IFM 2014 Lecture 5

Empirical evidence on monetary exchange rate models

Dr Michael Hatcher

Michael.Hatcher “at” glasgow.ac.uk

Outline of lecture

Lecture 5

- Comparing monetary models of exchange rates
- Early empirical evidence on monetary models
- The Meese-Rogoff critique
- Recent empirical evidence on monetary models
- Summary of empirical evidence

Monetary models: the big picture

- The main message of monetary models is that monetary policy is an important determinant of exchange rates
- The three models we have looked at make similar predictions for exchange rates, but are these predictions correct?
- We can answer this question using data on exchange rates and economic fundamentals
- This is the basic idea behind most empirical tests of monetary models of exchange rates

Monetary models: the big picture

- We can summarise the predictions of monetary models using the reduced-form equation

$$s = \alpha_0(m - m^*) + \alpha_1(y - y^*) + \alpha_2(\pi^e - \pi^{e*}) + \alpha_3(r - r^*)$$

Table 1 – Predictions of monetary ER models

Coefficient	α_0	α_1	α_2	α_3
FPMM	$+1$	$-$	$+$	0
Dornbusch	$+1$	$-$	0	$-$
RID	$+1$	$-$	$+$	$-$

Source: MacDonald Ch. 6.1, p. 137

First generation tests of monetary models

- Based on simple regression analysis (eg Ordinary Least Squares)
- Estimate the model using data and see whether the coefficients have the correct magnitude and sign
- **Example 1:** we should find $\widehat{\alpha_0}$ close to 1 and that the null hypothesis $\alpha_0 = 1$ cannot be rejected by statistical tests
- **Example 2:** we should find a negative coefficient on home GDP and a positive coefficient of the same magnitude on foreign GDP
- How do monetary models fare in these tests?

First generation tests of monetary models

Frenkel (1976): A Monetary Approach to the Exchange Rate

- Dollar-Mark data from German hyperinflation:

$$s = \underset{(0.05)}{\mathbf{0.975}} m + \underset{(0.073)}{\mathbf{0.591}} \pi^e$$

- Standard errors are in brackets and bold coefficients are statistically different from zero

- FPMM appears to fit this period very well:

  1. Both coefficients have the correct sign and are statistically significant
  2. The null hypothesis $\alpha_0 = 1$ cannot be rejected

First generation tests of monetary models

Hodrick (1978) – see MacDonald p. 138

- Also studies FPMM using Dollar-Mark data, but during early 1970s:

$$s = \mathbf{1.5}m - \mathbf{1.4}m^* - \mathbf{2.2}y + 0.1y^* + \mathbf{2.5}i + \mathbf{1.93}i^*$$

- Some support for the FPMM:
  1. All coefficients have the correct sign, except i^*
  2. Coefficients on money supply terms are almost equal and not significantly different from 1

- But...the coefficients on home and foreign GDP are very different and the latter is NOT statistically significant

First generation tests of monetary models

Smith and Wickens (1990) – see MacDonald p. 140

- Effective exchange rate for the Pound from 1973-91
- Estimate a sticky-price model using econometrics and then simulate the estimated model
- The estimated model is consistent with exchange rate overshooting – a 5% increase in the money supply leads to exchange rate overshooting by 21%
- These results provide support for the Dornbusch model

First generation tests of monetary models

Frankel (1979): On the Mark

- Estimates his real interest differential (RID) model using the Dollar-Mark exchange rate from July 1974 to Feb 1978:

$$s = \mathbf{0.97}(m - m^*) - \mathbf{0.52}(y - y^*) + \mathbf{29.40}(\pi^e - \pi^{e*}) - \mathbf{5.4}(r - r^*)$$

- Frankel 'proxies' for $\pi^e - \pi^{e*}$ and $r - r^*$ using nominal interest rates
- Results are supportive:
  1. All coefficients have the correct signs and are statistically significant
  2. Money supply coefficient ≈ 1 and other coefficients look plausible
  3. Further evidence of exchange rate overshooting

Frankel's RID model vs data: in-sample

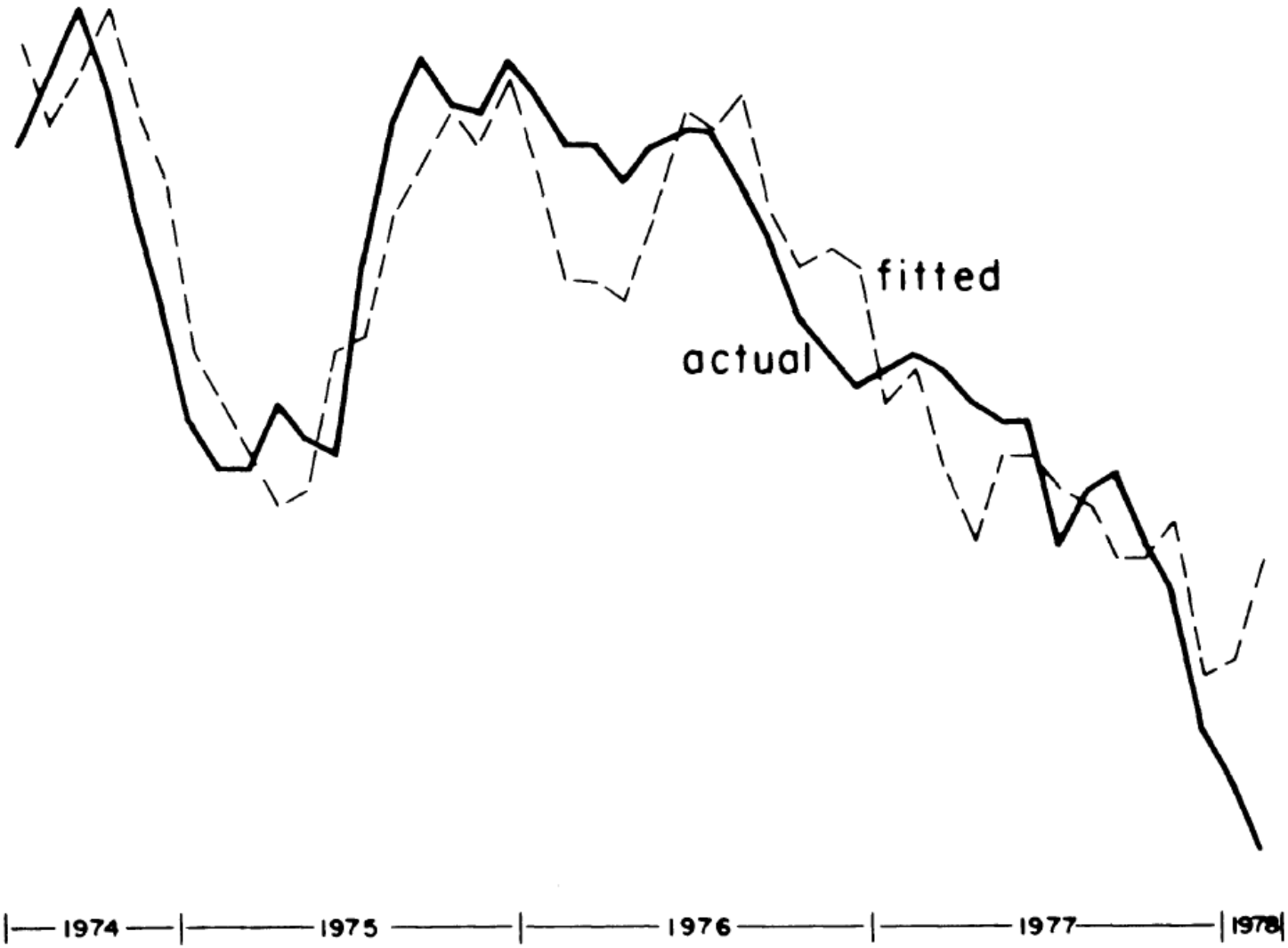


FIGURE 1. PLOT OF (*log* OF) MARK/DOLLAR RATE,
OLS REGRESSION FROM TABLE 1

Second generation tests of monetary models

- In later tests, researchers included data from the 1980s and late 1970s
- This was bad news for monetary models:
  1. Coefficients with the wrong signs
  2. Poor in-sample fit
- Frankel (1982): "*mystery of multiplying marks*" (MacDonald p. 140)
- DM was appreciating as the German money supply was increased – ie estimates of α_0 had the wrong sign!

Second generation tests of monetary models

- Frankel (1982) argues that the monetary model failed to explain the behaviour of the DM-Dollar exchange rate because ignores the current account
- He argues for a real wealth term in the money demand function
- **Intuition:** current account surplus redistributes wealth from US to Germany, increasing demand for DMs and reducing demand for $s
- Adding real wealth to the money demand function restores correct signs, statistical significance and in-sample fit

Second generation tests of monetary models

- Some researchers have argued that the monetary models performed poorly in the 1980s due to instability in money demand driven by financial innovation
- Others have argued that the problem lies with the assumption that UIP holds
- In particular, deviations from UIP could be driven by a time-varying risk premium
- Ignoring movements in the risk premium could explain the poor performance of monetary models in the 1980s

Early empirical tests: a summary

- First generation tests of monetary models were strongly supportive of all three models – FPMM, Dornbusch, RID
- Second generation tests found far less favourable results, but small modifications of the monetary model can account for some of the discrepancy in performance
- **Overall verdict:** early empirical tests mostly supportive of monetary models of exchange rates

The Meese-Rogoff critique

- Meese and Rogoff (1983) drew attention to the fact that all early empirical tests of monetary models were **in-sample tests**
- That is, they tested how well the models explained what HAD happened, not whether they could predict what was GOING to happen to exchange rates in the future
- MR reasoned that if monetary models are effective models, they should outperform simple models in **out-of-sample forecast tests**
- They set out to establish whether this indeed the case. Their findings came as a big surprise to economists at the time!

In-sample vs out-of-sample tests of exchange rates

- **In-sample tests**
  1. Estimate parameters to provide a 'best fit' over the period in question
  2. Compare model forecasts (ie 'fitted values') with actual values
- **Out-of-sample tests**
  1. Estimate parameters to provide a 'best fit' for some period
  2. Use the model to forecast for some future period *outside* the sample
- Out-of-sample tests set the bar high, so we often compare our models against a simple **random walk model**
- Random walk says: **future exchange rate = today's exchange rate**

Meese and Rogoff (1983)

- MR use monthly data from the 1970s and focus mainly on short run forecast performance
- Run regression for RID/Dornbusch model:

$$s = \alpha_0(m - m^*) + \alpha_1(y - y^*) + \alpha_2(\pi^e - \pi^{e*}) + \alpha_3(i - i^*) + resid$$

- FPMM arises when $\alpha_2 = 0$, so they test this model as well
- Effective dollar exchange rate & Dollar-DM, Dollar-Pound and Dollar-Yen bilateral exchange rates
- Regressions are estimated for the period 1973-76, then forecast 1977-80 **out-of-sample**

Meese and Rogoff (1983)

- M&R compare the forecast performance of the monetary models against a random walk:

$$s = s_{-1} + resid$$

- Forecast performance is measured using **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

Meese and Rogoff (1983): the results

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

	RW	Flex-price	Dornbusch/RID
$/Yen	3.68	4.11	4.40
$/Pound	2.56	2.82	2.90

Source: Meese and Rogoff (1983), Table 1, p. 13.

- **Key points:**
  1. Random walk outperforms the monetary models despite its simplicity
  2. Similar findings at the 6-month and 12-month forecast horizons

Recent empirical evidence on monetary models

- Since Meese and Rogoff (1983), the literature has focused on 3 areas:
  1. **Cointegration studies**
  2. **Out-of-sample forecasting revisited**
  3. **Fundamentals vs exchange rate volatility**
- Do these studies give us cause to be more optimistic about monetary exchange rate models?

Cointegration

- If X and Y share a common trend they are **cointregated**

- Cointegration implies that there is a **long run equilibrium relationship** between the variables X and Y

Cointegration

Example 1

- Suppose Y = log of UK CPI and X = log of US CPI
- Cointegration of X and Y implies that PPP holds in the long run
- We can test for a single cointegrating relationship using the Engle-Granger test

Example 2

- If a model has more than one equation, we need to test for multiple cointegrating vectors
- We use the Johansen method to test for multiple cointegrating vectors

Cointegration studies

MacDonald and Taylor (1993)

- Dollar-Mark data from Jan 1976 to Dec 1990
- Engle-Granger test rejects cointegration, but Johansen does not
- The cointegrating equation is

$$s = \mathbf{1}(m - m^*) - \mathbf{1}(y - y^*) + 0.05(i - i^*)$$

- This is the estimated long run equilibrium for the exchange rate
- The coefficients have the correct sign and are of plausible magnitude

Cointegration studies

Mark and Sul (2001)

- Quaterly data 1973Q1 to 1997Q4 for 19 countries
- Statistically significant evidence of cointegration
- As with MacDonald and Taylor (1993), the results are supportive of monetary models
- In particular, the estimated long run equilibrium is consistent with the flex-price monetary model

Out-of-sample forecasting revisited

- Meese and Rogoff (1983) allow for only very limited exchange rate dynamics in their analysis
- This may be unfair on monetary models because exchange rates are highly persistent and there may be structural changes over time (eg in the money market)
- MacDonald argues that estimations of monetary models should be amended to capture these short run dynamics
- We can then test the estimated equations out-of-sample against a random walk

Out-of-sample forecasting revisited

MacDonald and Taylor (1993)

- MT use their cointegrating relationship and the model of short run dynamics (error correction model) to predict out-of-sample

Table 3 – Root mean square error (RMSE)

Horizon	Monetary model	Random walk
1 month	0.028	0.030
6 months	0.081	0.088
12 months	0.131	0.148

Source: MacDonald and Taylor (1993), Table 3, p. 104.

- These findings overturn the Meese-Rogoff result, but MT use actual and not forecast values on the RHS of the equation

Out-of-sample forecasting revisited

MacDonald and Marsh (1997)

- MM forecast-out-of-sample when RHS variables must also be forecast

Table 4 – RMSE ratios (Yen-Dollar)

Horizon	$\frac{RMSE^{Model}}{RMSE^{RW}}$
1 month	1.059
6 months	0.949
12 months	0.618

Source: MacDonald and Marsh (1997), Table 7, p. 662.

- At longer horizons the model significantly outperforms a random walk
- **Caveat:** they introduce additional short run dynamics in the model without a good theoretical justification

Out-of-sample forecasting revisited

Mark (1995)

- The MacDonald cointegration papers point to improved out-of-sample performance as the forecast horizon is increased
- Mark shows that the monetary model does significantly better than a random walk out-of-sample at long horizons

Table 5 – 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.

Out-of-sample forecasting revisited

Mark (1995)

- Mark's results suggest that monetary models are useful predictors of future exchange rates, but ONLY at relatively **long horizons** such as 3 or 4 years ahead
- At horizons less than one year, exchange rate movements are driven by transitory factors which are not related to economic fundamentals. Mark's in-sample results show this very clearly – see next slide.
- We use the term **'noise'** for all the transitory factors that affect exchange rates but which are unrelated to fundamentals
- Some have argued that short-term exchange rate movements are the result of **noise trading** – ie trading based on whims and fads

Mark (1995) – Figs 1 to 5

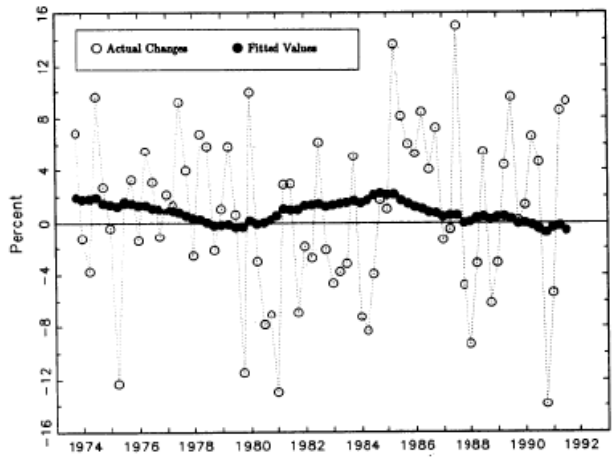


FIGURE 1. ONE-QUARTER CHANGES IN THE LOG DOLLAR/DEUTSCHE-MARK EXCHANGE RATE

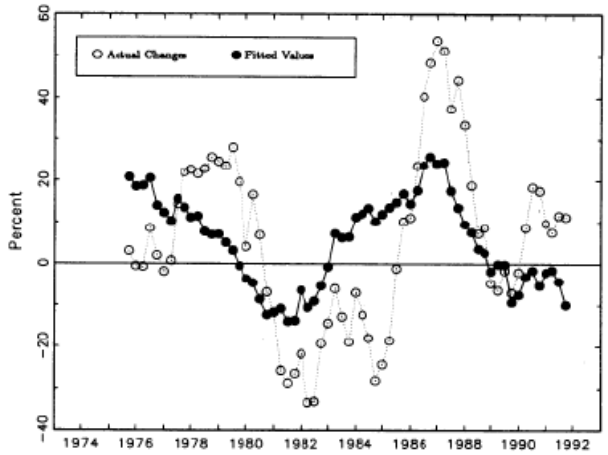


FIGURE 3. EIGHT-QUARTER CHANGES IN THE LOG DOLLAR/DEUTSCHE-MARK EXCHANGE RATE

Fundamentals (•) are not useful at modelling actual exchange rate changes (o) at short horizons

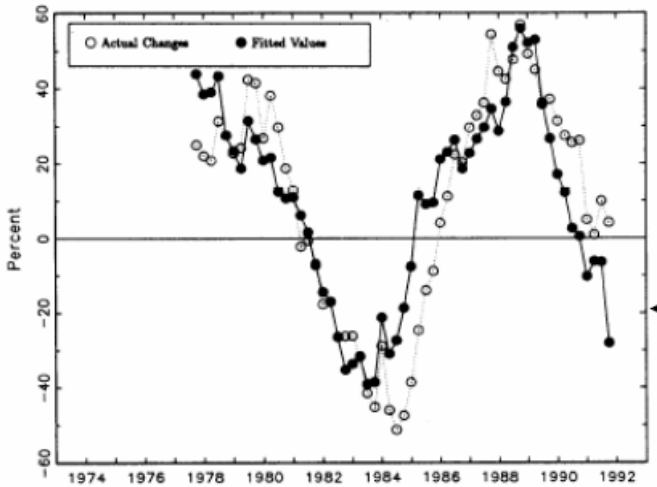


FIGURE 5. SIXTEEN-QUARTER CHANGES IN THE LOG DOLLAR/DEUTSCHE-MARK EXCHANGE RATE

Fundamentals can model exchange rates at longer horizons

Fundamentals vs exchange rate volatility

Flood and Rose (1995)

- The move from fixed to floating exchange rates when Bretton Woods ended is a 'natural experiment'
- Was the move from fixed exchange rates to floating accompanied by an increase in the volatility of macroeconomic fundamentals?
- Test of **excess volatility** based on the flex-price model:

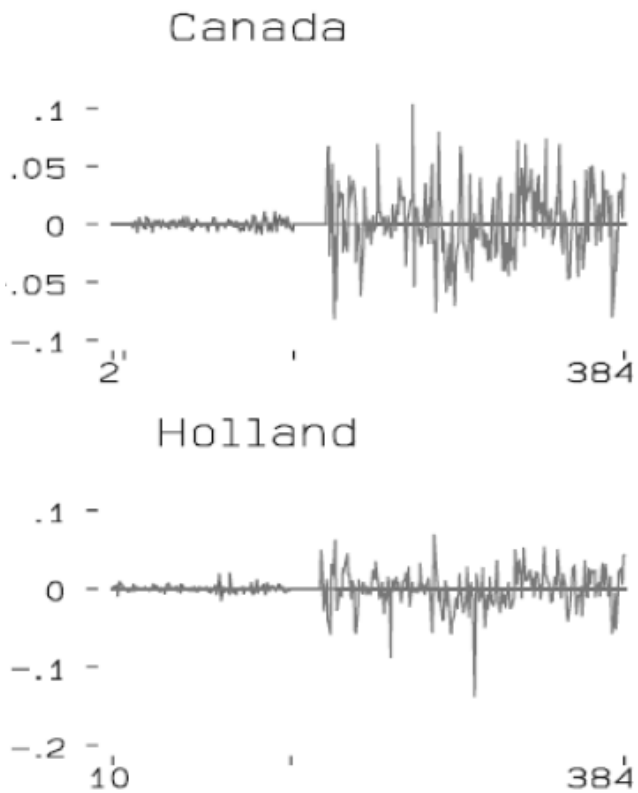
$$s = m - m^* - \eta(y - y^*) + \sigma(i - i^*)$$

- **Traditional Fundamentals:** $TF = m - m^* - \eta(y - y^*)$
- **Virtual Fundamentals:** $VF = s - \sigma(i - i^*)$
- If the model is correct, TF and VF should be equal

Flood and Rose (1995)

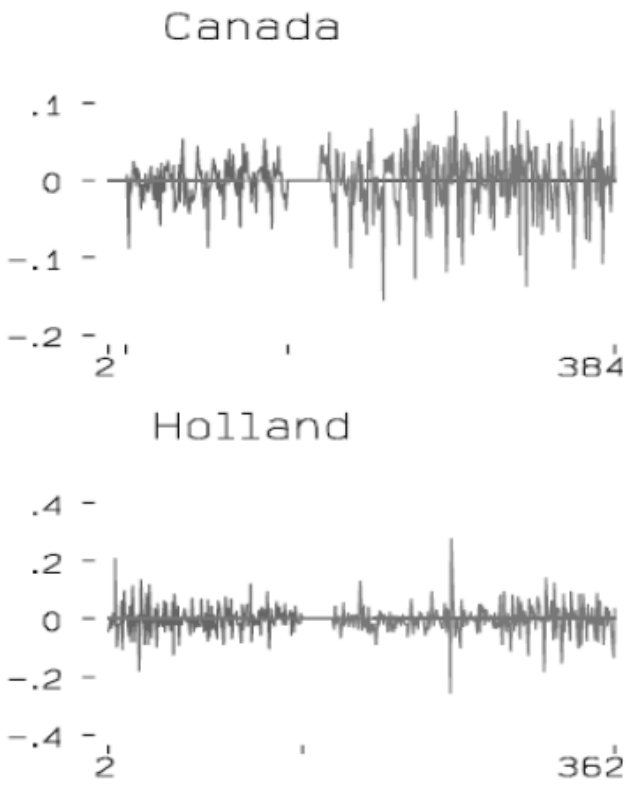
Virtual Fundamentals:

$$VF = s - \sigma(i - i^*)$$



Traditional Fundamentals:

$$TF = m - m^* - \eta(y - y^*)$$



Flood and Rose (1995)

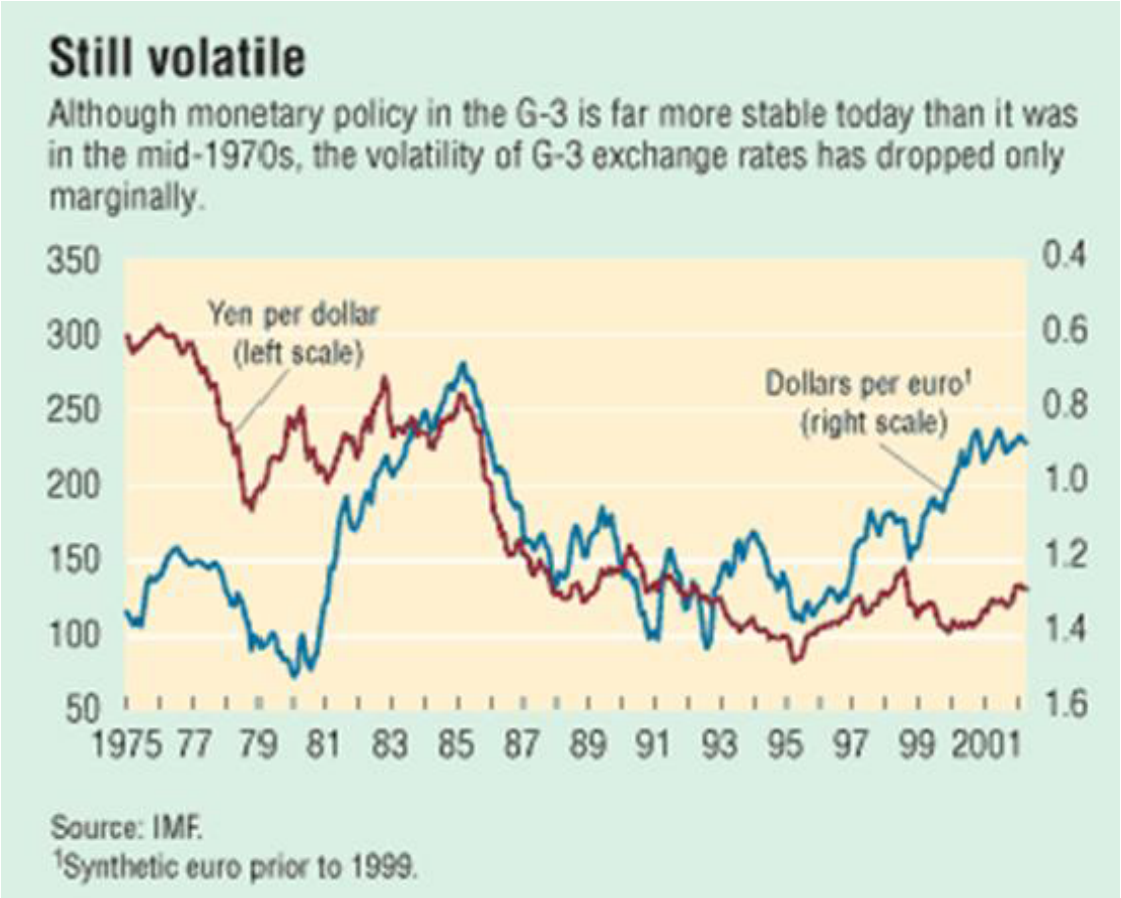
- In OECD countries there is little change in TF volatility, but a clear increase in VF volatility after the end of Bretton Woods
- The substantial increase in VF volatility arose because the exchange rate was no longer fixed
- But there was no clear increase in TF volatility after Bretton Woods
- Economic fundamentals therefore cannot account for the big increase in exchange rate volatility after the move to floating

Rogoff (2002)

- Rogoff points out that because economic fundamentals are far more stable today than in the 1970s, we should have seen a substantial fall in exchange rate volatility
- The fact that exchange rate volatility has fallen only marginally since the 1970s suggests that there must be important determinants of exchange rate movements which are 'missing' from monetary models
- Since we do not know exactly what these missing factors are, Rogoff poses the question

Why are G-3 exchange rates so fickle?

Rogoff (2002)



Source: Rogoff (2002): Why are G-3 exchange rates so fickle?

Summary of empirical evidence

- Early empirical tests of monetary models gave promising results
- But this credibility was shattered by the results of Meese and Rogoff (1983), which have not been convincingly overturned to this day
- There is now a strong consensus that economic fundamentals cannot explain much of the exchange rate movements we see over very short horizons – daily, weekly, monthly
- For this reason, market microstructure has gained attention
- However, monetary models do very well in out-of-sample forecast tests at long horizons such as 3+ years, so these models can be useful for medium or long run forecasting and analysis

Next time...

- We will cover two topics:
  1. Exchange rate risk
  2. Equilibrium exchange rates
- The first topic will include the Carry Trade and modifying the UIP condition to include a risk premium
- In the second topic you will be introduced to concepts of equilibrium exchange rates, including models such as BEER and CHEER
- **Advance reading:**
  1. Pilbeam Box 7.2 (p. 154-55) and Ch. 8.2-8.3
  2. MacDonald Ch. 9 (except 9.6.4) or Driver and Westaway (2004)