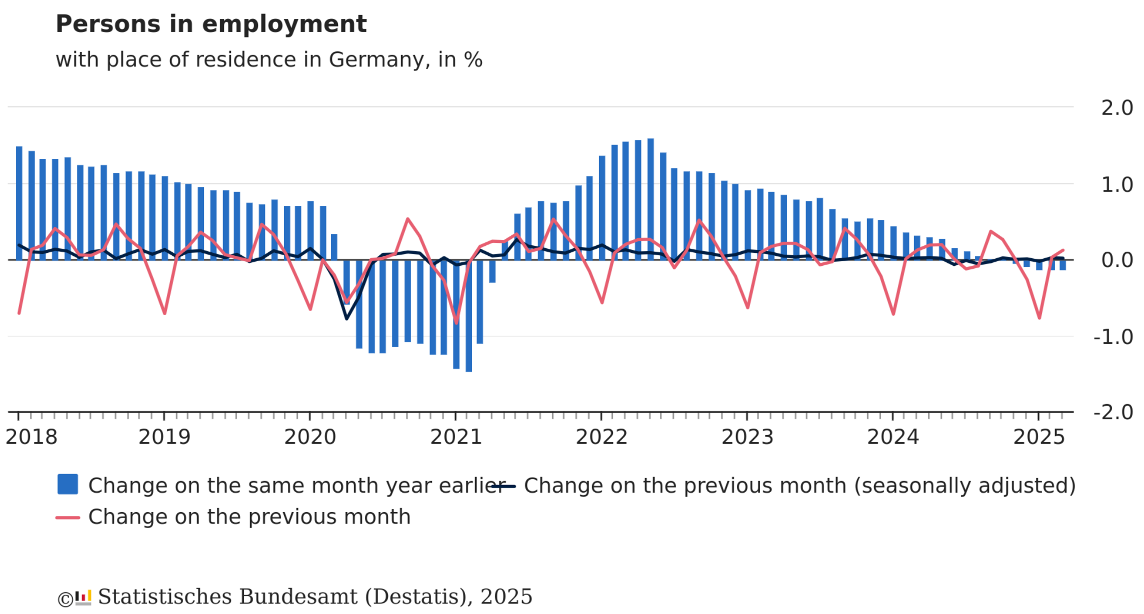
Source: *Statistisches Bundesamt (Destatis), 2025*

Figure 24.2: Germany's GDP, Price adjusted, 2020=100



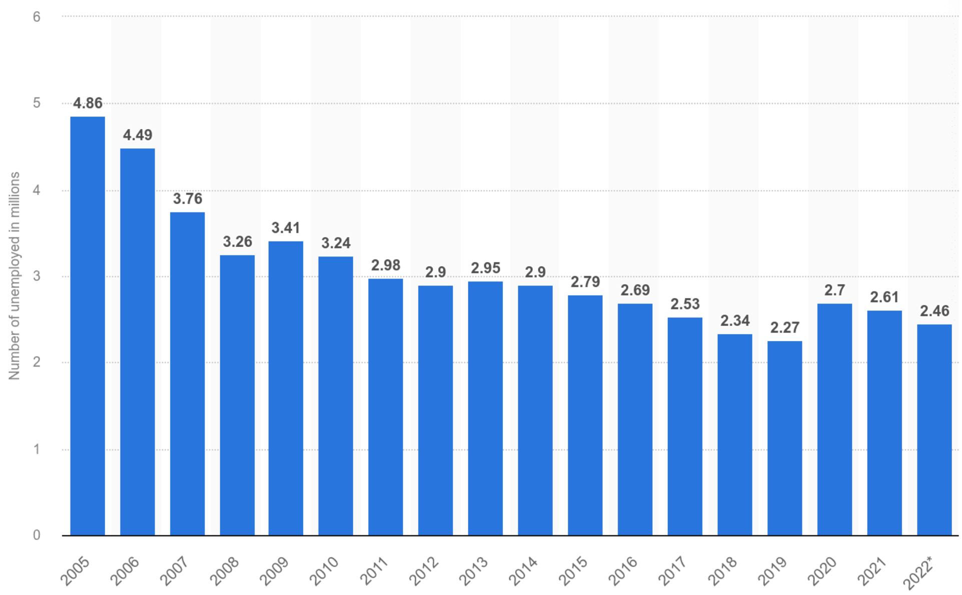
Source: *Statistisches Bundesamt (Destatis), 2022*

Figure 24.3: Persons in employment with place of residence in Germany, in %



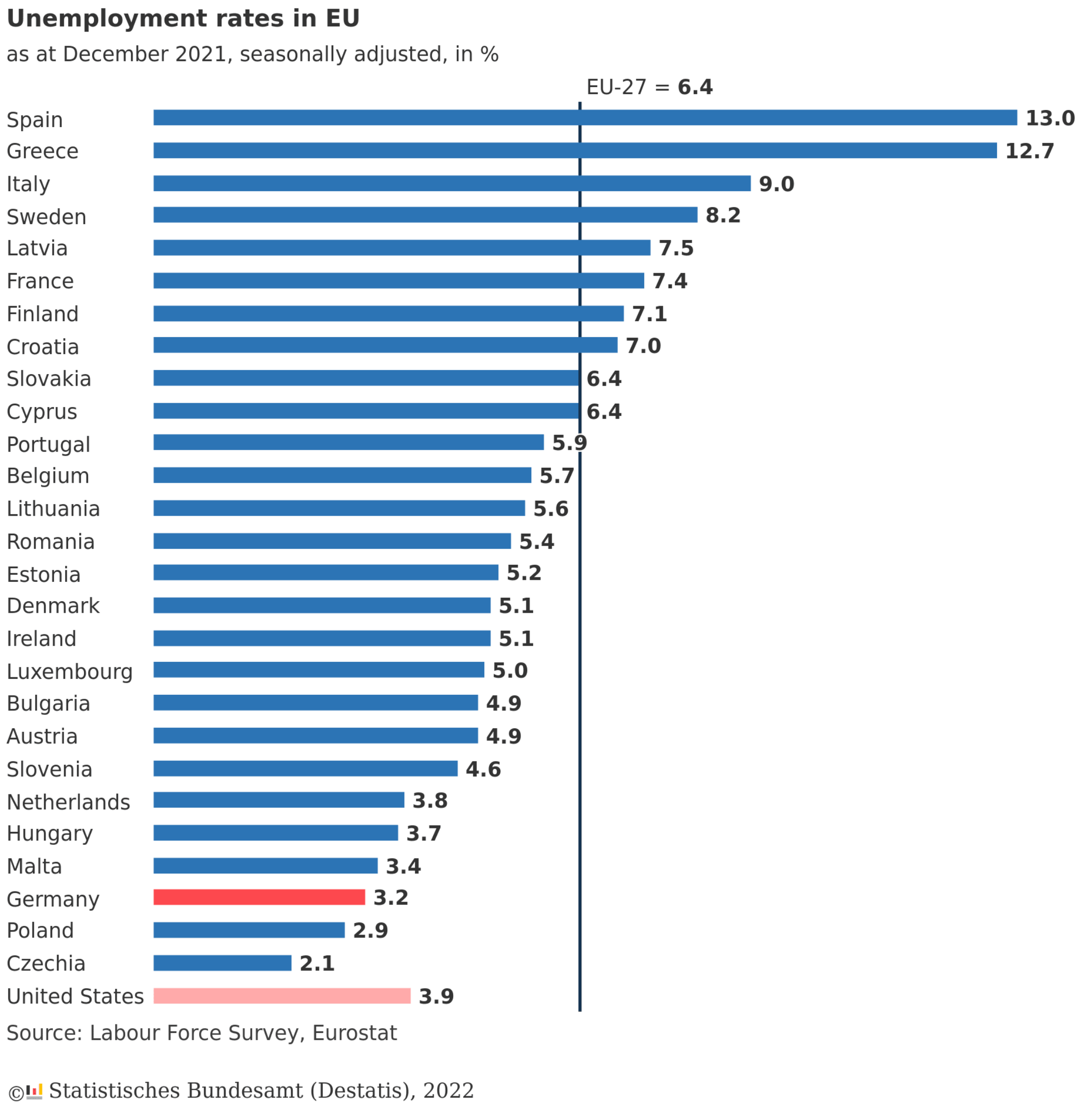
Source: *Statistisches Bundesamt (Destatis),2025*

Figure 24.4: Annual average unemployment figures for Germany from 2005 to 2022



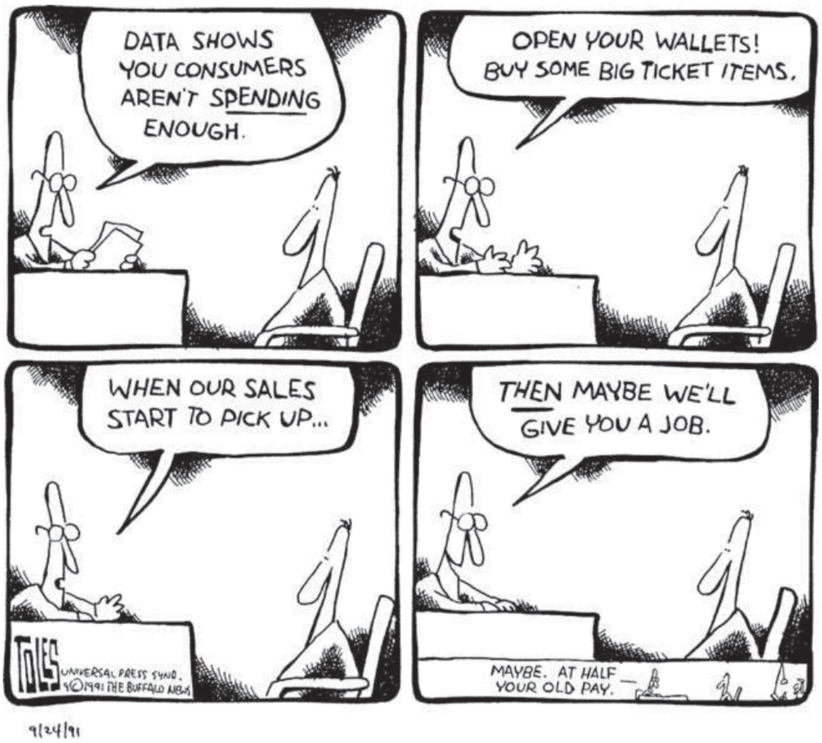
Source: *Statistisches Bundesamt (Destatis)*

Figure 24.5: Unemployment rates, EU



Source: *Statistisches Bundesamt (Destatis)*

Figure 24.6: Open your wallets!



Source: Blanchard & Johnson (2013, p. 43)

- €156 billion (4.9% of GDP) in March and €130 billion (4% of GDP) in June.
- They plan to issue €218.5 billion in debt this year to fund these initiatives.

Key measures include:

- Investments in healthcare equipment, hospital capacity, and vaccine research.
- Expanded access to short-term work subsidies (Kurzarbeit), childcare benefits for low-income parents, and basic income support for the self-employed.
- €50 billion in grants for small businesses and self-employed individuals affected by the pandemic, interest-free tax deferrals until year-end, and €2 billion in venture capital for startups.
- Extended unemployment insurance and parental leave benefits.

The June stimulus package offers temporary VAT reduction, income support for families, grants for struggling SMEs, local government financial aid, credit guarantees for exporters, and investments in green energy and digitalization. In August, the government extended short-term work benefits from 12 to 24 months.

At the same time, through the newly created economic stabilization fund WSF (Wirtschaftsstabilisierungsfonds) and the public development bank KfW (Kreditanstalt für Wiederaufbau), are increasing guarantee volumes and public guarantee access for various firms and institutions. Eligible entities may receive up to 100% in guarantees, raising the total by at least €757 billion (24% of GDP). These entities also facilitate public equity injections into strategically important firms.

In addition to the federal government's fiscal package, many local governments (Länder and municipalities) have announced their own measures to support their economies, amounting to €141 billion in direct support and €63 billion in state-level loan guarantees.

24.3 Aggregate demand

When economists consider year-to-year shifts in economic activity, they focus on the interactions among **production, income, and demand**:

- Changes in the demand for goods lead to changes in production.
- Changes in production lead to changes in income.
- Changes in income lead to changes in the demand for goods.

24.3.1 The composition of GDP

The GDP as a value-added measure can basically be subdivided into consumption, investment, government spending, and trade (see Figure 24.7).

24.3.1.1 Consumption, C

Consumption refers to the goods and services purchased by consumers, such as food, airline tickets, new cars, vacations, etc.

24.3.1.2 Investment, I

Investment is the purchase of capital goods. It includes nonresidential investment (e.g., firms buying new plants and machines) and residential investment (e.g., people buying new houses).

> Note
>
> To most people, *investment* means buying assets like gold or shares of BMW. Economists use *investment* to mean purchasing new capital goods, such as new machines, buildings, or houses. When economists refer to buying gold, shares of BMW, or other financial assets, they usually use the term *financial investment*.

24.3.1.3 Government Spending, G

Government spending refers to the purchase of goods and services by federal, state, and local governments. It does not include government transfers (e.g., Medicare, Social Security) or interest payments on government debt. While these are government expenditures, they are not purchases of goods and services.

24.3.1.4 Imports, IM

Imports are the purchases of foreign goods and services by consumers, business firms, and the domestic government.

24.3.1.5 Exports, X

Exports are the sales of domestic goods and services to foreign countries.

> Inventory investment is not part of demand and GDP!
>
> In any given year, production and sales need not be equal. Some of the goods produced in a given year are not sold in that year, but in later years. And some of the goods sold in a given year may

Figure 24.7: The composition of U.S. GDP, 2010

		Billions of Dollars	Percent of GDP
	GDP (*Y*)	14,660	100
1	Consumption (*C*)	10,348	70.5
2	Investment (*I*)	1,756	12.0
	Nonresidential	1,415	9.7
	Residential	341	2.3
3	Government spending (*G*)	3,001	20.4
4	Net exports	−516	−3.5
	Exports (*X*)	1,838	12.5
	Imports (*IM*)	−2,354	−16.0
5	Inventory investment	71	0.5

Source: *Survey of Current Business*, May 2010, Table 1-1-5

have been produced in an earlier year. The difference between goods produced and goods sold in a given year is called *inventory investment*.

$$\begin{aligned} \text{production - sales} &= \text{inventory investment} \\ \Leftrightarrow \text{production} &= \text{sales} + \text{inventory investment} \end{aligned}$$

Note: The terms *output* and *production* are synonymous. There is no rule for using one or the other. If production exceeds sales and firms accumulate inventories as a result, then inventory investment is said to be positive. If production is less than sales and firms' inventories fall, then inventory investment is said to be negative. Inventory investment is typically small.

24.3.2 Demand for goods

Denote the total demand for goods by Z. Using the decomposition of GDP, we can write Z as

$$Z \equiv C + I + G + X - IM$$

This equation is an identity (which is why it is written using the symbol $\equiv$ rather than an equals sign). To think about the determinants of Z fruitfully, let's make some simplifications to focus on the issue at hand:

- Assume that all firms produce the same good, which can then be used by consumers for consumption, by firms for investment, or by the government.
- A *good* is an item that stands for both physical goods and services.
- Assume that firms are willing to supply any amount of the good at a given price level P. This assumption allows us to focus on the role demand plays in the determination of output.
- Assume that the economy is closed, i.e., it does not trade with the rest of the world. Thus, both exports and imports are zero. Although this is untrue, this assumption simplifies our discussion because we won't have to think about what determines exports and imports.
- Under the assumption that the economy is closed (a.k.a. in autarky), the demand for goods is simply the sum of (1) consumption, (2) investment, and (3) government spending:

$$Z \equiv C + I + G$$

(1) Consumption

$$C = C(\underbrace{Y_D}_{(+)})$$

The consumption function, $C = C(Y_D)$, captures how consumer spending changes with disposable income. The $(+)$ indicates that consumption increases as disposable income (Y_D) rises, though not one-to-one. Disposable income is what remains after taxes (T) and government transfers:

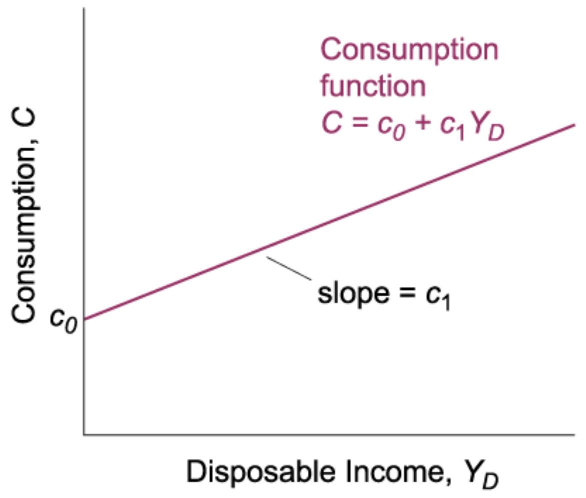
$$Y_D \equiv Y - T$$

A linear version of the consumption function is shown in Figure 24.8:

$$C = c_0 + c_1 Y_D$$

- This function has two parameters, c_0 and c_1:
  - c_0 is the function's intercept.
  - c_1 is the marginal propensity to consume, showing the effect of an additional dollar of disposable income on consumption ($0 \leq c_1 < 1$).

Figure 24.8: Consumption and disposable income



Source: Blanchard & Johnson (2013, p. 47)

(2) Investment

Variables within the model can be endogenous, meaning they depend on other variables in the model. Conversely, exogenous variables are those not explained within the model. Here, we treat investment as given, making it exogenous. For now, we write:

$$I = \bar{I}$$

(3) Government spending

Government spending (G) and taxes (T) represent fiscal policy, which involves the government's decisions on taxation and spending. We treat G and T as exogenous variables because they are typically set by the government, and we won't explain them further in the model. As this assumption remains unchanged, we don't use a bar notation for G and T, simplifying the notation. Note that T refers to taxes minus government transfers.

24.3.3 Equilibrium in the goods market

Equilibrium output is determined by the condition that supply (output/production) be equal to demand.

24.3.3.1 The determination of equilibrium output

Equilibrium in the goods market occurs when production (Y) equals the demand for goods (Z).

$$Y = Z$$

If you're unfamiliar with the term equilibrium, you can find more information here.

Then, using our assumptions of (1) to (3):

$$\begin{aligned} Y &= \underbrace{C + I + G}_{Z} \\ Y &= \underbrace{c_0 + c_1 Y_D}_{C} + \underbrace{\bar{I}}_{I} + G \\ Y &= c_0 + c_1 \underbrace{(Y - T)}_{Y_D} + \bar{I} + G \end{aligned}$$

The equilibrium condition requires production (Y) to equal demand (Z). Demand, Z, depends on income, Y, which in turn is equal to production. We use Y to denote both because GDP can be viewed from the production side or the income side.

Once the model is built, we solve it to understand what influences output levels, like changes in government spending. Solving the model involves not only algebra but also understanding the reasons behind the results. We use graphs to visualize the results—sometimes skipping algebra—and words to describe the outcomes and underlying mechanisms.

Economists employ these three tools to solve a model effectively:

- Algebra: Ensures logical consistency.
- Graphs: Aids in building intuitive understanding.
- Words: Provides clarity and explanation.

24.4 The model using algebra

Let's derive key components from the equilibrium equation $Y = c_0 + c_1(Y - T) + \bar{I} + G$ to Y:

$$Y = \underbrace{\frac{1}{1 - c_1}}_{\text{multiplier}} \underbrace{\left(c_0 + \bar{I} + G - c_1 T\right)}_{\text{autonomous spending}}$$

Components:

- **Autonomous Spending:** Independent of output since all variables are exogenous.
- **The Multiplier:** Greater than one because the propensity to consume (c_1) ranges between zero and one. As (c_1) approaches one, the multiplier grows. An increase by one unit in autonomous spending raises output by more than one unit.

24.5 FAQ

Where does the multiplier effect come from?

- From the consumption equation, an increase in c_0 boosts demand. This prompts higher production, which raises income. The rise in income further boosts consumption and demand, creating a cycle.
- The initial demand increase triggers successive output increments. Each production increase elevates income and demand again—continuing the cycle.
- The multiplier sums the successive production increases stemming from a demand rise.
- When demand grows by \$1 billion, production rise after n rounds equals \$1 billion times:

$$1 + c_1 + c_1^2 + \cdots + c_1^n = \frac{1}{1 - c_1}$$

This is a geometric series. If you feel like you need explanations to that, please consider Appendix B.

Is the government omnipotent?

- Adjusting government spending or taxes can be challenging.
- Predicting the responses of consumption and investment is uncertain.
- Expectations significantly influence outcomes.
- The pursuit of specific output levels might lead to negative consequences.
- Budget deficits and public debt could have long-term effects.

How long does it take for output to adjust?

- Output increases gradually in response to heightened consumer spending, not immediately reaching the new equilibrium. This depends on firms revising production schedules.
- Understanding the timeline for output adjustment is known as the dynamics of adjustment.

What is the value of the multiplier in the real world?

To determine the multiplier's value and examine behavioral equations, economists use econometrics, involving statistical methods. The process is complex, with varying results based on conditions.

Ramey (2019) observes effects of spending during the financial crisis:

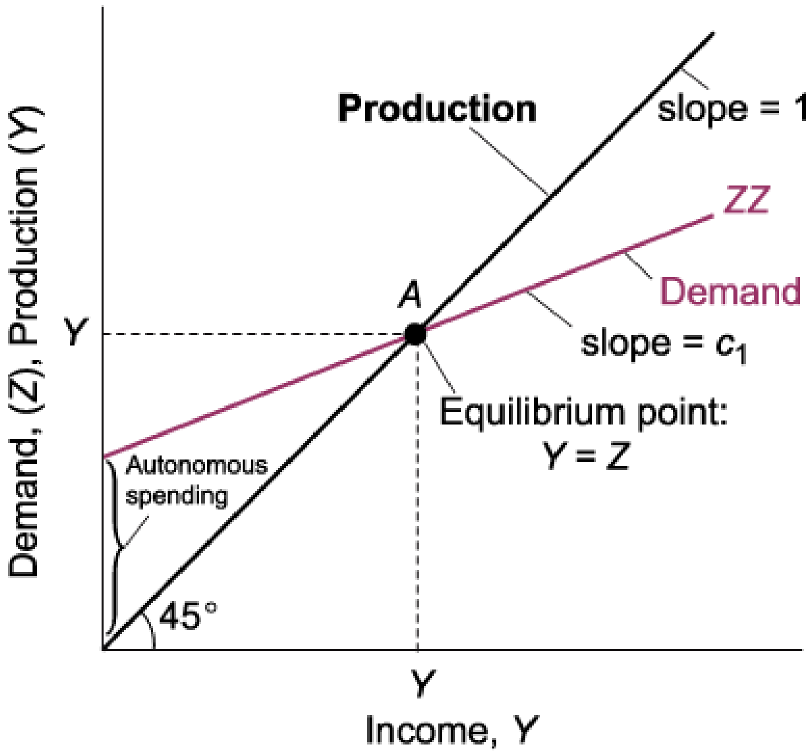
> Reviewing the estimates, I come to the surprising conclusion that the bulk of the estimates for average spending and tax change multipliers lie in a fairly narrow range, 0.6 to 1 for spending multipliers and -2 to -3 for tax change multipliers. However, I identify economic circumstances in which multipliers lie outside those ranges.

24.6 The model using graphs

24.7 The model using words

- The first-round demand increase leads to an equal production rise of \$1 billion, shown by the distance AB.
- This production increase results in an equal income rise, indicated by the distance BC, also \$1 billion.
- The second-round demand increase, shown by distance CD, equals \$1 billion (the first-round income rise) times the propensity to consume, c_1 — resulting in \$$c_1$ billion.

Figure 24.9: Equilibrium in the goods market: The Keynesian cross



Source: Blanchard & Johnson (2013, p. 51)

- This second-round demand increase induces an equal production rise, shown by distance CD, and consequently an equal income rise, indicated by distance DE.
- The third-round demand increase results in $$c_1$ billion (second-round income increase) times c_1, the marginal propensity to consume; equaling $$c_1 \cdot c_1 = c_1^2$ billion, and so forth.
- An increase in autonomous spending has a greater than one-for-one effect on equilibrium output.
- An increase in demand leads to higher production and corresponding income growth. Consequently, output increases are larger than the initial demand shift, multiplied by the multiplier.

24.7.1 The goods market and the investment-savings (IS) relation

Recall: Equilibrium in the goods market exists when production, Y, equals demand for goods, Z. In the simple model above, the interest rate did not affect goods demand. The equilibrium condition was:

$$Y = C(Y - T) + I + G$$

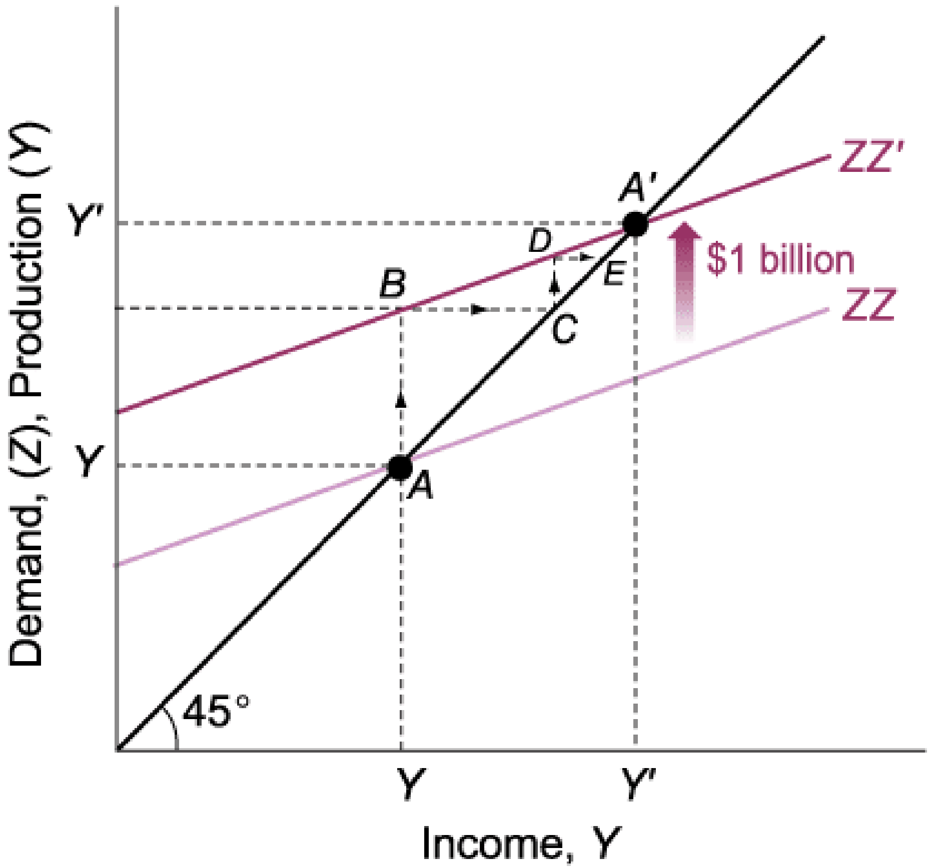
24.7.2 The derivation of the IS curve

Now, let us loosen the assumption that investments are exogenous by capturing the effects of two determinants of investment:

- The level of sales, Y, is positively associated with investments $\left(\frac{\partial I}{\partial Y} > 0\right)$
- The interest rate, i, is negatively associated with investments $\left(\frac{\partial I}{\partial i} < 0\right)$

$$I = I(Y, i)$$

Figure 24.10: The effects of an increase in autonomous spending on output



Source: Blanchard & Johnson (2013, p. 52)

Considering the above investment relation, the equilibrium condition in the goods market becomes:

$$Y = C(Y - T) + I(Y, i) + G$$

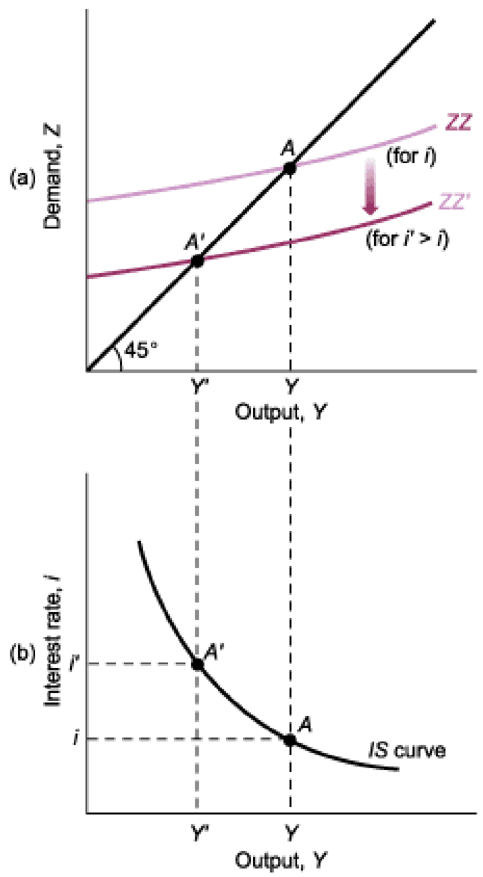
The derivation of the IS curve is visualized in Figure 24.11.

Exercise 24.2. Determinants of investments
Explain the intuition behind our assumptions that $\frac{\partial I}{\partial Y} > 0$ and $\frac{\partial I}{\partial i} < 0$.

Solution

Consider a firm facing an increase in sales and needing to in- crease production. To do so, it may need to buy additional machines or build an additional plant. In other words, it needs to invest. A firm facing low sales will feel no such need and will spend little, if anything, on investment.
Consider a firm deciding whether or not to buy a new machine. Suppose that to buy the new machine, the firm must borrow. The higher the interest rate, the less attractive it is to borrow and buy the machine.

Figure 24.11: IS curve derivation



Source: Blanchard & Johnson (2013, p. 88)

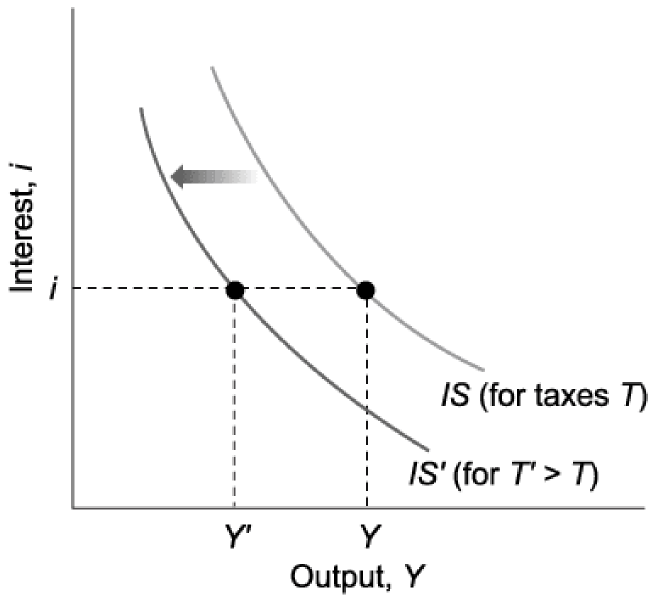
24.7.3 Shifts of the IS curve

G, I and T can shift the IS curve. For example, an increase in taxes shifts the IS curve to the left.

Exercise 24.3. Shifting the IS curve
How does G, I, and T shifts the IS curve?

Solution

Figure 24.12: Shifts of the IS curve



Source: Blanchard & Johnson (2013, p. 89)

24.8 Investment equals savings

Savings is the sum of private plus public savings.

Private saving (S) is saving by consumers:

$$S \equiv Y - T - C$$

Public saving equals taxes minus government spending:

- If $T > G$, the government has a budget surplus—public saving is positive.
- If $T < G$, the government has a budget deficit—public saving is negative.

$$\begin{aligned} Y &= C + I + G \\ \Rightarrow \underbrace{Y - T - C}_{S} &= I + G - T \\ \Rightarrow S &= I + G - T \\ \Rightarrow I &= \underbrace{S}_{\text{private savings}} + \underbrace{(T - G)}_{\text{public savings}} \end{aligned}$$

- Thus, if $T = G$, then $I = S$.

- The equation above states that equilibrium in the goods market requires that investment equals saving—the sum of private plus public saving.
- This equilibrium condition for the goods market is called the IS relation.
- IS stands for *investments equals savings*.
- What firms want to invest must be equal to what people and the government want to save.

24.9 Summary

What you should remember about the components of GDP:

- GDP is the sum of consumption, investment, government spending, inventory investment, and exports minus imports.
- Consumption (C) is the purchase of goods and services by consumers. It's the largest component of demand.
- Investment (I) includes nonresidential investment—buying new plants and machines by firms—and residential investment—buying new houses or apartments by individuals.
- Government spending (G) refers to goods and services purchased by federal, state, and local governments.
- Exports (X) are goods purchased by foreigners.
- Imports (Im) are goods purchased by U.S. consumers, firms, and government from abroad.
- Inventory investment is the difference between production and purchases, which can be positive or negative.

What you should remember about our first model of output determination:

- In the short run, demand determines production. Production equals income, which in turn affects demand.
- The consumption function depicts consumption dependence on disposable income, with the propensity to consume showing how much consumption rises for a given increase in disposable income.
- Equilibrium output is the output level where production matches demand. In equilibrium, output equals autonomous spending multiplied by the multiplier. Autonomous spending is demand that doesn't depend on income, and the multiplier is $\frac{1}{1-c_1}$, where c_1 is the propensity to consume.
- Increased consumer confidence, investment demand, government spending, or lowered taxes all boost equilibrium output in the short run.

Chapter 25

Financial market

Learning objectives:

Students will be able to:

- Understand the basic functioning of the money market.
- Recognize that money supply and money demand determine the interest rate.
- Explain how central banks influence money demand by influencing the interest rate.
- Analyze the effects of a monetary expansion.
- Derive the building blocks of our short-run model: the LM-curve.

Required readings:
Blanchard & Johnson (2013, ch. 5).

Recommended readings: Blanchard & Johnson (2013, ch. 4).

25.1 Semantic traps: Money, income, and wealth

Words such as *money* or *wealth* have specific meanings in economics, which differ from their everyday use.

25.1.0.1 Income

Income is what you earn from work plus what you receive in interest and dividends. It is a **flow**, meaning it is expressed per unit of time.

25.1.0.2 Saving

Saving is the part of after-tax income not spent, and it is also a flow. Savings is sometimes used as a synonym for wealth (a term we will not use here).

25.1.0.3 Financial wealth

Financial wealth, or simply **wealth**, is the value of all your financial assets minus liabilities. Unlike income or saving, financial wealth is a **stock** variable.

25.1.0.4 Investment

Investment is the purchase of new capital goods, like machines and buildings. Buying shares or financial assets is called financial investment.

25.1.0.5 Money

- can be used for transactions but pays no interest.
- two types of money:
  - currency (coins and bills)
  - checkable deposits (bank deposits on which you can write checks)

25.1.0.6 Bonds

Bonds pay a positive interest rate, i, but cannot be used for transactions.

Exercise 25.1. Don't say "I have a lot of money"
Read the text below taken from Blanchard, 2013, p. 65. Understand the difference in meaning of *money*, *income*, and *wealth*:

> In everyday conversation, we use *money* to denote many different things. We use it as a synonym for income: "making money." We use it as a synonym for wealth: "She has a lot of money."
>
> In economics, you must be more careful. Here is a basic guide to terms and their precise meanings in economics.
>
> Money is what can be readily used to pay for transactions. Money is currency and checkable deposits at banks.
>
> Income is what you earn from working plus what you receive in interest and dividends. It is a flow—expressed in units of time: weekly, monthly, or yearly income, for example. J. Paul Getty was once asked his income. Getty answered: " \$1,000". He meant \$1,000 per minute!
>
> Saving is part of after-tax income not spent. It is also a flow. If saving is 10% of income, and the income is \$3,000 per month, then save \$300 per month. Savings (plural) is sometimes used as a synonym for wealth. To avoid confusion, we will not use *savings* in this course.
>
> Financial wealth, or simply wealth, is the value of all your financial assets minus financial liabilities. In contrast to income or saving, which are flow variables, financial wealth is a stock variable. It is wealth at a given moment in time.
>
> At a given moment in time, you cannot change the amount of financial wealth. It changes over time as you save or dissave, or as the value of assets and liabilities change. But you can change the composition of wealth; for example, decide to pay back part of a mortgage by writing a check against a checking account. This reduces liabilities (smaller mortgage) and corresponding assets (smaller checking account balance); but does not change wealth at that moment.
>
> Financial assets for buying goods are called money. Money includes currency and checkable deposits against which you can write checks. Money is also a stock. Someone wealthy might have small money holdings—\$1,000,000 in stocks but \$500 in a checking account. A person with large income might have small money holdings—\$10,000 monthly but \$1,000 in a checking account.
>
> Investment is reserved for purchasing new capital goods. When talking about buying shares or financial assets, refer to them as financial investments.
>
> Learn to be economically correct:
>
> Do not say "I am making a lot of money"; say "I have a high income."
> Do not say "I have a lot of money"; say "I am very wealthy."

25.2 The demand for money

Exercise 25.2. Money or bonds
How much will you hold of either? What determines your decision? What quantity of bonds would you hold if the interest rate was zero?

The demand for money comes from households, firms, and governments using money as a means of exchange and store of value. The law of demand holds: as the interest rate rises, the quantity of money demanded decreases because the interest rate represents an **opportunity cost of holding money**. Higher interest rates make money less effective as a store of value.

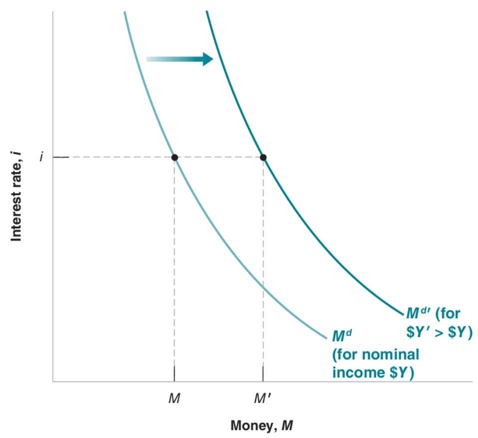
The *demand for money* depends on transactions in the economy and the interest rate. While transactions are hard to measure, they're likely roughly proportional to nominal income. Demand for money is described as follows:

$$M^d = \$Y \underbrace{L(i)}_{\frac{\partial L(i)}{\partial i}<0}$$

Read this as: The demand for money M^d equals nominal income $Y times a function of the interest rate i, denoted by $L(i)$. An increase in the interest rate decreases money demand as people shift more wealth to bonds.

For a given nominal income, lower interest rates increase money demand. At a given interest rate, rising nominal income shifts money demand right. See Figure 25.1.

Figure 25.1: The demand for money



Note: Blanchard & Johnson (2013, p. 66)

25.3 The supply of money and equilibrium

To find equilibrium in financial markets, understand that the price of money is the interest rate. Like any market, equilibrium is where demand and supply meet. Simplifying, assume monetary authorities (central banks) supply money and set interest rates.

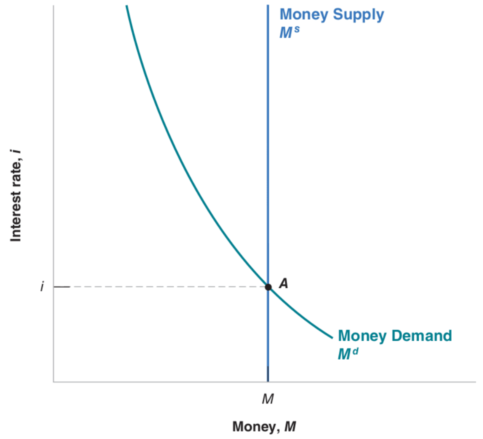
A central bank can either choose money supply, setting interest rates where supply equals demand, or choose the interest rate and adjust money supply to achieve its chosen rate.

Equilibrium requires money supply equals money demand, $M = M^d$:

$$\underbrace{M}_{\text{money supply}} = \underbrace{\$Y\,L(i)}_{\text{money demand}}$$

This equilibrium relation is called the LM relation where LM stands for Liquidity and Money.[1]

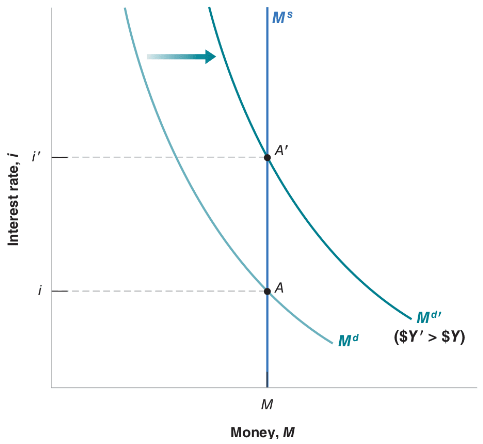
Figure 25.2: The determination of the interest rate



Note: Blanchard & Johnson (2013, p. 68)

- The interest rate must be such that money supply (independent of interest rate) equals money demand (dependent on interest rate). See Figure Figure 25.2.
- An increase in nominal income raises the interest rate as shown in Figure Figure 25.3.
  - As mentioned, a central bank lowering interest rates from i to i' is akin to increasing money supply, seen in Figure Figure 25.5.

Figure 25.3: The effects of an increase in nominal income on the interest rate



Note: Blanchard & Johnson (2013, p. 69)

25.4 The derivation of the LM curve

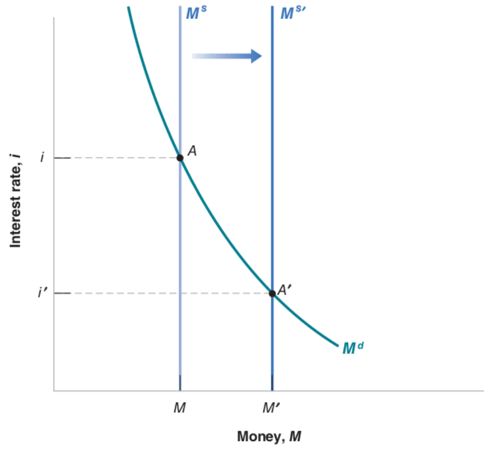
25.4.1 Using algebra

Assuming money demand is linear:

$$M^d = Y - hi \quad \text{with } h > 0$$

[1]Economists use liquidity as a measure of how easily an asset can be exchanged for money. Money is fully liquid; other assets less so.

Figure 25.4: The effects of an increase in the money supply on the interest rate



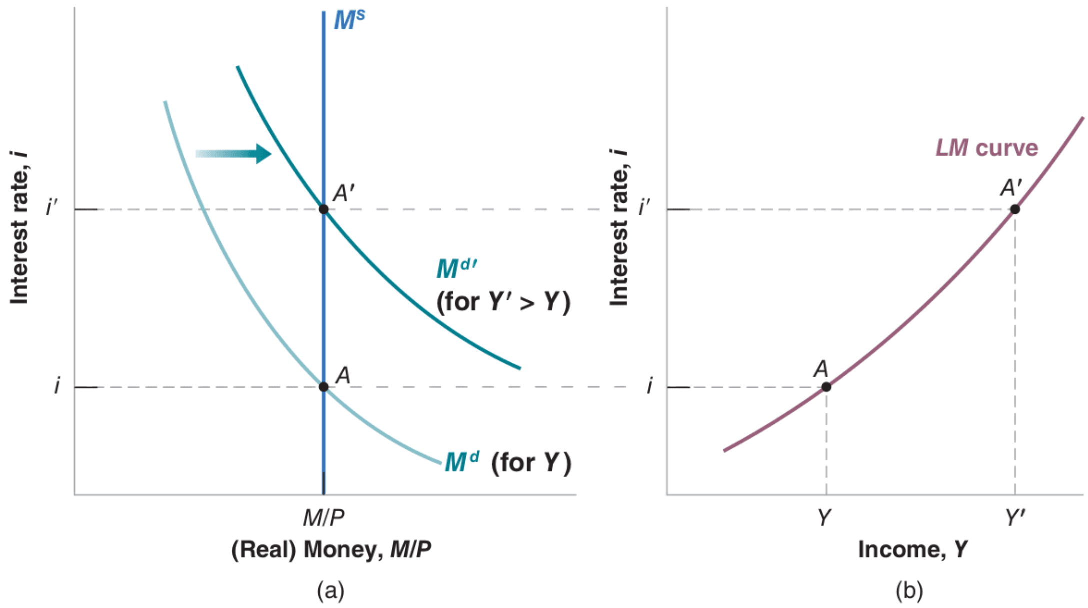
Note: Blanchard & Johnson (2013, p. 70)

The parameter h represents how much demand for real money balances decreases as interest rates rise. Money supply (M) is set by the central bank and is assumed constant for a period. Solving for the interest rate gives the LM curve:

$$i = \frac{1}{h}(Y - M)$$

25.4.2 Using graphs (see Figure 25.5)

Figure 25.5: Equilibrium in the goods market



Note: Blanchard & Johnson (2013, p. 87)

(a) An income increase, at a given interest rate, raises demand for money. Given supply, this demand rise increases the equilibrium interest rate.
(b) Equilibrium in financial markets implies an income increase raises interest rates. The LM curve is upward sloping.

25.5 Taylor rule

- The Taylor rule derives from empirical insights into how central banks operate.
- It can replace the LM curve in the IS-LM Model, forming the IS-TR Model.
- It's a formula predicting central banks' interest rate changes due to economic shifts.
- The Taylor rule recommends raising interest rates when inflation or GDP growth exceed desired levels.
- Critics say the Taylor principle can't account for sudden economic shocks.
- For more on the Taylor rule, see the Wikipedia entry: Taylor rule.
- Formally, the rule is expressed as:

$$i_t = \pi_t + r_t^* + a_\pi(\pi_t - \pi_t^*) + a_y(y_t - \bar{y}_t)$$

In this equation:

- i_t: target short-term nominal interest rate,
- π_t: inflation rate per GDP deflator,
- π_t^*: desired inflation rate (*target inflation rate*),
- r_t^*: assumed equilibrium real interest rate,
- y_t: logarithm of real GDP,
- $\bar{y}_t$: logarithm of potential output (linear trend).

Technical note on growth rates and logarithm

Taylor rule calculates $y_t - \bar{y}_t$. This linearly approximates growth rates—growth rate from time $t = 0$ to $t = 1$ in x is approximately

$$\frac{x_1 - x_0}{x_0} \approx \ln x_0 - \ln x_1$$

Empirics showed it looks like this for central banks like the ECB and FED:

$$i_t = \pi_t + 2 + 0.5(\pi_t - 2\%) + 0.5(y_t - \bar{y}_t)$$

Exercise 25.3. Taylor rule
Using the equation above, calculate the expected interest rate set by the central bank for the following inflation rates, π_t. Apply the Taylor Rule.

- 4%
- 1%
- 0%
- -2% (Deflation)

Plot the Taylor Rule with i on the y-axis and Y on the x-axis.

Chapter 26

IS-LM model

Students will be able to:

- Understand the power of fiscal and monetary policy in a general equilibrium.
- Describe how the IS-LM model explains the interaction of real goods markets and financial markets in balancing interest rates and total output in an economy.
- Explain how investment acts as the key channel through which changes in real interest rates affect GDP in the short run.
- Recognize how the government or central bank can increase aggregate demand to combat economic downturns and crises.

Required readings:
Blanchard & Johnson (2013, ch. 5).

26.1 Putting the IS and the LM relations together

The IS relation stems from the condition that the supply of goods must equal the demand for goods, revealing how the interest rate affects output. Conversely, the LM relation stems from the condition that the supply of money must equal the demand for money, illustrating how output affects the interest rate. Now, by putting IS and LM relations together, we understand that at any time, both the supply of goods must equal the demand for goods, and the supply of money must equal the demand for money—both relations must hold. Together, they determine output and the interest rate.

The equilibrium in the goods market shows an interest rate increase leads to a decrease in output, depicted by the IS curve in Figure **??**.

$$\text{IS relation:} \quad C(Y-T) + I(Y,i) + G$$

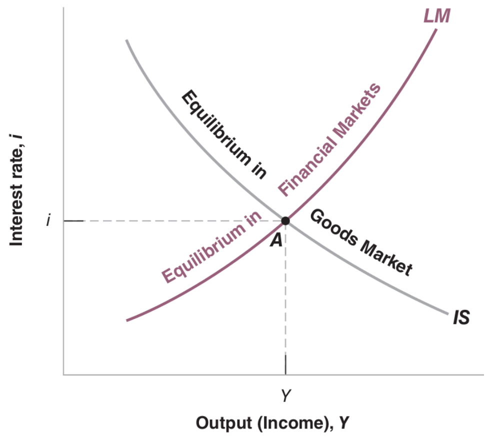
The equilibrium in financial markets implies an output increase leads to an interest rate increase, represented by the LM curve in Figure **??**.

$$\text{LM relation:} \quad \frac{M}{P} = YL(i)$$

The IS-LM model is visualized in Figure 26.1. Only at point A, where both curves intersect, are goods and financial markets in equilibrium.

You'll notice the LM relation is expressed in *real* terms—relating real money (money in terms of goods), real income (income in terms of goods), and the interest rate. Remember: nominal GDP equals Real GDP times the GDP deflator: $\$Y = Y \cdot P$. Conversely, Real GDP equals nominal GDP divided by the GDP deflator: $\frac{\$Y}{P} = Y$.

Figure 26.1: The IS-LM model

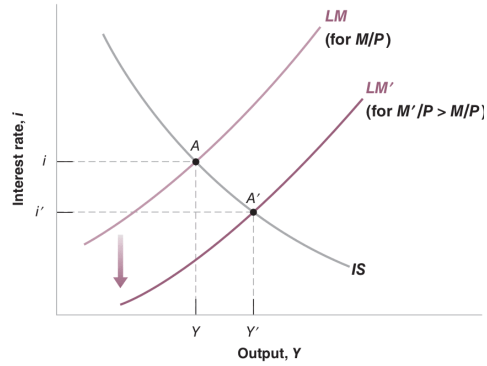


Note: Blanchard & Johnson (2013, p. 93)

26.2 Monetary policy

A **monetary expansion** results in higher output and lower interest rates. Conversely, the reverse holds for a monetary contraction. See Figure Figure 26.2.

Figure 26.2: The effects of a monetary expansion



Note: Blanchard & Johnson (2013, p. 97)

26.2.0.1 Fiscal Policy

Fiscal contraction or consolidation refers to fiscal policy that reduces the budget deficit; increasing the deficit is called a fiscal expansion. Taxes and government spending affect the IS curve but not the LM curve, whereas changes in money supply impact the LM curve but not the IS curve. Figure 26.3 provides an overview of fiscal and monetary policy effects in the IS-LM model.

Figure 26.3: The effects of fiscal and monetary policy in the IS-LM model

	Shift of *IS*	Shift of *LM*	Movement in Output	Movement in Interest Rate
Increase in taxes	left	none	down	down
Decrease in taxes	right	none	up	up
Increase in spending	right	none	up	up
Decrease in spending	left	none	down	down
Increase in money	none	down	up	down
Decrease in money	none	up	down	up

Note: Blanchard & Johnson (2013, p. 98)

Exercise 26.1. Fiscal contraction

- What are the effects of this fiscal contraction on output, composition, and interest rates?
- What are the effects of a monetary expansion?

Solution

When answering questions about the effects of policy changes, follow these three steps:

1. **Equilibrium Impact:**Determine how the change affects equilibrium in the goods market and the financial markets. Specifically, assess how it shifts the IS and/or the LM curves.

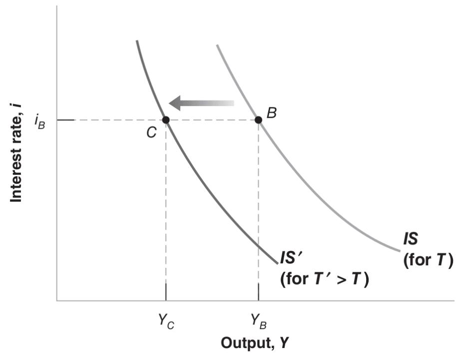
2. **Intersection Effects:** Characterize the effects of these shifts on the intersection of the IS and LM curves. Analyze what this does to equilibrium output and the equilibrium interest rate.

3. **Descriptive Analysis:** Describe the effects in words.

a)

1. Impact on output:

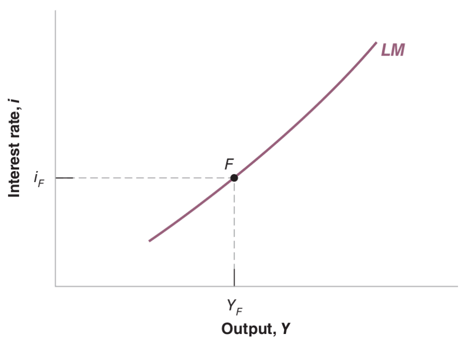
Figure 26.4: Effects of fiscal contraction on output



Note: Blanchard & Johnson (2013, p. 95)

Impact on financial markets:

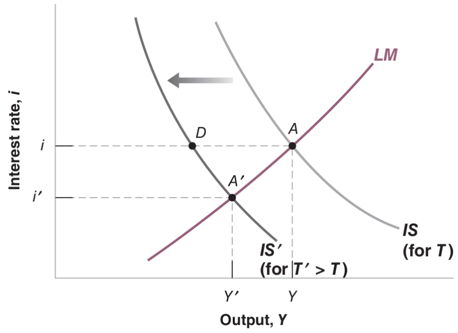
Figure 26.5: Effects of fiscal contraction on financial markets



Note: Blanchard & Johnson (2013, p. 95)

2. Overall Effects:

Figure 26.6: Overall effects of fiscal contraction



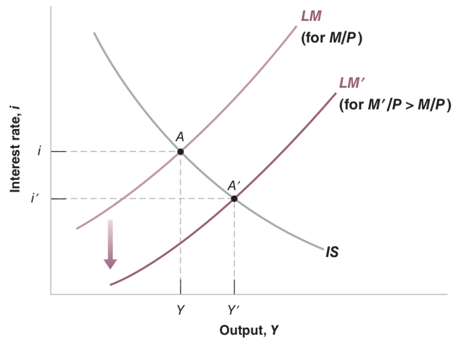
Note: Blanchard & Johnson (2013, p. 95)

3. In Words: An increase in taxes leads to lower disposable income, causing people to reduce consumption. This decrease in demand, in turn, leads to a drop in output and income. Simultaneously, lower income reduces money demand, lowering the interest rate. The interest rate decline mitigates but does not fully counteract the increased tax impact on goods demand.

b) Effects of a Monetary Expansion

A monetary expansion results in higher output and a lower interest rate.

Figure 26.7: Effects of a monetary expansion



Note: Blanchard & Johnson (2013, p. 97)

26.3 Limitations of the IS-LM model

- It's built on simplistic and unrealistic assumptions about the macroeconomy. Sir John Richard Hicks (1904-1989)[1] claimed the model's flaws were *fatal*, better used as a "classroom gadget, to be superseded by something better." However, *new* or *optimized* IS-LM frameworks have emerged over time.
- The model's a limited policy tool; it doesn't detail how tax or spending policies should be formulated, limiting its practical appeal.
- It lacks insights on inflation, rational expectations, or international markets, though later models attempt to incorporate these. The model also overlooks capital formation and labor productivity.

[1]British economist and major twentieth-century figure. See: John Hicks

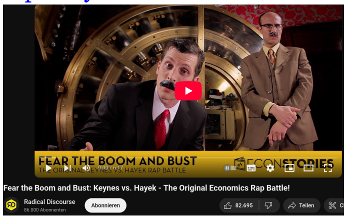
Hayek vs. Keynes

Friedrich August Hayek (1899-1992) opposed Keynesian policy, believing instead in the free market's inherent price system to mitigate bust-and-boom cycles. In short, his view was that business cycles and economic crisis can only be avoided by trusting the free market and avoiding the boom itself. The clash between Keynesian and Classical/Austrian School economics is often represented with Keynes vs. Hayek analogies.

Exercise 26.2. Rap battle

Figure 26.8: Fear the Boom and Bust: Keynes vs. Hayek

https://youtu.be/d0nERTFo-Sk



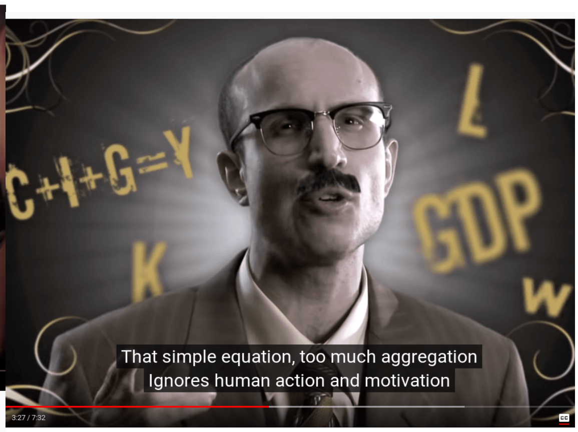
Source: Youtube

Watch the video of Figure 26.8 and read the lyrics and comments at Genius Lyrics. Access comments on shaded text.
Explain the Keynesian strategy for combating bust and boom cycles. Explain Friedrich Hayek and the Austrian school's approach to fighting bust-and-boom cycles. Also consider the video screenshots in Figure 26.9.

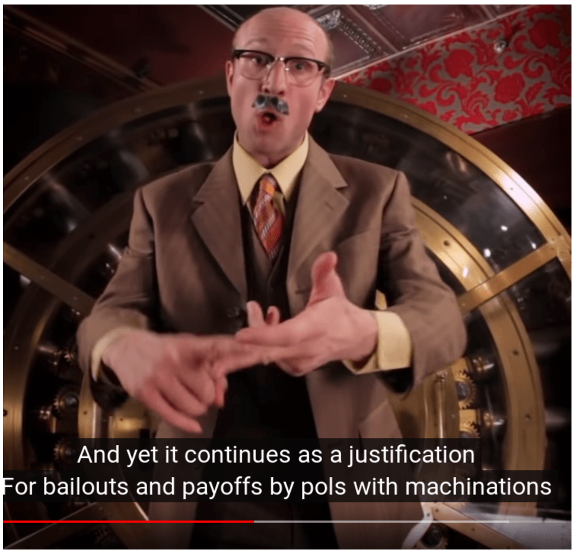
Figure 26.9: Hayek vs Keynes

(a) a)

(b) b)



(c) c)



Source: *Youtube*

Solution

- The **Keynesian** strategy focuses on government intervention to stabilize the economy using fiscal and monetary policies during recessions and expansions. Fiscal policies involve adjusting government spending and taxation, and monetary policies involve influencing interest rates and money supply.
- **Friedrich Hayek**, unlike Keynes, advocated letting the market function freely without government or central bank manipulation, believing stable money supply and non-intervention to prevent cycles.

The Keynesian economic strategy for addressing bust and boom cycles hinges on government intervention to stabilize the economy, according to John Maynard Keynes. Bust and boom cycles—which encompass recessions and expansions—are seen as natural parts of the business cycle, potentially triggered by variations in consumer demand, credit availability, or government policy changes.
To counteract these cycles, Keynesian economists propose utilizing fiscal and monetary policies to stabilize the economy and foster growth. Fiscal policy involves modifying government spending and taxation to influence economic activity levels. For instance, during a recession, increased government spending on infrastructure or social welfare can boost demand and spur growth. Conversely, in an economic expansion, reducing spending or raising taxes can temper the economy and guard against overheating.

Monetary policy employs interest rate adjustments and money supply changes to influence economic activities. During a recession, the central bank might lower interest rates to encourage borrowing and investment, concurrently increasing the money supply by purchasing government bonds or other assets to stimulate demand and encourage growth. Conversely, during expansion phases, raising interest rates and decreasing money supply can help curb inflation and prevent overheating.

Overall, the Keynesian strategy employs a blend of fiscal and monetary policies to stabilize and spur economic growth.

Friedrich Hayek, an Austrian economist, preferred an approach distinct from Keynes' to address bust and boom cycles. Hayek considered these cycles as stemming from money and credit manipulations by governments and central banks, with such interventions themselves fueling economic instability.

Hayek advocated for a free, non-interfered market system as the optimal means to address bust and boom cycles, discouraging fiscal or monetary manipulations by the government. He stressed allowing the market to self-regulate and adapt to shifting economic conditions.

He identified the business cycle as a result of "malinvestment," occurring when money and credit supplies are artificially expanded, leading to unsustainable overinvestment in certain sectors. When credit expansions cease, these malinvestments become evident, sparking an economic downturn.

For Hayek, preventing bust and boom cycles required maintaining a stable, fixed money supply while dissuading the central bank from manipulating money and credit supplies. He also advised against government deficit spending or stimulating demand via increased spending, viewing such actions as catalysts for further instability and malinvestment.

In essence, Hayek's approach to navigating bust and boom cycles pivoted on facilitating a free market without interference and stabilizing the money supply—a philosophy aligned with the Austrian School of economics.

Exercise 26.3. IS curve (0)
The following equations describe an economy:

$$C = 10 + 0.5Y$$

(Consumption function)

$$I = 190 - 20i$$

(Investment function)

$$G = 0$$

Derive the IS curve and represent it graphically.

Exercise 26.4. IS curve again
Given:

$$C = 100 + 0.75Y_d$$
$$I = 50 - 25i$$
$$T = G = 50$$

Where C is consumption, Y_d disposable income, I investment, T taxes, G government purchases, i interest rate. Derive the IS curve for the economy.

Exercise 26.5. IS curve (1)
Given behavioral equations:

$$C = 160 + 0.6Y_D$$
$$I = 150$$
$$G = 150$$
$$T = 100$$

Solve the following:

- Equilibrium GDP (Y)
- Disposable income (Y_D)
- Consumption spending (C)

Exercise 26.6. IS curve (2)
Using the above economy:

- Solve for equilibrium output. Compute total demand. Is it equal to production? Explain.
- Assume G is now 110. Solve for equilibrium output. Compute total demand. Is it equal to production? Explain.
- Assume G is 110, compute private plus public saving. Is it equal to investment? Explain.

Exercise 26.7. Automatic stabilizers
Assume fiscal policy variables G and T are independent of income. In reality, taxes depend on income and are higher when income's high. Examine how automatic tax responses reduce autonomous spending impacts.
Behavioral equations:

$$C = c_0 + c_1 Y_d$$
$$T = t_0 + t_1 Y$$
$$Y_d = Y - T$$

G and I remain constant, t_1 is between 0 and 1.

- Solve for equilibrium output.
- What is the multiplier? Does the economy respond more to changes in autonomous spending when t_1 is 0 or positive? Explain.
- Why is fiscal policy called an automatic stabilizer?

Exercise 26.8. IS-LM
Given the IS/LM model:
Consumption function:

$$C = 200 + 0.25(Y - T)$$

Investment function:

$$I = 150 + 0.25Y - 1000i$$

Fiscal policy:

$$G = 250$$
$$T = 200$$

Real money demand:

$$\left(\frac{M}{P}\right)^d = 2Y - 8000i$$

Real money supply:

$$\frac{M}{P} = 1600$$

Answer these:

- Derive the IS curve.
- Derive the LM curve.
- Solve for Y^*.
- Solve for i^*.
- Solve for C^*, I^*.
- If $\frac{M}{P} = 1840$, repeat parts (a) through (e). Comment on equilibrium variable movement relative to initial $\frac{M}{P} = 1600$.
- If $\frac{M}{P} = 1600$, $G = 400$, repeat parts (a) through (e). Comment on equilibrium variable movement relative to initial $G = 250$.

Exercise 26.9. Foreign multiplier
Given macro aggregates for an economy:

$$C = 60 + 0.8Y_d$$
$$I = 100 - 5i$$
$$i = 0.06$$
$$G = 76$$
$$T = 15$$
$$TR = 60$$
$$X = 70$$
$$M = 12 + 0.2Y$$

Where TR denotes transfer payments, X exports, M imports. TR affects disposable income $Y_d = Y - T + TR$.

- Derive the IS curve using the data.
- Calculate equilibrium income.
- Calculate the *foreign trade multplier* and compare it with the *multiplier* when ignoring foreign trade. Interpret foreign trade's impact on Keynesian policy.

Chapter 27

Aggregate supply and demand

This chapter discusses the AS-AD model.

Recommended videos:

- Macro: Unit 2.1 – Aggregate Demand
- Macro: Unit 2.2 – Short-Run Aggregate Supply

27.1 Economic shocks and consequences

The first lockdown on March 23, 2020 was a **shock**, see Figure 27.1.

Figure 27.1: Shock images

An economic shock is “an unexpected or unpredictable event that affects an economy, either positively or negatively. Technically, it is an unpredictable change in exogenous factors—that is, factors unexplained by an economic model—that may influence endogenous economic variables.” (Wikipedia, 2025e)

Exercise 27.1. Economic consequences
Open the link: Economic Impact of the Lockdown
List what you consider the most important economic effects of the first lockdown. Discuss your choice in class.

Solution

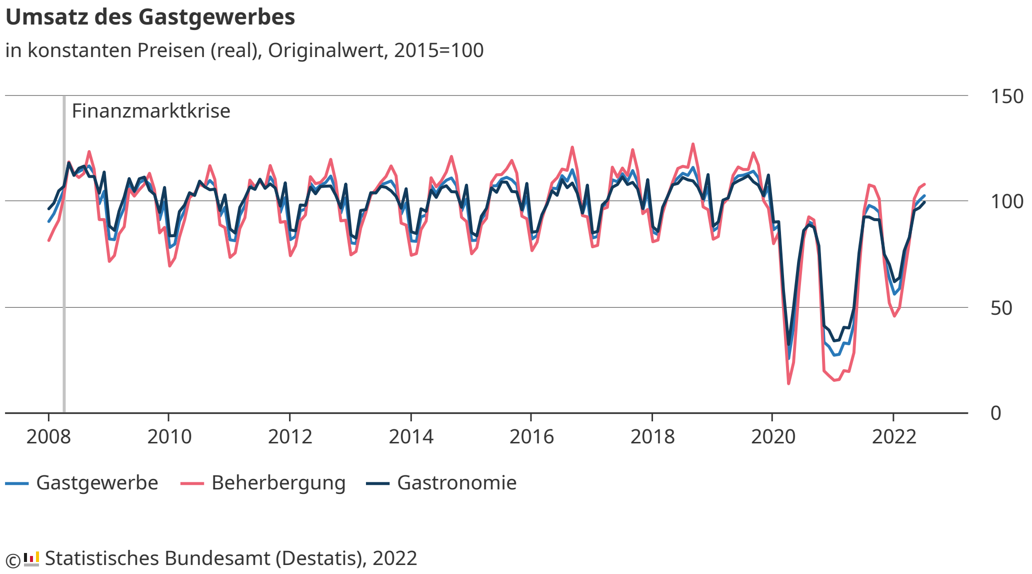
Various economic effects include:

- GDP decreased by 4.9%: Economic output declined significantly in 2020.
- Deficit ratio reached 4.2%: Second-highest government deficit since German unification.
- Air passengers decreased by 74.5%: Lowest figure post-German unification.
- Consumer spending by private households fell by 4.6%: Sharpest decline in decades.
- Online retail sales surged by 27.8% since pandemic outbreak.
- 0% population growth in Germany: First since 2011.
- Foreign university entrants reduced by 21% in 2020 academic year.
- Real wages decreased by 1.1%: Sharpest decline since record-keeping began.
- Traffic fatalities dropped by 10.7%: Lowest level in nearly 70 years.
- Electricity from renewable sources reached 47%: A record high.

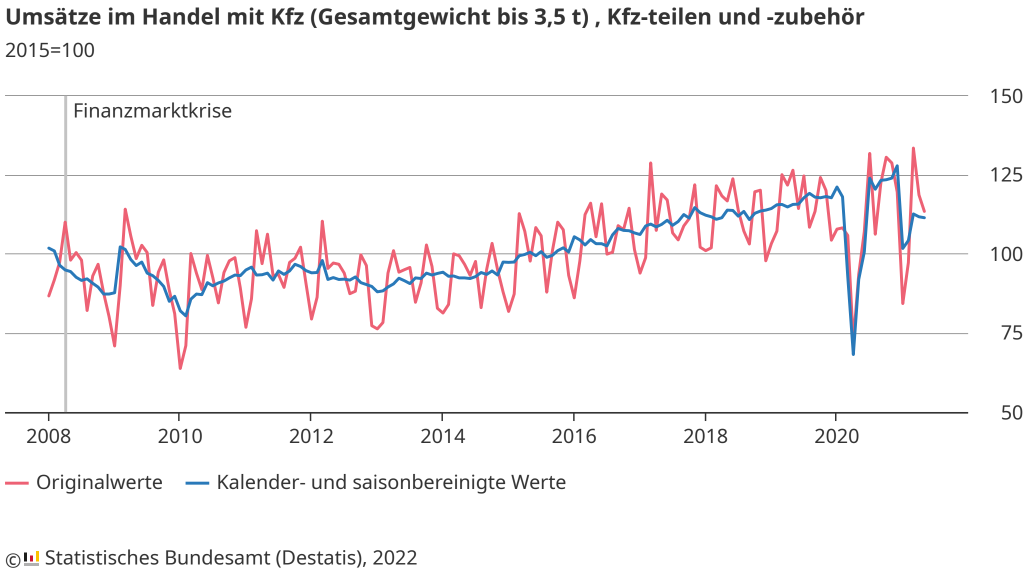
Source: Destatis (2021), also see here and here

Figure 27.2: Economic consequences

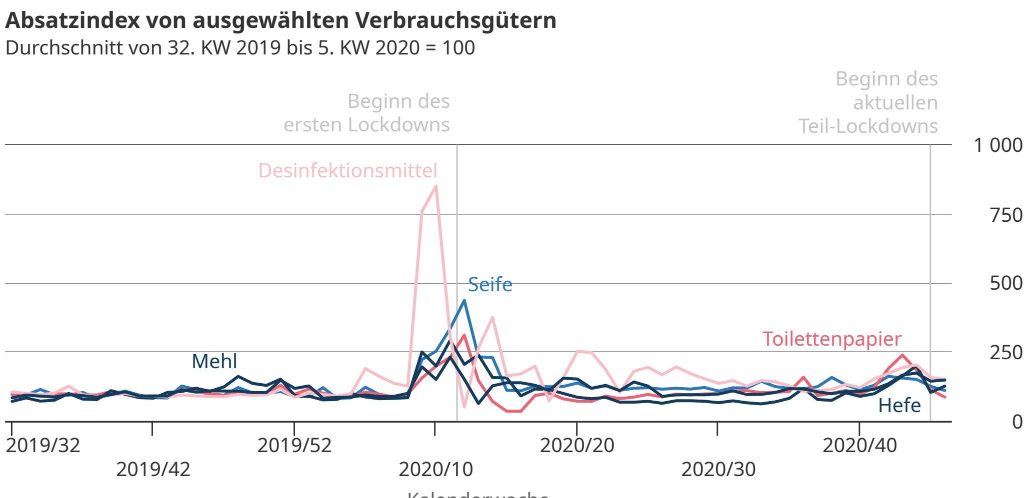
(a) a) Hospitality revenue and prices



(b) b) Car sales



(c) c) Consumer goods sales

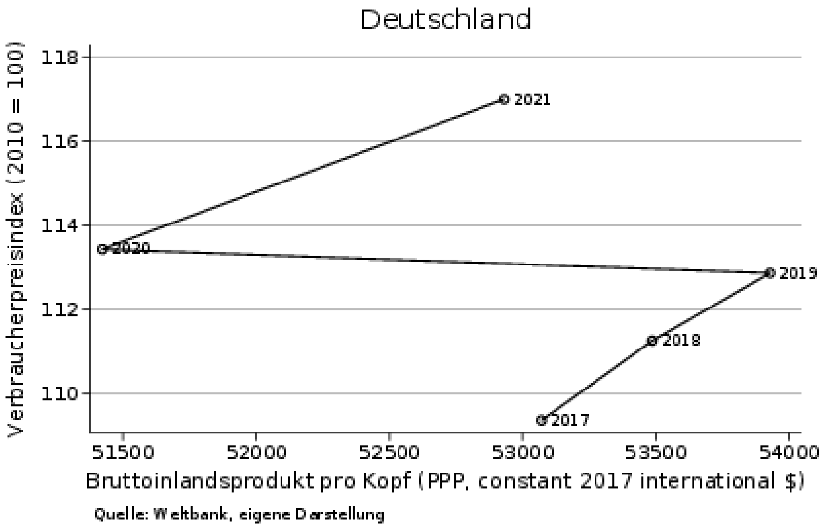


During the Corona crisis, various markets experienced significant shifts. Let us consider the Gross Domestic Product (GDP) and the price level over time in Figure 27.3.

The GDP indicates the total value of all goods and services produced as final goods and services within the national borders of an economy during one year, after deduction of all intermediate consumption.

The price level is an economic indicator that shows how many monetary units must be paid in an economy for the prices of certain goods and services in a basket of goods.

Figure 27.3: GDP and price levels



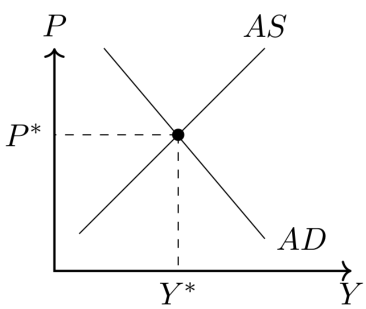
How did GDP fall while keeping price levels roughly constant?

- **Less buying/selling**: Value added decreased.
- **Why?** Was there less demand or fewer offerings? For example, were reduced hospitality sales due to fewer guests (demand down), business closures (supply down), or both?
- Apart from anecdotal evidence, assessing all effects empirically can be challenging. Typically, only price and successfully demanded quantity can be observed.
- Solution: Use theory: AS-AD Model.

General equilibrium

Supply and demand interplay determines market equilibrium, see Figure 27.4.

Figure 27.4: AS AD model



27.2 Aggregated Demand (AD)

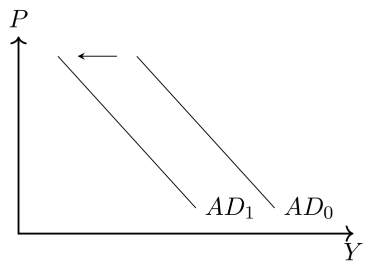
The AD curve represents total goods demand by everyone for goods and services as a function of the price level within a given period.

- Aggregate demand equals the sum of:
  - **Consumer goods demand** (C)
  - **Investments** (I)
  - **Government expenditure** (G)
  - **Net exports** (NEX = demand from abroad EX minus domestic demand for foreign goods IM)

$$Y^D = C + G + I + \underbrace{EX - IM}_{NEX}$$

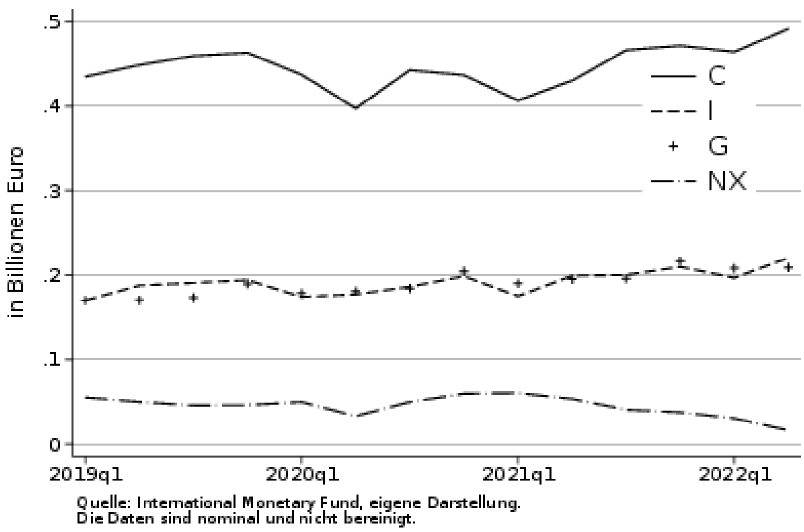
- As prices rise, demand falls (ceteris paribus).
- If Y^D decreases (and P remains constant), the curve shifts left, see Figure 27.5.

Figure 27.5: AS AD model shift



During the first lockdown in Germany, consumer goods demand and net exports fell. Government demand and demand for capital goods remained virtually unchanged.

Figure 27.6: AS AD model shift



27.3 Aggregated Supply (AS)

The AS curve depicts the value of goods suppliers can provide within a given period, depending on the price level. Supply usually increases with prices.

Supply usually increases with prices and the first lockdown certainly caused a leftward shift in the AS curve, see Figure 27.7.

Figure 27.7: AS AD model shift

Supply Factors:

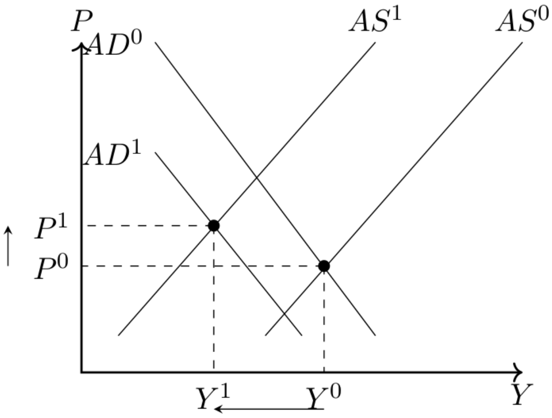
- **Resources** (input prices/availability): Impacted by pandemic, war, disasters, politics.
- **Regulation**: Impacted by taxes, laws, subsidies.
- **Labor costs**: Impacted by unions, minimum wages, taxes.
- **Productivity**: Impacted by technology, R&D, management practices.

Exercise 27.2. Effects of the lockdown on equilibrium
Discuss the lockdown's impact on aggregate supply and demand. Sketch AS and AD curve equilibrium in a price-output diagram before and after the lockdown. Reflect on actual changes stemming from GDP and the price level in Germany.

Solution

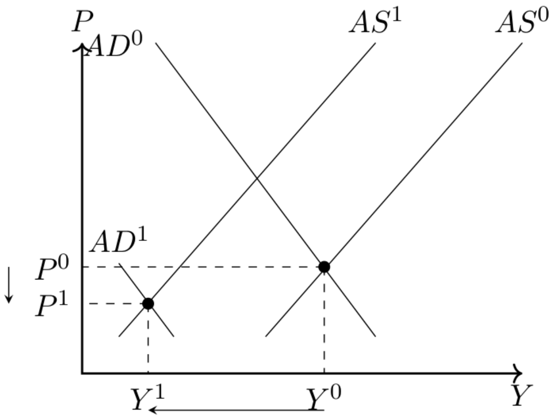
AS-curve: The lockdown likely raised production costs (precaution measures), disrupted resource availability, and restricted spatial mobility or events—all leading to a leftward shift in AS.
AD-curve: Diverse impacts complicate analysis: - Increased demand for select goods (hygiene products). - Government interventions elevated demand (VAT reduction, short-time allowance). - Simultaneously, demand for goods requiring spatial mobility or proximity declined sharply (tourism, automotive, restaurants).
Initially, demand-reducing effects may have dominated before stabilizing. Data suggests returning demand in Germany post-first lockdown.
Two potential scenarios:
Scenario 1: Slight demand decrease

Figure 27.8: Output decreases, while prices increase.



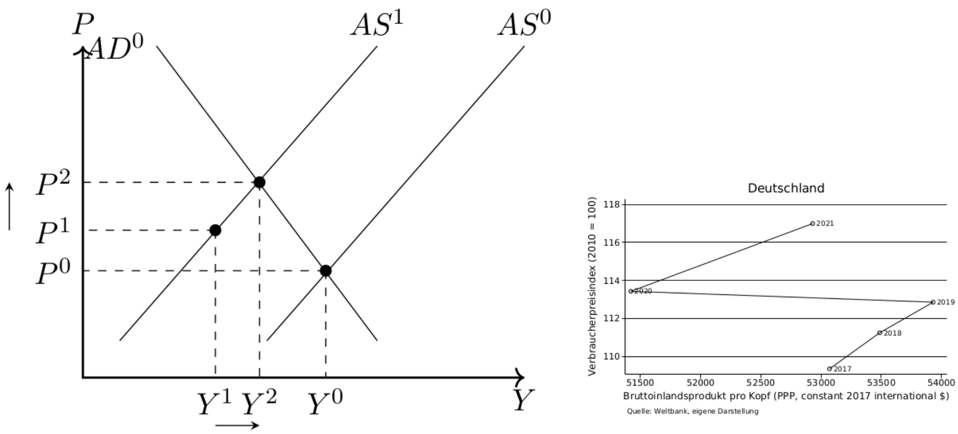
Scenario 2: Significant demand decrease

Figure 27.9: Output decreases, while prices decrease.



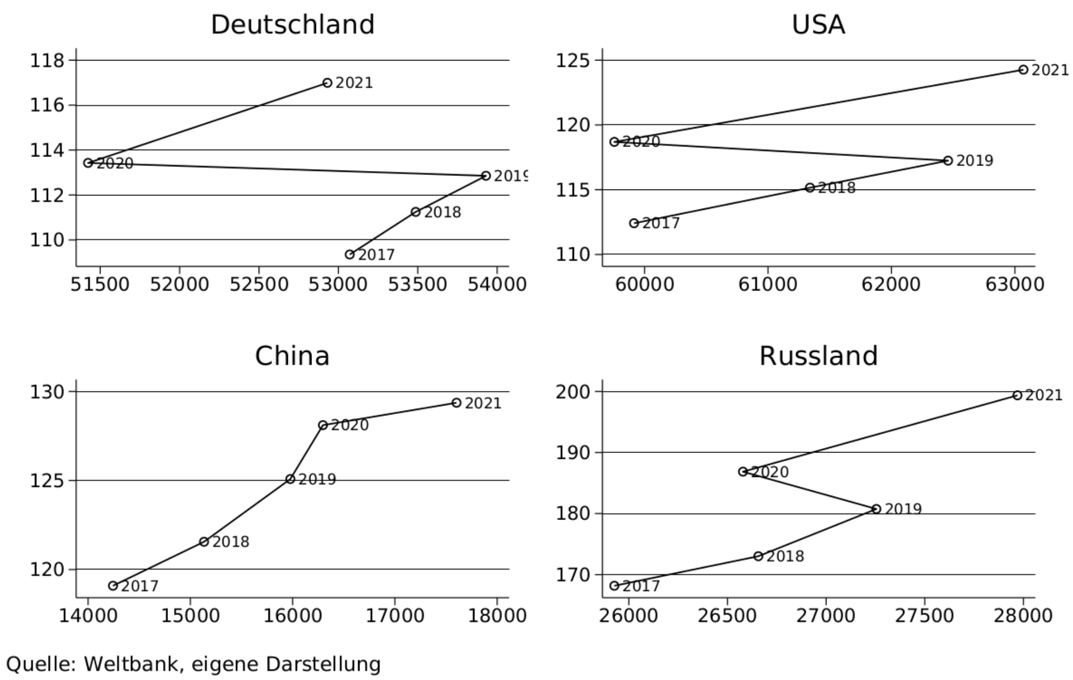
Actual case:
Figure 27.10 shows the theoretical visualization and the actual outcomes.

Figure 27.10: Covid times in Germany



27.4 International data

Figure 27.11: Global impact of Covid



Exercise 27.3. Comparing the financial crisis to the Corona crisis
Analyze the graphs below and read BMWK: Ist Krise gleich Krise?.
Discuss differences between the 2009 financial crisis and the 2020 Corona crisis from aggregate supply and demand perspectives. Additionally, please consider Figure 27.12. Address demand components in both crises. Using the AS-AD model, explain why general price increases were mostly absent during the financial crisis despite expansionary policies, whereas prices rose during the Corona crisis.

Figure 27.12: Impact of Covid

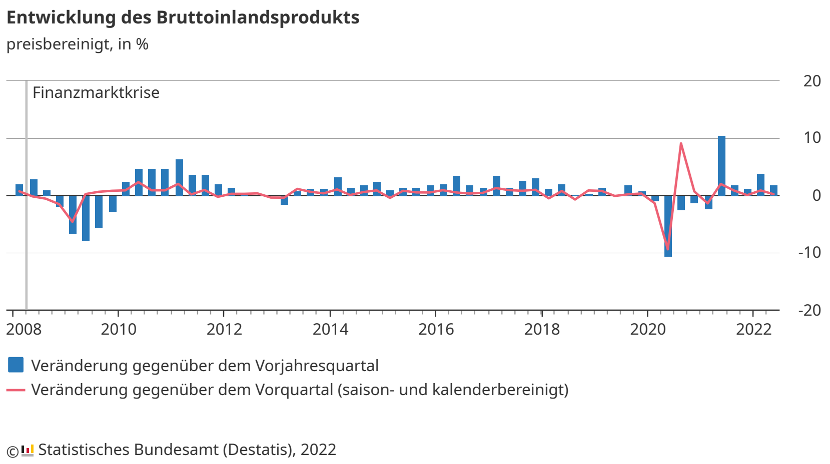


Figure 27.13: a)

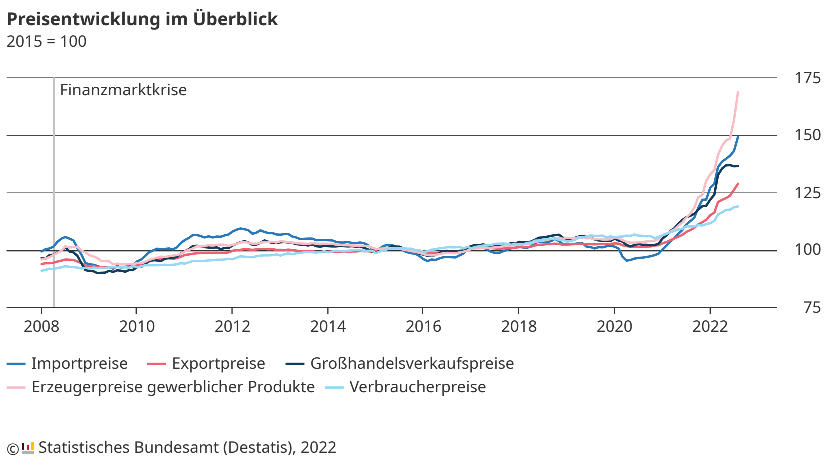


Figure 27.14: b)

27.5 Summary

- Aggregate demand arises from supply-demand interaction.
- Policymakers can counteract negative effects of exogenous shocks:
  - Increase government spending and cut taxes to enhance consumption, investment, exports.
  - Ease fears to bolster consumption and investment.
  - Reduce production costs and promote productivity (short-time allowance, subsidized loans, R&D support, etc.).

The AS-AD model aids understanding, anticipating, and analyzing macroeconomic ratios.

Chapter 28

Negative interest rates policy

28.1 Do negative interest rates work?

Learning objectives:

Students will be able to:

- Explain and evaluate the goals and the effectiveness of a monetary policy with negative interest rates policy (NIRP).
- What is the objective of ECB's NIRP?
- How can ECB's NIRP affect economies?
- What is special about a NIRP from a macroeconomic perspective?
- Can negative central bank policy rates translate into negative deposit rates or negative lending interest rates (the cost of debt for the borrower)?
- Determine whether lowering interest rates below zero can be an effective tool for stimulating aggregate demand.
- Identify the downsides of a NIRP.

Abstract: In recent years, the European Central Bank (ECB) and some other central banks engaged in a radical new policy experiment by setting negative policy rates. This course discusses whether negative interest rates policy (NIRP) is an effective tool for stimulating aggregate demand and keeping prices at a stable inflation rate of 2%. In particular, I present aggregate and bank-level data demonstrating that once the policy rate turns negative, the pass-through to deposit and lending rates seems to be limited, see Figure 28.1.

Figure 28.1: Comic on how negative interest rates work

Source: Source: app.hedgeye.com

Figure 28.2: Stamps and inflation

(a) a)

(b) b)

28.2 My stamps taught me a lot

I was about 10 years old and passionate about collecting stamps when I discovered an interesting stamp in an album I had received as a gift. Curious, I asked my father if I was now a double millionaire, see Figure 28.2. Unfortunately, he had to disappoint me.

Lesson 1: Currencies can disappear and their value over time is not fixed.

Starting in 2002, Deutsche Post refused to accept all my mint stamps denominated in pfennigs. The ECB stamp is denominated in pennies and cannot now be used.

Lesson 2: Currency reforms can occur without war or hyperinflation, and assets can be lost with them.

Even if the ECB stamp were still accepted, its current value in pennies would not be enough to mail a letter. Today, it costs 156 pfennigs, or 80 cents, to send a letter. That means sending a letter has become 40% more expensive.

Lesson 3: Inflation still exists.

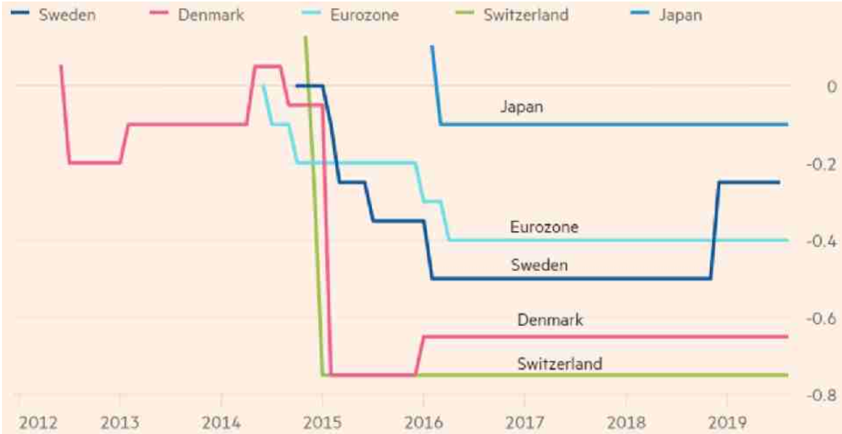
28.3 Put money in a bank account and get rich

My parents always told me: "Stop buying that many stamps. Better take your money to a bank and get rich from the deposit interest." I doubt, however, if this strategy is valid in times when the ECB and some other central banks set negative key interest rates, see Figure 28.3. Negative interest rate policies were long considered unthinkable because economists believed in the so-called *Zero Lower Bound (ZLB)*. This refers to the notion that a NIRP is ineffective because private banks cannot charge negative deposit rates; otherwise, people would withdraw their cash and keep it privately. As some have recently learned, there are indeed some banks that have charged negative interest rates on customer deposits without any bank runs.

It must be noted, however, that commercial banks charge negative interest rates only on a small scale. Most banks charge negative interest rates only on part of the deposited assets, only for companies, or only for (short-term) assets above a certain amount. According to a survey of Verivox, as of June 7, 2022:

- 451 banks have published negative interest rates for retail customers on their websites or in their online price lists.
- 23 banks charge fees for the usually free overnight deposit accounts, creating a de facto negative interest rate.

Figure 28.3: Five negative central bank policy rates



Source: Refinitiv, FT

- According to media reports, some banks and savings banks charge negative interest rates but do not publish them online.

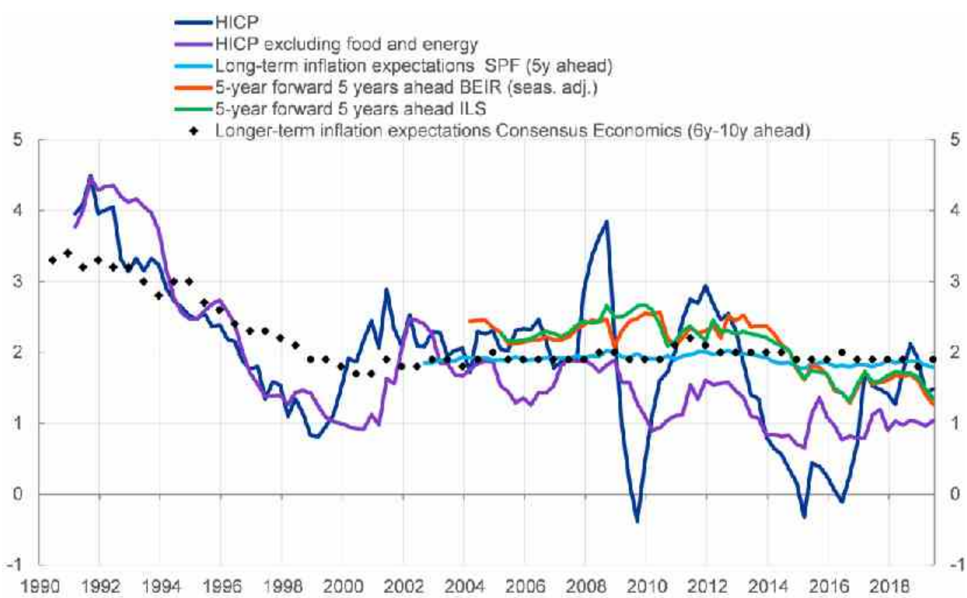
28.4 European Central Bank

28.4.1 Objective

The primary objective of the European Central Bank (ECB) is to maintain price stability within the Eurozone, specifically an inflation rate of under 2%. In particular, the goal is to achieve "a year-on-year increase in the Harmonised Index of Consumer Prices (HICP) for the euro area of below 2%" (see: ECB). Moreover, the ECB "shall support the general economic policies in the Union" (see Article 127(1) TFEU).

In Figure 28.4, I present inflation rates and inflation expectations from 1990 onwards. The figure shows that the inflation rate has circulated more or less around 2%, despite the Eurozone experiencing serious economic turbulence over the last decades. Thus, we can say that the ECB has been successful in achieving its main objective.

Figure 28.4: Euro area HICP inflation and inflation expectations



Source: ECB, Consensus Economics, Thomson Reuters, ECB calculations.

28.4.2 Monetary policy instruments

In recent years, the ECB has deployed an innovative, multi-pronged approach in designing its policy stance. In summary, the current policy mix includes four elements: (i) pushing the policy rate into negative territory, (ii) forward guidance on the future policy path, (iii) the asset purchase programs, and (iv) the targeted longer-term refinancing operations (TLTROs). Importantly, these measures work as a package, with significant complementarities across the different instruments. However, we do not aim to discuss these instruments here. Instead, we focus on the most recognized instrument, that is, the central bank interest/policy rate (CBPR).

28.4.3 Central bank interest/policy rate (CBPR)

When people talk about the **central bank interest/policy rate (CBPR)**, they usually refer to the deposit facility rate, which is one of the three interest rates the ECB sets every six weeks. This rate defines the interest banks receive for depositing money with the central bank overnight.

28.4.3.1 The textbook economics of the CBPR

All major introductory macroeconomic textbooks assume that investments increase when interest rates decrease, and vice versa. This *investment function* is illustrated in Figure 28.5. An increase in investments transmits into higher aggregate demand and output through the IS curve, as illustrated in macroeconomic textbooks. It doesn't require a formal model to understand that higher aggregate demand and output yield higher prices.

However, most textbooks refrain from discussing how the investment function behaves when interest rates approach zero or even become negative. The reason is that NIRP was long considered unthinkable, as highlighted by a quote from Warren Buffet:

> "What's happened with interest rates is really extraordinary. I mean, you can go back and read everything, Keynes, Adam Smith, Ricardo, Galbraith, Paul Samuelson, or you name. You won't see a word in my view anything I've ever seen about sustained negative interest rates. I mean, we are doing something the world hasn't seen." Warren Buffet in a CNBC interview, 2016.

Instead, the so-called **Zero Lower Bound (ZLB)** was dominant. It posits that a short-term nominal interest rate of zero causes a liquidity trap and limits the capacity of central banks to stimulate economic growth. The main argument is that it is difficult to encourage investors to deposit money at zero or negative interest rates. Thus, economist thought that central banks will not reduce interest rates below this bound. As already mentioned, they were wrong.

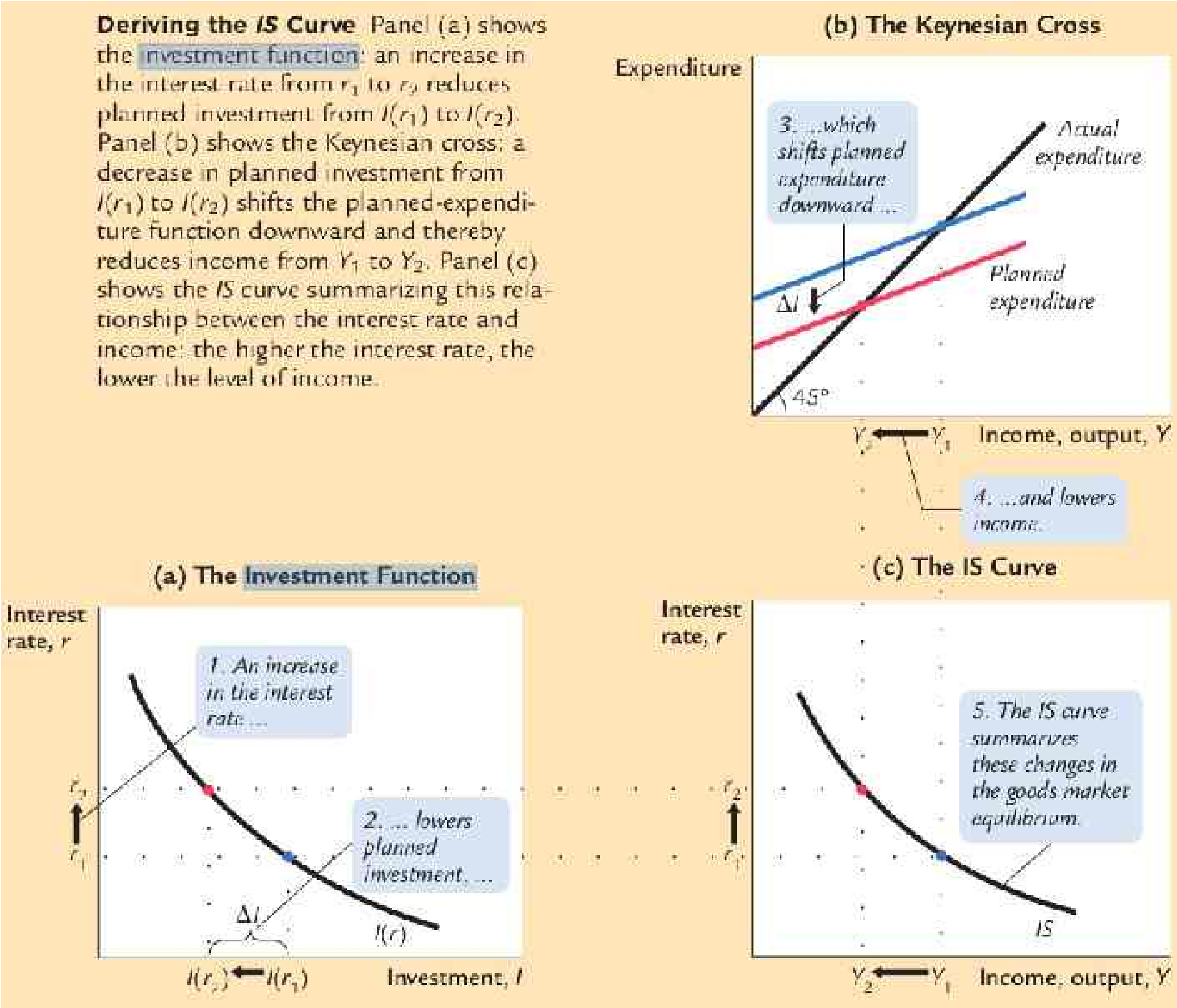
We should re-investigate the investment function. As NIRP exists, we should discuss whether NIRP is an effective tool for stimulating investments and increase prices.

Basically, four ways exist in which NIRP can increase investments:

- Banks can lend more to households and companies, rather than holding on to cash, which has now become costly.
- Businesses can invest more, as funding investments is now cheaper.
- Households could save less or borrow to spend more.
- Demand for the currency could fall, leading to a depreciation of the currency, an increase in the price of imported goods, and growing demand for the country's exports, which are now cheaper for foreign buyers.

If we abstract from the fourth way, the effectiveness of NIRP hinges on whether the policy rates pass through to deposit and lending rates. In the next section, I will present the work of Eggertsson et al. (2017) to answer that question. This was one of the few studies available at the time of writing these notes, see Figure 28.6.

Figure 28.5: The investment function and and the IS curve when interest rate is zero



Source: G. N. Mankiw (2010, p. 299)

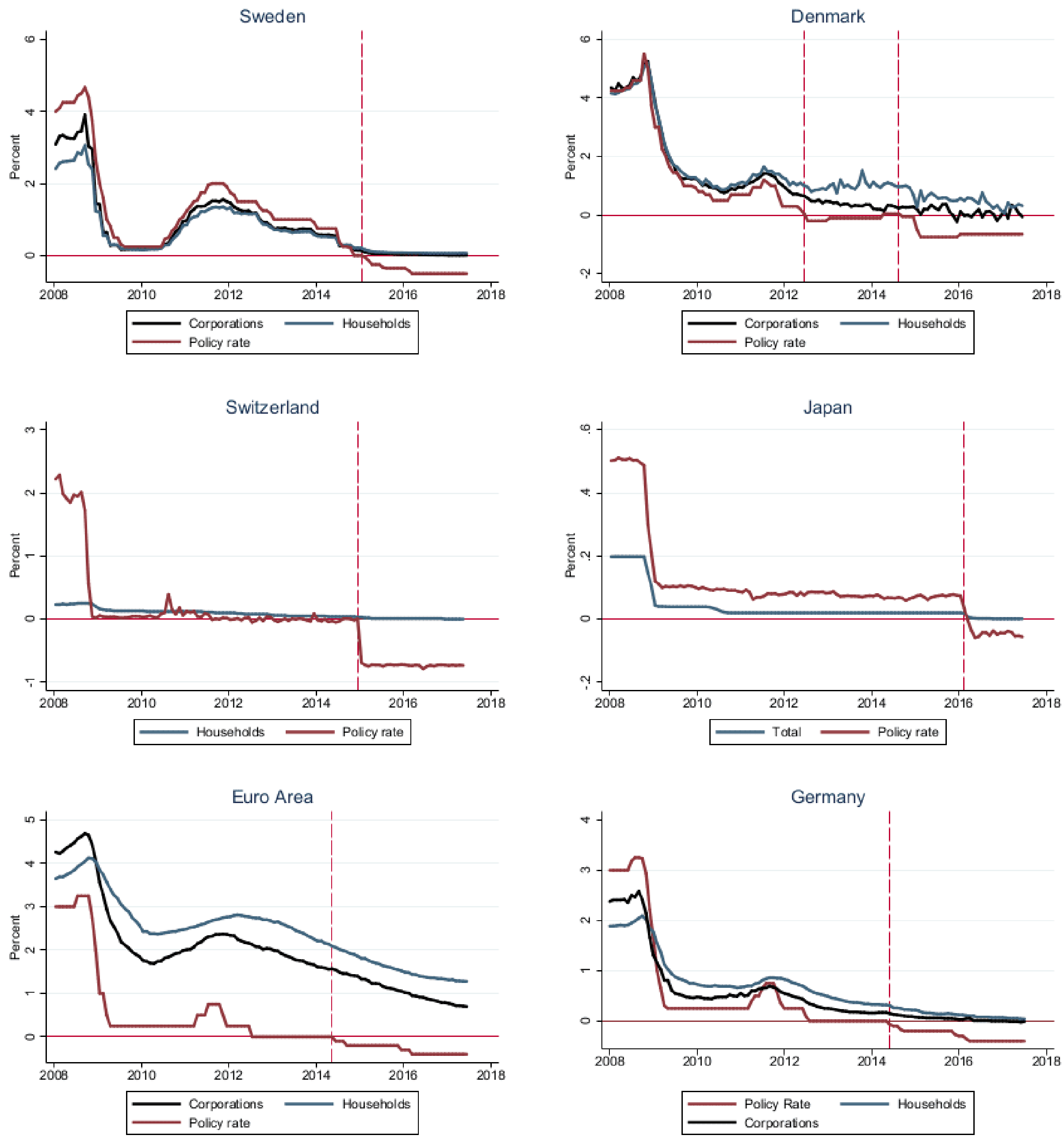
Figure 28.6: Research on NIRP is a growing but underdeveloped literature strand

Source: investmentnews.com

28.5 Limited pass-through to deposit rates

In Figure 28.7, I plot aggregate deposit rates for six economic areas where the policy rate is negative. The red vertical lines mark the month in which policy rates became negative. The Swedish central bank lowered its key policy rate below zero in February 2015. Deposit rates, which in Sweden are usually below the policy rate, did not follow the central bank rate into negative territory. Instead, deposit rates for both households and firms remain stuck at, or just above, zero. A similar picture emerges for Denmark, which crossed the ZLB twice. In both Sweden and Denmark, the negative policy rate has not been transmitted to deposit rates.

Figure 28.7: Aggregate deposit and policy rates



Source: Eggertsson et al. (2017)

The deposit rates in Switzerland and Japan were already very low for some time when the ZLB was crossed. However, even then the other rates did not follow the policy rate into negative territory.

The ECB hit the ZLB in June 2014. Aggregate deposit rates in the Euro Area are high and thus have more room to fall before reaching the zero lower bound. Moreover, the deposit rate does not normally follow the policy rate as closely as in other cases. One reason for this is the heterogeneity of the Euro Area. Focusing on Germany, a similar pattern emerges; that is, despite negative policy rates, the deposit rate appears bounded by zero.

Limited pass-through to deposit rates: Overall, the presented aggregate evidence indicates that the impact of policy rates on deposit rates was limited and strongly suggests a lower bound on deposit rates.

28.6 Limited pass-through to lending rates

In the relevant figure, I plot lending rates for the six economic areas with negative policy rates. While lending rates usually closely follow the policy rate, a disconnect appears once the policy rate breaks the ZLB. Lending rates in Sweden, Denmark, and Switzerland seem less sensitive to the respective policy rates once they become negative.

The Euro Area is somewhat of an outlier, as lending rates have appeared to decrease. This is not surprising in light of the higher-than-zero deposit rates documented above. Again, in the case of Germany, where the zero lower bound on the deposit rate is binding, lending rates appear less responsive.

To further investigate the behavior of banks regarding lending rates, I present daily bank-level data for thirteen Swedish credit institutions. The analysis shows that while there is some initial reduction in lending rates, most rates increase again shortly thereafter when the policy rate is negative. This indicates that the total impact on lending rates seems limited. Moreover, there is substantial dispersion, with several banks maintaining their lending rates unchanged despite repeated interest rate reductions below zero.

Limited pass-through to lending rates: The impact of policy rates on lending rates seems limited once the ZLB has passed. Moreover, the dispersion of lending rates within territories increased when the policy rate turned negative, and some banks even increased (!) their lending rates when the policy rate was negative.

28.7 Does NIRP work?

Overall, there is a lack of research evaluating the empirical impact of NIRP. Considering the fact that NIRP is a relatively new phenomenon, this is not surprising. Additionally, the NIRP is hard to evaluate as there is no counterfactual, and the policy rate instrument is just one of many monetary instruments used by the ECB in recent years. Thus, it is difficult to establish an empirical identification strategy that allows for a sort of ceteris paribus interpretation.

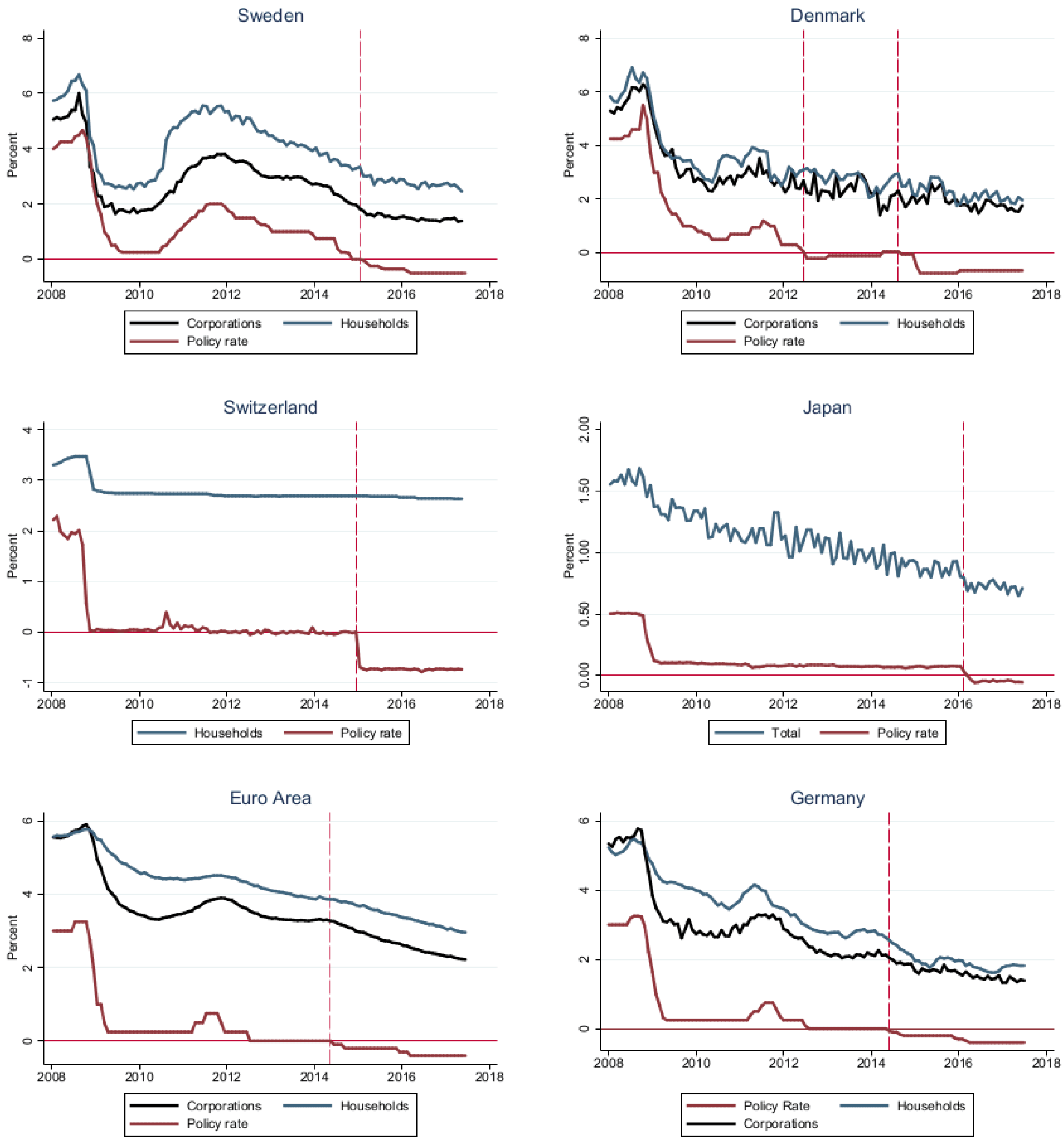
The ECB faced heavy criticism for the NIRP. While I cannot list all points of skepticism, I would like to mention some reasonable ones here:

- Private banks cannot transmit negative interest rates to their customers. This reduces the profitability of private banks, which may subsequently raise lending rates to preserve their interest margin. We saw this in Sweden, where banks increased rates for mortgages and loans to maintain profitability. This undermines policy effectiveness.
- If lending rates become very low, more risky investments get financed, introducing economic uncertainties to the market.
- Finally, a NIRP may harm the reputation of the Euro as people may flee into other (financial) assets or alternative currencies like Bitcoin.

Exercise 28.1. Sparkassen CEO criticizes the ECB policy
Printed below is an open letter from the Sparkassen-CEO Helmut Schleweis to the ECB president Mario Draghi, published in BILD Zeitung a week ago, see Figure 28.9. Read it and try to answer or discuss the following questions:

- Name the main objective of the ECB.

Figure 28.8: Aggregate lending and policy rates



Source: Eggertsson et al. (2017)

- Discuss what Mr. Schleweis wants the ECB to focus on.
- Comment on the following statement: "Anyone who invests money with you must even pay something." In particular, discuss who 'invests' money in the ECB.
- High interest rates are usually good for those who have money and bad for those who want to borrow money, right? Moreover, according to Mr. Schleweis, those who have money can flee 'into real estate with their money' in cases where interest rates are low. With that in mind, doesn't it seem that those who have money always win?
- The ECB set negative interest rates primarily to increase aggregate demand and prices. Discuss whether Europe would 'move closer' or if some states would 'reduce their debts' faster with high interest rates and deflation.

Figure 28.9: Headline Bild

Source: Bild Zeitung (15.08.2019)

Dear Mario Draghi,

First and foremost, allow us to state that we have great respect for the difficult task you face in keeping the Euro stable and Europe united.

However, what you are doing is wrong. For years, you have been throwing more and more money at the market. You have abolished the interest rate. And you have loaned money in unimaginable amounts to highly indebted states.

By doing this, you are gradually changing Europe, Germany, and the lives of millions of people – not for the better, but, in the long term, for the worse. It no longer costs anything to take on debts. Saving money no longer generates interest. Anyone who invests money with you must even pay something.

You are thereby turning the rules of the economy upside down. People who are able are fleeing into real estate with their money – prices and rents are rising. The retirement provisions of millions are melting away. Social insurances, pension funds, and foundations are losing significant amounts of money every day, losing their capacities. For years, we have taught Germany's children that saving money makes sense, as one should provide for bad times during crises. You are undermining that culture. All of this cannot end well in the long term.

And what is it all for? Have European states in crisis used the bought time to reduce their debts? Has Europe moved closer together? Your monetary policy has achieved none of this.

If one is in a dead-end street, one should not increase the speed. It is time to turn around – step by step. Now!

Best wishes, Helmut Schleweis

Part VI

MONETARY INTERNATIONAL ECONOMICS

Chapter 29

Currencies

Learning objectives:

Students will be able to:

- Interpret exchange rates and explain how their fluctuations affect the relative prices of goods in different countries.
- Predict how changes in exchange rates can impact business decisions and national economies.
- Understand the relationship between interest rates and inflation in open economies.
- Explain the concepts of interest rate parity and purchasing power parity.
- Analyze and evaluate trade balances.

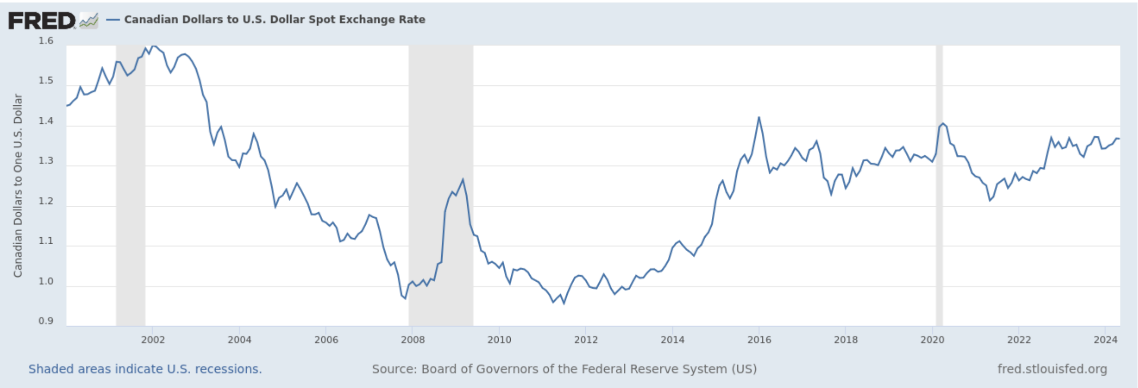
29.1 Introduction

An exchange rate indicates the value of one currency in relation to another. Exchange rate fluctuations have a significant impact on the revenues, costs, and profits of businesses; they affect how much you can afford to spend and can even influence job security.

Please work on the questions posed in Exercise 29.1 and Exercise 29.2. They are designed to motivate an introduction the topic.

Exercise 29.1. Exchange rates over time

Figure 29.1: Canadian Dollars to U.S. Dollar Exchange Rate



a) As can be seen in Figure 29.1, 1 United States Dollar (USD) equals about 1.38 Canadian Dollar (CAD) today. Since January 2002, has the USD depreciated (lost value) or appreciated (gained value) against the CAD? Explain your decision.

Solution

a) To determine whether the USD has depreciated or appreciated against the CAD since January 2002, we need to compare the current exchange rate to the rate from January 2002. The exchange rate in January 2002 was about

$$1\text{USD} = 1.6\text{CAD}.$$

The exchange rate in January 2024 is about

$$1\text{USD} = 1.38\text{CAD}.$$

That means, if you convert 1 USD in 2024, you get less CAD as compared to converting 1 USD in January 2002. In other words, it takes less CAD in 2024 to get 1 USD compared to the year 2002. Thus, the USD has *depreciated* against the CAD. In turn, the CAD has *appreciated*.

b) Assume that in January 2002, you exchanged a total of 2000 USD to Canadian Dollars (CAD) at a rate of 1.6 CAD per USD. Calculate how much that amount is worth today in USD.

Solution

b) Having exchanged 2000 CAD into USD in 2002 at an exchange rate of $ 1 USD = 1.6 CAD$ leaves you with

$$2000\ \text{USD} \cdot 1.6 \frac{\text{CAD}}{\text{USD}} = 3200\, \text{CAD}.$$

If you convert these 3200 CAD to USD in 2024 at an exchange rate of USD $=$ 1.38CAD you end up with

$$3200\text{CAD} \cdot \frac{1}{1.38} \frac{\text{USD}}{\text{CAD}} \approx 2318.84\ \text{USD}.$$

This means that you end up with USD 318.84 more, which corresponds to an increase of around 15.9%. The reason for this gain is that you have invested in a currency that has appreciated. Therefore, holding a currency can be considered a form of investment.

c) Suppose you have 1000 USD today, that is January 2024, and you plan to invest it in a Canadian fund that assures you a 2% annual interest rate.

i) Calculate how much USD you'll have after one year if the exchange rate remains on its current level of 1.38 CAD per USD.
ii) Calculate how much USD you'll have after one year if the exchange rate slightly chances to 1.42 CAD per USD.

Solution

c) First, you convert your USD to CAD in January 2024:

$$1000\ \text{USD} \cdot 1.38 \frac{\text{CAD}}{\text{USD}} = 1380\, \text{CAD}.$$

Then, you invest the CAD receiving 2% of interest after 1 year:

$$1380\text{CAD} \cdot 1.02 = 1407.6\ \text{CAD}.$$

Finally, you convert the CAD back to USD

i) at the rate 1.38 CAD per USD:

$$1407.6\ \text{CAD} \cdot \frac{1}{1.38} \frac{\text{USD}}{\text{CAD}} = 1020\ \text{USD}.$$

ii) at the rate 1.42 CAD per USD:

$$1407.6\ \text{CAD} \cdot \frac{1}{1.42} \frac{\text{USD}}{\text{CAD}} \approx 991.27\ \text{USD}.$$

This means that if you expect the exchange rate to remain unchanged, the Canadian fund could be a reasonable investment, offering a 2% return. However, if you anticipate that the CAD will depreciate by more than 2%, it would not be a profitable investment.

Exercise 29.2. Our relations are not good

Figure 29.2: Trump doubles metal tariffs on Turkey by 20%

Source: Twitter

Why is Trump implicitly expressing concerns about the weak Lira and the strong Dollar? Would he prefer a "strong" Turkish Lira and a "weak" Dollar? What factors actually contribute to his satisfaction? Can you understand the logic behind President Trump's decision to double metal tariffs in response to the decline of the Turkish Lira (see Figure 29.2)? Discuss.

29.2 Exchange rates

The most important economic indicators frequently discussed in the media and politics are Gross Domestic Product (GDP)[1], the policy rate[2], and the inflation rate[3]. These measures are designed to explain the functioning of economic markets and guide policymakers. However, the exchange rate is used less frequently in political and public debates, which I believe is a significant oversight for several reasons.

Firstly, similar to the aforementioned measures, exchange rate movements have a substantial impact on both markets and individuals. Moreover, the exchange rate serves as an accurate measure that reflects real market movements more quickly than most other indicators. Overall, a solid understanding of

[1] The total value added of a country in a given period

[2] The interest rate set by a central bank that influences the lending and borrowing rates of commercial banks to control inflation, manage employment levels, and stabilize the currency

[3] The percentage increase in the general price level of goods and services in an economy over a given period

exchange rates is crucial for making informed decisions, managing financial risks, optimizing operations, and strategically positioning companies in the global marketplace.

Before I explain this in greater detail, let me share my explanations for why the exchange rate is relatively unnoticed in public debates:

- **Complexity of interpretation:** It is comparatively difficult to interpret. GDP should be rising, while the inflation and policy rates should ideally be low. In contrast, the exchange rate is not so straightforward because there isn't a universally optimal exchange rate that everyone hopes for. The ideal rate depends on many factors, such as whether you want to buy goods from abroad or sell them to the rest of the world. Different stakeholders and investors will have varying preferences about the exchange rate. Many people, especially politicians, avoid the complexities of "it depends" arguments because it is challenging to make convincing cases based on intricate relationships.
- **Volatility:** The exchange rate is comparatively volatile, and its changes are difficult to predict.
- **Multiple exchange rates:** There isn't just one exchange rate; there are many, as any currency can be exchanged for any other currency. This means that a country's exchange rate may rise against currency A but fall against currency B.
- **Limited political influence:** The power of politics to directly and measurably influence a country's exchange rate is limited.
- **Understanding requirements:** The impact of exchange rate movements on our lives requires a solid understanding of economic markets, which many people lack.

While I cannot change the factors that contribute to the limited discussion of exchange rates, I can work to help you make sense of this topic. Before discussing the importance of the exchange rate in Section 29.4, let's first define the rate:

Exchange Rate

The price of one currency in terms of another is called an exchange rate. Exchange rates allow us to compare the prices of goods and services across countries, determining a country's relative prices for exports and imports.

To define the rate more formally, suppose the Euro (€) is the home currency and Turkish Lira (₺) the foreign currency, then the exchange rate in direct quotation (Preisnotierung) is

$$E^{\text{€}}_{\text{₺}} = \frac{X\text{€}}{Y\text{₺}}$$

and the exchange rate in indirect quotation (Mengennotierung) is

$$E^{\text{₺}}_{\text{€}} = \frac{Y\text{₺}}{X\text{€}}.$$

Both rates contain the same information, but have different interpretations:

- $E^{\text{€}}_{\text{₺}}$ tells that we have to give X € to receive Y ₺, whereas
- $E^{\text{₺}}_{\text{€}}$ tells that we have to give Y ₺ to receive X €.

Alternative interpretations:

- $E^{\text{€}}_{\text{₺}}$ tells that we have to give $\frac{X}{Y}$€ to receive 1 ₺, whereas
- $E^{\text{₺}}_{\text{€}}$ tells that we have to give $\frac{Y}{X}$₺ to receive 1 €.

Appreciation / Depreciation

A currency can appreciate or depreciate relative to other currencies.

- If the € appreciates, $E^{\frac{€}{₺}}$ decreases and $E^{\frac{₺}{€}}$ increases.
- If the € depreciates, $E^{\frac{€}{₺}}$ increases and $E^{\frac{₺}{€}}$ decreases.

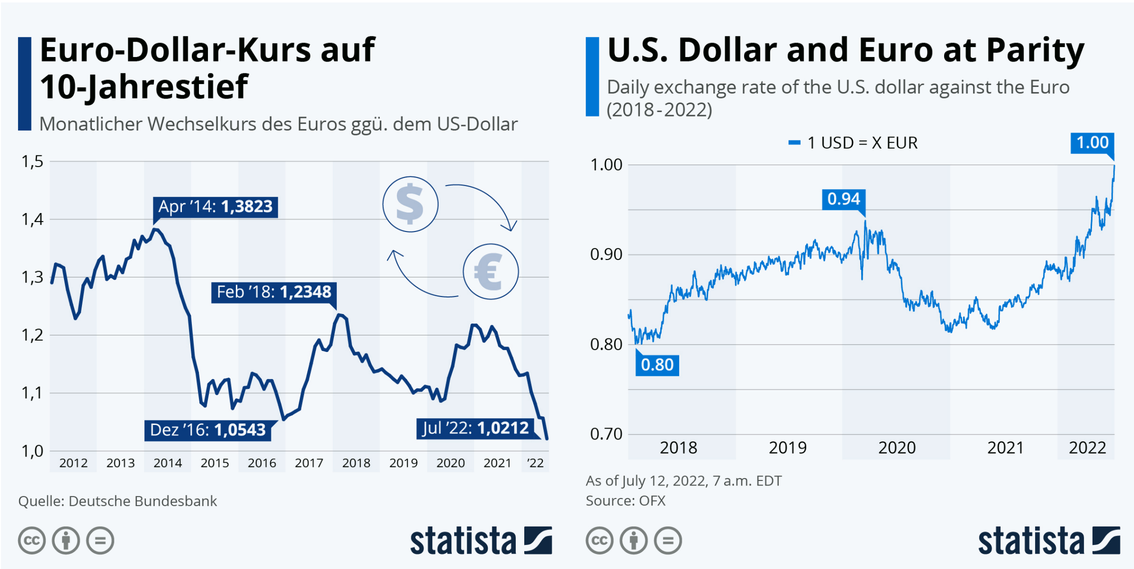
Conventions to talk about exchange rates:

- *Euro to Dollar* means $\frac{€}{\$}$ (This is especially confusing and it can also be understood the other way round but the first currency mentioned is *usually* interpreted as the numerator)
- *Euro per Dollar* means $\frac{€}{\$}$
- *Euro in Dollar* means $\frac{\$}{€}$
- *1 Euro costs X Dollars* means X $\frac{\$}{€}$

Exercise 29.3. Interpret the exchange rate representations shown in Figure 29.3. Consider the Euro as the home currency and write the most recent currency rates of the four figures in direct quotation.

Figure 29.3: Euro to Dollar

(a) (b)



(c) (d)

Source: Subfigures (c) and (d) are taken from Google.

Solution

The exchange rate in direct quotation is:

a)

$$E_{\frac{\text{€}}{\$}} = \frac{X\text{€}}{Y\$} = \frac{1\text{€}}{1,0212\$} = 0.97924011\frac{\text{€}}{\$}$$

Figure 29.3a is denoted in indirect quotation. From April 2014 to July 2022 the Euro depreciated as one Euro was equivalent to 1.3823 Dollar in April 2014 and only 1.0212 Dollar in July 2022.

b)

$$E_{\frac{\text{€}}{\$}} = \frac{X\text{€}}{Y\$} = 1$$

Figure 29.3b is denoted in direct quotation. From early 2018 to mid 2022 the Euro depreciated as one Dollar was equivalent to 0.80 Euro in early 2018 and 1.00 Euro in mid 2022.

c)

$$E_{\frac{\text{€}}{\$}} = \frac{X\text{€}}{Y\$} = \frac{1\text{€}}{1,1050\$} = 0.904977376\frac{\text{€}}{\$}$$

Figure 29.3c is denoted in indirect quotation. From the beginning of the graph somewhen 2019 till 9th of September 2024 the Euro depreciated as one Euro was equivalent to 1.1680 Dollar in 2019 and is now worth 1.1050 Dollar in July 2022.

d)
$$E^{\frac{€}{\$}} = \frac{X€}{Y\$} = \frac{1€}{1,0212\$} = 0.904731747\frac{€}{\$}$$

Figure 29.3d is denoted in indirect quotation. For example, from the 2nd of January 2021 to the 9th of September 2024 the Euro depreciated as one Euro was equivalent to 1.2011 Dollar in January 2021 and 1.1053 Dollar in July 2022.

Please note that Googles "EUR / USD" notation is misleading as it does not mean that the exchange rate is denoted in direct quotation, that is, $\frac{X€}{Y\$}$.

Exercise 29.4. Exchange currencies
Suppose 1 US Dollar (USD) is equivalent to 1.20 Euros (EUR).

a) Calculate the equivalent amount in Euros if a person exchanges 500 US Dollars.
b) If the exchange rate changes to $1.15\frac{USD}{EUR}$, recalculate the equivalent amount in Euros for the same 500 US Dollars.
c) If the exchange rate changes to $1.15\frac{USD}{EUR}$, has the Euro appreciated or depreciated?
d) A European tourist plans to spend 1,000 Euros during a trip to the United States. Calculate the equivalent amount in US Dollars at the exchange rate of $1.15\frac{EUR}{USD}$.

Solution

a) The equivalent amount in Euros for exchanging 500 US Dollars at the initial exchange rate of (1.20 , USD/EUR) is given by:

$$\text{Equivalent Euros} = \frac{500\,\text{USD}}{1.20\,\text{USD/EUR}}$$

b) If the exchange rate changes to (1.15 , USD/EUR), the new equivalent amount in Euros is:

$$\text{New Equivalent Euros} = \frac{500\,\text{USD}}{1.15\,\text{USD/EUR}}$$

c) The equivalent amount in US Dollars for spending 1,000 Euros at the initial exchange rate is:

$$\text{Equivalent USD} = 1,000\,\text{EUR} \times 1.20\,\text{USD/EUR}$$

d) If the European tourist exchanges their money at the changed rate of (1.15 , USD/EUR), the new equivalent amount in US Dollars is:

$$\text{New Equivalent USD} = 1,000\,\text{EUR} \times 1.15\,\text{USD/EUR}$$

29.3 Relative prices and exchange rates

After understanding the concept of exchange rates, let us consider how trade in goods between two countries operates when each country uses a different currency as its legal tender.

Let us consider a stylized example: Assume the home country produces beer and the foreign country produces wine. If you want to exchange a beer for wine, the relative price indicates the amount of beer you need to provide in order to receive a unit of wine (in direct quotation) or the quantity of wine you will receive for a unit of beer (in indirect quotation).

For example, a relative price of 1 means you can exchange 1 liter of beer for 1 liter of wine. However, if we assume that beer is measured in 500 ml cans and wine in 1-liter bottles, the relative price denoted with $P^{\frac{beer}{wine}}$ would be represented as:

$$P^{\frac{beer}{wine}} = \frac{\text{2 cans of beer}}{\text{1 bottle of wine}}.$$

This means you can exchange 2 cans of beer for one bottle of wine.

If the relative price increases, you will need to provide more beer to receive a bottle of wine. Conversely, if the relative price decreases, you will need to provide less beer to obtain a bottle of wine.

> **i Relative prices**
>
> Relative prices determine the relative price of commodities across countries. For example, an increase in the price of foreign commodities makes imported commodities relatively more expensive and home commodities relatively cheaper for buyers at home.

Relative prices are (directly) determined by exchange rates. To logically prove this statement, let us assume for simplicity an exchange rate of 1,

$$E^{\frac{₺}{€}} = E^{\frac{€}{₺}} = 1$$

and that a liter of beer costs 1 € at home and a wine costs 1 ₺ abroad. Thus, we can buy both a wine or a beer for 1 €. Due to the fact that we must pay the wine producer with ₺, we must convert the € beforehand. The process goes like visualized in Figure 29.4:

Figure 29.4: One wine per Euro

$$\boxed{\text{exchange } 1\ €} \longrightarrow \boxed{1€ \cdot 1\frac{₺}{€} = 1₺} \longrightarrow \boxed{\text{buy wine}} \longrightarrow \boxed{1₺ \cdot 1\frac{\text{wine}}{₺} = 1 \text{ wine}}$$

Now, assume that the € appreciates and the exchange rate becomes $E^{\frac{€}{₺}} = 0.5$ and $E^{\frac{₺}{€}} = 2$, respectively. Then, you receive more than one wine if we assume that the price of wine in ₺ remains unchanged. The process is visualized in Figure 29.5:

Figure 29.5: Two wine per Euro

$$\boxed{\text{exchange } 1\ €} \longrightarrow \boxed{1€ \cdot 2\frac{₺}{€} = 2₺} \longrightarrow \boxed{\text{buy wine}} \longrightarrow \boxed{2₺ \cdot 1\frac{\text{wine}}{₺} = 2 \text{ wine}}$$

That means, exchange rates determine the relative prices. If the home currency appreciates (depreciates), buying goods and services abroad becomes relative cheaper (more expensive).

Of course, if many people now buy wine and aim to convert € to ₺, this may impact the exchange rate and the price of wine. We come back to that later.

> **i Exchange rates and relative prices**
>
> The exchange rate determines the relative price of commodities across countries. For example, an appreciation of a currency makes commodities more expensive for foreign buyers and in turn makes foreign commodities cheaper for buyers at home.

29.4 The importance of exchange rates

Here is an incomplete list of arguments to emphasize the importance of exchange rates for economies, businesses, and individuals:

- **Import/export costs**: Exchange rate fluctuations determine the relative prices and hence affect the cost of importing goods and materials and the global demand for domestic products. An appreciation of the home currency makes imports relatively cheaper but exports more expensive for the rest of the world, while depreciation has the opposite effect.
- **Revenue conversion**: Multinational companies earn revenues in multiple currencies. Exchange rate changes can significantly impact the value of these revenues when converted back to the home currency, affecting overall profitability.
- **Foreign investments**: Companies investing in foreign assets or operations need to understand exchange rates to forecast returns accurately and manage exchange rate risk.
- **Risk management**: Knowledge of exchange rates enables businesses to hedge against currency risk using financial instruments like forwards, futures, options, and swaps. This is crucial for stabilizing cash flows and protecting profit margins.
- **Market competitiveness**: Exchange rates affect the relative cost competitiveness of goods and services in international markets. Companies need to understand these implications to price their products competitively and make strategic decisions about entering or exiting markets.
- **Macroeconomic insights**: Exchange rates are influenced by and also affect economic indicators such as inflation, interest rates, and economic growth. Understanding these relationships helps in making informed predictions about market conditions.
- **Contractual agreements**: Businesses engaged in international trade must understand exchange rates to negotiate and structure contracts effectively, determining terms such as the currency of payment and exchange rate clauses.
- **Government and Policy Understanding**: Exchange rates are often influenced by governmental and central bank policies. Understanding the dynamics between exchange rates and policy decisions is vital for anticipating regulatory changes and their potential impact on business operations.

29.5 Trump, relative prices, and trade policy

Let's return to Trump's Twitter message . Steel producers in the U.S. (and Donald Trump himself) are unhappy about a strong dollar (and a weak Turkish Lira) because it makes their products relatively expensive for Turkish buyers while making Turkish steel relatively cheap for U.S. consumers.

Trump had two options to address this issue: altering the exchange rates or adjusting the relative prices of goods between countries. Changing the exchange rate directly is a challenging task. Although buying or selling currencies on the foreign exchange market can influence exchange rates, the market is so large that the actions Trump could take as President would have minimal impact (see Section 29.6). Adjusting policy rates could influence exchange rates more effectively, as we will discuss in Chapter 30. However, the Federal Reserve, which sets policy rates and thus has an impact on interest rates, operates independently from political orders. Consequently, Trump's influence over their decisions is limited.

As a result, Trump chose to increase the price of foreign steel in the U.S. by introducing or raising tariffs. The approach works, American steel producing companies get protected from foreign competition and might sell more domestically. However, there many negative consequences that detoriate the overall welfare. Foremost, everybody in the U.S. must pay more for steel (and for products made with steel and aluminum). David Boaz, Executive Vice President of the Cato Institute, a libertarian think tank, highlights this issue in his response on Twitter (see Figure 29.6).

Figure 29.6: *Who wins in the end?*

Source: Twitter

To quantify the costs of Mr. Trumps's tariffs, let me quote the well-written article by Amiti et al. (2019) (p. 188-189):

> *"We find that by December 2018, import tariffs were costing US consumers and the firms that import foreign goods an additional $3.2 billion per month in added tax costs and another $1.4 billion per month in deadweight welfare (efficiency) losses. Tariffs have also changed the pricing behavior of US producers by protecting them from foreign competition and enabling them to raise prices and markups, and we estimate that the combined effects of input and output tariffs have raised the average price of US manufacturing by 1 percentage point, which compares with an annual average rate of producer price inflation from 1990 to 2018 of just over 2 percentage points. US tariffs and the foreign retaliatory tariffs also affect international supply chains, and we estimate that if the tariffs that were in place by the end of 2018 were to continue, approximately $165 billion of trade per year will continue to be redirected in order to avoid the tariffs. We also show that the rise in tariffs has reduced the variety of products available to consumers."*

In addition, it can be argued that increased tariffs might actually make the dollar stronger. If buyers stop purchasing steel from Turkey due to higher tariffs, they will need fewer Turkish lira and therefore will exchange fewer U.S. dollars for Turkish lira. This reduced demand for Turkish lira could lead to a stronger dollar.

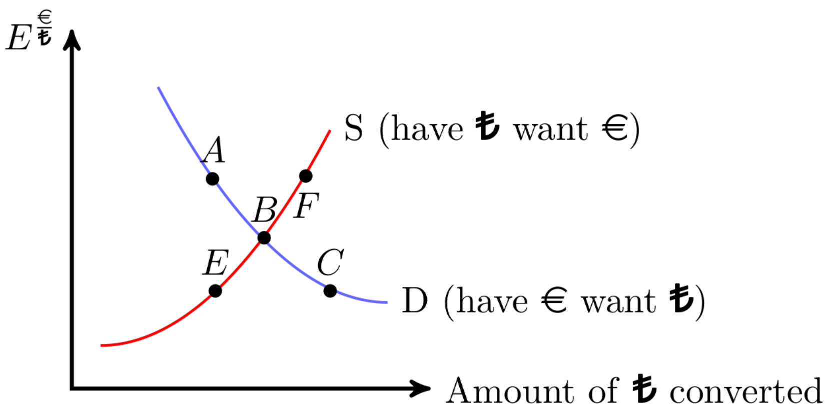
While raising tariffs and initiating trade disputes could be a strategy to gain political support and possibly get re-elected, there is a general consensus among economists that raising tariffs usually leads to economic losses and detrimental outcomes for all countries involved.

29.6 The FOREX

29.6.1 The market

In a market, individuals exchange goods and services, offering something to receive something else in return. In the FOREX (foreign exchange market), participants exchange currencies. Like all markets, the price here is influenced by the supply and demand dynamics of currencies.

Figure 29.7: Example of a foreign exchange market



- **When the Euro (€) is considered strong, the exchange rate** $E^{\frac{€}{₺}}$ is low:
  - At this lower exchange rate, there's a high demand for Turkish Lira (₺) (point C), but the supply of ₺ is scarce (point E).
  - Consequently, the Euro faces depreciation pressure, leading to an increase in the exchange rate $E^{\frac{€}{₺}} \uparrow$.
- **Conversely, when the Euro (€) is weak, the exchange rate** $E^{\frac{€}{₺}}$ is high:
  - With the exchange rate high, the demand for ₺ drops (point A), while its supply burgeons (point F).

  - As a result, the Euro is under appreciation pressure, causing the exchange rate to decrease $E^{\text{€}}_{\text{₺}} \downarrow$.

- **Point B represents the equilibrium exchange rate**, where the demand for ₺ meets its supply. At this juncture, holders of ₺ are unwilling to part with more, and similarly, Euro holders are not inclined to exchange more.

In 2022, the daily (!) traded volume of currencies averaged approximately $ 7,506 billion, as highlighted in Table 29.1.

Table 29.1: Daily turnover of global foreign exchange market from 2001 to 2022 (in billion U.S. dollars)

name	2001	2004	2007	2010	2013	2016	2019	2022
Total	1.239	1.934	3.324	3.973	5.357	5.066	6.581	7.506
USD	1.114	1.702	2.845	3.371	4.662	4.437	5.811	6.639
EUR	470	724	1.231	1.551	1.790	1.590	2.126	2.292
JPY	292	403	573	754	1.235	1.096	1.108	1.253
GBP	162	319	494	512	633	649	843	968
CNY	0	2	15	34	120	202	285	526
AUD	54	116	220	301	463	349	446	479
CAD	56	81	143	210	244	260	332	466
CHF	74	117	227	250	276	243	326	390
All others combined	170	251	568	786	1124	1223	1921	2093

Note: All others combined are: HKD, SGD, SEK, KRW, NOK, NZD, INR, MXN, TWD, ZAR, BRL, DKK, PLN, THB, ILS, IDR, CZK, AED, TRY, HUF, CLP, SAR, PHP, MYR.
Source: https://github.com/TheEconomist/big-mac-data (July 18, 2018).

29.6.2 Actors on the FOREX

As indicated in Figure 29.8, there are several major players involved in trading on the foreign exchange market. In particular, commercial banks, multinational corporations and non-bank financial institutions, such as investment funds, play an important role in trading and speculation. Central banks also play a crucial role as they intervene to stabilize their national currency and thus influence the direction of the market.

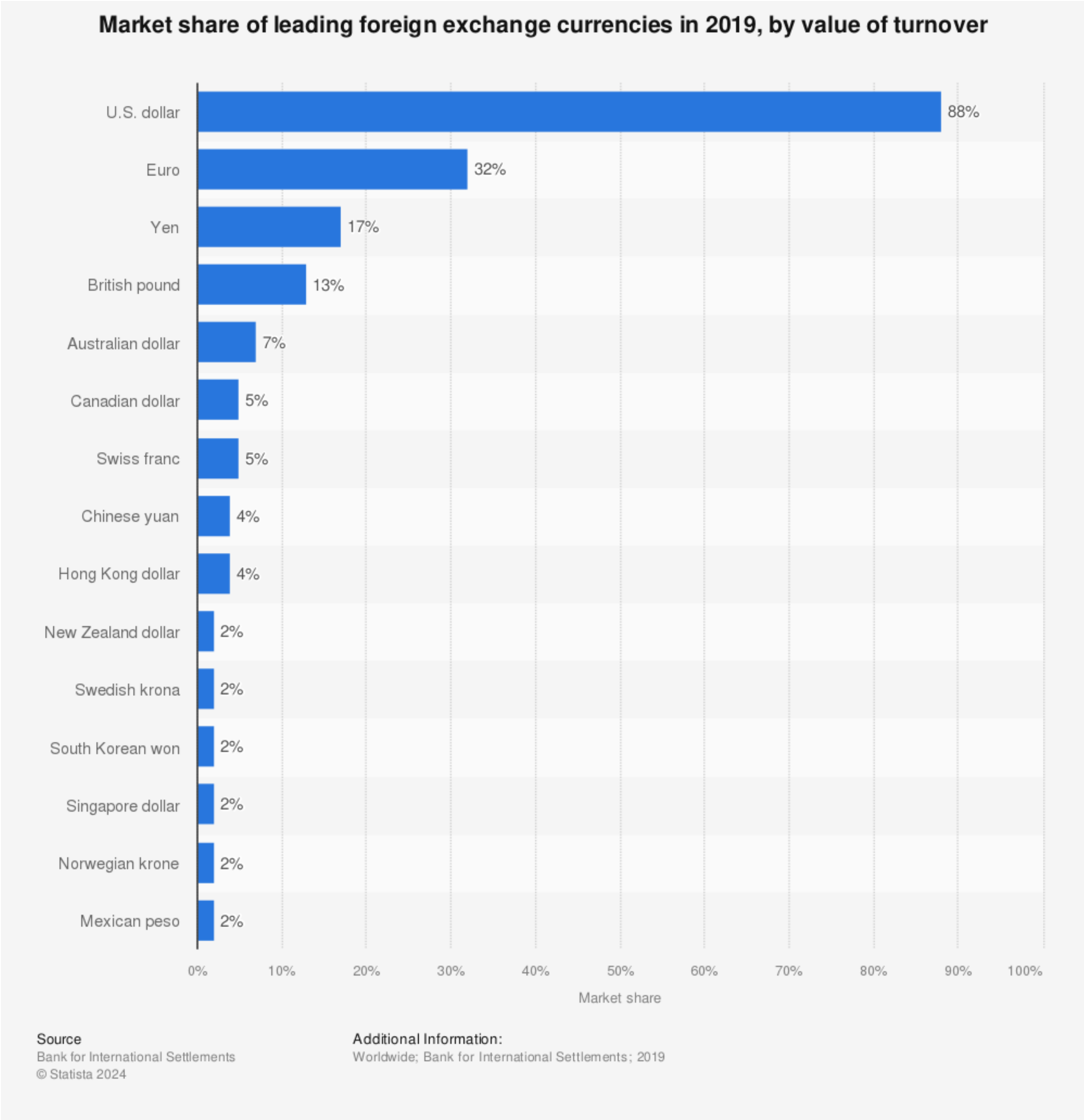
Figure 29.8: Players on the foreign exchange market

29.6.3 The vehicle currency

Instead of converting directly between two less common currencies, it's more efficient to use a broadly accepted and stable currency as a vehicle. That means, if you want to exchange currency A to B. You do not exchange currency A directly to B but you convert currency A first to the vehicle currency C and then from C to B.

As depicted in Figure 29.9, around 32% of all currency transactions included the Euro while a notable 88% involved the U.S. Dollar which makes the Dollar the standard vehicle currency. The Dollar acts as a medium in transactions between currencies that do not directly trade with high volume. This can reduce transaction costs and streamline the process.

Figure 29.9: Market share of leading foreign exchange currencies in 2019



29.7 Purchasing power parity assumption

The **P**urchasing **P**ower **P**arity (PPP) assumption is also know as the **law of one price**. It says that in competitive markets with zero transportation costs and no trade barriers, identical goods have the same price all over the world when expressed in terms of the same currency. The idea behind this is that if differences in prices exist, profits can be made through **international arbitrage**, that is, the process of buying a good cheap in one country and selling the good with a profit in another country. This process can quickly equalize real price differences across countries.

However, in the real world, prices differ substantially across countries (see the Big Mac Index in Table 29.2 and Exercise 29.5). The assumptions of the PPP do mostly not hold perfectly in reality: some goods and services are not trade-able, firms might have different degrees of market power across countries, and the transaction costs are not zero. Here are more reasons, why the PPP does not always apply, especially in the short run:

- Transportation costs are not zero. Shipping goods can be time consuming and expensive.
- Many goods and services, such as real estate or personal services, cannot be traded.
- International markets may be segmented due to regulatory barriers, tariffs and other trade restrictions.
- Countries have different consumption preferences. That means, the same basket of goods is not necessarily equally demanded. The willingness to pay for goods vary across countries often significantly.
- Countries impose different taxes and provide different subsidies on goods and services, which affects their prices and leads to deviations from PPPs.
- Short-term fluctuations in exchange rates may deviate from the values predicted by PPPs due to speculation, interest rate differentials and other factors.
- Differences in inflation rates between countries may lead to deviations from PPP, especially in the short run.
- The same product may be perceived differently in different countries due to brand names, quality differences or local customization, resulting in different prices.
- Regulations like warranty and product classifications are different and have an impact on the product and the willingness to pay for it.
- Political instability, war or economic sanctions can affect currency values and prices and lead to deviations from PPP.
- Prices of goods and services do not always adjust immediately to changes in the exchange rate, leading to short-term deviations from PPP.

Exercise 29.5. Big Mac Index
The differences of prices across countries can be illustrated with the Economist's *Big Mac Index*. It indicates the price of a Big Mac in different countries in terms of the US Dollar. Table 29.2 shows some countries with on average expensive and cheap Big Macs.

Table 29.2: The price of a Big Mac across countries

Country	Price
Switzerland	\$6.57 (6.50 CHF)
Sweden	\$5.83 (51.00 SEK)
United States	\$5.51 (5.51 USD)
Norway	\$5.22 (42 NOK)
Canada	\$5.08 (6.65 CAD)
Euro area	\$4.75 (4.56 EUR)
...	...
Egypt	\$1.75 (31.37 EGP)
Ukraine	\$1.91 (50 UAH)
Russia	\$2.09 (130 RUB)
Malaysia	\$2.10 (8.45 MYR)
Indonesia	\$2.19 (31,500 IDR)
Taiwan	\$2.27 (69 TWD)

Source: https://github.com/TheEconomist/big-mac-data (July 18, 2018).

a) Read Wikipedia's page on the Big Mac Index and discuss the *Big-Mac-Index* critically. Is it really a reasonable real-world measurement of purchasing power parity?
b) Compare the *Big-Mac-Index* to the *Mac-Index* (see: themacindex.com) looking for price differences of the *Mac mini M1 256GB*. Why are the price differences for Apple products so much smaller compared to McDonald's *Big Mac*? *In case the website offline, here is a snapshot of it.)*
c) Using the data of Table 29.2, calculate the exchange rate of Euros (EUR) to Swiss Francs (CHF) in both the direct and the indirect quotation. Interpret your result.
d) Calculate how many Dollars you can buy with 100€. Then, use that dollars to buy Swiss Francs. How many Swiss Francs do you get?
e) *Multiple choice:* Which of the following statements is true?

   i) The table indicates that the *Purchasing Power Parity Assumption* is fulfilled.
   ii) The exchange rate of US Dollar to Swiss Franc (CHF) is close to one.
   iii) The exchange rate of US Dollar to the Russian Ruble (RUB) is about $62.2\frac{\$}{RUB}$.
   iv) The exchange rate of Canadian Dollar (CAD) to the Euro (EUR) is about 0.73.
   v) With one Canadian Dollar (CAD) you can buy 0.73 US Dollars.

Solution: Big Mac Index

a) Please take part in the discussion in class.

b) Please take part in the discussion in class.

c) The exchange rate of Euros to Swiss Francs in direct quotation is:
$$E^{\frac{\text{EUR}}{\text{CHF}}} = \frac{4.56\text{ EUR}}{4.75\text{ USD}} \cdot \frac{6.57\text{ USD}}{6.50\text{ CHF}} = \frac{29.9592\text{ EUR}}{30.875\text{ CHF}} \approx 0.9703\frac{\text{EUR}}{\text{CHF}}$$
and in indirect quotation:
$$E^{\frac{\text{CHF}}{\text{EUR}}} \approx 1.0305\frac{\text{CHF}}{\text{EUR}}.$$
That means, we have to pay about 0.97 Euro for one Swiss Franc or one Euro costs about 1.03 Swiss Franc.

d) For 100 Euro we get
$$100\text{ EUR} \cdot \frac{4.75\text{ USD}}{4.56\text{ EUR}} \approx 104.16\text{ USD}$$
and these can be converted to
$$104.16\text{ USD} \cdot \frac{6.50\text{ CHF}}{6.57\text{ USD}} \approx 103.05\text{ CHF}$$

e) Here are the answers:

   i) is false: The price of a Big Mac in \$ is different across countries.
   ii) is correct.

   iii) is false: 1 Ruble costs 0.0160 Dollar:
$$\frac{2.09\text{ USD}}{130\text{ RUB}} = 0.016\frac{\text{USD}}{\text{RUB}}.$$
   iv) is incorrect:
$$\underbrace{\frac{6.65\text{ CAD}}{5.08\text{ USD}}}_{\approx 1.309} \cdot \underbrace{\frac{4.75\text{ USD}}{4.56\text{ EUR}}}_{\approx 1.0416} \approx 1.36\frac{\text{CAD}}{\text{EUR}}.$$
   v) is incorrect:
$$\frac{6.05\text{ CAD}}{5.08\text{ USD}} \approx 0.76\frac{\text{CAD}}{\text{USD}}.$$
   Thus, with one Canadian Dollar you can buy 0.76 U.S. Dollar.

Exercise 29.6. International arbitrage

Table 29.3: Table of price variations across countries

Country	Price of Good *08/15*
Germany	\$2
Switzerland	\$6
United States of America	\$6

a) Consider a scenario where the good *08/15* is freely tradeable across countries without any cost (akin to digital software). You have \$100, and upon examining the prices of *08/15* in three different countries, you notice discrepancies as depicted in Table 29.3. Discuss how you could profit from *international arbitrage*, the practice of exploiting price differences of a good across countries. Describe the potential impact on the prices of the good once arbitrage begins.

b) Assuming *08/15* can be traded freely across borders like software, imagine your arbitrage efforts have harmonized the prices of the good worldwide, as illustrated in the Table 29.4:

Table 29.4: Table of prices and currencies across countries post-arbitrage

Country	Price in USD	Price in Local Currency
Germany	\$4	EUR 2
Switzerland	\$4	CHF 6
United States of America	\$4	-

Now, calculate and elucidate the following exchange rates:

- $\frac{\text{USD}}{\text{EUR}}$
- $\frac{\text{EUR}}{\text{USD}}$
- $\frac{\text{USD}}{\text{CHF}}$
- $\frac{\text{CHF}}{\text{USD}}$
- $\frac{\text{CHF}}{\text{EUR}}$
- $\frac{\text{EUR}}{\text{CHF}}$

Solution

a) International arbitrage strategy

- **Strategy**: Buy 50 units of good *08/15* in Germany for \$2 each with your \$100. Then, sell these units in Switzerland or the USA for \$6 each, making a total of \$300. This is a classic arbitrage strategy.
- **Impact on Prices**: Consider that you repeat that winning strategy to buy in Germany and sell in some other country, prices will change: The increased demand in Germany will cause the price there to rise, while the increased supply in Switzerland and the USA will cause the price to drop. Eventually, the price differences will equalize, eliminating the arbitrage opportunity.

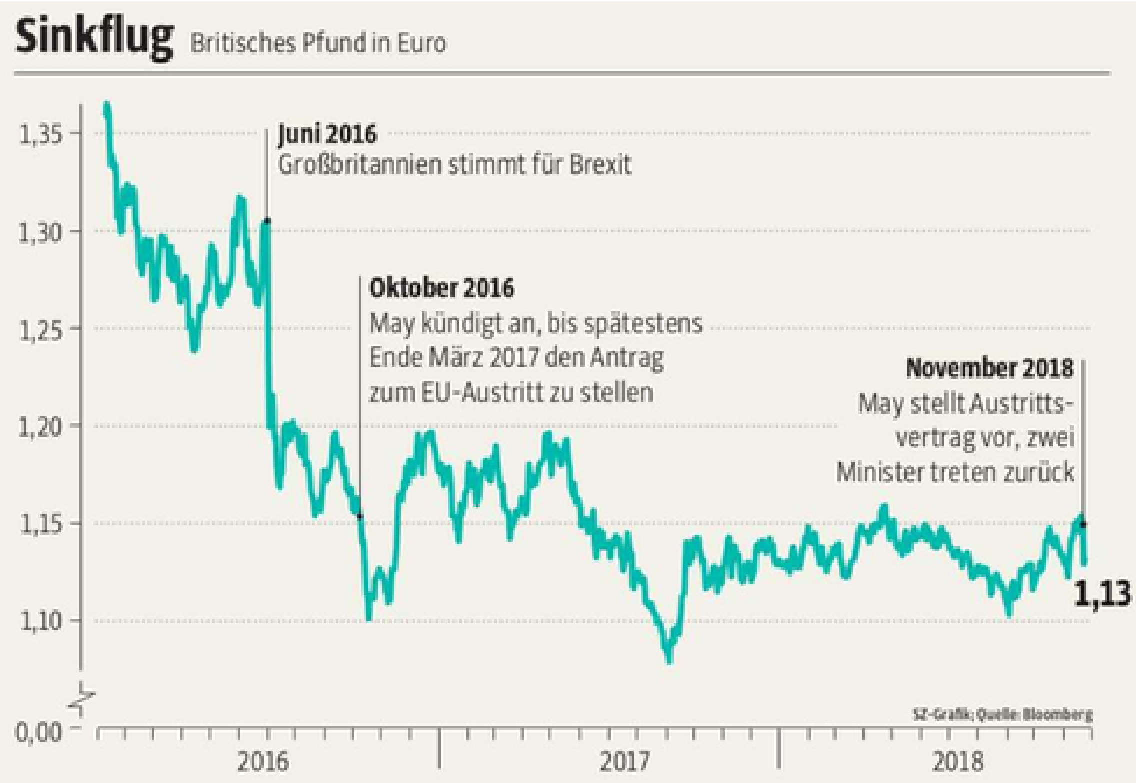
b) Calculating exchange rates

- **USD to EUR**: $\frac{4USD}{2EUR} = 2\frac{USD}{EUR}$
- **EUR to USD**: $0.5\frac{EUR}{USD}$
- **USD to CHF**: $\frac{2}{3}\frac{USD}{CHF}$

- **CHF to USD**: $1.5\frac{CHF}{USD}$
- **CHF to EUR**: $\frac{3}{1}\frac{CHF}{USD}$
- **EUR to CHF**: $\frac{1}{3}\frac{EUR}{CHF}$

Exercise 29.7. Brexit and the exchange rate
Examine Figure 29.10 and discuss the reasons behind the depreciation of the British pound since June 2016.

Figure 29.10: The Price of the British Pound (€/£)



Source: Süddeutsche Zeitung am Wochenende, 17./18. November 2018, year 74, week 46, No. 265, p. 1 (front page).

Chapter 30

International investments

Investing, whether through holding a currency or storing purchasing power, is inherently speculative, regardless of whether the investment is domestic or international. When you hold a foreign currency, it's crucial to acknowledge that its value can both appreciate and depreciate. Currency values can fluctuate significantly over time due to factors such as economic policy, market sentiment, and global events. In the following sections, I will present a framework to help understand the key determinants of the rate of return on your investment. As illustrated in Figure 30.1, we will explore how a country's interest rates, trade balances, price levels, and exchange rates are interconnected and must be analyzed together, rather than in isolation.

Figure 30.1: Illustration of Interest Rate, Exchange Rate, and Trade Balance

Source: Generated using OpenAI (2025).

30.1 Foreign exchange reserves

Currencies serve as a store of value, an important function in the financial world. Foreign exchange reserves are assets held on reserve by a central bank in foreign currencies, which can include bonds, treasury bills, and other government securities. The primary purpose of holding foreign exchange reserves is to manage the exchange rate of the national currency and ensure the stability of the country's financial system.

Accordingly to the *Currency Composition of Official Foreign Exchange Reserves (COVER)* database of the *International Moentary Fund (IMF)*, the total foreign exchange reserves in Q3 2023 had been 11,901,53 billion U.S. Dollar. That is, $ 11,901,530,000,000!

The size of a country's foreign exchange reserves can be influenced by various factors, including its balance of trade, exchange rate policies, capital flows, and the overall health of its economy. While having substantial reserves is generally seen as a sign of economic strength and stability, excessively accumulating reserves can also indicate underlying economic imbalances or protectionist policies.

30.2 Three components of the rate of return

An investment usually has different characteristics such as the default risk, opportunities, and liquidity. These characteristics and individual preferences are important to decide which investment is superior. In this course, however, we mostly refrain from discussing sophisticated features of investments here. We focus on the most important feature of an investment, that is, the rate of return. In particular, three components are important to calculate the rate of return:

30.2.1 Interest rate

The interest rate of an investment is a crucial factor that determines the return earned on invested capital over a specific period. It represents the percentage of the initial investment that is paid back to the investor as interest or profit. Formally, we can write:

$$\underbrace{I_{t-1}}_{\text{investment in t-1}} \cdot \underbrace{(1+i)}_{\text{1+interest rate}} = \underbrace{I_t}_{\text{payout amount in t}} \tag{30.1}$$

where I denotes the value of an asset measured in € in the respective time period t.

30.2.2 Exchange rate

When investing in assets denominated in foreign currencies, investors need to convert their domestic currency into the foreign currency at the prevailing exchange rate. After the investment has been paid out in the foreign country, the investor must convert the foreign currency back to his home currency. Thus, the initial cost of the investment and the subsequent returns are influenced by the exchange rate at the beginning and the end of the investment.

Formally, we can write if the an investment takes in foreign country, that is, Turkey between $t-1$ and t:

$$I^{\text{€}}_{t-1} \cdot E^{\frac{\text{₺}}{\text{€}}}_{t-1} \cdot E^{\frac{\text{€}}{\text{₺}}}_{t} = I^{\text{€}}_t \tag{30.2}$$

30.2.3 Inflation

Inflation refers to the quantitative measure of the rate at which prices, represented by a basket of goods and services, increase within an economy over a specific period. Conversely, negative inflation is termed deflation. Mathematically, inflation can be defined as follows:

$$\pi = \frac{P_t - P_{t-1}}{P_{t-1}} = \frac{P_t}{P_{t-1}} - 1$$

Where π represents the inflation rate and P_t denotes the price at time t. When inflation affects all prices, it also impacts the value of assets in which investors are invested. This relationship can be expressed as:

$$I_t = I_{t-1} \cdot (1+\pi) \tag{30.3}$$

30.3 Rate of return of an investment abroad

The rate of return, r, is the growth rate of an investment over time and can be described as follows:

$$r = \frac{I_t^{€} - I_{t-1}^{€}}{I_{t-1}^{€}} = \frac{I_t^{€}}{I_{t-1}^{€}} - 1,$$

Combining Equation 30.1, Equation 30.2, and Equation 30.3, we can describe the value of our investment in period t as follows:

$$I_t^{€} = I_{t-1}^{€} \cdot (1+i^*) \cdot E_{t-1}^{\frac{₺}{€}} \cdot E_t^{\frac{€}{₺}} \cdot (1+\pi^*), \tag{30.4}$$

where $I_{t-1}^{€}$ denotes the initial investment, i^* denotes the interest rate abroad and π^* the inflation abroad. Dividing by $I_{t-1}^{€}$ and subtracting 1 from both sides of Equation 30.4, we see that the rate of return for an investment abroad, r^*, has three determining factors, that are: interest rate $(1+i^*)$, inflation $(1+\pi)$, and the change of exchange rates over time $(E_{t-1}^{\frac{₺}{€}} \cdot E_t^{\frac{€}{₺}})$:

$$\underbrace{\frac{I_t^{€^*}}{I_{t-1}^{€}} - 1}_{r} = (1+i^*) \cdot (1+\pi^*) \cdot \underbrace{E_{t-1}^{\frac{₺}{€}} \cdot E_t^{\frac{€}{₺}}}_{\alpha} - 1$$

$$r^* = (1+i^*) \cdot (1+\pi^*) \cdot \alpha - 1 \tag{30.5}$$

with

- $\alpha = 1$ if the exchange rate does not change over time and

- $\alpha > 1$ if the home currency € depreciates or
- $\alpha < 1$ if the home currency € appreciates.

So the exchange rate changes over time work as a third factor of your rate of return.

By assuming no inflation ($\pi^* = 0$), we can write

$$\begin{aligned} r^* &= (1+i^*) \cdot \alpha - 1 \\ \Leftrightarrow r^* &= \alpha + \alpha i^* - 1. \end{aligned} \tag{30.6}$$

Reorganizing Equation 30.6 helps to interpret it. Firstly, let us expand the right hand side of this equation adding and subtracting i^* which obviously does not change the sum of the right hand side of the equation. Secondly, re-write the equation and thirdly, set $(\alpha - 1) = w$:

$$\begin{aligned} \Leftrightarrow r^* &= \alpha + \alpha i^* - 1 + i^* - i^* \\ \Leftrightarrow r^* &= \alpha - 1 + i^* + \alpha i^* - i^* \\ \Leftrightarrow r^* &= \underbrace{(\alpha - 1)}_{w} + i^* + i^* \underbrace{(\alpha - 1)}_{w} \\ \Leftrightarrow r^* &= w + i^* + i^* w \end{aligned} \tag{30.7}$$

This equation outlines the rate of return on an investment in a foreign country, influenced by two primary factors: i^* and w.

Assuming that the product iw is very small, we can say that the rate of return equals approximately the interest rate plus the rate of depreciation:

$$r^* = w + i^*.$$

This approximation is often called the *simple rule for* r.

Exercise 30.1. Exchange rates and where to invest
Suppose you want to buy a new car in Germany in one year, i.e, t=2023. Today, i.e., t=2022, you have €10,000 to invest for one year.
Given the following conditions:

- The annual interest rate in Europe is 1%.
- The annual interest rate in the U.S.A. is 2%.
- One US-Dollar can be converted to €0.93 this year.
- You expect that €1 can be converted to $1.09 next year.
- Moreover, you expect no inflation in Germany and the U.S.
- No banking fees or alike.

a) Calculate the return on an investment in the U.S. and Germany, respectively.
b) Do you expect the euro to appreciate or depreciate from 2022 to 2023?

Solution

Exchange rates and where to invest (Exercise 30.1)

a) Rate of return in the EU is 1 percent and hence you will have € 10,100 in 2023. Rate of return in the US is about 0.62 percent:

$$10000€ \cdot \frac{1\$}{0.93€} \cdot 1.02 \cdot \frac{1€}{1.09\$} = 10062.1485€$$

Thus, it is better to invest in Europe.
b) In 2022 you have to pay 93 Cent for a dollar and in 2023 you expect to pay about 91 Cent for a dollar. Thus, you expect the Euro to appreciate.

Exercise 30.2. Turkey vs. Germany
You have 100€ this year, $t-1$, which you like to invest till next year, t.

a) Where should you invest, given the following informations:
   - The interest rate in Germany is 1%.
   - The interest rate in Turkey is 10%.
   - 1€ can be converted to 7 ₺ this year in the FOREX
   - You expect that 1 € can be converted to 7.1 ₺ next year in the FOREX.
   - You expect no inflation in Germany and Turkey.
b) Calculate the exchange rate in period t that makes investing in Germany and Turkey equal profitable.
c) Explain why the Turkish Lira is under appreciation pressure in t-1.

Solution

Turkey vs. Germany (Exercise 30.2)

a) When focusing solely on the interest rate, investing in Turkey appears more advantageous. However, if we consider only the development of the exchange rate, investing in Germany becomes more appealing due to the Euro appreciating relative to the Lira from period $t-1$ to t. Therefore, it's essential to calculate the return on investment to determine which of the two effects predominates. This can be done in three different ways:

b) **(Exact) calculation method in four steps:**

```
1. exchange € to ₺ in t-1:
```

$$100€ \cdot E_{t-1}^{₺/€} = 100€ \cdot 7\frac{₺}{€} = 700₺$$

2. invest in either Germany or Turkey:

$$GER \rightarrow 100€ \cdot (1 + 0.01) = 101€$$

$$TUR \rightarrow 700₺ \cdot (1 + 0.1) = 770₺$$

3. re-exchange ₺ to €:

$$770₺ \cdot E_t^{€/₺} = 770₺ \cdot \frac{1€}{7\frac{1}{10}₺} = \frac{7700}{71} \approx 108.4507$$

4. calculate the return on investment, r:

$$\begin{aligned} r_{GER} =& 0.01 \\ r_{TUR} =& \frac{108.4507 - 100}{100} = 0.084507 \end{aligned}$$

Answer: The return on investment is lower in Germany. Thus, it is superior to invest the 100€ in Turkey.

ii) **(Exact) Calculation method in one step:**

$$\overbrace{r}^{\text{rate of return}} = \frac{I_t^{€} - I_{t-1}^{€}}{I_{t-1}^{€}}$$

$$\text{with } I_t^{€} = \overbrace{I_{t-1}^{€}}^{\text{investment in t-1}} \cdot \overbrace{E_{t-1}^{₺/€}}^{\text{exchange rate in t-1}} \cdot \overbrace{(1+i)}^{\text{1+interest rate}} \cdot \overbrace{E_t^{€/₺}}^{\text{exchange rate in t}}$$

$$\begin{aligned} TUR \rightarrow I_t^{€} =& 100€ \cdot 7\frac{₺}{€} \cdot (1 + 0.1) \cdot \frac{1€}{7.1₺} = 108.4507 \rightarrow r_{TUR} = 0.084507 \\ GER \rightarrow I_t^{€} =& 100€ \cdot 1 \cdot (1 + 0.01) \cdot 1 = 101€ \rightarrow r_{GER} = 0.01 \end{aligned}$$

iii) **(Approximative) calculation method:** Steps a) to c) can be summarized as two rates of changes:

$$\underbrace{r'}_{\text{approximative rate of return}} = \underbrace{i}_{\text{interest rate}} + \underbrace{w}_{\text{rate of depreciation}}$$

$$\text{with} \quad w = \frac{E_t^{€/₺}}{E_{t-1}^{€/₺}} - 1$$

$$\begin{aligned} r'_{GER} =& 0.01 \\ r'_{TUR} =& 0.1 + \frac{\frac{10}{71}}{\frac{10}{70}} - 1 = 0.1 + \frac{700}{710} - 1 = 0.1 - \frac{10}{710} = \frac{61}{710} \approx 0.08591 \end{aligned}$$

b) Both investments are equal profitable if

$$r_{GER} = r_{TUR}.$$

Given the information in period $t-1$, the exact exchange rate in period t that makes investments are equal profitable, $E_t^{€/₺*}$, is calculated as follows:

$$\begin{aligned} I_t^{€} &= I_{t-1}^{€} E_{t-1}^{₺/€} (1 + i) E_t^{€/₺*} \\ \Leftrightarrow E_t^{€/₺*} &= \frac{I_t^{€}}{(I_{t-1}^{€} E_{t-1}^{₺/€} (1 + i))} = \frac{101}{(100 \cdot 7 \cdot 1.1)} = \frac{101}{770} \approx 0.1311 \end{aligned}$$

The approximate exchange rate in period t that makes investments are equal profitable, $E_t^{€/₺*'}$, is calculated as follows:

$$\begin{aligned} r_{GER} =& i_{TUR} + \frac{E_t^{€/₺*'}}{E_{t-1}^{€/₺}} - 1 \\ \Leftrightarrow r_{GER} - i_{TUR} + 1 =& \frac{E_t^{€/₺*'}}{E_{t-1}^{€/₺}} \\ \Leftrightarrow E_t^{€/₺*'} =& (r_{GER} - i_{TUR} + 1) \cdot E_{t-1}^{€/₺} \\ \Leftrightarrow E_t^{€/₺*'} =& (0.01 - 0.1 + 1) \cdot \frac{1}{7} = \frac{91}{100} \cdot \frac{1}{7} = \frac{91}{700} = 0.13 \end{aligned}$$

Let us proof our results by re-calculating the rate of return for an investment in Turkey with $E_t^{€/₺*}$ and $E_t^{€/₺*'}$:

$$\begin{aligned} r'_{TUR} =& 0.1 + \frac{\frac{91}{700}}{\frac{1}{7}} - 1 = \frac{637}{700} - 0.9 = 0.01 \\ I_t^{€*} =& 100€ \cdot 7\frac{₺}{€} \cdot (1 + 0.1) \cdot \frac{91}{700}\frac{€}{₺} = \frac{70070}{700} = 100.1 \\ \rightarrow r^*_{TUR} =& 0.01 \end{aligned}$$

c) The ₺ must appreciate in t-1 since it is more profitable to exchange € to store the asset value in Turkey. That means the demand curve in the FOREX shifts upwards till the exchange rate equals the exchange rate that makes both investments equal profitable and hence nobody has an incentive to demand more ₺ for the given exchange rate $E_t^{€/₺*}$ as calculated above.

Exercise 30.3. Suppose you have 50,000 Indian Rupees (INR) this year that you want to invest for one year from t to $t + 1$ and then buy something with the Indian Rupees in India. Calculate the return on an investment in India and Germany, given the following conditions:

- The annual interest rate in India is 5% and 2% in Germany.
- 1 INR can be converted to 0.01 Euro (EUR) this year, t.
- You expect the Indian Rupee to depreciate, that is, you expect 1 EUR to cost 1 INR more next year, that is $t + 1$.
- Moreover, you expect no inflation in India and Germany.

Solution

The return on investment for the investment in India is 5%.
The return on investment for the investment in Germany can be calculated as follows:

$$50,000 \text{ INR} \cdot \underbrace{\frac{0.01\text{EUR}}{1 \text{ INR}}}_{=\frac{100 \text{ INR}}{1 \text{ EUR}}} \cdot 1.02 \cdot \frac{101 \text{ INR}}{1 \text{ EUR}} = 51,510 \text{ INR}$$

To calculate the rate of return calculate

$$\frac{51,510 - 50,000}{50,000} \cdot 100 = 3.02.$$

Thus, the return on investment for the investment in Germany is 3.02%. One challenge of this exercise is to consider “1 EUR to cost 1 INR more” properly. This does not mean 1 INR is equal to 1 €!

30.4 The interest parity condition

Assume the rate of return is lower domestically than it is for investments abroad. Representing the foreign country with an asterisk ($*$), this situation, where investing money abroad is more profitable, can be expressed as:

$$r < r^*.$$

Given that domestically the rate of return, r, equals the interest rate, i, assuming zero inflation, and that the simple rule for an investment abroad is described by $r^* = w + i^*$, we can rewrite the equation as:

$$i < w + i^*.$$

What would happen if financial market actors became aware of this?

Market participants would likely convert their domestic currency into the foreign currency to invest abroad, increasing demand for the foreign currency. Consequently, the foreign currency would appreciate, becoming relatively more expensive. This implies that w is negative. This appreciation process halts when investing abroad no longer offers a higher return. If the attractiveness of investments is equalized, the FOREX is in equilibrium. The deposits of all currencies offer the same expected rate of return. In other words, in equilibrium the exchange rate, w, assures that the rate of return from the home country, r, is equal to the rate of return in any foreign country, denoted with an asterisk ($*$):

$$r = r^* \tag{30.8}$$

$$i = w + i^* \tag{30.9}$$

$$\tag{30.10}$$

$$\Leftrightarrow w = i - i^* \tag{30.11}$$

The interest parity condition (Equation 30.11) enables us to analyze how variations in interest rates and expected exchange rates affect current exchange rates through comparative static analysis of the equation:

$$\frac{\partial w}{\partial i} > 0; \quad \frac{\partial w}{\partial i^*} < 0.$$

This means:

- An increase in the domestic interest rate results in a positive change in the depreciation rate, leading to the depreciation of the domestic currency.
- An increase in the foreign interest rate causes a negative change in the depreciation rate, resulting in the appreciation of the domestic currency.

30.5 The theory in real markets: Unpegging the Swiss Franc

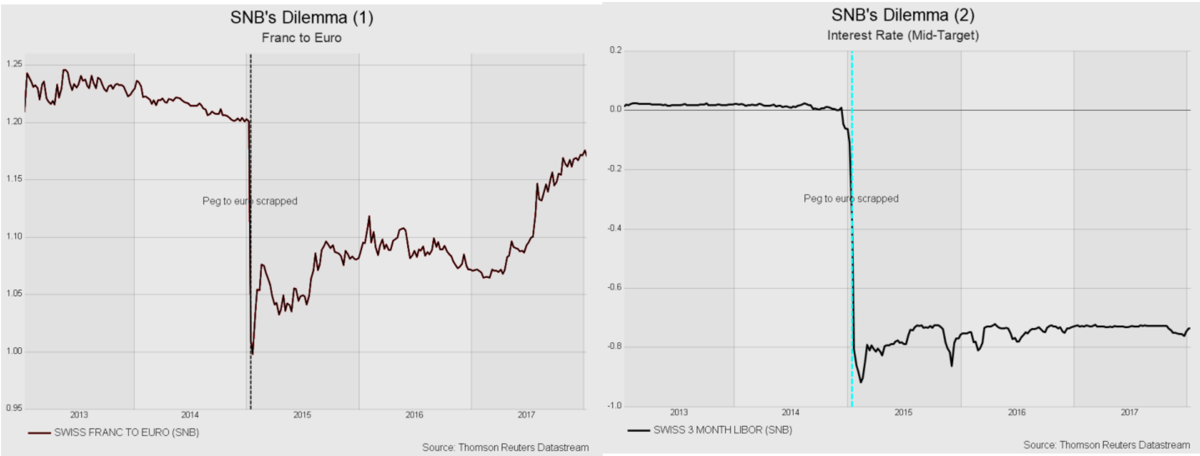
You might now question whether this theory of the interest parity condition truly holds in real-world markets. Analyzing international markets and the FOREX empirically is challenging due to the frequent occurrence of both large and small exogenous shocks on a global scale, each impacting market outcomes in various ways. Furthermore, market dynamics are often influenced by emotions and speculation rather than solely measurable facts. However, there are instances where the shocks are so significant that the fundamental forces driving the market become visible, even without a sophisticated empirical identification strategy that controls for confounding effects. The case study of the unexpected unpegging of the Swiss Franc serves as a poignant example. It vividly demonstrates that the principles underpinning the interest parity condition are not merely theoretical constructs but actively influence real market behaviors.

Until early 2015, the Swiss National Bank (SNB) had a policy goal to maintain the franc above the cap of 1.20 Francs per Euro, aiming to protect exporters and combat deflationary pressures. However, in a surprising move, the SNB unpegged the Franc in 2015. This decision was influenced by the appreciation pressure on the Franc, as many investors many investors wanted to store their assets in the Swiss Franc. Following the SNB's announcement, the exchange rate plunged from 1.20 to 1.00 Franc per Euro ($E^{\frac{CHF}{€}}$), as illustrated in Figure 30.2a Almost simultaneously, the interest rate experienced a decline, as depicted in Figure 30.2b. These developments align precisely with what the interest parity condition would predict, demonstrating its applicability in real-world financial market dynamics.

Figure 30.2: The impact of unpegging the Franc on capital markets

(a) The exchange rate: $E^{\frac{CHF}{€}}$

(b) Interest rate for investments in Switzerland



To analyze the relationship between changes in exchange rates and interest rates, we need to consider the interest parity assumption of Equation 30.11:

$$w = i - i^*$$

where

$$w = \frac{E_t^{\frac{€}{CHF}}}{E_{t-1}^{\frac{€}{CHF}}} - 1.$$

In January 2015, the exchange rate $E^{\frac{CHF}{€}}$ decreased from 1.20 to 1.00. Alternatively, we can express this change in direct quotation, noting that the exchange rate $E^{\frac{€}{CHF}}$ increased from $E_{t-1}^{\frac{€}{CHF}} \approx \frac{1}{1.20} \approx 0.83$ to $E_t^{\frac{€}{CHF}} \approx 1.00$, resulting in

$$w = \frac{E_t^{\frac{€}{CHF}}}{E_{t-1}^{\frac{€}{CHF}}} - 1 = \frac{1}{0.83} - 1 = 0.20.$$

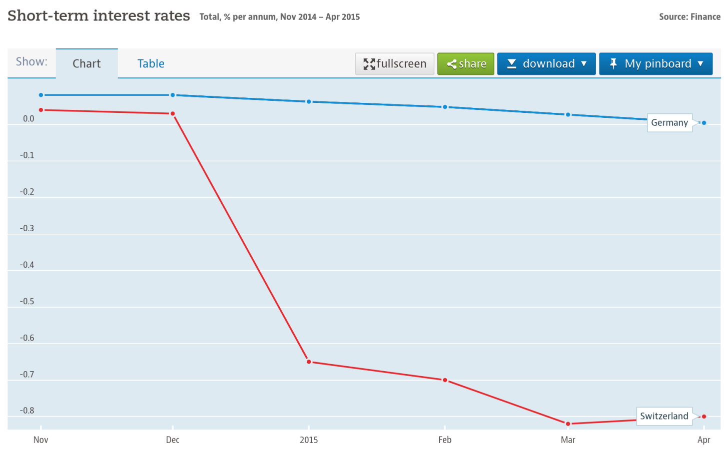
Since $w > 0$, the fraction on the left-hand side of the interest rate parity equation must also be positive, as already mentioned. This implies that

$$i - i^* > 0,$$

which means that an interest rate spread must occur. This condition can occur if the foreign interest rate i^* decreases or the domestic interest rate i increases. In our observations, we can indeed see a pattern that is consistent with our theoretical expectations.

It is important to acknowledge that our theoretical framework simplifies the complex interplay of factors that influence both exchange rates and interest rates. Despite this simplification, the model highlights the key forces driving market dynamics. However, it is important to point out that the actual numbers may not perfectly match our theoretical predictions in quantitative terms, as shown in Figure Figure 30.3.

Figure 30.3: Short-term interest rates across Germany and Switzerland over time



Source: Data are taken from the OECD and show the total, % per annum.

30.6 The Fisher Effect

The *Fisher Effect* is an economic theory proposed by economist Irving Fisher (1867-1947), which describes the relationship between (expected) inflation and both nominal and real interest rates.

According to the *Fisher Effect*, the nominal interest rate is equal to the sum of the real interest rate and the (expected) inflation rate. In formula terms, it is often expressed as:

$$r = i + \pi. \tag{30.12}$$

We can derive Equation 30.12 assuming that the exchange rate is stable over time

$$\left(E_{t-1}^{\frac{€}{₺}} = E_t^{\frac{€}{₺}} \Leftrightarrow \frac{E_{t-1}^{\frac{€}{₺}}}{E_t^{\frac{€}{₺}}} = 1 \Leftrightarrow \alpha = 1 \right)$$

and using this in Equation 30.5, we get:

$$r^* = (1 + i^*) \cdot (1 + \pi^*) \cdot \underbrace{\alpha}_{=1} - 1 \tag{30.13}$$

$$\Leftrightarrow r = i + \pi + \pi i \tag{30.14}$$

Assuming that the product πi is very small, we can say that the rate of return equals approximately the interest rate plus the inflation rate. This approximation shown in Equation 30.12 is often called the *Fisher Effect*.

Considering now cross-country differences in their rate of return, we can explain the rate of return spread by the inflation rate and the nominal interest rate spread as follows:

$$r_{GER} - r_{TUR} = \pi_{GER} - \pi_{TUR} + i_{GER} - i_{TUR}. \tag{30.15}$$

We have learned in Section 30.4 (the interest parity condition) that the rate of return can differ only in the short run and will be equal across countries in the long run ($r_{GER} - r_{TUR} = 0$). Utilizing this concept in Equation 30.12, we can demonstrate that the nominal interest rates of countries will adjust to accommodate any changes in (expected) inflation, and vice versa:

$$i_{GER} - i_{TUR} = \pi_{GER} - \pi_{TUR}.$$

More information on the Fisher effect can be found here: Wikipedia (2025a): Wikipedia entry to the Fisher Effect.

Chapter 31

Balance of payments

Required readings: Council of Economic Advisers (2004, ch. 14)

31.1 Introduction

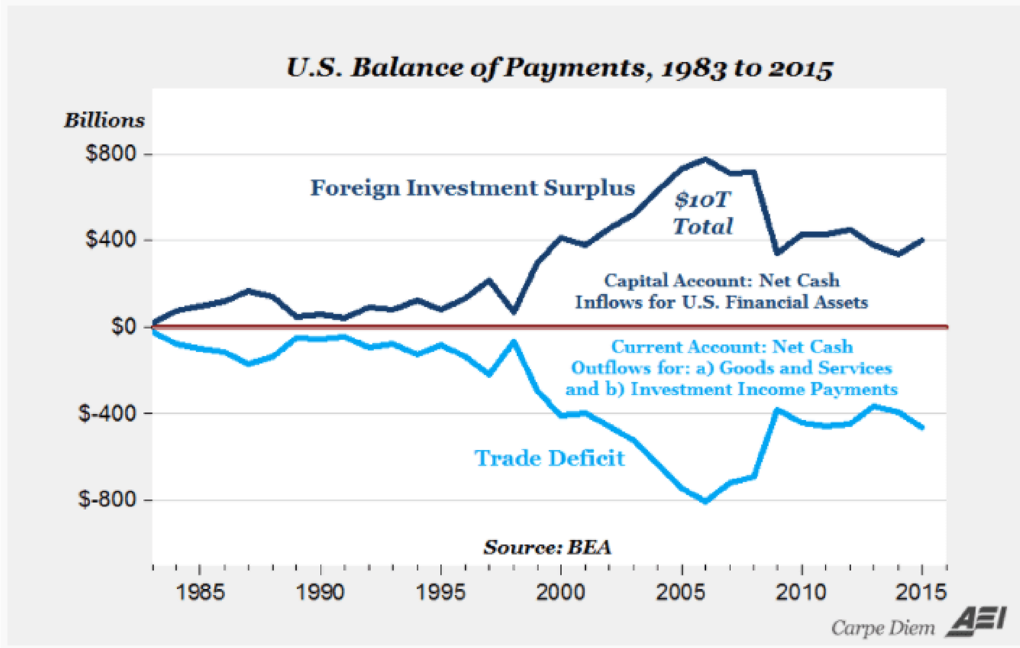
The *Balance of Payments* is a record of a country's financial transactions with the rest of the world. It tracks the money flowing in and out through various economic activities. If we account for all transactions, the inflow and outflow should theoretically balance. Before I elaborate on this concept, let's clarify some key terms:

- *Exports*: Goods and services sold to other countries.
- *Imports*: Goods and services bought from other countries.
- *Trade balance*: The difference between the value of goods and services a country sells abroad and those it buys from abroad, also known as *net exports*.
- *Trade surplus*: When a country sells more than it buys, resulting in a positive trade balance.
- *Trade deficit*: When a country buys more than it sells, leading to a negative trade balance.
- *Balanced trade*: When the value of exports equals imports.
- *Net capital outflow*: The difference between the purchase of foreign assets by domestic residents and the purchase of domestic assets by foreigners. This equals net exports, indicating that a country's savings can fund investments domestically or abroad. We will elaborate on that later on in greater detail.

Exercise 31.1. Some facts about foreign trade
Make yourself familiar with the descriptive statistics at destatis.de, the World Trade Organization here and here, the OECD, and World Trade Historical Database by the CEPR.

Exercise 31.2. Figure 31.1 represents the foreign investment surplus and the trade deficit. Discuss why the two lines mirror each other. Could this be a coincidence?

Figure 31.1: U.S. Balance of Payments



31.2 The payments must be balanced!

Every international financial transaction is essentially an exchange. When a country sells goods or services, the buying country compensates by transferring assets. Consequently, the total value of goods and services a country sells (its net exports) must be equal to the value of assets it acquires (its net capital outflow).

The *Balance of Payments* account consists of two primary components:

1. The **Current account** (Leistungsbilanz) measures a country's trade balance (goods and services exports minus imports) plus the effects of net income and direct payments. It is positive, if a country is a net lender to the rest of the world and negative, if it is a net borrower from the rest of the world. In other words, an account surplus increases a country's net foreign assets.

2. The **Capital account** (Kapitalbilanz) reflects the net change in ownership of national assets. Capital can flow in the form of following:

    1. **Foreign Direct Investment (FDI)**: It involves investing in foreign companies with the intention of controlling or significantly influencing their operations.
    2. **Foreign Portfolio Investment (FPI)**: This type of investment is in foreign financial assets, such as stocks and bonds, where the investor does not seek control over the companies.
    3. **Other investments**: This includes capital flows into bank accounts or funds provided as loans. It also encompasses the reserve account, which is managed by the central bank responsible for buying and selling foreign currencies.

Ignoring statistical effects, these two subaccounts must sum to zero. Table 31.1 shows you a hypothetical balance of payment account.

Table 31.1: A hypothetical account

Receipt (credit)		Payments (debits)	
Current Account			
1. Export of goods and services	800	3. Import of goods and services	600
2. Unilateral receipts	300	4. Unilateral payments	390
Total	**1100**	**Total**	**990**
Capital Account			
5. Borrowings	700	7. Lendings	750
6. Sale of gold/assets	100	8. Purchase of gold/assets	150
Total	800	**Total**	900
		Errors and omissions	10
Total	1900	**Total**	1900

Example

Imagine Boeing, an American company, sells airplanes to a Japanese airline:

1. Boeing transfers airplanes to the Japanese firm, and in return, the Japanese firm pays Boeing in Yen. This transaction increases exports (boosting net exports) and results in the United States acquiring foreign assets in the form of Yen (increasing net capital outflow).
2. Boeing might then convert its Yen to U.S. Dollars through a financial exchange. For example, if an American mutual fund wants to invest in a Japanese company, Boeing's sale of planes (a net export) is mirrored by the mutual fund's investment in Japan (a net capital outflow).
3. Alternatively, Boeing could exchange its Yen with an American company looking to purchase goods or services from Japan. In this scenario, the value of imports matches the value of exports, leaving net exports unchanged.

While it's true that the overall totals of payments and receipts must inherently balance, certain transaction types can create imbalances, leading to either deficits or surpluses. These imbalances may manifest in various sectors such as trade in goods (commodities), services trade, foreign investment income, unilateral transfers (including foreign aid), private investment, and the flow of gold and currency between central banks and treasuries, among other international dealings. It's crucial to note, though, that the accounting framework ensures these surpluses and deficits ultimately zero out, adhering to the principles of double-entry bookkeeping.

Example

Take, for example, a scenario where Americans purchase cars from Germany without engaging in any other transactions with it. The outcome is that Germans accumulate dollars, which can be maintained as bank deposits in the United States or within other U.S.-based assets. The American payment for German automobiles is counterbalanced by German acquisitions of dollar assets, including investments in U.S. entities and institutions. This exchange means Germany sells cars to the U.S., while the U.S. sells dollars or dollar-backed assets to Germany. Consequently, Germany experiences a trade surplus, indicated by a positive trade balance and a corresponding surplus in its current account, which encompasses the trade balance. Nonetheless, this also implies Germany faces a deficit in its capital account, characterized by a net outflow of money.

31.3 A normative discussion of imbalances in the capital and current account

Normatively discussing imbalances in the capital and current accounts of countries involves evaluating these phenomena from a perspective of what ought to be, considering ethical, practical, and policy implications. These imbalances are not merely numerical figures; they reflect underlying economic activities and policy decisions with significant implications for national and global economic health.

31.3.1 Current account imbalances

The current account includes trade in goods and services. A surplus in the current account indicates that a country is exporting more goods than it imports.

Surpluses: Normatively, persistent current account surpluses might be viewed as a sign of a country's competitive strength in the global market. However, they can also indicate underconsumption or insufficient domestic investment, suggesting that a country is not fully utilizing its economic resources to improve the living standards of its population. Furthermore, large surpluses can lead to tensions with trading partners and might prompt accusations of unfair trade practices or currency manipulation.

Deficits: On the other hand, persistent deficits could signal domestic economic vitality and an attractive environment for investment, reflecting high consumer demand and robust growth. Yet, they can also indicate structural problems, such as a lack of competitiveness, reliance on foreign borrowing to sustain consumption, or inadequate savings rates. Over time, large deficits may lead to unsustainable debt levels, making the country vulnerable to financial crises.

31.3.2 Capital account imbalances

The capital account records the net change in ownership of national assets. It includes the flow of capital into and out of a country, such as investments in real estate, stocks, bonds, and government debt.

Inflows: Capital account inflows can signify strong investor confidence in a country's economic prospects, potentially leading to increased investment and growth. However, excessive short-term speculative inflows can destabilize the economy, leading to asset bubbles and subsequent financial crises when the capital is suddenly withdrawn.

Outflows: Capital outflows might indicate a lack of confidence in the domestic economy or better opportunities abroad. While some level of outflow is normal for diversified investment portfolios, large and rapid outflows can precipitate a financial crisis by depleting foreign reserves and putting downward pressure on the currency.

31.4 A formal representation

In the following, I present a streamlined perspective on the global trading system. This overview does not engage with the benefits or drawbacks of maintaining trade surpluses or deficits, a subject that warrants its own discussion. However, it aims to identify the factors influencing current account deficits and surpluses.

31.4.1 Closed economy

Within a closed economy, we identify three principal actors: households, firms, and the government. Let's define C as the consumption of goods and services by households, encompassing necessities and luxuries like food, housing, and entertainment. Let G represent government expenditures, which cover infrastructure, social services, military outlays, education, and more. Lastly, I symbolizes the investment by firms in assets such as machinery, buildings, and research and development. Given these components, the total economic output, Y, can be expressed by the *fundamental equation of economics* as:

$$Y = C + I + G.$$

This equation encapsulates the aggregate spending within a closed economy, highlighting the interplay between consumption, investment, and government expenditure in determining overall economic activity.

If we define national savings, S, as the share of output not spent on household consumption or government purchases, then the investments, I, must be equal to the savings in a closed economy:

$$\begin{aligned} Y &= C + I + G \\ \Leftrightarrow \underbrace{Y - C - G}_{S} &= I \\ \Leftrightarrow S &= I, \end{aligned}$$

This implies that within a closed economy, any portion of the output that is not consumed—either privately by households (C) or by the government (G)—necessarily must be allocated towards investment (I). Thus, the equation underscores a foundational economic principle: the total output of an economy (Y) is either consumed or invested, leaving no surplus output.

31.4.2 Open economy

In an open economy, the dynamics of household consumption, government expenditures, and firm investments extend beyond domestic production to include imports from and exports to foreign markets. Thus, an economy can import and export goods. Denoting imports by IM and exports by EX, we can re-write the fundamental equation of economics by adding the concept of net exports (NEX), the difference between a country's exports and imports. A positive net export value ($EX > IM$) indicates a trade surplus, reflecting that the economy exports more than it imports. Conversely, a negative net export value ($EX < IM$) signifies a trade deficit, where imports exceed exports:

$$\begin{aligned} Y &= C + I + G + \underbrace{EX - IM}_{NEX} \\ \Leftrightarrow \underbrace{Y - C - G}_{S} &= I + NEX \\ \Leftrightarrow \underbrace{S - I}_{NCO} &= NEX \end{aligned}$$

In scenarios where investment equals savings ($I = S$), the economy's net exports are zero, reflecting a balance between domestic production not allocated towards household or government consumption and investments. However, when an economy experiences a trade surplus ($NEX > 0$), such as Germany in recent decades, it implies that domestic savings exceed investments. This surplus indicates that the country produces more than it spends on domestic goods and services, channeling excess savings into investments abroad. Thus, savings not utilized domestically ($S - I$) are equivalent to the net capital outflow (NCO), establishing a direct link between a country's trade surplus and its role as a global lender or investor:

$$NCO = NEX$$

> **i** Net exports must be equal to net capital outflow
> The accounting identities above simply state that there is a *balance of payments*. The Balance of Payment accounts are based on double-entry bookkeeping and hence the annual account has to be balanced. If an economy has a current account trade deficit (surplus), it is offset one-to-one by a capital account surplus (deficit) to assure a balance of payments. In other words, if an economy wants to import more goods than it produces, it must attract foreign capital to be invested at home.

31.5 Case study: U.S. trade deficit

Consider a scenario where the United States is unable to attract sufficient capital flows from abroad to finance its trade deficit. In such a case, American consumers continue purchasing foreign goods with US

Dollars, leading to an outflow of US Dollars that surpasses inflow. This imbalance results in an increased supply of US Dollars relative to its demand, causing the value of the US Dollar to depreciate. A depreciated US Dollar would, in theory, make US exports more competitive (cheaper for foreign buyers) and imports more costly, thereby potentially reducing the current account deficit. However, the trade deficit of the United States has remained relatively stable, and the US Dollar has not experienced significant depreciation. This stability is partly why former President Trump criticized other countries for allegedly *manipulating* their currencies, see Figure 31.2.

As Trump thinks a trade deficit is bad for the United States, he would like to have a weak dollar and low interest rates. He advocated for a weaker dollar (I guess he would never express it like that) and lower interest rates to address this issue. A weaker dollar would render American products more affordable internationally, stimulating exports and discouraging imports. Concurrently, lower interest rates in the United States would diminish the country's appeal for foreign capital investments (I would decrease), leading to reduced net capital inflows. This adjustment would, in turn, decrease the **Capital Account** surplus and, by extension, shrink the **Current Account** deficit. Specifically, Trump accused the Chinese government and the European Central Bank of implementing policies that undervalue their currencies (the Renminbi and the Euro), thereby gaining an unfair advantage in trade.

Figure 31.2: Trump worries about the U.S. trade deficit

Despite significant efforts by President Trump to reduce the U.S. trade deficit, the endeavor did not achieve its intended outcome, as illustrated in Figure 31.3. One likely reason for this shortfall was the reduction of taxes for large corporations, which enhanced the rate of return on investments. This policy made investing in the U.S. more appealing to foreign investors, potentially counteracting efforts to diminish the trade deficit.

Figure 31.3: The trade deficit of the United States over time

Exercise 31.3. Discuss the pros and cons of Germany's net export surplus. Please watch this video, see Figure 31.4.

Figure 31.4: Marcel Fratzscher and Clemens Fuest about Germany's trade surplus

Source: YouTube

Part VII

INTERNATIONAL TRADE

Chapter 32

Basics

Recommended readings: Suranovic (2012, Chapters 2, 3, 5)

Learning objectives:

Students will be able to:

- Understand the basic concepts underpinning international trade, including the principle of mutual benefits.
- Evaluate reasons for trade, including technology differences, resource endowments, and government policies.
- Explain the difference of absolute comparative advantage and their role in driving trade patterns.
- Understand how differences in labor and capital endowments influence trade patterns.
- Discuss the impact of international trade on factor prices.

Trade is usually a voluntary decision by buyers and sellers, which means that transactions would not take place if one party were to lose from the exchange. While this reasoning is persuasive, it alone does not fully justify unrestricted international trade. In the following chapters, we will look at the concept that trade should be mutually beneficial to the parties directly involved. We will also discuss the ways in which trade can be beneficial to all parties, even though it is not necessarily beneficial to all. The remainder is structured as follows:

- Section 32.1 explains Mankiw's principle that trade can make everyone better off.
- Section 32.2 paraphrases the sources of international trade.
- Section 32.3 provides a theoretical framework of trade and shows that under certain circumstances international trade can yield a miserable growth path for a country.
- Section 32.4 explains that more trade does not have to be good for a country's wealth.
- Chapter 33 introduces the concept of comparative advantage. It claims that trade is due to autarky price differences that stem from country-specific differences such as technology, factor endowments, or taste.

- Chapter 34 shows that opening up to free trade generates winners and losers and that countries' endowments with labor and capital determine patterns of trade.

32.1 Trade can make everyone better off

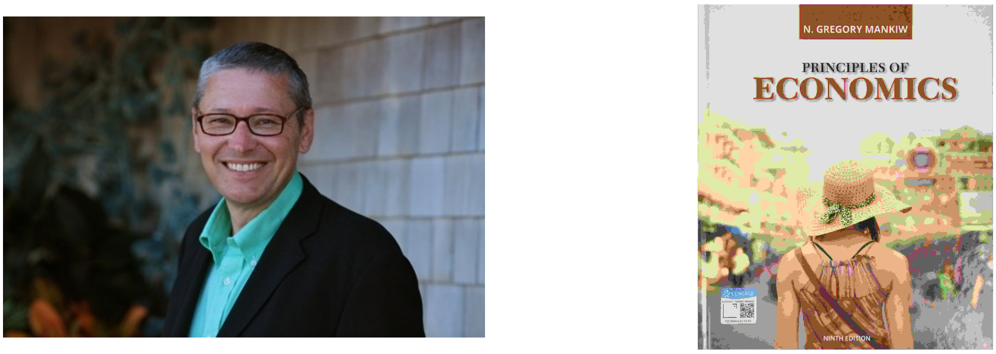
N. Gregory Mankiw (*1958) is one of the most influential economists. In his best-selling textbook *Principles of Economics* (N. G. Mankiw, 2024, pp. 8–9) he claims ten principles of economics of which one is entitled *Trade can make everyone better off* which he explains as follows:

> You have probably heard on the news that the Japanese are our competitors in the world economy. In some ways, this is true, for American and Japanese firms do produce many of the

Figure 32.1: Mankiw and his textbook

(a) N. Gregory Mankiw

(b) Mankiw's textbook



Source: Harvard.edu and N. G. Mankiw (2024).

> same goods. Ford and Toyota compete for the same customers in the market for automobiles. Compaq and Toshiba compete for the same customers in the market for personal computers.
>
> Yet it is easy to be misled when thinking about competition among countries. Trade between the United States and Japan is not like a sports contest, where one side wins and the other side loses. In fact, the opposite is true: Trade between two countries can make each country better off.
>
> To see why, consider how trade affects your family. When a member of your family looks for a job, he or she competes against members of other families who are looking for jobs. Families also compete against one another when they go shopping, because each family wants to buy the best goods at the lowest prices. So, in a sense, each family in the economy is competing with all other families.
>
> Despite this competition, your family would not be better off isolating itself from all other families. If it did, your family would need to grow its own food, make its own clothes, and build its own home. Clearly, your family gains much from its ability to trade with others. Trade allows each person to specialize in the activities he or she does best, whether it is farming, sewing, or home building. By trading with others, people can buy a greater variety of goods and services at lower cost.
>
> Countries as well as families benefit from the ability to trade with one another. Trade allows countries to specialize in what they do best and to enjoy a greater variety of goods and services. The Japanese, as well as the French and the Egyptians and the Brazilians, are as much our partners in the world economy as they are our competitors.

32.2 Reasons for Trade

Trade involves willingly giving up something to receive something else in return, which should benefit both parties involved, although not necessarily everyone affected by the trade. We will discuss the negative effects of international trade on bystanders later. In this section, we briefly outline basic reasons for individuals and hence countries to engage in trade. Of course, the list is incomplete.

Differences in Technology: Advantageous trade can occur between countries if they have different technological abilities to produce goods and services. Technology refers to the techniques used to convert resources (labor, capital, land) into outputs. Differences in technology form the basis for trade in the Ricardian Model of comparative advantage. We will revisit this in more detail in Chapter 33.

Differences in Endowments: Trade also occurs because countries differ in their resource endowments, which include the skills and abilities of the workforce, available natural resources, and the sophistication of capital stock such as machinery, infrastructure, and communication systems. Differences in resource endowments are the basis for trade in the pure exchange models (see Section 32.3) and the Heckscher-Ohlin Model (see Chapter 34).

Differences in Demand: Trade between countries occurs because demands or preferences differ. Individuals in different countries may prefer different products even if prices are the same. For example, Asian populations might demand more rice, Czech and German people more beer, the Dutch more wooden shoes, and the Japanese more fish compared to Americans.

Economies of Scale in Production: Economies of scale, where production costs fall as production volume increases, can make trade between two countries advantageous. This concept, known as *increasing returns to scale*, plays a significant role in Paul Krugman's *New Trade Theory*, which we will discuss later.

Existence of Government Policies: Government tax and subsidy programs can create production advantages for certain products, leading to advantageous trade arising solely from differences in government policies across countries. We will explore the impact of tariffs and regulations in Chapter 37.

32.3 Exchange economy

Recommended reading

Suranovic (2012, Chapter 3)

32.3.1 A simple barter model

The simplest example to show that trade can be beneficial to people is the barter model. In trade, barter is a system of exchange in which participants in a transaction directly exchange goods or services for other goods or services without using a medium of exchange, such as money.

Figure 32.2: Stylized example of weißwürst and pretzels

Source: Wikipedia

Suppose there are two people, Anton (A) and Barbara (B). Anton has 10 Weißwürste (white sausages) and Barbara has 10 pretzels. Together, they are isolated from the rest of the world for a few days due to a natural disaster. Fortunately, they both have additional access to an endless supply of sweet mustard and beer and they now wonder how to share pretzels and sausages the upcoming days. Let's assume that both of them accept only a white sausage eaten together with a pretzel. That is, eating two pretzels with a sausage is no better than eating a pretzel and a sausage. After some discussion, Barbara gives 5 pretzels and Anton gives Barbara 5 sausages in return. They strongly believe that there is no better way to share food.

This example shows that trade can be beneficial for two individuals. Here we basically assume two things. Firstly, two individuals can trade and secondly, they are endowed with different goods.

Exercise 32.1. How Barbara and Anton trade

a) Visualize the starting point of Anton and Barbara as described above in a two-way plot where the Anton's initial endowment with sausages is drawn on the y-axis and Barbara's endowment with pretzels is drawn on the x-axis.
b) Given their preferences, mark the consumption point after goods were traded. Also, draw in the plot how much Anton and Barbara exports and imports, respectively.
c) Sketch the indifference curve of both individuals in the consumption point after trade has happened.
d) Draw a new two-way plot and assume that Barbara now gives away 2 pretzels in order to receive one sausage. Mark the resulting consumption points of Anton and Barbara. Given their unchanged preference for having one sausage with one slice of bread at best, visualize with the help of sketched indifference curves that both individuals are worse off as compared to consuming 5 units of pretzels and sausages each.

Solution 32.1. In Figure 32.3 you find a sketch of a solution to tasks a. to c. Figure 32.4 provides a solution to task d.

Figure 32.3: The deal of Anton and Barbara

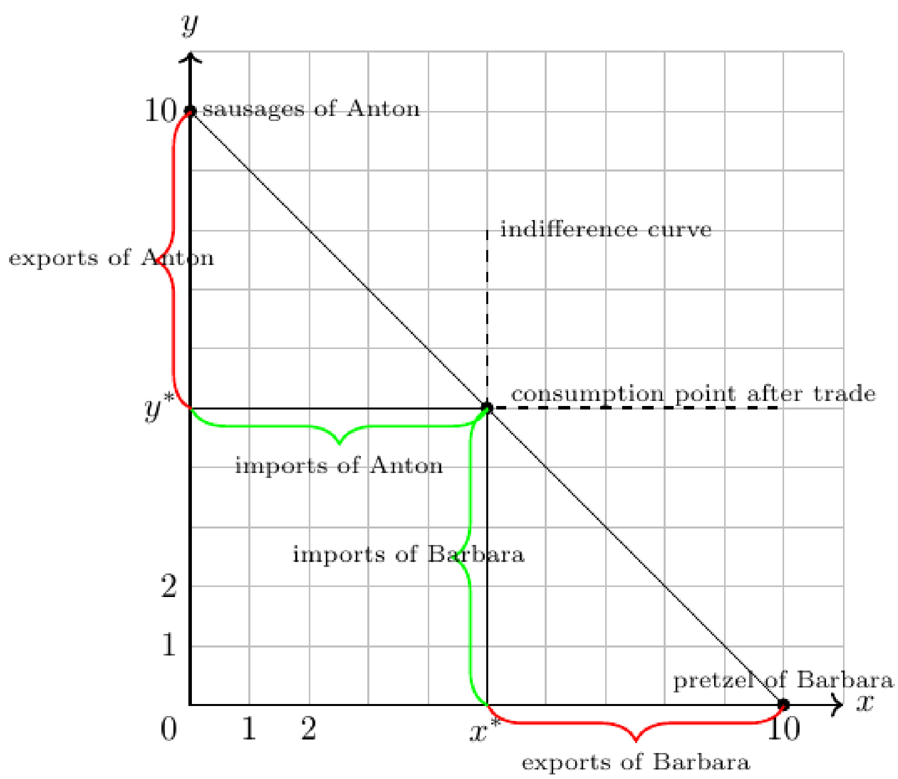
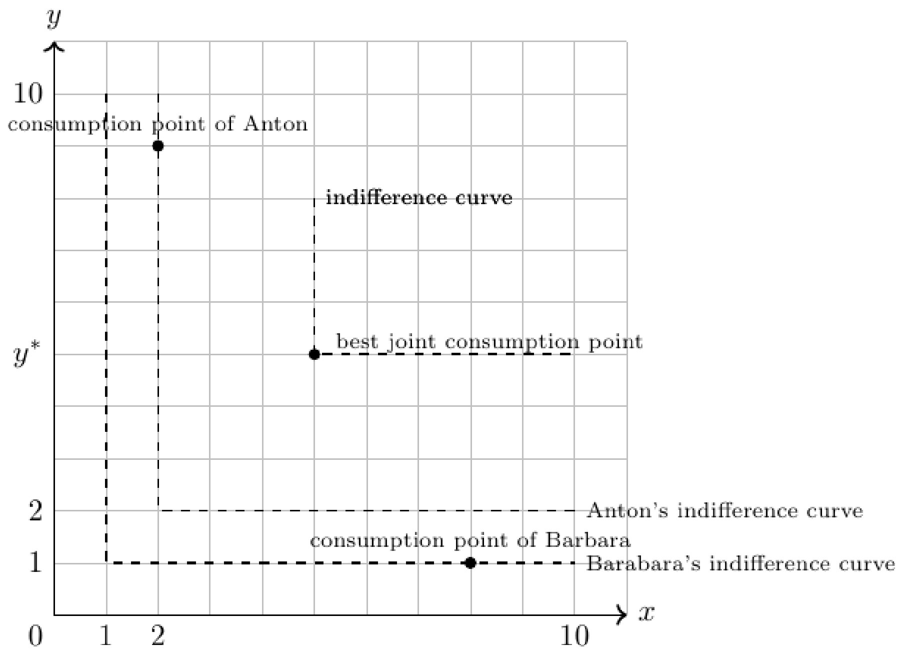


Figure 32.4: Indifference curves of Anton and Barbara



32.3.2 Terms of trade

Definition

The terms of trade is defined as the quantity of one good that exchanges for a quantity of another. It is typical to express the terms of trade as a ratio.

In the example of Barbara and Anton, the exchange of goods occurs at a 1:1 ratio. In economics, this is referred to as the terms of trade being 1. The terms of trade are defined as the relative price of exports in relation to imports, or in other words, how much of one good can be exchanged for another. For instance, determining how many sausages can be exchanged for how many pretzels. The terms of trade, determined by the two trading partners, depend on a variety of distinct factors, including:

Preferences: For trade to occur, each trader must desire something the other has and be willing to give up something of their own to obtain it. Formally, the expected utility of consuming some of Anton's bread must exceed the disutility of foregoing a few of his sausages, and vice versa for Barbara. Typically, the goods are substitutable rather than perfectly complementary, as is assumed in our specific example.

Uncertainty: Both individuals have clear preferences. If Barbara has never tried Anton's sausages, and Anton typically prefers bread over pretzels, offering free samples before an exchange could reduce uncertainty. Without a sample, their trade would be based on expectations about the taste of the other's product.

Scarcity: The availability of the two goods influences the terms of trade. If, for instance, Barbara has 1000 pretzels, the terms of trade with the sausages would likely change.

Size: The physical size of the goods can impact the terms of trade.

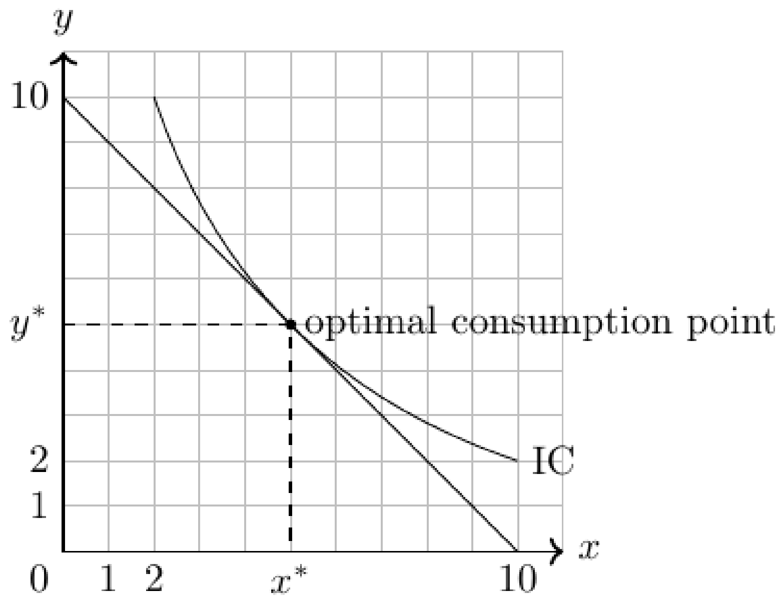
Quality: The quality of goods affects the terms of trade. If the pretzels are stale and hard, both might prefer fewer pretzels per sausage.

Persuasion: If Barbara is a more persuasive salesperson than Anton, she might be able to negotiate more favorable terms of trade.

Government Policy: Taxes imposed by an official based on the traded quantities could affect the terms of trade. Additionally, if laws prevent Barbara and Anton from meeting, no trade would occur.

Exercise 32.2. Terms of trade

Figure 32.5: Optimal consumption point



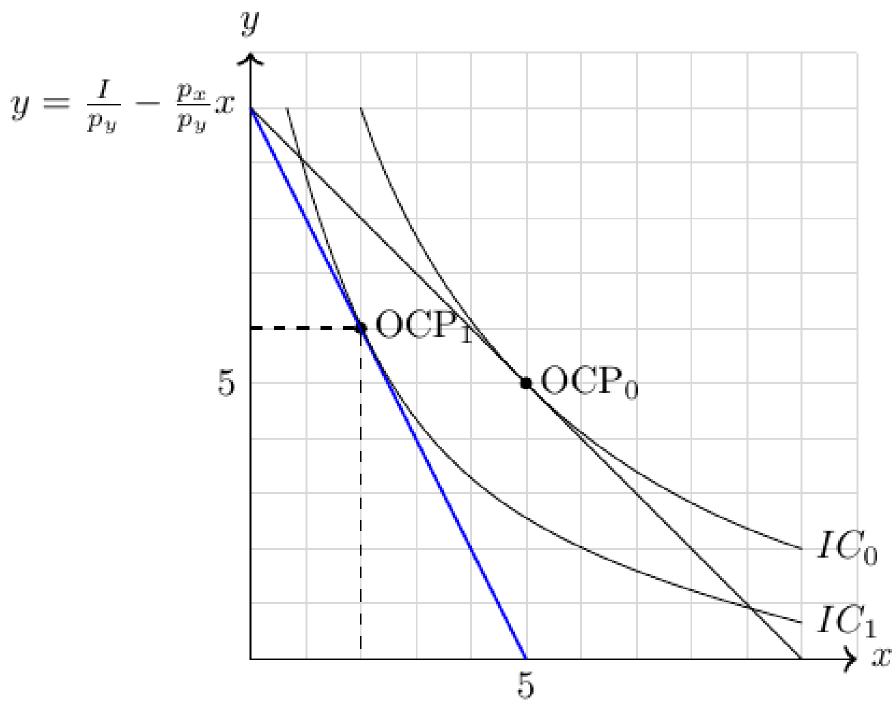
Suppose you have a fixed income $I = 10$ that you can spend on consuming two substitutable goods x, y at certain prices $p_x = 1, p_y = 1$. The current consumption decission is sketched in the figure above. Suppose the price of good x increases, that is, $p_x = 2$. Draw the new budget line. How will consumption change? What are the new terms of trade?

Solution

The new point of optimal consumption OCP_1 at $(x = 2, y = 6)$ illustrates that an increase in the price of good x leads consumers to substitute good x and consume more of good y but less of good x.

The terms of trade are now $\frac{p_x}{p_y} = 2$. That is, consumers are willing to give up 1 unit of good x to receive 2 units of good y. The budget line is drawn in blue.

Figure 32.6: Optimal consumption point after price increase



Note: The indifference curve IC_1 in the graph is just a guess of mine because we don't have preferences in form of a utility function given. For example, you can also draw an indifference curve that gives you the optimal consumption point at $(x = 1; y = 8)$ or $(x = 4; y = 2)$.

32.3.3 Endowments in an Exchange Economy

In this section, we examine a basic scenario where productive units within an economy are unable to adjust their output to recent changes in world market prices, which stem from global demand and supply fluctuations. Economists refer to the resulting availability of goods as endowments. Essentially, a country is endowed with a certain quantity of goods and seeks to trade these goods on global markets to maximize its welfare. In Chapter 34 we will assume that countries are endowed with a certain amount of factors of production that they can use to produce various goods.

32.3.3.1 Fixed production

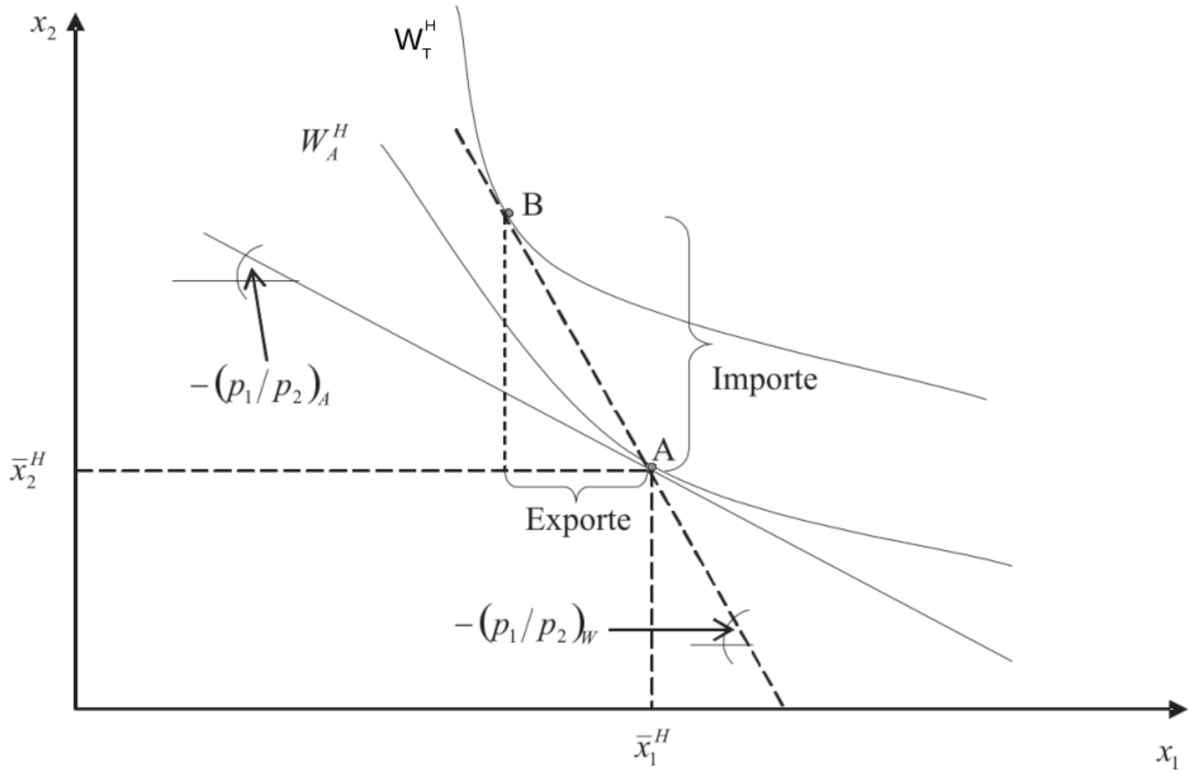
Imagine that country H produces $\bar{x}_1^H$ units of good 1 and $\bar{x}_2^H$ units of good 2. In autarky (a state of where there is no trade), it consumes all the goods it produces. This scenario is shown in Figure 32.7, where point A represents the optimal welfare outcome with utility W_A^H for country H in autarky.

Now, let's assume country H can trade with the rest of the world at global market prices, where the price ratio of good 1 to good 2 in the world market, $(\frac{p_1}{p_2})_W$, is greater than in autarky, $(\frac{p_1}{p_2})_A$:

$$\left(\frac{p_1}{p_2}\right)_W > \left(\frac{p_1}{p_2}\right)_A, \tag{32.1}$$

With trade, country H can achieve a higher utility, $W_T^H > W_A^H$, by exporting good x_1 and importing good x_2, thus moving to a more advantageous consumption point.

Figure 32.7: Optimizing consumption through trade



32.3.3.2 Flexible production

- Trade is even more beneficial to a country if it can adjust its production to export more goods that are relatively high priced in the world market. This statement is shown in Figure 32.8.
- In autarky, optimal consumption would be at point A and optimal consumption would be at point C under free trade. Now suppose that producers in country H know that they can sell their goods at price p_1^W and p_2^W before deciding what to produce. Then they would choose production point B on the production frontier curve to export good x_1 and import good x_2 at price $(\frac{p_1}{p_2})_A$ to be consumed at point D. Welfare at point D is higher than at point C or A because we end up at the highest indifference curve.

Exercise 32.3. Production and consumption

Figure 32.8: Optimizing consumption by adjusting production and trade

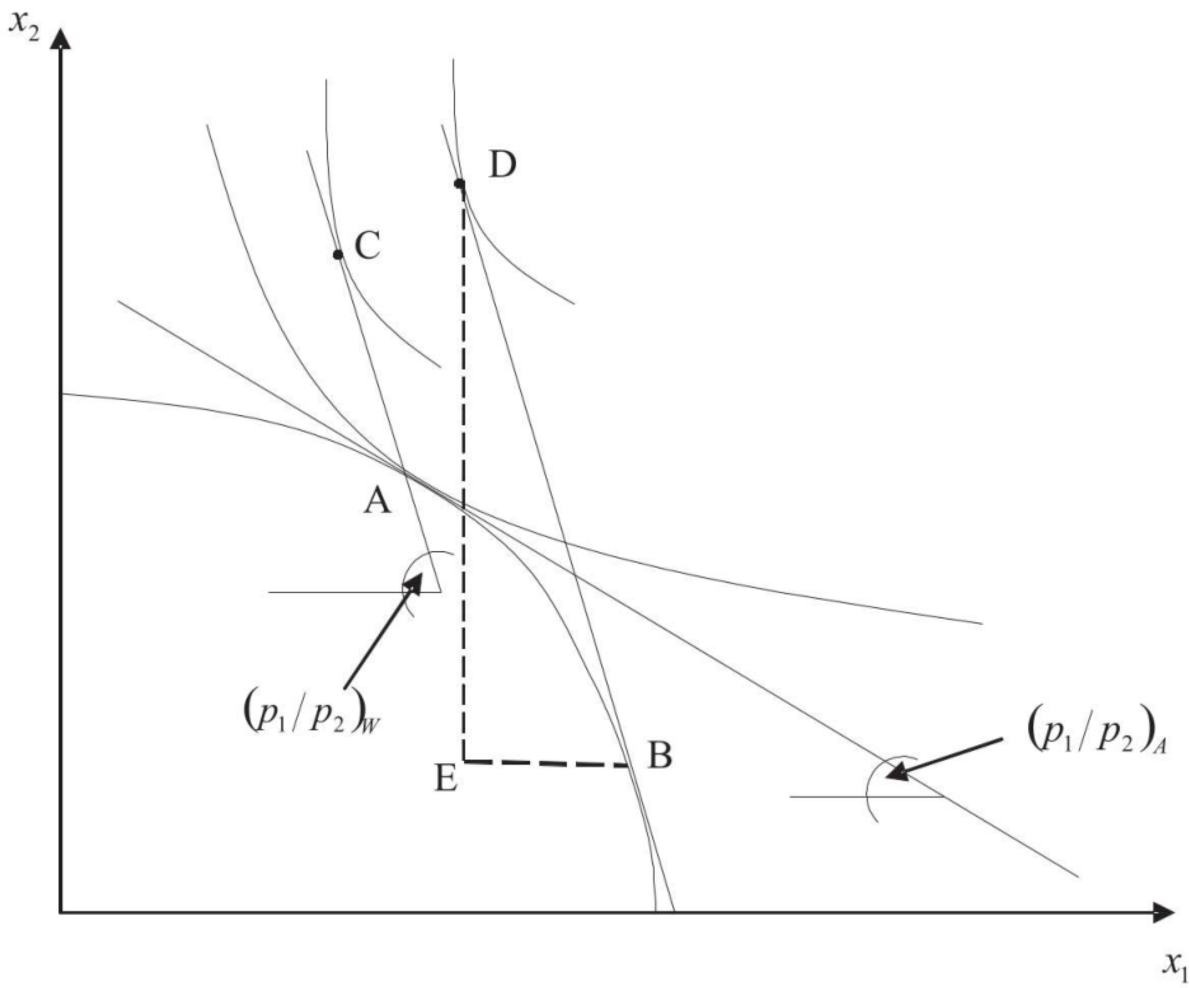
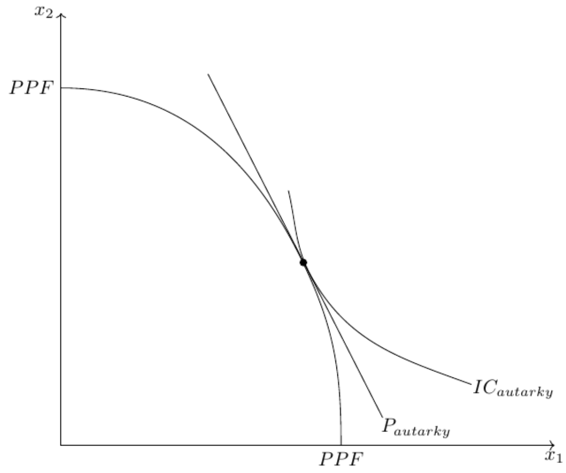


Figure 32.9: Optimizing consumption by adjusting production and trade



In Figure 32.9 the production possibility frontier curve, PPF, of a country, H, in autarky in which only two products, x_1 and x_2, can be produced and consumed, respectively.

a) Given the country is in autarky (that is, no trade), the price relation of both goods within the country is represented by the line denoted with $P_{autarky}$. The indifference curve that represents the utility maximizing level of utility is denoted with $IC_{autarky}$. Mark in the figure how much of both goods are produced and consumed, respectively.

b) Suppose country H opens up to trade with foreign countries. Further assume that the country can trade with other countries at fixed world market prices

$$\left(\frac{p_1}{p_2}\right)_W > \left(\frac{p_1}{p_2}\right)_A, \tag{32.2}$$

where $(\frac{p_1}{p_2})_A$ denotes the price relation of country H in autarky, $P_{autarky}$. Sketch the world market price relation in the figure and mark the new production point on the production possibility frontier curve. Moreover, mark below those statements that are **true**:

c) Country H will produce more of good x_1 than in autarky

d) Country H will produce more of good x_2 than in autarky

e) Country H will consume more of good x_1 than in autarky

f) Country H will export good x_1 and import good x_2.

g) Country H will export good x_2 and import good x_1.

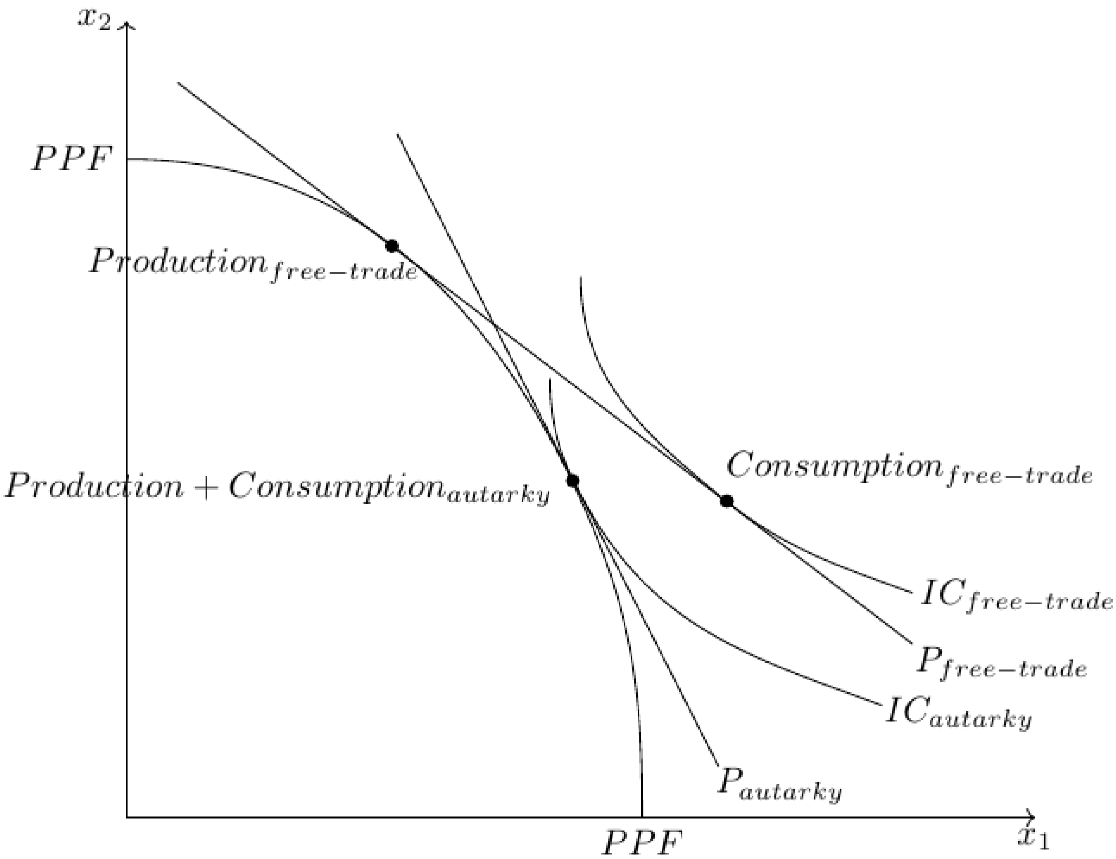
h) Country H will suffer a loss of welfare due to opening up to trade.

Exercise 32.4. Production and consumption
Show that opening markets to foreign trade can be beneficial for a small economy where only two goods can be produced and consumed. Use a two-way diagram to do this. In particular, show the consumption and production point of the economy in autarky with the corresponding price relation. Then assume that the economy opens up to the foreign market, allowing it to buy goods at world prices that are different from prices in autarky. Show the consumption and production point of the autarkic economy with the corresponding price relation under free trade. Can you outline the higher level of welfare in free trade?

Solution

As visualized in Figure 32.10, the indifference curve under free trade lies above the IC under autarky. This reflects the higher utility level under free trade.

Figure 32.10: Gains from trade



32.4 More trade is not necessarily good (immiserizing growth)

So far, I have implicitly assumed that the world market price is fixed and not changed by the entry of country H into the free trade market. When the latter is the case, economists speak of a small open economy (SOE). In general, a SOE is an economy that is so small that its policies do not change world prices.

Suppose that country H is not an SOE. What would happen to world prices if country H offered a lot of good x_1 to receive good x_2? Obviously, $(\frac{p_1}{p_2})_W$ would fall. In the worst case, country H is so large that

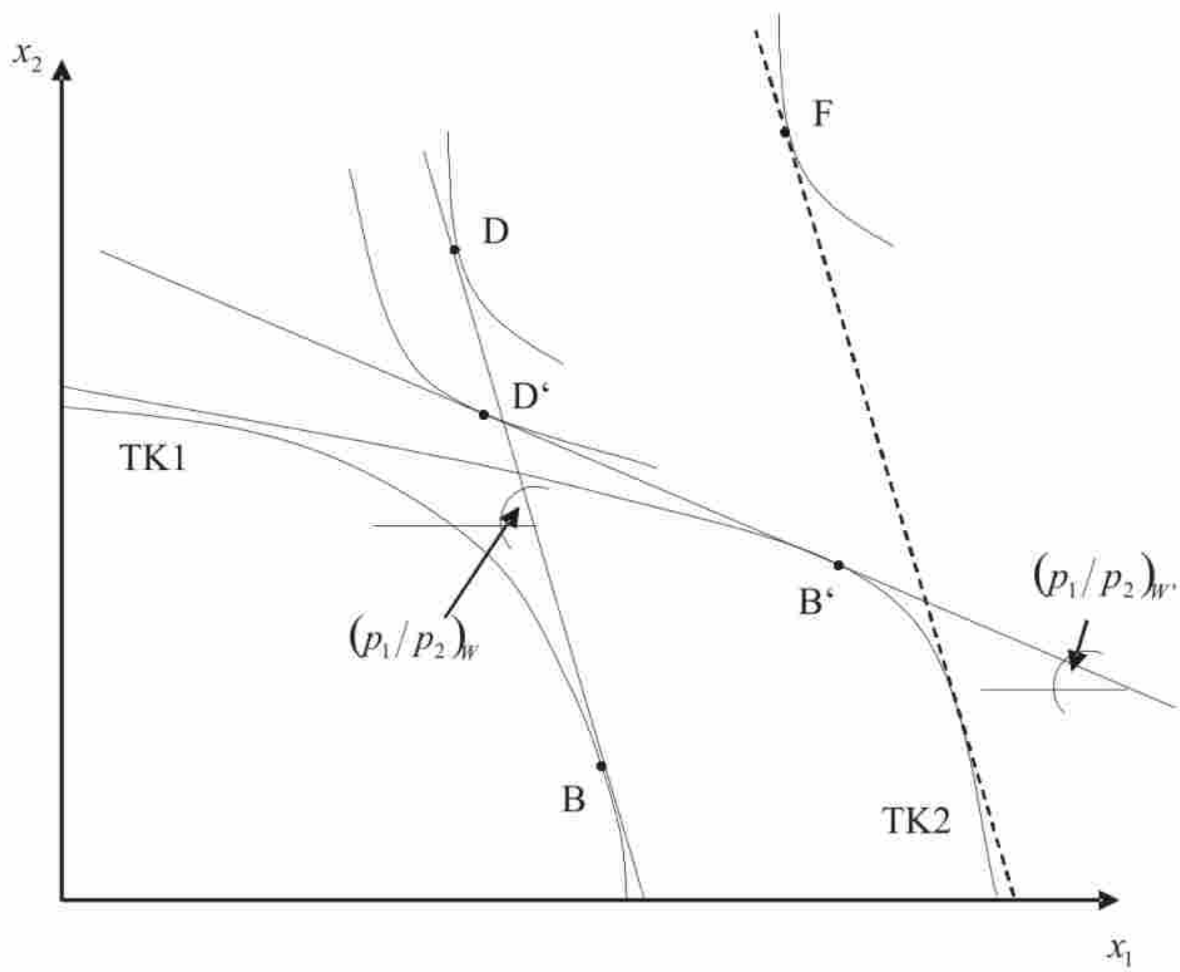
$$\left(\frac{p_1}{p_2}\right)_W = \left(\frac{p_1}{p_2}\right)_A .$$

This means that country H has no benefits from free trade.

Assuming that a (large) country cannot opt out from free trade and that the exporting sector grows, there is a theoretical scenario called *immiserizing growth* that shows that free trade countries are worse off in the long run. This scenario is illustrated in Figure 32.11. The figure summarizes two periods. In the first period, country H produces at point B and consumes at point D, trading goods at world prices $(\frac{p_1}{p_2})_W$. Then country H grows in sector 1. This is shown in the new production possibility curve TK2. If country H were able to trade at the old world price, it would be able to consume at point F. Unfortunately, country H is not a SOE, and therefore world prices (from country H's perspective) deteriorate to $(\frac{p_1}{p_2})'_W$.

This has bad implications for country H, since its optimal consumption is now at point D', which has lower welfare relative to point D. However, this is not an argument against trade, since the welfare at point D' is still above the production possibility curve in autarky, TK1.

Figure 32.11: Immiserizing growth



Chapter 33

Comparative advantage

Learning objectives

- Less-developed countries can compete in international markets even if they are less productive in producing everything. In other words, opening to trade is beneficial for countries that have an absolute disadvantage in the production of all goods.
- Both, developed and less-developed countries can gain from international trade.
- Specialization in production increases the price of exported goods for that country. As a result, prices converge.
- A discussion of national competitiveness is not useful through the lens of the Ricardo theorem.

Recommended reading: Suranovic (2012, Chapter 2)

Figure 33.1: This painting shows Ricardo, aged 49 in 1821.

Source: National Portrait Gallery

David Ricardo (1772-1823), one of the most influential economists of his time, had a simple idea that had a major impact on how we think about trade. In Ricardo (1817), he argued that bilateral trade can be a positive-sum game for both countries, even if one country is less productive in all sectors, if each country specializes in what it can produce relatively best.

He introduced the theory of comparative advantage that is still an important corner stone of the modern theory of international trade[1] The theory is also known as the *Ricardian model*. It refers to the ability of one party (an individual, a firm, or a country) to produce a particular good or service at a lower opportunity cost than another party. In other words, it is the ability to produce a product with the highest relative efficiency, given all other products that could be produced. In contrast, an absolute advantage is defined as the ability of one party to produce a particular good at a lower absolute cost than another party.

[1] Actually, strictly speaking, this is not correct, since the original description of the idea can already be found in Torrens (1815). However, David Ricardo formalized the idea in his 1817 book using a convincing and simple numerical example. For more information on this, as well as a great introduction to the Ricardian model and more, I recommend Suranovic (2012).

Figure 33.2: Comparative advantage: Specialize and exchange

As shown in Figure 33.2, the concept of comparative advantage is quite simple. Two parties can increase their overall productivity by sharing the workload based on their respective comparative advantages. Once they have achieved this increase in productivity, they must agree on how to divide the resulting output. Of course, both parties must benefit compared to a scenario in which they work independently.

33.1 Defining absolute and comparative advantages

A subject (country, household, individual, company) has an **absolute advantage** in the production of a good relative to another subject if it can produce the good at lower total costs or with higher productivity. Thus, absolute advantage compares productivity across subjects but within an item.

A subject has a **comparative advantage** in the production of a good relative to another subject if it can produce that good at a lower opportunity cost relative to another subject.

Let me explain the idea of the concept of comparative advantage with some examples:

Old and young

Two women live alone on a deserted island. In order to survive, they have to do some basic activities like fetching water, fishing and cooking. The first woman is young, strong and educated. The second is older, less agile and rather uneducated. Thus, the first woman is faster, better and more productive in all productive activities. So she has an absolute advantage in all areas. The second woman, in turn, has an absolute disadvantage in all areas. In some activities, the difference between the two is large; in others, it is small. The law of comparative advantage states that it is not in the interest of either of them to work in isolation: They can both benefit from specialization and exchange. If the two women divide the work, the younger woman should specialize in tasks where she is most productive (for example, fishing), while the older woman should focus on tasks where her productivity is only slightly lower (for example, cooking). Such an arrangement will increase overall production and benefit both.

The lawyer's typist

The famous economist and Nobel laureate Paul Samuelson (1915-2009) provided another example in his well-received textbook of economics, as follows: Suppose that in a given city the best lawyer also happens to be the best secretary. However, if the lawyer focuses on the task of being a lawyer, and instead of practicing both professions at the same time, hires a secretary, both the lawyer's and the secretary's performance would increase because it is more difficult to be a lawyer than a secretary.[2]

33.2 Autarky: An example of two different persons

Assume that A and B want to produce and consume y and x respectively. Because of the complementarity of the two goods, each must be consumed in combination with the other. The utility function of both

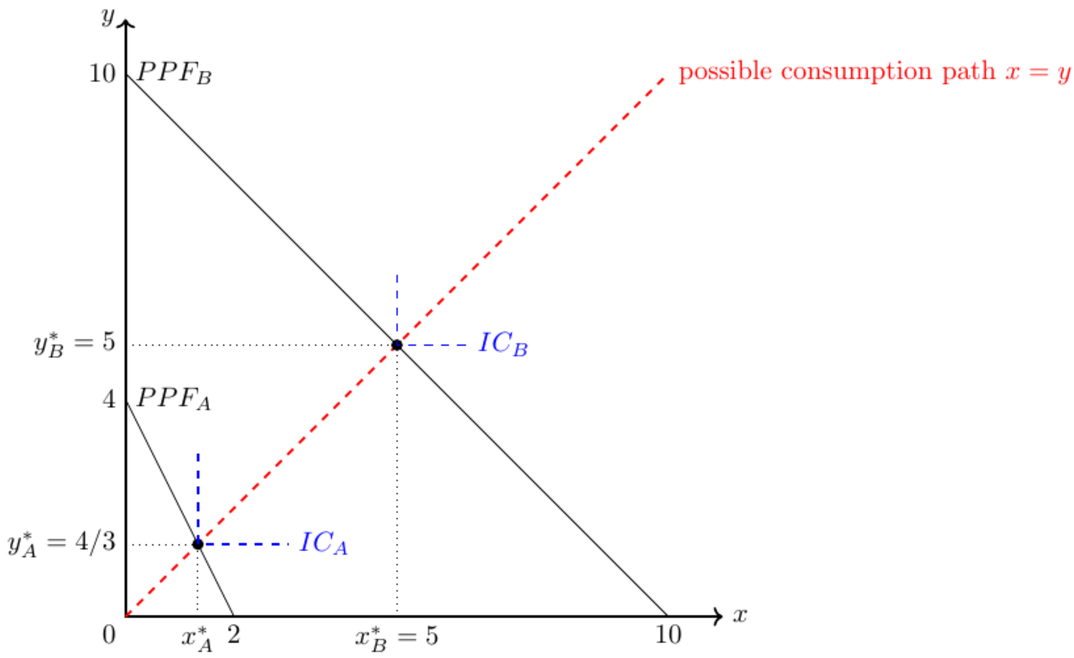
[2]In the first eight editions the example comprised a male lawyer who was better at typing than his female secretary, but who had a comparative advantage in practising law. In the ninth edition published 1973, both lawyer and secretary were assumed to be female (see Backhouse & Cherrier, 2019). Unfortunately, women are still discriminated against in introductory economics textbooks (see Stevenson & Zlotnik, 2018).

persons is $U_{\{A;B\}} = min(x, y)$. Both persons work for 4 time units, that is, their units of labor are $L_A = L_B = 4$. A needs 1 units of labor to produce one unit of good y and 2 units of labor to produce one unit of good x. B needs $\frac{4}{10} = 0.4$ units of labor to produce one unit of good y or good x. Thus, their **labor input coefficients**, which measure the units of labor required by a subject to produce one unit of good, are $a_y^A = 1, a_x^A = 2, a_y^B = 0.4, a_x^B = 0.4$:

input coefficient (a)	A	B
Good y	1	0.4
Good x	2	0.4

Spending all her time in the production of y, A can produce $\frac{L_A}{a_y^A} = \frac{4}{1} = 4$ units of y and B can produce $\frac{L_B}{a_y^B} = \frac{4}{0.4} = 10$ units of y. Spending all her time in the production of y, A can produce $\frac{L_A}{a_x^A} = \frac{4}{2} = 2$ units of $x$and B can produce $\frac{L_B}{a_x^B} = \frac{4}{0.4} = 10$ units of x. Knowing this, we can easily draw the production possibility frontier curves (PPF) of person A and B as shown in Figure 33.3.

Figure 33.3: The production possibility frontier in autarky



In autarky, both person maximize their utility: Individual A can consume $\frac{4}{3}$ units of each good and individual B can consume 5 units of each good. The respective indifference curves are drawn in dashed blue lines in Figure 33.3.

Exercise 33.1. Indifference curves for perfect complementary goods

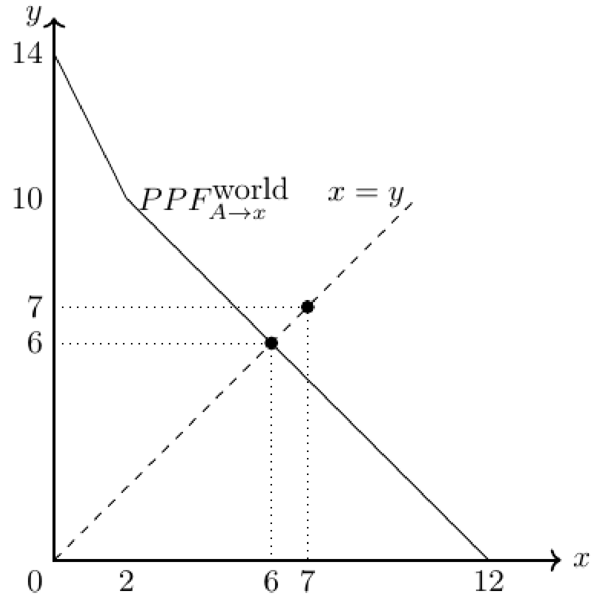
a) Name some real world examples of goods that are perfectly complementary.
b) The blue dashed lines in Figure 33.3 represent the indifference curves of individual A and B. The upward sloping dashed black line is denoted with "possible consumption path''. Explain, why is it not correct–in strict sense–to name it like that?

33.2.1 Can person A and B improve their maximum consumption with cooperation?

Let us assume the two persons come together and try to understand how they can improve by jointly deciding which goods they should produce. If we assume that both persons redistribute their joint production so that both have an incentive to share and trade, we can concentrate on the total production output. Their joint PPF curve can then be drawn in two ways:

1. Person A specializes in good x, then the joint production possibilities are presented in Figure 33.4.

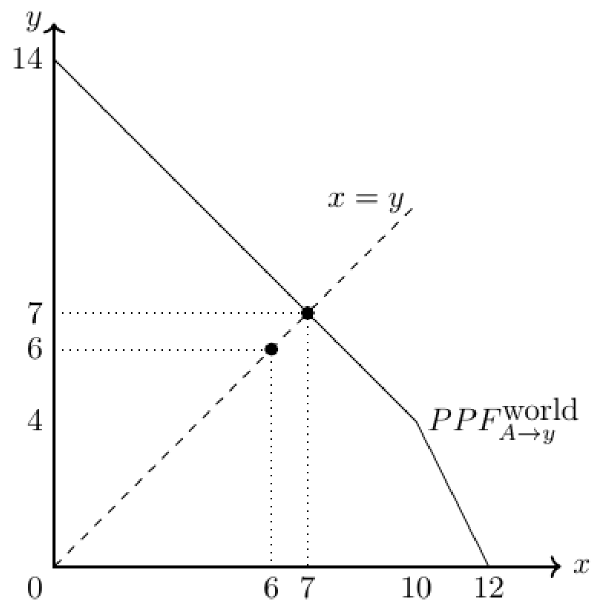
Figure 33.4: World PFF, A specializes in x



If A produces only good x, as shown in Figure 33.4, we see that A and B can consume a total of 6 units of goods x and y. This is less in total than in autarky, where A can consume $\frac{4}{3}$ units of each good and person B can consume 5 units of each good, giving a combined consumption of $\frac{19}{3} = 6,\bar{6}$.

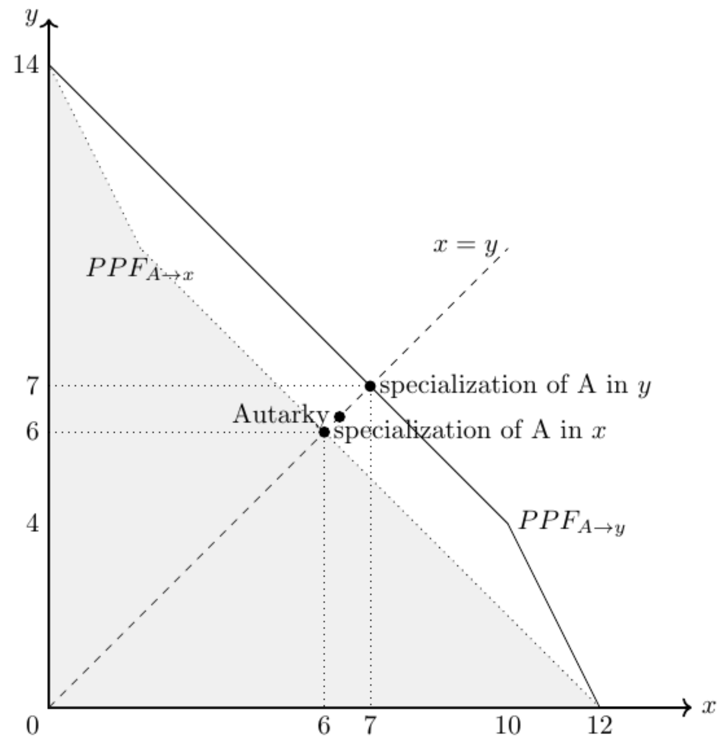
2. Person A specializes in good y, then the joint production possibilities are presented in Figure 33.5.

Figure 33.5: World PFF, A specializes y



If A produces only good y, as shown in Figure 33.5, we see that A and B can consume a total of 7 units of goods x and y. Thus, both can be better off compared to autarky, since the total quantity distributed

Figure 33.6: World PFF in autarky when A specialize in producing good y



is larger. Thus, we have an **Pareto improvement** here because at least one person can be better off compared to autarky.

In Figure 33.6, the three possible consumption scenarios are marked with a dot and the PPFs of person A specializing in the production of good x ($PPF_{A\to x}$) or good y ($PPF_{A\to y}$) are also drawn. The scenario with person A specializing in the production of good y is the output maximizing solution.[3]

33.2.2 Optimal production in cooperation

In order to produce the most bundles of both goods, the optimal cooperative production is

production in cooperation	A	B
Good y	4	3
Good x	0	7

33.2.3 Check for absolute advantage

Employing 10 units of labor B can produce more of both goods and hence has an absolute advantage in producing x and y. Formally, we can proof this by comparing the input coefficients of both countries in each good:

absolute advantage	A		B	
Good y	$a_y^A = 1$	$>$	$0.4 = a_y^B$	$\Rightarrow$ B has an absolute advantage in good y

[3]Note that this is also true for any other utility function, since $PPF_{A\to y}$ is always above $PPF_{A\to x}$.

absolute advantage	A		B	
Good x	$a_x^A = 2$	$>$	$0.4 = a_x^B$	$\Rightarrow$ B has an absolute advantage in good x

33.2.4 Check for comparative advantage

The slope of the PPFs represent the *marginal rate of transformation*, the terms of trade in autarky and the opportunity costs of a country. The opportunity costs are defined by how much of a good x (or y) a person (or country) has to give up to get one more of good y (or x). For example, A must give up $\frac{a_x^A}{a_y^A} = \frac{1}{2} = 0.5$ of good x to produce one more of good y. Thus, A's opportunity costs of producing one unit of y is the production foregone, that is, a half good x. All opportunity costs of our example are:

opportunity costs of producing ...	A	B
... 1 unit of good y:	$\frac{a_y^A}{a_x^A} = \frac{1}{2} = 0.5$ (good x)	$\frac{a_y^B}{a_x^B} = \frac{0.4}{0.4} = 1$ (good x)
... 1 unit of good x:	$\frac{a_x^A}{a_y^A} = \frac{2}{1} = 2$ (good y)	$\frac{a_x^B}{a_y^B} = \frac{0.4}{0.4} = 1$ (good y)

Person A has a comparative advantage in producing good y since A must give up less of good x to produce one unit more of good y than person B must. In turn, Person B has a comparative advantage in producing good x since B must give up less of good y to produce one unit more of good x than person B must give up of good y to produce one unit more of good x. Thus, every person has a comparative advantage and if both would specialize in producing the good in which they have a comparative advantage and share their output they can improve their overall output as was shown in Figure 33.6.

An alternative and more direct way to see the comparative advantages of A and B, respectively, is by comparing the two input coefficients of A with the two input coefficients of B:

$$\frac{a_y^A}{a_x^A} \lesseqgtr \frac{a_y^B}{a_x^B} \quad \Rightarrow \quad \frac{1}{2} < \frac{0.4}{0.4}.$$

Thus, A has a comparative advantage in y and B in x.

Comparative advantage: Definition
Economic subjects (e.g., individuals, households, firms, countries) should specialize in the production of that good in which they have a comparative advantage, that is, the ability of an economic subject to carry out a particular economic activity (e.g., producing goods) at a lower opportunity cost than a trade partner.

- $\frac{a_y^A}{a_x^A} > \frac{a_y^B}{a_x^B} \Rightarrow$ country A (B) has a comparative advantage in good x (y)
- $\frac{a_y^A}{a_x^A} < \frac{a_y^B}{a_x^B} \Rightarrow$ country A (B) has a comparative advantage in good y (x)
- $\frac{a_y^A}{a_x^A} = \frac{a_y^B}{a_x^B} \Rightarrow$ no country has a comparative advantage

33.2.5 Trade structure and consumption in cooperation

If A specializes in the production of y, she must import some of good y, otherwise she cannot consume a bundle of both goods as desired. In turn, B wants to import some of the good y. B will not accept to consume less than 5 bundles of y and x as this was his autarky consumption. Thus, B wants a minimum of 2 units of good y from A. A will not accept to give more than $4 - \frac{4}{3} = 2\frac{2}{3}$ items of good y away and he wants at least $\frac{4}{3}$ items of good x. Overall, we can define three trade scenarios:

1. All gains from cooperation goes to A (see Figure 33.7 and Table 33.6);

2. All gains from cooperation goes to B (see Table 33.8); or
3. The gains from specialization and trade are shared by A and B with a trade structure between the two extreme scenarios.

Table 33.5: Consumption and trade when all gains from cooperation goes to A

Consumption	A	B
Good y	2	5
Good x	2	5

Table 33.6: Consumption and trade when all gains from cooperation goes to A

Trade	A	B
Good y	-2	2
Good x	2	-2

Table 33.7: Consumption and trade when all gains from cooperation goes to B

Consumption	A	B
Good y	$\frac{4}{3}$	$5\frac{2}{3}$
Good x	$\frac{4}{3}$	$5\frac{2}{3}$

Table 33.8: Consumption and trade when all gains from cooperation goes to B

Trade	A	B
Good y	$-\frac{2}{3}$	$\frac{2}{3}$
Good x	$\frac{4}{3}$	$-\frac{4}{3}$

Each of the three cases yield a *Pareto-improvement*, that is, none gets worst but at least one gets better by mutually decide on production and redistribute the joint output. In the real world, however, it is often difficult for countries to cooperate and decide mutually on production and consumption. In particular, it is practically difficult to enforce redistribution of the joint outcome so that everyone is better off. So let's examine whether there is a mechanism that yields trade gains for both trading partners.

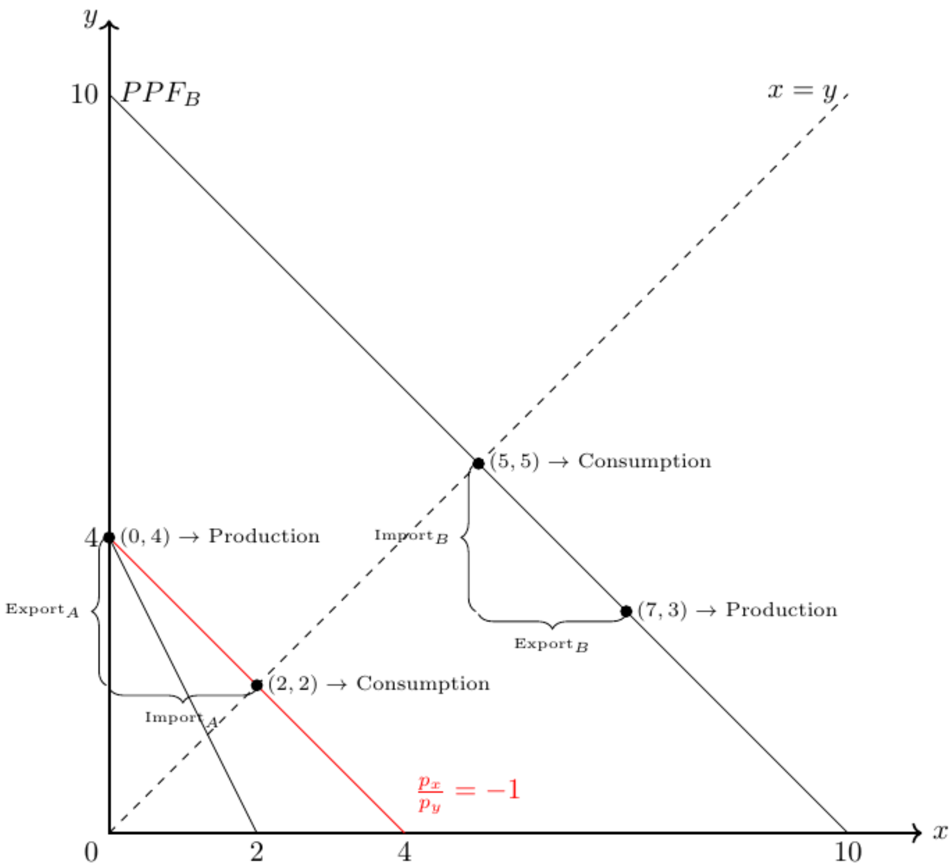
33.3 The Ricardian model

To understand the underlying logic of the argument, let us formalize and generalize the situation of two subjects and their choices for production and consumption.

In particular, the Ricardian Model build on the following assumptions:

- 2 subjects (A,B) can produce 2 goods (x,y) with
- technologies with constant returns to scale. Moreover,
- production limits are defined by $y^i Q_y^i + a_x^i Q_x^i = L^i$\$, where a_j^i denotes the unit of labor requirement for person $i \in \{A, B\}$ in the production of good $j \in \{x, y\}$ and Q_j^i denotes the quantity of good j produced by person i, and Q_j^i the quantity of good j produced by person i and Q_j^i the quantity of good j produced by person i. (Imagine they both work 4 hours).
- Let a_j^i denote the so-called labor input coefficients, that is, the units of labor required by a person $i \in \{A, B\}$ to produce one unit of good $j \in \{x, y\}$.

Figure 33.7: Bilateral trade with one winner



- Suppose further that person B requires fewer units of labor to produce both goods, that is, $a_y^A > a_y^B$ and $a_x^A > a_x^B$, and that
- a comparative advantage exists, that is, $\frac{a_y^B}{a_x^B} \neq \frac{a_y^A}{a_x^A}$.

Ricardian theorem
If each country specialize in the production in the good for which it has a comparative advantage and exports this good, both countries gain from trade when the new world market price relation, $\frac{p_y^*}{p_x^*}$, lies between the price relations of both countries[4]

$$\frac{a_y^B}{a_x^B} = \frac{p_y^B}{p_x^B} > \frac{a_y^*}{a_x^*} = \frac{p_y^*}{p_x^*} > \frac{p_y^A}{p_x^A} = \frac{a_y^A}{a_x^A}$$

because the consumption possibilities enlarge for both countries compared to a situation with no trade.

[4]In order to see that the relative prices within a country equals the relative productivity parameters, consider that nominal income of labor in producing good $j \in \{x, y\}$, $w_j L_j^i$, must equal the production value, that is, $p_j^i x_j^i$:

$$w_j L_j^i = p_j^i x_j^i.$$

Setting $w_j = 1$ as the numeraire and re-arranging the equation, we get

$$p_j^i = \frac{L_j^i}{x_j^i} = a_j^i.$$

33.4 Distribution of welfare gains

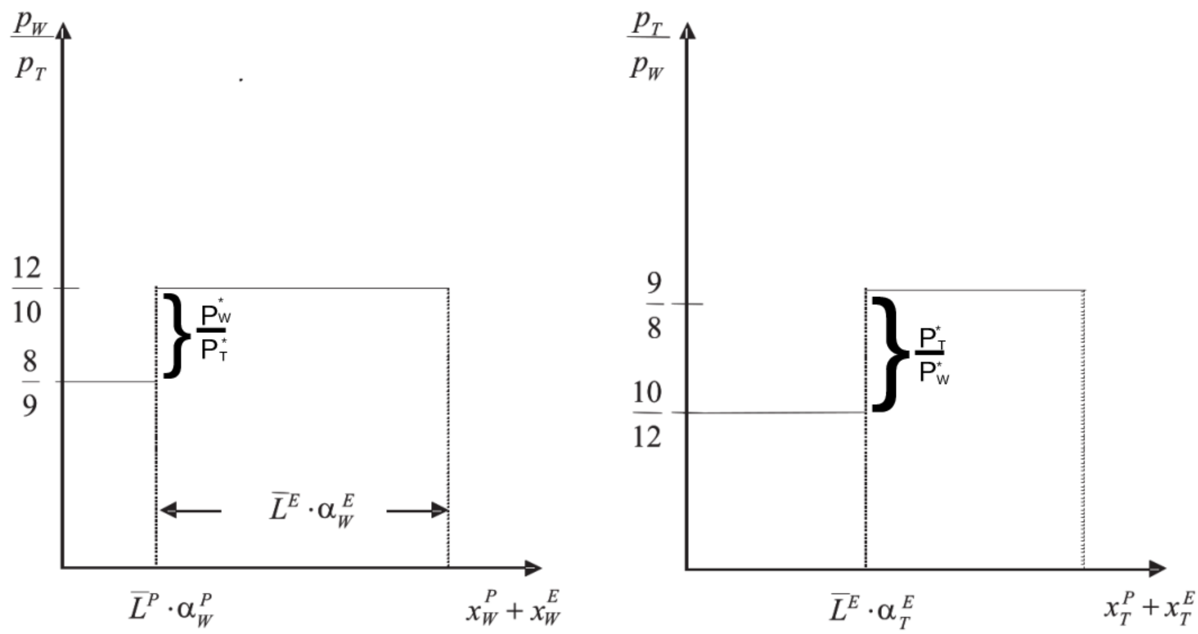
The Ricardo theorem tells us nothing about the precise distribution of welfare gains. In this section, I will show that the distribution of welfare gains is the result of relative supply and demand in the world.

To illustrate this, consider Ricardo's famous example[5] of two countries (England and Portugal) that can produce cloth T and wine W with different input requirements, namely:

$$\frac{p_W^P}{p_T^P} = \frac{a_W^P}{a_T^P} = \frac{8}{9} < \frac{12}{10} = \frac{a_W^E}{a_T^E} = \frac{p_W^E}{p_T^E}$$

Thus, England has an absolute disadvantage in the production of both goods, but England has a *comparative advantage in the production of cloth* and Portugal has a *comparative advantage in the production of wine*. Let us further assume that both countries are similarly endowed with labor, $\bar{L}$. Then we can calculate the world supply of cloth and wine given relative world prices, $\frac{p_T}{p_W}$. Since we know that Portugal will only produce wine if the price of wine relative to cloth is above $\frac{p_W}{p_T} = \frac{8}{9}$ and England will only produce wine if the price of wine relative to cloth is above $\frac{p_W}{p_T} = \frac{12}{10}$, we can draw the relative world supply of goods as shown in the left panel of Figure 33.8. Note that α in the figure means $\frac{1}{a}$. Similarly, we can draw in the world supply of clothes, shown in the left panel of Figure 33.8.

Figure 33.8: World's relative supply



Whether both countries specialize totally in the production of one good, or only one country does so depends on world demand for both goods at relative prices. Since we know from the Ricardo Theorem that the world market price relation, $\frac{p_T^*}{p_W^*}$, must be between the two autarky price relations:

$$\frac{p_T^P}{p_W^P} > \frac{p_T^*}{p_W^*} > \frac{p_T^E}{p_W^E}. \tag{33.1}$$

If world demand for cloth would be sufficiently high to have a world price of

$$\frac{p_T^P}{p_W^P} = \frac{9}{8}$$

[5] The example is explained by Suranovic (2012) in greater detail.

Portugal would not gain from trade. On the contrary, if world demand for wine would be sufficiently high to have a world price of

$$\frac{p_T^P}{p_W^P} = \frac{10}{12}$$

England would not gain from trade. Thus, the price span between $\frac{10}{12}$ and $\frac{9}{8}$ says us which country gains from trade. For example, at a world price of

$$\frac{p_T^*}{p_W^*} = 1$$

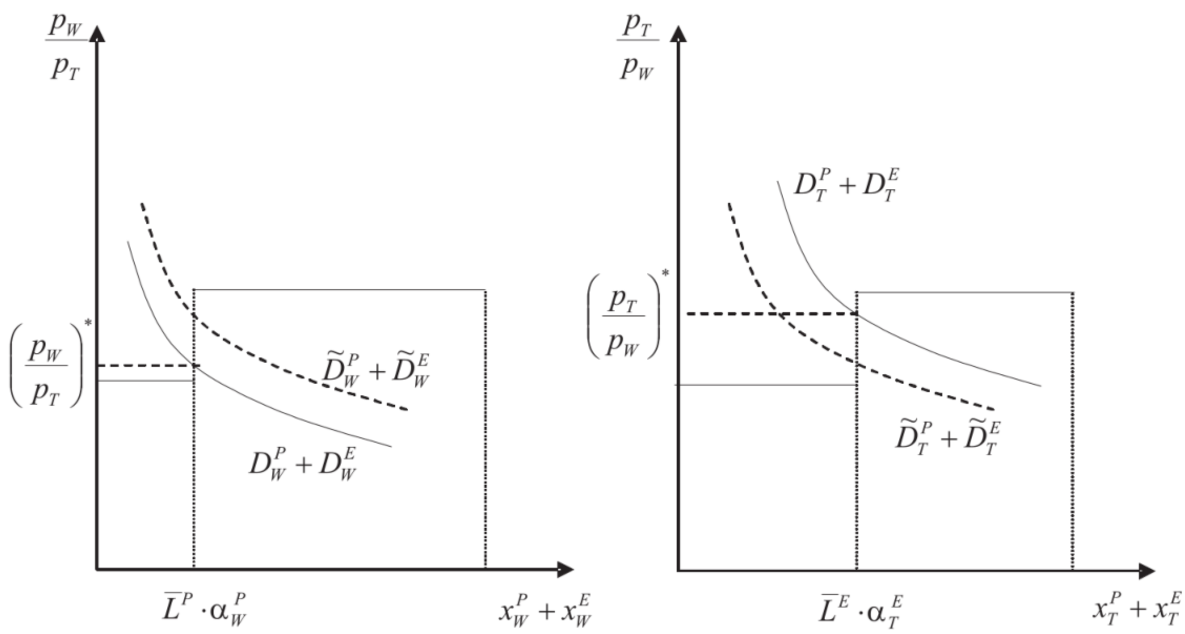
about 57%

$$\left[\frac{\left(1 - \frac{10}{12}\right)}{\left(\frac{9}{8} - \frac{10}{12}\right)} \approx 0.57\right] \tag{33.2}$$

of the gains through trade will be distributed to Portugal and about 43% will be distributed to England.

In Figure 33.9, I show two demand curves of the World. The dashed demand curve represents a world with a relative strong preference on wine and the other demand curve represents a relative strong demand for cloth. Since Portugal has a comparative advantage in producing wine, they would happy to live in a world where demand for wine is relatively high, whereas the opposite holds true for England.

Figure 33.9: World's relative supply and demand



Exercise 33.2. Comparative advantage and opportunity costs
Assume that only two countries, A and B, exist. Both countries are equally endowed with labor which is the only production factor. Both countries can produce either good y or good x. The table below gives the input coefficients, a, for both countries, that is, the units of labor needed to produce one unit of good y and good x, respectively. Assume that both countries have 12 units of labor available.

	Country A	Country B
Good y	1	3
Good x	2	4

a) Name the country with an absolute advantage.
b) Draw the production possibility curves in a y-x-diagramm.
c) What are *opportunity costs*?
d) Calculate how many goods of x country A has to give up to produce one unit more of good y.
e) Calculate how many goods of y country A has to give up to produce one unit more of good x.
f) Calculate how many goods of x country B has to give up to produce one unit more of good y.
g) Calculate how many goods of y country B has to give up to produce one unit more of good x.
h) Name the country with a comparative advantage in good y.
i) Name the country with a comparative advantage in good x.

Solution

a) Country A has an absolute advantage in producing both goods as

$$a_y^A = 1 < 3 = a_y^B$$

and

$$a_x^A = 2 < 4 = a_x^B$$

b) Solution is shown in the lecture.
c) Opportunity cost is the value of what you lose when choosing between two or more options. Alternative definition: Opportunity cost is the loss you take to make a gain, or the loss of one gain for another gain.
d) If A wants to produce one unit more of good y it has to give up $\frac{1}{2}$ units of good x.
e) If A wants to produce one unit more of good x it has to give up 2 units of good y.
f) If B wants to produce one unit more of good y it has to give up $\frac{3}{4}$ units of good x.
g) If A wants to produce one unit more of good x it has to give up $\frac{4}{3}$ units of good y.

opportunity costs of producing ...	A	B
... 1 unit of good y	$\frac{a_y^A}{a_x^A} = \frac{1}{2} = 0.5$ (good x)	$\frac{a_y^B}{a_x^B} = \frac{3}{4}$ (good x)
... 1 unit of good x	$\frac{a_x^A}{a_y^A} = \frac{2}{1} = 2$ (good y)	$\frac{a_x^B}{a_y^B} = \frac{4}{3} =$ (good y)

h) Country A has a comparative advantage in producing good y.
i) Country B has a comparative advantage in producing good x.

Exercise 33.3. The best industry is not competitive
Assume that only two countries, A and B, exist. Both countries are equally endowed with labor which is the only production factor. Both countries can produce either good y or good x. The table below gives the input coefficients, a, for both countries, that is, the units of labor needed to produce one unit of good y and good x, respectively.

Good	Country A	Country B
Good y	10	9
Good x	12	10

Discuss absolute and comparative advantages. How much faster does B needs to in producing good y to become an exporter of that good?

Solution

The logic of opportunity cost is straightforward. You must compare the opportunity costs across countries: If country A wants to produce one more unit of good y, it requires 10 units of labor. With these 10 units, it could produce 10/12 = 0.83 units of good x because it requires 12 units of labor to produce 1 unit of good x. If country B wants to produce one more unit of good y, it requires 9 units of labor. With these 9 units, it could produce 9/10 = 0.9 units of good x because it requires 10 units of labor to produce 1 unit of good x. Thus, the opportunity costs of country A are smaller compared to country B in producing good y. This is because country A has to give up less production of good x in order to produce 1 more unit of good y.

opportunity costs of producing...	Person A	Person B
...1 unit of good y:	$\frac{a_y^A}{a_x^A} = \frac{10}{12} \approx 0.83$ (good x)	$\frac{a_y^B}{a_x^B} = \frac{9}{10} = 0.9$ (good x)
...1 unit of good x:	$\frac{a_x^A}{a_y^A} = \frac{12}{10} = 1.2$ (good y)	$\frac{a_x^B}{a_y^B} = \frac{10}{9} \approx 1.11$ (good y)

Thus, A has a comparative advantage in producing good y and B has a comparative advantage in producing good x. This seems to be counterintuitive as B can produce faster anything and everybody else.

When looking on input coefficients, we get

$$\frac{a_y^A}{a_x^A} = \frac{10}{12} < \frac{9}{10} = \frac{a_y^B}{a_x^B}$$

which gives us the same comparative advantages as described above.

To become an exporter of y, B needs to have lower opportunity costs in the production of y than A. This can happen by becoming more productive in producing y **and/or** by becoming 'slower' in producing good x so that $\frac{a_y^B}{a_x^B} < \frac{10}{12}$

Exercise 33.4. Comparative advantage and input coefficients
Assume that only two countries, A and B, exist. Both countries are equally endowed with labor which is the only production factor. Both countries can produce either good y or good x. The table below gives the input coefficients, a, for both countries, that is, the units of labor needed to produce one unit of good y and good x, respectively.

	Country A	Country B
Good y	400	2
Good x	300	1

a) Name the country with an absolute advantage.
b) Name the country with a comparative advantage in good y.
c) Name the country with a comparative advantage in good x.

Solution

a) Country B has an absolute advantage in producing both goods.
b) Country A has a comparative advantage in producing good y.
c) Country B has a comparative advantage in producing good x.

Exercise 33.5. Comparative advantage: Germany and Bangladesh
The table below gives the unit of labor needed to produce one machine, one ship, and one cloth in Germany and Bangladesh.

	Machine	Ship	Cloth
Bangladesh	100	10000	50
Germany	5	50	3

a) Which country has an absolute advantage in the production of machines, ships, and clothes?
b) What is Germany's and Bangladesh's comparative advantage if we look only at machines and ships?
c) What is Germany's and Bangladesh's comparative advantage if we look only at machines and clothes?
d) What is Germany's and Bangladesh's comparative advantage if we look only at ships and clothes?
e) Can you infer from the previous calculations which good Germany will export for sure and which good it will surely not export?

Solution

a) Germany has an absolute advantage in the production of the three goods because it labor input coefficients are smaller in all three goods.
b) Since $p_B^{m/s} = \frac{100}{10000} < p_G^{m/s} = \frac{5}{50}$ Bangladesh has a comparative advantage in producing machines and Germany has a comparative advantage in producing ships.
c) Since $p_B^{m/c} = \frac{100}{50} > p_G^{m/c} = \frac{5}{3}$ Bangladesh has a comparative advantage in producing clothes and Germany has a comparative advantage in producing machines.
d) Since $p_B^{s/c} = \frac{10000}{50} > p_G^{s/c} = \frac{50}{3}$ Bangladesh has a comparative advantage in producing clothes and Germany has a comparative advantage in producing ships.
e) Germany has a clear comparative advantage in producing ships and hence will export ships. Moreover, Germany has a clear comparative disadvantage in producing cloth and will definitely import clothes.

Exercise 33.6. Multiple choice: Ricardian model
Assume that only two countries, A and B, exist. Both countries are equally endowed with labor which is the only production factor. Both countries can produce either good y or good x. The table below gives the input coefficients, a, for both countries, that is, the units of labor needed to produce one unit of good y and good x, respectively.

	Country A	Country B
Good y	40	20
Good x	30	10

Which of the following statements is/are true?

a) Country A has an absolute advantage in producing both goods.
b) Country B has an absolute advantage in producing both goods.
c) Country A has a comparative advantage in good y and a comparative disadvantage in good x.
d) Country B has a comparative advantage in good y and a comparative disadvantage in good x.
e) Trade will not occur between these two countries.

Solution

Choices b) and c) are correct.

Exercise 33.7. Ricardian Model again
Assume that only two countries, A and B, exist. Both countries are equally endowed with the only production factor labor which can be used to produce either good y or good x. The table below gives input coefficients, a, for both countries, that is, the units of labor needed to produce one unit of good y and good x, respectively.

	Country A	Country B
Good y	11	22
Good x	8	16

Which of the following statements is true?

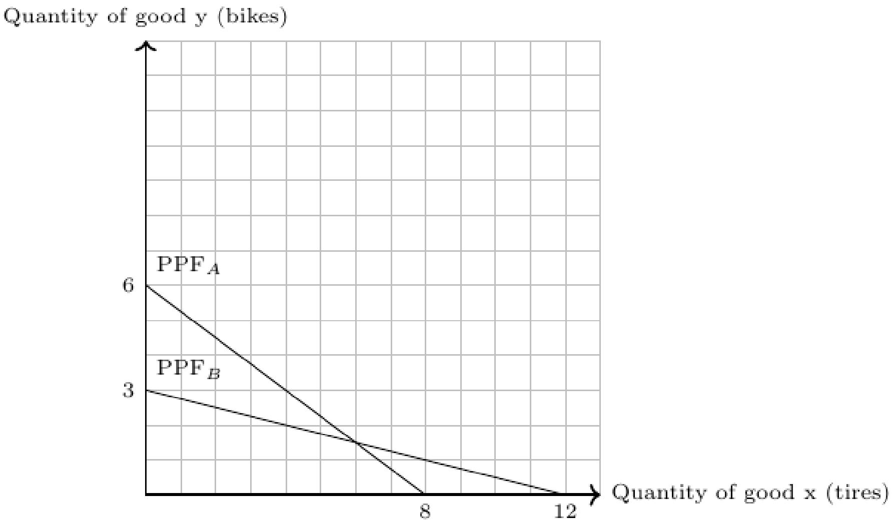
a) Country A will export good y and import good x.
b) Country B will export good y and import good x.
c) Country B has an absolute disadvantage in producing both goods.
d) Trade will not occur between these two countries.

Solution

c) and d) are true.

Exercise 33.8. Bike and tires
Consider two countries, A and B. Both have a labor endowment of 24, $L^A = L^B = 24$. In both countries two goods can be produced: bikes, which are denoted by y, and bike tires, which are denoted by x. Assume that the two goods can only be consumed in bundles of one bike and two bike tires. The following graph illustrates the production possibility (PPF) curve of both countries in autarky, i.e, country A and B do not trade with each other.

Figure 33.10: Production possibilities of bike and tires in A and B



a) How many **complete bikes**, that is, one bike with two tires, can be consumed in autarky in country A and B, respectively. Draw the production points for country A and B into the figure. (A calculation is not necessary.)
b) Calculate —for both countries—the input coefficients, a, that is, the units of labor needed to produce one unit of good y and good x, respectively. Fill in the four input coefficients in the following table:

	Country A	Country B
Good y (bikes)	( )	( )
Good x (bike tires)	( )	( )

c) Fill in the ten gaps (   ) in the following text:

If we assume that both countries specialize completely in the production of the good at which they have a comparative advantage and trade is allowed and free of costs, then

- country A produces (   ) units of bikes and (   ) units of tires and
- country B produces (   ) units of bikes and (   ) units of tires.

Moreover, since both countries aim to consume complete bikes, that is, one bike with two tires,

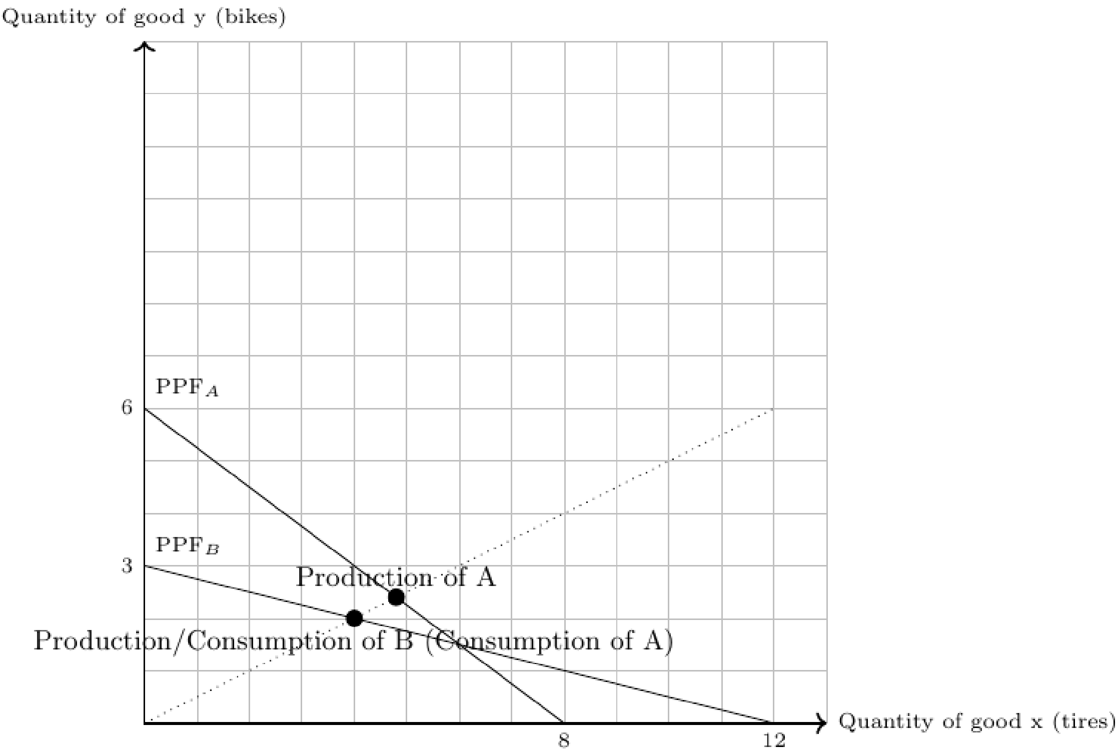
- country A exports (   ) units of (   ) and imports (   ) units of (   ) and
- country B exports (   ) units of (   ) and imports (   ) units of (   ).

Under free trade - country A can consume (   ) complete bikes and - country B can consume (   ) complete bikes.

Solution

a) Both countries can consume 2 complete bikes, see Figure 33.11.

Figure 33.11: Production and consumption in A and B



b)

	Country A	Country B
Good y (bikes)	24:6=4	24:3=8
Good x (bike tires)	24:8=3	24:12=2

c) If we assume that both countries specialize completely in the production of the good at which they have a comparative advantage and trade is allowed and free of costs, then

- country A produces 6 units of bikes and 0 units of tires and
- country B produces 0 units of bikes and 12 units of tires.

Moreover, since both countries aim to consume complete bikes, i.e., one bike with two tires,

- country A exports 3 units of bikes and imports 6 units of tires and
- country B exports 6 units of tires and imports 3 units of bikes.

Under free trade

- country A can consume 3 complete bikes and
- country B can consume 3 complete bikes.

Exercise 33.9. Ricardian model MC
Assume that only two countries, A and B, exist. Both countries are equally endowed with the only production factor labor which can be used to produce either good y or good x. The table below gives input coefficients, a, for both countries, that is, the units of labor needed to produce one unit of good y and good x, respectively.

	Country A	Country B
Good y	321	899
Good x	459	999

Which of the following statements is true?

a) Country A has an absolute advantage in both goods.
b) Country A has an absolute advantage in good y
c) Country A has a comparative advantage in both goods.
d) Country B has a comparative advantage in both goods.
e) Country A has a comparative advantage in good y.
f) Country B has a comparative advantage in good y.

Solution

a), b), and e) are correct statements.

Chapter 34

Endowments

Learning objectives

- Understand the expansion of the Ricardian trade model through the introduction of multiple production factors.
- Learn that differences in countries' factor endowments drive international trade patterns according to the Heckscher-Ohlin framework.
- Understand that a country's comparative abundance in a particular factor gives it a comparative advantage in goods that use that factor intensively.
- Understand the tendency of international trade to equalize factor prices across countries.
- Reflect on how trade can serve as a substitute for the physical mobility of production factors between countries.

Recommended reading: Suranovic (2012, Chapter 5)

34.1 Nobel prize winning theory

The theory which we discuss in this section explains trade because of different endowments. It is also known as the *Heckscher-Ohlin model*. It is named after two Swedish economist, Eli Heckscher (1879-1952) and Bertil Ohlin (1899-1979). Bertil Ohlin received the Nobel Prize in 1977 (together with James Meade). The HO-Model, as it is often abbreviated, was the main reason for the price. Here is an excerpt of the Award ceremony speech:

> *Your Majesties, Your Royal Highnesses, Ladies and Gentlemen,*
>
> *The question why individuals, firms and nations exchange goods and services with each other, and how these processes are influenced by government policies, may be regarded as the basic issue in the science of economics. In the case of exchange between countries, the dominating theory was for a long time – from the beginning of the 19th century – David Ricardo's theory of comparative advantage. Ricardo explained there the structure of foreign trade by differences in the production technology between nations. Over the years the theory was gradually improved upon in various ways, but a more basic overhaul did not take place until Bertil Ohlin in the early 1930's published his work Interregional and International Trade, which is now a classic, and James Meade in the 1950's came out with his important volumes on The Theory of International Economic Policy.*
>
> *Bertil Ohlin showed in this work, which to some extent was inspired by a remarkable article by Eli Heckscher, that foreign trade may arise even if the production technology were identical in different nations. It is enough that the supplies of the factors of production of various kinds – such as labor of different types, capital, and land – differ among nations. The starting point of Ohlin's theory is that a country tends to be an exporter of commodities*

> *that use relatively large amounts of the factors of production which are in ample supply as compared to domestic demand – in the hypothetical case without foreign trade. For instance, to take a simple example, if land is abundant in Australia while labor is relatively plentiful in England, we would expect Australia to be an exporter of commodities which for their production require much land, such as wool, while England would be an exporter of commodities the production of which requires relatively much labor, such as textiles.*
>
> *From this simple theoretical structure, the so-called Heckscher-Ohlin model, follow a number of interesting theorems. One of them, the factor price equalization theorem, tells us that foreign trade tends to equalize the prices of the factors of production in different countries. For instance, when Australia starts to export land-intensive goods, the demand for land goes up relative to labor, with a rise in land prices as a result, while the export of labor-intensive goods by England pulls up wages there relative to the price of land. Thus, trade in commodities tends to have the same effects on the prices of the factors of production as if the factors themselves could move freely between countries. In this sense, commodity trade is a substitute for international mobility of the factors of production. Another inference from Ohlin's theory is that a tariff on a labor-intensive good, such as textiles, affects the distribution of income in favor of labor in the importing country, while a tariff on a capital-intensive commodity, such as wool or steel, results in an income redistribution in favor of the owner of capital.*
>
> Source: www.nobelprize.org

The Ricardo model explains international trade as advantageous because of comparative advantages that are the result of technological differences. This means that comparative advantage in the Ricardian model is solely the result of **productivity differences**. The size of a country or the size of the countries' endowments does not matter for comparative advantage in the Ricardian model because there is only one factor of production in Ricardian models, namely labor. However, the assumption that there is only one factor of production is unrealistic, and we should ask what happens **if there is more than one factor of production but no productivity differences**? What happens if the two factors are available differently in different countries? What is the significance of endowment differences for international trade? And which owner of a factor of production will be a winner when a country opens up to world trade, and who will lose? The HO model can provide answers to these questions.

In Table 34.1, I show that countries do indeed differ substantially in their total factor productivity, capital stock, and labor endowments, which are likely correlated with total population.

Table 34.1: Endowment differences across countries in 2010

RegionCode	Capital stock at current PPPs (in mil. 2011USD)	Population (in millions)	Capital stock per capita
ITA	10421041	60	174885
ESP	7806612	47	167518
FRA	10405968	65	160395
GBR	9973122	63	159019
DEU	12687682	80	157738
USA	48876336	310	157729
AUS	3332890	22	150382
CAN	5065392	34	148431
JPN	17161376	127	134790
SAU	3716382	28	132300
KOR	6052155	49	123287
TWN	2835890	23	122549
ROU	1271652	20	62647
VEN	1765996	29	60905
BRA	9869311	199	49691
RUS	6746460	143	47126
POL	1769004	39	45859
THA	2977965	67	44652

RegionCode	Capital stock at current PPPs (in mil. 2011USD)	Population (in millions)	Capital stock per capita
IRN	3234132	74	43555
ARG	1773984	41	43034
MEX	5054693	119	42613
TUR	2938288	72	40634
UKR	1616826	46	35420
IDN	8146254	242	33716
COL	1446480	46	31501
CHN	42218080	1341	31483
PER	681036	29	23185
PHL	1560017	93	16767
IRQ	443733	31	14375
IND	15356803	1231	12475

Source: Penn World Tables 9.0

34.2 The Heckscher-Ohlin (factor proportions) model

Assumptions:

1. **Two countries**: Home country and foreign country. Variables referring to foreign countries are marked with an asterisk, $*$.

2. **Two goods**: x and y.

3. **Two factors of production**: K and L. This is new in relation to the Ricarkian model! Let's name the factors K and L, which stands for capital and labor.

4. **Goods differ in terms of their need for factors of production**:

$$\frac{K_y}{L_y} \neq \frac{K_x}{L_x}.$$

This means that one good must be produced in a capital-intensive way and the other in a labor-intensive way. If we assume that good y is capital intensive and good x is labor intensive in production, we can write:

$$\frac{K_y}{L_y} > \frac{K_x}{L_x}.$$

In this inequality, the quantity of capital required to produce good y, K_y, is on the left-hand side relative to the quantity of labor required to produce good y, L_y, that is, the capital intensity of good y.The capital intensity of good x is on the right-hand side of the inequality. Rewriting this inequality, we can express it in terms of labor intensities: $\frac{L_y}{K_y} < \frac{L_x}{K_x}$. It should be clear that both inequalities say the same thing.

5. **No technology differences between countries**: Since we already know from Ricardian theory that productivity or technology differences are a source of international trade, we do not want to explain the same thing again with the HO model. So we assume that all input coefficients are the same in all countries.

6. **Different relative factor endowments**:

$$\frac{K}{L} \neq \frac{K^*}{L^*}.$$

Since countries are assumed to have different factor endowments, the model links a country's trade pattern to its endowment of factors of production. The capital-labor ratio in the home country, $\frac{K}{L}$, must differ from the ratio abroad. Suppose the home country is capital-rich and the foreign country is labor-rich. Then we have the following ratios between capital and labor in the two countries:

$$\frac{K}{L} > \frac{K^*}{L^*}.$$

This means that the capital-labor ratio (a country's capital intensity) is higher in the home country than abroad. In terms of the ratio between labor and capital, that is, the labor intensity of a country, this can be expressed as follows: $\frac{L}{K} < \frac{L^*}{K^*}$. It should be clear that both inequalities say the same thing.

7. **Free factor movement between sectors** Both factors can be used in the production of both goods. Note that cross-country movement of factors (migration, foreign direct investment) is not allowed.

8. **No trade costs** Final products can be traded without any costs.

9. **Equal tastes in countries and homothetic preferences** Consumers in both countries have the same utility function. Homothetic preferences simply mean that for given relative prices, income does not affect the ratio of consumption.

34.3 Heckscher-Ohlin theorem

- Consider that the home country has relatively more capital and the foreign country relatively more labor and that the good y is capital intensive in production whereas the good x is labor intensive.
- Then it is relatively cheap for the home country to produce the capital-intensive good because it is endowed with a lot of capital, while it is relatively costly to produce the good with which the country is hardly endowed.

- Thus, the home country has a comparative advantage in producing the capital-intensive good.
- The opposite is true for the foreign country.

Heckscher-Ohlin Theorem

The capital abundant country exports the capital-intensive good. The labor abundant country exports the labor-intensive good.
In other words:
A country export goods that are intensive in its relatively abundant factor and will import goods that are intensive in its relatively scarce factor.

34.4 Factor-price equalization theorem

- As a result of the Heckscher-Ohlin theorem, output of the good in which the country has a comparative advantage would increase. The capital intensive country will produce more capital intensive goods and the labor intensive country will produce more labor intensive goods.
- As the production of the good that makes intensive use of the abundant resource increases, the demand for that resource will also increase. Demand for the scarce resource will also increase, but to a lesser extent.
- If production of the good that intensively uses the scarce resource decreases, both abundant and scarce resources will be released, but relatively more of the scarce resource than of the abundant resource.
- In autarky, the relatively scarce factor in the home country was labor and factor prices were as follows:

$$\frac{w}{r} > \frac{w^*}{r^*}$$

- After opening to trade, production shifts to the home country so that the wage falls ($w \downarrow$) and the rent rises ($r \uparrow$).

- After opening to trade, production shifts abroad so that the wage rises, $w^* \uparrow$, and the rent falls, $w^* \downarrow$.
- This reallocation process, and hence the change in factor prices, continues until factor prices are equal in all countries:

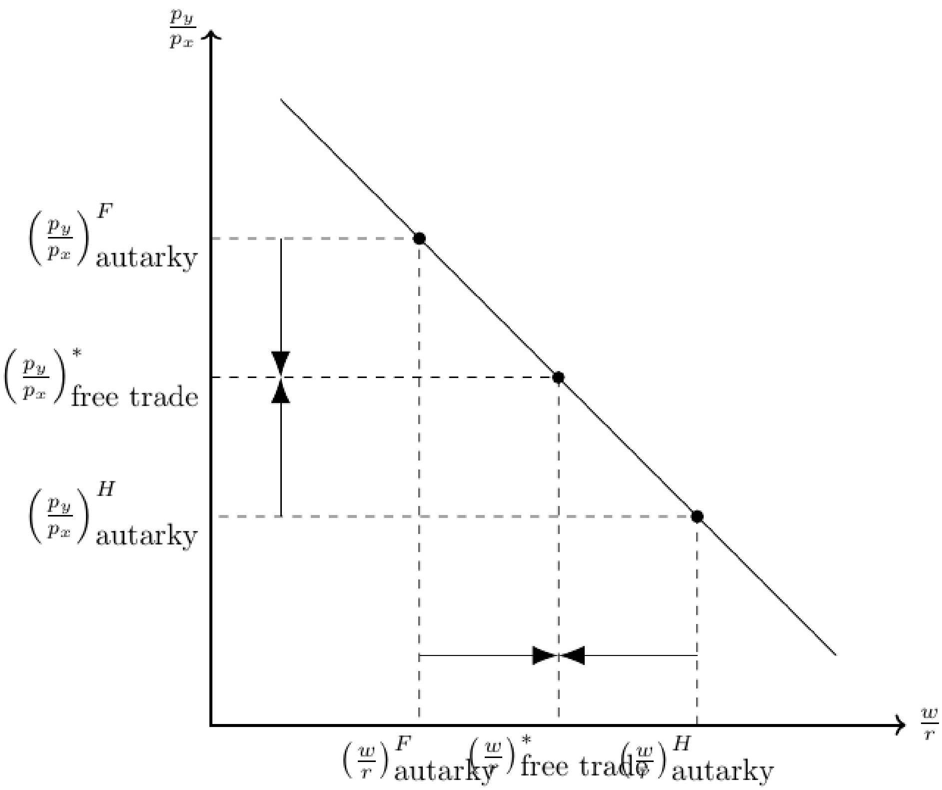
$$\frac{w}{r} = \frac{w^*}{r^*}$$

- Figure 34.1 visualizes the reasoning behind the factor-price equalization theorem.

Factor-price equalization theorem

The prices of the two factors of production (wage and rent) will be equalized across countries as a result of international trade in goods.

Figure 34.1: HO Model and factor prices



- I recommend a clip of Mike Moore explaining how trade based on factor endowments affects wages and returns to capital, see this video:

Why does the Factor-Price Equalization Theorem not (fully) hold?

In the real world, factor prices do not equalize due to frictions such as transportation costs, trade barriers, and the presence of goods that are rarely or never traded.

Trade as an alternative to factor movements:

The factor price equalization theorem contains an interesting insight: if a country allows free trade in its products, it will automatically export the abundant factor indirectly in the form of goods that intensively use the abundant factor.

Exercise 34.1. Ricardo and Heckscher-Ohlin

a) Discuss the main differences of the Ricardian Model and the Heckscher-Ohlin Model.
b) Assume that only two countries, A and B, exist. Both countries are equally endowed with the only production factor labor which can be used to produce either good y or good x. The table below gives input coefficients, a, for both countries, that is, the units of labor needed to produce one unit of good y and good x, respectively. Name the country with a comparative advantage in good y.

	Countries	
	A	B
Good y	10	11
Good x	1	2

Exercise 34.2. HO-Model in one figure
Suppose consumers from country A and the foreign country B like to consume two goods that are neither perfect substitutes nor perfect complements. Moreover, assume for simplicity that both countries have the same size but have different endowments, as stated in the assumptions above. Moreover, assume the factor intensity of production as stated in the assumptions above.

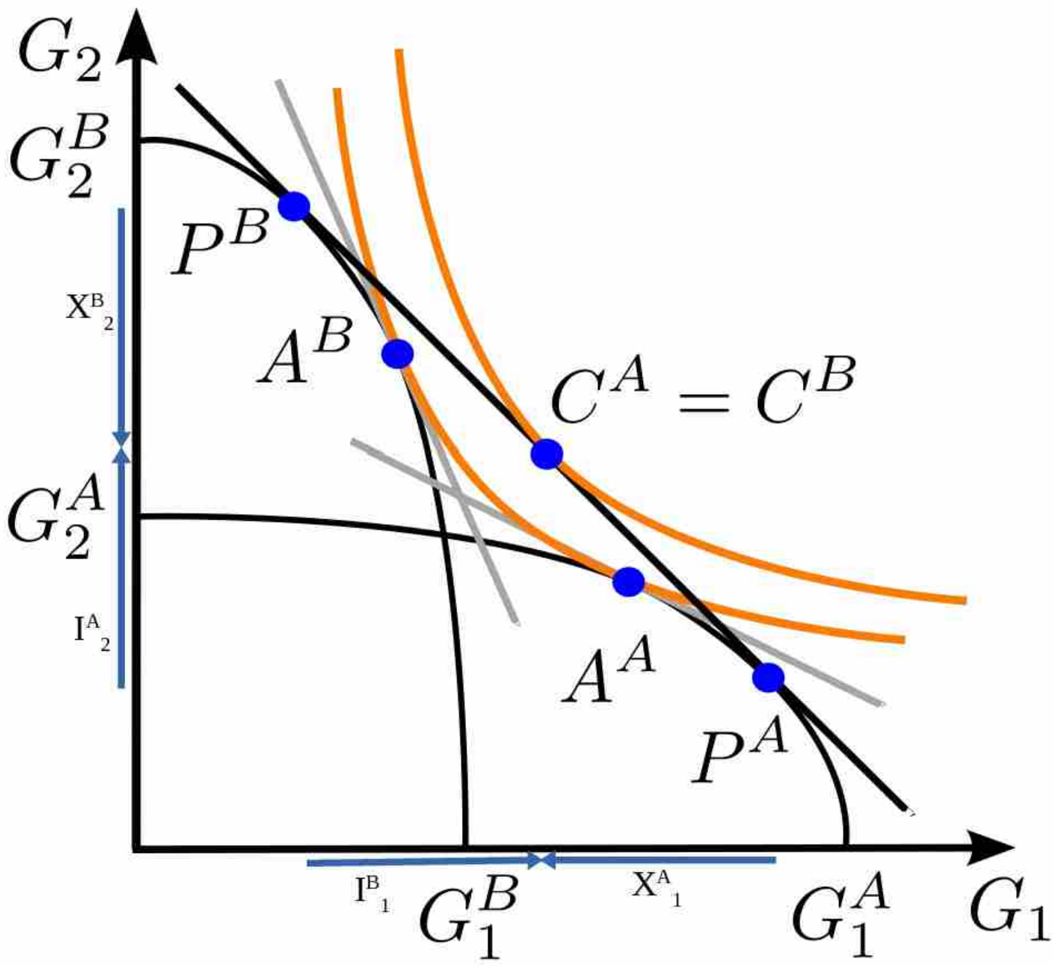
a) Sketch the production frontiers for both countries in autarky. Show graphically the relative price in autarky.
b) You will see that the relative prices of goods differ across countries:

$$\left(\frac{p_1}{p_2}\right) \neq \left(\frac{p_1}{p_2}\right)^*.$$

That means, the Home country A has a comparative advantage in producing good 1.
c) Now, sketch the world market price that will maximize the utility.
d) Where are the new production and consumption points of both countries?
e) Show in the graphic how much each country trades.
f) I recommend a clip of Mike Moore who also explains the HO-Model with production possibility curves, see this video.

Solution

Figure 34.2: HO-Model in one figure



Two identical countries (A and B) have different initial factor endowments. I assume that country A is abundantly endowed with the production factor that is intensively used in the production of good 1, the reverse holds for country B. Thus, the two solid black lines in Figure 34.2 represents the respective production possibility frontier curves. The orange lines represents the respective indifference curves. Autarky equilibria are marked with A^A and A^B, respectively. The production points in trade equilibrium are marked with P^A and P^B, the consumption point of both countries is in $C^A = C^B$. Thus, production and consumption points are divergent. The indifference curve under free trade is clearly above the other indifference curve in autarky. The solid black line that is tangient to the consumption point under free trade represents the utility maximizing world market price under free trade. The exports, X, and imports; I, are denotes correspondingly to the goods and country names.

Exercise 34.3. Multiple choice: HO-Model
Given are the assumptions of the Heckscher-Ohlin Model. In particular, assume that only two countries, A and B, and two goods, y and x, exist. Consider the following data:

	Countries	
	A	B

Factor Endowments		
Labor Force	20	30
Capital Stock	30	40

If good y is capital intensive in production and good x is labor intensive in production then, following the Heckscher-Ohlin Theorem, ...

a) ... country A will export good y.
b) ... country B will export good y.
c) ... both countries will export good y.
d) ... trade will not occur between these two countries.

Solution

Multiple choice: HO-Model (Exercise 34.3)

Answer a) is correct.

Chapter 35

The specific factor model

Figure 35.1: Not everybody wins with free trade

Source: *otherwords.org*

From the Ricardian model, we know that trade is a positive-sum game. If free trade is beneficial to a country, as Ricardo predicts, why isn't everyone happy with free trade? In democratic societies, policy-makers sometimes adopt protectionist trade policies because of pressure from interest groups and public demand. The discrepancy between the promises and potential benefits of trade on the one hand and the negative consequences of free trade for many groups on the other is illustrated in Figure 35.1. The models so far do not give us a way to see which groups actually suffer from free trade, and thus we have no clue why there are incentives for interest groups to oppose free trade. Are anti-free trade policy preferences the result of ignorance, general worldviews, political ideology, environmental attitudes, social trust, or other factors? Well, these things may play a role, but there are also economic factors, that is, the self-interest of individuals and groups within an economy, that can account for anti-free trade attitudes. In the following sections, we will discuss a theory that shows that while free trade benefits countries as a whole, not everyone within a country benefits equally. Some benefit more than others, and some are actually made worse off by free trade.

In the next two subsections, we derive some key hypotheses that free trade favors those people in a country who have abundant factors of production and disadvantages those who have scarce factors. Moreover, free trade favors investors and workers in export-oriented industries with comparative advantages.

35.1 Assumptions

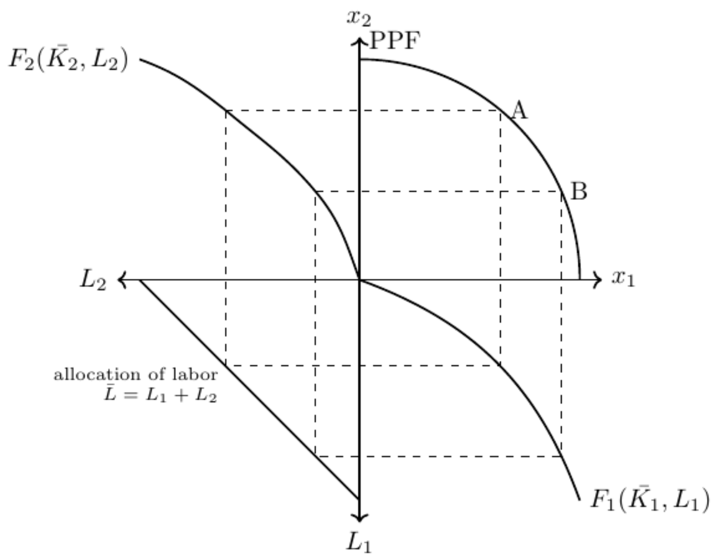
The sector-specific model, also known as the Ricard-Viner model, can show that there are winners and losers in international trade. The model is based on the following assumptions:

1. 2 countries $i \in \{A, B\}$
2. 2 goods (sectors) $g \in \{1, 2\}$
3. 3 factors of production: Labor L, capital specific to the production of good 1, K_1, and capital specific to the production of good 2, K_2[1]. The technologies for the production of both goods are now represented by two production functions $Q_1 = F_1(\bar{K}_1, L_1)$ and $Q_2 = F_2(\bar{K}_2, L_2)$, where both factors of production have positive but decreasing marginal products
4. The capital allocated to each sector is fixed for both countries: $K_1 = \bar{K}_1, K_2 = \bar{K}_2$
5. The labor assigned to each sector (L_1 and L_2) can change in response to external shocks: $\bar{L} = L_1 + L_2$
6. perfect competition
7. perfect market clearing (no unemployment)
8. country A is a small open economy (we consider only country A and therefore do not use a subscript for countries in the following)

35.2 The production possibility frontier with two factor inputs:

The two production functions, the fixed endowments and the distribution of labor determine the aggregate PPF. The PPF, which is the product of two production functions (F_1 and F_2), is shown in Figure 35.2. The figure shows, for both production points A and B, how the mobile factor of production, labor, must be reallocated from sector 2 to sector 1 in order to produce more of good 1 in production point B. The second and fourth quadrants show the respective production functions of sectors 1 and 2.

Figure 35.2: PPF with two factors and positive but declining marginal products



35.3 Equillibrium in autarky:

- Depending on a country's demand for good 1 and 2 a production point on the PPF is chosen at which it must hold that the slope of the PPF curve and the price relation (that is, relation of marginal product of labor in sector 1 and sector 2) must be equal:

$$\frac{p_1}{p_2} = \frac{\frac{\partial F_2}{\partial L_2}}{\frac{\partial F_1}{\partial L_1}}$$

- What can we say about the rents of the production factors?

[1]You can think of capital specific to the production of manufacturing goods (good 1) and land specific to the production of food sector goods (good 2)

- From the assumption of perfect competition it follows that firms do not make a positive profit in equilibrium, $\pi \overset{!}{=} 0$. Thus, the equilibrium wage for sectors $g \in \{1, 2\}$ are given by the profit maximizing of firms

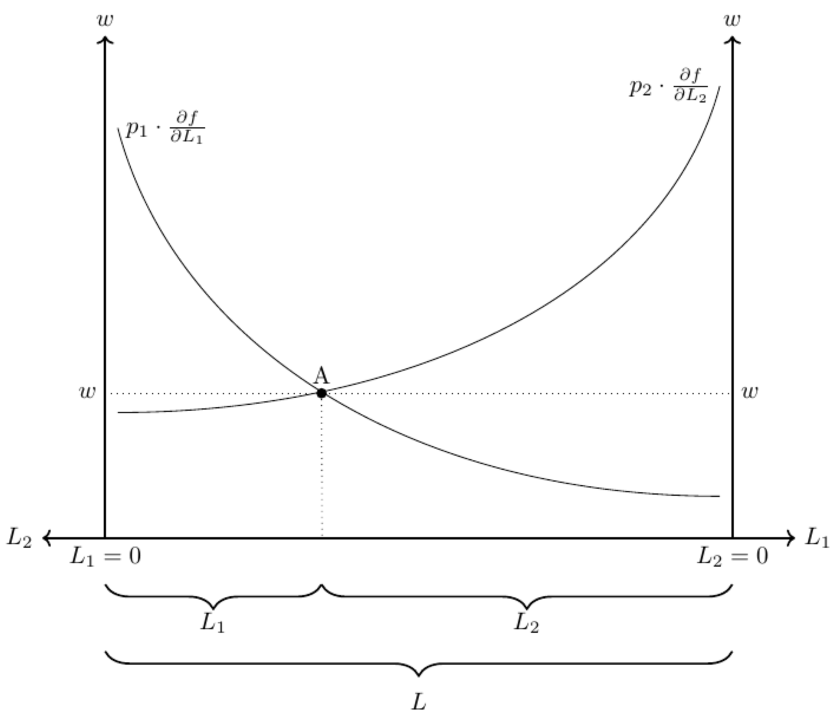
$$\pi_g = p_g \cdot F_g(\bar{K}_g, L_g) - w_g L_g - r_g K_g$$
$$\frac{\partial \pi_g}{\partial L_g} = p_g \cdot \frac{\partial F_g}{\partial L_g} - w_g \overset{!}{=} 0 \qquad \Leftrightarrow w_g = p_g \frac{\partial F_g}{\partial L_g}$$

- We know that labor can move freely between sectors and an equilibrium exists when there are no incentives to move any further. That is the case when wages in both sectors are equal, $w_1 = w_2$. Thus, we can express wages in terms of purchasing power in units of good 1 as follows:

$$w_1 = p_1 \frac{\partial F_1}{\partial L_1} \quad \text{and} \quad w_2 = p_2 \frac{\partial F_2}{\partial L_2}$$
$$\Rightarrow w = p_1 \frac{\partial F_1}{\partial L_1} = p_2 \frac{\partial F_2}{\partial L_2}$$
$$\Leftrightarrow \frac{w}{p_1} = \frac{\partial F_1}{\partial L_1}$$
$$\Leftrightarrow \frac{w}{p_2} = \frac{\partial F_2}{\partial L_2}$$

- Figure 35.3 presents the equilibrium wage and the optimal allocation of labor into sector 1 and 2.

Figure 35.3: Equilibrium with two sectors



35.4 Equilibrium under free trade:

Assume the price of good 1 and good 2 increase due to a trade opening in the same proportion. What happens with the real wage and the real incomes of capital-1 and capital-2 owners? The answer is: no real changes occur.

- The wage rate, w, rises in the same proportion as the prices, so the real wages are unaffected. In Figure 35.3 this can be shown by shifting both curves upward.

- The real incomes of capital owners also remain the same because there will be no reallocation of labor across sectors.

Now, assume only the price of good 1 rises for 10% while p_2 remains fixed, $\frac{p_1'}{p_2} > \frac{p_1}{p_2}$. What happens with the real wage and the real incomes of capital-1 and capital-2 owners? The answer is: some win, some lose, and some maybe win.

Wages:

- $p_1 \frac{\partial F_1}{\partial L_1}$ rises and hence labor reallocates from sector 2 to sector 1 ($L_1 \uparrow$ and $L_2 \downarrow$). This is shown in Figure 35.4.
- This reallocation of labor has some implications for the real wages measured in purchasing power of good 1 and 2, respectively:
- The price of good 1 has increased by 10%, the wage has however increased by less than 10% (compare the length of BC and BD in the figure), whereas the price for food stays constant.
- Thus, the purchasing power in buying good 2 increased, whereas the purchasing power in buying good 1 decreased. Hence, workers gain when buying good 2 but lose when buying good 1
- Overall, the welfare effect from real wages is unclear and depends on preferences.

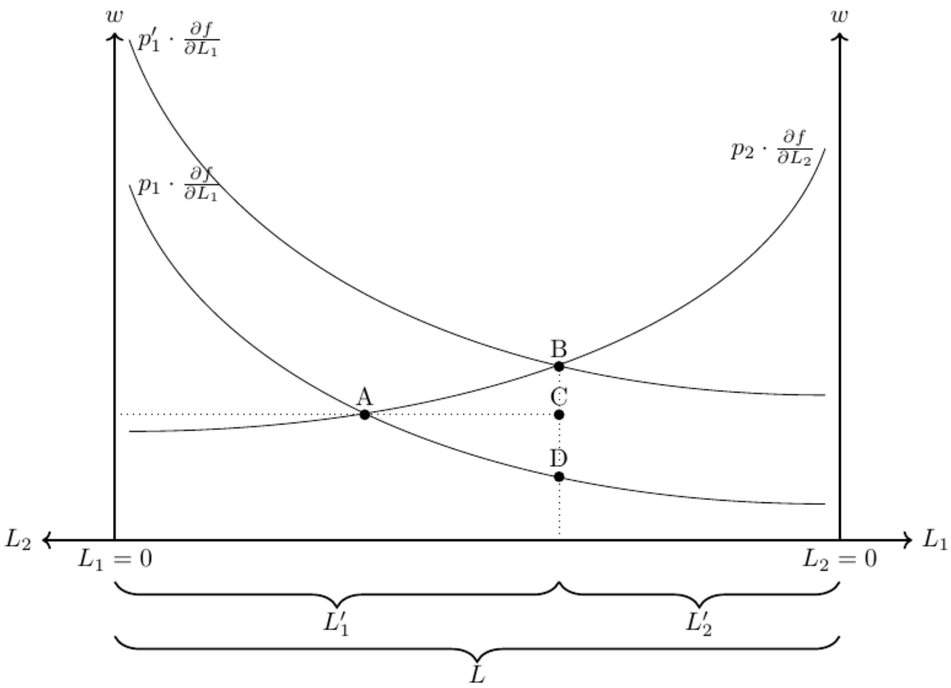
Owner of capital-1:

- Owners of capital-1 receive a 10% higher price on their products but have to pay a less than 10% higher wage.
- Overall, capital-1 owners gain from free trade because they can employ more workers (at a higher price) now.

Owner of capital-2:

- Owner of capital-2 receive the same price on their products but have to pay a higher wage.
- Overall, capital-2 owners lose from free trade because they can employ less workers at a higher price now.

Figure 35.4: Equilibrium when one price changes



Part VIII

TRADE POLICY

Chapter 36

World Trade Organization

36.1 Principles

Figure 36.1: The World Trade Organization (WTO)

The World Trade Organization (WTO) (see Figure 36.1) is an intergovernmental organization that regulates international trade and replaced in 1995 the General Agreement on Tariffs and Trade (GATT). 164 (!) countries are currently member of the WTO. The WTO facilitates the smooth and free flow of global trade through the administration and monitoring of a rules-based system that should among others help to make international trade (policy) more predictable. This set of rules is embodied in the WTO Agreements which are based on basic principles, that are described in the following three sub-sections.

> Watch: The World Trade Organization (WTO) - Explained With Maps

36.1.1 Non-discrimination:

The Most Favoured Nation rule (MFN)

The MFN ensures non-discrimination between trading partners as it states that if a WTO member grants a country an advantage, it has to give such advantage to all WTO members. Thus, a WTO member has to grant the most favorable conditions under which it allows trade in a certain product type to all other WTO members. However, there is no rule without an exceptions.[1]

> Watch: E-Learning short videos - Most-favoured nation (MFN)

The National Treatment Principle (NTP)

The NTP ensures non-discrimination between domestic and foreign products or services. It prohibits a member from favoring its domestic products over imported products. The NTP aims to provide equality

[1] For example, a member may provide preferential treatment only to some countries within a free trade area or customs union, without having to extend such better treatment to all members. Another exception enables developed members to give unilateral preferential treatment to goods imported from developing countries and least-developed countries (LDCs), without having to extend such better treatment to other members.

of competitive conditions for imported products in relation to domestic products. Again, no rule without exceptions.[2]

Watch:

E-Learning short videos - General Exceptions
E-Learning short videos - The National Treatment Principle

36.1.2 Transparency

All WTO members must publish their trade regulations and changes therein. Moreover, members should respond to requests for information by other members.

36.1.3 More open and predictable trade

While the use of tariffs and quotas is not prohibited, members have committed to carry out multilateral negotiations periodically with a view to reduce the general level of trade barriers.

36.2 The Dispute Settlement Body

To make decisions on trade disputes between governments that are adjudicated by the organization, the WTO has established the Dispute Settlement Body (DSB). The Dispute Settlement Body is a meeting of the WTO General Council that brings together all representatives of WTO member governments, usually at the ambassador level. Any WTO member that believes another member is in violation of an obligation or WTO rule can file a complaint. The goal of the Dispute Settlement Body is then to find a solution to the dispute, including any violation. The first step is consultations between governments. If the dispute cannot be resolved through discussions, the DSB makes a decision and the offending country is ordered to correct its policies. In most cases, countries find a mutually acceptable solution to the dispute. If the offending country does not correct its policy or provide other compensation, the WTO authorizes retaliatory action by the complaining country against the offending country. The adjudication process can take some time, as can the implementation of remedies to enforce or compensate for the violation of a WTO rule. Figure 36.2 provides an overview of the average number of active, that is, unresolved, complaints in recent years.

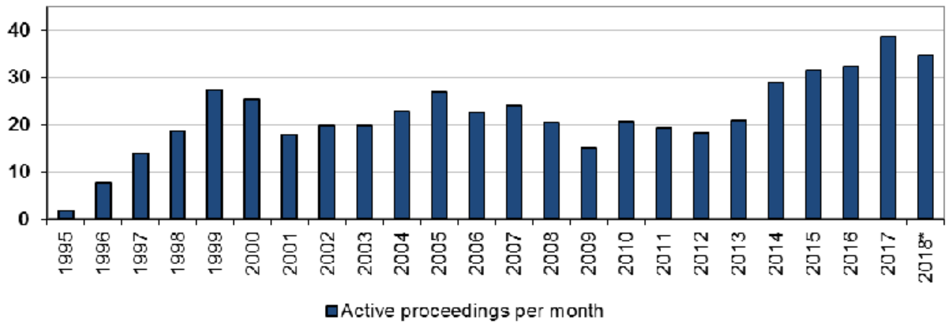
Up-to-date sources of information

- Book about trade disputes from 1995 to 2020: Organization (2010): WTO Dispute Settlement: One-page Case Summaries 1995–2020.
- WTO landing page about *Dispute settlement*
- Map of disputes between WTO Members

Referring to Reich (2017) the USA was a sinner. As Figure 36.4, Figure 36.6, and Figure 36.5 show, the US was the respondent in a relatively high proportion of all issued panel reports, namely in 38% of them (78 out 207). However, this high rate of US participation as respondent to complaints on trade violations is still much lower than its share in suspension requests. In the years I reviewed, there were 75 complainants that prevailed over the US. These are the cases where there is a potential for suspension requests in case of non-compliance. Indeed, 26 of these complainants ended up submitting suspension request against the US. That corresponds to 34.6% of the total. In other words, more than one third of the complainants who prevailed over the US in dispute settlement procedures, were forced to turn to trade sanctions in their effort to obtain compliance by the US.

[2]For example, there may be a security need to develop and purchase products domestically, or government procurement may, as is often the case, be used as a policy tool to promote smaller business, local industry or advanced technologies, see GATT Article III:8(a).

Figure 36.2: Average annual number of active proceedings per month 1995-2018



Note: Annual averages are calculated on the basis of the number of active proceedings per month (January to December) over the yearly period concerned (e.g. in 2017, 39 proceedings were active per month, on average). The 2018 average is based on the number of active proceedings in January, February and March. Source: www.wto.org

Figure 36.3: Duration of each stage of proceedings

Average length of process, months		Statutory deadline	Mean
Consultations	From the date of Request of consultations to the establishment of panel	2 months	6.6
Panel proceedings	From the establishment of panel to circulation of the panel report	6 months	15.1
Appeals	From the date of the Notice of Appeal until the date of the circulation of the Appellate Body	2–3 months	3.3
RPT, Bilateral agreement	Total length of agreed period between parties of RPT during which implementation must occur.		11.6
RPT, Arbitration Award	The average RPT awarded by the arbitrator in the awards circulated.		9.6
Compliance panel	From the date of the request to establish a first compliance panel until the date of circulation of the Compliance Panel Report.	3 months	8.7
AB compliance	From the date of the first Notice of Appeal until the date of circulation of the Appellate Body compliance report.		3.4

Source: Johannesson & Mavroidis (2017)

Figure 36.4: Most active countries at the trade dispute settlement body

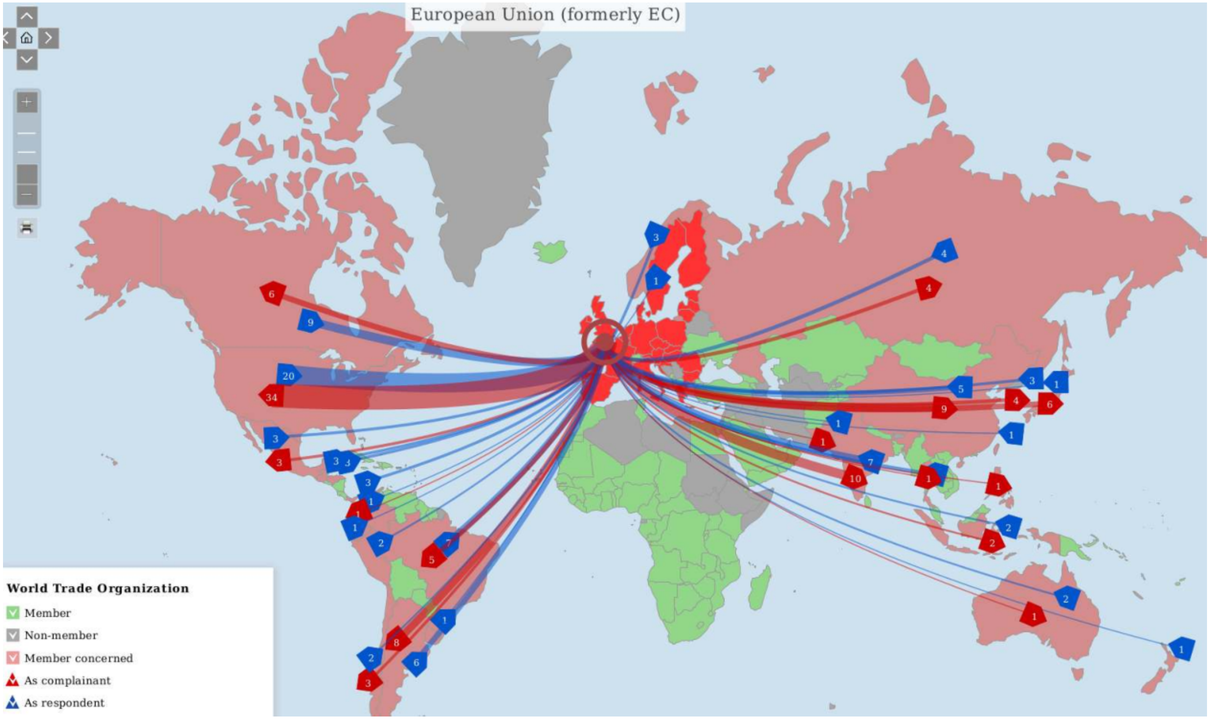
Member State:	**As Complainant**	**As Respondent**	**Complainant + Respondent**	**As Third Party**
United States	114	130	244	140
European Union[24]	97	84	181	165
Canada	35	20	55	119
China[25]	15	39	54	139
India	23	24	47	128
Brazil	31	16	47	111
Argentina	20	22	44	60
Japan	23	15	38	170
Mexico	24	14	38	82
Korea	17	16	33	112

Source: Reich (2017)

> **Suspension requests are. . .**
>
> . . . the "last station" on the long winding road of the WTO dispute settlement procedures and they represent the targeted member state's unwillingness to submit to the system and to respect its international obligations.

When China acceded to the WTO, many scholars and policy makers were very skeptical about the willingness and ability of China to comply with international trading rules. However, the number of suspension requests that have been filed against China is zero (at the time when Reich (2017) published his study). China's record on compliance, at least for now and at least as measured by the number of suspension requests filed against it, seems to be perfect.

Figure 36.5: Map of trade disputes of the European Union



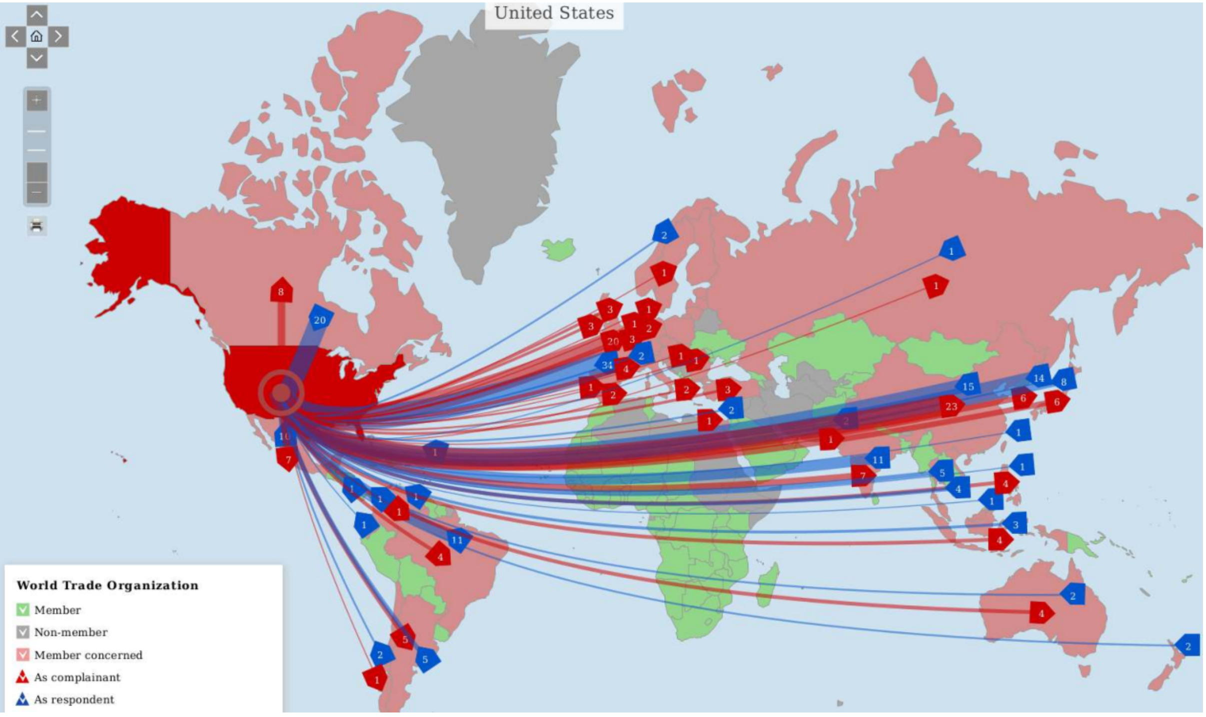
Source: *www.wto.org*

36.3 Trump and the WTO

Read the following excerpt of an article entitled with *"Trump Trade Fight Heads to Global Court as WTO Nears the Rubicon"* by Bryce Baschuk at www.bloomberg.com published on 21. of November 2018:

> The Geneva-based WTO has long avoided this politically fraught confrontation, which could irreparably harm the organization tasked with deciding international trade disputes. But barring any unforeseen developments, the WTO on Nov. 21 will grant requests from members including China and the European Union to determine if U.S. steel and aluminum tariffs imposed in March – and based on national security concerns – are legal.
>
> U.S. trade officials say that the WTO has no authority to mediate national security matters and should simply issue a decision that says the matter is outside of the WTO's remit. WTO Director-General Roberto Azevedo has gone so far as to warn countries against taking this dispute to the WTO, arguing that it instead "requires conversation at the highest political level." The fight could end up sidelining the WTO.
>
> *"If the WTO finds that Trump's tariffs are permitted under the national security exception, it opens a gaping hole that would allow any other country the right to impose trade barriers on*

Figure 36.6: Map of trade disputes of the United States of America



Source: www.wto.org

any product at any moment and for no particular reason other than protectionism" Chad Bown, a senior fellow at the Washington-based Peterson Institute for International Economics, said in an interview.

In applying the tariffs, Washington relied on a rarely-used WTO national security exemption, which permits governments to take "any action which it considers necessary for the protection of its essential security interests." The Trump administration has already blocked the process once, and since the rules don't allow further preventative actions, the WTO will likely create a dispute settlement panel, which would consist of three experts. Any decision would likely be rendered in 2019 or 2020.

Exercise 36.1. God's diplomacy
Watch the speech of Boris Johnson and discuss what is meant with free trade is god's diplomacy.

Figure 36.7: Boris Johnson

Source: *x.com/mattwridley*

Chapter 37

Trade policy

In this chapter, we discuss countries' incentives and opportunities to influence trade flows and the welfare implications of trade policy. In particular, we provide information on how the World Trade Organization organizes the world trading system.

37.1 Globalization

The term "globalization" is often used in different contexts and is usually implicitly associated with diverse and sometimes contradictory ideas about how the world works. There is no clear and generally accepted definition of the term. The use of the term carries a high risk of being misunderstood, as the conversation partner may have a different understanding of the term.

Nevertheless, it is important to understand the various meanings of the term to be able to understand the arguments that involve the term. Additionally, it allows you to phrase your own argument more precisely.

So, how can we get known to the various meanings of the term globalization. One way is to ask ChatGPT. Below you find my take on asking OpenAI (2024).

> Discuss: What do people mean when they use the term "globalization"? NextGeneration:AI
>
> Globalization is a multifaceted concept that refers to the increasing interconnectedness and interdependence of countries and cultures around the world. When people use the term "globalization," they often mean several interrelated processes:
>
> Economic Globalization: This aspect emphasizes the integration of national economies through trade, investment, and capital flows. It involves the reduction of trade barriers, the rise of multinational corporations, and the spread of global supply chains. Economic globalization has led to increased access to goods, services, and jobs across borders.
>
> Cultural Globalization: This involves the sharing and blending of cultural elements such as language, traditions, music, and values. Through media, travel, and technology, cultural practices and ideas can spread more freely, leading to both cultural exchange and homogenization. It raises discussions around the preservation of local cultures versus the influence of dominant global cultures.
>
> Political Globalization: This refers to the increasing influence of international institutions and agreements, such as the United Nations, the World Bank, and trade treaties. It encompasses the idea of global governance and the shared responsibility of nations to address global challenges like climate change, human rights, and security.
>
> Technological Globalization: This highlights the role of technology in fostering globalization. Advances in communication, transportation, and information technology have made it easier for people and businesses to connect globally. The internet, for example, enables instantaneous communication and the transfer of information across borders.

Social Globalization: This aspect focuses on the movements of people around the world, including migration, tourism, and the exchange of ideas and social practices. It emphasizes how global interactions affect societal structures and relationships.

Environmental Globalization: This addresses the global nature of environmental issues, such as climate change and biodiversity loss, which require international collaboration and efforts to manage resources sustainably.

Critically, globalization is also a subject of debate and contention. Advocates argue that it can lead to economic growth, cultural exchange, and improved living standards. Critics, however, point to issues such as economic inequality, cultural erosion, and exploitation as consequences of globalization. Additionally, events like the COVID-19 pandemic have sparked discussions about the vulnerabilities and risks associated with a highly interconnected world.

Overall, globalization encompasses a broad range of interactions and dependencies that shape contemporary society, economy, and culture on a global scale.

37.2 Political arguments for trade restrictions

Like most things in real life, trade is never all good or all evil. There are arguments in favor of opening up foreign markets and promoting international cooperation, but there are also plausible arguments that justify restricting international trade. Very often it is an empirical question as to which line of argumentation dominates.

When politicians and interest groups debate the pros and cons of trade, we must be aware of the unfortunate circumstance that not everything that is plausible is logically correct or empirically dominant. Below I will discuss some plausible arguments in favor of trade restrictions. The list is incomplete. Each argument is a topic in itself, and it needs to be further investigated whether these arguments are really valid arguments in favor of trade restrictions.

37.2.1 The desire to reduce domestic unemployment

As we learned in the previous sections, the domestic production is the result of the world market price in the long-run. However, in the short run this means that production factors need to reallocate from one sector to the other. So far, we assumed that this reallocation happens without any frictions. Thus, we just moved along the PPF curve. In reality the transformation process is costly because the people loose their jobs without finding a job in another sector instantaneously without any costs. In reality a transformation process comes along with costs such as social costs and search and matching costs. Thus, it can be a rational strategy to decrease the reallocation/transformation pressure in order to organize the reallocation of productions factors properly holding the external negative effects of transformation low. Nevertheless, we should not forget that (in the long run) reallocation of production factors and the adaption of new technologies is basically one of the most important sources of welfare growth, if not the only source.

37.2.2 The key enabling technology argument

If domestic industries are fostered, there might be technological spillovers to other industries in the country. As the government internalizes these spillovers, they have an incentive to protect and support these key to growth industries and technologies, respectively.

37.2.3 The need to counteract dumping in international trade

Selling goods in a foreign market below the price charged domestically can be called dumping. This sort of price competition is harmful when foreign producers hamper competition and discourage innovation and upgrading. For example, predatory dumping can give arguments for anti-dumping policy interventions. Predatory dumping is a type of anti-competitive behavior in which a foreign company prices its products below market value in an attempt to drive out domestic competition. This may lead to conditions where the company has a monopoly in a certain product or industry in the targeted market with bad implications for social welfare.

37.2.4 The government revenue argument

Government can finance their budget by raising tariffs.

37.2.5 The national defense argument

National defense is an obviously legitimate goal for any sovereign government and hence, domestic industries that supply goods and services that are important for a potential military emergency should have a special protection.

37.2.6 The wish to decrease the national balance of payments deficit

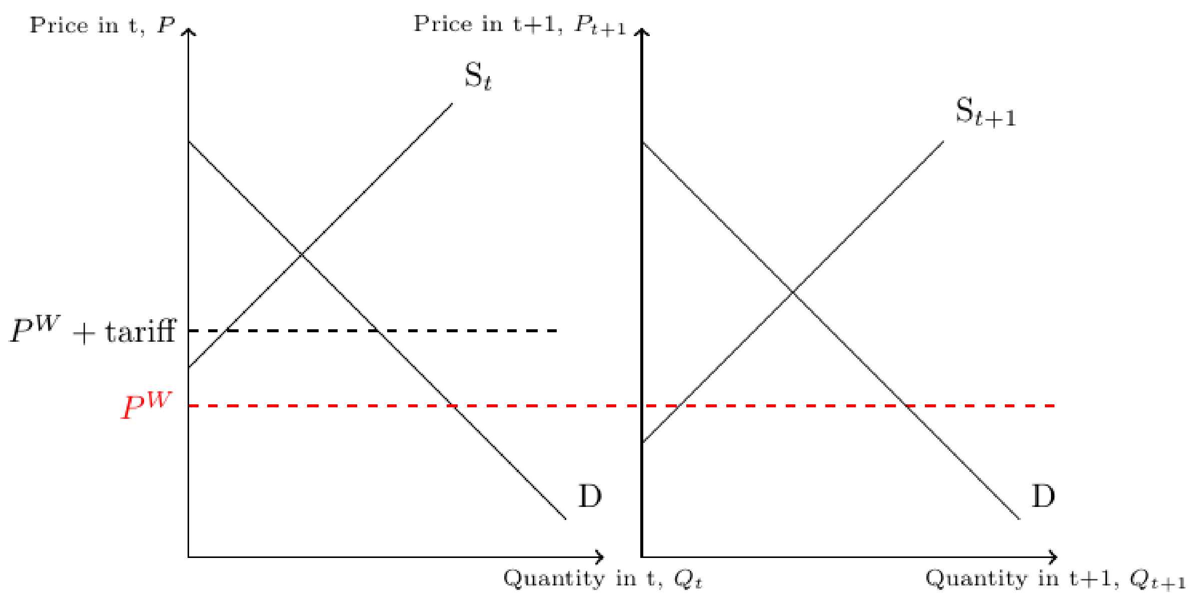
Countries that have a large trade deficit wish – for whatever reason (see Chapter 31}) – to increase import restrictions in order to decrease the export deficit.

37.2.7 The income redistribution argument

As we have learned, trade generates winners and losers and hence is a source for the distribution of wealth. Government can use this knowledge to redistribute income or decrease income inequality. However, it is almost certain that this politic is not the most efficient and best way to achieve the said goals because we have also learned that trade is beneficial for a country as a whole.

37.2.8 The infant industry argument

Figure 37.1: The infant industry argument



The basic idea is that no economic activities will happen in industries in which there are no possibilities to make positive profits because competition from abroad is currently to strong. A finite protection from international competition can make firms to grow and become more productive so that they can face foreign competition after the protection is abolished. The core of the argument is that infant industries do not have economies of scale like competitors from abroad and, hence, need to be protected until they can attain similar economies of scale.

Figure 37.1 provides a visualization that may help to understand the infant industry argument. In the left panel you see that the domestic supply curve lies above the world market price, P^W. Thus, the domestic industry is not competitive enough to produce at costs lower than the world market price. A tariff in time t would protect the domestic market so that some firms start to produce and sell their goods at home. The hope of the government now is that the firms become more productive over time and in turn their supply curve shifts downwards. The downward shifted supply curve in time $t+1$ is shown in the right panel. Here, the government can remove the tariff without crowding out the domestic production.

Exercise 37.1. Arguments for trade restrictions (Solution 37.1)
Explain briefly (2-3 sentences) the infant industry argument.

Solution 37.1. Arguments for trade restrictions (Exercise 37.1)
A finite protection from international competition can make firms to grow and become more productive so that they can face foreign competition after the protection is abolished. The core of the argument is that infant industries do not have economies of scale like competitors from abroad and, hence, need to be protected until they can attain similar economies of scale.

Exercise 37.2. Buy local be happy?

Figure 37.2: Biden and "BUY AMERICAN"

In many countries, including the U.S. (see Figure 37.2), people tend to believe that it is better to buy at home than abroad. A Statement of The White House on July 28, 2021 says:

> "The President believes that when we spend American taxpayers' dollars, it should support American workers and businesses. In his first week in office, President Biden signed Executive Order 14005, Ensuring the Future is Made in All of America by All of America's Workers, launching a whole-of-government initiative to strengthen the use of federal procurement to support American manufacturing.''

There are intuitive reasons to think that way. However, there are also some logical and persuasive arguments that confront that point of view. Please read the following quotes and discuss whether or not buying locally can be a welfare-enhancing strategy.
The first excerpt is entitled with *15 Reasons to Buy American Made Products* and stems from www.buydirectusa.com:

> Next time you are in a store or shopping online look for the Made in USA label. The job you save by doing so could one day be your own!
>
> 1. When you buy American products you support American workers. Existing jobs are saved and more employment opportunities are created.

2. When you buy American Made products you support companies that are doing business in America.
3. Hundreds of major American corporations are continuing to ship thousands of jobs overseas. Displacing the American worker.
4. Since 2000. the United States has lost an incredible 32% of its manufacturing jobs.
5. To prevent more of our manufacturing cities all over America from being transformed from thriving communities into crime infested hellholes. What happened to Flint, MI and Camden, NJ can happen in any American city when corporations decide to move production overseas.
6. China is now the number one supplier of components that are critical to the operation of US defense systems. Does this bother anyone else?
7. According to the Economic Policy Institute The economy has been unable to create jobs due to America's massive trade deficit.
8. U.S. trade policies encourage businesses to relocate production of goods to other nations without penalizing them for selling those goods back to the United States. This has resulted in millions of lost jobs for the American people.
9. Since 1975, the US has imported more goods than it has exported. In 2010, the US had a deficit of $478 billion in global trade.
10. Over 30 years of trade policies such as NAFTA and CAFTA have taken jobs from the American people.
11. For every $1 billion in goods imported, the economy loses 9,000 jobs.
12. No regulation or safety standards in products made overseas. Chinese-made drywall used in US homes is creating health and safety hazards.
13. Moral implications of the exploitation of foreign workers and violations of child labor laws overseas.
14. Environmental standards are minimal or non existent in how products are made overseas. This has an impact on everyone on the planet.
15. Chinese imports accounted for more than 60% of the recalls announced by the Consumer Product Safety Commission in 2007

UPDATE

16. COVID – Where did that get released from?
17. When you buy products from the CCP, you are helping to fund their military which are a growing threat around the globe.
18. You don't have to swim to get the products you need.

The second quote stems from Federal Reserve Bank of Dallas (2002, p. 16) who try to de-mystify the intuition of the buy local propagandists using a lot of data and some logical arguments of which you can read one here:

> "A common myth is that it's better for Americans to spend their money at home than abroad. The best way to expose the fallacy in this argument is to take it to its logical extreme. If it's better for me to spend my money here than abroad, then it's even better to buy in Texas than in New York, better yet to buy in Dallas than in Houston... in my own neighborhood... within my own family... to consume only what I can produce. Alone and poor."

37.3 Stylized facts on trade openness

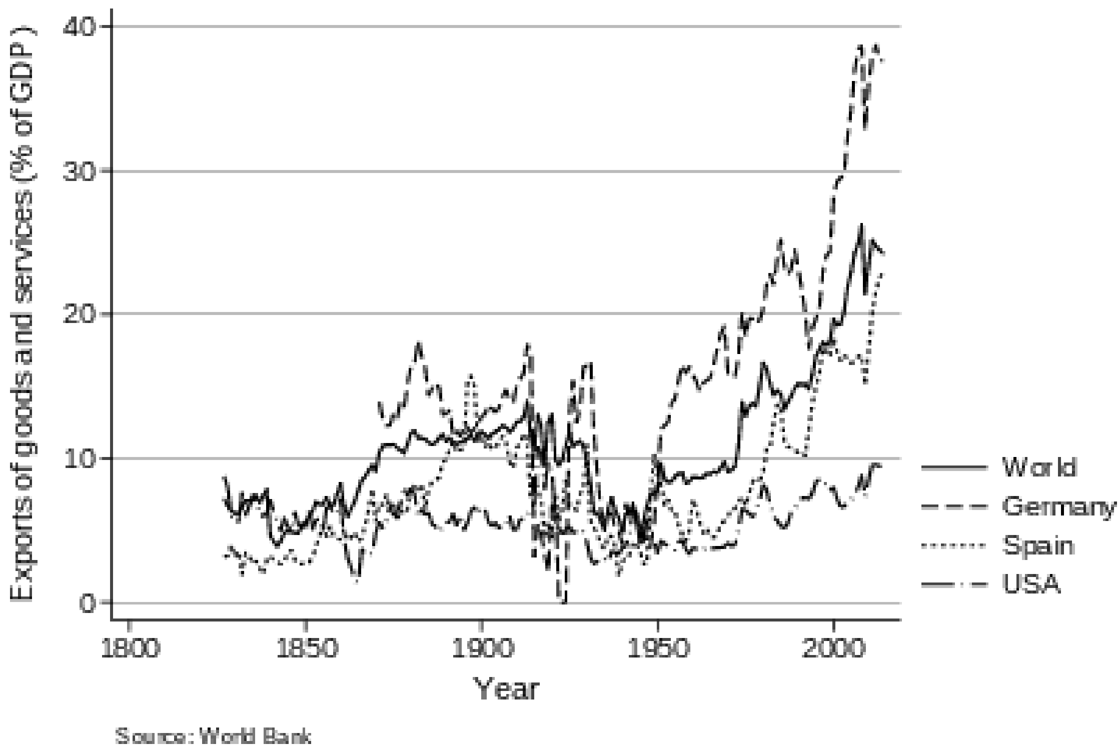
While often mentioned in the academic literature and heavily discussed in politics, the term *trade openness* lacks an accepted definition. Mostly it refers to the outward or inward orientation of a given country's economy and touches many things including some measureable indicators such as

- **Volume of trade:** the sum of exports and/or imports (see Figure 37.3)
- **Trade openness:** trade to GDP ratio (see Figure 37.4, and Figure 37.5)
- **Trade policy regime:** tariff profile, border efficiency, . . .
- **Openness to FDI:** FDI inflow to GDP, ease of doing business
- **Infrastructure:** logistics performance, communications infrastructure, telephone lines, Internet
- **Political regime:** stability, democratic, open minded, reliable, . . .

Figure 37.3: Global sum of exports

Figure 37.4: Export plus imports as a share of GDP

Figure 37.5: Globalization is not a new phenomenon



37.4 Trade anecdotes

37.4.1 The Regional Comprehensive Economic Partnership (RCEP)

The leaders of China and another 14 countries in the Asia-Pacific region (see Figure 37.9) have signed one of the biggest free trade deals in history, covering 2.2 billion people and 30% of the world's economic output. The deal will cover nearly 28% of global trade.

Figure 37.6: Transportation and communication costs

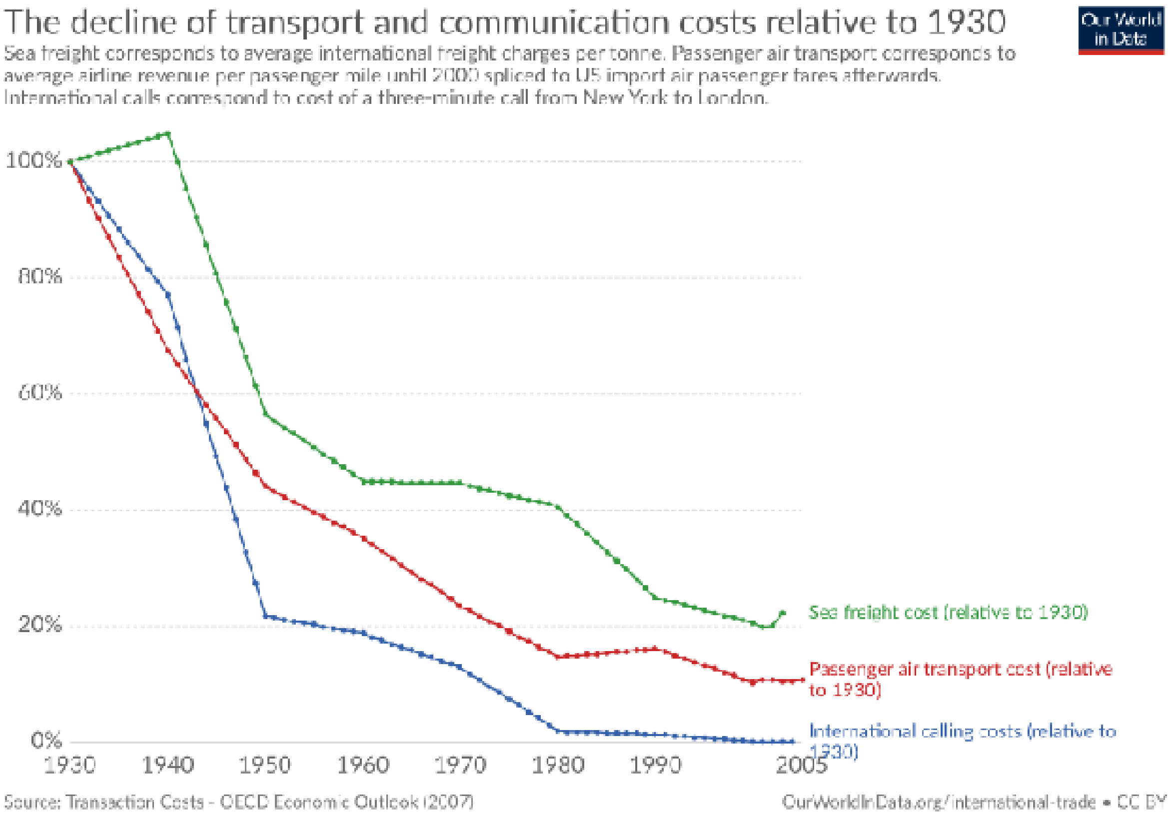


Figure 37.7: Number of Preferential Trade Agreements

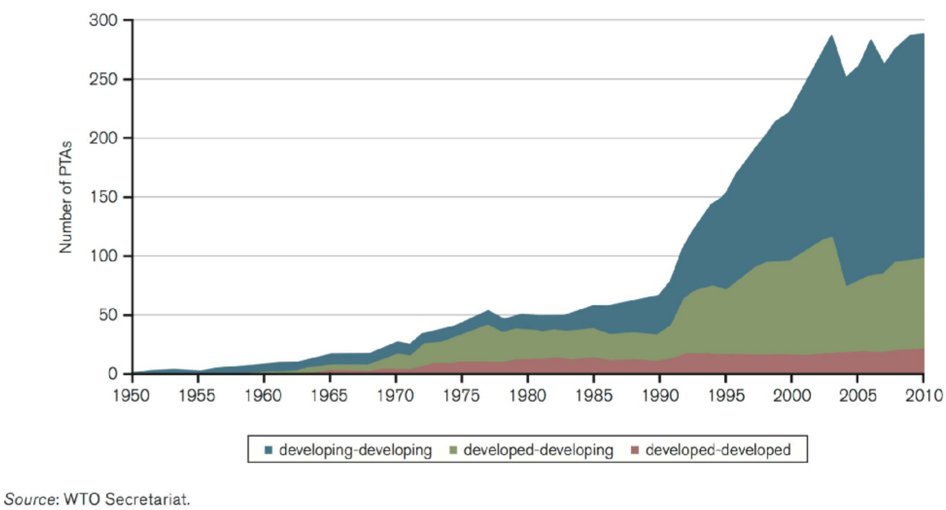
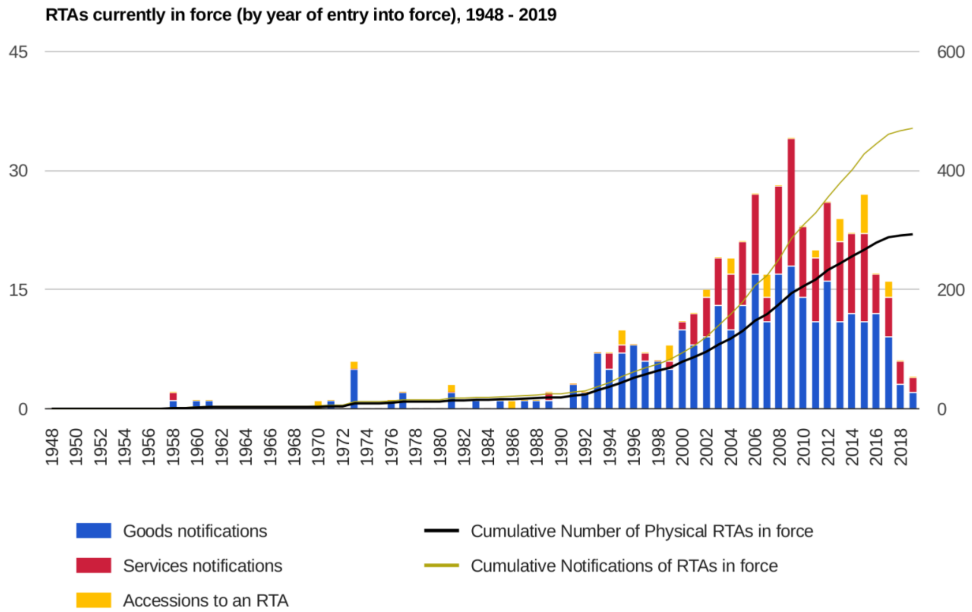


Figure 37.8: Number of Regional Trade Agreements



Source: WTO

Figure 37.9: The Regional Comprehensive Economic Partnership (RCEP)

Leaders and trade ministers of 15 Regional Comprehensive Economic Partnership (RCEP) countries pose for a virtual group photo in Hanoi, Vietnam on Sunday, Nov. 15, 2020. -

The Regional Comprehensive Economic Partnership (RCEP) was signed over a video link on November 15th after eight years of negotiations.

The deal sets the terms of trade in goods and services, cross-border investment and new rules for increasingly important areas such as electronic commerce and intellectual property. The effect on the trade of finished goods between Asian nations will be particularly marked, analysts have said.

Trade and investment flows within Asia have vastly expanded over the past decade, a trend that has accelerated amid feuding between the US and China, in which the two superpowers have imposed billions of dollars' worth of punitive tariffs on each other's exports.

Unlike the CPTPP – the Comprehensive and Progressive Agreement for Trans-Pacific Partnership – and the EU, it does not establish unified standards on labor and the environment or commit countries to open services and other vulnerable areas of their economies.

Donald Trump in 2017 pulled out of the Trans-Pacific Partnership, a deal previously envisaged as a way of curbing China's influence.

37.4.2 Trade dispute between the USA and the European Union

Watch: Trade wars: How they work and who they impact

In June 2018, the U.S. government imposed tariffs on € 6.4 billion worth of European steel and aluminum exports, followed by additional tariffs in January 2020 affecting approximately € 40 million worth of EU exports of certain steel and aluminum derivatives. The EU imposed countervailing measures on € 2.8 billion worth of U.S. exports to the EU in June 2018 (a similar EU response followed the second set of U.S. tariffs in 2020). The remaining countervailing measures, affecting up to € 3.6 billion worth of exports, were scheduled to take effect on June 1, 2021. The EU suspended these measures until December 1, 2021, to allow the parties to work together on a longer-term solution. Following today's announcement by the U.S., these measures will not be imposed. (see European Commission, 2021)

Figure 37.10: Biden and von der Leyen on G20 leaders' summit in Rome, October 31

Source: REUTERS/Kevin Lamarque

In November 2021, President Biden has signed a deal to end tariffs on steel imports from the EU, which were imposed by his predecessor Donald Trump. But the agreement does not cover exports from the UK, putting British steelmakers at a disadvantage as is discussed in an article of the BBC, see *UK steel makers 'left behind' as US ends trade war*.

37.4.3 Boeing vs. Airbus

Boeing has continually protested over launch aid in the form of credits to Airbus, while Airbus has argued that Boeing receives illegal subsidies through military and research contracts and tax breaks. All that yielded litigation at the WTO and a series of decisions that allowed (trade) penalties of both sides.

For example, on 2 October 2019, the WTO approved US tariffs on $7.5 billion worth of European goods, and officially authorized them on 14 October, despite the European Union urging for a negotiated settlement. On 30 September 2020, however, the WTO approved the European Union's retaliatory tariffs on $4.1 billion worth of US goods, this is in addition to the previous unimplemented sanction allowing the EU the right to impose tariffs of up to $8.2 billion on US goods and services

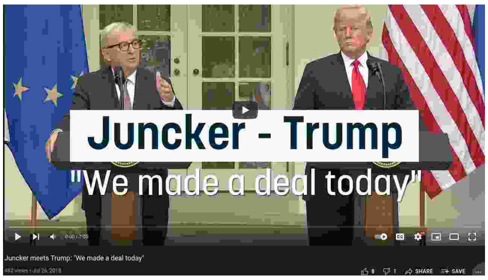
This is a trade war where nobody will probably be better of in the end. For more details on this dispute, I recommend reading the Wikipedia entry.

On June 15, 2021, the U.S. and the EU achieved a major breakthrough in the trade dispute between Boeing and Airbus, agreeing to end the 17-year dispute. All tariffs were suspended for five years.

37.4.4 Trump vs. the European Union (a.k.a. Jean-Claude Juncker)

Under president Trump, United States imposed tariffs on goods such as cars, olives, single malt whiskey, pecorino cheese, and wine. The EU, in turn, has raised tariffs on goods such as orange juice, bourbon, peanut butter, power boats, and Harley-Davidson motorcycles. This escalation was brought to a halt on July 25, 2020, Jean-Claude Junker and Donald J. Trump met at the White House to discuss the ongoing trade dispute, see Figure 37.11. They announced that the United States and the European Union would work to reduce tensions created by Trump's confrontational trade policies in the past. Before that meeting they made their standpoints clear as paraphrased below.

Figure 37.11: Juncker and Trump made a deal



> Donald J. Trump wrote via Twitter on March 3, 2018:
>
> > "The United States has an $800 Billion Dollar Yearly Trade Deficit because of our very stupid trade deals and policies. Our jobs and wealth are being given to other countries that have taken advantage of us for years. They laugh at what fools our leaders have been. No more!"
>
> Jean-Claude Juncker said on March 2 (see euronews.com):
>
> > "So now we will also impose import tariffs. This is basically a stupid process, the fact that we have to do this. But we have to do it. We will now impose tariffs on motorcycles, Harley Davidson, on blue jeans, Levis, on Bourbon. We can also do stupid. We also have to be this stupid."
>
> Donald J. Trump wrote via Twitter on March 3, 2018:
>
> > "If the E.U. wants to further increase their already massive tariffs and barriers on U.S. companies doing business there, we will simply apply a Tax on their Cars which freely pour into the U.S. They make it impossible for our cars (and more) to sell there. Big trade imbalance!"

37.4.5 Trump and his trade war with China

Donald J. Trump said in his 2016 presidential campaign, see time.com:

> *"We allowed foreign countries to subsidize their goods, devalue their currencies, violate their agreements and cheat in every way imaginable, and our politicians did nothing about it. Trillions of our dollars and millions of our jobs flowed overseas as a result. I have visited cities and towns across this country where one-third or even half of manufacturing jobs have been wiped out in the last 20 years. Today, we import nearly $800 billion more in goods than we export. We can't continue to do that. This is not some natural disaster, it's a political and politician-made disaster. Very simple. And it can be corrected and we can correct it fast when we have people with the right thinking. Right up here. [...] To understand why trade reform creates jobs, and it creates a lot of them, we need to understand how all nations grow and prosper. Massive trade deficits subtract directly from our gross domestic product. From 1947 to 2001, a span of over five decades, our inflation-adjusted Gross Domestic Product grew at a rate of 3.5 percent. However, since 2002, the year after we fully opened our markets to Chinese imports, the GDP growth rate has been cut in half. [...] A Trump administration will change our failed trade policies, and I mean quickly."*

I don't want to go into details about the trade disputes of China and USA. A concise and continually revised overview is offered by Wikipedia.

The following charts show the trade surplus/deficit (exports minus imports) for the USA, China, Russia, and Germany. The data were downloaded on 15th of June 2022 from tradingeconomics.com.

Figure 37.12: Balance of trade of the U.S. over time

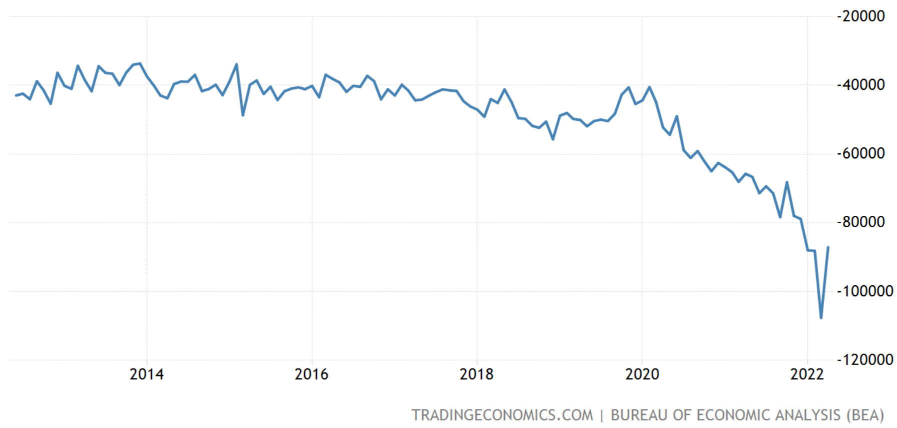


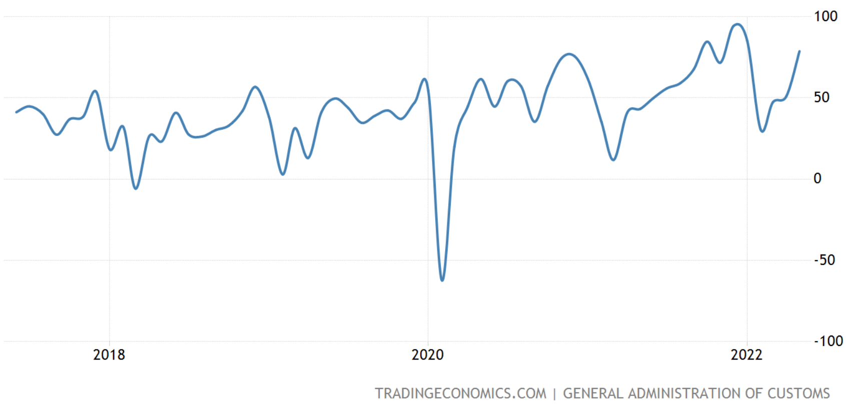
Figure 37.12 indicates that Trump was not successful in reducing the trade deficit. Overall, it seems to be the case that trade wars are not that easy to win as he claimed. It is rather difficult to impact the trade deficit within some years. Moreover, it is almost impossible to create more jobs that are lost and boost the economy with starting trade disputes.

For those who are interested: Here is a well researched article about that topic by Ryan Hass and Abraham Denmark, entitled *More pain than gain: How the US-China trade war hurt America*.

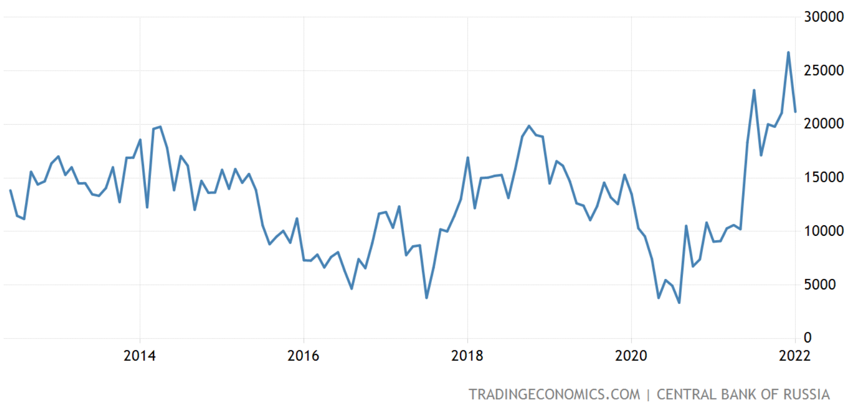
Exercise 37.3. Balance of payments across countries
Figure 37.13 shows the balance of trade over time for China, Russia, and Germany. Discuss the impact of COVID-19 on the balance of payments over time across the three countries.

Figure 37.13: Balance of trade of China, Russia, and Germany over time

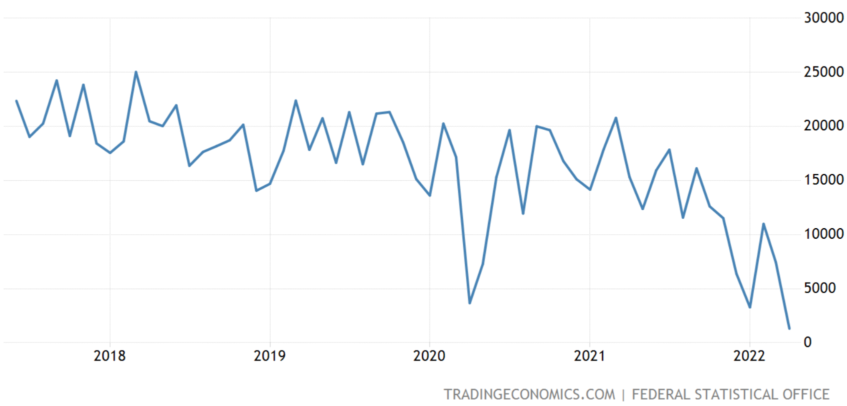
(a) China: Balance of trade



(b) Russia: Balance of trade



(c) Germany: Balance of trade



Exercise 37.4. Trump complains about the WTO

a) In an bloomberg interview Donald Trump said:

"I called NAFTA the second-worst trade deal ever made. I would say the WTO was the single worst trade deal ever made.

And if they don't shape up, I would withdraw from the WTO. We rarely won a lawsuit except for the last year. You know, in the last year, we're starting to win a lot. You know why? Because they know if we don't, I'm out of there. I'll take them out."

Discuss the legal constitution of the WTO and whether Donald Trump is right when he claims that other countries treat the United States unfair. Thereto, I recommend the article Why Trump's wrong about WTO treating US unfairly from Kucik (2018).

b) WTO members are not permitted to increase import tariffs without justification. An exception to this rule, however, is given when the *national security* of a nation is at risk. On this basis (which has been challenged within the WTO by several nations, including Canada), U.S. President Trump has issued executive orders imposing import tariffs on steel and aluminum imports for a set of different countries. Discuss whether this behavior can be considered as fair.

Solution

a) Trump's claims are difficult to assess because it is unclear what he means by fairness or how to define fairness in trade relations in general.

   When referencing WTO rules, U.S. policy is far from a model of fairness to others, as too many countries have sued the U.S. for its discriminatory policies. Although he is wrong in his claim that the U.S. has "rarely won a lawsuit, with the exception of last year" (the U.S. win rate is similar to the average win rate), the U.S. is the country that has sued other members more often than any other country.

b) Imposing and increasing tariffs based on the exception rule could irreparably damage the WTO's authority to adjudicate trade disputes. This is because U.S. trade representatives contend that the WTO does not have the authority to mediate national security issues and should simply issue a ruling that the matter is not within the WTO's jurisdiction. This argument puts a gun to the WTO's head. If the WTO's Dispute Settlement Body follows this line of reasoning, any country could easily impose tariffs in the future, citing *national security*, without the WTO being able to judge whether or not the issue is truly one of national security. This reminds (me) of the Mexican standoff, that is, a confrontation between three or more parties in which there is no strategy that allows one party to win.

Exercise 37.5. Please read the following article "What's behind Trump's trade war?" by Derviş & Conroy (2018) and reflect on the arguments presented by the two authors. Do you comprehend their points in light of everything you've learned in the course so far? If anything is unclear, please specify what you find confusing.

What's behind Trump's trade war?

Derviş & Conroy (2018):

> *"Donald Trump's justifications for his aggressive trade policy – that it will reduce the US current-account deficit and save vulnerable American industries – do not withstand scrutiny. At the heart of Trump's trade war is an impulse to free American power from the supposed shackles of multilateralism.*
>
> *WAHINGTON, DC – Since World War II's end, trade has grown 50 percent faster than global GDP, owing largely to successive rounds of liberalization under the auspices of the World Trade Organization (previously the General Agreement on Tariffs and Trade, or GATT). But now, U.S. President Donald Trump's latest dose of import tariffs could push the world into a full-blown trade war, undoing much of that progress.*
>
> *Proponents of free trade have always celebrated the growth of international commerce because they regard it as a sign that countries are capitalizing on their comparative advantages through specialization, which implies increased efficiency overall. By contrast, critics of free trade worry that it might lock poor countries into producing goods that offer little room for productivity growth, and point out that even if there are aggregate gains from globalization, there are also clear losers.*

In fact, few would disagree that a static comparative advantage theory is a poor guide for development policy. A more dynamic framework is needed to determine whether trade also brings knowledge and learning to new markets. If it does, then it can be an engine of future economic growth and social progress.

Overall, there is overwhelming evidence that trade has indeed enriched developing countries where supportive policies have been in place. Over time, developing countries have learned to complement trade policies with higher investment in infrastructure and education. But with the world trading system now under assault by the United States, the question for developing countries is how to respond.

To justify his tariffs, Trump points to America's bilateral (or multilateral) trade deficits with its trading partners. But while tariffs can change the composition of trade flows, they will have little bearing on the current-account balance, which is determined by national savings and investment. If savings fall short of investment—as they do in the U.S.—the current account will necessarily be in deficit.

To be sure, tariffs can have an incidental effect on the current-account balance. As a tax on domestic consumers and a subsidy for certain domestic producers, tariffs reduce consumers' disposable income and augment capital income. To the extent that more capital income is saved relative to labor income, tariffs will increase the economy's overall savings rate. Nevertheless, this effect on the savings-investment balance is both weak and indirect.

At the micro level, Trump might argue that tariffs are necessary to protect particular sectors. But many of the goods imported into the U.S. actually contain intermediate inputs that were originally produced domestically (this is even more the case for China). So, to determine whether tariffs are actually protecting the value added-wages and profits in a particular U.S. sector, one must also account for the U.S. value added within imports that are now facing levies. Assuming that Trump's advisers have explained these complications to him, one wonders what his real rationale is.

While Trump's desire to prop up politically important industries and reduce the U.S. current-account deficit has certainly played a role in his trade policy, it is clear that his main target is the WTO and the multilateralism that it represents. Trump seems to think that multilateralism dilutes American power, given that the U.S. can always use its economic and geopolitical clout to win a bilateral dispute. What he doesn't realize is that even the world's most powerful country still needs impartial global rules and disinterested institutions to oversee them.

Over the past 70-odd years, the GATT/WTO system has developed into a multilateral arrangement whereby the same rules apply to all countries alike. That is not to say that bigger and richer countries lack advantages over smaller and poorer countries. Countries like the U.S. can allocate more staff and specialists to support their own producers in complicated trade negotiations, while also pursuing parallel (back-channel) diplomacy. Legally, however, the WTO is a grouping of equals. The "most favored nation" provision means that an advantage extended to one country's producers must be extended to all.

Perhaps most important, the WTO has a dispute-settlement mechanism (DSM) that provides for the timely resolution of disagreements between member states. Though the U.S. has won most of the cases that it has brought before the WTO's arbitration panel, it has also lost some. With the ability to hand down binding judgments, the DSM is a unique feature of the WTO system. No other multilateral body has such a mechanism.

There are many ways that the multilateral system could be improved, of course. The WTO, the World Bank, and the International Monetary Fund should be devising new approaches to address the growing influence of Big Tech; and competition policy needs to be brought into the twenty-first century. It might also be appropriate for the WTO to adopt a form of weighted voting, similar to the procedure used by the IMF and World Bank.

As for the criticism that globalization produces both winners and losers, this is not an argument against trade; it is an argument for policies to compensate those who have been left behind. On that basis, those who have rightly criticized the WTO in the past should

> *join forces with its supporters. Both sides have an interest in defending this key institution of global governance from the xenophobic unilateralism embodied by Trump's policies."*

37.5 Gains from trade

Figure 37.14 and Figure 37.15 contain domestic supply and demand curves. In autarky with no possibilities to trade, supply and demand must meet. Under free trade and a given world market price, P^W, countries can trade with each other. This has implications for the producer surplus (yellow area) and the consumer surplus (blue area), as shown in the figures. The area of the triangles a and b as denoted in Figure 37.15 represents the welfare gain from free trade that can be achieved given the world market price, P^W.

Figure 37.14: Two countries in autarky

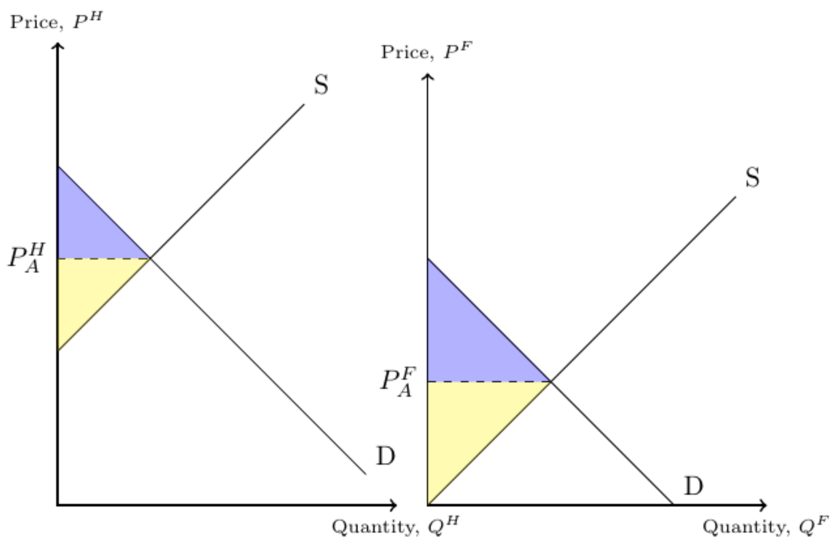
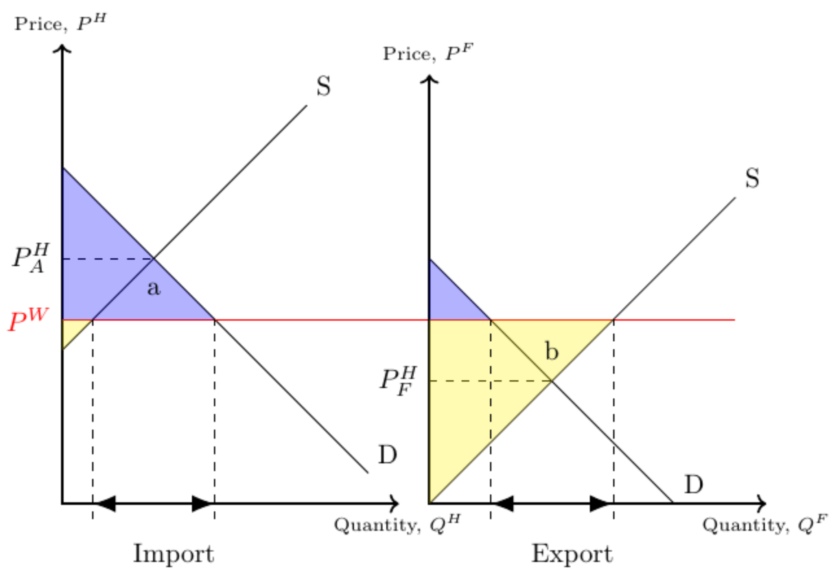


Figure 37.15: Two countries that trade with each other

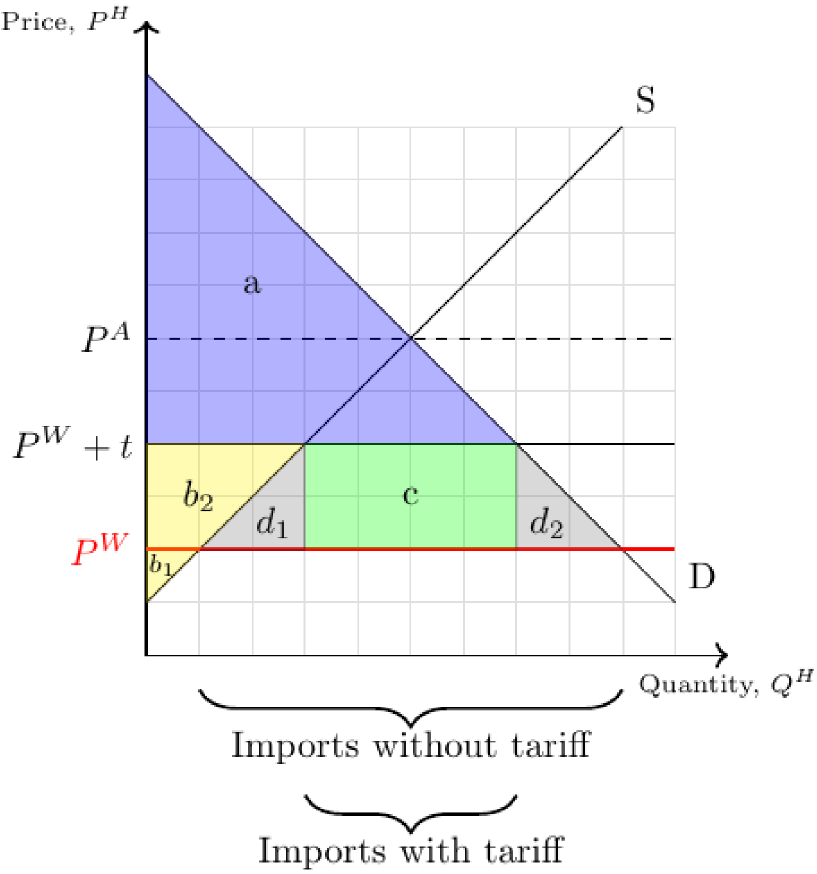


37.6 Tariffs in small open economies

Figure 37.16 can teach us a lot about the impact of a tariff t on trade and welfare. A tariff raises the domestic price of imported goods. If we assume that the imposition or change of a country's tariff has no effect on the world price, we consider what is called a small open economy, which is so small that the country's consumption and production decisions do not affect the world price. In other words, the country takes the world price for granted because its import demand does not change the world price.

In autarky, the economy represented in Figure 37.16 would consume 5 units at price P^A, and total welfare would be represented by areas $a+b_2+b_1$. Under free trade without tariffs, the country imports 8 units and consumes 9 units at the price of P^W. The consumer surplus corresponds to areas $a+b_2+d_1+c+d_2$ and the producer surplus corresponds to area b_1. After the introduction of tariff t, the consumer surplus is equal to area a and the producer surplus is equal to area b_1+b_2. Thus, consumer surplus has decreased while producer surplus has increased. The area c is equal to the government's revenue. It represents the portion of the consumer welfare loss that is transferred to the government. Overall, welfare has decreased. The welfare loss is equal to the areas of the two triangles d_1 and d_2. These triangles represent what is called the *deadweight loss* due to the tariff.
Specifically, triangle d_1 represents the reduction in imports that is replaced by domestic production, and triangle d_2 represents the loss in consumption due to a reduction in imports and a reduction in domestic consumption.

Figure 37.16: Tariff in a small open economy



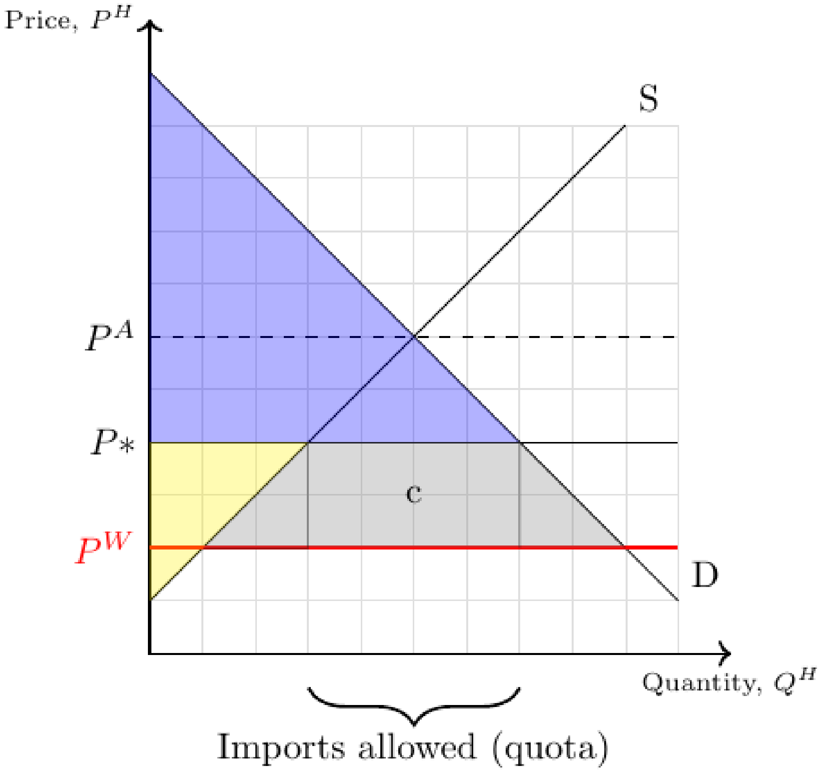
> **ℹ The implications of a tariff in a small economy**
>
> While a tariff protects domestic producers and increases their surplus, it reduces the surplus of consumers and leads to a deadweight loss of revenue. Overall, a tariff leads to a reduction in a country's welfare.

37.7 Quotas in small open economies

A trade restriction that sets a physical limit on the quantity of a good to be imported is called an import quota. It gives government officials more power and control than a tariff because they can strictly limit the quantity of goods traded and have the administrative authority to grant (or sell) import licenses to certain foreign exporters.

Figure 37.17 shows the impact of an import quota that allows an import quantity of 4 units. In this scenario, 7 units are consumed, four of which are imported. The price at which all seven units are consumed is $P*$. This is somewhat surprising because the world price P^W is less than P^*. The reason is that all firms that are allowed to sell their products do so at the highest possible price, that is, P^*. As above, the blue area is the consumer surplus and the yellow area is the producer surplus. The gray area is the loss in value due to the import rate. The rectangle c is only part of this loss, since we assume that the government does not sell the licenses to the best bidding exporting firm

Figure 37.17: Tariff in a small open economy



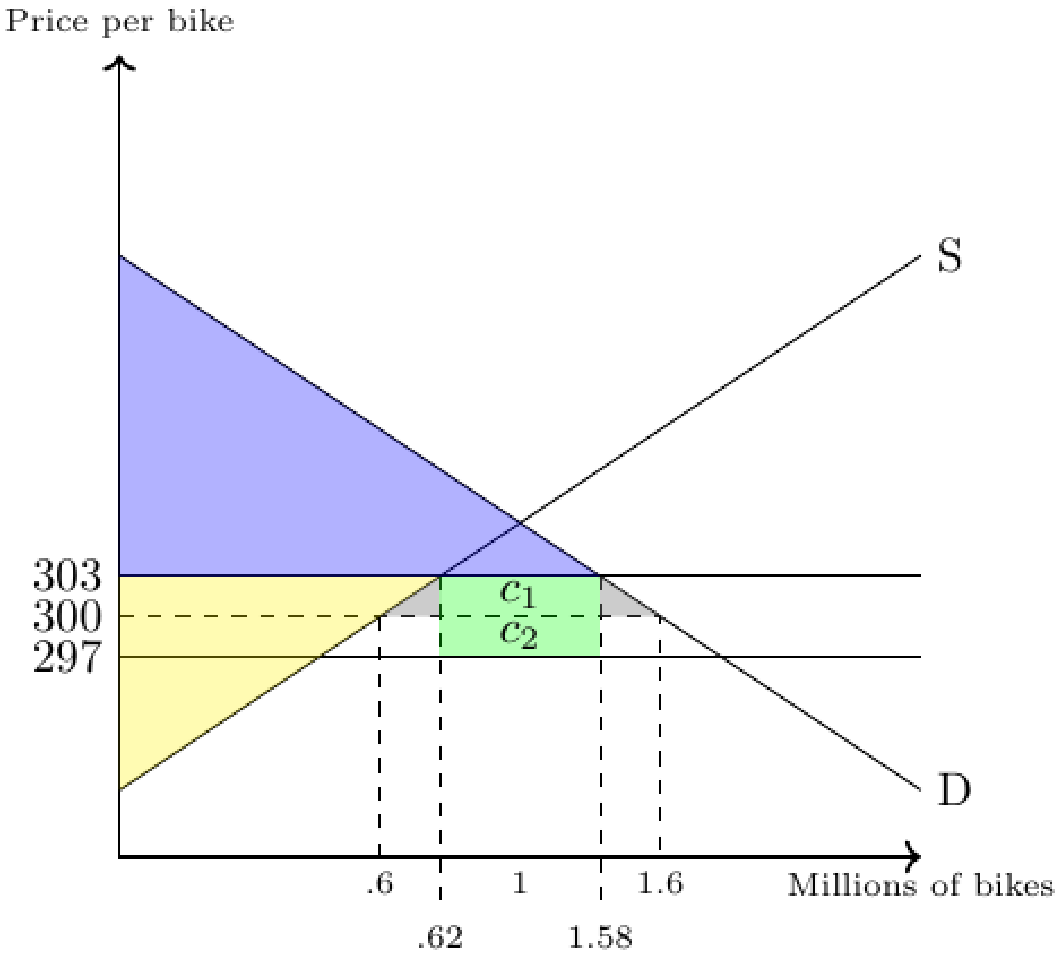
37.8 Tariffs in large open economies

So far, we have assumed that the country of interest is small and takes the world market price as given. However, large countries' demand for imported goods can have an impact on world prices. If this is the case, we can show that a tariff can actually improve a country's welfare. Figure 37.18 illustrates the effects of a tariff on welfare, prices, and trade. In particular, we show the impact of a small tariff of 6 euros per bicycle.

Under free trade, the market for bicycle imports is cleared at a price of €300 and the country imports one million bicycles.

Now, if a tariff of 6€ per bicycle is imposed, the tariff drives a wedge between the price foreign exporters receive and the price domestic buyers of imports pay. That is, it becomes more expensive for domestic buyers to purchase imported bicycles. This, in turn, leads to an immediate drop in domestic demand for

Figure 37.18: The effect of a tariff in a large country



bicycles and pushes the world market price for bicycles to €297 Given the new world market price for bicycles, the domestic price for imported bicycles is €303 (297+6).

The consumer surplus is now represented by the blue area and the producer surplus by the yellow area. The green area represents the tariff revenue collected by the government. The two gray triangles, in turn, show the tariff-related deadweight losses. Compared to the free trade scenario, the country gains rectangle c_2. If the revenue in this area is greater than the deadweight loss, the country has improved its overall welfare by imposing a tariff.

Let us calculate whether this is the case here:

- Area c_2:
$$(1.58 \text{ million bikes} - 0.62 \text{ million bikes}) \cdot (€300 - €297) = €2.88 \text{ million}$$
- Deadweight loss:
$$\underbrace{\frac{(0.62 \text{ mio b.} - 0.6 \text{ mio b.}) \cdot (€303 - €300)}{2}}_{\text{left triangle}} + \tag{37.1}$$
$$\underbrace{\frac{(1.6 \text{ mio b.} - 1.58 \text{ mio b.}) \cdot (€303 - €300)}{2}}_{\text{right triangle}} \tag{37.2}$$
$$= €0.06 \text{ million} \tag{37.3}$$
- Indeed, the net gain is €2.82 million. Thus, a small tariff can increase the welfare of a country.

37.9 Other nontariff trade barriers

In addition to tariffs, there are a variety of other trade barriers. These so-called non-tariff barriers (NTBs) include quotas, export subsidies, domestic production subsidies, government buy-at-home policies, and product standards. Here is a more complete list:

- Import quotas
- Voluntary export restraints
- Antidumping laws
- Exchange-rate controls
- Countervailing duties
- Government subsidies
- Licensing, labeling and packaging restrictions
- Quality controls and technical standards
- Domestic-content laws
- Political rhetoric
- Embargoes and sanctions
- Most/least-favored nation status

For example, **product standards** are much more important than you might think. For example, no car from the United States can be sold in the European Union without modifications because our safety standards are different. Another example is the CE marking (see below). Harmonization of product standards is usually an important issue in trade agreements.

CE Marking

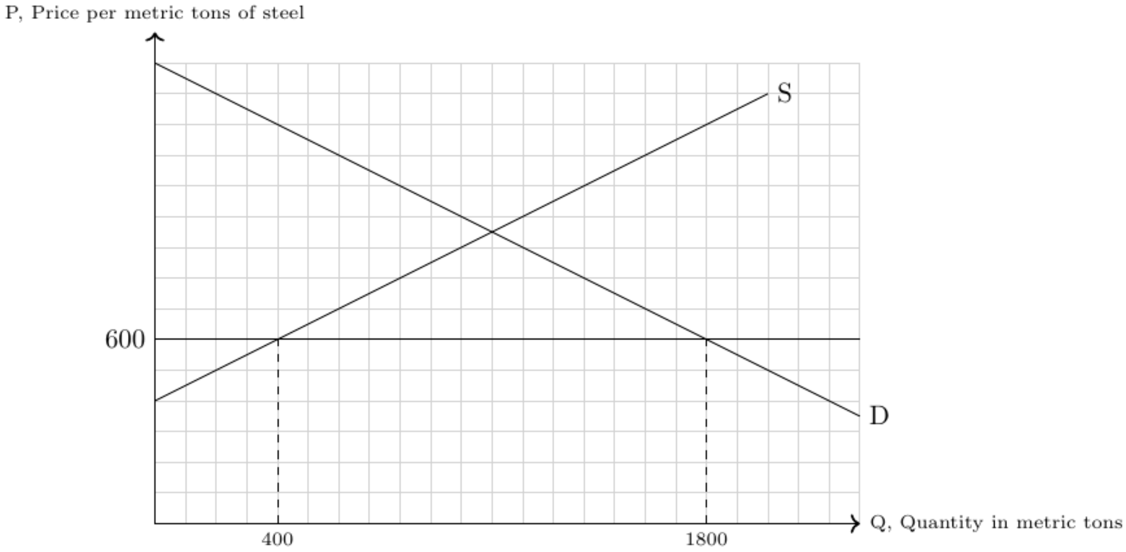
Figure 37.19: The CE marking

The CE marking shown in Figure 37.19 is one example for a non tariff trade barrier. It is not an abbreviation for *China Export*, as many believe. While CE is sometimes indicated as an abbreviation of *Conformite Europeenne* (French for *European Conformity*), it is not defined as such in the relevant legislation. The mark indicates that the product may be sold freely in any part of the European Economic Area, irrespective of its country of origin. The CE marking is a declaration by the manufacturer (not by some authority!) that the product complies with EU standards for health, safety and environmental protection for products sold within the European Economic Area (EEA). Thus, it is not a quality indicator or a certification mark and may also be found on products sold outside the EEA. You may also know the _FCC Declaration of Conformity} which is used for selling certain electronic devices in the United States.

Exercise 37.6. Tariff (Solution 37.2)
Referring to Figure 37.20, the government of a large country needs your help to decide whether the introduction of a tariff of $100 per metric ton of on steel is a good idea, or not. At the current world market price of $p^W = 600\$$, the country imports 14 millions metric tons of steel. The government expects that a tariff of $100 per ton of steel would decrease the world market price of steel for $1.

a) Calculate how much the overall welfare gain (or loss) of the country would be in case the government decides to introduce a tariff of $ 100 per ton of steel. Assume thereby that the supply curve is given by
$$P^s = 400 + \frac{1}{2}Q^s$$
and the demand curve is given by
$$P^d = 1500 - \frac{1}{2}Q^d.$$
These curves are also shown in the figure below.
b) What would be the tariff so high that it makes an import of steel prohibitively expensive.
c) What would be the world market price so low that it makes any domestic production unprofitable.
d) What would be the world market price so high that the country exports steel.

Figure 37.20: Exercise: Tariff



Solution 37.2. Tariff (Exercise 37.6)

a) By analogy with Figure 37.18, here we should compare the two gray triangles with area c_2.

The price per metric ton of steel from foreign suppliers will be \$699 because government will charge \$100 on each ton of steel which is now worth \$599 on world markets. As \$699 is still below the autarky price of \$950, domestic suppliers will set prices to be equal to \$699. Thus,

$$
\begin{aligned}
699 &= 400 + \frac{1}{2}Q^s \Leftrightarrow Q^s = 598 \\
699 &= 1500 - \frac{1}{2}Q^d \Leftrightarrow Q^d = 1602 \\
1602 - 598 &= 1004
\end{aligned}
$$

That means, at a price of \$699 domestic supply is 598 and domestic demand is 1602 tons of steel. 1004 tons will be imported.
To calculate the *welfare loss* (the two triangles), we can calculate the left triangle only and double it (please note that this is only possible if both triangles really have the same size which is only the case if both supply and demand curves have the same slope in absolute terms!):

$$
\begin{aligned}
&\overbrace{\left(\underbrace{(598-400)}_{\text{loss in quantity}} \cdot \underbrace{\frac{1}{2}}_{\text{to get the triangle}} \cdot \underbrace{(699-600)}_{\text{increase in price}}\right)}^{\text{left triangle}} \cdot \overbrace{2}^{\text{right triangle is of same size}} \\
&= 9801 \cdot 2 \\
&= 19602
\end{aligned}
$$

The welfare gain (the new square that is due to the change in world market price, a.k.a. c_2) is

$$
1004\text{tons} \cdot 1\left[\frac{\$}{\text{tons}}\right] = 1004\$.
$$

Thus, overall welfare gain is

$$
1004 - 19602 = -18598.
$$

That means, the welfare loss exceeds the welfare gain by \$ 18598.

b)

$$
\begin{aligned}
400 + \frac{1}{2}Q &= 1500 - \frac{1}{2}Q \\
\Leftrightarrow Q &= 1100 \\
P^s &= 400 + \frac{1}{2} \cdot 1100 \\
P^s &= 950
\end{aligned}
$$

At a price above \$950, no steel would be imported. Thus, a tariff must be so high that the price of foreign steel within the country exceeds \$950, that is, $P^W + t > 950$. Assuming that the world market price would have a lower bound of \$599, that is, any tariff above \$100 would not decrease the world market price any further, a tariff of \$351 (950-599=351) would make imported steel prohibitively expensive.

c) Below a price of \$400 any domestic production would be unprofitable because the supply curve tells us that no domestic producer would be able to supply anything at and below the price of \$400. To proof that just set $Q^s = 0$ in the function of the supply curve and you get $P^s = 400$.

d) At a world market price above \$950, it would be profitable to export steel because domestic supply exceeds domestic demand and the world market price is higher than the production costs.

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Appendix A

Glossary

Autarky: Autarky is the characteristic of self-sufficiency; the term usually applies to political states or their economic systems. Autarky exists whenever an entity survives or continues its activities without external assistance or international trade.

Balance of payments: The balance of payments, also known as balance of international payments and abbreviated B.O.P. or BoP, of a country is the record of all economic transactions between the residents of the country and the rest of the world in a particular period of time (e.g., a quarter of a year). These transactions are made by individuals, firms, and government bodies. Thus, the balance of payments includes all external visible and non-visible transactions of a country. It is an important issue to be studied, especially in the international financial management field.

Balance of trade: The balance of trade, commercial balance, or net exports (sometimes symbolized as NX), is the difference between the monetary value of a nation's exports and imports over a certain time period.

Balanced trade: When the value of exports equals the value of imports.

Budget constraint line: Shows the possible combinations of two goods that are affordable given a consumer's limited income.

Closed economy: If a self-sufficient economy also refuses to conduct any trade with the outside world, then economists may term it a "closed economy."

Complements: Goods that go together; a decrease in the price of one results in an increase in demand for the other, and vice versa.

Competitive market: A market in which there are many buyers and many sellers, ensuring that no single buyer or seller can significantly impact the market price.

Consumer equilibrium: Occurs when the ratio of the prices of goods is equal to the ratio of the marginal utilities, indicating the point at which a consumer achieves maximum satisfaction.

Deadweight loss: The loss in social surplus that occurs when a market produces an inefficient quantity of goods.

Demand: Refers to the willingness and ability of consumers to purchase a quantity of a good or service at a given point in time or over a period.

Demand curve: A graph illustrating how much of a given product a household would be willing to buy at different prices.

Demand schedule: A table that shows the relationship between the price of a good and the quantity demanded.

Diminishing marginal utility: The principle that each additional unit of a good consumed provides less additional satisfaction than the previous unit.

Elasticity: A concept used to quantify the responsiveness of one variable when another variable changes.

Equilibrium: The condition that exists when the quantity supplied equals the quantity demanded, resulting in no tendency for price changes.

Excess demand: The condition where the quantity demanded exceeds the quantity supplied at the current price.

Excess supply: The condition where the quantity supplied exceeds the quantity demanded at the current price.

Export: An export in international trade is a good or service produced in one country that is bought by someone in another country. The seller of such goods and services is an exporter; the foreign buyer is an importer.

Giffen good: A type of good for which an increase in price leads to an increase in quantity demanded, contrary to the basic law of demand.

Import: An import in the receiving country is an export from the sending country. Importation and exportation are the defining financial transactions of international trade.

Indifference curve: In economics, an indifference curve connects points on a graph representing different quantities of two goods, points between which a consumer is indifferent. That is, any combinations of two products indicated by the curve will provide the consumer with equal levels of utility, and the consumer has no preference for one combination or bundle of goods over a different combination on the same curve.

Inferior good: A good for which an increase in income results in a decrease in demand.

International trade: International trade is the exchange of capital, goods, and services across international borders or territories.

Labor demand: Refers to the amount of work that employers are willing to hire at a given wage.

Labor supply: Refers to the amount of time workers are willing to work at a given wage.
Law of demand: The principle that, other things being equal, the quantity demanded of a good falls when the price of the good rises.

Law of supply: The principle that, other things being equal, the quantity supplied of a good rises when the price of the good rises.

Marginal utility: The additional satisfaction gained from consuming one more unit of a good.

Marginal utility per dollar: The additional satisfaction gained from purchasing a good adjusted by the product's price; calculated as MU/Price.

Market: A group of buyers and sellers engaged in the exchange of a particular good or service.

Market-clearing price: An alternative term for market equilibrium; it refers to the fact that the market is cleared of all unsatisfied demand and excess supply at the equilibrium price.

Net capital outflow: The difference between the purchase of foreign assets by domestic residents and the purchase of domestic assets by foreigners. This equals net exports, indicating that a country's savings can fund investments domestically or abroad. We will elaborate on that later on in greater detail.

Normal good: A type of good for which an increase in income or a decrease in price leads to an increase in demand.

Perfectly competitive market: A market characterized by the identical nature of goods offered for sale and a large number of buyers and sellers, ensuring no single entity can influence the market price.

Perfect substitutes: Goods that are identical in nature and can be used in place of one another.

Price ceiling: A legally mandated maximum price that sellers may charge for a good, typically set by the government.

Price control: Government regulations aimed at influencing the prices of goods and services rather than allowing market forces to determine them.

Price floor: A legally mandated minimum price set by the government.

Producer surplus: The extra benefit producers receive from selling a good, calculated as the price received minus the minimum acceptable price.

Production-possibility frontier: A production–possibility frontier (PPF) or production possibility curve (PPC) is a curve that shows various combinations of the amounts of two goods that can be produced within the given resources and technology— a graphical representation showing all the possible options of output for two products that can be produced using all factors of production, where the given resources are fully and efficiently utilized per unit time.

Protectionism: Protectionism is the economic policy of restricting imports from other countries through methods such as tariffs on imported goods, import quotas, and a variety of other government regulations.

Quantity demanded: The total amount of a good that buyers are willing and able to purchase at a given price.

Quantity supplied: The total amount of a particular good that sellers are willing and able to sell at a given price.

Subsidy: An economic incentive given to remove some type of burden in the interest of market welfare; a subsidy drives a wedge, decreasing the price consumers pay.

Substitutes: Goods that can be used in place of one another; when the price of one increases, demand for the other often rises.

Supply: The willingness and ability of producers to create goods and services and bring them to market.

Supply curve: A graph that illustrates the quantity of a good that a firm will supply at various price levels.

Tariff: A tariff is a tax on imports or exports between sovereign states. It is a form of regulation of foreign trade and a policy that taxes foreign products to encourage or safeguard domestic industry. Traditionally, states have used them as a source of income. They are now among the most widely used instruments of protectionism, along with import and export quotas.

Tax: Money collected by a government from buyers or sellers, directly or indirectly, in exchange for services provided to the community.

Total utility: The overall satisfaction derived from consuming a certain quantity of goods or services.

Trade: Trade involves the transfer of goods or services from one person or entity to another, often in exchange for money. Economists refer to a system or network that allows trade as a market.

Trade balance: The difference between the value of goods and services a country sells abroad and those it buys from abroad, also known as net exports.

Trade surplus: When a country sells more than it buys, resulting in a positive trade balance.

Trade deficit: When a country buys more than it sells, leading to a negative trade balance.

Trade barrier: Trade barriers are government-induced restrictions on international trade.

Trade war: A trade war is an economic conflict resulting from extreme protectionism in which states raise or create tariffs or other trade barriers against each other in response to trade barriers created by the other party.

Utility: Within economics, the concept of utility is used to model worth or value. Its usage has evolved significantly over time. The term was introduced initially as a measure of pleasure or satisfaction within the theory of utilitarianism by moral philosophers such as Jeremy Bentham and John Stuart Mill. The term has been adapted and reapplied within neoclassical economics, which dominates modern economic theory, as a utility function that represents a consumer's preference ordering over a choice set. It is devoid of its original interpretation as a measurement of the pleasure or satisfaction obtained by the consumer from that choice.

Appendix B

Mathematical preliminaries

Please feel free to download and study my introduction for mathematics for economics here.

Appendix C

Past exams

Note

I have taught several courses, which are now summarised in the course *Economics*, including *International Economics*, *Economic Thinking in a Global Context*, *Macroeconomics*, *Microeconomics* and *Managerial Economics*. There are sub-areas from each of these courses that are also covered in the Economics course.
If you have any questions, please do not hesitate to contact me. However, I do not offer solutions to the exams.

C.1 Macroeconomics

Please feel free to download a collection of past *Macroeconomics* exams here.

C.2 Economic Thinking in a Global Context

Please feel free to download a collection of past *Economic Thinking in a Global Context* exams here.

C.3 International Economics

Please feel free to download a collection of past *International Economics* exams here.

C.4 Managerial Economics

Please feel free to download a collection of past *Managerial Economics* exams here.