International Finance: Lecture 5
Exchange Rate Determination: IRP & PPP

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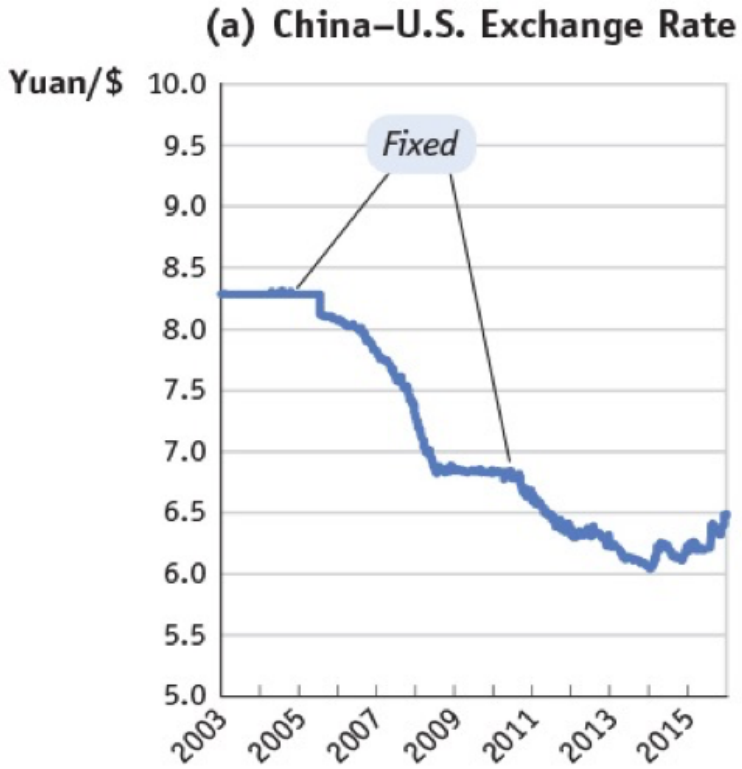
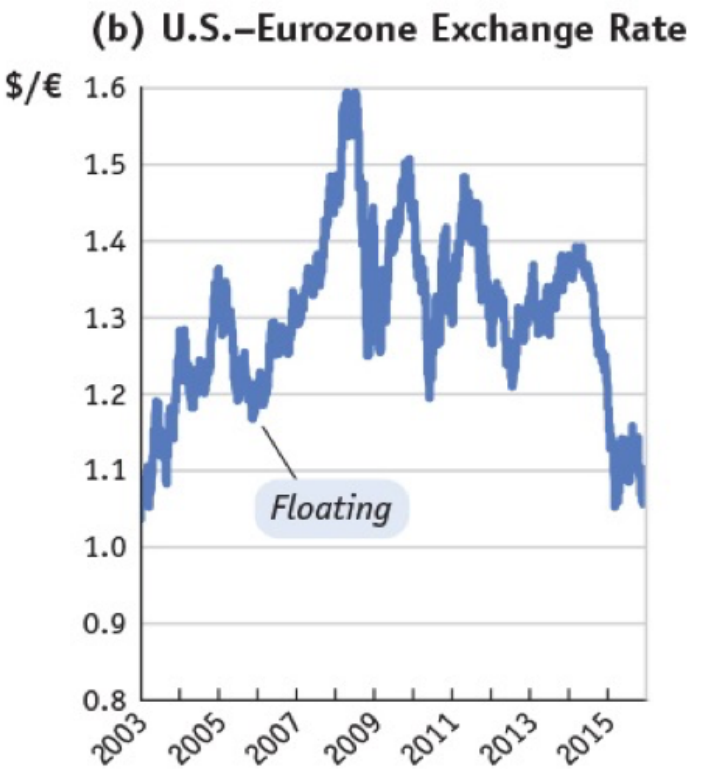
Outline

Fixed vs Floating Rate



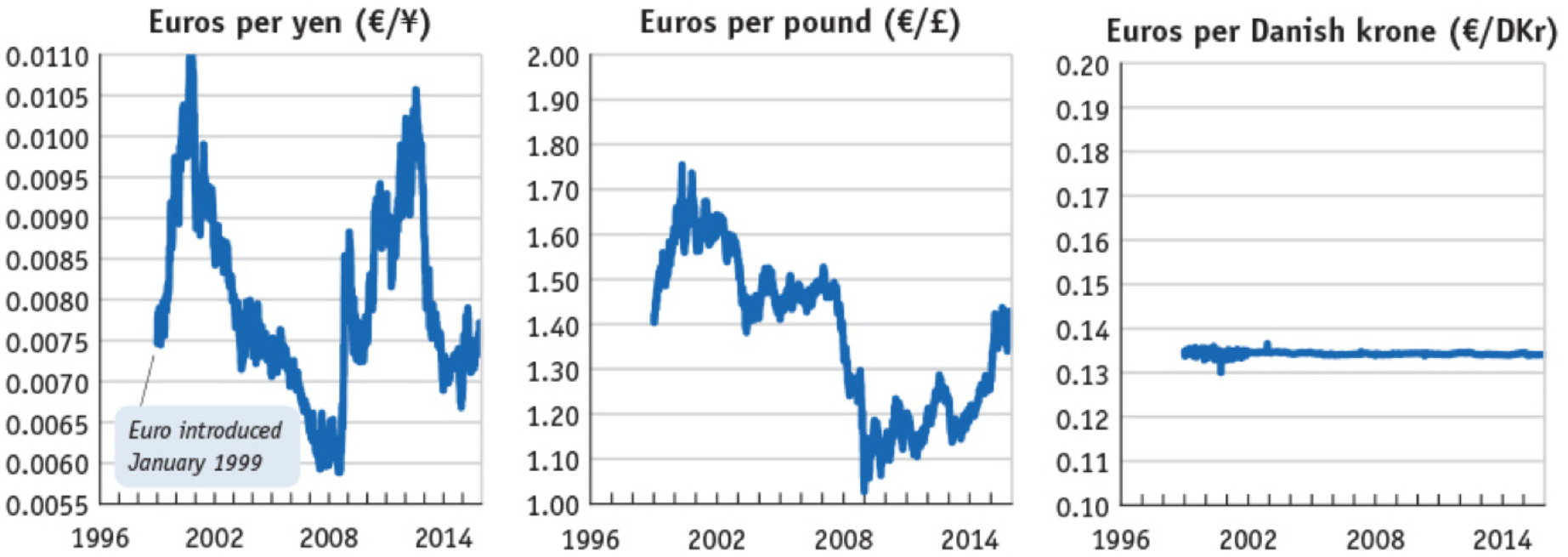


Source: FT (2017). From 2003 to 2016, the China-U.S. rate varies little and would be considered a fixed exchange rate, despite a period of a gradual trend. The U.S.-Eurozone rate varies a lot and would be considered a floating exchange rate.

U.S. Dollar against Selected Advanced Countries

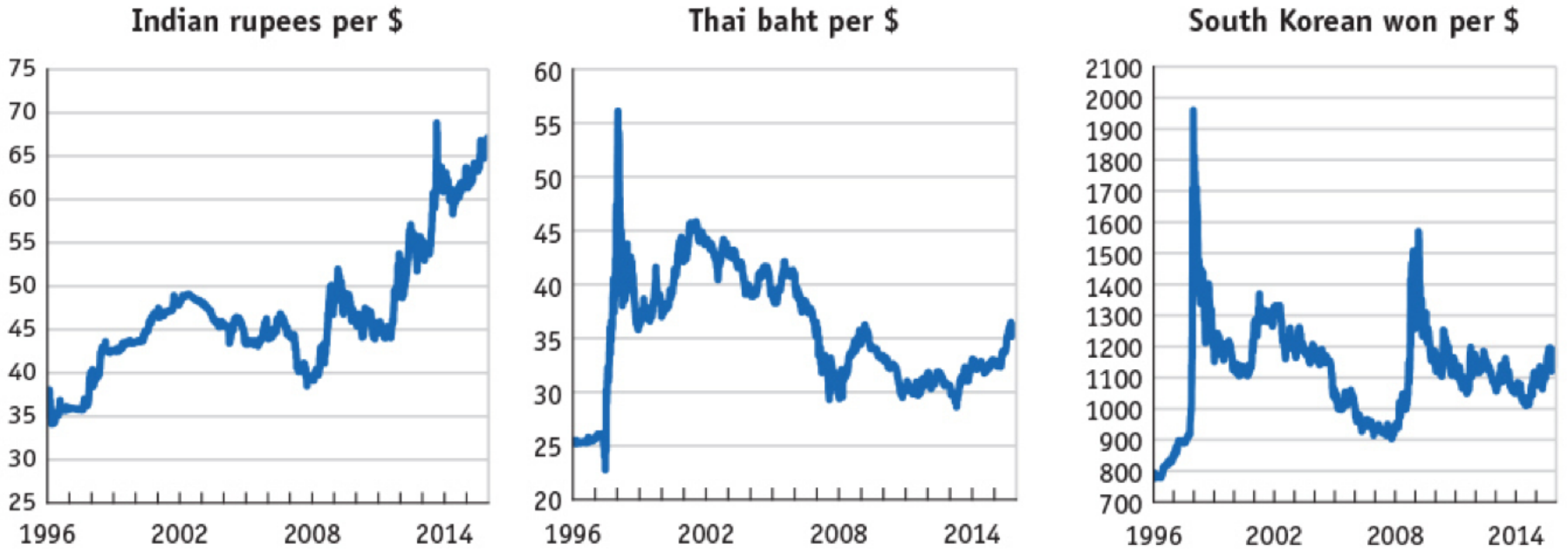
Source: FT (2017). The U.S. dollar is in a floating relationship with the yen, the pound, and the Canadian dollar (or loonie). The U.S. dollar is subject to a great deal of volatility because it is in a floating regime, or free float.

Euro against Selected Advanced Countries



Source: FT (2017). This figure shows exchange rates of three currencies against the euro, which was introduced in 1999. The pound and the yen float against the euro. The Danish krone provides an example of a fixed exchange rate. There is only a tiny variation around this rate, within a 2% band.

U.S. Dollar against Selected Developing Countries



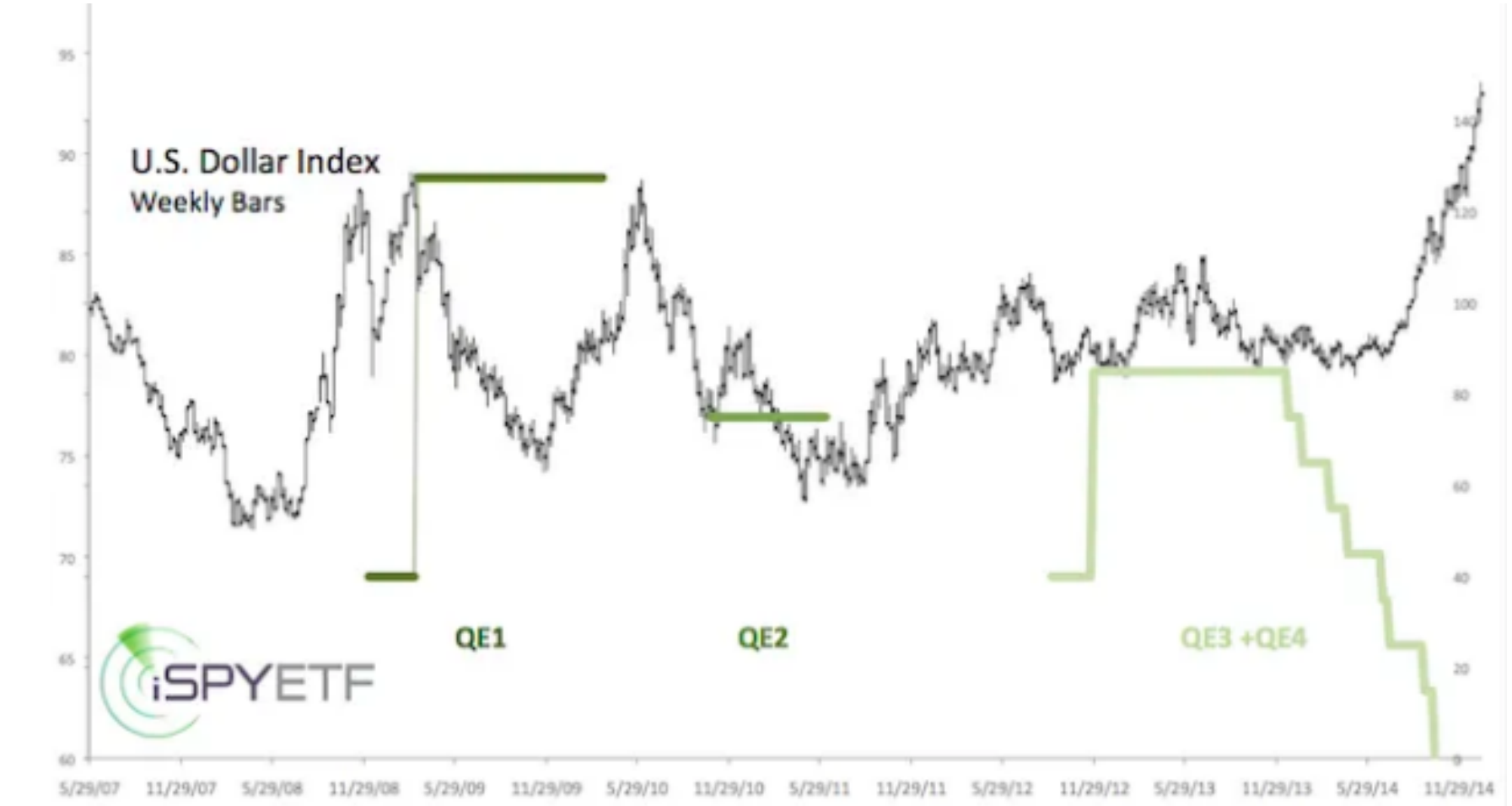
Source: FT (2017). Exchange rates in developing countries show a wide variety of experiences and greater volatility. Pegging is common but is punctuated by periodic crises (sharp declines in currency value for Thailand, South Korea, and India).

U.S. Dollar against Selected Developing Countries

Source: FT (2017). Argentine is an example of a middle ground, somewhere between a fixed rate and a free float, called a managed float. Colombia is an example of a crawling peg. The Colombian peso is allowed to crawl gradually, and it steadily depreciated at an almost constant rate for several years from 1996 to 2002.

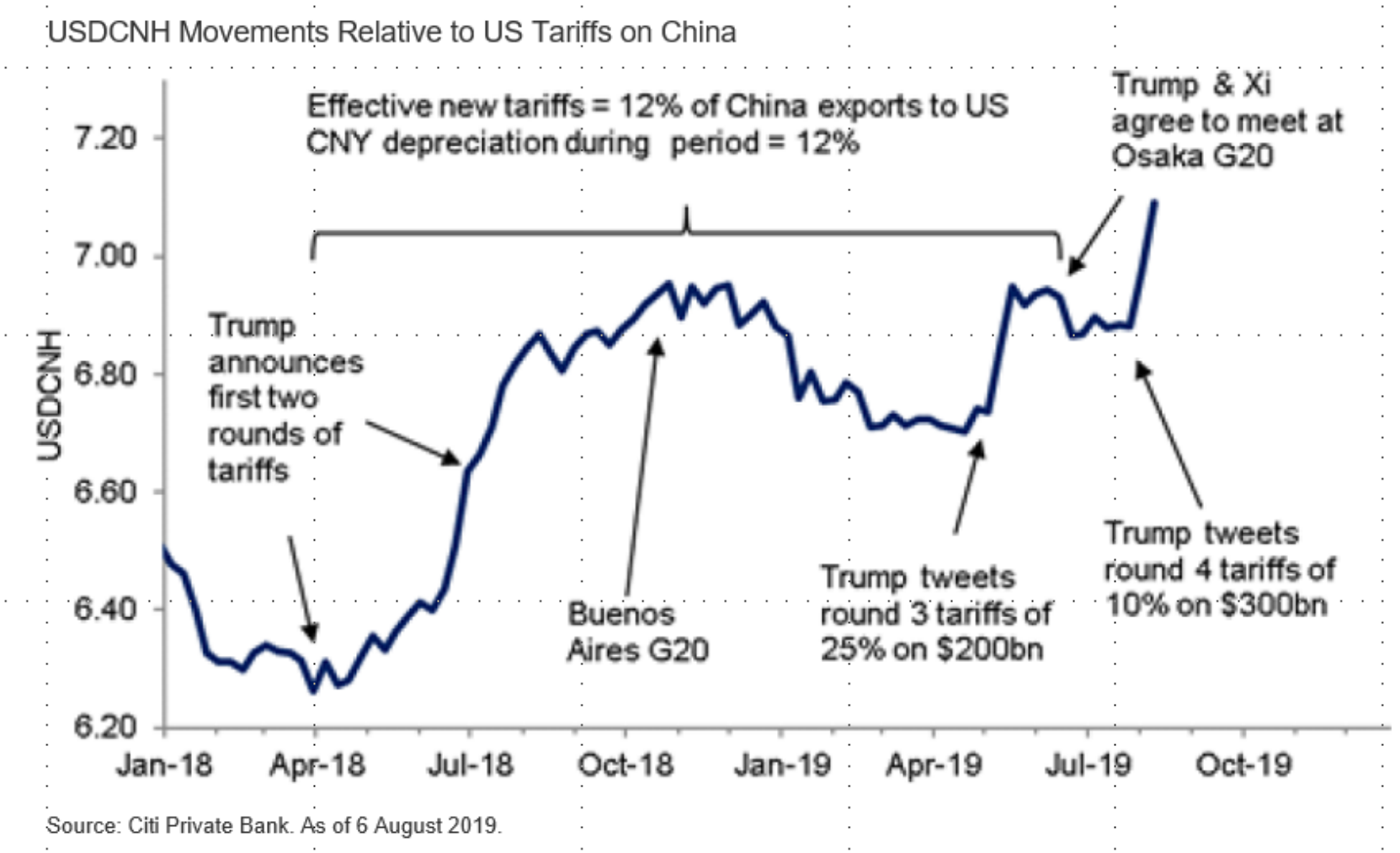
Economic Downturn and Weakening Currency 2015 (w)

U.S. Monetary Policy, QE, and the Dollar (w)

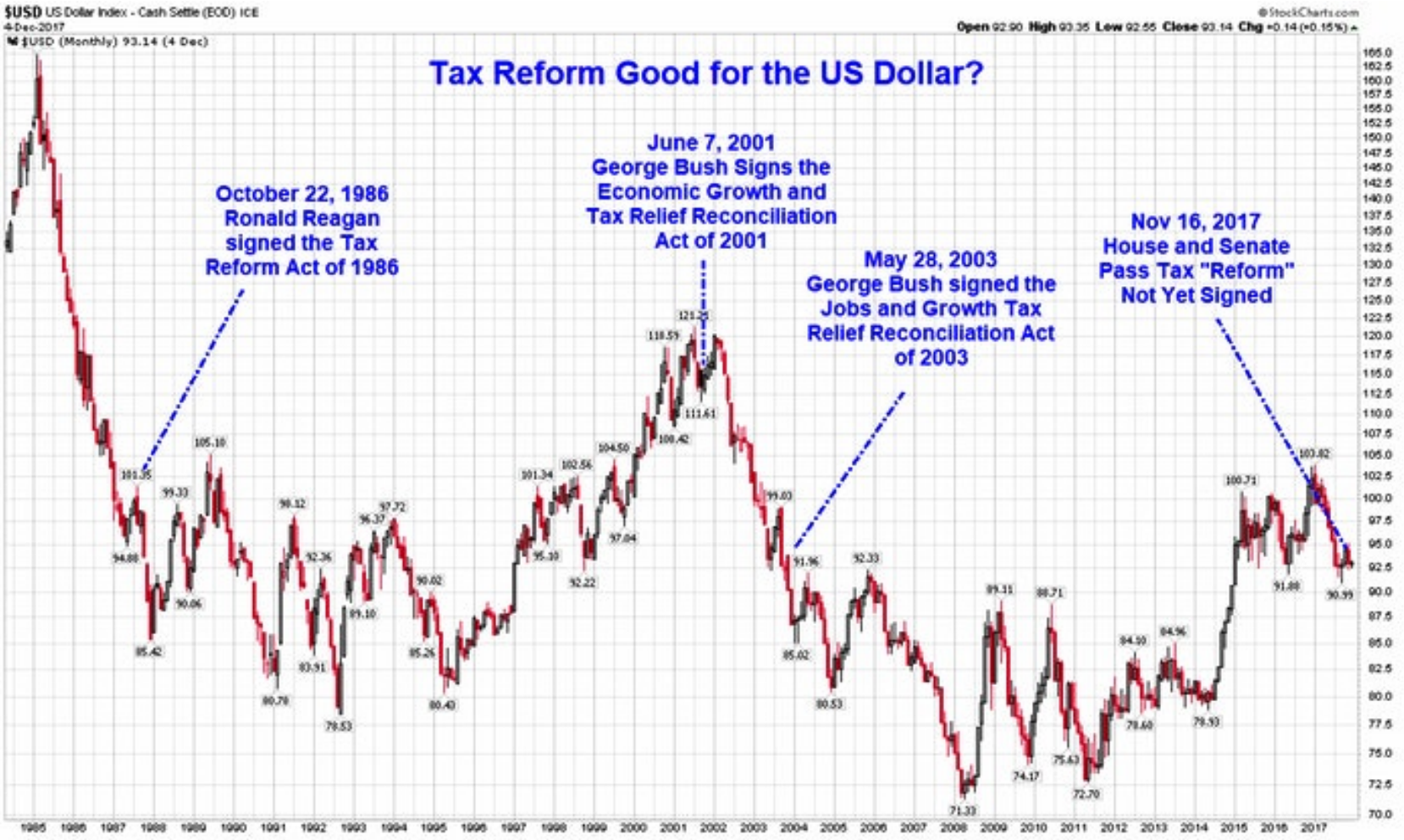


https://ispyetf.wordpress.com/tag/qe1/

U.S. Trade Policy and Yuan 2018-19 (w) (w)

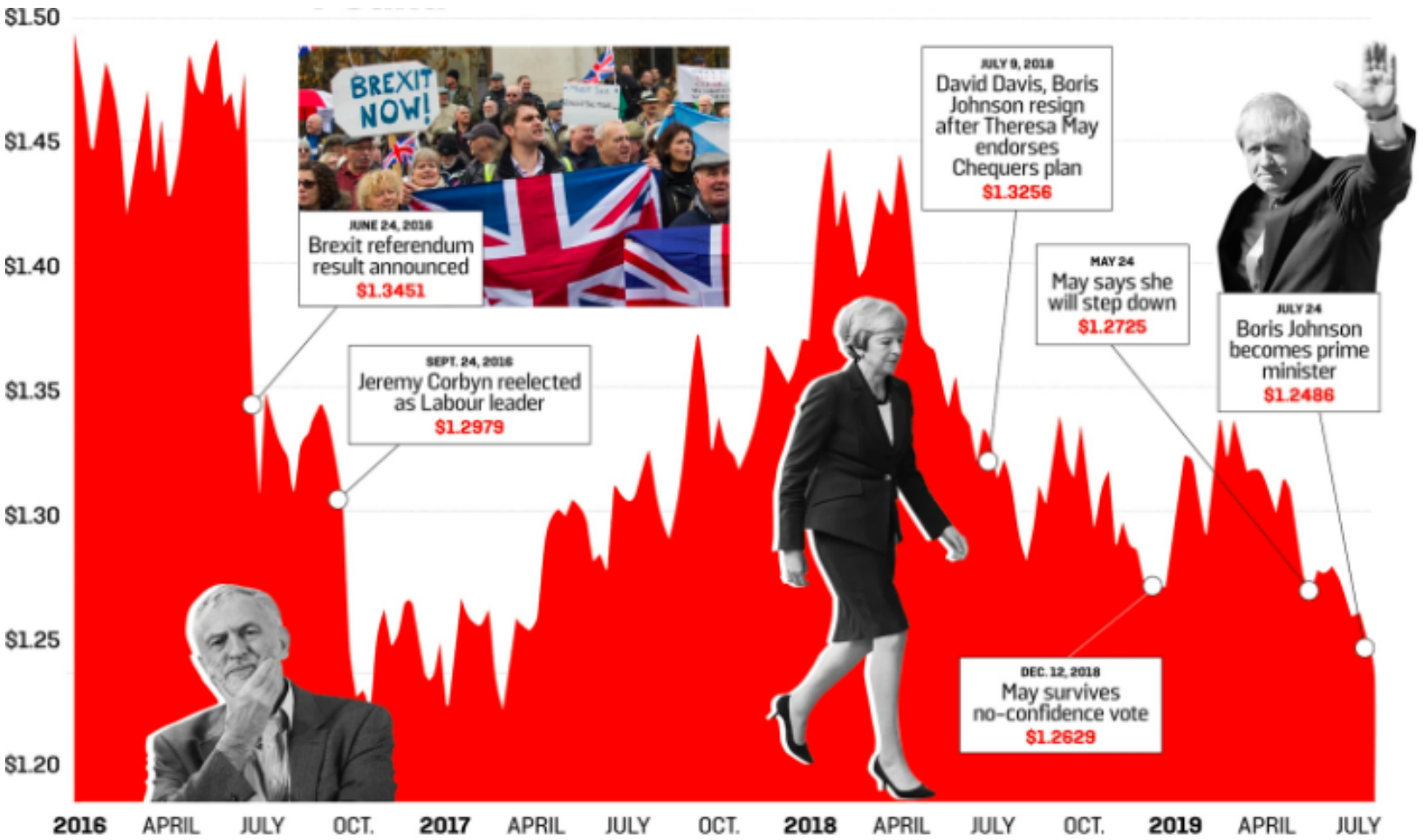


U.S. Tax Policy and Dollar (w)



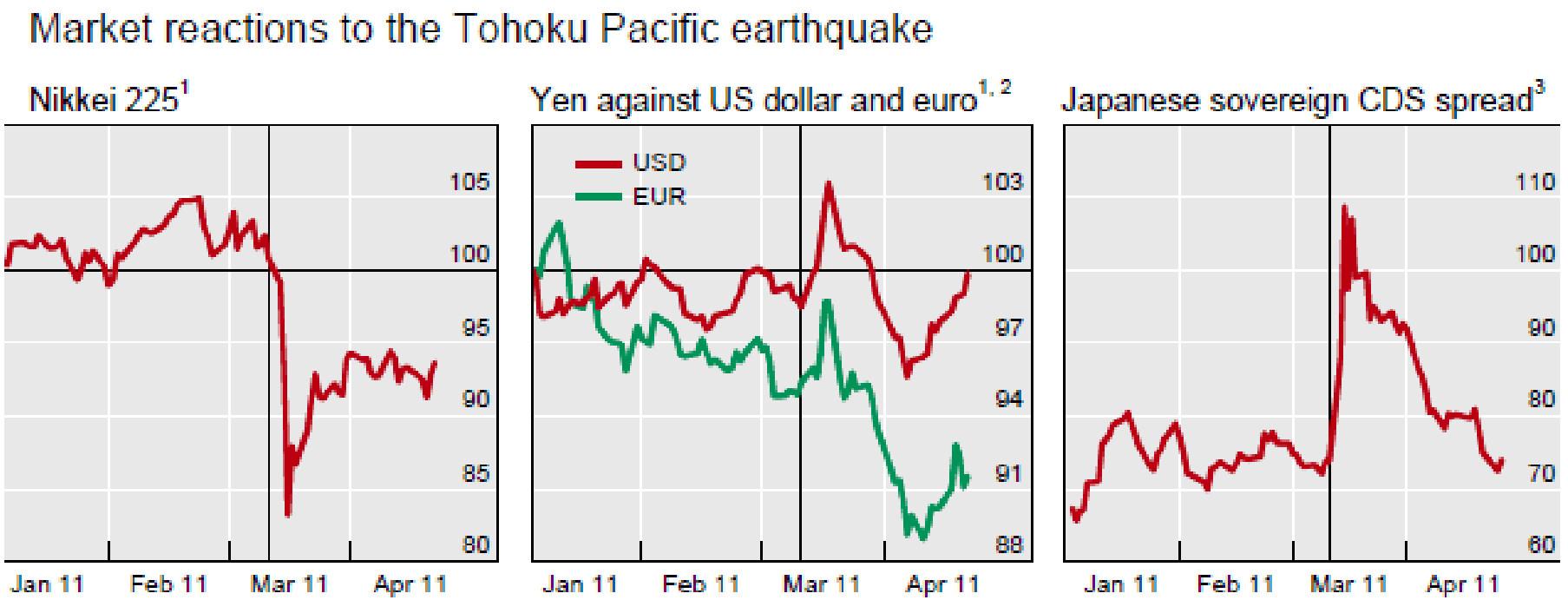
https://www.fxstreet.com/analysis/is-tax-reform-good-for-the-us-dollar-how-about-gold-201712060531

Brexit Geopolitics and Pound 2016 (w)



https://foreignpolicy.com/2019/07/31/brexit-means-bad-news-for-the-british-pound-infographic/

Japanese Natural Disaster and Yen 2011 (w)



The vertical line indicates the date of the earthquake.

[1] 3 January 2011 = 100. [2] An increase indicates a yen appreciation. [3] Five-year spread, in basis points.

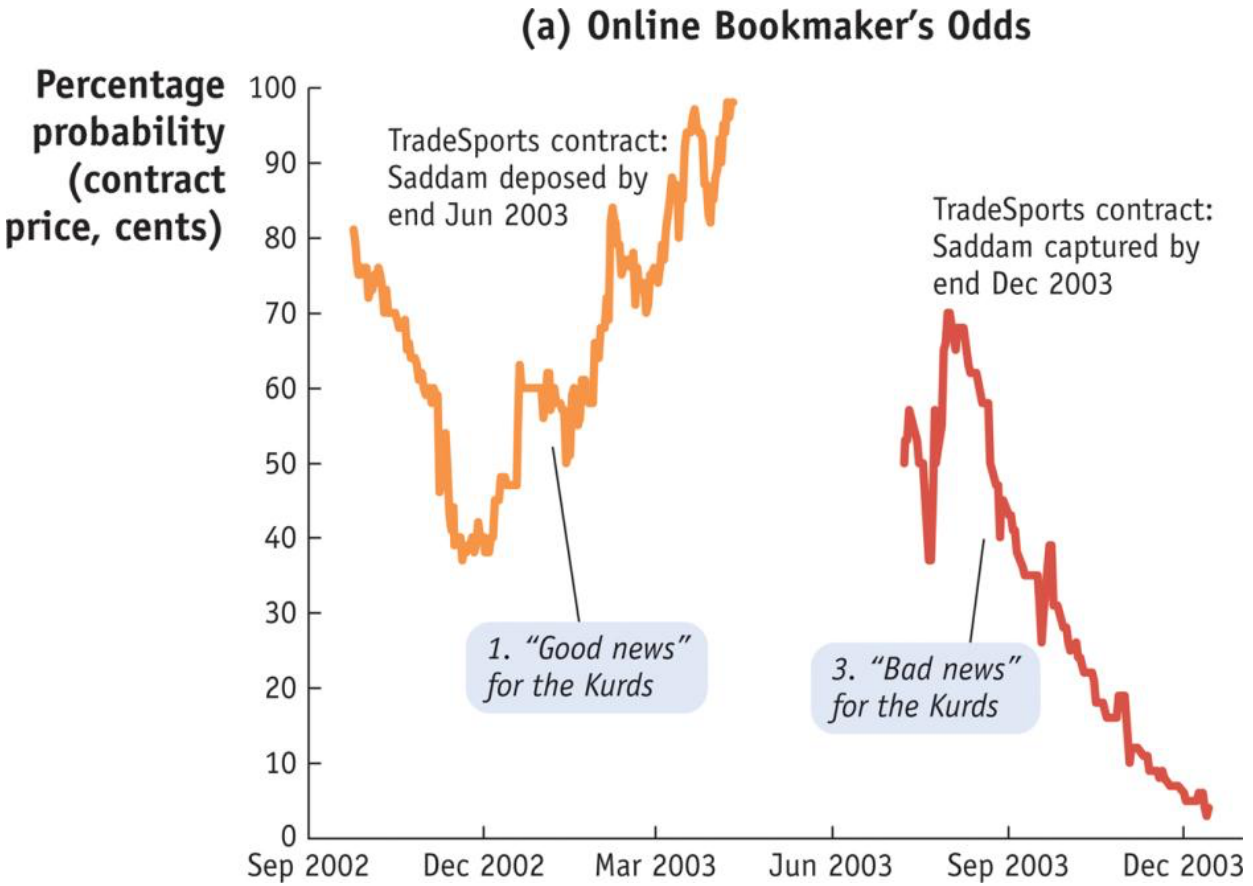
Source: Bloomberg. Graph A

Financial markets reacted very strongly in the immediate aftermath of the disaster.

Iraq Wartime News and Exchange Rate 2002-2003

- In 2003 Iraq was invaded by a U.S.-led coalition of forces intent on overthrowing the regime of Saddam Hussein, and the effects of war on currencies were again visible.
- What became of all these dinars? Iraqis fared better than the holders of Confederate dollars.
- A new dinar was created under a currency reform announced in July 2003 and implemented from October 15, 2003, to January 15, 2004.
- Exchange rate expectations soon moved into line with the increasingly credible official conversion rates and U.S. dollar exchange rates for the new dinar.

Iraq Wartime News and Exchange Rate



Regime change looked more likely from 2002 to 2003. When the U.S. invasion ended, the difficult postwar transition began.

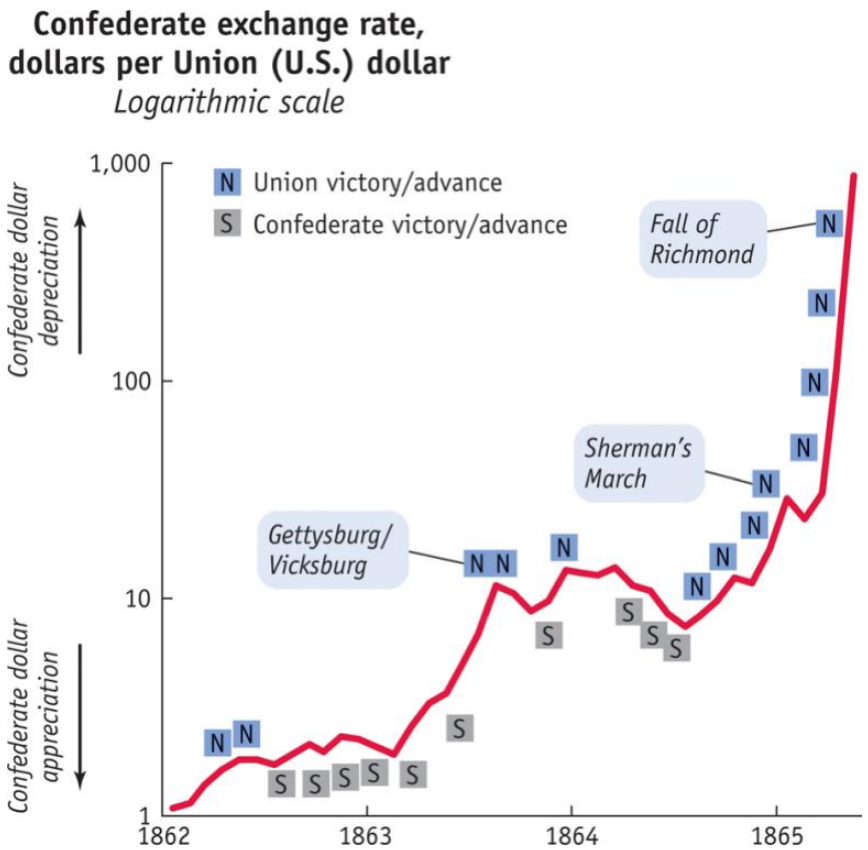
Insurgencies and the failure to find Saddam Hussein became a cause for concern.

Source: FT (2017)

Iraq Wartime News and Exchange Rate

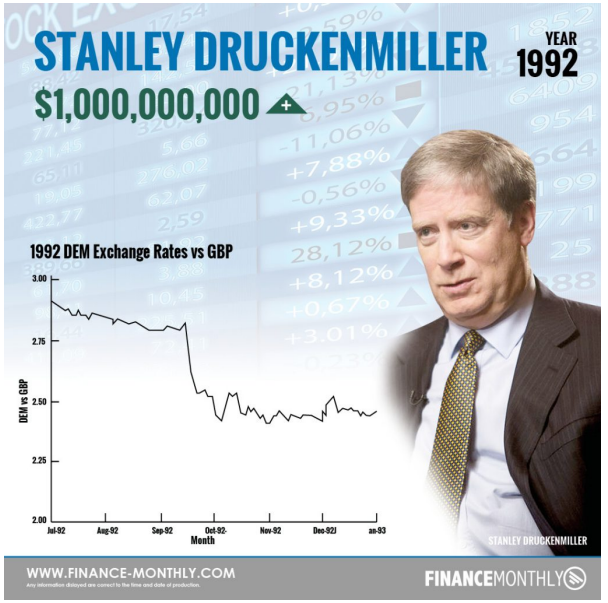
Source: FT (2017). The Swiss dinar, the currency used by the Kurds, initially appreciated against the U.S. dollar and the Saddam dinar. With bad news for the Kurds, the Swiss dinar then depreciated against the dollar until December 2003.

U.S. Civil War and Exchange Rate



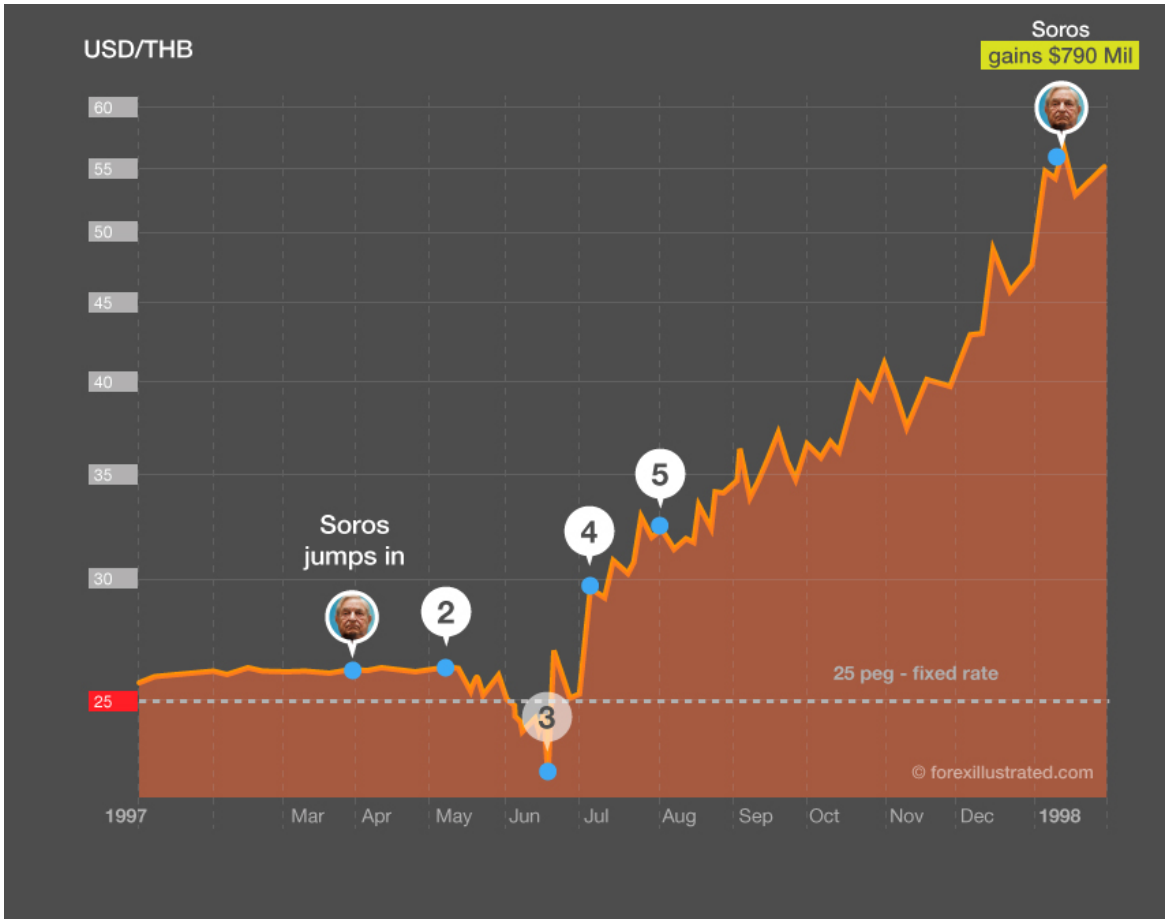
Exchange Rates and News in the U.S. Civil War The value of the Confederate dollar fluctuated against the U.S. dollar and is shown on a logarithmic scale. Against the backdrop of a steady trend, victories and advances by the North (N) were generally associated with faster depreciation of the Confederate currency, whereas major Southern successes (S) usually led to a stronger Confederate currency. Source: FT (2017).

Speculation and Exchange Rate: Legends (w) (w) (w)



https://www.finance-monthly.com/2017/10/the-top-10-greatest-stock-market-trades-ever/

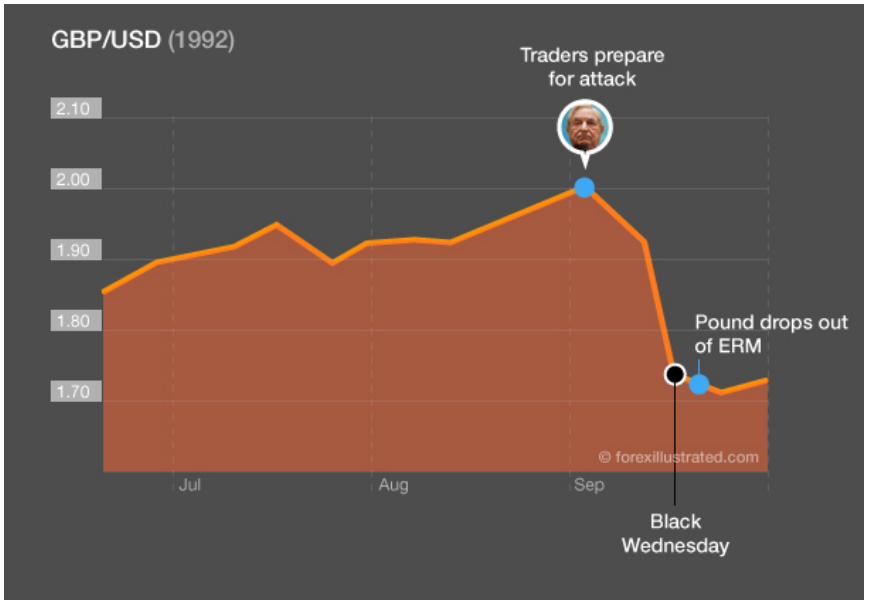
Speculation and Exchange Rate: George Soros (w)

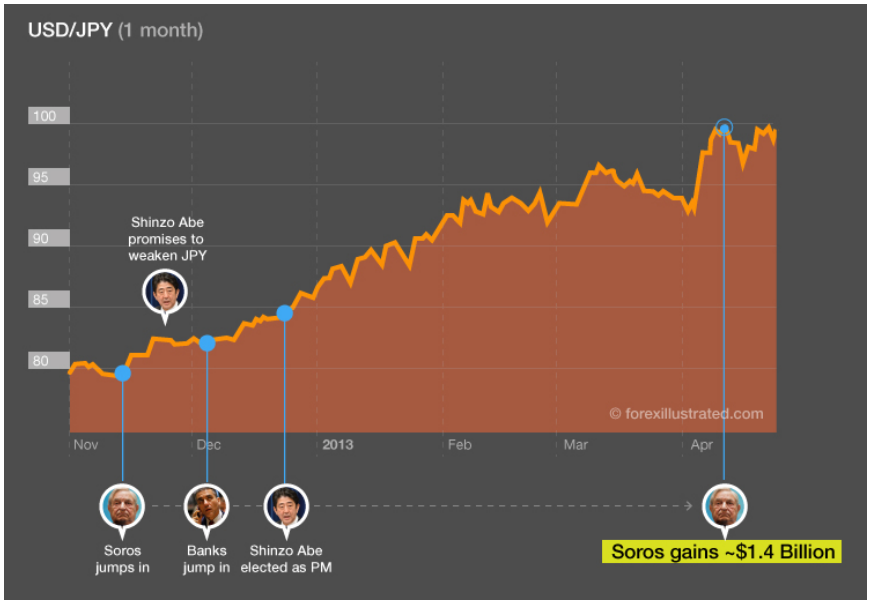


http://forexillustrated.com/trading-strategies-biggest-trades-soros/

1997-1998 $790 million against the Thai baht and triggers the Asian crisis

Speculation and Exchange Rate: George Soros (w)





1992 $1 billion against the GBP

2011-12 $1.4 billion against the JPY

http://forexillustrated.com/trading-strategies-biggest-trades-soros/

The Next Big Question

- So far our study has focused on the exchange rate descriptions, measurements, calculations and patterns. A natural question follows is what determines the "price" of a currency?
- Like the price of any good or asset in a market, exchange rates are determined by the interaction of supply and demand factors.
- In this section, we will examine the demand and supply factors in the foreign exchange market in general. And study the long run and short run exchange rate determination in particular.
- In the short run, if prices are "sticky" and the asset approach will result in Interest Rate Parity (IRP). In the long run, prices are assumed to be "flexible" and the monetary approach leads to the Purchasing Power Parity (PPP).

Foreign Exchange Market Players

The major participants in the world's largest financial market.

1. Commercial banks and other depository institutions: transactions involve buying/selling of deposits in different currencies for investment purposes.
2. Non-bank financial institutions (mutual funds, hedge funds, securities firms, insurance companies, pension funds) may buy/sell foreign assets for investment.
3. Non-financial businesses conduct foreign currency transactions to buy/sell goods, services and assets.
4. Central banks: conduct official international reserves transactions and currency swaps.

The Demand For a Foreign Currency

Recall that the primary function of a currency is to facilitate transactions (medium of exchange). The other two are store of value (investment vehicle) and unit of account (metric standard).

- In fact, there is no significant difference between domestic and foreign currency! They follow the law of demand and supply.
- The Universal Law of Demand: the quantity demanded for a currency is negatively related to the price of the (foreign) currency, ceteris paribus. ($P\uparrow \Rightarrow Q_d\downarrow$ and $P\downarrow \Rightarrow Q_d\uparrow$)
- Shown in a graph, the demand curve for a (foreign) currency is downward-sloping. Tricky question: D v.s. Q_d?
- However, new interpretation is needed for the price of a (foreign) currency. What is the price of a (foreign) currency?

Exchange Rate and International Business

- Exchange rates plays a central role in international trade and investment because they allow us to compare the prices of goods and services produced in different countries.
- Households and firms use exchange rate to translate foreign prices into domestic currency terms, and vice versa.
- When a country's currency depreciates, foreigners find that its exports (goods, services, and assets) are cheaper and domestic residents find that imports from abroad are more expensive.
- An appreciation has opposite effects: foreigners pay more for the country's products and domestic consumers pay less for foreign products.
- Currency value change has less obvious but more profound impact on a country's external debt and liability, particularly for the EMDEs.

Demand Factors of FX

- Foreign Exchange Rate (Price): affects Q_d not D!
- Commodity and Service Trade: import and export demand.
- Relative Productivity: higher productivity growth leads to more goods and services for trade, inducing higher demand.
- Business Investment: foreign direct investment.
- Financial Investment: relative risk and rate of return for assets (a currency itself is also a financial asset).
- Transaction Cost: trade barriers (tariffs & quotas) and capital controls (illegal transactions, speculative attacks, etc..).
- Macroeconomic Impacts: monetary and fiscal policies.
- Event-driven Market Expectations: economic, social, geographical, and political shocks.

Demand for FX: Questions

Under each of the following scenarios, we assume all else constant.

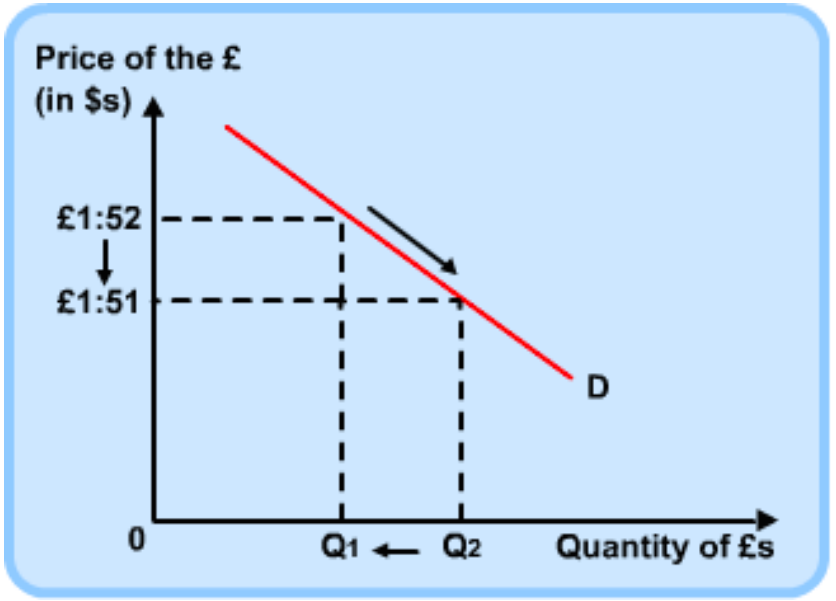
- If Japanese cars become more popular in America, how would you predict yen-dollar ER?
- Suppose the US increases its tariff or puts a lower quota on Japanese steel, what would happen to yen-dollar ER?
- Suppose the Fed edges interest rate upward by 50bps, ER? How about a rise in foreign interest rate?
- When Japan began to experience higher inflation rate relative to US in the past several year (could lead to higher π^e and i.), ER?
- How about 1) expectations of a rise in the American price level relative to the foreign price level; 2) expectations of higher US productivity relative to foreign productivity.

Supply of a Foreign Currency

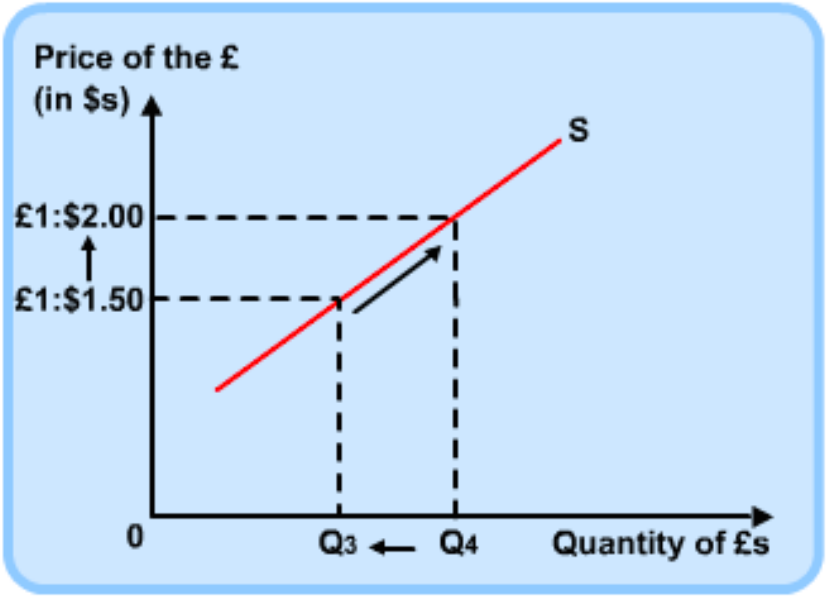
While demanders could also play a role of suppliers and vice versa, there is a special participant in the foreign exchange market. In practice, a country's central bank plays pivotal roles in affecting foreign exchange supply.

- The Law of Supply: the quantity supplied for a currency is positively related to the price of the (foreign) currency, ceteris paribus. ($P \uparrow \Rightarrow Q_s \uparrow$ and $P \downarrow \Rightarrow Q_s \downarrow$)
- Unlike markets for goods and assets, the foreign exchange market is tightly monitored and regulated by most national governments and central banks in consideration of financial stability and safety, especially under the fixed rate regime.
- Central banks rountinely engage in international financial transactions, called foreign exchange interventions.

Demand and Supply: FX Market (w)



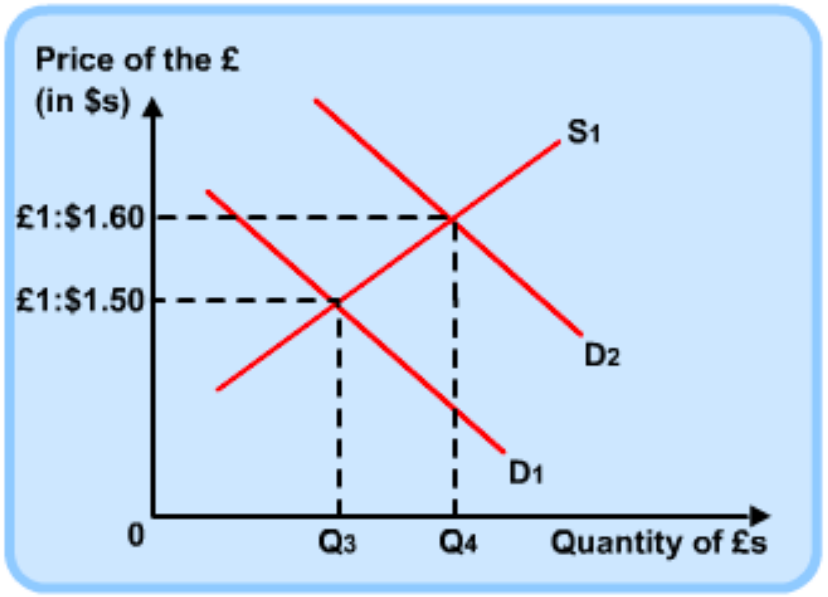
Demand curve for GBP ($P \rightarrow Q_d$)



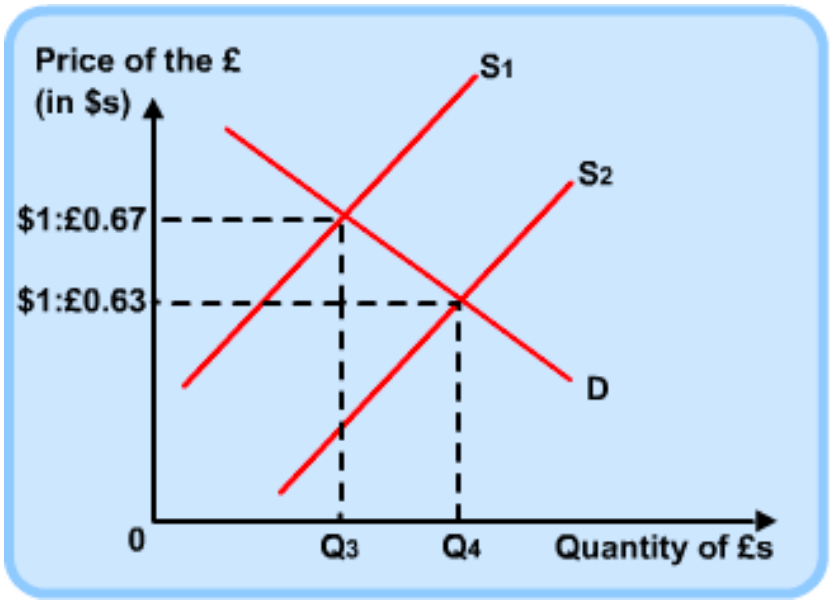
Supply curve of GBP ($P \rightarrow Q_s$)

https://www.s-cool.co.uk/a-level/economics/exchange-rates/revise-it/how-is-the-exchange-rate-determined

FX Market Equilibrium (w)



Stronger demand drives up GBP



More dollar supply weakens dollar.

https://www.s-cool.co.uk/a-level/economics/exchange-rates/revise-it/how-is-the-exchange-rate-determined

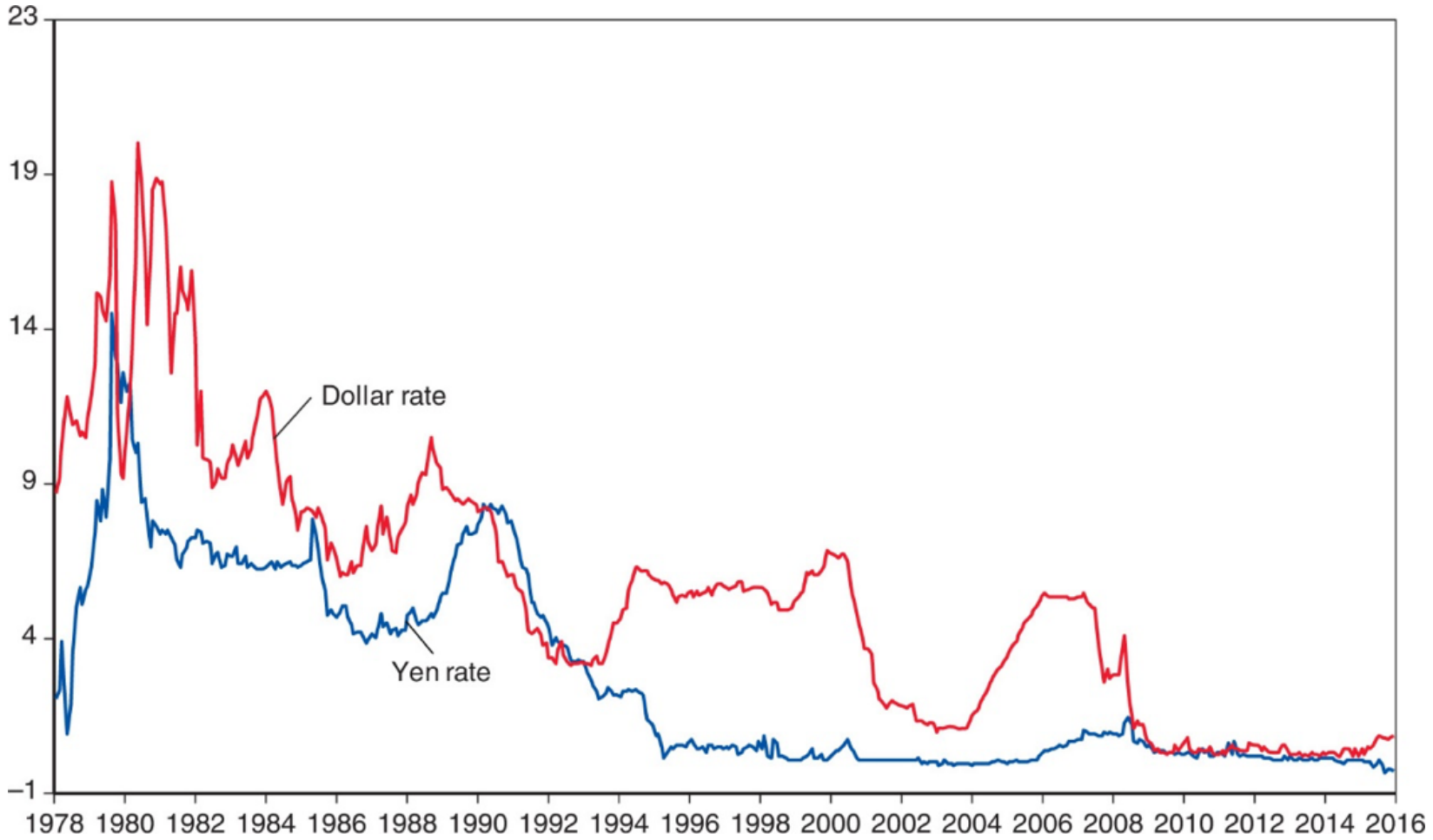
The Demand for FX: Asset Approach

- What influences the demand of (willingness to buy) deposits denominated in domestic or foreign currency? Factors that influence the return on assets determine their demand.
- Rate of return: the percentage change in value that an asset offers during a time period.
- Real rate of return: inflation-adjusted rate of return, which represents the additional amount of goods & services that can be purchased with earnings from the asset.
- Risk (volatility of return) of holding assets also influences decisions about whether to buy them. Risk increases return premium.
- Liquidity of an asset, or ease of using the asset to buy goods and services, also influences the willingness to buy assets.

Return on FX Asset

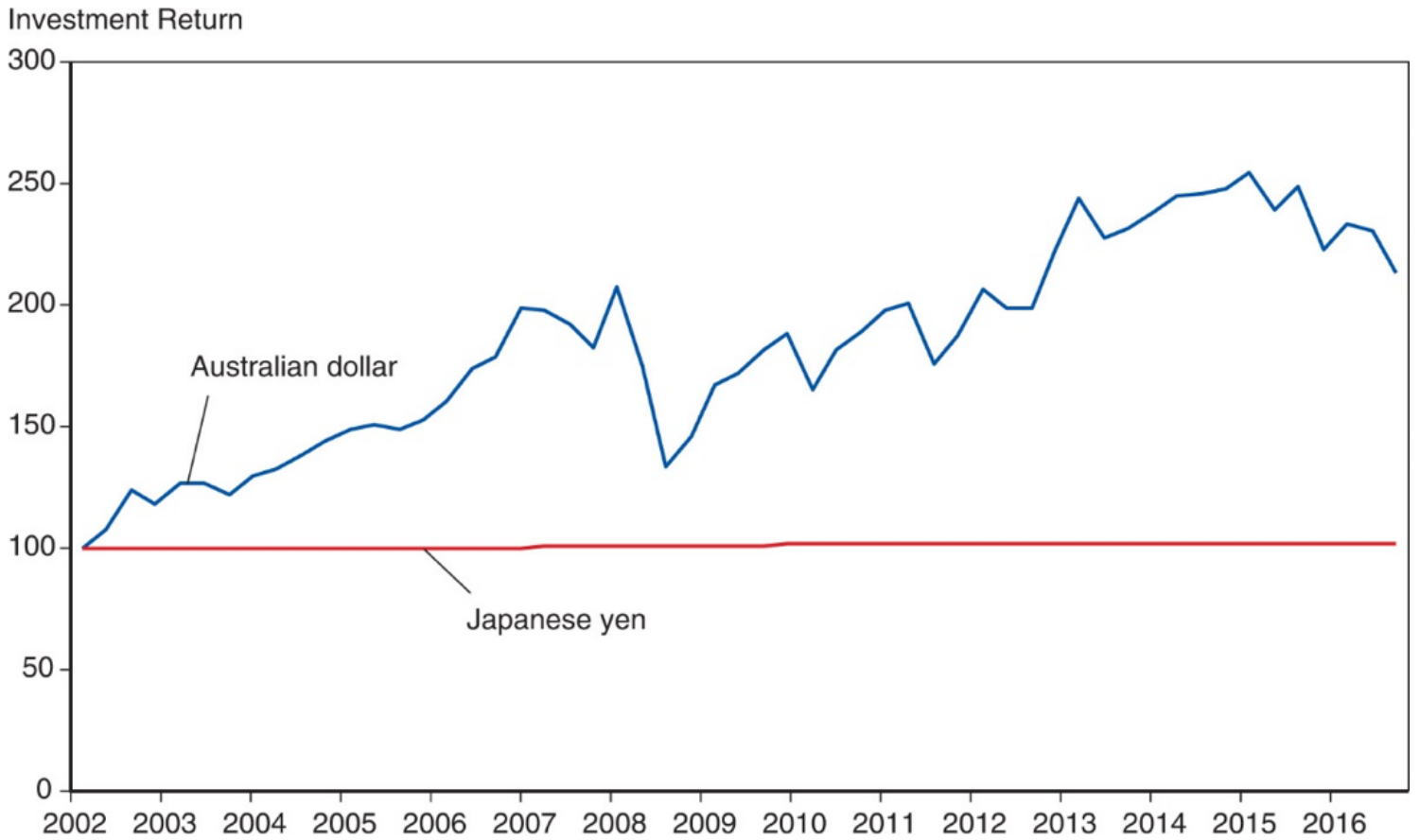
- What is the rate of return on a currency investment without risk?
- Currency deposit (CDs) or superior sovereign debt instruments.
- A currency deposit's interest rate is the amount of a currency that an individual or institution can earn by lending a unit of the currency for a year.
- The rate of return for a deposit in domestic currency is the interest rate that the deposit earns.
- To compare the rate of return on a deposit in domestic currency with one in foreign currency, consider 1) the interest rate for the foreign currency deposit; and 2) the expected rate of appreciation or depreciation of the foreign currency relative to the domestic currency.

Interest Rates on Dollar and Yen 1978-2016



KOM (2018). Three-month interest rates are shown.

Carry Trade on AUD-YEN 2002-2016



Source: KOM (2018). Measured in cumulative investment total return, the AUD-YEN carry trade (borrow YEN buy AUD) has been profitable on average but is subject to sudden large reversals, as in 2008.

Supply of FX: Central Bank FX Asset

- Central banks trade foreign government bonds in the foreign exchange markets. Foreign currency deposits and foreign government bonds are often substitutes: both are fairly liquid assets denominated in foreign currency.
- Quantities of both foreign currency deposits and foreign government bonds that are bought and sold influence the exchange rate.
- A purchase of any asset, including foreign exchange, by the central bank will be paid for with domestic currency or a check written from the central bank.
- A sale of any asset, including foreign exchange, by the central bank will be paid for with currency or a check written to the central bank.

Supply of FX: Central Bank Intervention

- There is a direct link between central bank intervention in the foreign exchange market and the domestic money supply.
- When a country's central bank purchases foreign assets, the country's money supply automatically increases. Similarly, a CB sale of foreign assets automatically lowers the money supply.
- A central bank can fix the exchange rate of its currency against foreign currency if it is willing to trade unlimited amounts of domestic money against foreign assets at that rate.
- To fix the exchange rate, the CB must intervene in the foreign exchange market whenever necessary to prevent the emergence of an excess demand or supply of domestic currency assets.

Foreign Exchange Intervention and Money Supply

Why the central bank "fixes" the exchange rates?

- "Manipulation": pegging the values of their currencies often "undervalued" relative to dollar, many export-oriented developing economies can catch up faster.
- Regional currency arrangements: some countries belong to exchange rate unions, organizations whose members agree to fix their mutual exchange rates while allowing their currencies (or a common currency) to fluctuate in value against the currencies of nonmember countries.
- The benefits (e.g. promote trade and investment) exceed the costs (e.g. diminish monetary autonomy and stability).

Sterilized vs Nonsterilized Intervention

- Central banks sometimes carry out equal foreign and domestic asset transactions in opposite directions to nullify the impact of their foreign exchange operations on the domestic money supply. This type of policy is called sterilized foreign exchange intervention.
- If central banks are not sterilizing and the home country has a balance of payment surplus, for example, any associated increase in the home central bank's foreign assets implies an increased home money supply. Similarly, any associated decrease in a foreign central bank's claims on the home country implies a decreased foreign money supply.

(Note: a country's balance of payments or official settlement balance is the net purchases of foreign assets by the home central bank less net purchases of domestic assets by foreign central banks. It also equals the current account plus capital account balances less the nonreserve component of the financial account balance.)

Application: Global Financial Crisis and the Dollar

"With the start of the global financial crisis in August 2007, the dollar began an accelerated decline in value, falling by 9% against the euro until mid-July of 2008 and by 6% against a wider basket of currencies. After hitting an all-time low against the euro on July 11, the value of the dollar suddenly shot upward, by over 20% against the euro by the end of Oct and by 15% against a basket of currencies." – Mishkin (2015)

- What is the relationship between the global financial crisis and these large swings in the value of dollar?
- During 07 interest rates fell in the US (325bps$\downarrow$ in Sep07 to Apr08) and remained unchanged in Europe ($i_{\$} \downarrow \Rightarrow RoR_{\$} \downarrow \Rightarrow D_{\$} \downarrow$).
- Started in the summer of 08 interest rates fell in Europe (i & $i^e \downarrow$).
- Increased demand for US Treasuries "flight to quality" (safe haven).

Outline

What is Foreign Exchange Arbitrage?

- Many people envision foreign exchange dealers buying and selling currencies at a furious pace and generating magnificent profits. Indeed, some traders have reputations for earning enormous profits. We must understand, however, that an activity known as arbitrage leads to these profits.
- Arbitrage, in its simplest terms, means "buy low and sell high," and is an activity through which individuals seek immediate profits based on price differentials.
- Individuals can also profit on currencies across time, through currency speculation or hedging.
- Foreign exchange arbitrage is the act of buying a currency at one price and immediately selling it at a different price.

Spatial Arbitrage: Definition

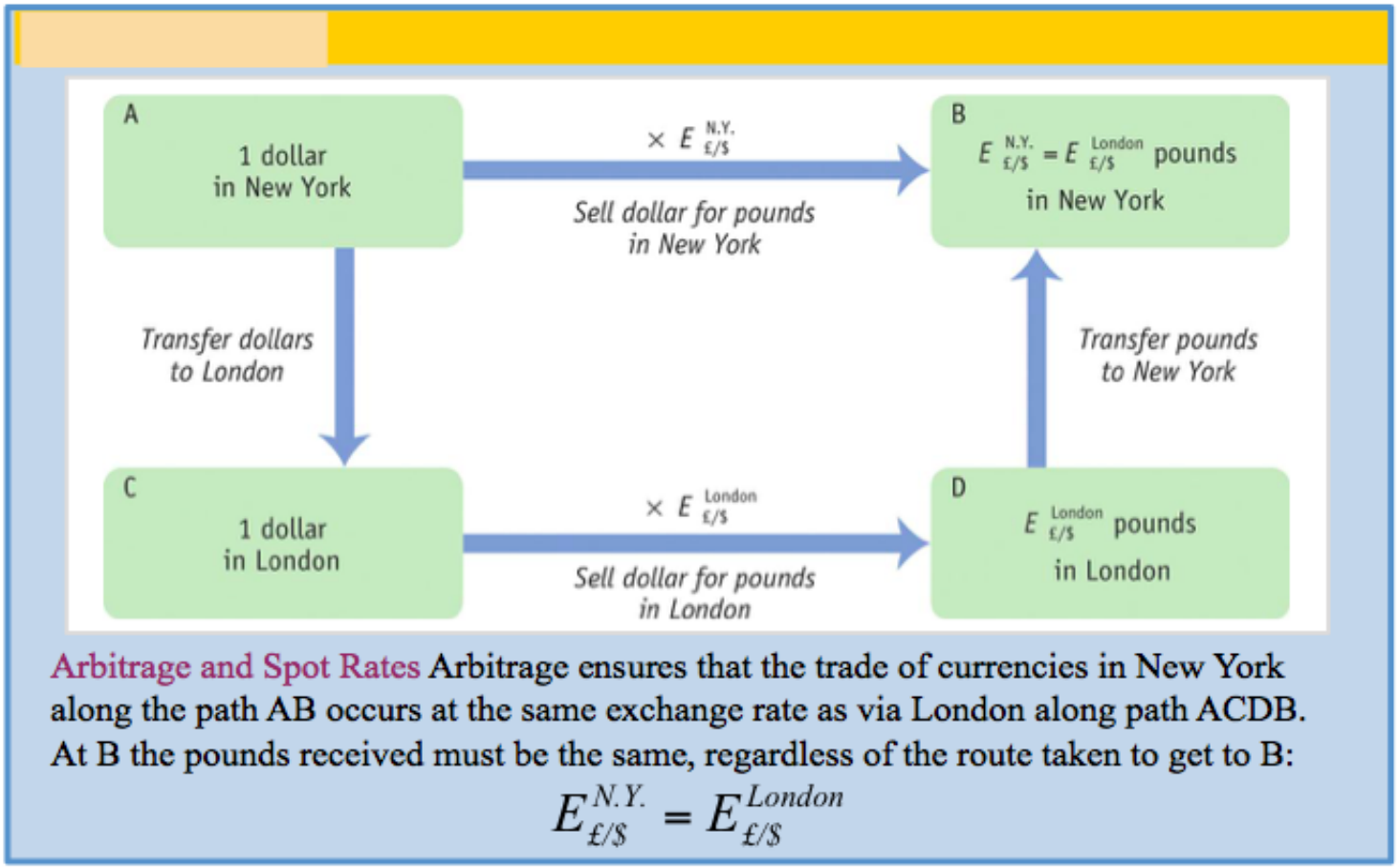
- Understanding arbitrage is one of the keys to thinking like an economist and is essential in studying exchange rates.
- If arbitrage opportunities exist in a market, then it is considered to be out of equilibrium. If no such opportunities exist, the market is in equilibrium and satisfies no-arbitrage condition.
- Two common types of arbitrage (according to the number of currencies involved) can be found in the Forex market.
- Spatial arbitrage refers to arbitrage transactions conducted across space, such as across two different geographical markets. Spatial arbitrage can nvolve a pair or many pairs of currencies.
- Triangular arbitrage (or three-way arbitrage) involves three transactions undertaken in three different market and/or in three different currencies in order to profit from differences in prices.

Bilateral Arbitrage: Example

Suppose Biwei trades dollars and pounds for a bank with branches in New York and London. Biwei can electronically transfer the funds cost free between the two branch locations. Forex trading commissions are the same in each city and so small as to be negligible. Suppose further the bilateral exchange rates in New York is E^{NY}=0.5£/\$ and in London E^{LN}=0.55£/\$. How does Biwei profit from \$1,000?

- Where can the pound be bought at a cheaper price?
- Where can the pound be sold at a higher price?
- What is the amount of profit Biwei can make with \$1,000?
- When will the market reach equilibrium (no-arbitrage)?

Bilateral Arbitrage: Diagram



Arbitrage and Spot Rates Arbitrage ensures that the trade of currencies in New York along the path AB occurs at the same exchange rate as via London along path ACDB. At B the pounds received must be the same, regardless of the route taken to get to B:

$$E^{N.Y.}_{£/\$} = E^{London}_{£/\$}$$

Source: FT (2017)

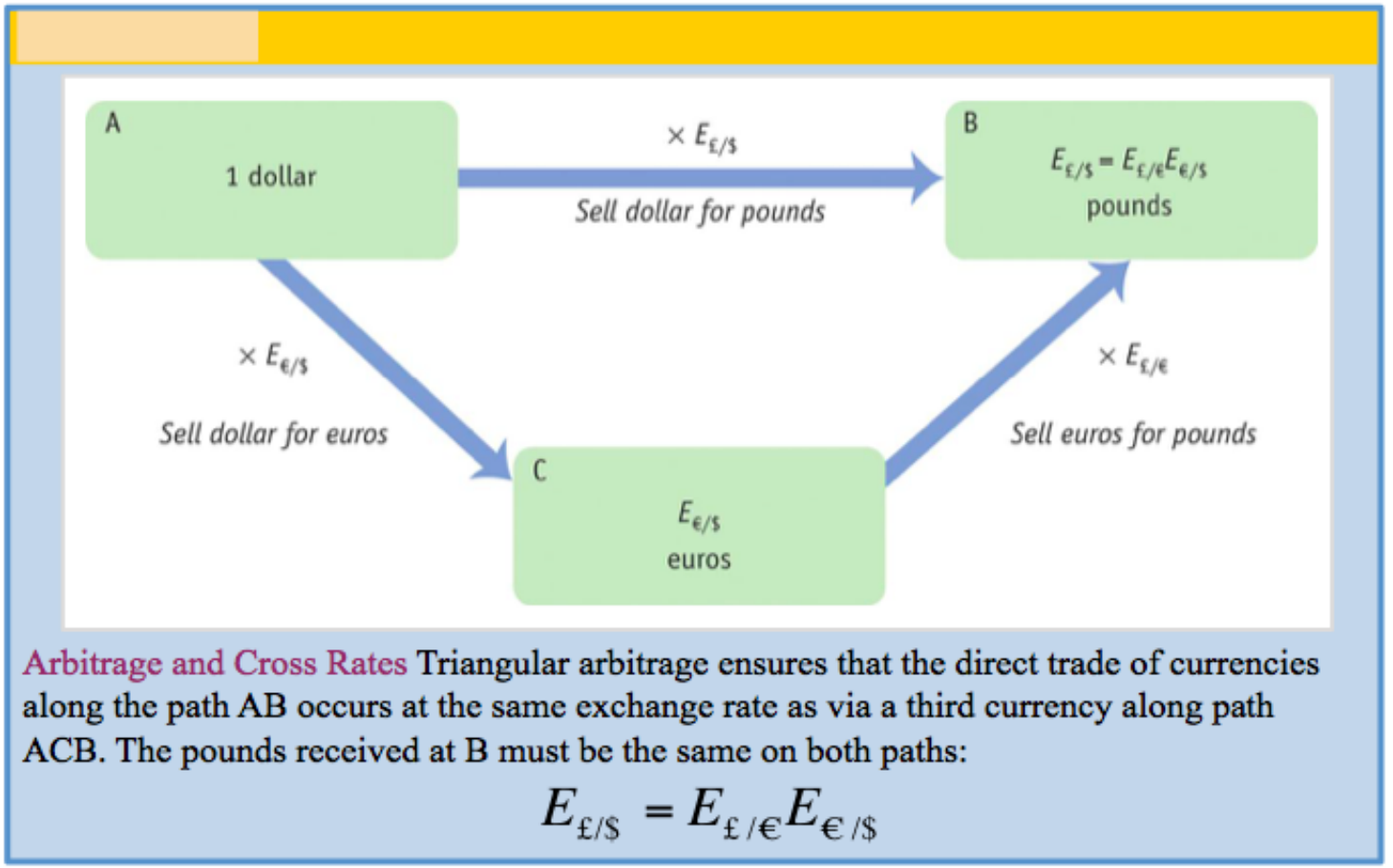
Triangular Arbitrage: Example

As a FX trader in New York, you are considering trading dollars and pounds, but also consider indirect or "triangular" trade via a vehicle currency of dollar. Suppose there are three bilateral rates quotes: E^{NY}=0.5£/\$, E^{NY}=0.8€/\$, E^{LN}=0.7£/€.

- How to profit from \$1,000? What is the profit rate?
- Calculate the £/\$ cross rate from the £/€and €/\$ bilateral rates.
- Where is cheaper to buy pound in terms of dollar?
- Where is more expensive? How to perform triangular arbitrage?
- Under what condition will there be no arbitrage opportunity?

The strategy is to buy low and sell high. Recall that $E_{£/\$}$ is the direct bilateral rate and $E_{£/€} \times E_{€/\$}$ is the cross rate. The no-arbitrage condition: $E_{£/\$} = E_{£/€} \times E_{€/\$}$.

Triangular Arbitrage: Diagram

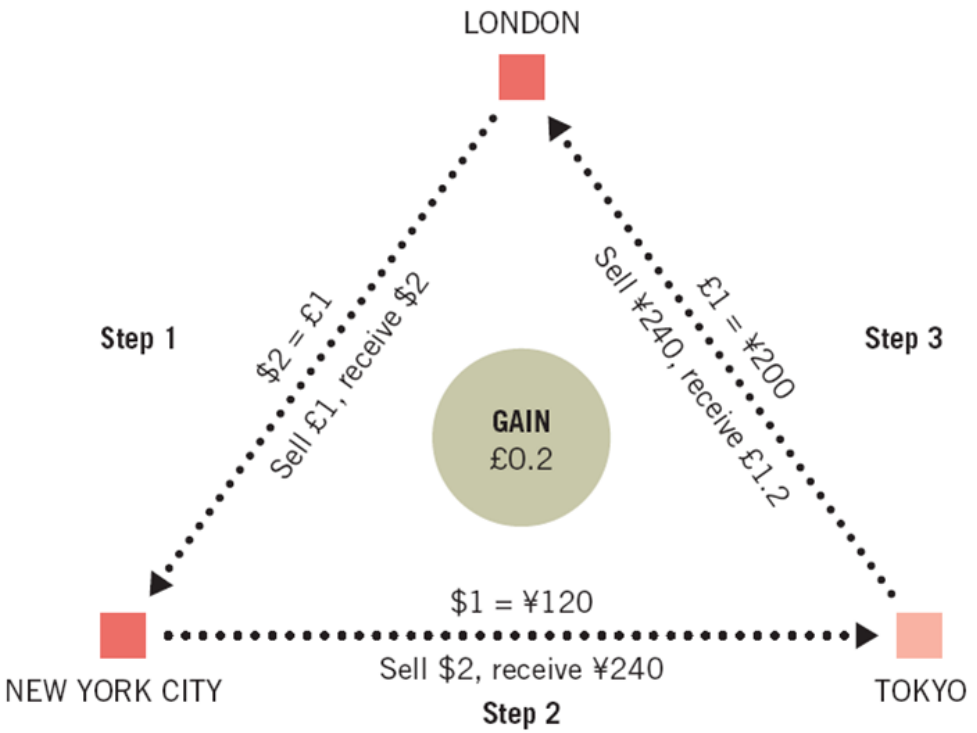


Arbitrage and Cross Rates Triangular arbitrage ensures that the direct trade of currencies along the path AB occurs at the same exchange rate as via a third currency along path ACB. The pounds received at B must be the same on both paths:

$$E_{£/\$} = E_{£/€}E_{€/\$}$$

Source: FT (2017)

Cross Rates and Vehicle Currencies



The figure shows the process for FX triangular arbitrage:

1. Triangular Arbitrage
2. Vehicle currency: £
3. Three Bilaterals: 2\$/£, 120¥/\$, 200¥/£
4. Cross rate: 240¥/£ = (2\$/£)*(120¥/\$)
5. Profit: 40¥=0.2£

Can you identify this strategy?

http://forex-intfinancialmarkets.blogspot.com/p/arbitrage-and-currency-market.html

Statistical Arbitrage: Explanation (w)

- Another common FX arbitrage trading system is statistical arbitrage.
- This strategy is based on shorting a basket of over-performing and buying a basket of under-performing currencies, with the idea that the over-performing currencies will eventually decrease in value, while under-performing currencies will increase in value.
- Of course, tight historical correlation between the two baskets would be an advantage in this basket trading FX strategy, in order to create a market-neutral portfolio.
- Most assets eventually revert to their mean value, and mean-reverting strategies aim to exploit this phenomenon.
- Correlation is a statistical method that measures the interrelationship and interdependence between two (or more) variables.

Statistical Arbitrage: FX Correlation 2012-2018

	AUDUSD	EURCHF	EURGBP	EURJPY	EURUSD	GBPJPY	GBPUSD	USDCHF	USDJPY	XAUUSD
AUDUSD		0.7810	0.0789	0.5618	0.9116	0.2291	0.7041	-0.8195	-0.6375	0.4407
EURCHF	0.7810		0.3383	0.5912	0.9131	0.0675	0.5173	-0.5325	-0.6305	0.4460
EURGBP	0.0789	0.3383		-0.3065	0.1749	-0.8544	-0.5708	0.0969	-0.5624	0.6376
EURJPY	0.5618	0.5912	-0.3065		0.6607	0.7536	0.7782	-0.5803	0.1184	-0.1341
EURUSD	0.9116	0.9131	0.1749	0.6607		0.2172	0.7079	-0.8299	-0.6653	0.4807
GBPJPY	0.2291	0.0675	-0.8544	0.7536	0.2172		0.7991	-0.3674	0.4787	-0.5279
GBPUSD	0.7041	0.5173	-0.5708	0.7782	0.7079	0.7991		-0.7632	-0.1437	-0.0612
USDCHF	-0.8195	-0.5325	0.0969	-0.5803	-0.8299	-0.3674	-0.7632		0.5089	-0.4030
USDJPY	-0.6375	-0.6305	-0.5624	0.1184	-0.6653	0.4787	-0.1437	0.5089		-0.7881
XAUUSD	0.4407	0.4460	0.6376	-0.1341	0.4807	-0.5279	-0.0612	-0.4030	-0.7881	

https://alpari.com/en/beginner/articles/forex-arbitrage-strategy/

As the table shows, the EUR/USD pair is highly correlated with the AUD/USD pair, with a high positive correlation of 0.9116. If the euro is an over-performing currency, and the Australian dollar an under-performing currency, you could look to sell EUR/USD and buy AUD/USD to create a market-neutral arbitration portfolio.

Finance Theory: Return v.s. Risk

- Our previous discussion of arbitrage has been focused on spotting profit opportunities for currencies simultaneously traded at different prices across space.
- Certainly, this is not the only type of arbitrage activity in the FX market. Investors can also arbitrage across currencies over time.
- Another type of arbitrage arises from the investors' decision on in which currency they should hold their money balances.
- The economic analysis on this necessity requires a framework of comparing return and risk for the investment.
- What is return? What is risk? How to measure them? How to apply the return-risk framework in forex market?

Financial Investment: FX Assets

- Let's start with a very simple case. Investors' cash can be placed in bank deposit accounts denominated in various currencies where it will earn a modest interest rate.
- For example, a trader working for a major bank in New York could leave the bank's cash in euro deposit for one year earning 4% euro interest rate or she could put the money in a US dollar deposit for one year earning a 5% dollar interest rate.
- How could she decide which asset, the euro or the dollar deposit, is a better investment?
- Is it always better to place money in a higher return asset?
- The answer hinges on the exchange rates between two currencies in the investment horizon!

FX Asset Investment: Dollar or Euro Deposit?

An investor in New York cares about returns in U.S. dollars. A dollar deposit pays a known return, in dollars. But a euro deposit pays a return in euros, and one year from now we cannot know for sure what the dollar-euro exchange rate will be.

Suppose the US dollar deposit rate is $i_{\$} = 5\%$ and the Euro deposit rate is i€=4%. Current exchange rate is $E = 1$ \$/€, if an investor expects future exchange rate will be $F = 1.03$ \$/€, transaction cost is zero.

- Calculate the rate of return for dollar deposit.
- Calculate the rate of return for euro deposit in dollars.
- In which currency should the investor deposit?

FX Asset Investment: Exchange Rate Risk

- The problem facing our trader is the exchange rate risk - the uncertainty of the end of investment period exchange rate.
- A US investor with dollar assets would need to convert them into euro assets if she decides to invest in euro asset. The exchange rate applies for this transaction is the spot rate.
- By the end of the investment, our US investor would then need to convert the euro assets back into dollar assets (why?). The exchange rate applies for this transaction is the future rate, which is not known at the beginning of the investment.
- The type of arbitrage our savvy investor pursues depends on whether she chooses to hedge her exposure to this exchange rate risk or not.

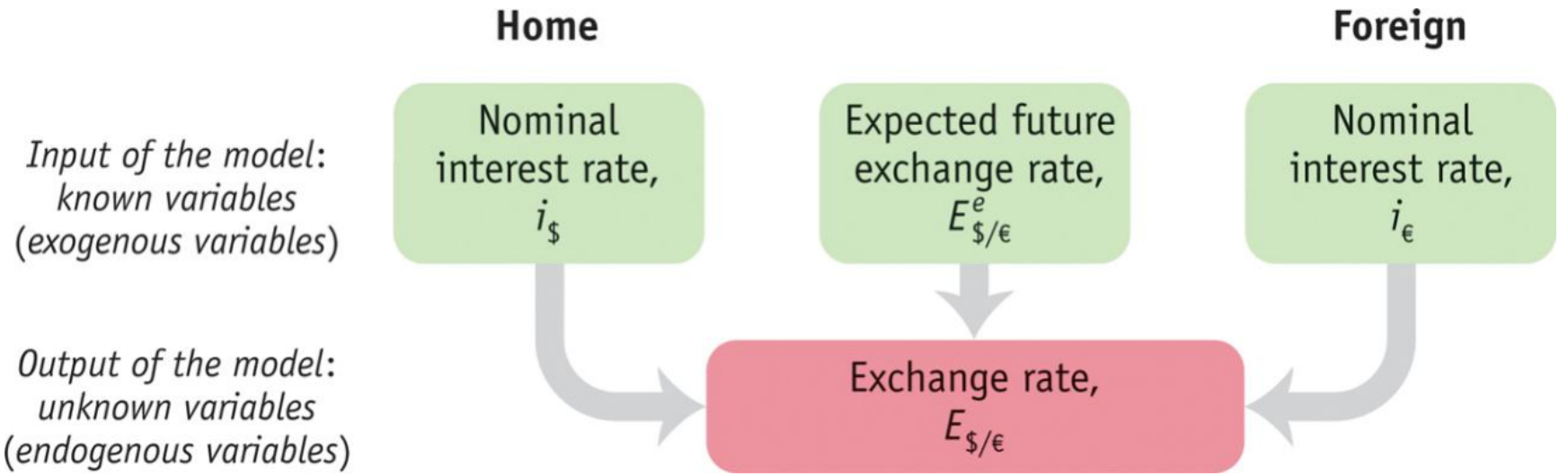
Riskless Arbitrage: Covered Interest Rate Parity

- As we know from our study on derivatives, an investor may elect to cover or hedge exposure to exchange rate risk by using a forward contract so that their decision simplifies to a case of riskless arbitrage. Suppose further $E_{\$/€}$=1.03 and $F_{\$/€}$=1.05.
- How should our investor make her decision for one year horizon?
- Dollar deposit return: $D_{\$}(1+i_{\$})$ where $D_{\$}$ is the investor's dollar principal and $i_{\$}$ is the annual interest rate on the dollar deposit.
- Euro deposit return: $(D_{\$}/E_{\$/€})(1+i_{€})\times F_{\$/€}$ where $F_{\$/€}$ is the forward rate specified in a foreign exchange forward contract.
- No arbitrage argument leads to the covered interest rate parity (CIP): a condition relating interest rate differentials to the forward premium or discount.

Risky Arbitrage: Uncover Interest Rate Parity

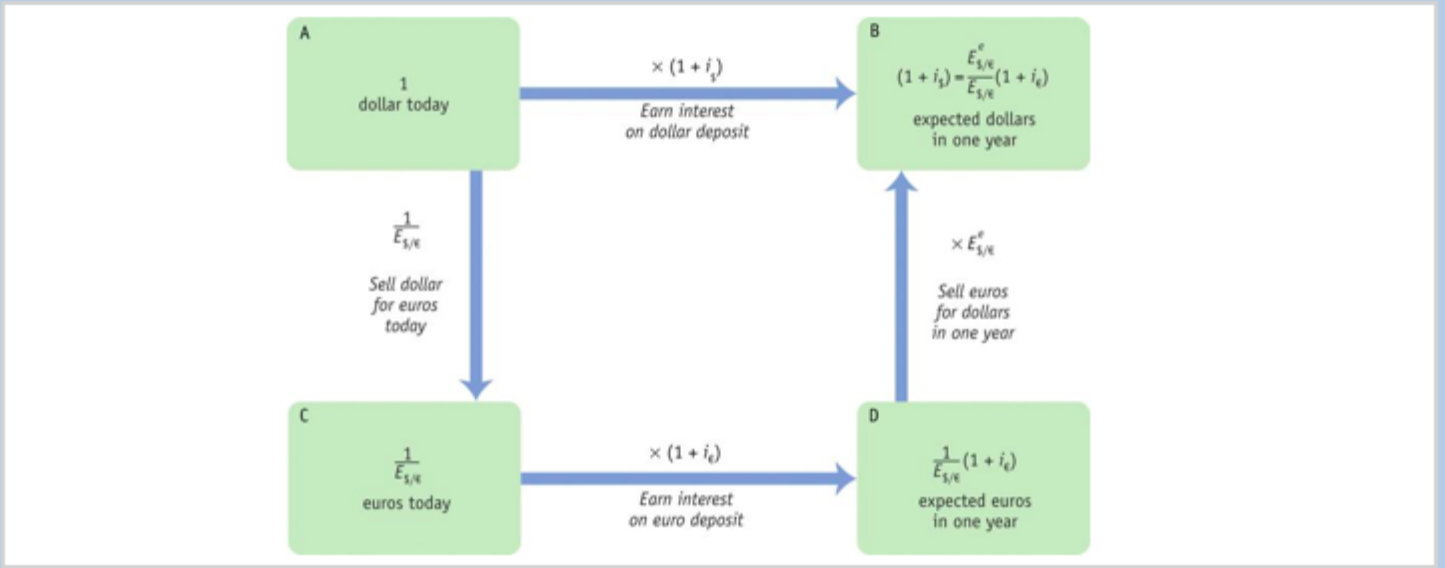
- Bold enough, an investor may not engage in a forward contract, and instead wait until their investment matures, whereupon their decision is a case of risky arbitrage.
- The future exchange rate applies in a risky arbitrage is the expected exchange rate which we denote $E^e_{\$/€}$.
- In this case, unlike the covered arbitrage, the return on euro deposit (converted back into dollar) is not known at the beginning of the period. Therefore, it is a risky arbitrage.
- Uncovered interest parity (UIP): a condition relating interest rate differentials to an expected change in the spot exchange rate of the domestic currency.

Interest Rate Parity: Model



Source: FT (2017). Building Block: Uncovered Interest Parity–The Fundamental Equation of the Asset Approach. In this model, the nominal interest rate and expected future exchange rate are treated as known exogenous variables (in green). The model uses these variables to predict the unknown endogenous variable (in red), the current spot exchange rate.

Uncovered Interest Rate Arbitrage: Diagram

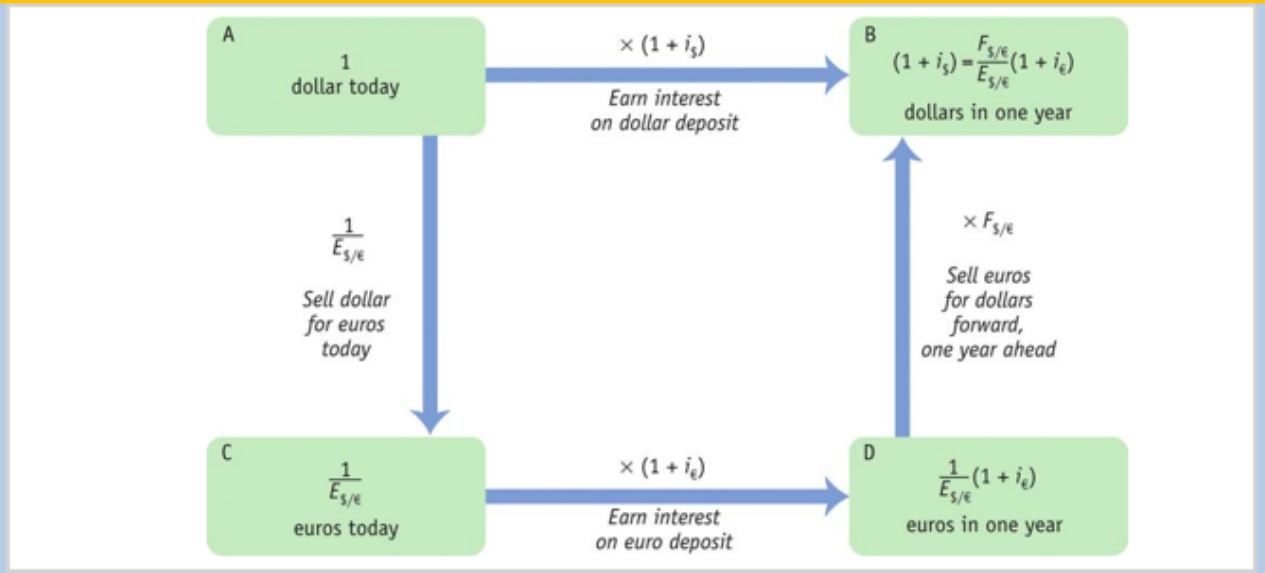


Arbitrage and Uncovered Interest Parity Under CIP, returns to holding dollar deposits accruing interest going along the path AB must equal returns from investing in euros going along the risky path ACDB. Hence, at B, the expected payoff must be the same on both paths:

$$(1 + i_{\$}) = \frac{E^e_{\$/€}}{E_{\$/€}}(1 + i_€)$$

Source: FT (2017)

Covered Interest Rate Arbitrage: Diagram



Arbitrage and Covered Interest Parity Under CIP, returns to holding dollar deposits accruing interest going along the path AB must equal the returns from investing in euros going along the path ACDB with risk removed by use of a forward contract. Hence, at B, the riskless payoff must be the same on both paths:

$$(1 + i_{\$}) = \frac{F_{\$/€}}{E_{\$/€}}(1 + i_{€})$$

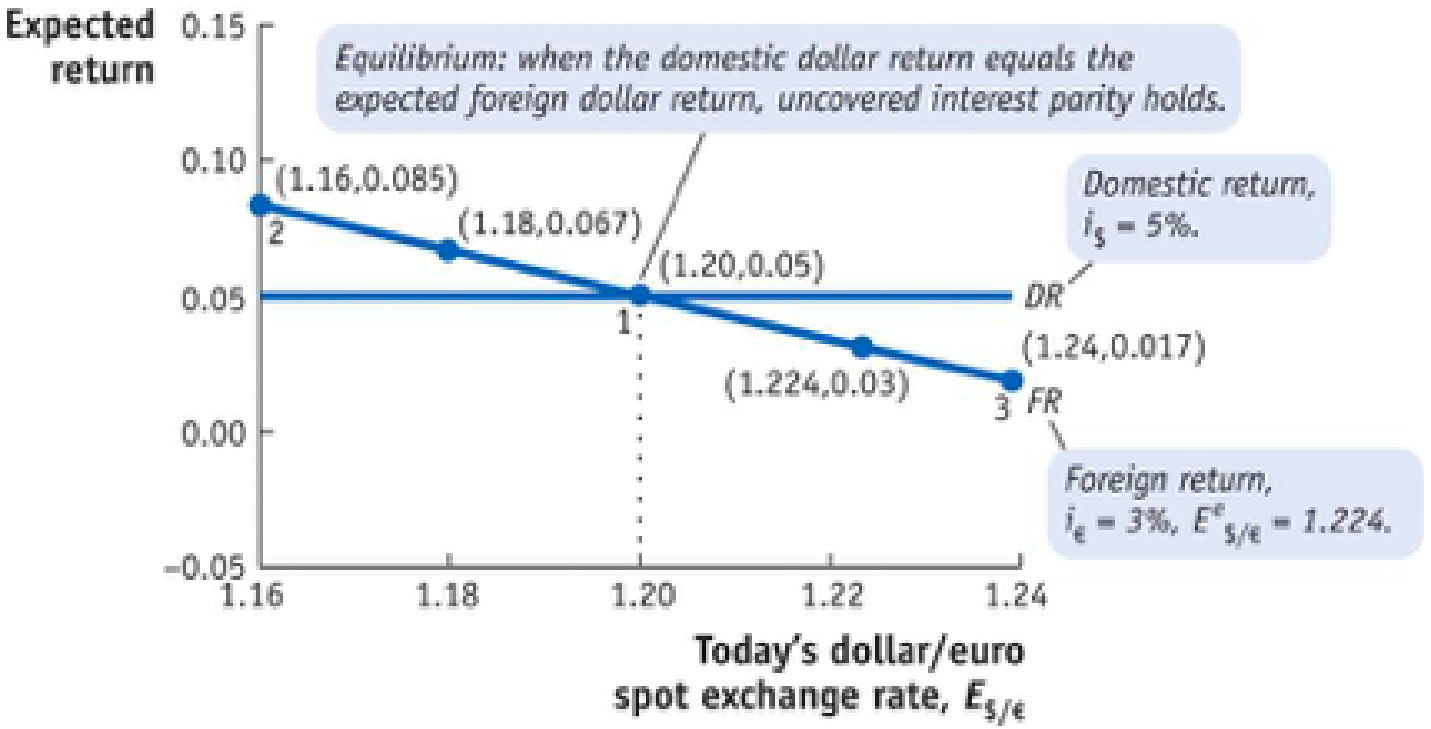
Source: FT (2017)

FX Market IRP Equilibrium: A Numerical Example

	Interest Rate on Dollar Deposits (annual)	Interest Rate on Euro Deposits (annual)	Spot Exchange Rate (today)	Expected Future Exchange Rate (in 1 year)	Expected Euro Appreciation against Dollar (in 1 year)	Expected Dollar Return on Euro Deposits (annual)
	Domestic Return ($)					Foreign Expected Return ($)
	$i_\$$	$i_€$	$E_{\$/€}$	$E^e_{\$/€}$	$\frac{E^e_{\$/€} - E_{\$/€}}{E_{\$/€}}$	$i_€ + \frac{E^e_{\$/€} - E_{\$/€}}{E_{\$/€}}$
	0.05	0.03	1.16	1.224	0.0552	0.0852
	0.05	0.03	1.18	1.224	0.0373	0.0673
Market equilibrium	0.05	0.03	1.20	1.224	0.02	0.05
	0.05	0.03	1.22	1.224	0.0033	0.0333
	0.05	0.03	1.24	1.224	-0.0129	0.0171

Source: FT (2017). The foreign exchange (FX) market is in equilibrium when the domestic and foreign returns are equal. In this example, the dollar interest rate is 5%, the euro interest rate is 3%, and the expected future exchange rate (one year ahead) is 1.224 \$/€. The equilibrium is highlighted in bold type.

FX Market IRP Equilibrium: A Numerical Example



Source: FT (2017). The dollar $R_\$$ is 5%, the euro R is 3%, and the expected future E is 1.224 \$/€. The FX market is in equilibrium at point 1, where the domestic returns and expected foreign returns are equal at 5% and the spot E is 1.20 \$/€.

CIRP Arbitrage: U.K. and Germany

- Financial Liberalization and Covered Interest Parity: Arbitrage between the United Kingdom and Germany since 1981.
- The data shows the difference in monthly pound returns on deposits in British pounds and German marks using forward cover from 1970 to 1995. In the 1970s, the difference was positive and often large: Traders would have profited from arbitrage by moving money from pound deposits to mark deposits, but capital controls prevented them from freely doing so.
- After financial liberalization, these profits essentially vanished, and no arbitrage opportunities remained. The CIRP condition held, aside from small deviations resulting from transactions costs and measurement errors.

Covered Interest Rate Arbitrage: Evidence

Source: FT (2017)

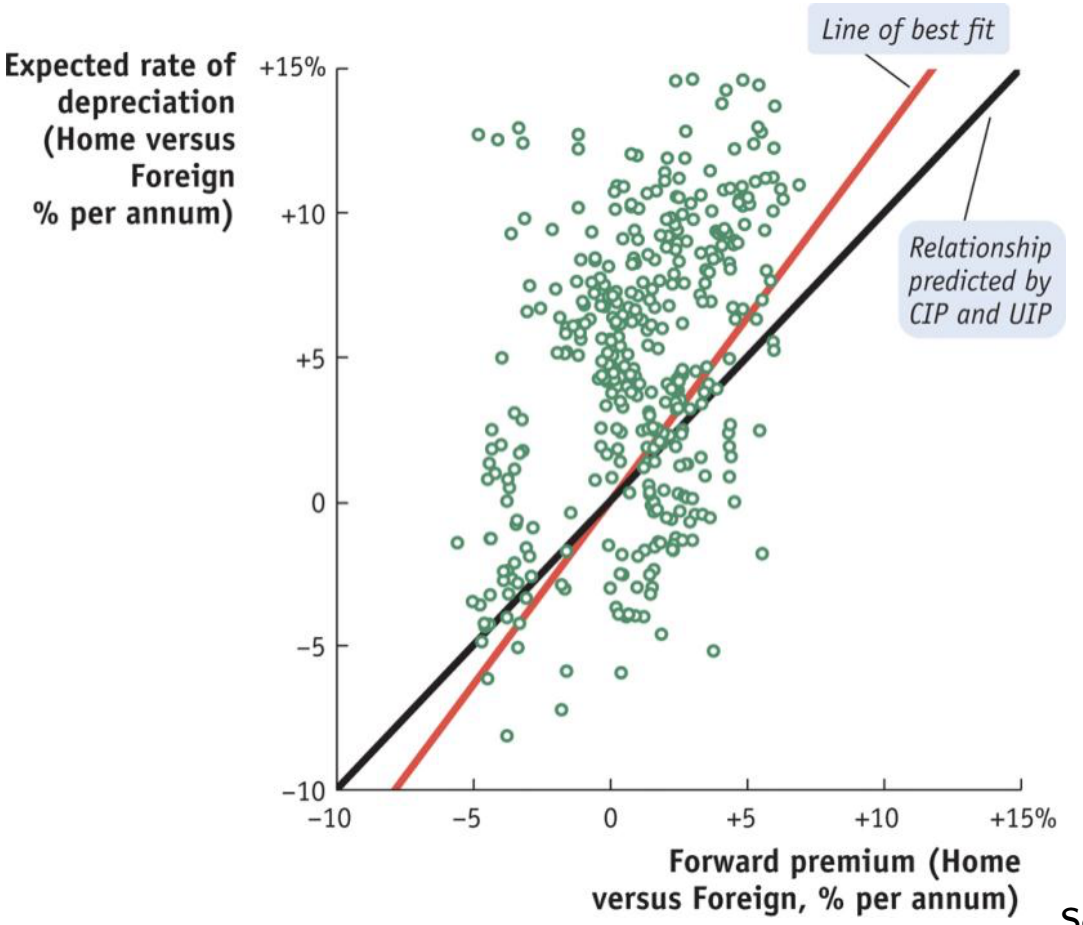
IRP Summary: Mathematical Forms

U.S. dollar interest rate R_H and Euro interest rate R_F.
Spot exchange rate E (\$/€) and future exchange rate F (\$/€)

1. Exact form: $(1+R_H) = F(1+R_F)/E$. Note: $F/E = 1+(F-E)/E$.
2. Continuous compounding: $e^{R_H} = Fe^{R_F}/E$ or $F = Ee^{(R_H - R_F)}$
3. Approximation (simple rule): $R_H \approx R_F + (F-E)/E$
4. Forward premium (€against \$): $(F-E)/E$
5. Covered interest rate parity: $F = F$ in a contract.
6. Uncovered interest rate parity: $F = E^e$ without hedging.

The dollar rate of return on euro deposits is approximately the euro interest rate plus the rate of depreciation of the dollar against the euro.

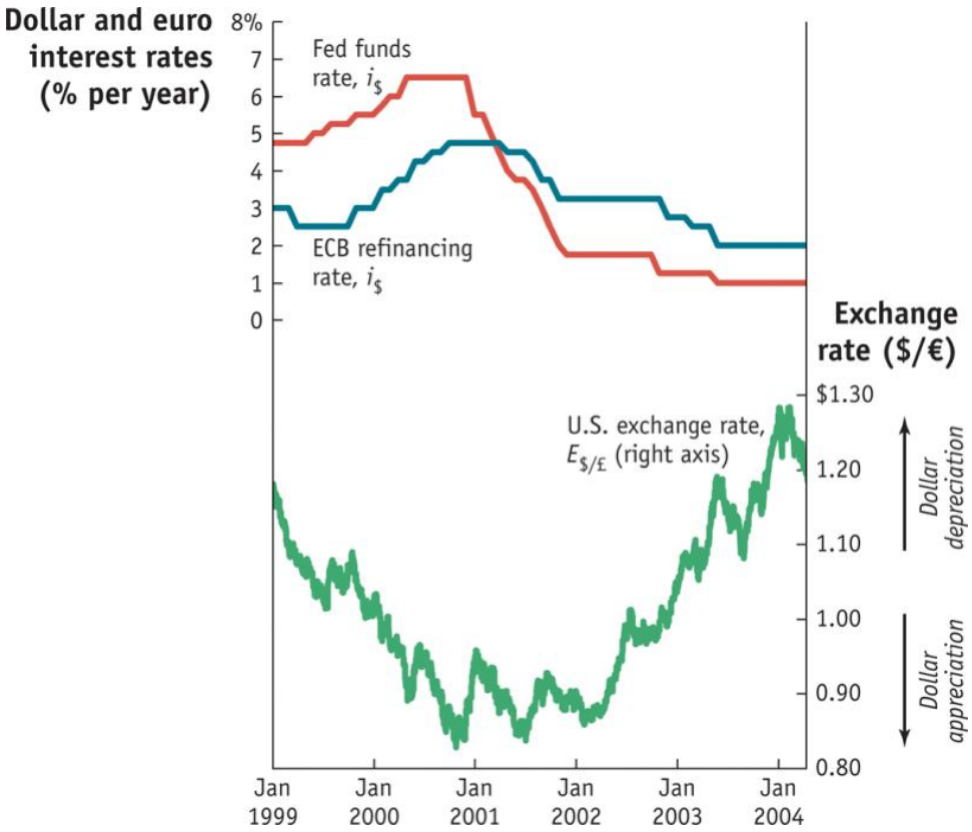
Uncovered Interest Rate Parity: Evidence



- When UIP and CIP hold, the 12-month forward premium should equal the 12-month expected rate of depreciation.
- A scatterplot showing these two variables should be close to the diagonal 45-degree line.
- Using evidence from surveys of individual forex traders' expectations over the period 1988 to 1993, UIP finds some support, as the line of best fit is close to the diagonal.

Source: FT (2017)

US-EU Interest Rates and Exchange Rates: 1999-2014



Source: FT (2017)

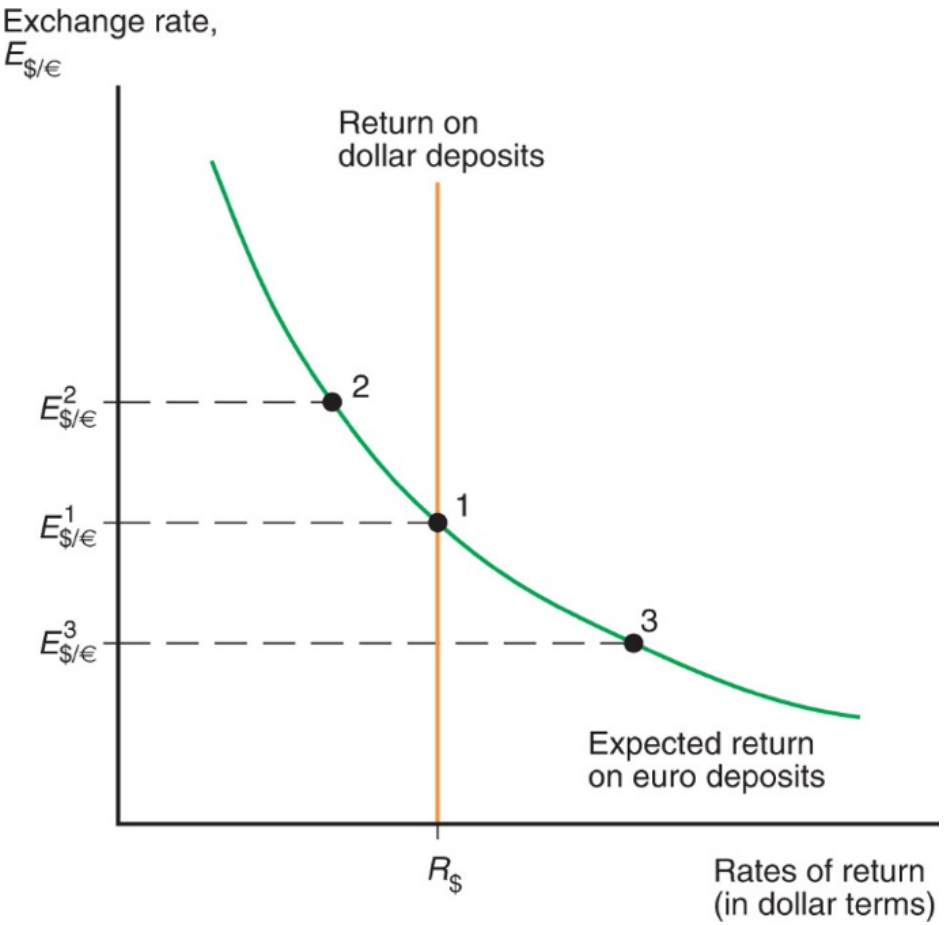
From the euro's birth in 1999 until 2001, the dollar steadily appreciated against the euro, as interest rates in the United States were raised well above those in Europe. In early 2001, however, the Federal Reserve began a long series of interest rate reductions. By 2002 the Fed funds rate was well below the ECB's refinancing rate. Theory predicts a dollar appreciation (1999-2001) when U.S. interest rates were relatively high, followed by a dollar depreciation (2001-2004) when U.S. interest rates were relatively low.

IRP Equilibrium: $R_{\$}=R_{€}+(E^e-E)/E$

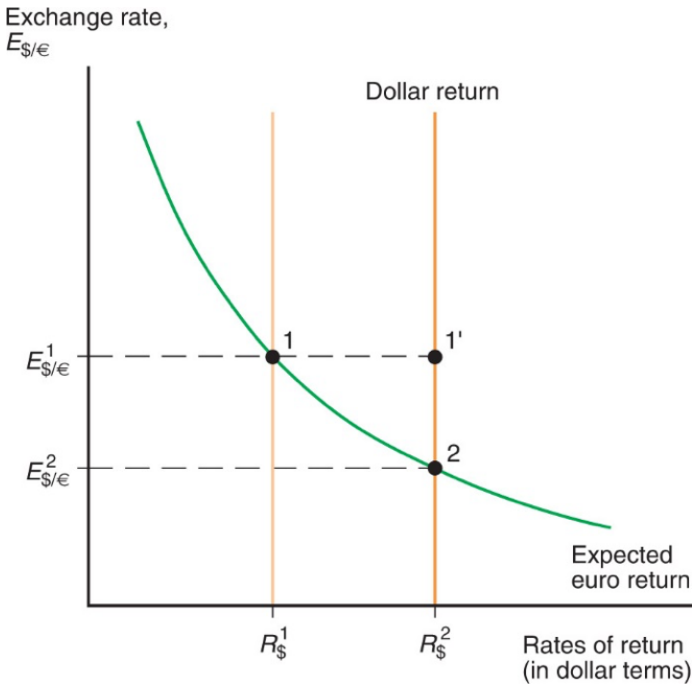
R€$+(E^e-E)/E$ is a function of E
R€$+E^e/E-1$ inversely related to E

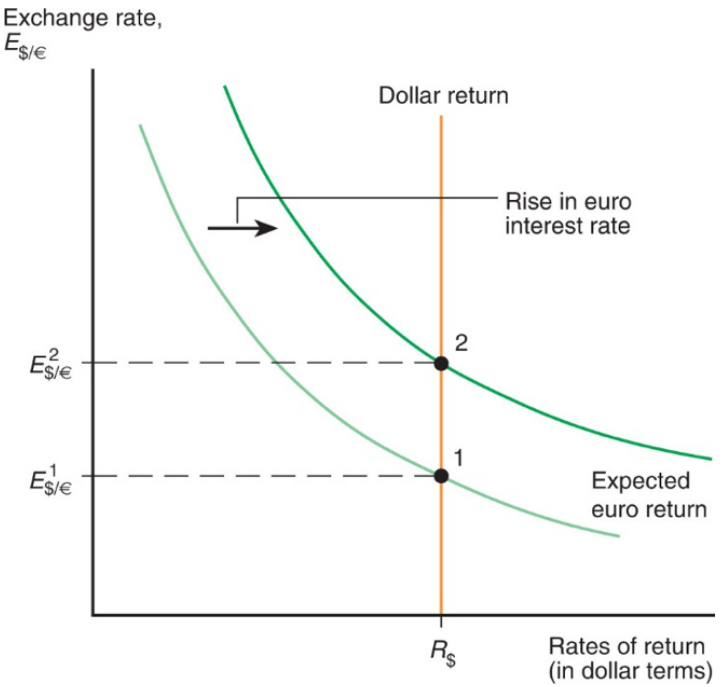
1. $R_{\$}$: U.S. dollar rate return
2. $R_{€}+(E^e-E)/E$: Expected Euro deposit return (in dollar terms)
3. In equilibrium, E is determined. Spot exchange rate E can be explained by $R_{\$}$, $R_{€}$, and expected future exchange rate E^e

Source: KOM (2018)



Spot Rate Determination: $R_{\$}=R_{€}+(E^e-E)/E$





$R_{\$} \uparrow \rightarrow E \downarrow$ (dollar appreciation)

R€ or $E^e \uparrow \rightarrow E \uparrow$ (dollar depreciation)

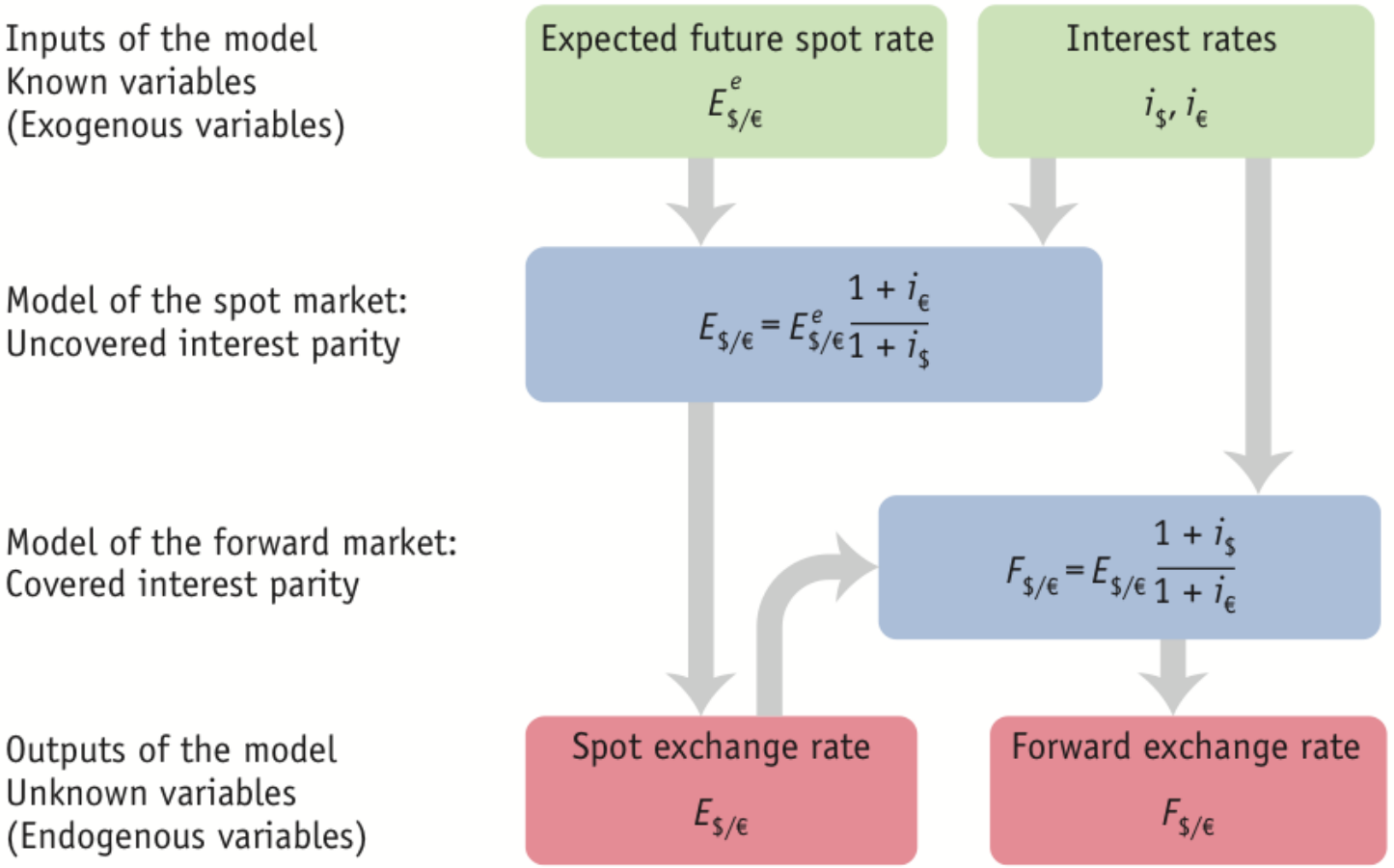
Source: KOM (2018). Self-fulfilling prophecy: If people expect the euro to appreciate in the future, then euro-denominated assets will pay in valuable euros, so that these future euros will be able to buy many dollars. The expected rate of return on euros therefore hikes. An expected appreciation leads to an actual appreciation.

IRP Summary: Spot and Future Exchange Rates

How interest rate parity condition explain spot and forward exchange rates? $(1+R_H) = F(1+R_F)/E$ or $R_H = R_F + (E^e - E)/E$.

1. In the spot market, UIRP provides a model of how the spot exchange rate is determined.
2. To use UIRP to predict the spot rate, we need to know the expected future spot rate and the prevailing interest rates for the two currencies.
3. In the forward market, CIRP provides a model of how the forward exchange rate is determined.
4. When we use CIRP, we derive the forward rate from the current spot rate (from UIP) and the interest rates for the two currencies.

CIRP, UIRP and Exchange Rates: Summary



Exchange Rate Predictability

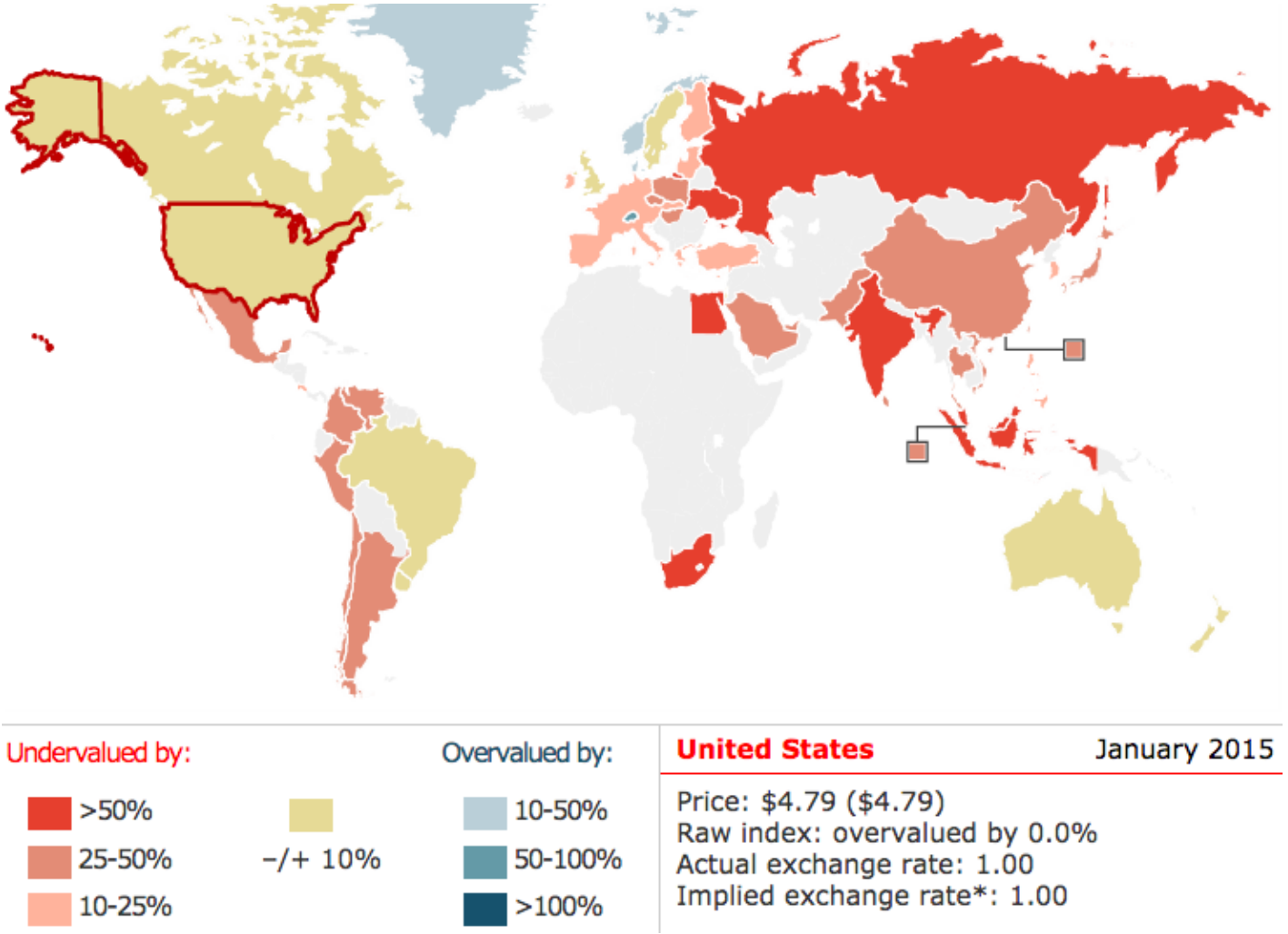
- According to the interest rate parity and expectations hypothesis, forward exchange rates should be equal to expected spot rates.
- The expectations hypothesis implies that the so-called carry trade, which involves borrowing in a low-interest currency and investing in a high-interest currency, should not yield positive excess returns, as the higher interest rate should be offset by currency depreciation.
- Hansen and Hodrick (1980) developed econometric tests using multiple forward rates of different maturities, and were able to reject the expectations hypothesis in foreign exchange markets.
- Fama (1984) showed that the coefficient of the forward rate in a regression on future spot rates is actually negative, rather than plus one as the expectations hypothesis would predict.
- These studies, as well as many others that followed, indicated that foreign exchange markets exhibit significant return predictability.

Outline

Burgernomics: Big Mac Index (w)

- The big mac index was invented by The Economist in 1986 as a lighthearted guide to whether currencies are at their "correct" level.
- It is based on the theory of purchasing-power parity (PPP), the notion that in the long run exchange rates should move towards the rate that would equalize the prices of an identical basket of goods and services (in this case, a burger) in any two countries.
- The big mac, the flagship burger of the McDonald's fast-food chain, is a model of consistency. Composed of seven ingredients, the double-decker sandwich is produced in nearly identical fashion across more than 36,000 restaurants in over 100 countries.
- According to the latest batch of data, almost every currency is undervalued against the dollar. The result is that the greenback itself looks stronger, relative to fundamentals, than at any point in three decades.

The Big Mac Index: 2015 (w)



The Big Mac Index: Undervalued Currencies (w)

The Big Mac index

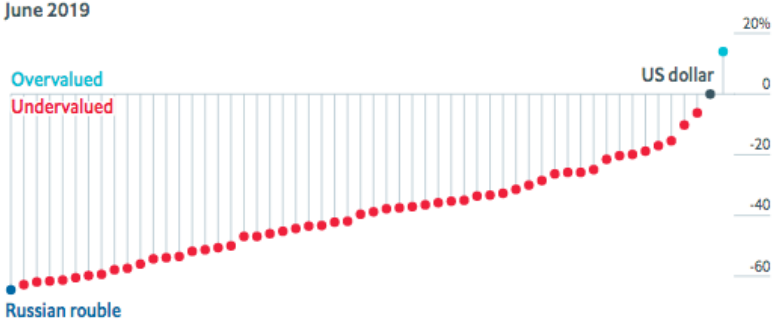
Country		2000 — 2019	Under/over valued, %
Russia	Rouble		-64.5
Malaysia	Ringgit		-62.8
South Africa	Rand		-61.9
Romania	Leu		-61.6
Ukraine	Hryvnia		-61.3
Indonesia	Rupiah		-60.5
Taiwan	NT$		-59.8
Azerbaijan	Manat		-59.4
Moldova	Leu		-57.9
Turkey	Lira		-57.4
Egypt	Pound		-56.0
Hong Kong	HK$		-54.3
Mexico	Peso		-53.9
India	Rupee		-53.5
Philippines	Peso		-51.8
Vietnam	Dong		-51.3
Poland	Zloty		-50.6
Argentina	Peso		-50.0
China	Yuan		-46.9
Pakistan	Rupee		-46.9
Hungary	Forint		-46.0

Choose a base currency: US dollar | Show index at: Jun 2019

Adjust the index to account for GDP per person: Raw index | GDP-adjusted

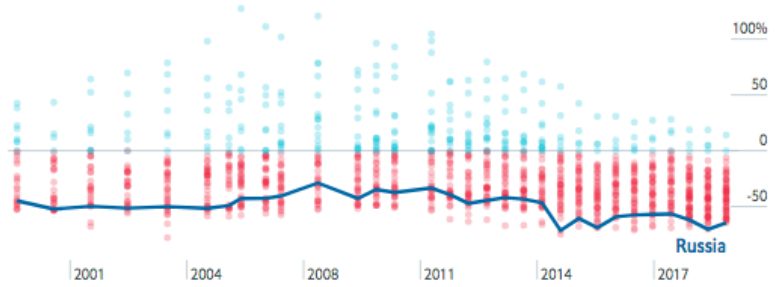
The Russian rouble is 65% undervalued against the US dollar

June 2019



A Big Mac costs 130 roubles in Russia and US$5.74 in the United States. The implied exchange rate is 22.65. The difference between this and the actual exchange rate, 63.84, suggests the Russian rouble is 64.5% undervalued

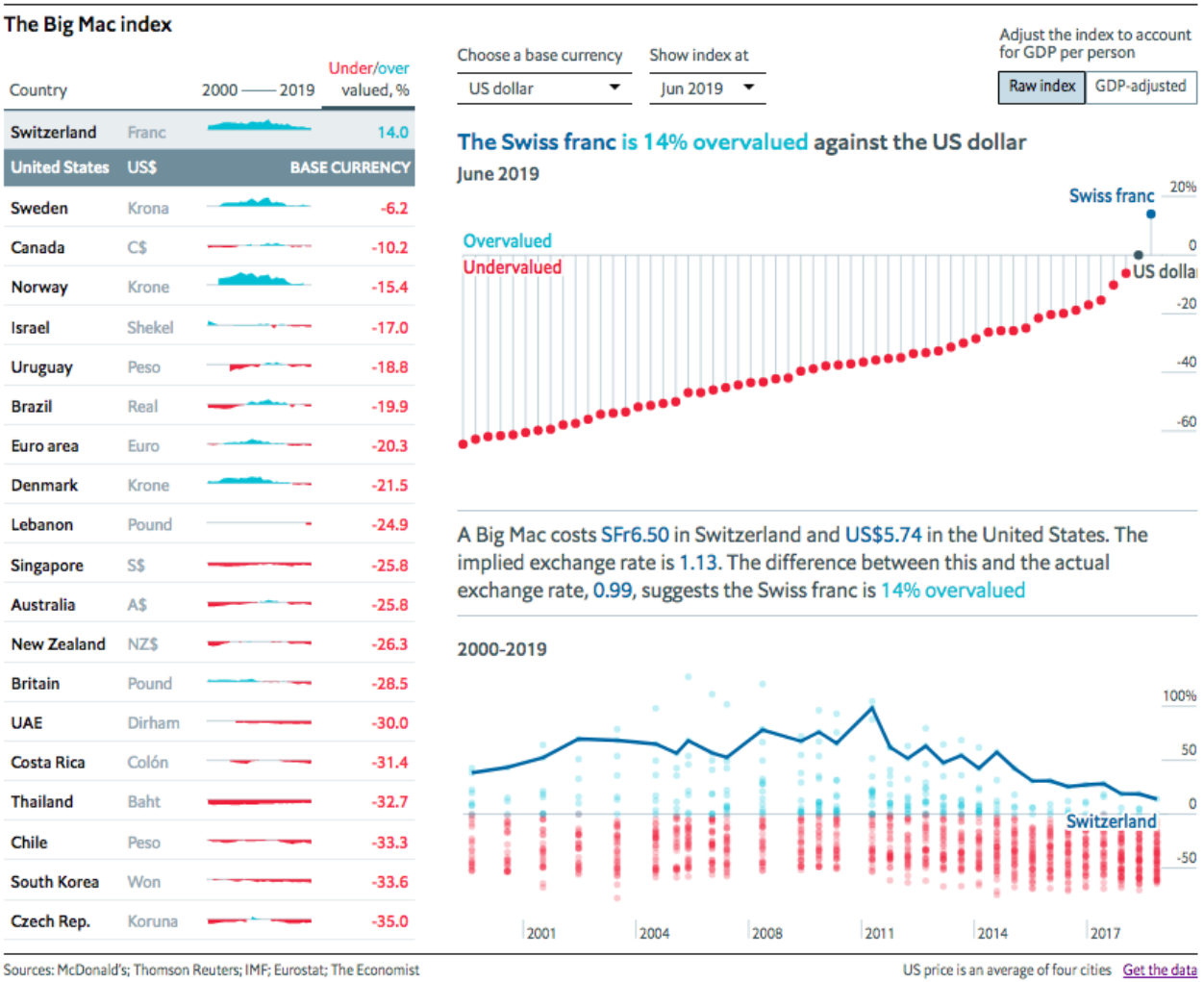
2000-2019



Sources: McDonald's; Thomson Reuters; IMF; Eurostat; The Economist

US price is an average of four cities Get the data

The Big Mac Index: Overvalued Currencies (w)



The Big Mac index

Country		2000 — 2019	Under/over valued, %
Switzerland	Franc		14.0
United States	US$		BASE CURRENCY
Sweden	Krona		-6.2
Canada	C$		-10.2
Norway	Krone		-15.4
Israel	Shekel		-17.0
Uruguay	Peso		-18.8
Brazil	Real		-19.9
Euro area	Euro		-20.3
Denmark	Krone		-21.5
Lebanon	Pound		-24.9
Singapore	S$		-25.8
Australia	A$		-25.8
New Zealand	NZ$		-26.3
Britain	Pound		-28.5
UAE	Dirham		-30.0
Costa Rica	Colón		-31.4
Thailand	Baht		-32.7
Chile	Peso		-33.3
South Korea	Won		-33.6
Czech Rep.	Koruna		-35.0

Choose a base currency: US dollar | Show index at: Jun 2019

Adjust the index to account for GDP per person: Raw index | GDP-adjusted

The Swiss franc is 14% overvalued against the US dollar

June 2019

A Big Mac costs SFr6.50 in Switzerland and US$5.74 in the United States. The implied exchange rate is 1.13. The difference between this and the actual exchange rate, 0.99, suggests the Swiss franc is 14% overvalued

2000-2019

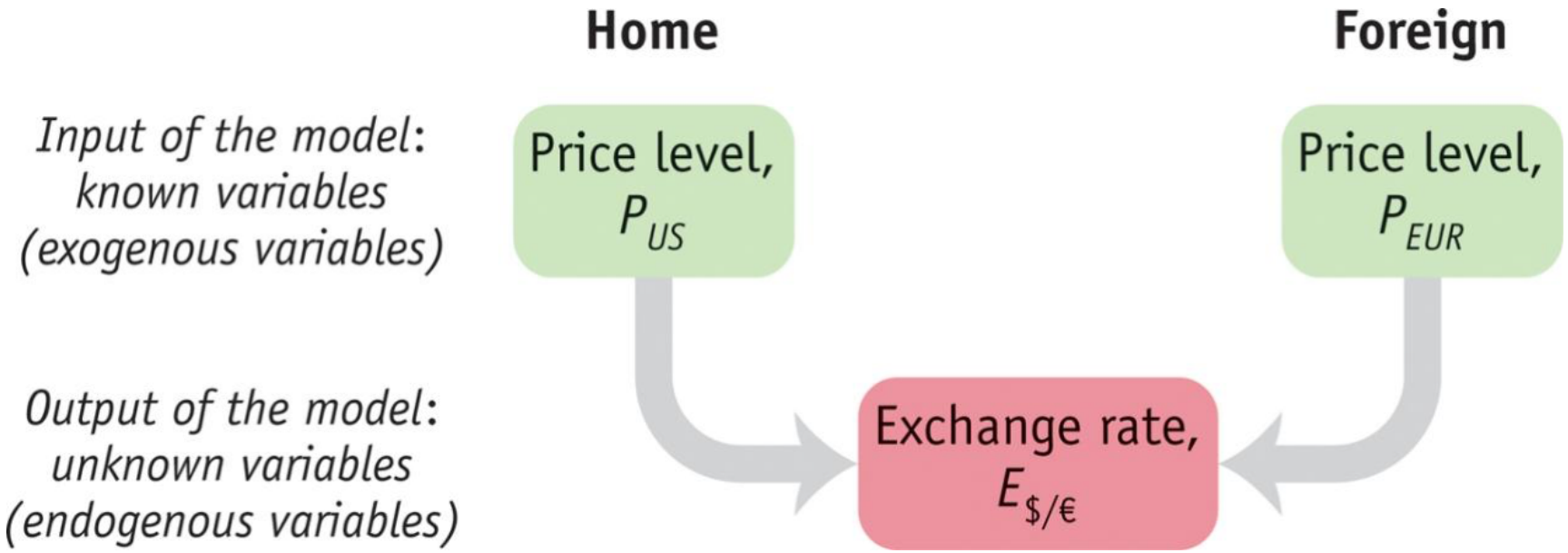
Sources: McDonald's; Thomson Reuters; IMF; Eurostat; The Economist

US price is an average of four cities Get the data

The Law Of One Price (LOOP)

- The law of one price (LOOP) states that in the absence of trade frictions (e.g., transport costs and trade policy barriers), and under conditions of free competition and price flexibility (where no individual seller or buyer has the power to manipulate prices and prices can freely adjust), identical goods sold in different locations must sell for the same price when prices are expressed in a common currency.
- Example: suppose that a diamond of a given quality is priced at €5000 in the Amsterdam market, and the exchange rate is \$1.20 per euro. If the law of one price holds, the same-quality diamond should sell in New York for (€5000)*(1.20\$/€)=\$6000 per diamond.
- PPP: P_{EU}*E$_{(\$/€)}$=$P_{US}$ or $\frac{P_{EU}*E}{P_{US}} = 1$. Real exchange rate equalization!
- Under the condition of free trade and perfect competition, this equation characterizes market equilibrium.

Absolute PPP Model: $E_{H/F} = P_H/P_F$



Source: FT (2017). Building Block: Price Levels and Exchange Rates in the Long Run. According to the PPP Theory In this model, the price levels are treated as known exogenous variables (in the green boxes). The model uses these variables to predict the unknown endogenous variable (red box), which is the exchange rate.

What if LOOP may not hold?

If the relative price of the diamond in Europe v.s. US is not equal to one, i.e., $P_{EU} \neq P_{US}$ or $RP^{d}_{US/EU} = \frac{P_{EU} * E}{P_{US}} \neq 1$. Economic man can arbitrage!

1. When $RP_{US/EU} = \frac{P_{EU} * E}{P_{US}} > 1$, the diamond is cheaper in US. There will be an opportunity to buy low in US and sell high in EU.
2. When $RP_{US/EU} = \frac{P_{EU} * E}{P_{US}} < 1$, the diamond is cheaper in EU. What shall the business person do? The arbitrage applies the opposite way.

Recall that $RP_{H/F} = NE_{H/F} \times (P_F / P_H)$ measures which basket is more expensive, foreign relative to home. In our example, it tells us how many units of the diamond in U.S. are needed to swap for an identical diamond in Europe. In contrast, the nominal exchange rate $E_{\$/€}$ expresses the price at which currencies can be exchanged.

Absolute PPP: Long Run Exchange Rate Determination

- The no-arbitrage argument ensures that $RP_{US/EU} = \frac{P_{EU} * E}{P_{US}} = 1$ and the LOOP would always hold in a trade frictionless world.
- The principle of Purchasing Power Parity (PPP) is the macroeconomic counterpart to the microeconomic law of one price.
- If we define a general price level P in each location as a weighted average of the prices of all goods in a basket, choosing the same goods and weights in both location. $(P = \sum_{i=1}^{N} w_i * p_i)$
- If the LOOP holds for each good in the basket, it will also hold for the price of a basket as a whole, i.e., $P_{EU} \times E_{(\$/€)} = P_{US}$ or $E_{(\$/€)} = \frac{P_{US}}{P_{EU}}$. This statement about equality of price levels is also called absolute PPP.
- PPP provides a theoretical solution to exchange rate determination. Equilibrium exchange rate is hence derived when price levels in two countries are equal when expressed in a common currency.

Absolute PPP: Long Run Equilibrium

- Purchasing power parity implies that the exchange rate at which two currencies trade equals the relative price levels of two countries.

$$E^*_{H/F} = \frac{P_H}{P_F} \text{ or } RE^*_{H/F} = \frac{P_F \times E_{H/F}}{P_H} = 1$$

- For example, if a basket of goods costs \$460 in the US and the same basket cost €400 in EU, the theory of PPP predicts an exchange rate of \$460/€400=\$1.15 per euro.
- Thus, if we know the price levels in different locations, we can use PPP to determine an implied exchange rate, subject to all of our earlier assumptions about frictionless trade, flexible prices, free competition, and identical goods.

Relative PPP: LR Changes in Exchange Rates

- PPP in its absolute form involves price levels, but we are often more interested in the rate at which price levels change.
- The rate of growth of the price level is known as the inflation rate.
- Taking logs on both sides and then total differentiation, we can derive the relative PPP from its absolute version.

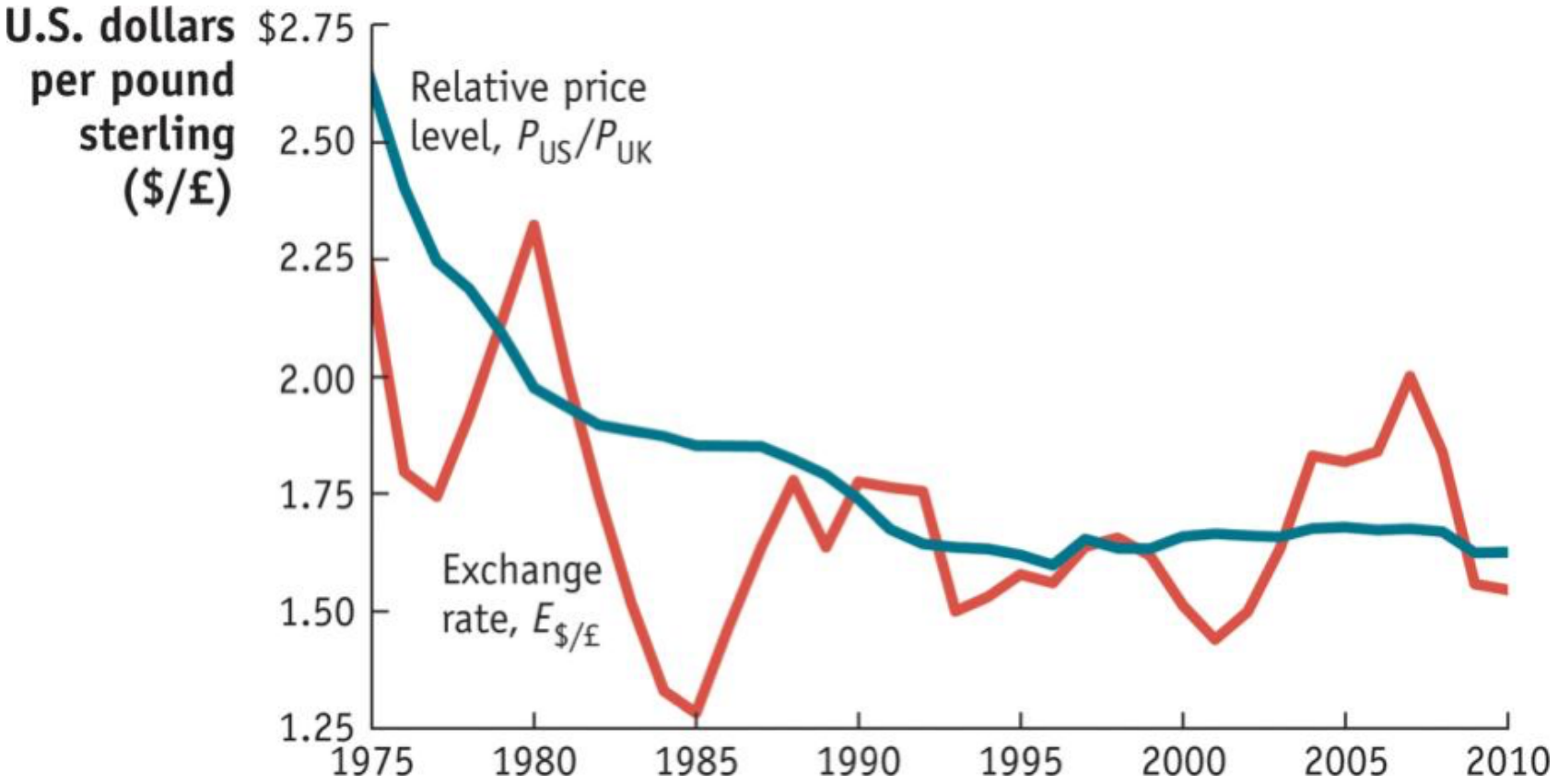
$$\frac{\triangle E_{H/F}}{E_{H/F}} = \frac{E_{H/F}^{t+1} - E_{H/F}^{t}}{E_{H/F}^{t}} = \frac{\triangle P_H}{P_H} - \frac{\triangle P_F}{P_F} = \pi_H - \pi_F$$

- The relative PPP implies that the rate of depreciation of the nominal exchange rate equals the difference between the inflation rate of two countries (the inflation differential).

Interpreting Relative PPP

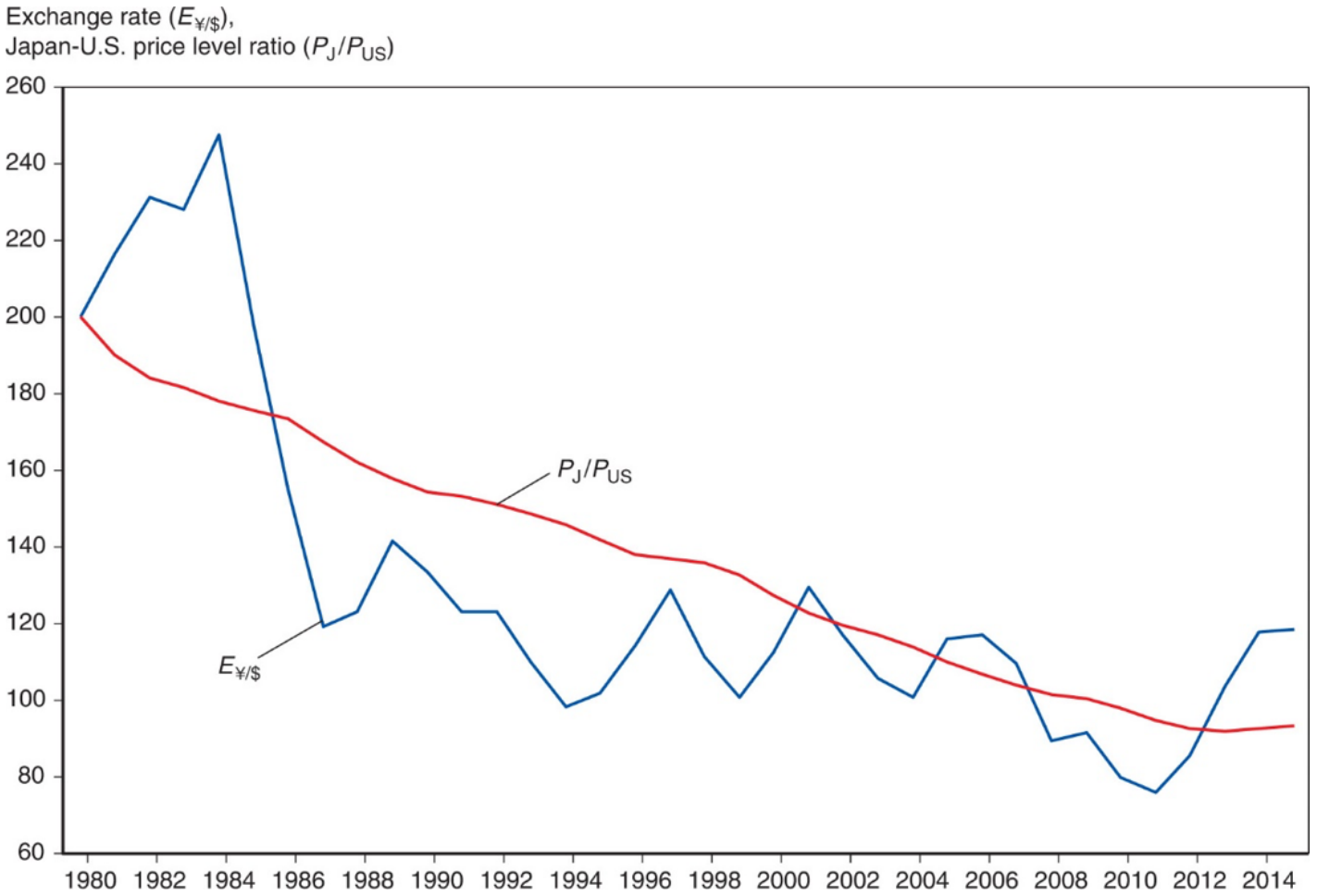
- Unlike absolute PPP, relative PPP predicts a relationship between changes in prices and changes in exchange rates, rather than a relationship between their levels.
- Relative PPP is derived from absolute PPP. Hence, the latter always implies the former: if absolute PPP holds, this implies that relative PPP must hold also. But the converse need not be true: relative PPP does not necessarily imply absolute PPP (if relative PPP holds, absolute PPP can hold or fail.)
- For example, in 1970, C\$1 = US\$1; in 1990, C\$1.16=US\$1. $CPI_{CA}^{70} = C\$100$, $CPI_{US}^{70} = \$100$; $CPI_{CA}^{90} = C\$392$, $CPI_{US}^{90} = \$336$; Over 20 years, Canadian prices rose 16% more than US prices, and the Canadian dollar depreciated 16% against the US dollar.

Testing PPP: US-UK Evidence



Source: FT (2017)

Testing PPP: US-JP Evidence

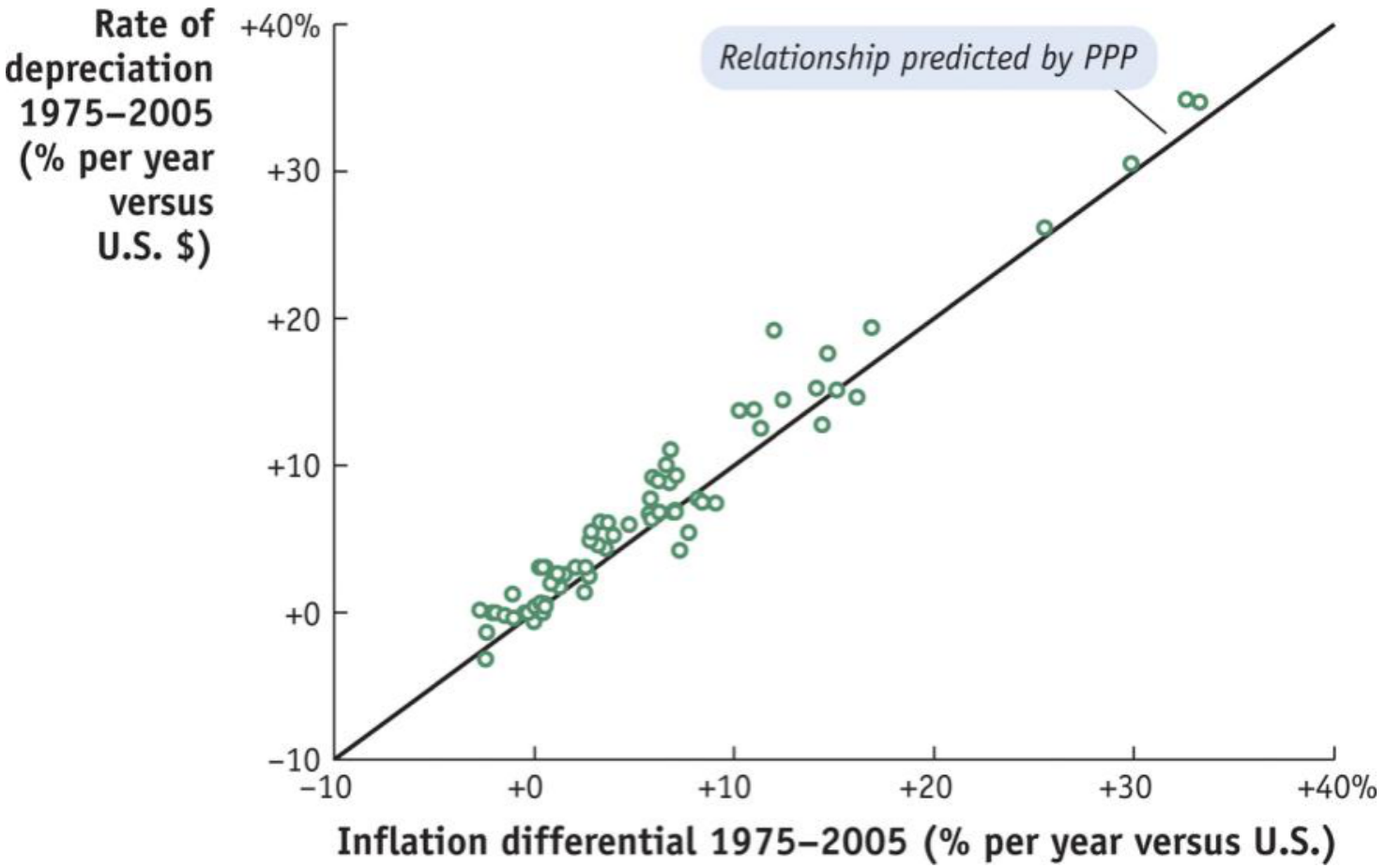


Source: KOM (2018)

Testing PPP: Evidence Summary

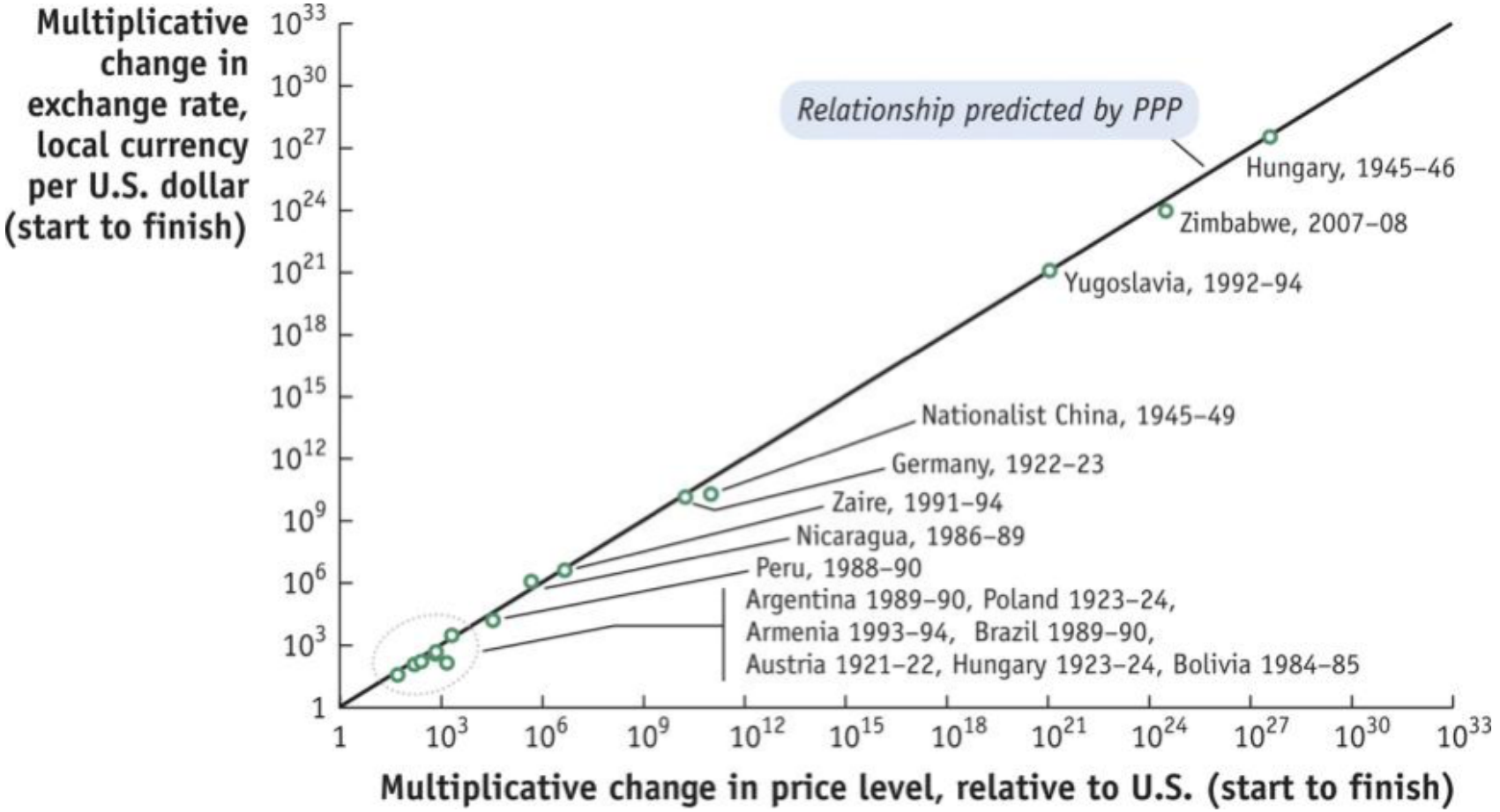
- Data for the US and the UK from 1975 to 2010 show that the exchange rate and relative price levels do not always move together in the short run. Relative price levels tend to change slowly and have a small range of movement; exchange rates move quickly and experience large swings.
- Data for US and Japan shows that in the early 1980s there was a steep appreciation of the dollar against the yen even though, with Japan's price level consistently falling relative to that in the US, relative PPP suggests that the dollar should have depreciated instead. The same inflation trends continued after the mid-1980s, but the yen then appreciated by far more than the PPP would have predicted.
- Therefore, relative PPP does not hold in the short run. It is a better guide to the long run, and we can see that the two series do tend to drift together over the decades.

Testing Relative PPP: U.S. Dollar



Source: FT (2017). US dollar against 82 countries.

Testing Relative PPP: Hyperinflations



Source: FT (2017). In logarithmic scales.

PPP: Deviation and Convergence

- To test absolute PPP, researchers compare the international prices of a broad reference basket of commodities, making careful adjustments for intercountry quality differences among supposedly identical goods.
- These comparisons typically conclude that absolute PPP is way off the mark: The prices of identical commodity baskets, when converted to a single currency, differ substantially across countries.
- Relative PPP is more consistent with data, but it also performs poorly to predict exchange rates, due to persistent deviations from PPP.
- Estimates suggest that these deviations may die out at a rate of about 15% per year, a measure called a speed of convergence, which implies that after one year, 85% (0.85=1-0.15) of an initial price difference persists; compounding, after two years, 72% (0.85^2) of the gap persists; and after four years, 52% (0.85^4) of the deviation remains.

Real PPP Forecasting: Speed of Convergence

- A 15% speed of convergence implies approximately half of any PPP deviation still remains after four years: economists would refer to this as a four-year half-life. Such estimates provide a rule of thumb that is useful as a guide to forecasting real exchange rates.
- Suppose the home basket costs \$100 and the foreign \$90, in home currency. Home's real exchange rate is 0.9, and the home currency is overvalued, with foreign goods less expensive than home goods.
- The deviation of the real exchange rate from the real PPP equilibrium is -10% (or -0.1). A rule of thumb tells us that next year 15% of this deviation will have disappeared (0.015), so the new deviation will be only -0.085, meaning that Home's real exchange rate would be forecast to be 0.915 after one year and be little closer to 1. All else equal, after four years, 52% of the deviation (or 0.052) would have been persisting, and the real exchange rate would by then be 0.948, -5.2% from real PPP.

Relative PPP Forecasting: $RE_{H/F} = E * P_F / P_H$

In the business of exchange rate forecasting, three methodologies are generally used: economic fundamentals, politics, and technical methods.

- Approximately half of any PPP deviation still remains after four years: Economists refer to this as a four-year half-life. Such estimates provide a rule of thumb that is useful as a guide to forecasting real exchange rates.
- When relative PPP holds, forecasting exchange rate changes is simple: Just compute the inflation differential.
- But how do we forecast when PPP doesn't hold, as is often the case? Knowing the real exchange rate and the convergence speed may still allow us to construct a forecast of real and nominal exchange rates.
- The rate of change of the nominal exchange rate equals the rate of change of the real exchange rate plus home inflation minus foreign inflation: $\frac{\triangle E_{H/F}}{E_{H/F}} = \frac{\triangle RE_{H/F}}{RE_{H/F}} + \frac{\triangle P_H}{P_H} - \frac{\triangle P_F}{P_F} = \frac{\triangle RE_{H/F}}{RE_{H/F}} + (\pi_H - \pi_F)$

PPP and IRP: Summary

1. Absolute PPP: $E_{H/F} = P_H/P_F$ or $RE_{H/F} = E * P_F/P_H = 1$
2. Relative PPP: $\frac{\triangle E_{H/F}}{E_{H/F}} = \pi_H - \pi_F$ or $\frac{\triangle RE_{H/F}}{RE_{H/F}} = \frac{\triangle E_{H/F}}{E_{H/F}} - (\pi_H - \pi_F)$
3. Real PPP: $\frac{\triangle E_{H/F}}{E_{H/F}} = \frac{\triangle RE_{H/F}}{RE_{H/F}} + \frac{\triangle P_H}{P_H} - \frac{\triangle P_F}{P_F} = \frac{\triangle RE_{H/F}}{RE_{H/F}} + (\pi_H - \pi_F)$
4. IRP Approximation: $R_H \approx R_F + \frac{\triangle E_{H/F}}{E_{H/F}}$ or $R_H - R_F \approx \frac{\triangle E_{H/F}}{E_{H/F}}$
5. Fisher Equation: $R \approx r + \pi^e$ or $r \approx R - \pi^e$
6. Real IRP: $r_H - r_F \approx (R_H - \pi_H) - (R_F - \pi_F) =$
   $(R_H - R_F) - (\pi_H - \pi_F) \approx \frac{\triangle E_{H/F}}{E_{H/F}} - (\pi_H - \pi_F) = \frac{\triangle RE_{H/F}}{RE_{H/F}}$

Accounting for Deviations from PPP

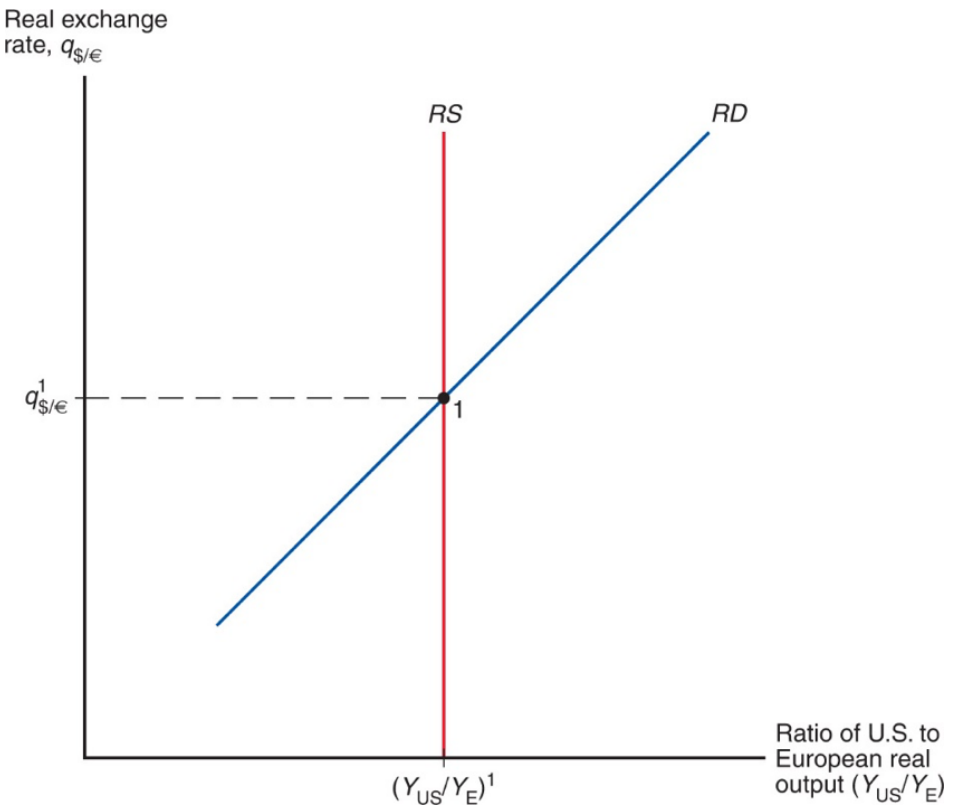
- If PPP were taken as a strict proposition for the short run,, then price adjustment via arbitrage would occur fully and instantaneously, rapidly closing the gap between common-currency prices in different countries for all goods in the basket.
- This doesn't happen. The evidence suggests that PPP work better only in the long run. But how long is the long run? Furthermore, what accounts for the short run deviations?
- Transaction and Institutional Costs: international transportation, trade barriers (e.g. tariffs, quota, duties...), legal obstacles.
- Heterogenous Products and Factors: different production costs.
- Nontraded Goods and Services: infinitely high transaction costs!
- Imperfect Competition and Market Power: monopoly pricing.

Real Exchange Rate Determination: $RE_{H/F} = E_{H/F} P_H / P_F$

1. A change in relative demand of domestic products:
   - An increase in relative demand of domestic products causes the value of domestic goods relative to the value of foreign goods to rise. Hence, a real appreciation of the value of domestic goods.
   - A decrease in relative demand of U.S. products causes a real depreciation of the value of U.S. goods.
2. A change in relative supply of domestic products:
   - An increase in relative supply of domestic products causes the price/cost of domestic goods relative to the price/cost of foreign goods to fall. Hence a real depreciation.
   - A real depreciation of the value of domestic goods makes domestic exports less expensive and imports into the domestic more expensive (thereby increasing relative quantity demanded to match increased relative quantity supplied).

Real Exchange Rate: Long-Run Determination

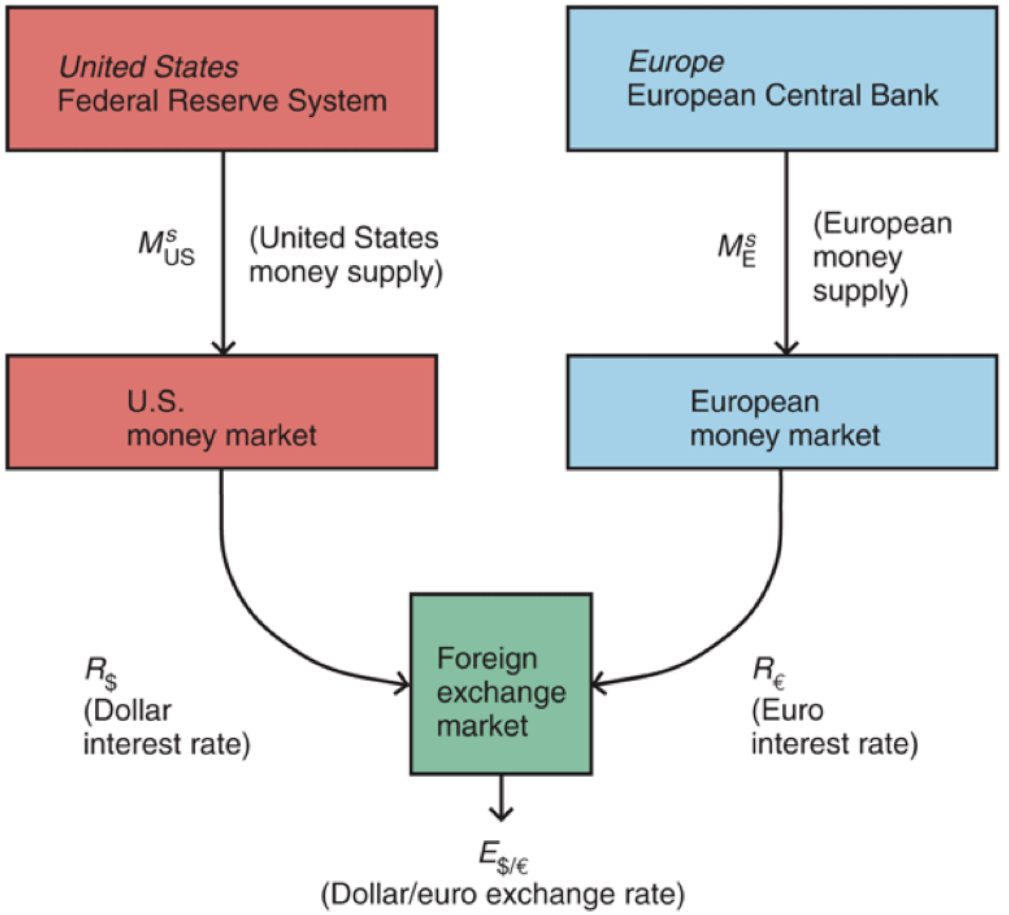
1. $RE_{H/F} = E_{H/F} P_H / P_F$
2. $RE_{H/F} \uparrow \Rightarrow RQD_{H/F} \uparrow$
3. $RD_{H/F} \uparrow \Rightarrow RE_{H/F} \uparrow$
4. $RD_{H/F} \downarrow \Rightarrow RE_{H/F} \downarrow$
5. $RS_{H/F} = Y_H / Y_F$
6. $Y = F(K, L)$
7. $RS_{H/F} \uparrow \Rightarrow RE_{H/F} \uparrow$
8. $RS_{H/F} \downarrow \Rightarrow RE_{H/F} \downarrow$



Source: KOM (2018)

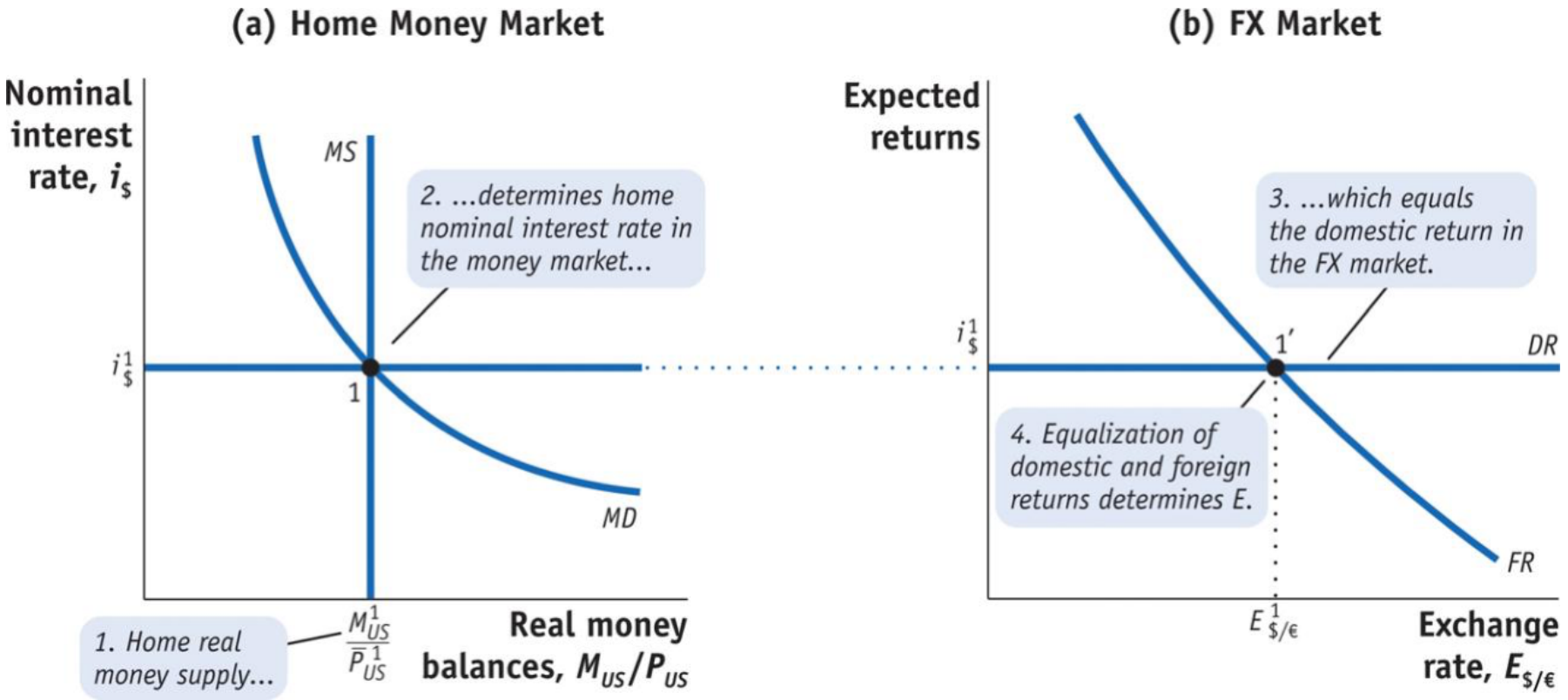
Money Market and FX Market: A Link

1. Monetary policy actions by the Fed affect the U.S. interest rate, changing the dollar/euro exchange rate that clears the foreign exchange market.
2. The ECB can affect the exchange rate by changing the European money supply and interest rate.
3. Money market interest rate affects currency price in the foreign exchange market.



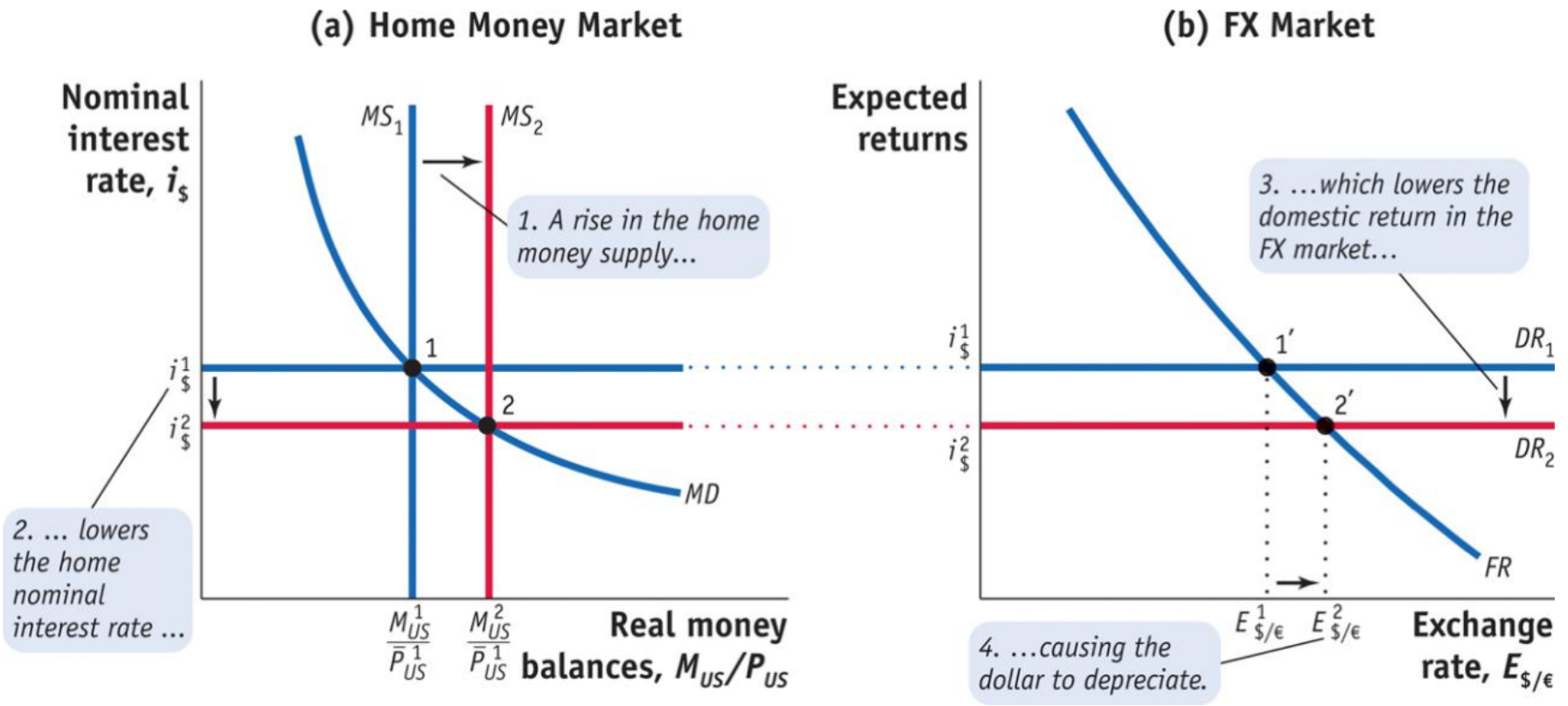
Source: KOM (2018)

Simultaneous Equilibrium in the Money and FX Markets



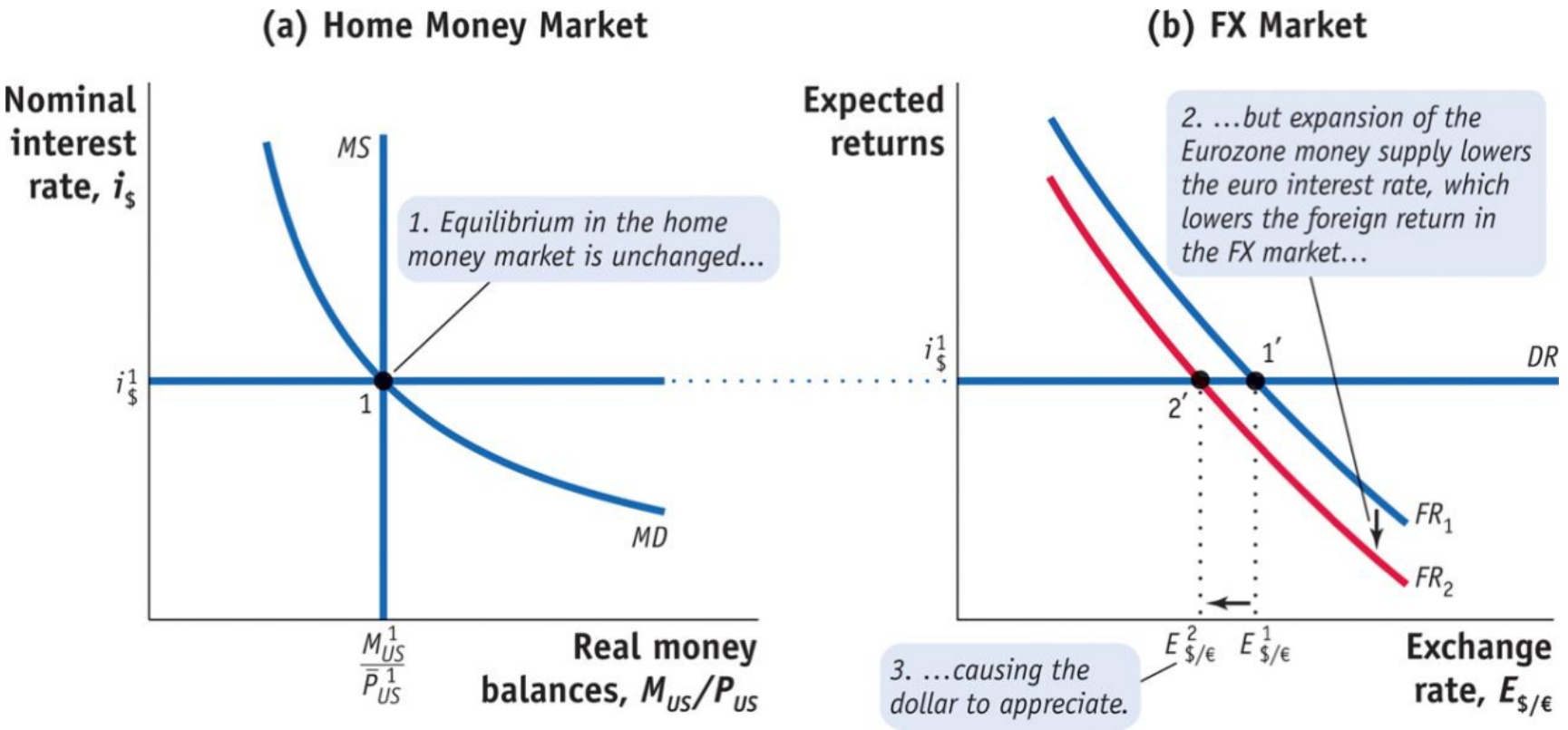
Source: FT (2017). Arbitrage forces the domestic and foreign returns in the FX market to be equal, a result that depends on capital mobility. $M_d = M_s \& DR = FR$.

Effect of Domestic Monetary Policy on Exchange Rate



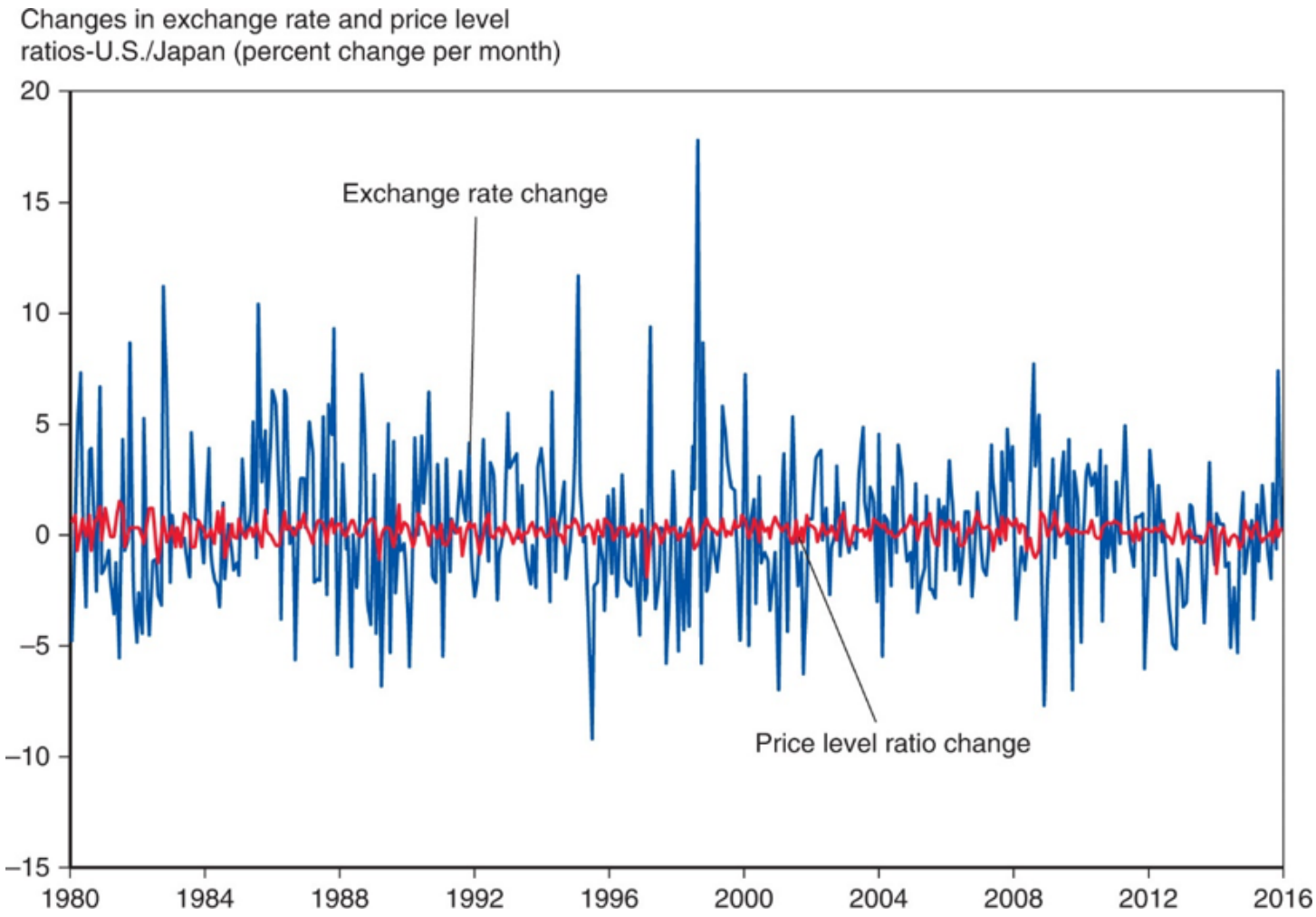
Source: FT (2017). Temporary expansion of the U.S. money supply leads to dollar depreciation. $M/P = L(i, Y) \Rightarrow i^* \Rightarrow E^*$. (IRP: $i_H = DR = FR = i_F + (F - E)/E$)

Effect of Foreign Monetary Policy on Exchange Rate



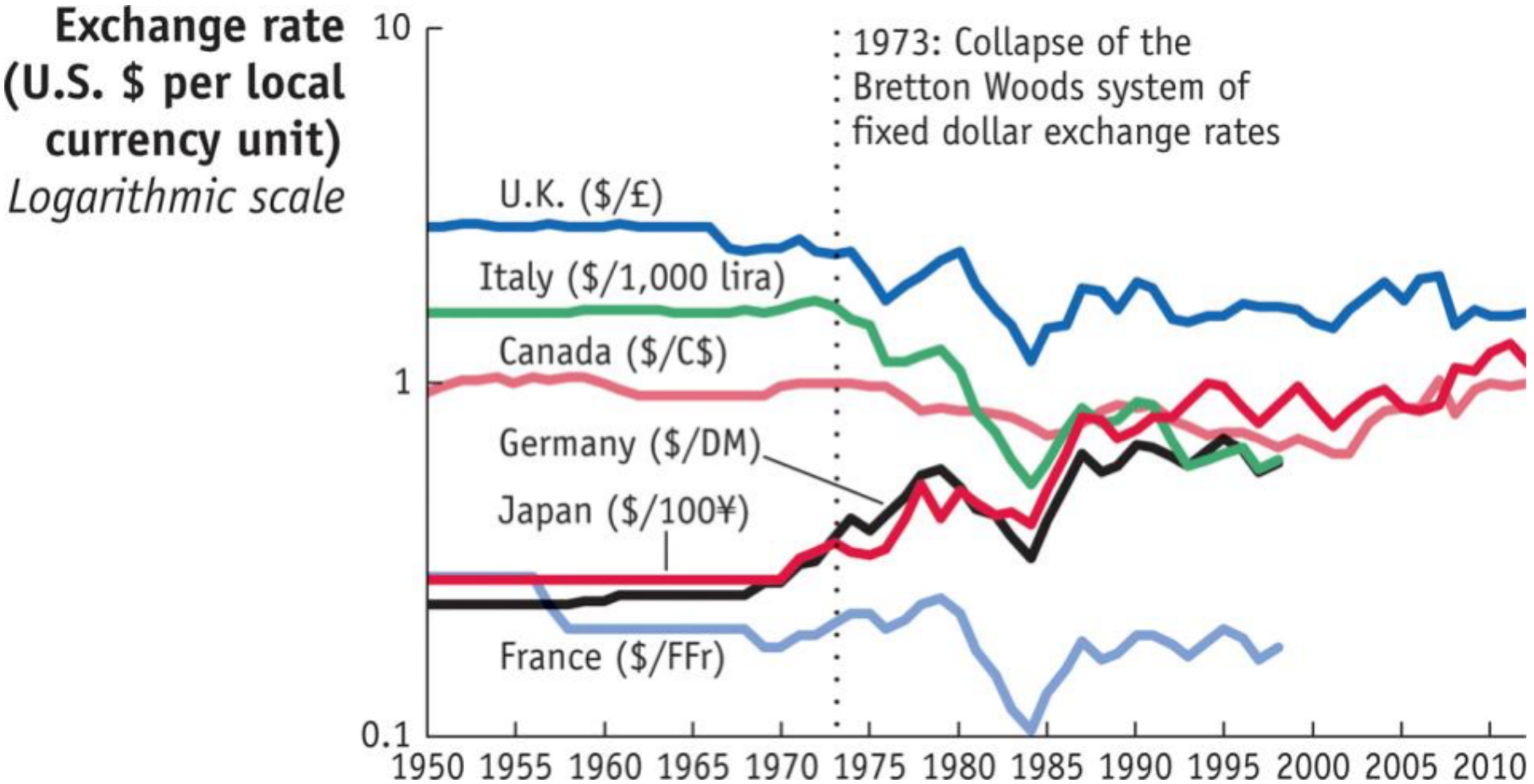
Source: FT (2017). Temporary expansion of the European money supply causes dollar appreciation. $MS_F \uparrow \Rightarrow i_F \downarrow \Rightarrow FR \downarrow \Rightarrow E \downarrow$.

Price Volatility vs Exchange Rate Volatility



KOM (2018)

Dollar Shock and Exchange Rate Overshooting

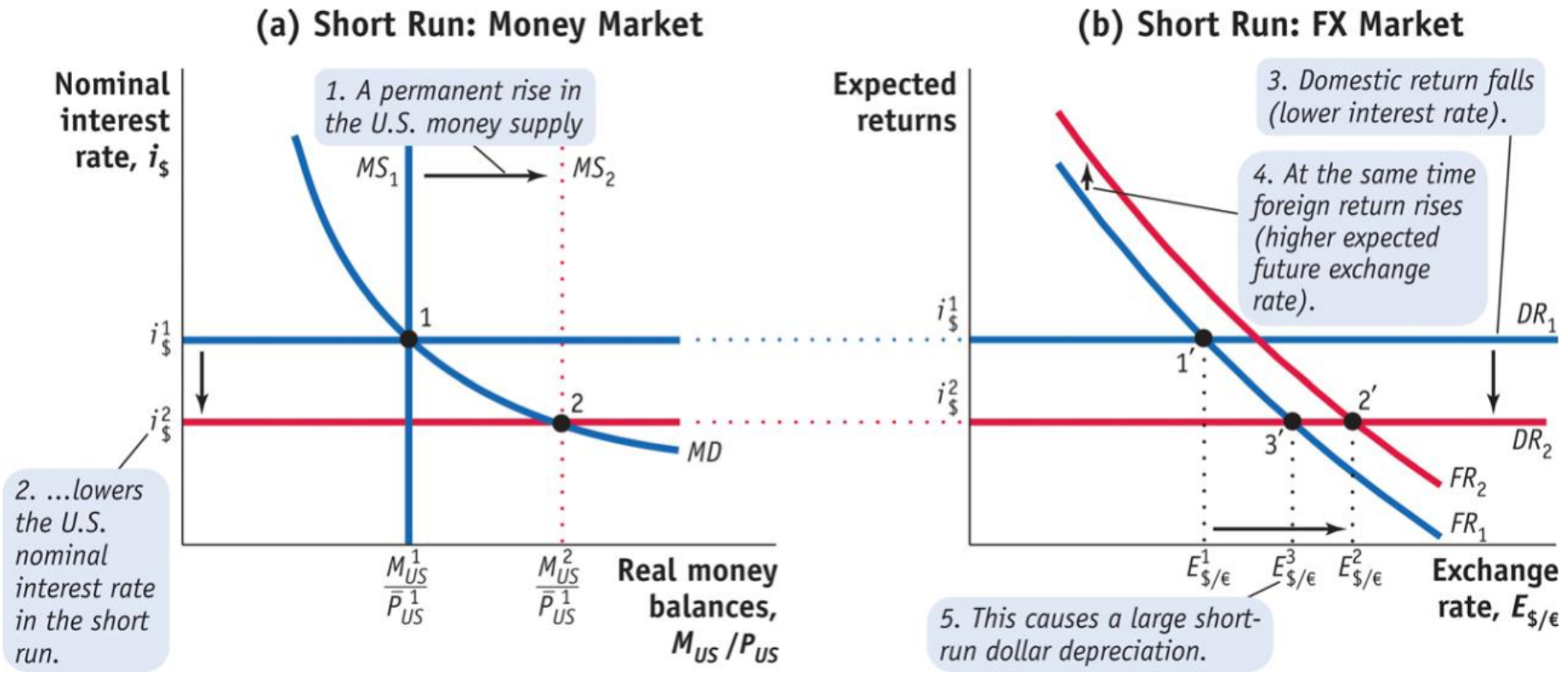


Source: FT (2017). Exchange Rates for Major Currencies Before and After 1973.

Price Adjustment, Policy Credibility, Market Expectations

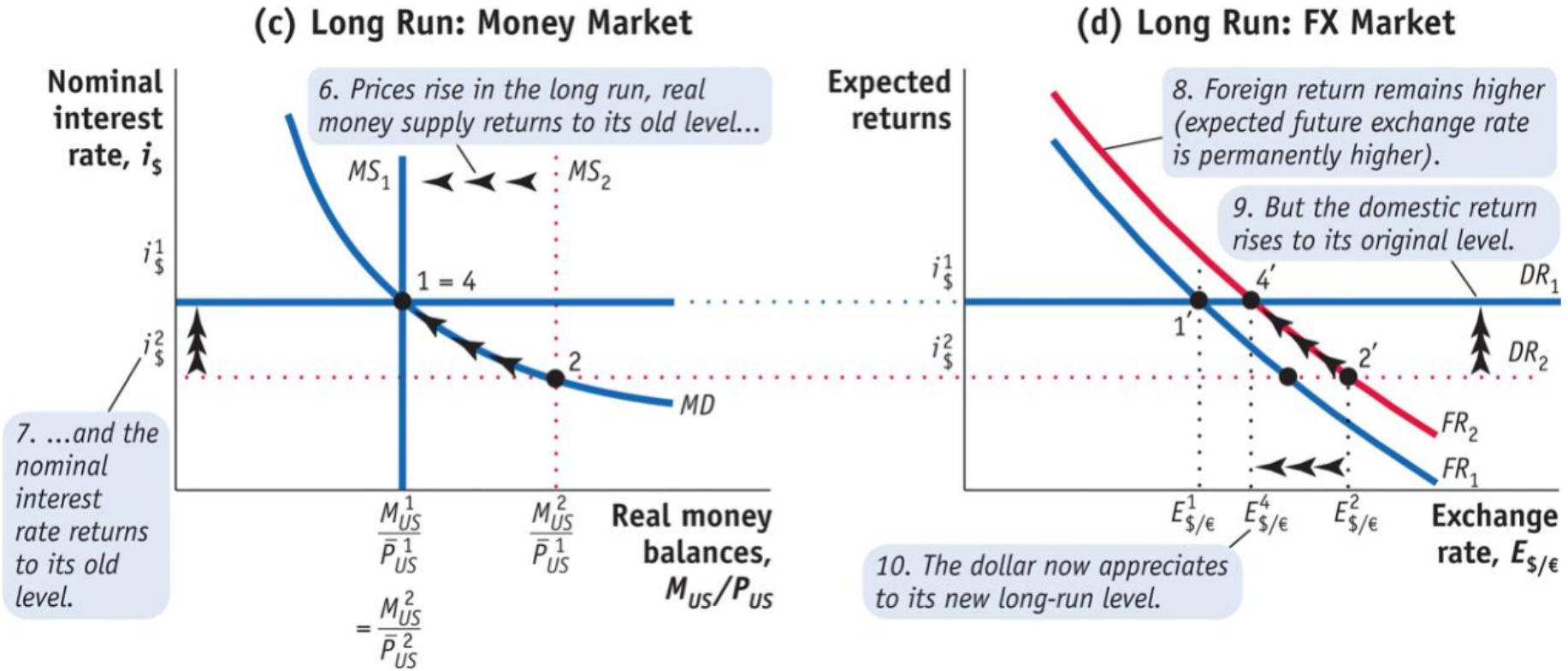
- In the short run, prices do not have sufficient time to adjust to market conditions. Assumption: Price "Rigidity" or "Stickiness" or $P = \overline{P}$.
- In the long run, prices of factors of production and of output have sufficient time to adjust to market conditions. "Flexibility" or $P \to \widetilde{P}$.
- In the long run, the quantity of money supplied is predicted not to influence the amount of output, real interest rates, and the aggregate demand of real monetary assets. Money neutrality: $Y_L = \widetilde{Y} = F(K, L)$.
- However, the quantity of money supplied is predicted to make the level of average prices adjust proportionally in the long run. $M/P \to \widetilde{Y}$.
- Temporary monetary policy does not change market expectations, whereas a permanent increase in money supply can: rising inflation expectation and expectation on currency depreciation: $M_s \uparrow \Rightarrow \pi^e \& E^e \uparrow$.

Market Expectation and Short-Run Overshooting



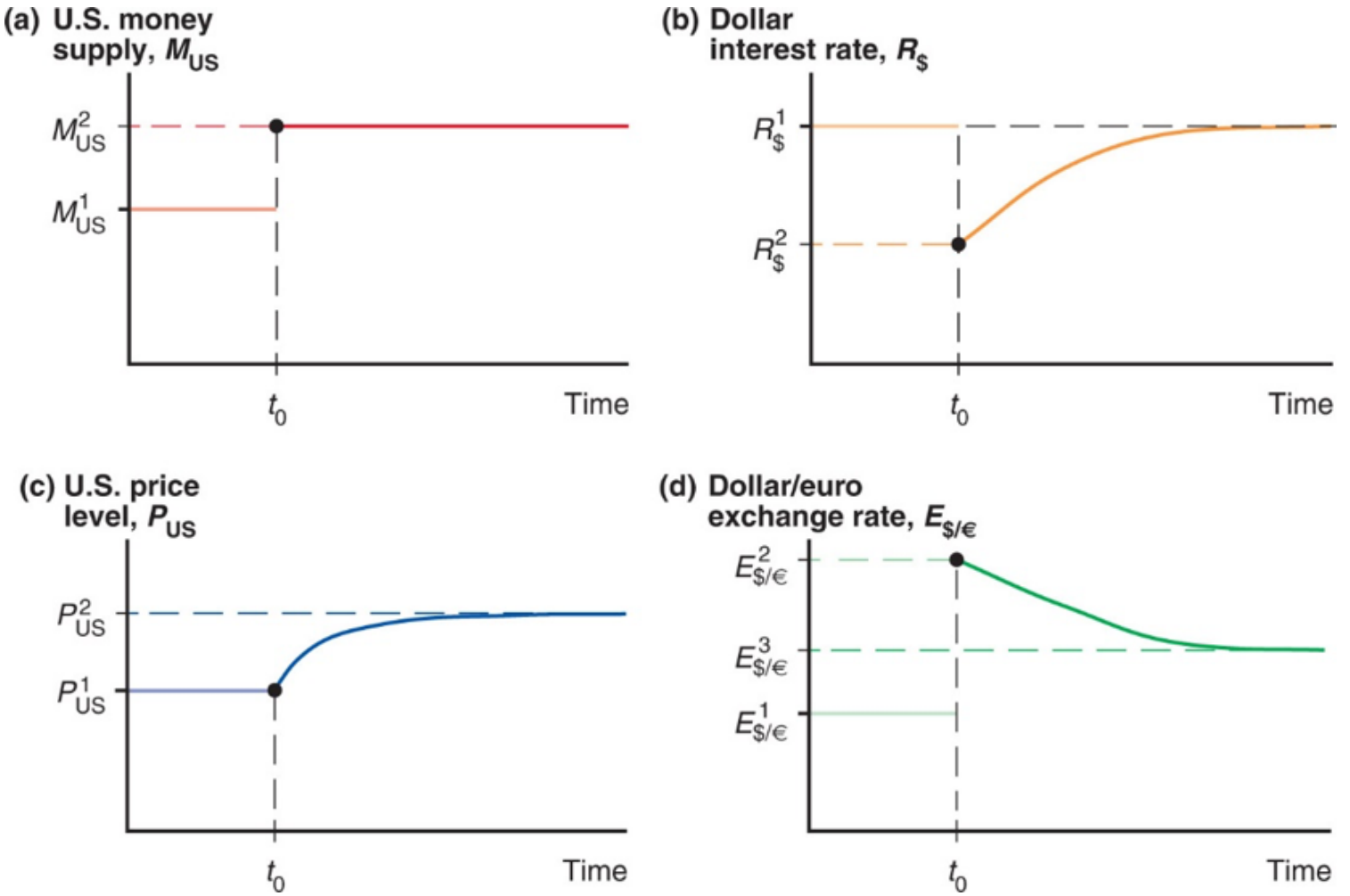
Source: FT (2017). A permanent change in the home money supply triggers a permanent, long-run depreciation of the dollar ($E^e \uparrow$). Overshooting: $E^2 - E^3$.

Long-Run Price and Exchange Rate Adjustments



Source: FT (2017). In the long run, prices are flexible, so the home price level and the exchange rate both rise in proportion with the money supply. $P \uparrow \Rightarrow i \uparrow \Rightarrow E \downarrow$.

Exchange Rate Overshooting: Time Path



KOM (2018)

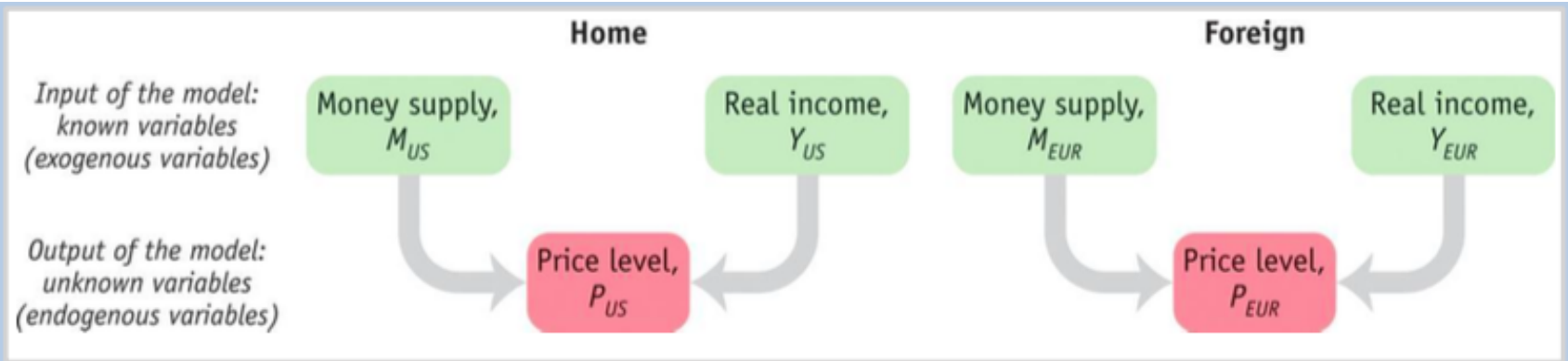
PPP: Money, Price, and Exchange Rate

- Up to now, we have concentrated on PPP, which says that in the long run the exchange rate is determined by the ratio of the price levels in two countries.
- But this prompts another question: what determines those price levels? Monetary theory supplies the answer.
- A simple monetary model (the quantity theory $MV = PY$) explains price levels in terms of equilibrium money levels and real income levels. The equilibrium condition in the money market (assuming V, L constant):

$$\boxed{M_s = M_d = PY/V = LPY}$$

- Recall that V is transaction velocity and L is liquidity coefficient.
- And, equivalently, real money supply equals real money demand: $\frac{M}{P} = LY$. The price level is thus determined: $P = \frac{M}{LY}$.

PPP: A Simple Monetary Model of Exchange Rate



Building Block: The Monetary Theory of the Price Level According to the Long-Run Monetary Model In these models, the money supply and real income are treated as known exogenous variables (in the green boxes). The models use these variables to predict the unknown endogenous variables (in the red boxes), which are the price levels in each country.

$$E^* = \frac{P_{US}}{P_{EU}} = \frac{M_{US}/L_{US}Y_{US}}{M_{EU}/L_{EU}Y_{EU}} = \frac{M_{US}/M_{EU}}{(L_{US}Y_{US}/L_{EU}Y_{EU})}$$

PPP: The Monetary Approach to Exchange Rates

- The quantity theory of money, combined with PPP, leads to the fundamental equation of the monetary approach to exchange rates.

$$E^* = \frac{P_{US}}{P_{EU}} = \frac{M_{US}/L_{US}Y_{US}}{M_{EU}/L_{EU}Y_{EU}} = \frac{M_{US}/M_{EU}}{(L_{US}Y_{US}/L_{EU}Y_{EU})}$$

- The important implications of this equation are as follows:
- All else equal, $M_{US} \uparrow \Rightarrow \text{E}_{(\$/€)}\uparrow$, the dollar depreciates;
- All else equal, $Y_{US} \uparrow \Rightarrow \text{E}_{(\$/€)}\downarrow$, the dollar appreciates;
- All else equal, $M_{EU} \uparrow \Rightarrow \text{E}_{(\$/€)}\downarrow$, the dollar appreciates;
- All else equal, $Y_{EU} \uparrow \Rightarrow \text{E}_{(\$/€)}\uparrow$, the dollar depreciates.
- Money liquidity demand L (real money balance) is assumed constants.

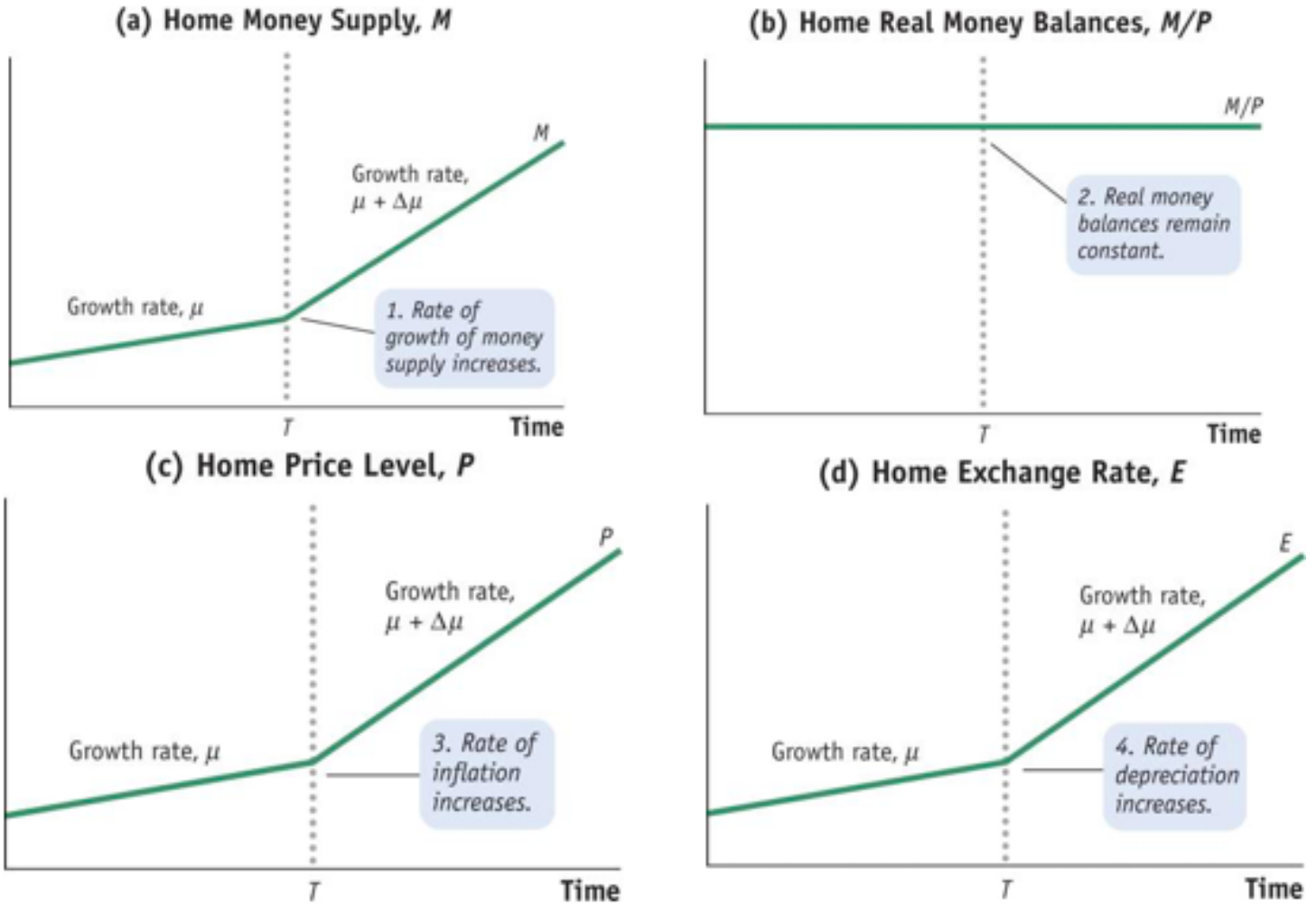
The Monetary Approach to Exchange Rate Dynamics

- The model just presented uses absolute PPP to link the level of the exchange rate to the level of prices and uses the quantity theory to link prices to monetary conditions in each country.
- As in relative PPP, we can extend our theory to examine the rate of change of each variable of interest. They are the rate of change in price level P, money supply M, real income Y and exchange rate E.
- Define $\pi =\triangle P/P$, $\mu =\triangle M/M$, $g =\triangle Y/Y$, and $e =\triangle E/E$.

$$\boxed{e^* = \pi_{US} - \pi_{EU} = (\mu_{US} - \mu_{EU}) - (g_{US} - g_{EU})}$$

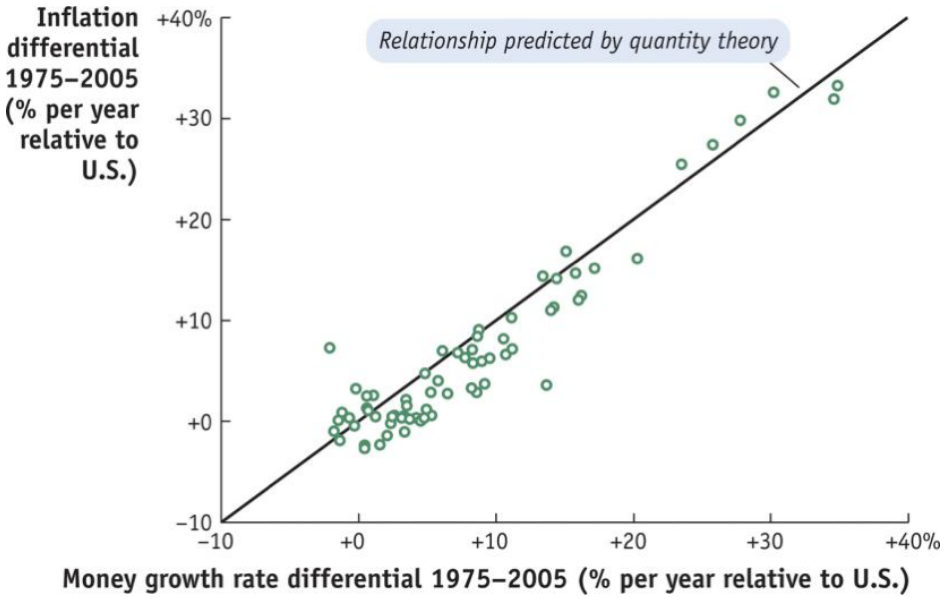
- Rate of depreciation of the nominal exchange rate equals differential in nominal money supply growth rate minus differential in real output growth rate. You shall derive this dynamic implications!

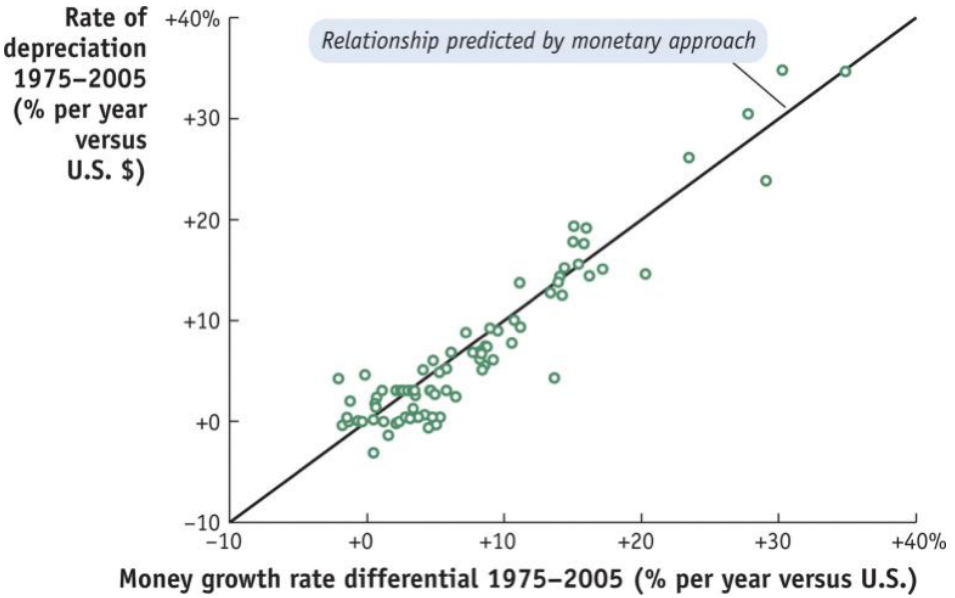
The Monetary Approach to Exchange Rates ($L = \bar{L}$)



FT (2017)

The Monetary Approach: Evidence



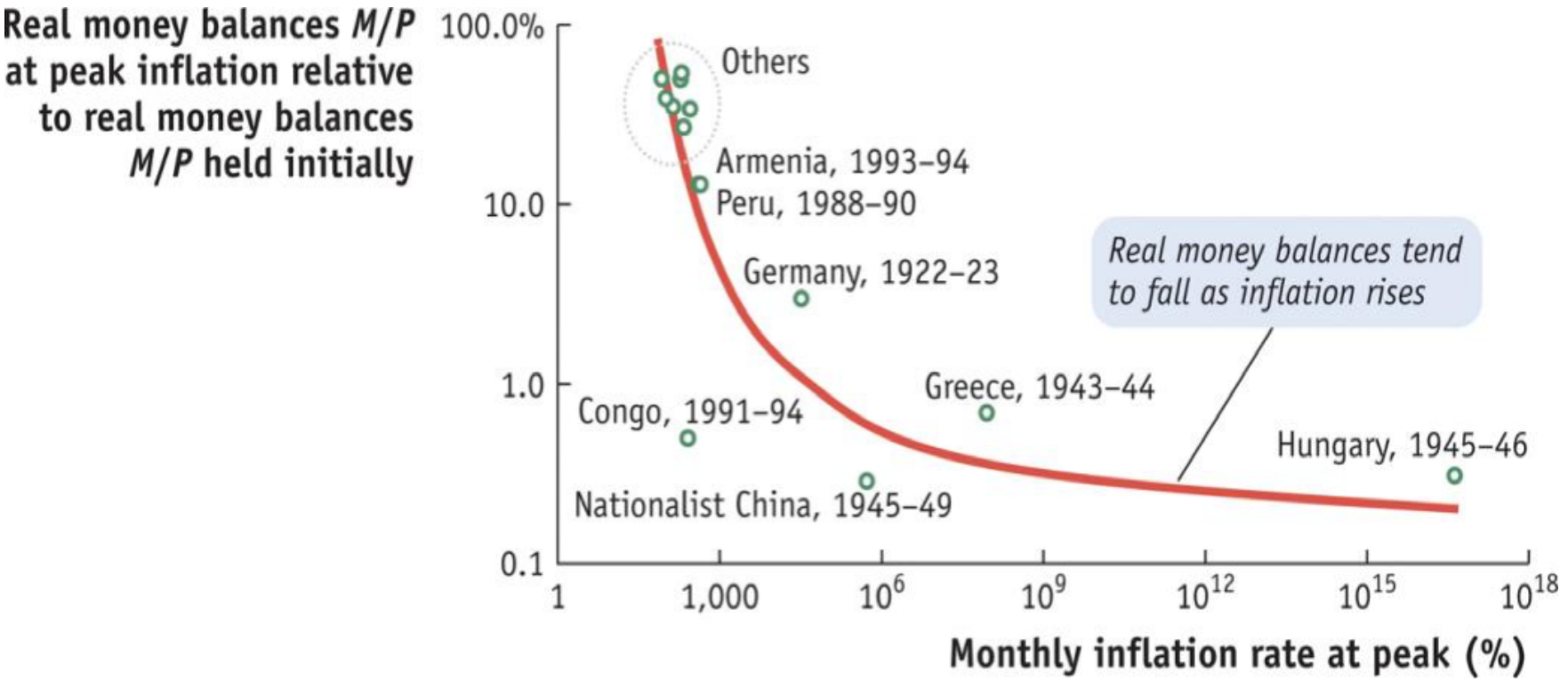


Source: FT (2017). The data show a strong correlation between the two variables and a close resemblance to the theoretical prediction of the monetary approach to exchange rates, which suggests that increases in the rate of money supply growth should be the same size as increases in the rate of exchange rate depreciation.

The Monetary Approach to Exchange Rates: Fisher Effect

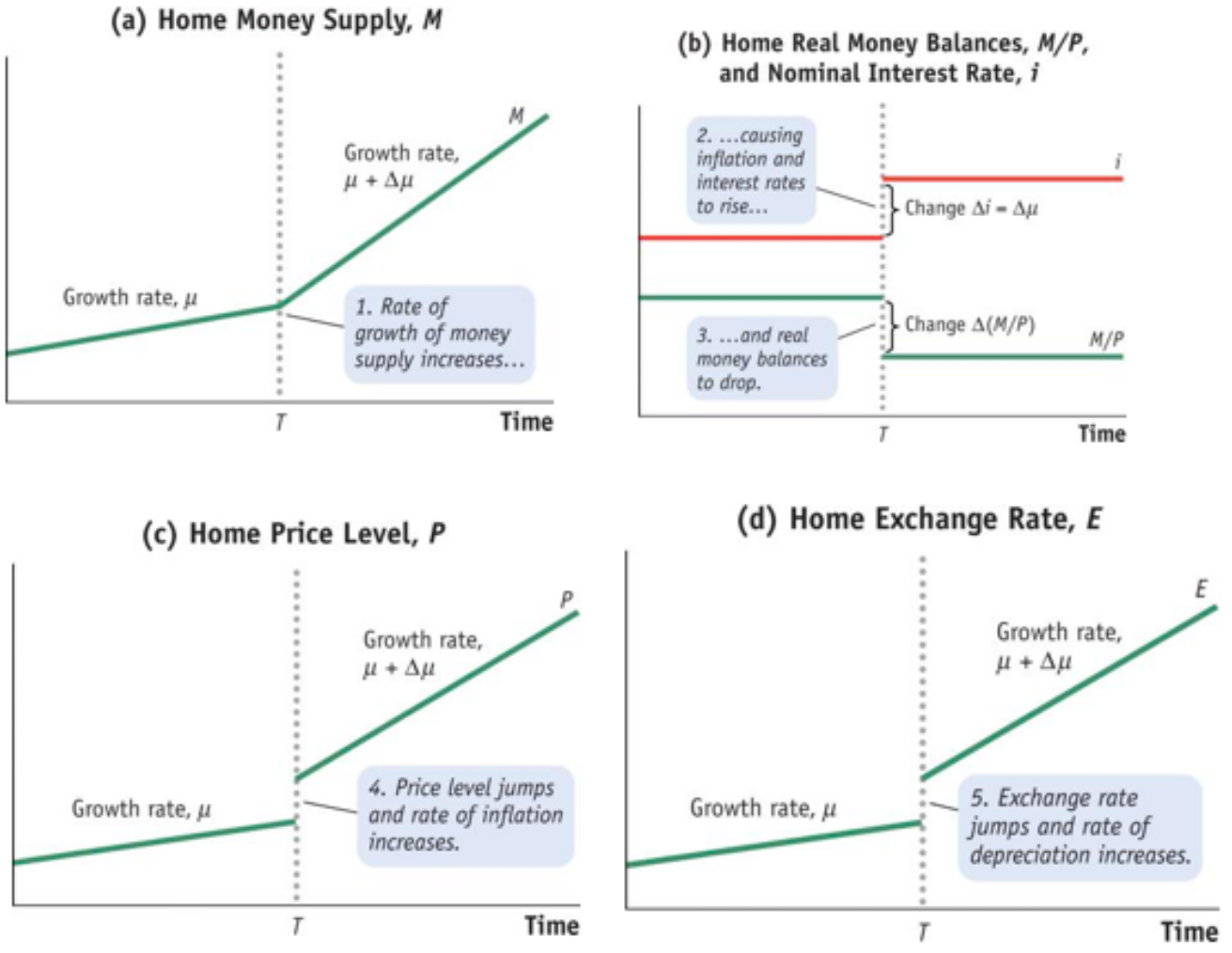
- In the long-run equilibrium, a rise in the difference between home and foreign interest rates occurs only when expected home inflation rises relative to expected foreign inflation. This is certainly not the case in the short run, when the domestic price level is sticky ($P = \overline{P}$).
- In the short run, the interest rate can rise when the domestic money supply falls, because the sticky price level leads to an excess demand for real money balances at the initial interest rate ($M_d/P = L(i, Y)$).
- Since there is no immediate increase in the money supply, but there is an interest rate rise that reduces money demand, there would be an excess supply of real U.S. money balances at the price level prevailing.
- In the face of this potential excess supply, the U.S. price level does jump upward, reducing the real money supply so that it again equals real money demand. Consistently with the upward jump in P, there will be a simultaneous proportional upward jump in E implied by PPP.

The Monetary Approach: Real Money Balance



Source: FT (2017). This figure shows that real money balances tend to collapse in hyperinflations as people reduce their holdings of rapidly depreciating currencies.

The Monetary Approach to Exchange Rates ($L = \widetilde{L}$)



FT (2017)

Money, Interest and Exchange Rates in the Short Run

"The long run is a misleading guide to current affairs. In the long run we are all dead. Economists set themselves too easy, too useless a task if in tempestuous seasons they can only tell us that when the storm is past the ocean is flat again."

–John Maynard Keynes, A Tract on Monetary Reform, 1923

- As we saw in the monetary approach to exchange rates, substantial deviations from PPP occur in the short run.
- The short-run failures of the monetary approach prompted economists to develop an alternative theory to explain exchange rates in the short run: the asset approach to exchange rate.
- Key assumptions in the asset approach: 1) currencies are assets; 2) prices are "sticky" in the short run (nominal rigidity).

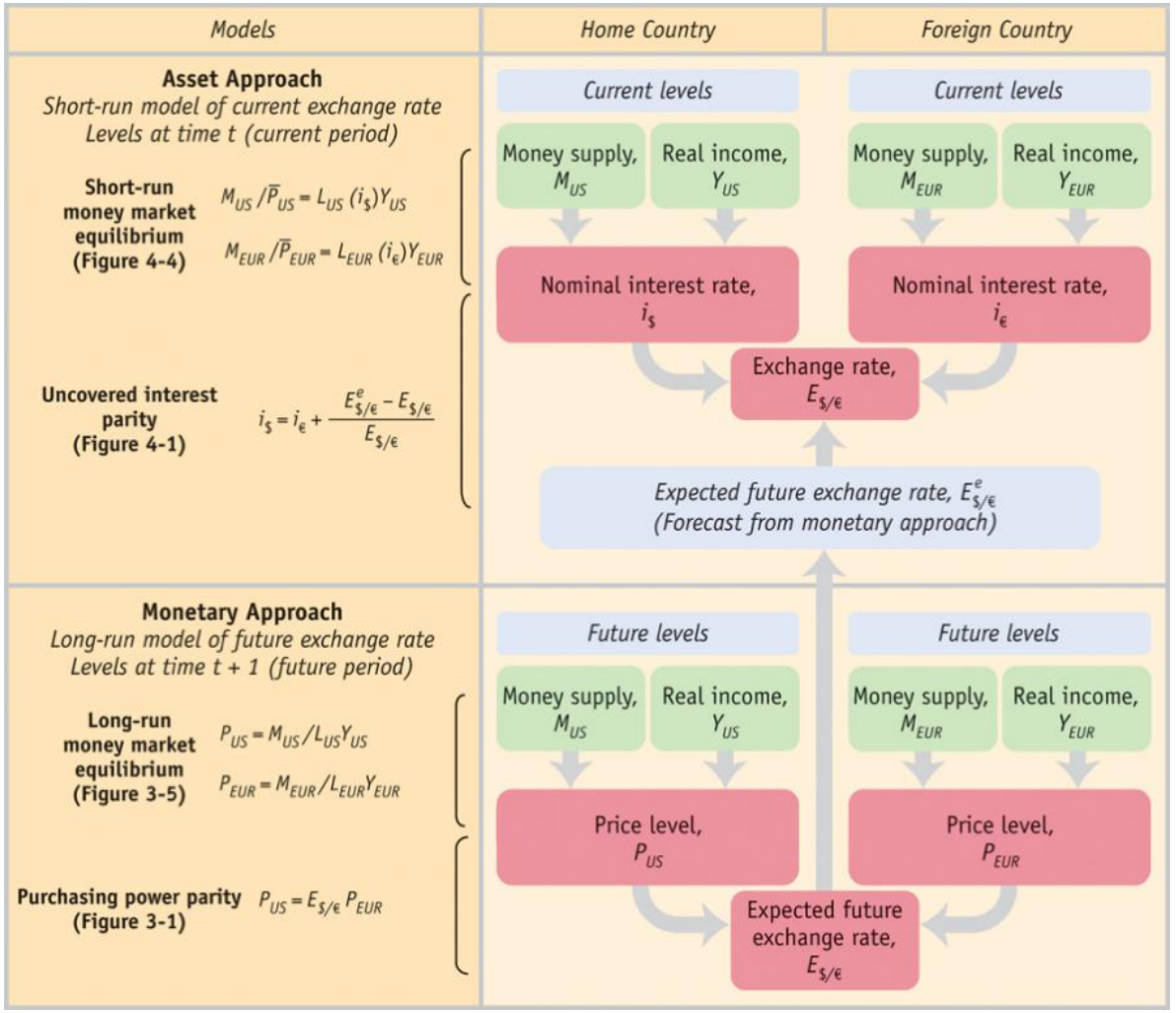
Asset Approach v.s. Monetary Approach

The monetary approach differs from the asset approach in how they treat price and interest rate in the long v.s. short horizon.

- In the long run, the price level P if fully flexible and adjusts to bring the money market to equilibrium; and the nominal interest rate i equals the world real interest rate plus domestic inflation.
- In the short run, the price level is sticky; it is a known predetermined variable, fixed at $P = \overline{P}$; and the nominal interest rate i is fully flexible and adjusts to bring the money market to equilibrium.

The asset approach (short run money market equilibrium and IRP) complements the monetary approach (long run monetary model and PPP) in producing a complete theory of exchange rate determination.

Overview Summary: Exchange Rate Determination



FT (2017)

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[3] Hansen, L.P. and R.J. Hodrick (1980), "Forward exchange rates as optimal predictors of future spot rates: an econometric analysis," Journal of Political Economy 88(5), 829-853.

[4] Fama, E.F. (1984), "Forward and spot exchange rates," Journal of Monetary Economics 14, 319-338.

[5] https://www.visualcapitalist.com/6-factors-that-influence-exchange-rates/