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5.1 The Exchange Rate in the Long Run

Global Business Environment

Luisa Lambertini

The CHF/USD ($E_{CHF/USD}$) Exchange Rate

The Price Level in the Long Run

- In the long run prices are flexible
- Price level in the long run:

$$P = \frac{M^s}{L(R, Y^f)}$$

- Long-run neutrality of money: In the long run, an increase in a country's money supply causes a proportional increase in its price level: $M^s \uparrow \dashrightarrow P \uparrow$

The Law of One Price (LOP)

- With competitive markets and no transportation costs, identical traded goods sold in different countries must sell for the same price when their prices are expressed in terms of the same currency

$$P^i_{CHF} = E_{CHF/EUR} \times P^i_{EUR}$$

- P^i_{CHF} is the CHF price of good i when sold in Switzerland
- P^i_{EUR} is the corresponding EUR price in the Eurozone
- Example: The price of a Rolex watch

Purchasing Power Parity (PPP)

- If all goods can be freely traded and there are no transportation costs or tariffs:

$$P_{EUR} \times E_{CHF/EUR} = P_{CHF}$$

- P_{CHF} is the CHF price of a reference commodity basket sold in Switzerland
- P_{EUR} is the euro price of the same basket in Europe
- all countries' price levels are equal when measured in terms of the same currency

Relative PPP

- Take percent deviations of PPP:

$$\frac{E_{CHF/EUR,t} - E_{CHF/EUR,t-1}}{E_{CHF/EUR,t-1}} \approx \pi_{CHF,t} - \pi_{EUR,t}$$

- $\pi_{X,t}$ = inflation rate in country X in period t
- Exchange rate depreciation between two currencies over any period should equal the inflation differential

The Exchange Rate in the Long-Run

- In the long run

$$E_{CHF/EUR} = \frac{P_{CHF}}{P_{EUR}} = \frac{M^{s}_{CHF}}{L(R_{CHF}, Y^{f}_{CHF})} \times \frac{L(R_{EUR}, Y^{f}_{EUR})}{M^{s}_{EUR}}$$

- $M^{s}_{CHF} \uparrow \rightarrow P_{CHF} \uparrow \rightarrow \ E_{CHF/EUR} \uparrow$
- Countries with faster money growth have higher inflation and higher rate of depreciation

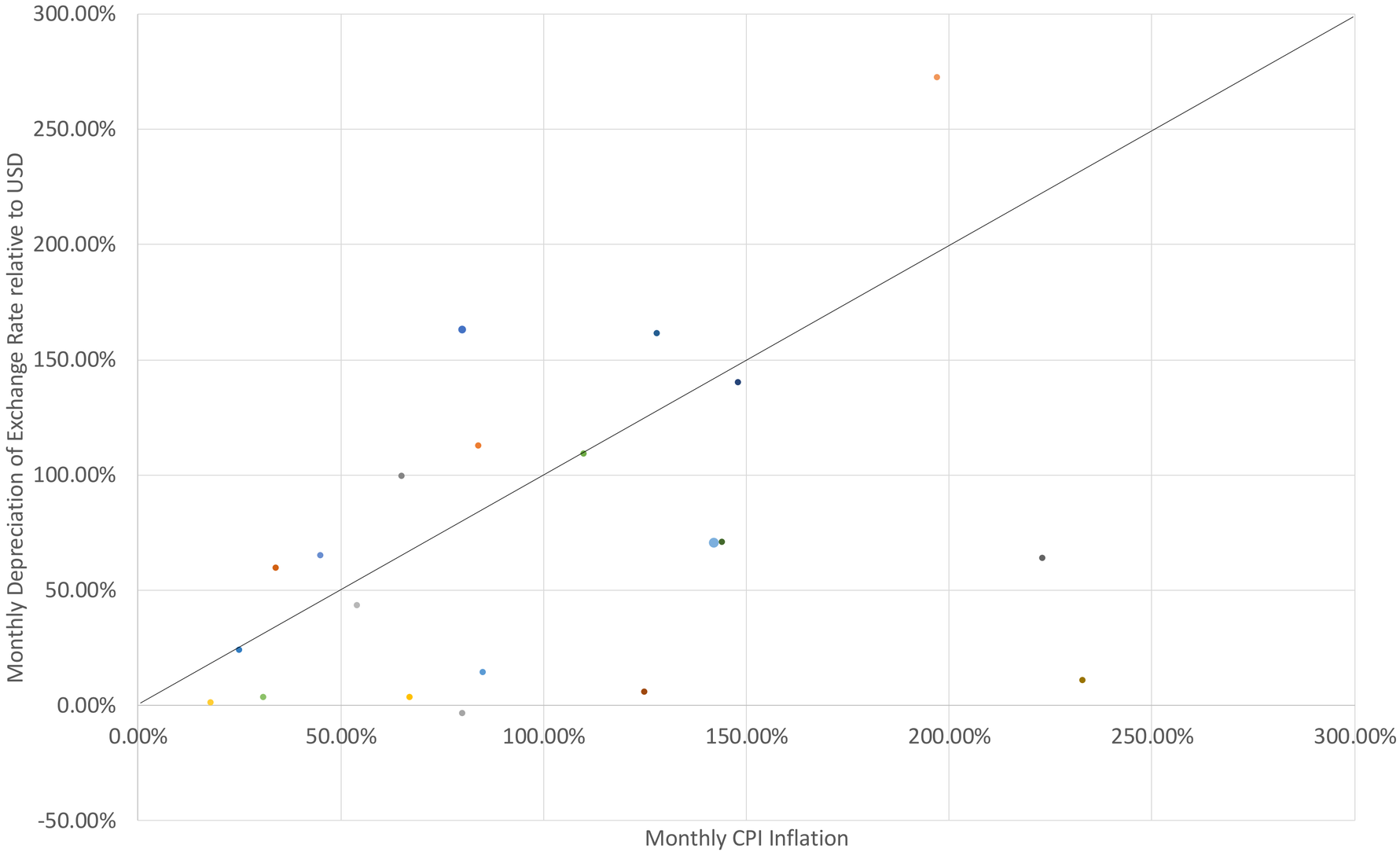
A Bit of Data – 1984:12 to 2019:12

Country	Average M1 growth	Average inflation	Average EX/USD depr
Switzerland	6.4	1.3	-2.1
United States	5.9	2.6	
Argentina	23.2	233	355
South Africa	14.1	8.1	6.8

Empirical Evidence

- Hyperinflation: inflation rate of 50% a month or higher
- Bolivia experienced hyperinflation 2017-18
- Russia experienced two episodes of very high inflation: 1992 to 1995 and in 1998
- During periods of high inflation, the long-run effects of money on the price level occur very quickly

Bolivia – December 2017 to August 2019



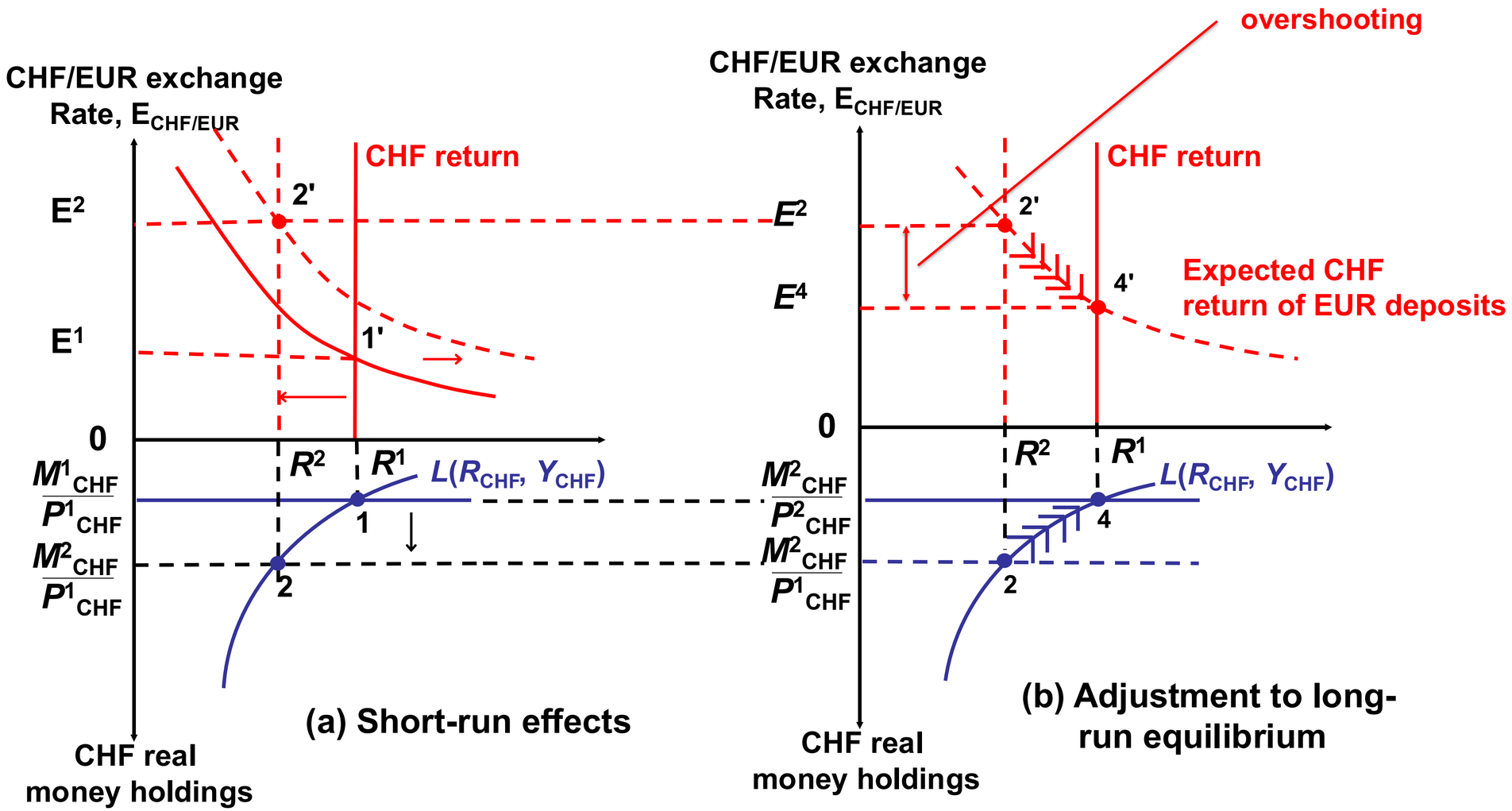
Exchange Rate Overshooting

- Short run: P_{CHF} and Y_{CHF} are given
- Suppose M_{CHF} rises permanently
- R_{CHF} falls while R_{EUR} remains unchanged

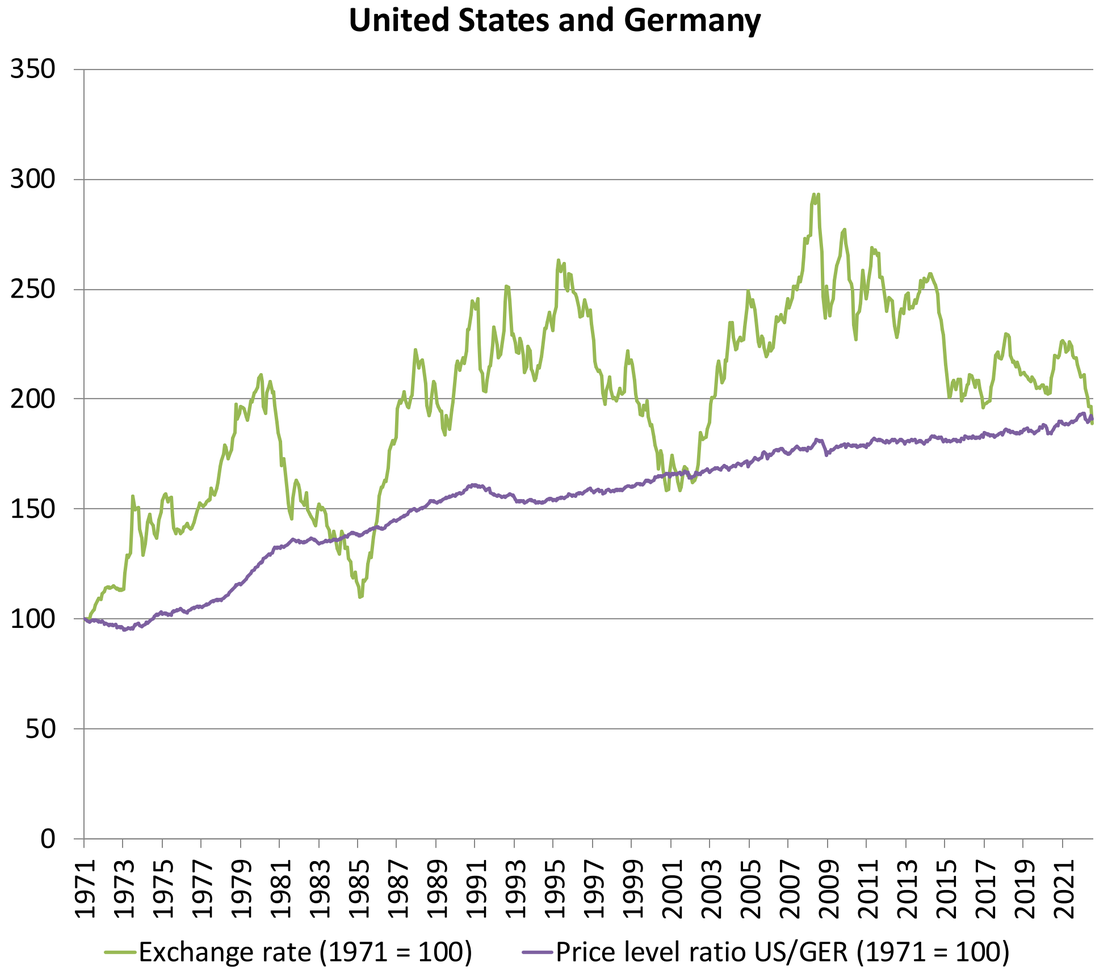
$$R_{CHF} = R_{EUR} + \frac{E^{e}_{CHF/EUR} - E_{CHF/EUR}}{E_{CHF/EUR}}$$

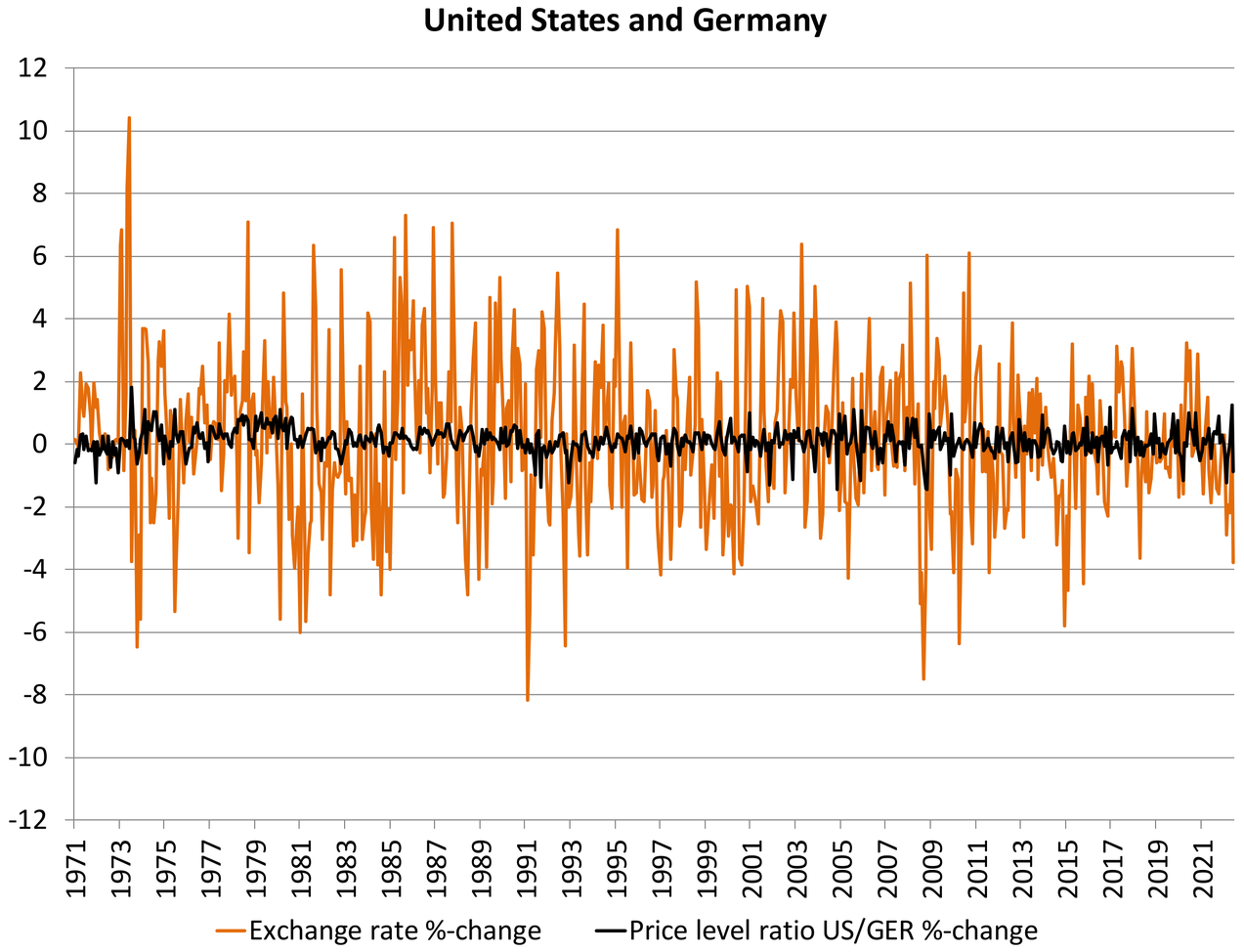
- $E^{e}_{CHF/EUR}$ depreciates proportionally to M_{CHF} (by PPP)
- $E_{CHF/EUR}$ depreciates more than $E^{e}_{CHF/EUR}$ → Exchange Rate Overshooting
- Short-run response is greater than the long-run response

Permanent Increase in M^s: Short- and Long-Run



Exchange Rate and Price Level Volatility





A Long-Run Model Based on PPP

- IPC

$$R_{CHF} = R_{EUR} + \frac{E^{e}_{CHF/EUR} - E_{CHF/EUR}}{E_{CHF/EUR}}$$

- Relative PPP

$$\frac{E_{CHF/EUR,t} - E_{CHF/EUR,t-1}}{E_{CHF/EUR,t-1}} \approx \pi_{CHF,t} - \pi_{EUR,t}$$

- Real interest rate *r* and the Fisher equation

$$(1 + r_{t+1}) = \frac{1 + R_t}{1 + \pi^{e}_{t+1}} \rightarrow r_{t+1} \approx R_t - \pi^{e}_{t+1}$$

- Assuming the real interest rate does not change:

$$R_{CHF} - R_{EUR} = \frac{E^{e}_{CHF/EUR} - E_{CHF/EUR}}{E_{CHF/EUR}} \approx \pi^{e}_{CHF,t} - \pi^{e}_{EUR,t}$$

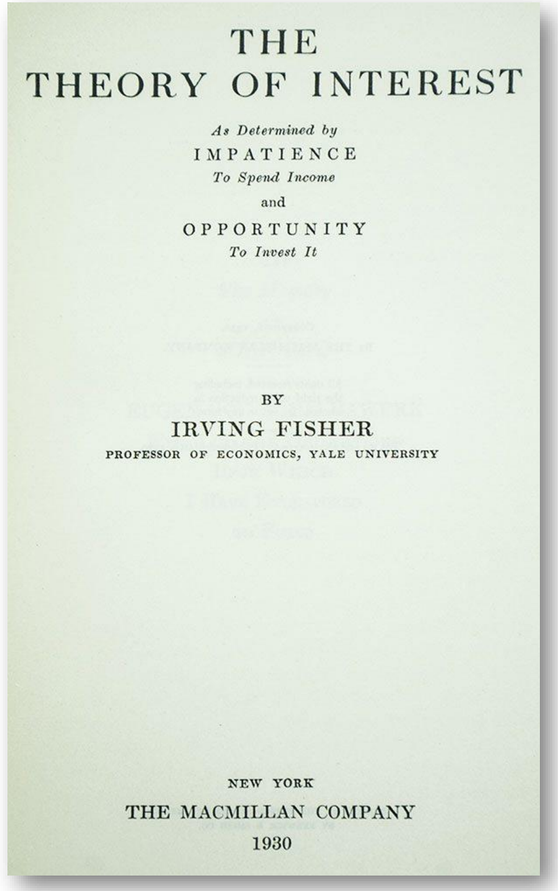
The Fisher Effect

- UIP + relative PPP

$$R - R^* = \pi^e - \pi^{*e}$$

- Note that

$$R - \pi^e = R^* - \pi^{*e} \Rightarrow \boldsymbol{r = r^*}$$


THE
THEORY OF INTEREST
As Determined by
IMPATIENCE
To Spend Income
and
OPPORTUNITY
To Invest It
BY
IRVING FISHER
PROFESSOR OF ECONOMICS, YALE UNIVERSITY
NEW YORK
THE MACMILLAN COMPANY
1930

The Exchange Rate in the Long Run - Summary

- Long-run neutrality of money
- LOP, PPP and relative PPP
- Permanent changes in money supply: short- and long-run effects

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5.2 Empirical Evidence on PPP and LOP

Global Business Environment

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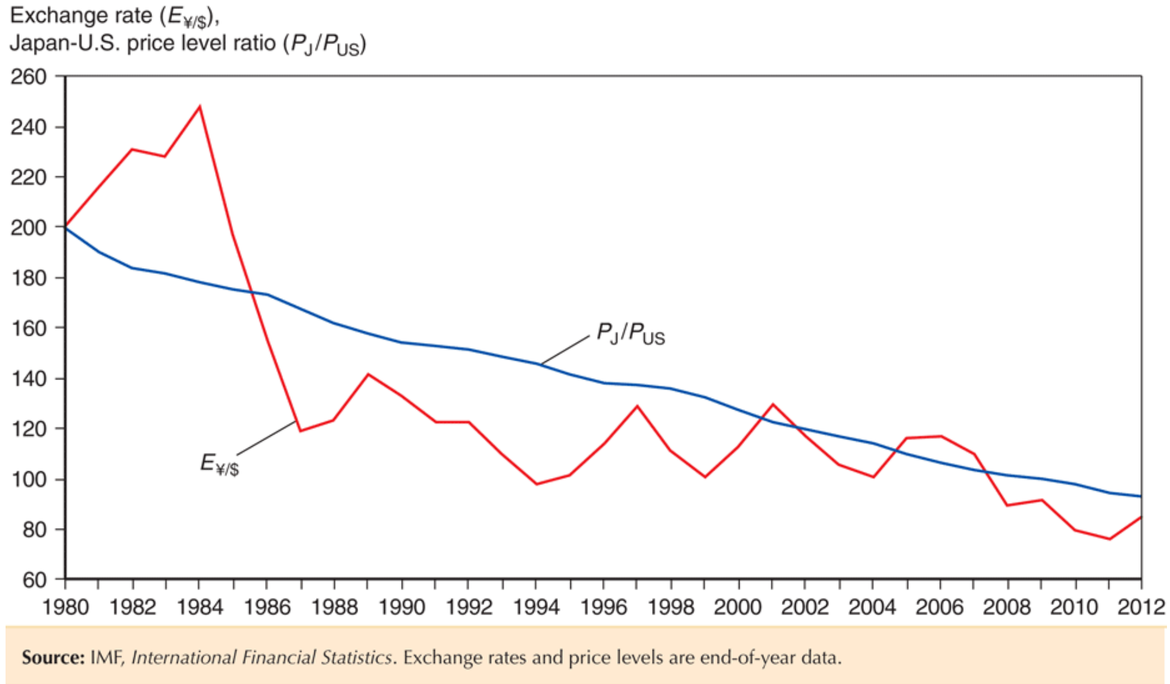
The Yen/Dollar Exchange Rate and Relative Japan-U.S. Price Levels, 1980–2012

FX and relative price levels do not always move together

- Relative price levels change slowly and have a small range of movement
- FX moves abruptly and experience large fluctuations



Source: IMF, *International Financial Statistics*. Exchange rates and price levels are end-of-year data.

But PPP is a long-run theory!

PPP in the Short Run

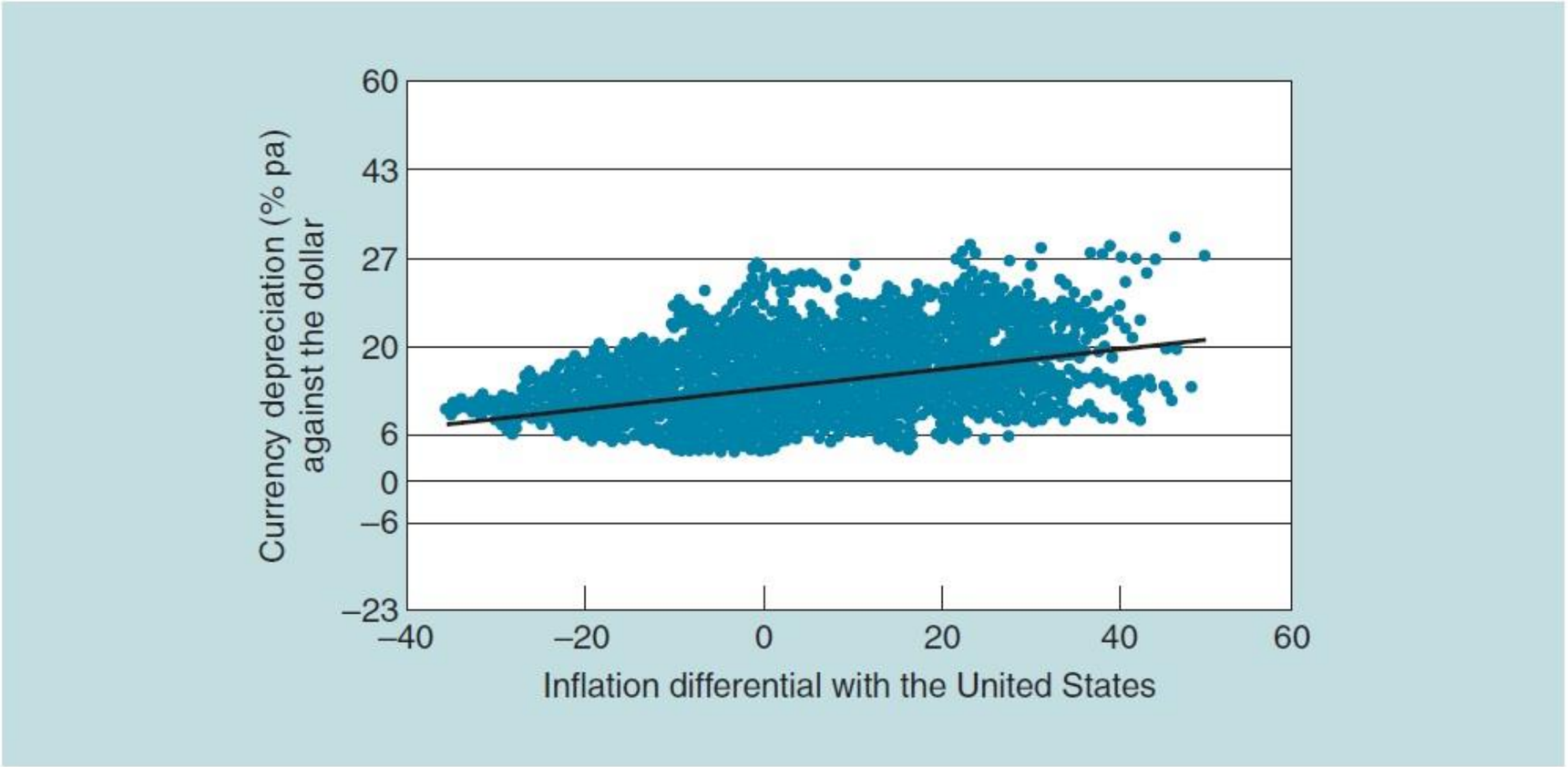
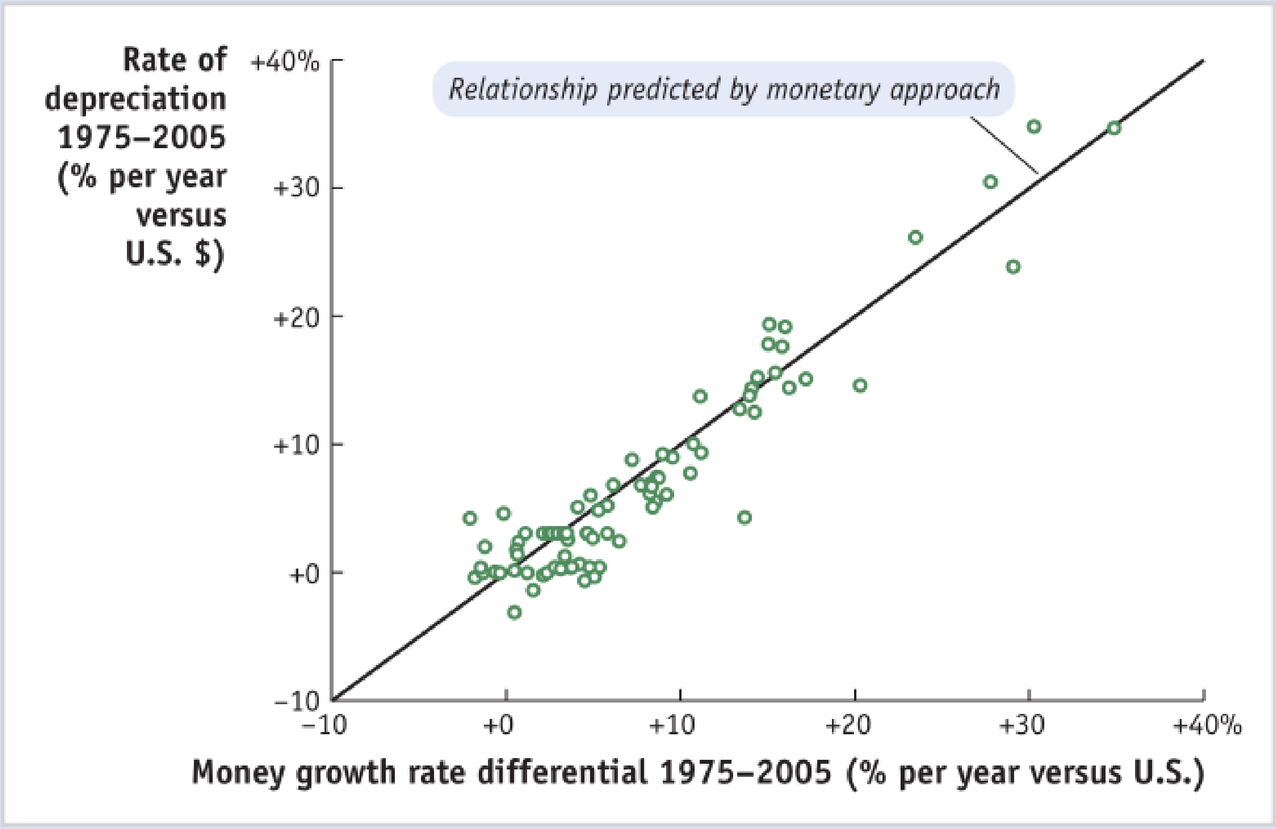


FIGURE 19.5a ● Annual change in exchange rates and inflation, 2010. *Source:* OECD.

PPP in the Long Run

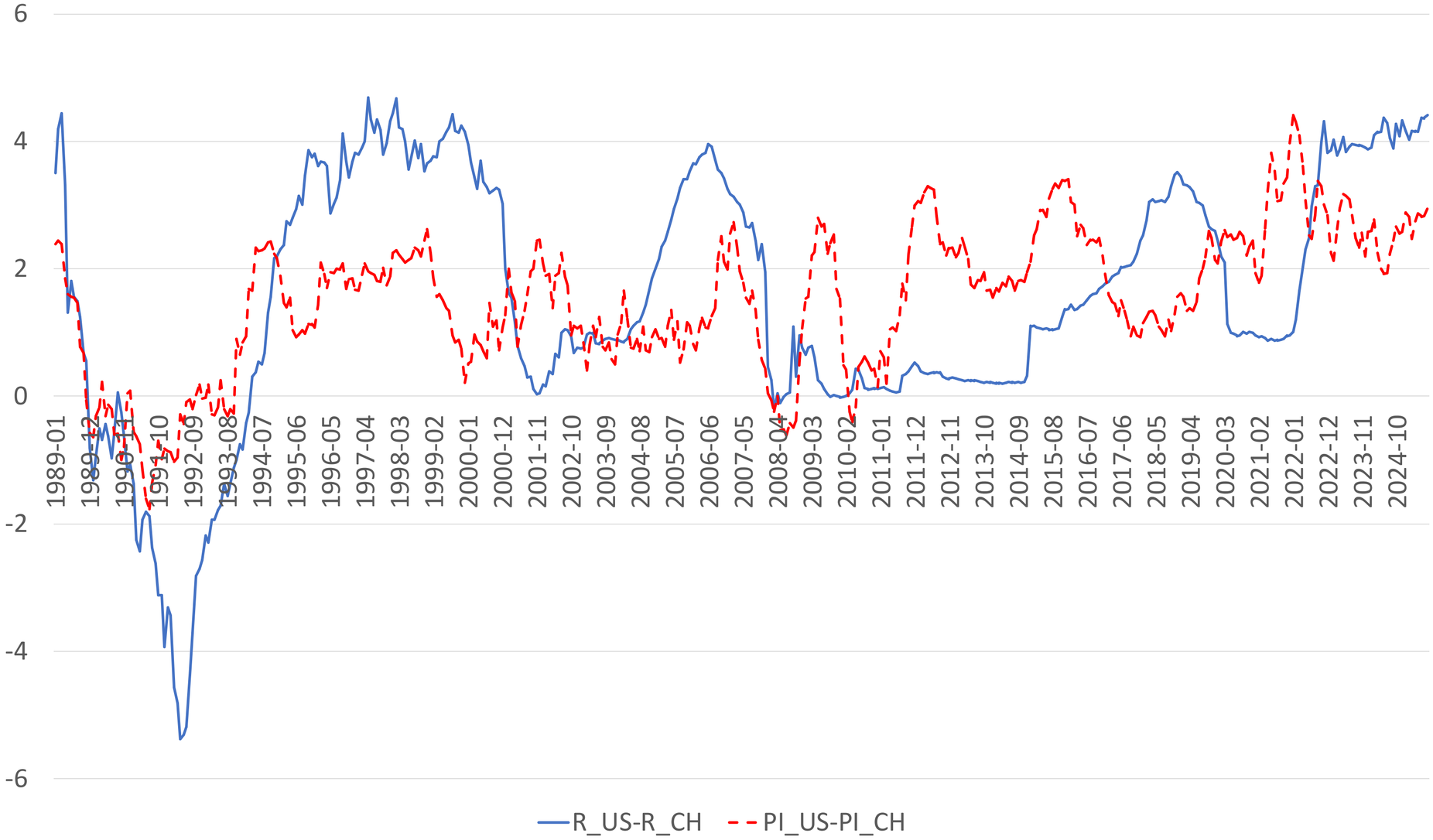


Money Growth Rates and the Exchange Rate, 1975–2005 This scatterplot shows the relationship between the rate of exchange rate depreciation against the U.S. dollar and the money growth rate differential versus the United States over the long run, based on data for a sample of 82 countries. The data show a strong correlation between the two variables and a close resemblance to the theoretical prediction of the monetary approach to exchange rates, which would predict that all data points would appear on the 45-degree line.

Source: IMF, International Financial Statistics.

The correlation between the two variables is strong and bears a close resemblance to the theoretical prediction of PPP that all data points would appear on the 45-degree line.

Switzerland and the United States



Source: SNB and FRED

Empirical evidence from hamburger prices…

- Big Mac Currencies, published by The Economist
- Started in 1986; it is a survey of Big Mac hamburger prices at McDonald's restaurants around the world
- A homogeneous good: the LOP would apply
- Evidence: The Big Mac index, The Economist, January 2025

Big Mac in January 2025

- Big Mac in the United States = USD 5.79 (P_{USD})
- Big Mac in Switzerland = CHF 7.2 (P_{CHF})
- January 2025 exchange rate $E_{CHF/USD}$ = 0.90085
- Big Mac in Switzerland at market prices = USD 7.99245 (7.2/0.90085)
- If LOP held, the exchange rate between CHF and USD would be

$$\frac{P_{CHF}}{P_{USD}} = E^{PPP}_{CHF/USD} \rightarrow \frac{7.2}{5.79} = 1.2435$$

Big Mac in January 2025, cont.

- In January 2025 CHF was more appreciated than LOP predicted: 0.90085 against 1.2435
- % under(-) / over(+) valuation of the CHF against USD

$$\left(\frac{E^{PPP}_{CHF/USD} - E_{CHF/USD}}{E_{CHF/USD}}\right) \times 100 = 38.0$$

- In January 2025 Switzerland was the country with the most overvalued currency against the USD, followed by Argentina (20.1%), Uruguay (19.3%) and Norway (15.3%). Taiwan was the most undervalued (-58.8%)

[1] Source: The Economist

Why does PPP fail to hold?

- Trade barriers and transport costs
- Nontraded goods
- Pricing to market
- Safe-heaven currencies

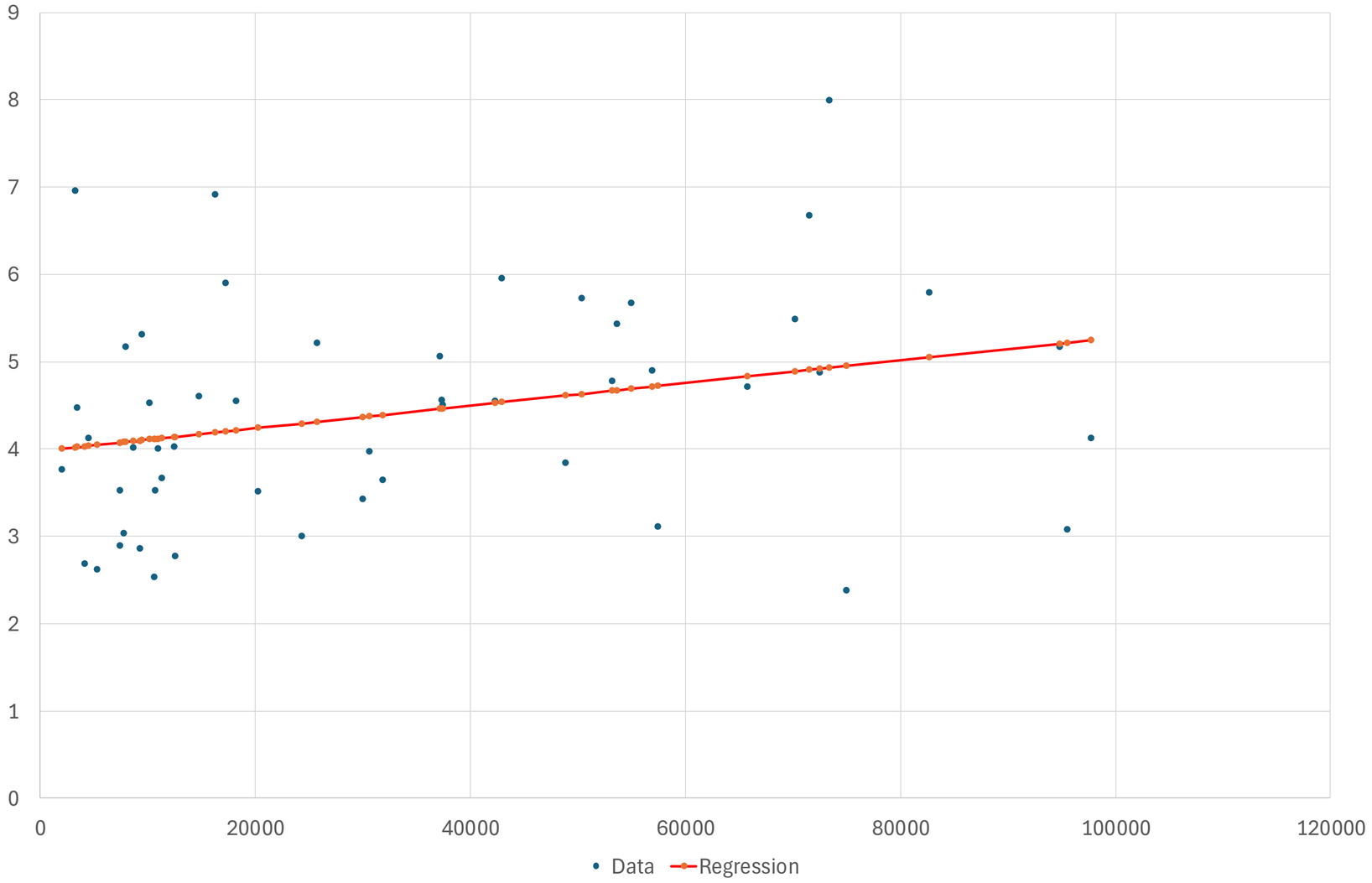
Trade barriers and transport costs

- Example: car -- same brand, same model – is sold in Switzerland and the United States at prices that violate LOP. Why?
- Shipping cost and insurance
- Automobile duty: 4%
- Importation tax: 8%
- Custom duty rate: CHF 0.15 per kilogram
- Organization, management and administrative procedures

Nontraded Goods

- Why is the Swiss Big Mac the most expensive in the world?
- Nontraded goods are more expensive in richer economies
- The Big Mac has a significant nontraded component: salary and social insurance of employees; rent; other retail costs
- Nontraded goods account for about 50% of GNP and hence 50% of the CPI
- GDP-adjusted Big Mac Index

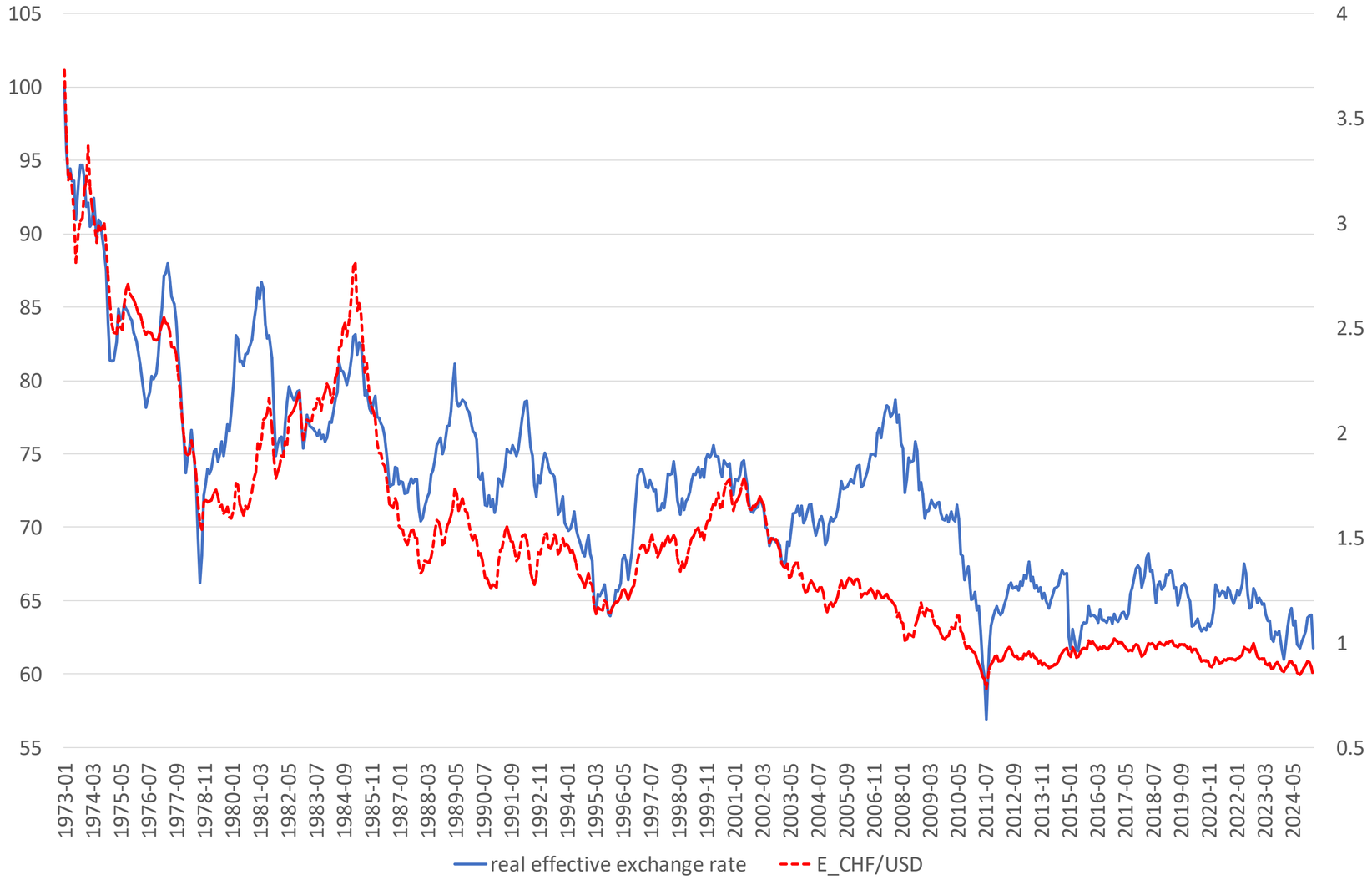
Big Mac and GDP per person



Safe Heaven Currencies

- These currencies appreciate during global crises or recessions
- The Swiss Franc is a safe-heaven currency
- Real Exchange Rate (RER) = E x P* /P
- Appreciated in real terms by 40% after the collapse of Bretton Wood
- Appreciated in real terms by 20% during the Global Financial Crisis

Real Effective Exchange Rate of Switzerland



Balassa-Samuelson theory

- Rich countries have higher productivity in the traded good sector and higher wage growth relative to emerging countries
- This leads to higher wages in the non-traded good sector in rich countries
- Traded-goods prices tend to be equalized across countries

$$P_T = E\ P^*_T$$

P_T = price of traded goods in rich economies

P^*_T = price of traded goods in emerging economies

Balassa-Samuelson theory

- Lower productivity in traded good sector means lower wages in emerging countries

$$P_N > E\ P^*_N$$

P_N = price of non-traded goods in rich economies

P^*_N = price of non-traded goods in emerging economies

- Non-traded goods account for 50% of the typical consumption basket:

$$P > E\ P^*$$

Pricing to market

- Up to now we have assumed that domestic producers set the price of their products in domestic currency $P_i \rightarrow$ export price is $E \times P_i$
- January 16, 2015: $E_{CHF/EUR}$ appreciates by 20%
- Swiss company X (luxury watches, pharmaceutical, etc.) does not want to lose its market share in the euro zone
- It sets the price of its exports to the euro zone in EUR, with $P_i^{EUR} < E \times P_i$
- Pricing to market or local currency pricing

Empirical Evidence on PPP and LOP - Summary

- Empirical evidence on the Fisher relationship
- LOP: evidence from the Big Mac
- Reasons why LOP and PPP fail to hold

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5.3 A General Model of Long-run Exchange Rates

Global Business Environment

Luisa Lambertini

Real exchange rate

- Real CHF/EUR exchange rate

$$q_{CHF/EUR} = \frac{E_{CHF/EUR} \times P_{EUR}}{P_{CHF}}$$

- If PPP holds, $q_{CHF/EUR} = 1$
- Allow for PPP not to hold and q to be different from 1

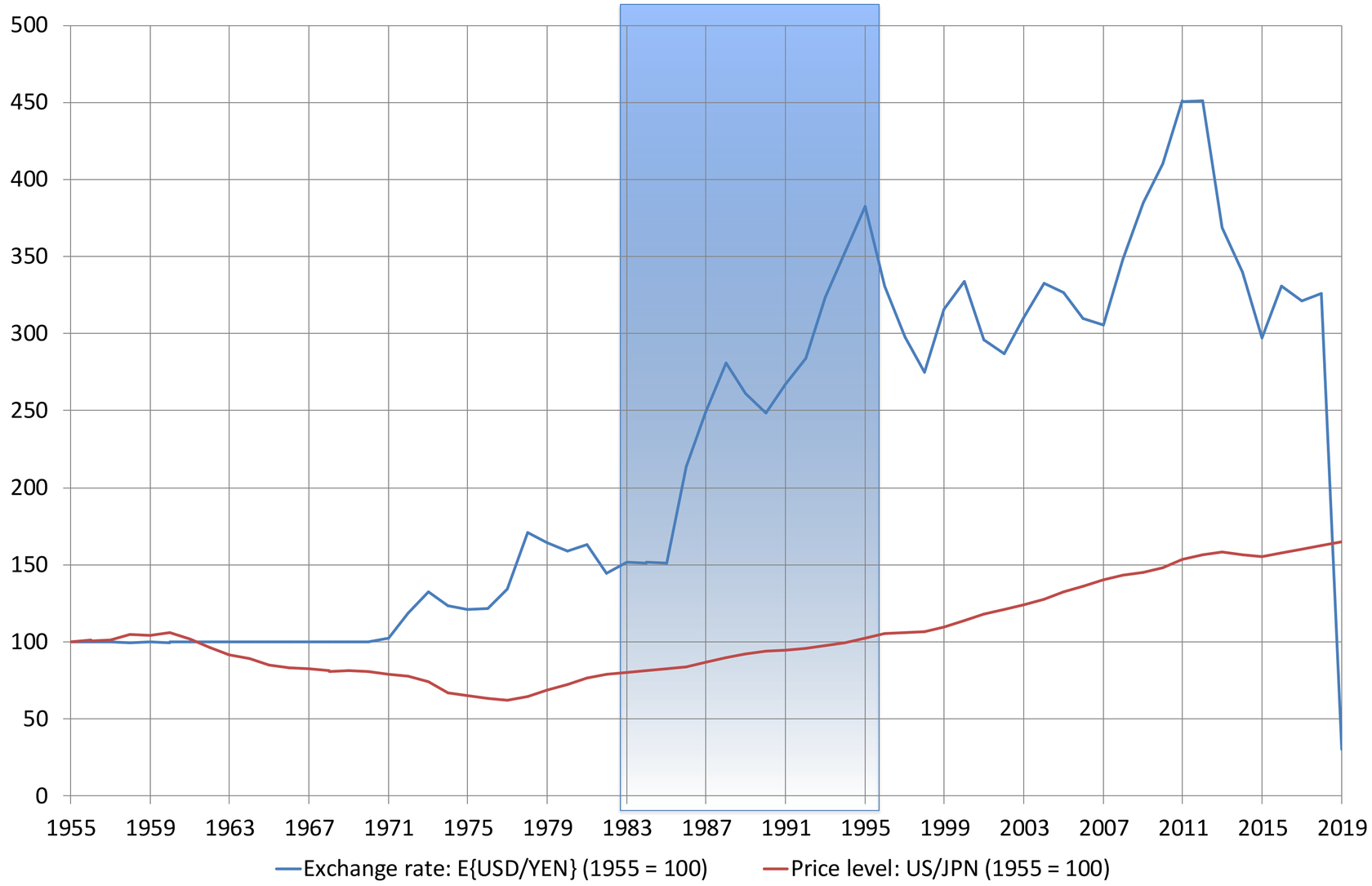
Real exchange rate, cont.

- Real exchange rate depreciation: $q_{CHF/EUR} \uparrow$
  - The Swiss consumption basket becomes cheaper relative to the Euro zone's
- Real exchange rate appreciation: $q_{CHF/EUR} \downarrow$
  - The Swiss consumption basket becomes more expensive relative to the Euro zone's

Factors affecting the real exchange rate

- Changes in the world relative demand for Swiss products
- An increase in the world relative demand for Swiss products raises the CHF price of the Swiss consumption basket relative to price of the Euro zone's consumption basket, $q_{CHF/EUR} \downarrow$
- Changes in the world relative supply of Swiss products
- An increase in the world relative supply of Swiss products lowers the CHF price of the Swiss consumption basket relative to price of the Euro zone's consumption basket, $q_{CHF/EUR} \uparrow$

Example: United States and Japan



Productivity differentials

- Japan had one of the highest traded-nontraded productivity growth differential between 1985 and 1995

$$q_{USD/JPY} = E_{USD/JPY} \times \frac{P_{JPY}}{P_{USD}}$$

$$= \frac{(\cancel{E_{USD/JPY} \times P_{JPY,T}})^{\alpha} \times (E_{USD/JPY} \times P_{JPY,N})^{1-\alpha}}{\cancel{P_{USD,T}}^{\alpha} \times P_{USD,N}{}^{1-\alpha}}$$

- $P_{JPY,N}$ ↑and $q_{USD/JPY}$ ↑

Nominal exchange rate in the long run

$$E_{CHF/EUR} = q_{CHF/EUR} \frac{P_{CHF}}{P_{EUR}}$$

$$= q_{CHF/EUR} \frac{M_{CHF}}{M_{EUR}} \times \frac{L(R_{EUR}, Y_{EUR})}{L(R_{CHF}, Y_{CHF})}$$

Changes in nominal long-run exchange rates

- Permanent increase in M_{CHF} relative to M_{EUR}

$$M_{CHF} \uparrow P_{CHF} \uparrow \rightarrow E_{CHF/EUR} \uparrow$$

- Permanent increase in the growth rate of M_{CHF} relative to the growth rate of M_{EUR} (see notes later)

$$\pi_{CHF} \uparrow \rightarrow R_{CHF} \uparrow \rightarrow L(R_{CHF}, Y_{CHF}) \downarrow \rightarrow P_{CHF} \uparrow \rightarrow E_{CHF/EUR} \uparrow$$

- Increase in the relative demand for Swiss products

$$q_{CHF/EUR} \downarrow \rightarrow E_{CHF/EUR} \downarrow$$

Changes in nominal long-run exchange rates, cont.

- Increase in the relative supply of Swiss products. There are two effects:

$$q_{CHF/EUR} \uparrow$$

$$Y_{CHF} \uparrow \rightarrow L(R_{CHF}, Y_{CHF}) \uparrow$$

$$E_{CHF/EUR} = q_{CHF/EUR} \times \frac{M_{CHF}}{L(R_{CHF}, Y_{CHF})} \times \frac{L(R_{EUR}, Y_{EUR})}{M_{EUR}}$$

$$\uparrow \qquad\qquad \downarrow$$

Final effect on the nominal long-run exchange rate is ambiguous

Permanent Increase in Domestic Money Growth

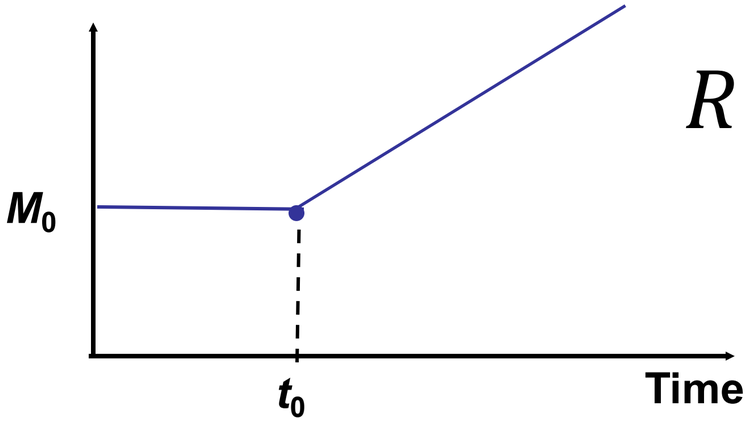
- Suppose M, M* are constant; $\pi = \pi^* = 0$, $E = E_0$ for $t < t_0$
- Suddenly at $t = t_0$ M starts growing at 2% per year; M* remains unchanged; real interest rate r also unchanged
- Assume that prices are flexible, also in the short run
- In the long run
  - $\pi = 2\%$, $\pi^* = 0$ long run neutrality of money
  - By relative PPP, $(E^e - E)/E = \pi^e - \pi^{*e} = 2\%$

Permanent Increase in Domestic Money Growth

- At t_0
  - Fisher relationship: $r = R - \pi^e$; then $\Delta\pi^e = 2\% \rightarrow \Delta R = 2\%$ (assuming r is unchanged)
  - By IPC: $R - R^* = (E^e - E)/E = 2\%$
  - M has not changed yet; i.e. $M = M_0$; however $R \uparrow \rightarrow L(R, Y) \downarrow \rightarrow P \uparrow$ instantaneously
  - See next slide

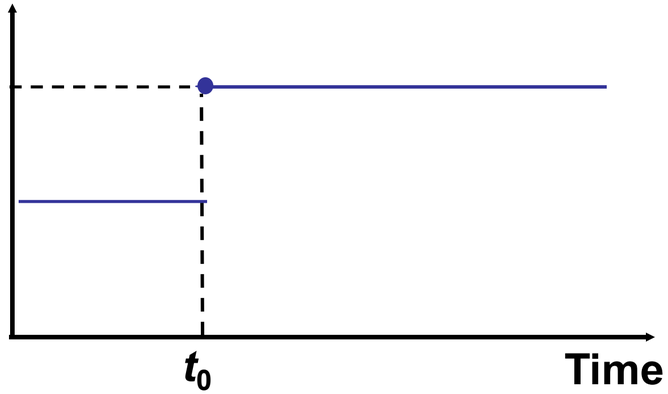
Permanent Increase in Domestic Money Growth

(1) Money supply, *M*



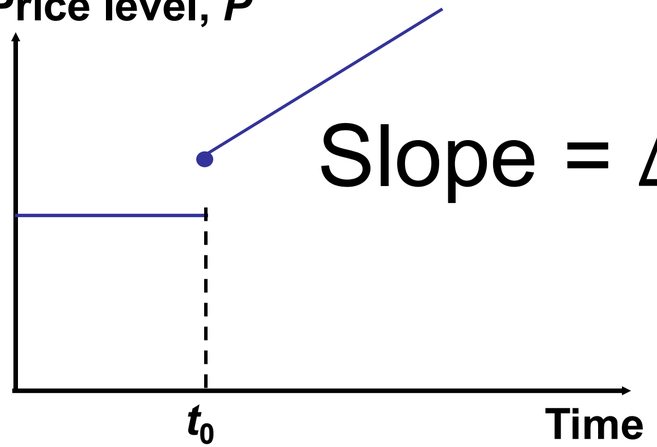
(2) Interest Rate, *R*

$$R + \Delta\pi$$



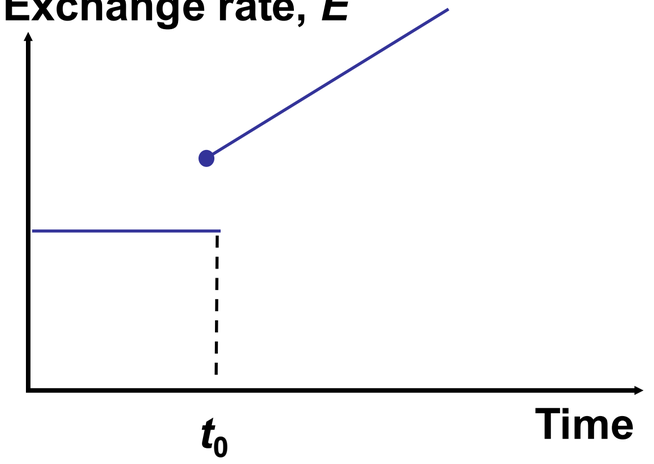
Ass: prices are flexible in the short run

(3) Price level, *P*



$$P = \frac{M^S}{L(R,Y)}$$

(4) Exchange rate, *E*



$$E = \frac{P}{P^*}$$

A Model of Long-run Exchange Rates - Summary

- Real exchange rate
- Factors affecting the real exchange rate
- The nominal exchange rate in the long run