International Economics

Lecture Notes

March 20, 2024

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1. Preface

About the notes

- These notes aims to support my lecture at the HS Fresenius but are incomplete and no substitute for taking actively part in class.
- A pdf version of these notes is available here
- I appreciate you reading it, and I appreciate any comments.
- This is work in progress so please check for updates regularly.
- Do not distribute without permission.
- For making an appointment, you can use the online tool that you find on my private homepage: https://hubchev.github.io/

About the author

Figure 1.1.: Prof. Dr. Stephan Huber

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 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 on my work, please visit my private homepage at hubchev.github.io.

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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.

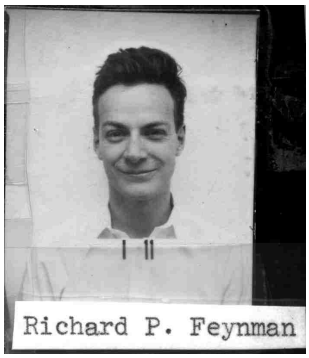
Unfortunately, students sometimes feel overwhelmed by these models because of their reliance on math and rigorous logical reasoning. There is often a perception that there are simpler ways to convey these arguments. While this may occasionally be true, I firmly believe that the formal approach to introducing 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. Nevertheless, they can offer deeper insights into a topic than narratives.
- 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 1.2.: 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 Manhatten Project (see Figure 1.2) 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:

- Study the lecture notes, i.e., try to understand the exercises and solve them yourself.
- Study the exercises, i.e., try to understand the logical rules and solve the problems yourself.
- Test yourself with past exams that you will find online.
- If you have the opportunity to form a group of students to study and prepare for the exam, 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 will do my best to help.

2. Monetary international economics

2.1. Currencies

Exercise 2.1. Our relations are not good

Figure 2.1.: Trump doubles metal tariffs on Turkey by 20%

Source: Twitter

Do you understand the logic behind Mr. Trump's action (see Figure 2.1) to double metal tariffs due to a fall of the Turkish Lira? Discuss.

2.1.1. Exchange rates

The price of one currency in terms of another is called an exchange rate. Exchange rates allow us to compare prices of goods and services across countries. Exchange rates determine a country's relative prices of exports and imports.

Suppose the € is the home currency and the foreign currency, then the exchange rate in direct quotation (Preisnotierung) is

$$E^{\frac{€}{}} = \frac{X€}{Y}$$

and the exchange rate in indirect quotation (Mengennotierung) is

$$E^{\frac{}{€}} = \frac{Y}{X€}.$$

Both rates contain the same information, but have different interpretations:

- $E^{\frac{€}{}}$ tells that we have to give X € to receive Y , whereas
- $E^{\frac{}{€}}$ tells that we have to give Y to receive X €.

Alternative interpretations:

- $E^{\frac{€}{}}$ tells that we have to give $\frac{X}{Y}$€ to receive 1 , whereas
- $E^{\frac{}{€}}$ 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 2.2. Exchange currencies (Solution A.1)

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 $1.15\frac{EUR}{USD}$.

2.1.2. Relative prices

- How much 'value' do I have to give to receive a 'value' from abroad?
- Assume the home country produces beer and the foreign country produces wine. Further assume you want to exchange a beer for wine, then the relative price gives the amount of beer you have to give to receive a unit of wine (in the direct quotation), or the amount of wine you receive for a unit of beer (indirect quotation).
- A relative price of 1 can mean, for example, that you can exchange 1 litre of beer with 1 litre of wine. However, we could also assume that beer is measured in cans of 500ml each and wine in 1 litre bottles. Then, the relative price would be $P^{\frac{beer}{wine}} = \frac{2 \text{ beer}}{1 \text{ wine}}$. That means, you can convert 2 cans of beer for one bottle of wine.
- If the relative prices increase, I must give more beer to receive a wine.
- If the relative prices decrease, I must give less beer to receive a wine.

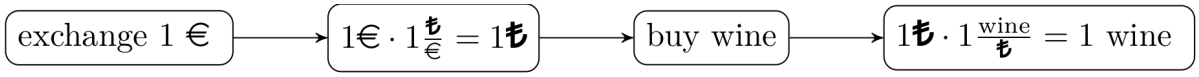
Relative Prices and International Trade

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.

2.1.3. Exchange rates and relative prices

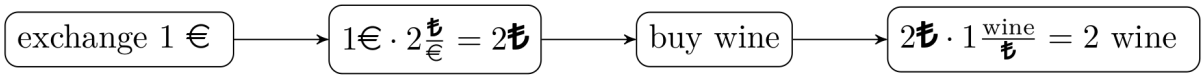
- Relative prices are (directly) determined by exchange rates.
- To prove this statement, assume an exchange rate of 1, $E^{€} = E^{\frac{€}{}} = 1$ and that a liter of beer costs 1 € at home and a wine costs 1 abroad.
- Thus, I can buy both a wine or a beer for 1 €. Due to the fact that I must pay the wine producer with , I must exchange the € beforehand. The process goes like shown in Figure 2.2:

Figure 2.2.: One Wine per Euro



Now, assume that the € appreciates and the exchange rate becomes $E^{\frac{€}{}} = 0.5$ and $E^{€} = 2$, respectively. Then, you receive more than one wine, see Figure 2.3:

Figure 2.3.: Two wine per Euro



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.

Exchange rates and international trade

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.

2.1.4. Trump and relative prices

Let's return to Trump's Twitter message. Steel producers in the US (and with them Donald Trump) are not happy about a strong dollar (and a weak lira), because it makes their products relatively expensive for Turkish buyers and Turkish steel relatively cheap for US consumers. Trump would have two options to change this situation: He could change the exchange rates or the relative prices of goods in different countries. Since it is difficult for him to influence the exchange rate (the central bank is independent), he decided to increase tariffs and thus the price of foreign steel in the United States. However, this has the disadvantage of making U.S. consumers pay more for these goods (and for goods made from and with steel and aluminum),

as David Boaz, executive vice president of the Cato Institute, an American libertarian think tank, notes in his response on Twitter, see Figure 2.1.

In addition, it can be argued that the increased tariffs will make the dollar even stronger because buyers who no longer purchase steel in Turkey due to the increased tariffs will no longer seek to exchange U.S. dollars for Turkish lira. Overall, it can be doubted that raising tariffs is a successful strategy.

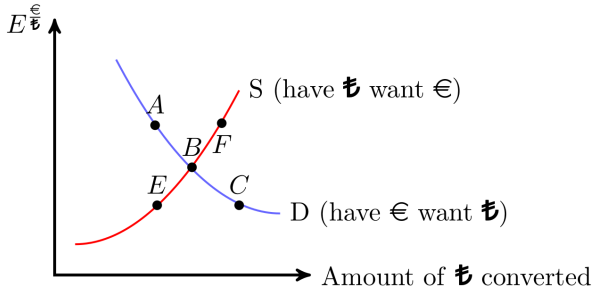
Figure 2.4.: *Who wins in the end?*

Source: Twitter

2.1.5. The FOREX

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 2.5.: Example of a foreign exchange market



- **When the Euro (€) is considered strong, the exchange rate** $E^{€/₺}$ 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 $E^{€/₺} \uparrow$.
- **Conversely, when the Euro (€) is weak, the exchange rate** $E^{€/₺}$ 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 $E^{€/₺} \downarrow$.
- **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.

2.1.6. The vehicle currency

Instead of converting directly between two less common currencies, it's more efficient to use a currency as a vehicle. The U.S. dollar, due to its broad acceptance and stability, is the most common vehicle currency. It acts as a medium in transactions between currencies that do not directly trade with high volume, reducing transaction costs and streamlining the process. For example, assume you want to exchange currency A to B. Now, imagine you can either exchange currency A directly to B, or indirectly by converting currency A to the US-$ and US-$ to currency B.

As depicted in Figure 2.6, 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.

In 2022, the daily (!) traded volume of currencies averaged approximately $ 7,506 billion, as highlighted in Table 2.1.

Figure 2.6.: Market share of leading foreign exchange currencies in 2019

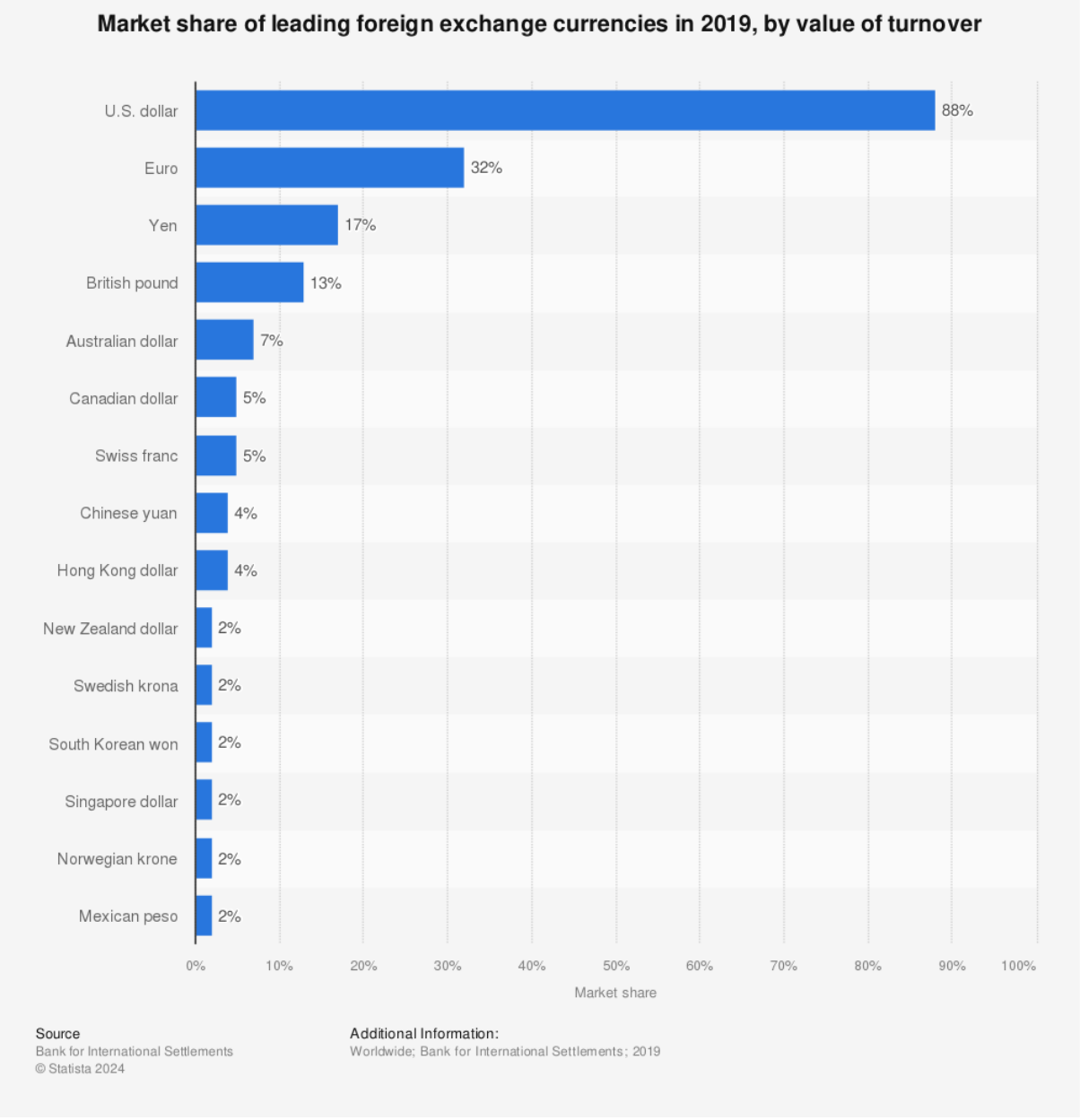


Table 2.1.: Daily turnover of global foreign exchange market from 2001 to 2022 (in billion U.S. dollars)

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).

2.1.7. Players on the FOREX

The FOREX market is navigated by various key players including commercial banks, which facilitate most currency transactions; corporations engaging in international business requiring currency exchange; nonbank financial institutions, like investment funds, playing significant roles in trading and speculation; and central banks, which intervene to stabilize their national currency, influencing the market's direction. Each group's actions interplay to determine currency values and market dynamics.

Figure 2.7.: Players on the foreign exchange market

2.1.8. Purchasing power parity assumption

The Purchasing Power Parity (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, i, have the same price, P_c^i, all over the world when expressed in terms of the same currency, c.

The idea behind this is that if prices differences would exist, profits could be made through arbitrage, that is, the process of buying a good cheap in country A the selling the good with a profit in country B. This process can quickly equalize real price differences across countries.

However, in the real world, prices differ substantially across countries (see *Big Mac Index* and Exercise 2.8 below) for several reasons. In particular, the strong assumptions of the PPP do not hold, some goods and services are not trade-able and firms might have different degrees of market power across countries.

Exercise 2.3. Big Mac Index (Solution A.2)
The differences of prices across countries can be illustrated with the Economist's *Big Mac Index*. This index measures the price of a Big Mac in different countries expressed in terms of the US Dollar. Table 2.2 shows countries with on average very expensive (2.2a) and cheap (2.2b) Big Macs.

Table 2.2.: The price of a Big Mac across countries

(a) An Big Mac is relatively expensive here:

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)

(b) An Big Mac is relatively cheap here:

Country	Price
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*?
c) Using the data of Table 2.2, 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.

Exercise 2.4. International arbitrage (Solution A.3)

Table 2.3.: 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 tradable 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 2.3. 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 2.4:

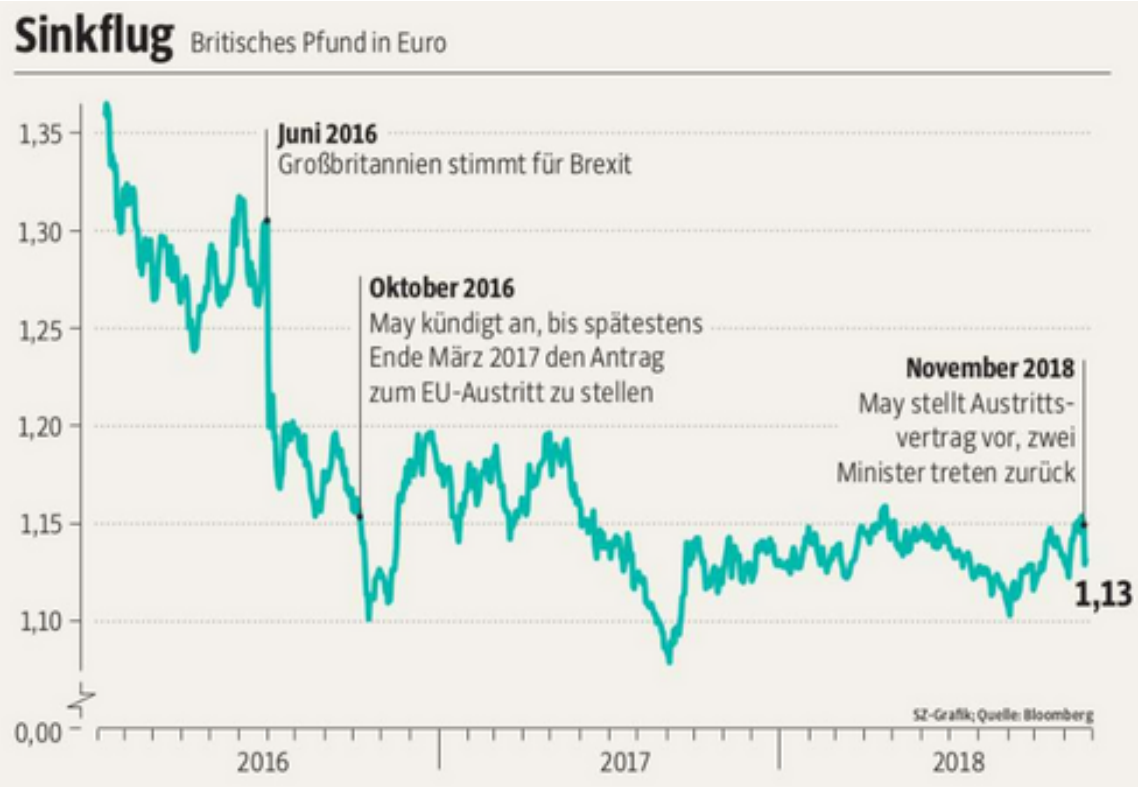
Table 2.4.: Table of prices and currencies across countries post-arbitrage

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: - $\frac{\text{USD}}{\text{EUR}}$ - $\frac{\text{EUR}}{\text{USD}}$ - $\frac{\text{USD}}{\text{CHF}}$ - $\frac{\text{CHF}}{\text{USD}}$ - $\frac{\text{CHF}}{\text{EUR}}$ - $\frac{\text{EUR}}{\text{CHF}}$

Exercise 2.5. Brexit and the exchange rate
Examine Figure 2.8 and discuss the reasons behind the depreciation of the British pound since June 2016.

Figure 2.8.: 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).

2.2. International investments

Currencies serve as a store of value, an important function in the financial world. However, this role is very complex due to their vulnerability to appreciation, depreciation and inflation. The value of a currency can fluctuate significantly over time, influenced by economic policy, market sentiment and global events. Consequently, choosing a currency in which to invest savings or investments is not only a practical decision, but also a speculative one. Investors and savers need to weigh up potential risks and opportunities and make informed decisions to protect their purchasing power. This speculative nature underlines the importance of understanding the currency markets and economic indicators.

2.2.1. 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:

2.2.1.1. 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:

$$\underbrace{I_{t-1}}_{\text{investment in t-1}} \cdot \underbrace{(1+i)}_{\text{1+interest rate}} = \underbrace{I_t}_{\text{payout amount in t}} \tag{2.1}$$

where I denotes the value of an asset measured in € in the respective time period t.

2.2.1.2. 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:

$$I^{€}_{t-1} \cdot E^{\overline{€}}_{t-1} \cdot E^{\underline{€}}_{t} = I^{€}_{t} \tag{2.2}$$

2.2.1.3. 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:

$$I_t = I_{t-1} \cdot (1+\pi) \tag{2.3}$$

2.2.2. 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 2.1, Equation 2.2, and Equation 2.3, we can describe the value of our investment in period t as follows:

$$I^{€}_t = I^{€}_{t-1} \cdot (1+i^*) \cdot E^{\overline{€}}_{t-1} \cdot E^{\underline{€}}_{t} \cdot (1+\pi^*), \tag{2.4}$$

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 2.4, 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 $(E^{\overline{€}}_{t-1} \cdot E^{\underline{€}}_{t})$:

$$\underbrace{\frac{I^{€}_{t}}{I^{€}_{t-1}}^{*} - 1}_{r} = (1+i^*) \cdot (1+\pi^*) \cdot \underbrace{E^{\overline{€}}_{t-1} \cdot E^{\underline{€}}_{t}}_{\alpha} - 1$$

$$r^* = (1+i^*) \cdot (1+\pi^*) \cdot \alpha - 1$$

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

$$\begin{aligned} r^* &= (1+i^*) \cdot \alpha - 1 \\ \Leftrightarrow r^* &= \alpha + \alpha i^* - 1. \end{aligned} \tag{2.5}$$

Reorganizing Equation 2.5 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 $(\alpha - 1) = w$:

$$\begin{aligned} &\Leftrightarrow r^* = \alpha + \alpha i^* - 1 + i^* - i^* \\ &\Leftrightarrow r^* = \alpha - 1 + i^* + \alpha i^* - i^* \\ &\Leftrightarrow r^* = \underbrace{(\alpha - 1)}_{w} + i^* + i^* \underbrace{(\alpha - 1)}_{w} \\ &\Leftrightarrow r^* = w + i^* + i^* w \end{aligned} \tag{2.6}$$

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 2.6. Exchange rates and where to invest (Solution A.4)
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?

Exercise 2.7. Turkey vs. Germany (Solution A.5)
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.

2.2.3. 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 ($*$):

$$r = r^* \tag{2.7}$$
$$i = w + i^* \tag{2.8}$$
$$\tag{2.9}$$
$$\Leftrightarrow w = i - i^* \tag{2.10}$$

The interest parity condition (Equation 2.10) 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.

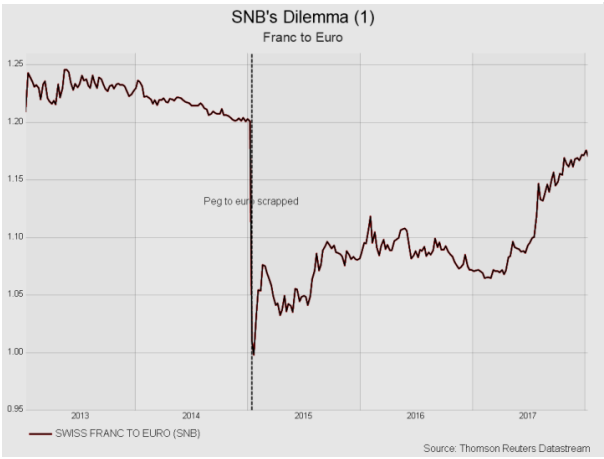
2.2.4. The theory in real markets: Unpegging the Swiss Franc

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.

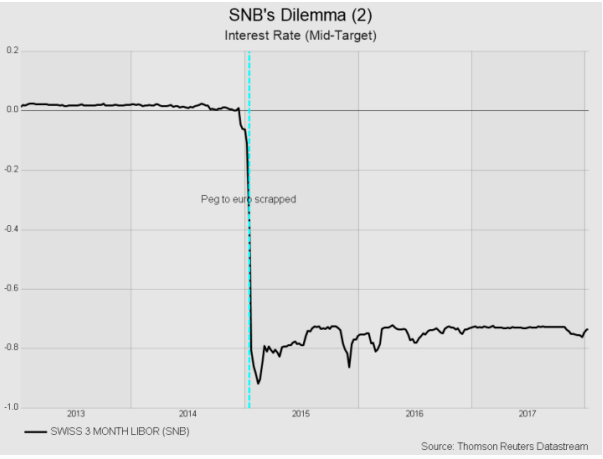
Until early 2015, the Swiss National Bank (SNB) had a policy goal to maintain the franc above the cap of 1.20 Francs per Euro, aiming to protect exporters and combat deflationary pressures. However, in a surprising move, the SNB unpegged the Franc in 2015. This decision was influenced by the appreciation 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 2.9a Almost simultaneously, the interest rate experienced a decline, as depicted in Figure 2.9b. These developments align precisely with what the interest parity condition would predict, demonstrating its applicability in real-world financial market dynamics.

Figure 2.9.: 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 2.10:

$$w = i - i^*$$

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

$$w = \frac{E_t^{\frac{€}{CHF}}}{E_{t-1}^{\frac{€}{CHF}}} - 1 = \frac{1}{0.83} - 1 = 0.20.$$

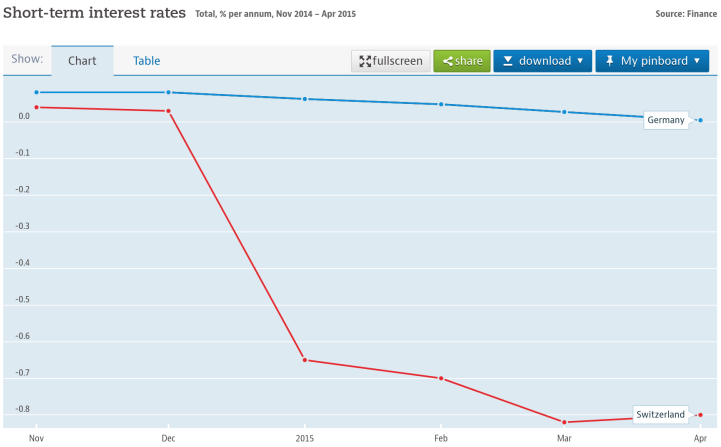
Since $w > 0$, the fraction on the left-hand side of the interest rate parity equation must also be positive, as already mentioned. This implies that

$$i - i^* > 0,$$

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 2.10.

Figure 2.10.: Short-term interest rates across Germany and Switzerland over time



Source: Data are taken from the OECD and show the total, % per annum.

2.2.5. The Fisher effect

The Fisher Effect is an economic theory proposed by economist Irving Fisher, which describes the relationship between 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:

$$r = i + \pi.$$

We can derive this equation which you see in almost every introductory economics textbook using Equation 2.5 and ignoring international exchanges as the Fisher Effect does not alter with international investments, that means, we assume that the exchange rate is stable over time ($E^{€}_{t-1} = E^{€}_{t}$):

$$I_t = I_{t-1} \cdot (1+\pi) \cdot (1+i) \tag{2.11}$$

$$\Leftrightarrow \frac{I_t}{I_{t-1}} - 1 = (1+\pi)(1+i) - 1 \tag{2.12}$$

$$\Leftrightarrow r = i + \pi + \pi i \tag{2.13}$$

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 is often called the *The Fisher Effect*.

Abstracting from exchange rate movements and interest rate differences, the rate of return is solely determined by the inflation rate and cross-country differences in their rate of return can be described by differences in inflation rates:

$$r_{GER} - r_{TUR} = \pi_{GER} - \pi_{TUR}.$$

2.3. Balance of payments

Exercise 2.8. Some facts about foreign trade
Make yourself familiar with the statistics at destatis.de, the World Trade Organization here and here, the OECD, and CEPR's World Trade Historical Database.

2.3.1. Introduction

The Balance of Payments (BoP) 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. Any imbalance means a country is either gaining or losing financial assets in foreign countries. If this concept seems arcane, this section aims to simplify it for you.

First, let's clarify some key terms:

- *Net exports*: The difference between the value of goods and services a country sells abroad and those it buys from abroad.
- *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.
- *Exports*: Goods and services sold to other countries.
- *Imports*: Goods and services bought from other countries.

- *Trade balance*: The difference between a country's exports and imports, 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.

2.3.2. Two types of capital flow abroad

Capital can flow out of a country primarily through two mechanisms:

1. **Foreign Direct Investment (FDI)**: This 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.

Let's consider an example to illustrate how these concepts work in practice. 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 dollars through a financial exchange. For instance, 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.

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).

2.3.3. The payments must be balanced!

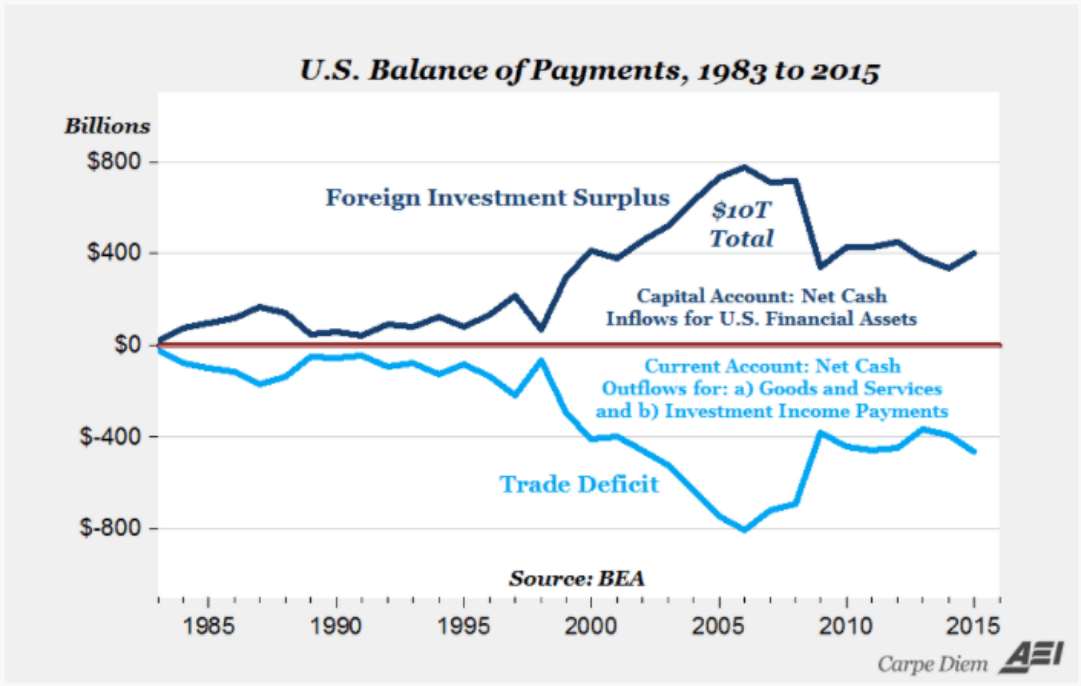
The Balance of Payments account consists of some primary components:

1. The **Current account** (Leistungsbilanz) measures a country's trade balance plus the effects of net income and direct payments. It consists of trade, net income, direct transfers of capital, and asset income.
2. The **Capital account** (Kapitalbilanz) reflects the net change in ownership of national assets.

Ignoring statistical effects, these two subaccounts must sum to zero. The U.S. Balance of Payments is an example provided in Figure 2.11.

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

Figure 2.11.: U.S. Balance of Payments



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.

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.

2.3.4. 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.

2.3.4.1. 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.

2.3.4.2. 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.

2.3.5. 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.

2.3.5.1. 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.

2.3.5.2. 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.

2.3.6. 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 2.12.

Trump's stance on the trade deficit was clear: he perceived it as detrimental to the United States. He advocated for a weaker dollar 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 2.12.: Trump worries about the U.S. trade deficit

As Trump thinks a trade deficit is bad for the United States, he would like to have a weak dollar and low interest rates. A weak dollar makes American products cheap for the rest of the world and has positive effects on exports and negative on imports. A low interest rate in the United States would make the country less attractive for foreign capital investments (I would become smaller), meaning the net capital inflows would decrease and so would the **Capital Account**'s surplus (and with it, the **Current Account** deficit would become smaller). In concrete terms, he claims that in particular the Chinese government and the European Central Bank run policies that keep their currencies (Renminbi and Euro) cheap.

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 2.13. 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 2.13.: The trade deficit of the United States over time

Exercise 2.9. Discuss the pros and cons of Germany's net export surplus. Please watch this video, see Figure 2.14.

Figure 2.14.: Marcel Fratzscher and Clemens Fuest about Germany's trade surplus
Source: YouTube

References

Richard P. Feynman. *"Surely you're joking, Mr. Feynman!": Adventures of a curious character.* W.W. Norton, 1985.

A. Solutions to exercises

Solution A.1. Exchange currencies (Exercise 2.2)

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:

$$\text{New Equivalent USD} = 1,000\,\text{EUR} \times 1.15\,\text{USD/EUR}$$

Solution A.2. Big Mac Index (Exercise 2.8)

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) To exchange 100 Euro to Swiss Francs, we need to calculate

$$100\ \text{EUR} \cdot 1.0305 \frac{\text{CHF}}{\text{EUR}} \approx 108.1428\ \text{CHF}$$

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.

Solution A.3. Big Mac Index (Exercise 2.4)

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**: $\frac{4}{3}\frac{CHF}{USD}$
- **EUR to CHF**: $0.75\frac{EUR}{USD}$

Solution A.4. Exchange rates and where to invest (Exercise 2.6)

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.

Solution A.5. Turkey vs. Germany (Exercise 2.7)

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:

i) **(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:

$$r_{GER} = 0.01$$
$$r_{TUR} = \frac{108.4507 - 100}{100} = 0.084507$$

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:**

$$\overset{\text{rate of return}}{\hat{r}} = \frac{I_t^€ - I_{t-1}^€}{I_{t-1}^€}$$

with $I_t^€ = \overset{\text{investment in t-1}}{\widetilde{I_{t-1}^€}} \cdot \overset{\text{exchange rate in t-1}}{\widetilde{E_{t-1}^{/€}}} \cdot \overset{\text{1+interest rate}}{\widetilde{(1+i)}} \cdot \overset{\text{exchange rate in t}}{\widetilde{E_t^{€/}}}$

$$TUR \rightarrow I_t^€ = 100€ \cdot 7\frac{}{€} \cdot (1+0.1) \cdot \frac{1€}{7.1} = 108.4507 \rightarrow r_{TUR} = 0.084507$$
$$GER \rightarrow I_t^€ = 100€ \cdot 1 \cdot (1+0.01) \cdot 1 = 101€ \rightarrow r_{GER} = 0.01$$

iii) **(Approximative) calculation method:** Steps a) to c) can be summarized as two rates of changes:

$$\underset{\text{approximative rate of return}}{\underbrace{r'}} = \underset{\text{interest rate}}{\underbrace{i}} + \underset{\text{rate of depreciation}}{\underbrace{w}}$$

$$\text{with} \quad w = \frac{E_t^{€/}}{E_{t-1}^{€/}} - 1$$

$$r'_{GER} = 0.01$$
$$r'_{TUR} = 0.1 + \frac{\frac{10}{71}}{\frac{10}{70}} - 1 = 0.1 + \frac{700}{710} - 1 = 0.1 - \frac{10}{710} = \frac{61}{710} \approx 0.08591$$

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.