IMEP 2014 Lectures 15 and 16:

Empirical research on exchange rates: theory vs evidence

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Outline of today's lectures

Lecture 15

- Defining stylized facts
- Stylized facts of exchange rates

Lecture 16

- Empirical tests of monetary exchange rate models
- Empirical research on monetary models: a summary

Lecture 15 – Stylized facts of exchange rates

Key reading:

1. Frankel and Rose (1994), Sections 1.A to 1.B.1.a (pp. 1-8)

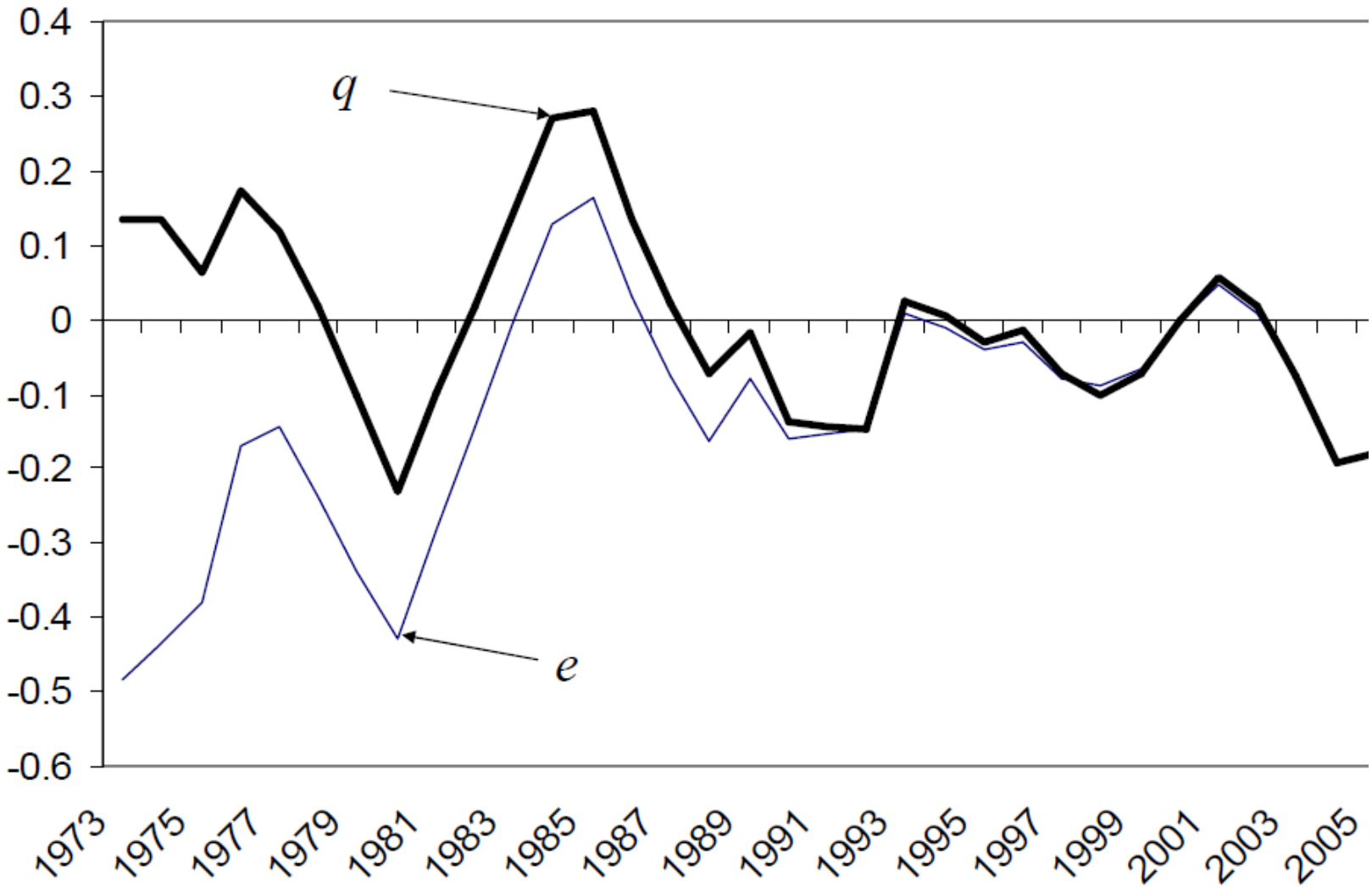
Defining stylized facts

- We use the term 'stylized facts' to refer to observations which have been confirmed in so many different contexts that they are regarded as empirical truths
- In the context of exchange rates, this means observations confirmed in many different countries over different sample periods
- A successful model should be able to explain most of the stylized facts of exchange rates

Stylized exchange rate fact (1)

- **Real and nominal exchange rates are highly persistent**
- In other words, high exchange rates today will tend to imply high exchange rates for several years into the future (see next slide)
- We measure persistence using the autoregressive coefficient ρ and the concept of half-life
- **Example:** long run studies of PPP have found $\rho \approx 0.85$
- The Dornbusch model implies that exchange rates are persistent, since they return to equilibrium only gradually after money supply shocks

Positive autocorrelation in exchange rates (£s per $)



Source: OECD

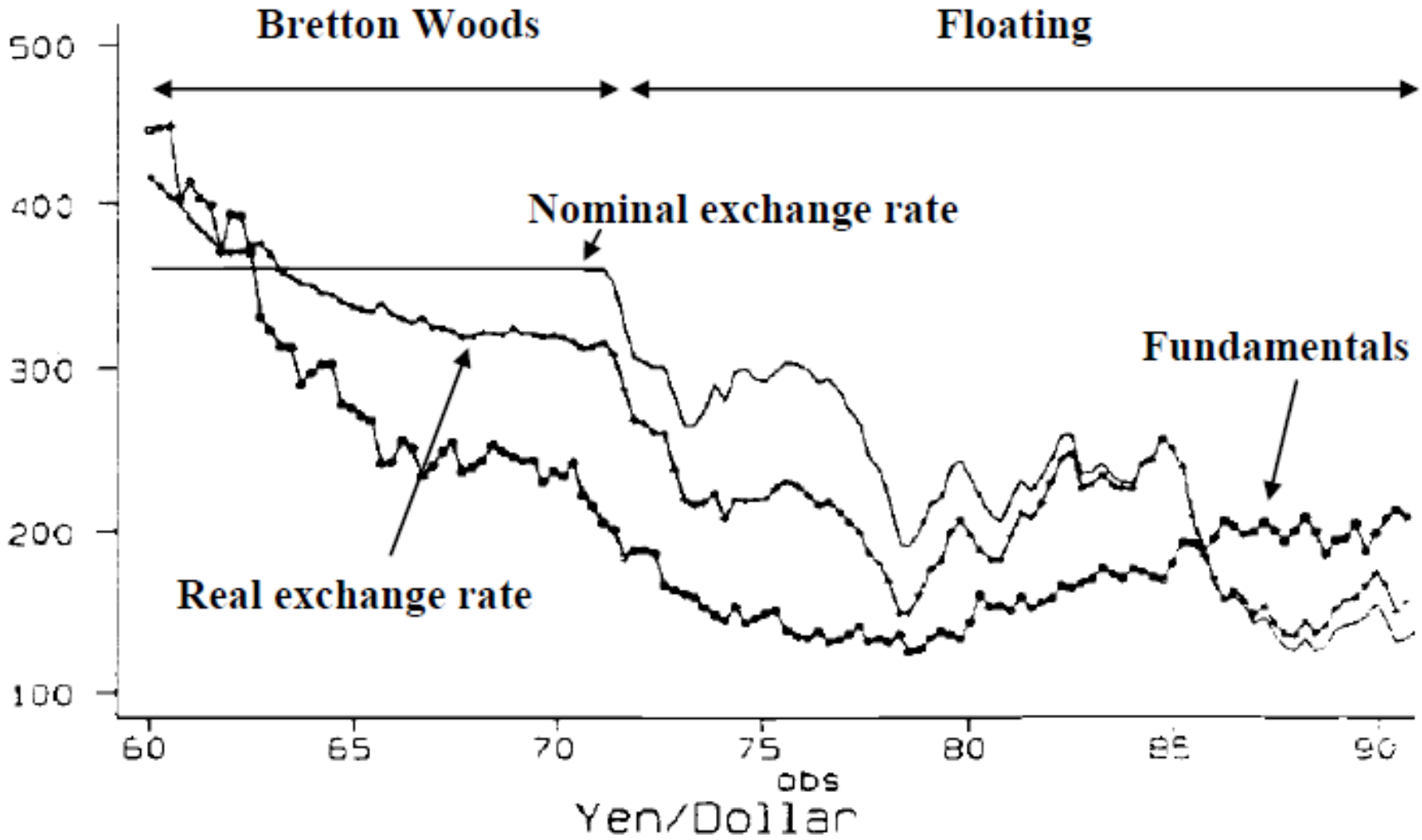
Stylized exchange rate fact (2)

- **Short run changes in exchange rates are largely unpredictable**
- In other words, it is very difficult to accurately forecast short run movements in exchange rates
- Indeed, sizeable short run movements in exchange rates sometimes happen in the absence of fundamental news announcements
- **Example:** the large USD/Yen depreciation on Oct 7 and 8 of 1998
- For these reasons, some have argued that short run ER movements are the result of 'noise trading'

Stylized exchange rate fact (3)

- **Exchange rates are very volatile compared to other macroeconomic variables**
- Macroeconomic variables such as money supplies, GDPs and interest rates are called 'macroeconomic fundamentals'
- Exchange rates are typically far more volatile than macro fundamentals
- Once we moved into the floating era, exchange rates become more volatile without any change in the volatility of fundamentals
- We can see this on the next slide...

Exchange rates and fundementals 1960-92

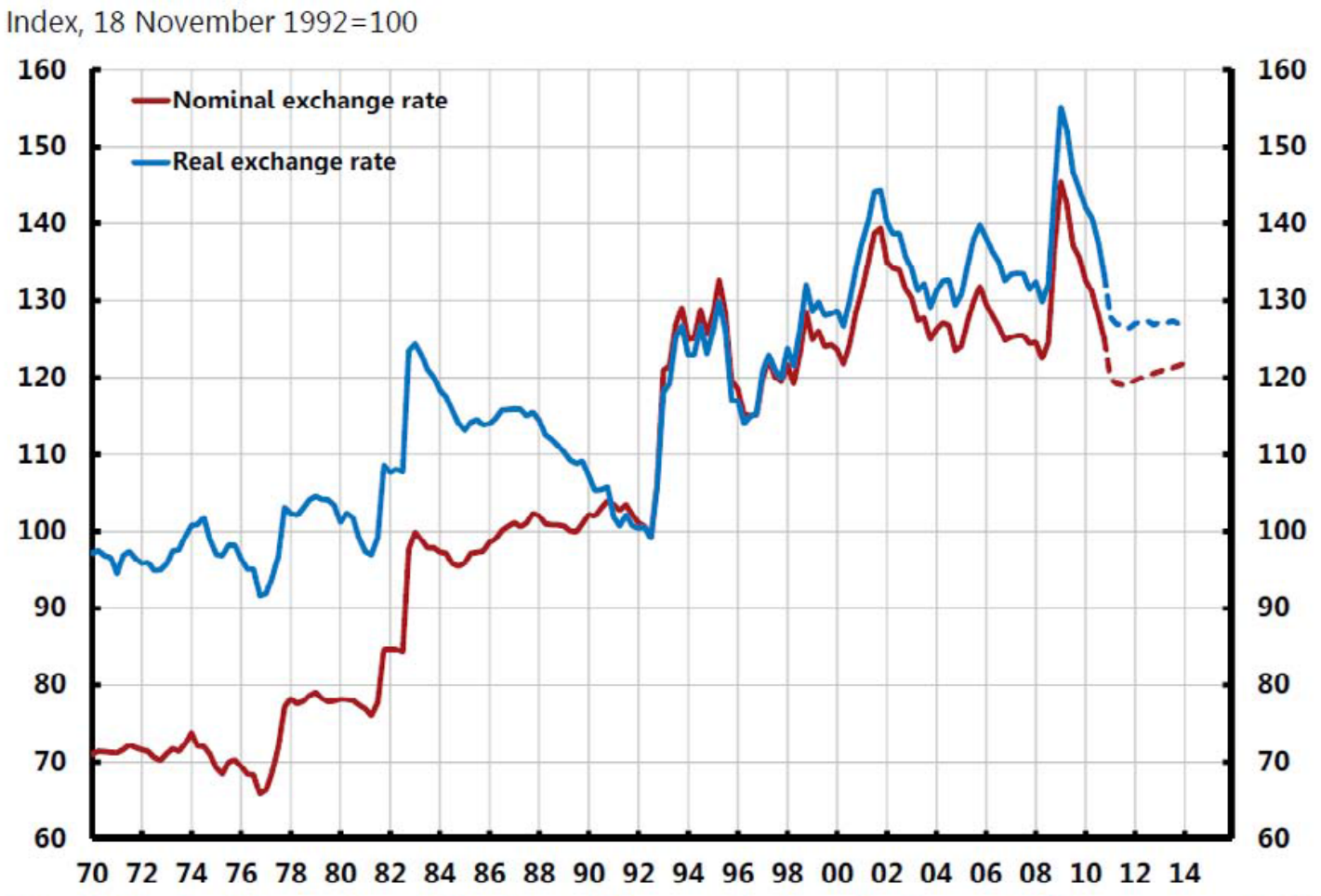


Source: Frankel and Rose (1994, Fig 1)

Stylized exchange rate fact (4)

- **Nominal and real exchange rates are strongly positively correlated in the short run**
- In fact, the correlation is often close to 1 (ie perfect correlation)
- The fact that $Q = \frac{SP^*}{P}$ and S are strongly correlated implies that most of the movement in Q comes from changes in the spot rate S
- One way to rationalize this is sticky prices: if $\frac{P^*}{P}$ is sticky, then movements in S will translate into movements in Q
- So the Dornbusch model does a good job of explaining this fact

The positive correlation between real and nominal ERs

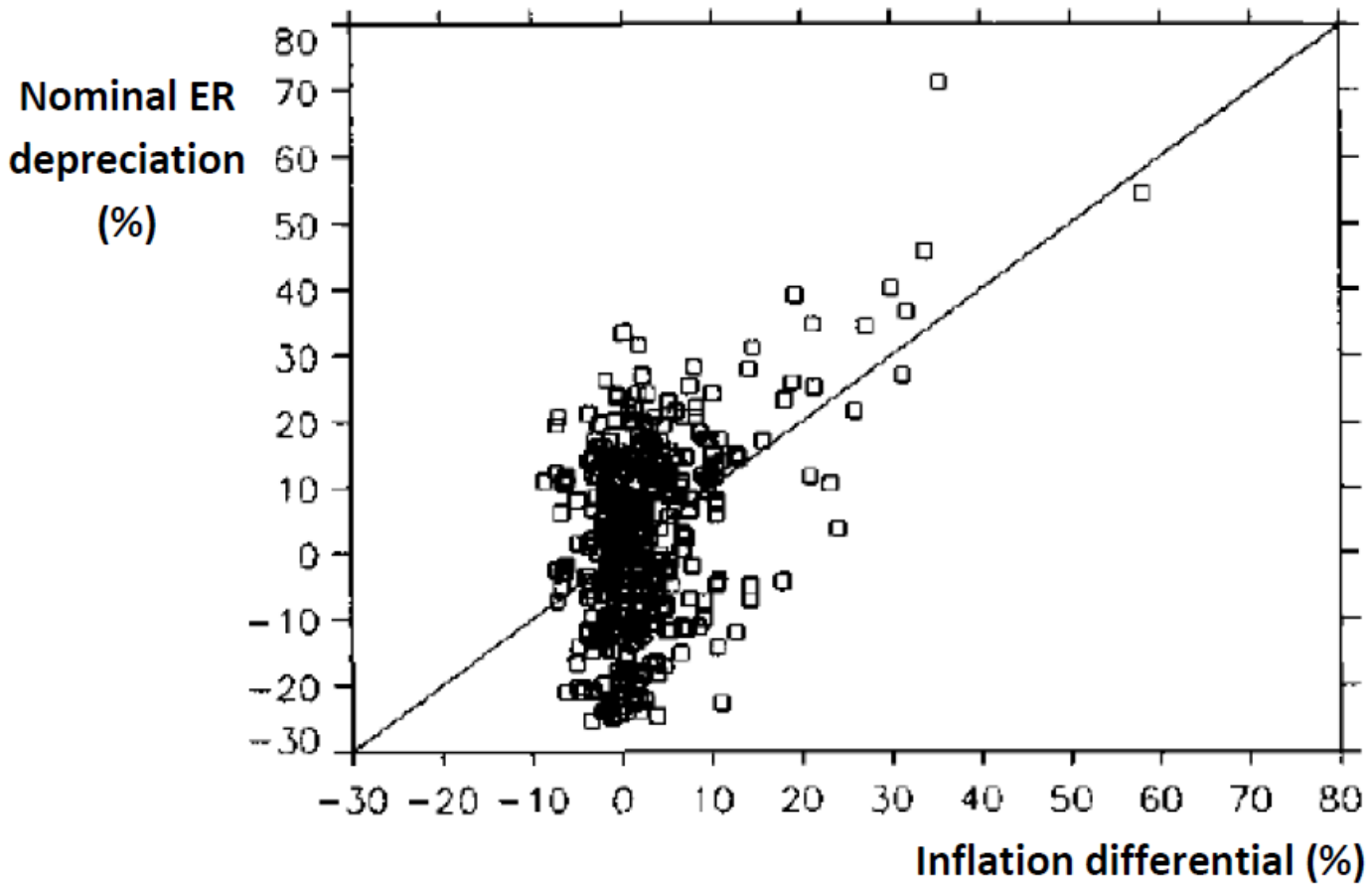


Source: Ekholm (2011); Swedish exchange rates

Stylized exchange rate fact (5)

- **Countries with high inflation have depreciating currencies**
- The next slide shows that there is a positive relationship between inflation and nominal exchange rate depreciation at high levels of inflation (20%+ per year)
- For this reason, monetary models of exchange rates do a good job of explaining nominal exchange rate movements during periods of high inflation or hyperinflation
- **Example:** Frenkel (1976) studied the Dollar-Mark exchange rate during German hyperinflation

Exchange rate change vs inflation differential (annually)

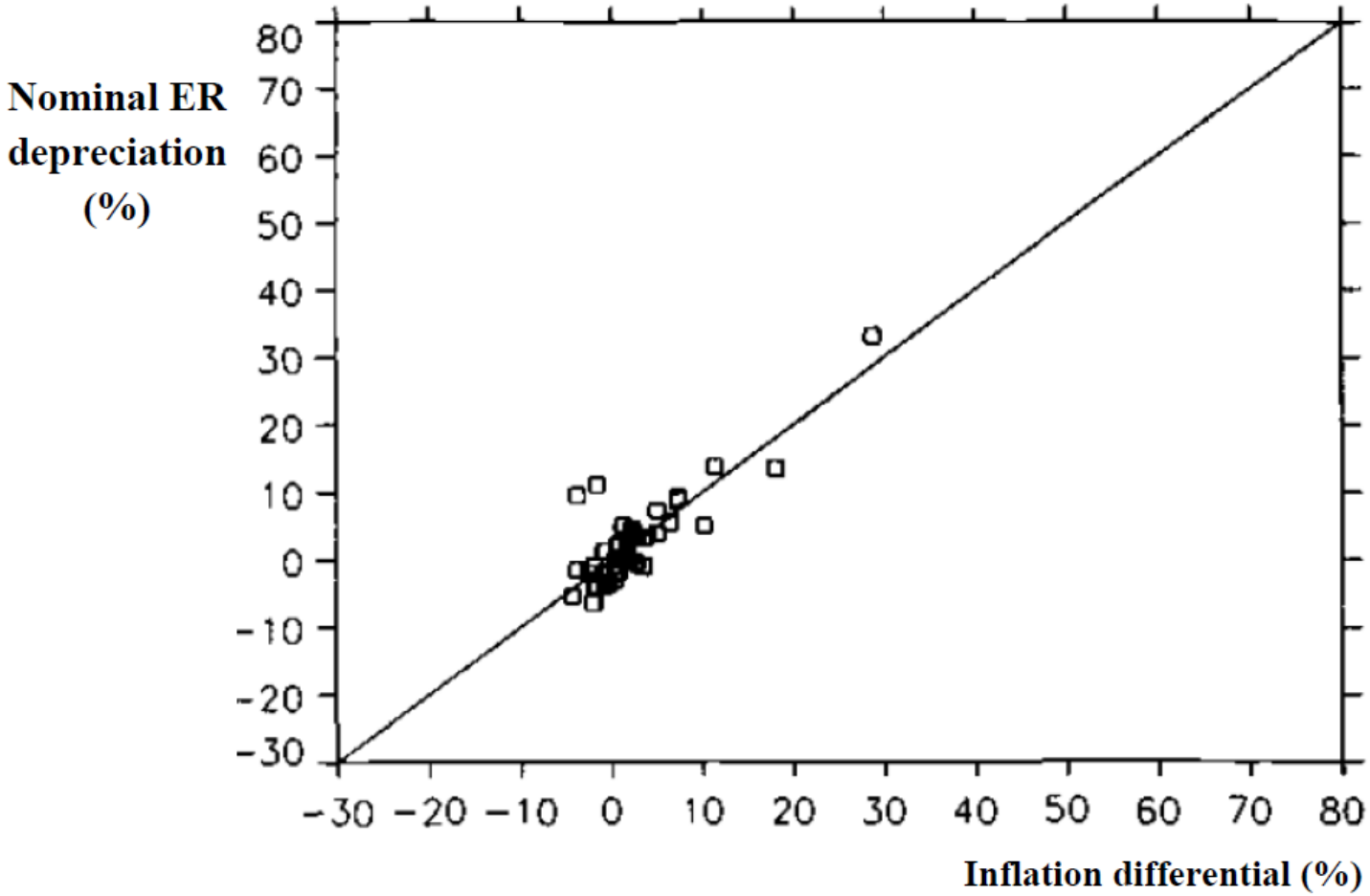


Source: Flood and Taylor (1996, Fig 8.4).
Labels added; sample period 1973-92.

Stylized exchange rate fact (6)

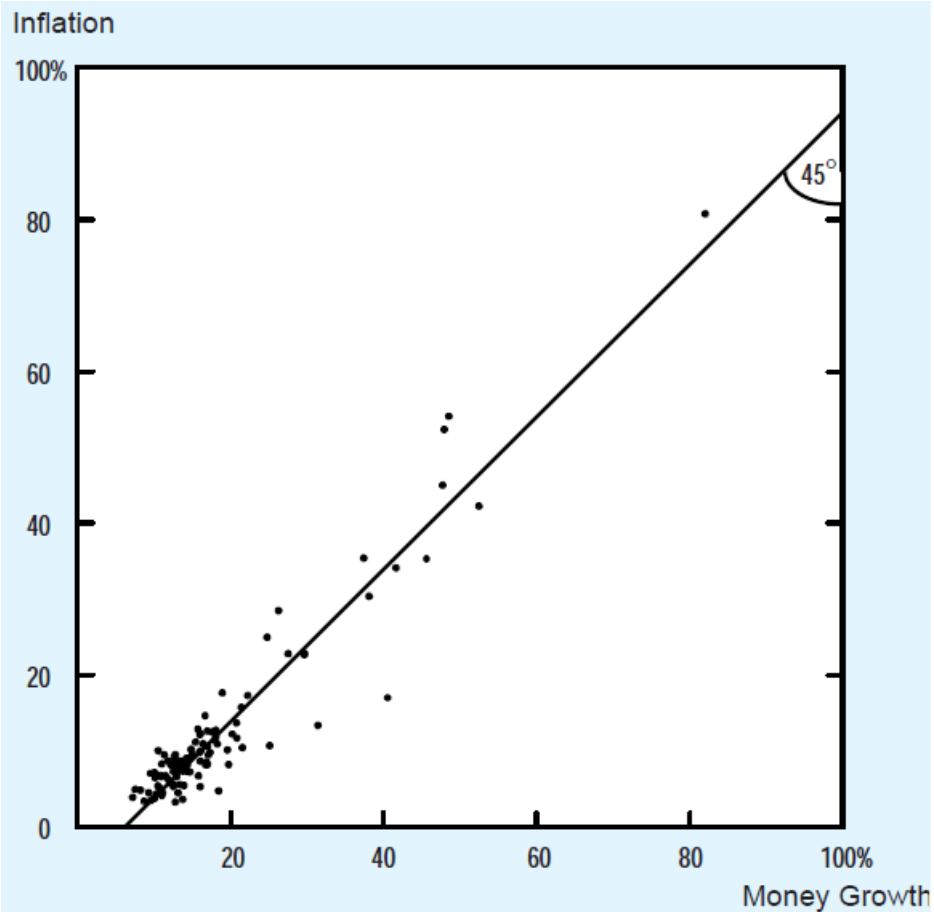
- **Long run nominal ER depreciation is approximately equal to the inflation differential and the money growth differential**
- The next slide shows that there is a tight positive relationship between inflation and nominal exchange rate depreciation in the long run
- The slide after shows that there is also a tight positive relationship between money supply growth and inflation
- These two observations imply that, in the long run, nominal ER depreciation is roughly equal to the money growth differential
- As a result, monetary models of exchange rates are useful for understanding long run movements in exchange rates

Exchange rate change vs inflation differential (10 years)



Source: Flood and Taylor (1996, Fig 8.6).
Labels added; sample period 1973-92.

Long run inflation vs long run money growth



Source: Bullard (1999, Fig 1, p. 30).

Figure shows 30-year averages. Sample: 1960-1990; 110 countries.

Stylized facts: summary

- There are a number of empirical facts about exchange rates that economic models attempt to replicate
- The flex-price monetary model can replicate facts (5) and (6)
- The sticky-price Dornbusch model can replicate facts (1), (4), (5), (6)
- But are these models useful for explaining and predicting real-world movements in exchange rates?
- We will answer this question in Lecture 16

THE END

Lecture 16

Empirical tests of monetary models of exchange rates

Key reading:

1. Obstfeld and Rogoff, Chapter 9.3.1 to 9.3.2 (pp. 621-26)
2. Frankel and Rose (1994), Sections 1.B.1.b to III (pp. 8-32), except 1.B.1.c

Empirical tests of exchange rate models

- This lecture will discuss formal tests of exchange rate models from the empirical literature
- We will only cover a small number of key studies in the literature
- This is an active area of research that is still growing rapidly
- The discussion is framed around Meese-Rogoff (1983), because this was a very influential paper in the empirical literature

Early empirical tests

- A number of authors tested monetary models of exchange rates during the mid to late 1970s
- The idea of these early tests was to estimate exchange rate models
- Then see if the estimated model can explain what happened to exchange rates during the sample period
- These are **in-sample tests** of exchange rate models. On the whole, the results were encouraging
- Frankel (1979) showed that a model similar to Dornbusch's explained the major movements in the DM-$ exchange rate

Frankel's (1979) model: in-sample, 1974-78

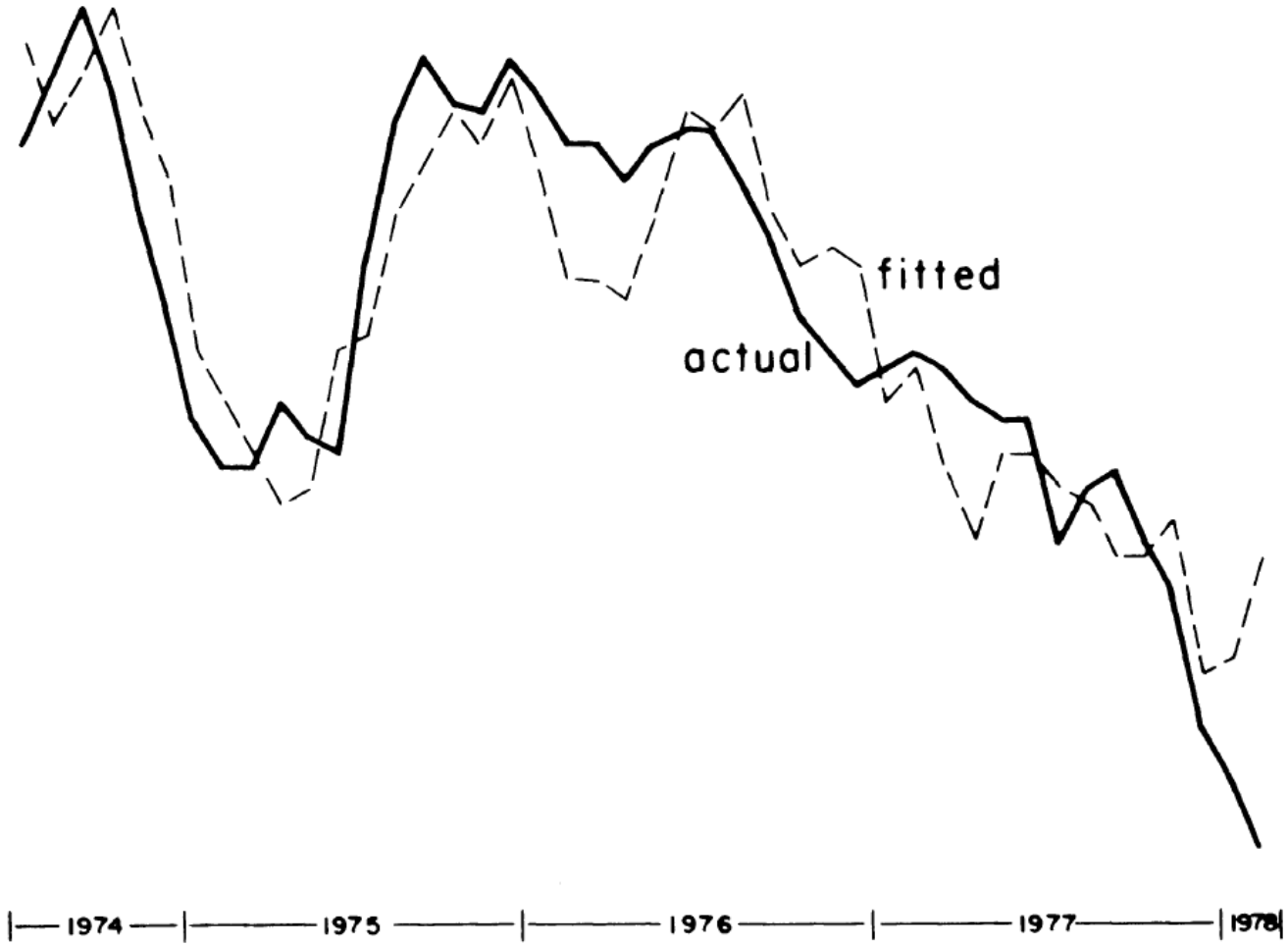


FIGURE 1. PLOT OF (*log* OF) MARK/DOLLAR RATE,
OLS REGRESSION FROM TABLE 1

Meese-Rogoff (1983): background

- Meese and Rogoff had seen the encouraging in-sample results of monetary exchange rate models
- They wanted to know if these models could forecast **out-of-sample**
- Out-of-sample forecasting is a difficult test, because a model 'fitted' to one period must produce accurate forecasts for some future period
- Nevertheless, most economists were confident that monetary models would be up to the challenge

The Meese-Rogoff (1983): methodology

- M&R needed to pick a benchmark time-series model to compare against. They went with a random walk: $e = e_{-1} + resid$
- This model predicts 'no change' in the nominal exchange rate
- M&R test the random walk model against the flex-price model and the Dornbusch model
- For the economic models:
  1. Estimated coefficients **updated each period** using rolling regressions
  2. **Actual** future values of regressors were used in place of forecasts

Meese-Rogoff (1983): results

Table 1 - Root mean square error (RMSE)[a]
(6-month forecast horizon; out-of-sample)

	RW	**Flex-price**	**Dornbusch**
$/mark	8.71	9.64	12.03
$/yen	11.58	13.38	13.94
$/pound	6.45	8.90	8.88

(a) See Meese and Rogoff (1983), Table 1, p. 13.

- **Key points:**
  1. The random walk clearly outperforms the monetary models
  2. Same conclusion at the 1-month and 12-month forecast horizons

Meese-Rogoff: summary

- At the end of the 1970s, economists were optimistic about monetary models of exchange rate
- Meese and Rogoff (1983) shattered this optimism
- As we shall see, their findings profoundly influenced the empirical literature and led to alternatives to monetary models
- Not all of this research was bad news for the monetary models

Meese-Rogoff (1988): background

- In a later paper, Meese and Rogoff set out to understand why the monetary models had failed so dramatically
- To do so, they test for the relationship between the real exchange rate and the real interest rate differential in the Dornbusch model:

$$q = \overline{q} - \chi(r - r^*) \qquad (1)$$

where $\chi = \frac{1}{\psi\delta}$

- Despite the fact that the monetary models failed to predict nominal exchange rates, they might do well on this score
- This is because unanticipated shifts in money demand will affect real exchange rates and real interest rates proportionately (M&R, p. 934)

Meese-Rogoff (1988): methodology

- Meese and Rogoff estimate in-sample regressions using monthly data from Feb 1974 to March 1986
- Real exchange rates: Dollar-Mark, Dollar-Yen and Dollar-Pound
- Esimated regressions are then used to forecast out-of-sample
- In these cases, the model is estimated over a shorter period and used to forecast out-of-sample Nov 1980 to March 1986
- Finally, test for a long run relationship between real exchange rates and real interest differentials using cointegration analysis

Meese-Rogoff (1988): results

- The estimates of χ are positive as expected
- However, the estimated coefficients are NOT statistically significant
- There is thus only weak support for the relationship in (1)
- Moreover, the out-of-sample performance of the regressions is worse than a random walk (next slide) – just as in Meese and Rogoff (1983)

Meese-Rogoff (1988): results cont'd

- Real exchange rates cannot be forecast out-of-sample using real interest differentials:

Table 2 - Root mean square error (RMSE)[b]
(1-month forecast horizon; out-of-sample)

	RW	**Dornbusch**
$/mark	3.51	3.93
$/yen	3.66	4.21
$/pound	3.59	3.93

(b) See Meese and Rogoff (1988), Table 3, p. 939.

Meese-Rogoff (1988): results cont'd

- The Engle-Granger cointegration test results were as follows:

Table 3 - Engle-Granger cointegration test results[c]

ER	Test stat
$/mark	−1.32
$/yen	−1.19
$/pound	−1.43

(c) See Meese and Rogoff (1988), Table 5, p. 943.
Reject null of no cointegration if stat $<$ -3.17.

- There is no evidence of cointegration between real exchange rates and real interest differentials

Meese-Rogoff (1988): summary

- There is some weak evidence of a negative relationship between real interest differentials and real exchange rates. However, that relationship is NOT statistically significant.
- There is also NO statistical evidence of a long run equilibrium relationship between the two variables (ie cointegration)
- These results tell us that M&R's earlier (1983) findings are not just due to large shifts in money demand
- Instead, it appears there is something fundamentally wrong with monetary models' predictions for real and nominal exchange rates

Mark (1995)

- One question Meese and Rogoff (1983, 1988) DO NOT answer is whether monetary models outperform the random walk at longer forecast horizons such as 2-5 years
- Mark (1995) investigates using data from the mid-70s to early 90s
- His out-of-sample forecast analysis begins in 1981 in order to include turning points in the Dollar exchange rate in 1985 and 1987
- We will consider the in-sample results first because these help to provide intuition

Mark (1995): in-sample results (one-quarter ahead)

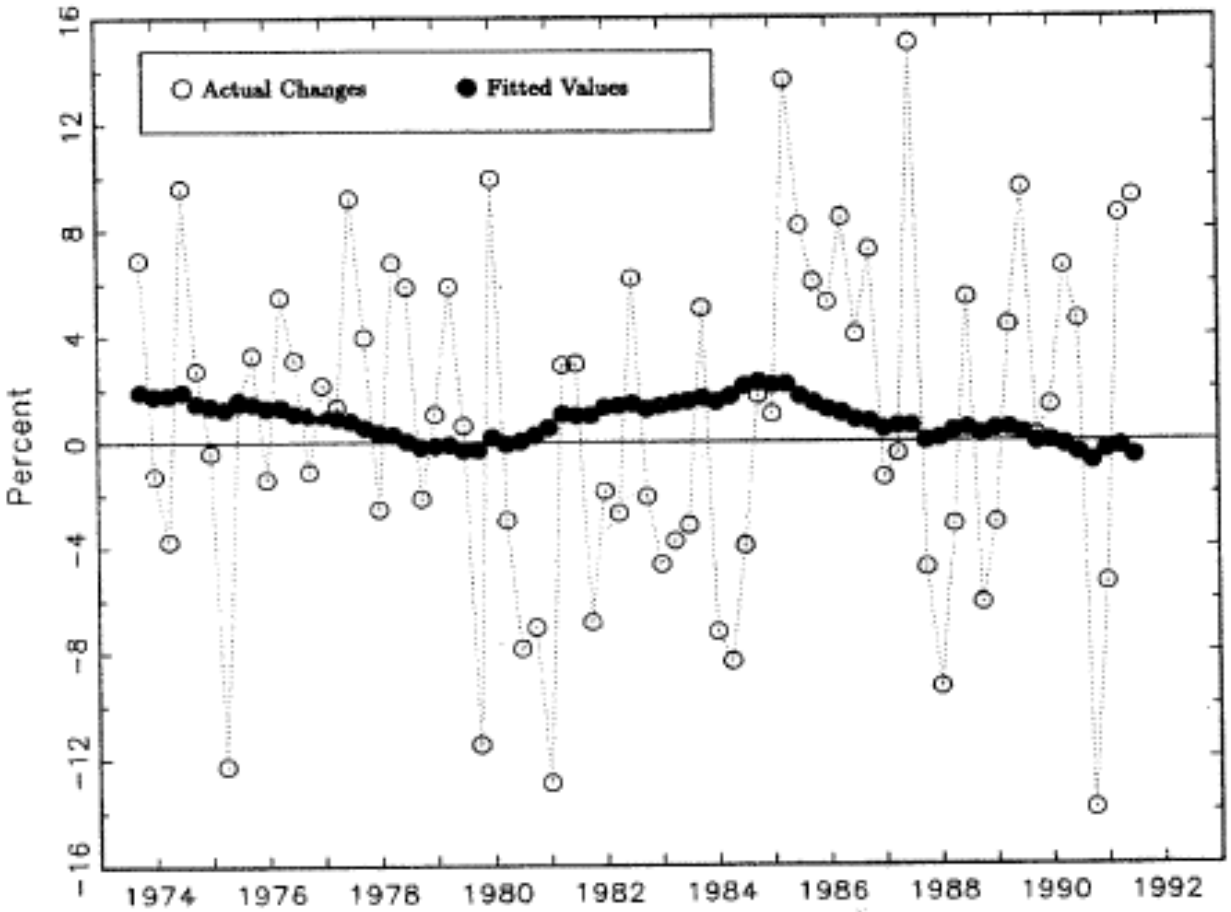


FIGURE 1. ONE-QUARTER CHANGES IN THE LOG DOLLAR/DEUTSCHE-MARK EXCHANGE RATE

Mark (1995): in-sample results (16 quarters ahead)

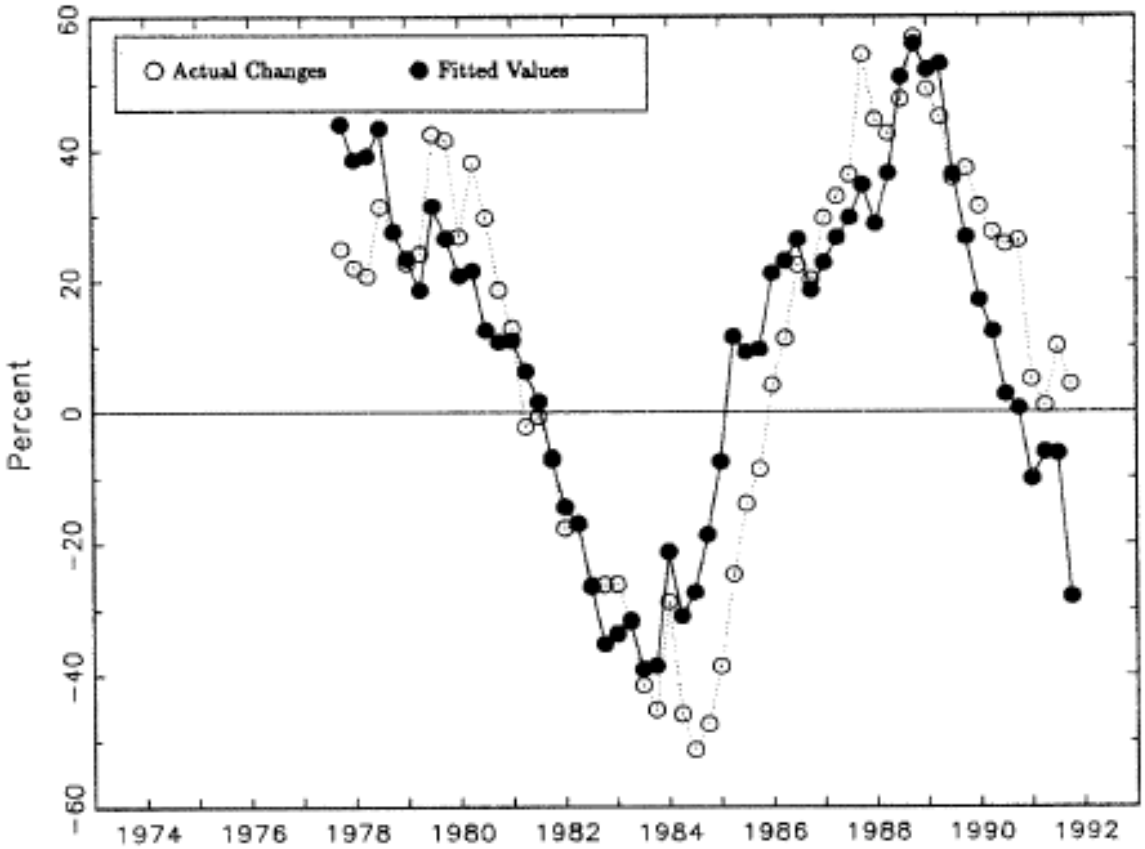


FIGURE 5. SIXTEEN-QUARTER CHANGES IN THE LOG DOLLAR/DEUTSCHE-MARK EXCHANGE RATE

Mark (1995): in-sample results comparison

- Short-term exchange rates are dominated by 'noise' (Fig 1), so the monetary model explains only a fraction of exchange rate changes
- But 4-year exchange rates are an entirely different story (Fig 5)
- The model can explain almost all of the change in the log exchange rate in this case
- This is because the effects of noise of exchange rates average out to zero over long horizons

Mark (1995): out-of-sample results

Table 4 – RMSE ratios (DM-Dollar)

Horizon	$\frac{RMSE^{Model}}{RMSE^{RW}}$
1 quarter	1.015
8 quarters	1.002
12 quarters	0.796
16 quarters	0.524

Source: Mark (1995), Table 4, p. 214.

- Monetary model is beaten by a random walk up to a 2-year horizon
- For other currency combinations, the results up to 2 years are more mixed, but the difference in performance is not statistically significant,
- But the model gives a statistically significant improvement in forecasting ability at long horizons such as 4 years

Mark (1995): summary

- Mark's results help us to understand Meese and Rogoff (1983)
- In particular, they confirm that monetary models of exchange rates are unlikely to beat a random walk at very short horizons
- It is clear, however, that the Meese-Rogoff result DOES NOT apply to longer forecast horizons such as 3 or 4 years
- Therefore, monetary models of exchange rates are useful for understanding and predicting exchange rates at long horizons

Empirical research on monetary models: a summary

- Both stylized facts and empirical tests pose difficulties for monetary models of exchange rates
- In particular, the models have trouble explaining and predicting short-term changes in exchange rates
- However, monetary models of exchange rates outperform random walks at long horizons, and they do well in times of high inflation or hyperinflation
- In the next lecture we will look at the monetary model's replacement: New Keynesian models with Taylor rules

THE END

Appendix: Root mean square error

- To evaluate how well a model forecasts exchange rates, we need a measure of forecast accuracy
- A popular measure is the **Root Mean Square Error:**

$$RMSE = \sqrt{\frac{\Sigma(F-A)^2}{N}}$$

- Here: F = forecast, A = actual, N = total number of forecasts
- A higher RMSE implies worse forecast performance

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