FETP/MPP8/Macroeconomics/Riedel

Exchange Rates and Interest Rates

How is the exchange rate determined?

Broadly speaking, there are two ways the exchange rate is determined.

1. The government fixes the exchange rate as a matter of policy. The are two ways the government can maintain a fixed the exchange rate.
    - If the government plays by "the rules of the game," it fixes the exchange rate by announcing a rate at which it will buy and sell foreign exchange. By doing so, the government (central bank) is obliged (1) to buy foreign exchange when there is excess supply in the market, adding its foreign exchange purchases to its stock of official foreign reserves ($\Delta R>0$) and (2) sell foreign exchange from its stock of foreign reserves when there is excess demand in the market.
    - Ration foreign exchange using licenses, quotas and other non-market means of clearing the market. This is not playing by the rule of a fixed exchange rate system.
2. Let the market for foreign exchange determine the equilibrium exchange rate. In the market, the exchange rate is determined by the interplay of supply and demand.

Note: We begin with a market determined exchange rate and later take up the economics of a fixed exchange rate system.

EXCHANGE RATES: Definitions

Definitions and terminology

The nominal exchange rate (E): the domestic price of a unit of foreign currency ($E_{H/F}$), or its reciprocal, the foreign price of a unit of home currency ($E_{F/H} = 1/E_{H/F}$).

- A rise in $E_{H/F}$ (hereafter E used for $E_{H/F}$) is a nominal devaluation of the domestic currency and nominal appreciation of the foreign currency.
- A rise in E lowers the cost of home goods in foreign markets and raises the cost of foreign goods in the home market. I.e. it makes the home country more competitive, other things (prices) equal.

The real exchange rate (e): the price of foreign goods (P*) relative to the price of domestic goods (P) expressed in a common currency: $e = E \cdot P^*/P$.

- A rise in e is a real (as opposed to nominal) devaluation and indicates an increase in the price competitiveness of domestic goods in foreign markets.
- A decline in e is a real appreciation, indicating a rise in relative price of domestic goods and hence a decline in the home country's price competitive.

EXCHANGE RATES: Definitions

Definitions and terminology

The purchasing power parity exchange rate: the exchange rate at which prices, when expressed in a common currency, are the same at home and abroad. This holds when:

$$E \cdot P^* = P \quad \Rightarrow \quad e = EP^*/P = 1 \quad \Rightarrow \quad E_{PPP} = P/P^*$$

The Big Mac PPP exchange rate index (as of July 2015):

Country	Price in domestic currency	Nominal exchange rate	Price in US dollars	PPP $ Exchange Rate	Dollar Over/under valuation
China	17	6.21	2.74	3.55	-42.84
Euro area	3.7	0.91	4.05	0.77	-15.37
Japan	370	123.94	2.99	77.24	-37.67
Thailand	108	34.09	3.17	22.55	-33.86
United States	4.79	1.00	4.79	1.00	0.00
Vietnam	60,000	21,810	2.75	12,526	-42.57

http://www.economist.com/content/big-mac-index

EXCHANGE RATES: Definitions

Definitions and terminology

Nominal and real effective exchange rates: the NEER and the REER: weight averages of indexes of nominal and real exchange rates for multiple countries (i) rates over time (t).

$$NEER_{j,t} = \sum_i w_i \bar{E}_{j/i,t} \qquad REER_{j,t} = \sum_i w_i \bar{e}_{j/i,t}$$

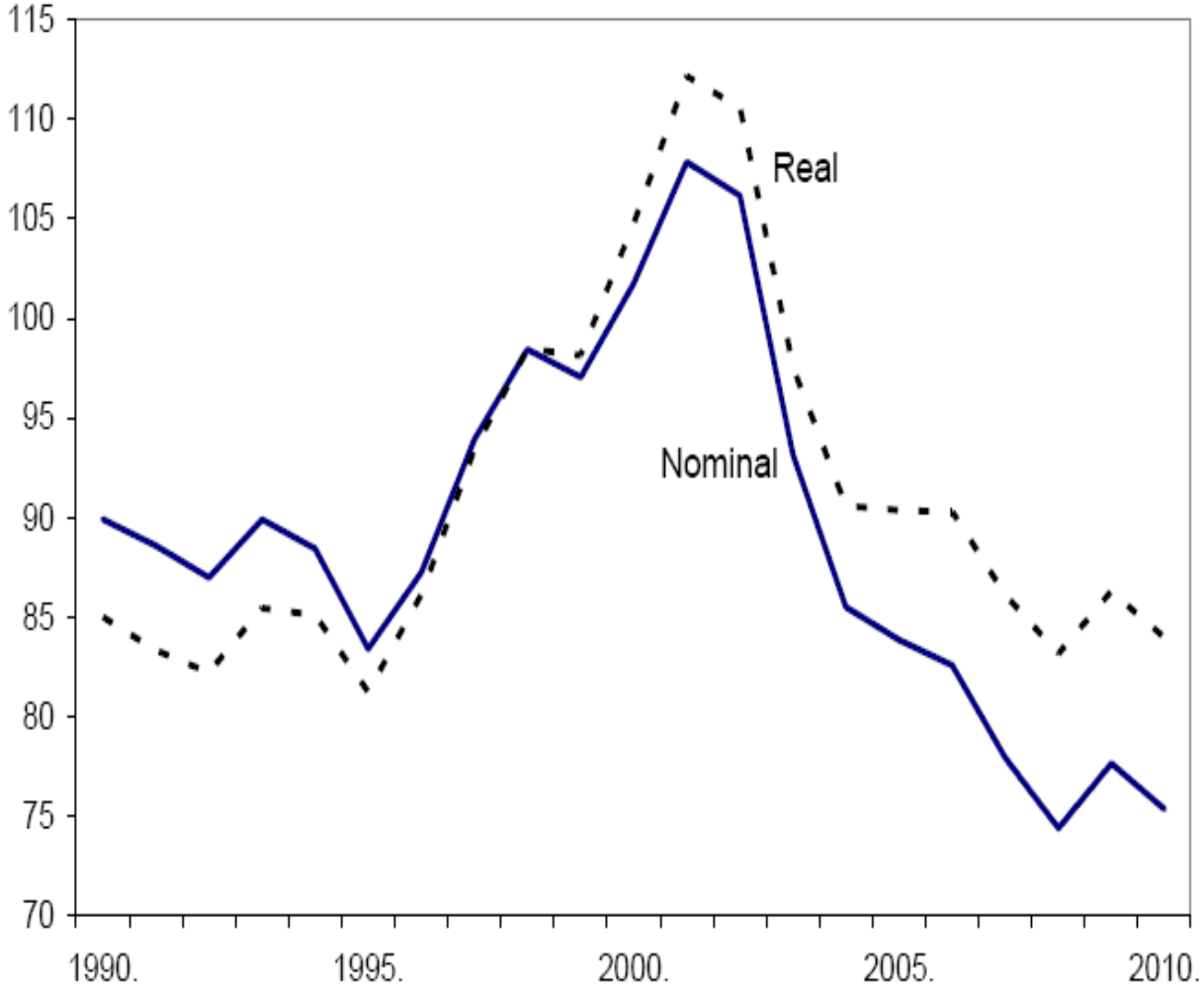
where w_i is the weight of country i in the trade of country j and $\bar{E}_{j/i,t}$ and $\bar{e}_{j/i,t}$ are country j's indexes of nominal and real exchange rates for country i in year t.

$NEER_{j,t}$ *and* $REER_{j,t}$ indicate the price competitiveness of a given country (j) vis-à-vis many (N) countries ($i = 1,2, \ldots N$).

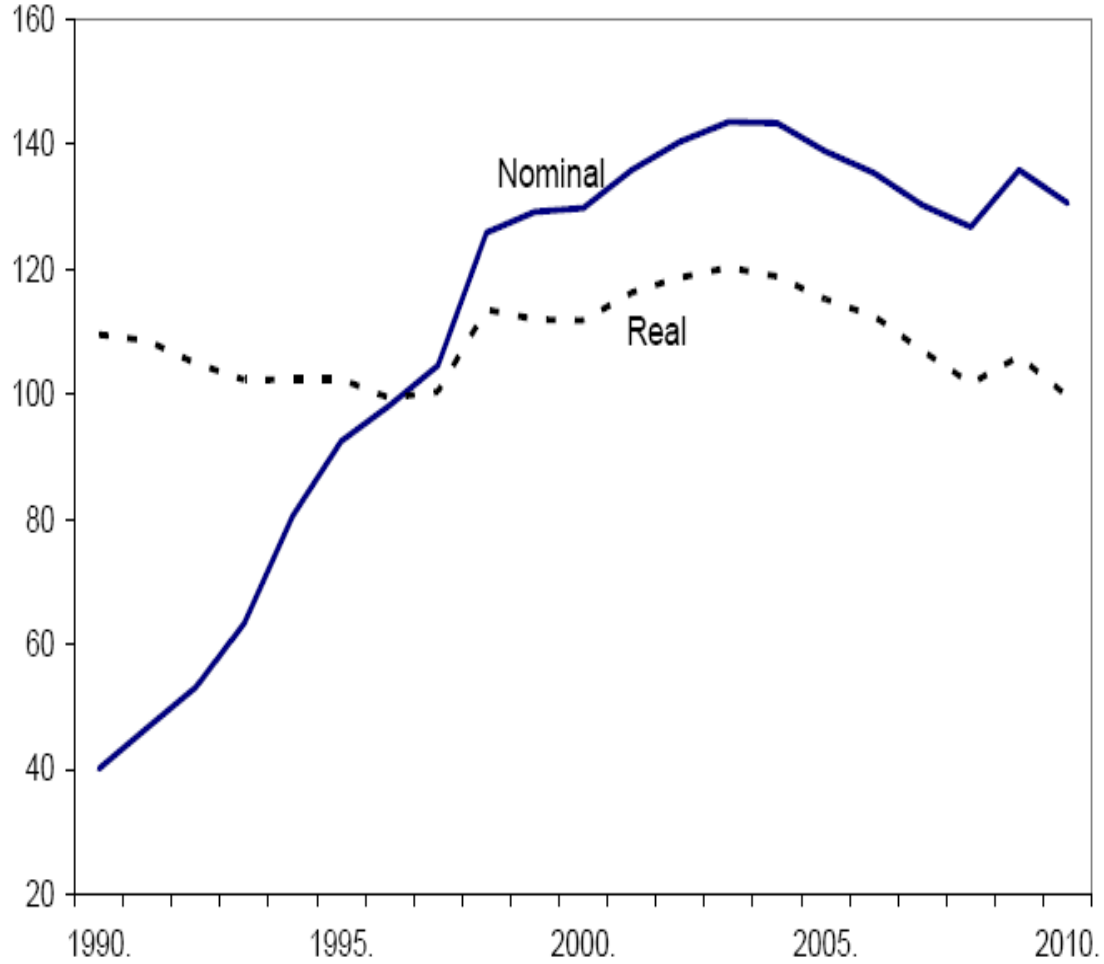
The figures below show the nominal and real effective exchange for the US dollar vis-à-vis two groups of countries: 1. Major currency countries and 2. Other (mostly emerging market) countries.

EXCHANGE RATES: Effective Exchange Rates

US NEER & REER: Major Currencies

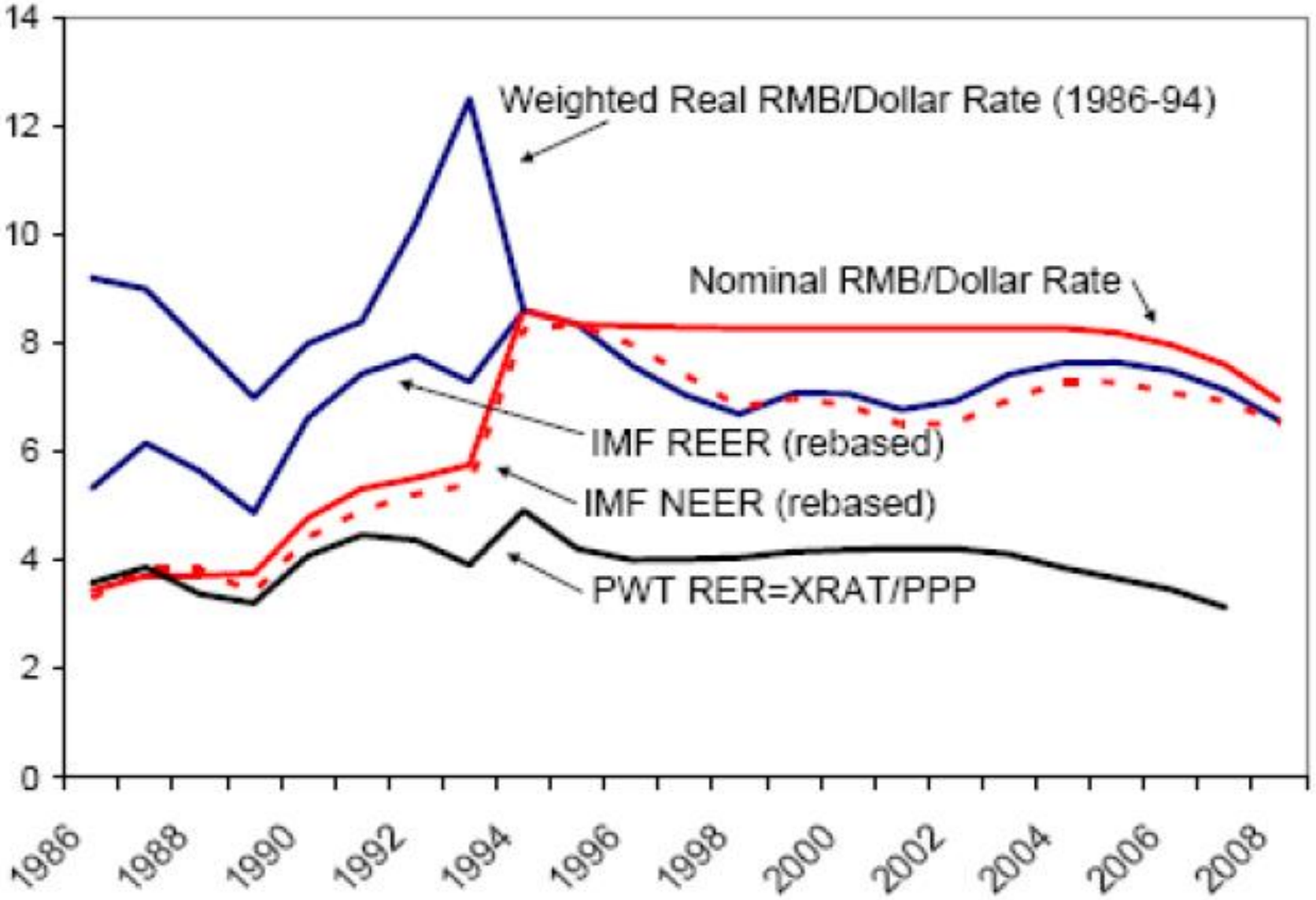


US NEER & REER: Other trade partners

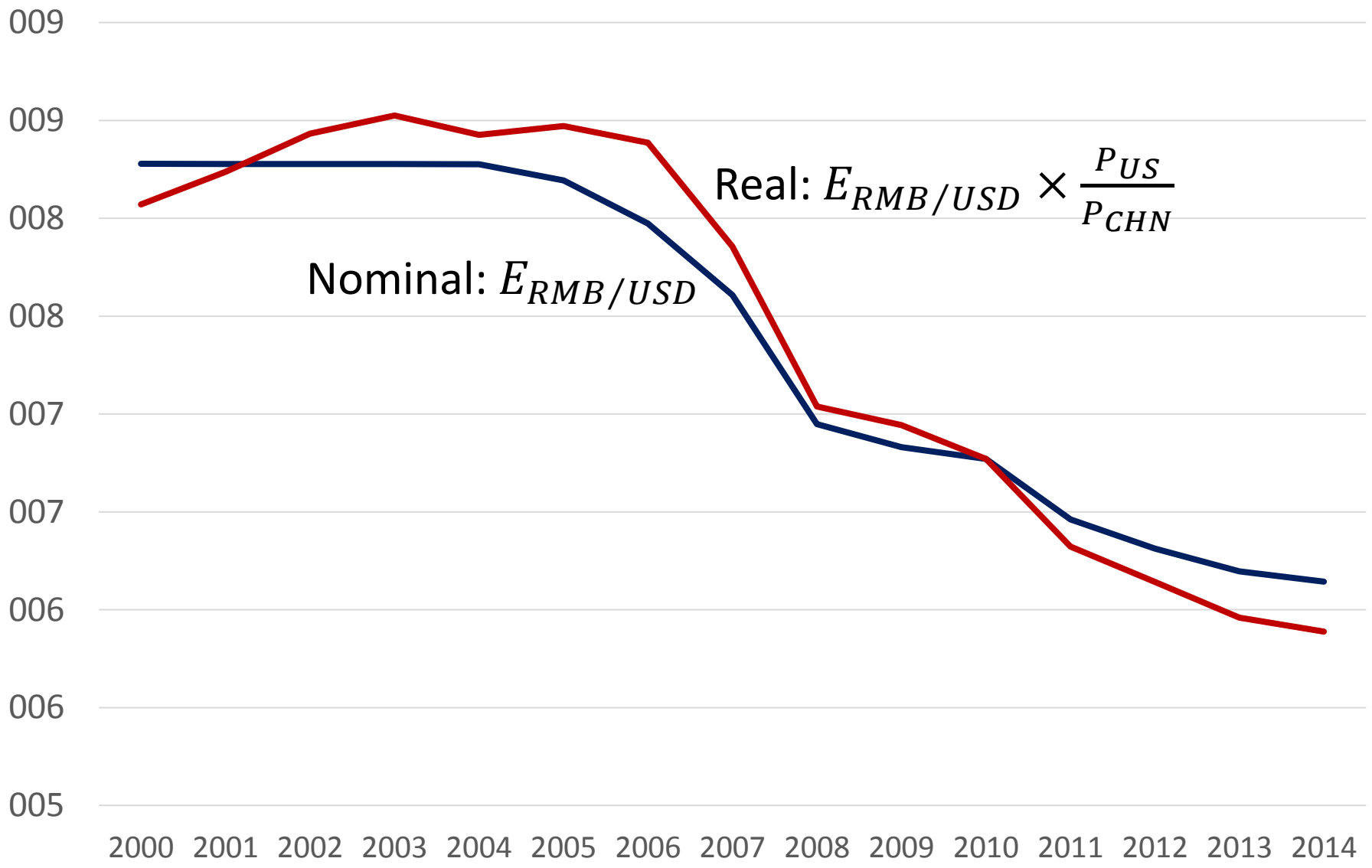


Note: As these indexes are constructed, a rise indicates appreciation

EXCHANGE RATES: China RMB NEER & REER

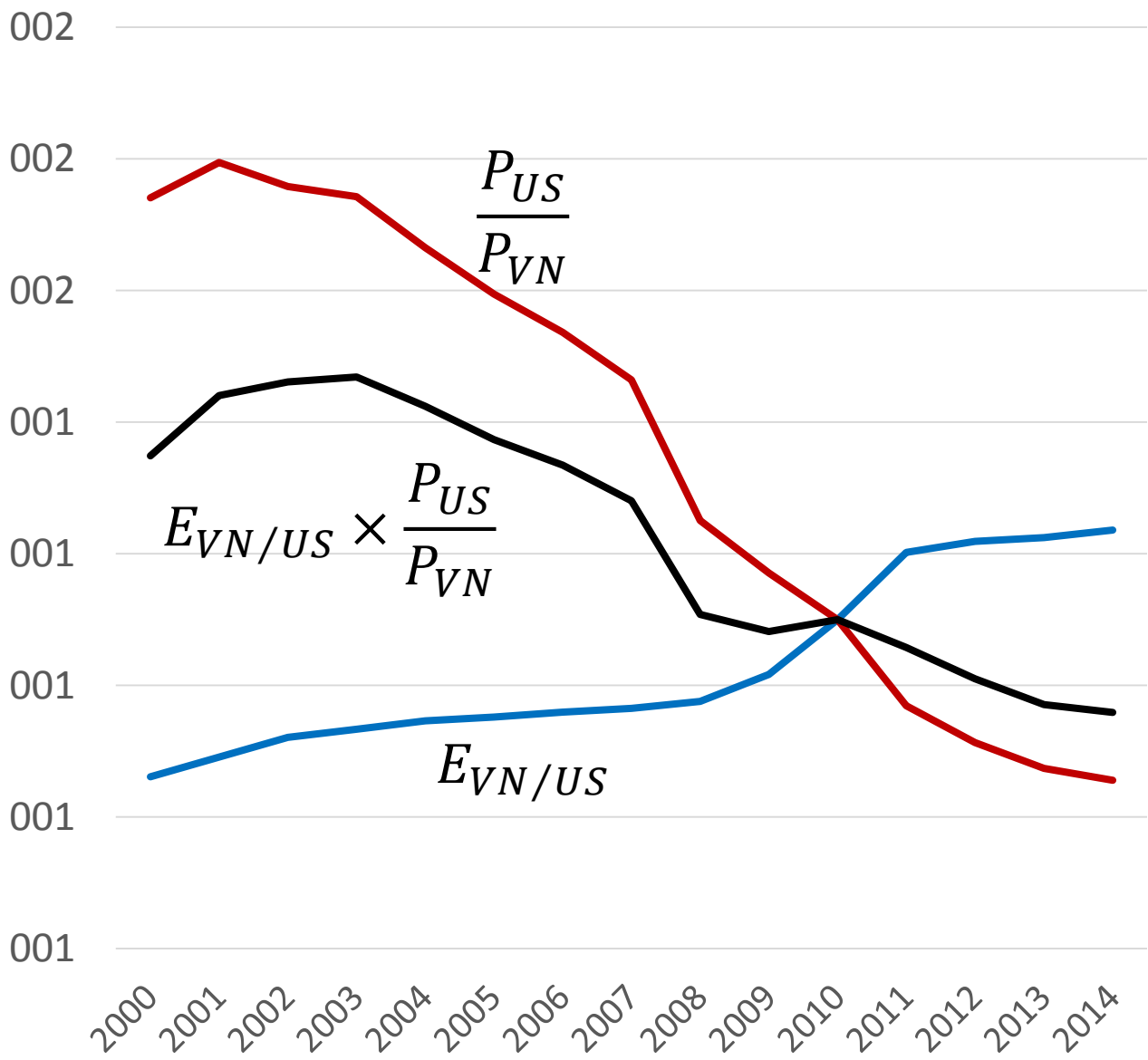


Nominal and Real RMB-Dollar Exchange Rates



Nominal and Real đồng-dollar exchange rate: 2000-2014

Year	$E_{VN/US}$	$E_{VN/US}$	P_{US}	P_{VN}	Pus/Pvn
2000	14,168	0.76	79.0	48.1	1.64
2001	14,725	0.79	81.2	47.9	1.69
2002	15,280	0.82	82.5	49.8	1.66
2003	15,510	0.83	84.4	51.4	1.64
2004	15,746	0.85	86.6	55.3	1.57
2005	15,859	0.85	89.6	59.9	1.49
2006	15,994	0.86	92.4	64.4	1.44
2007	16,105	0.87	95.1	69.7	1.36
2008	16,302	0.88	98.7	85.8	1.15
2009	17,065	0.92	98.4	91.9	1.07
2010	18,613	1.00	100.0	100.0	1.00
2011	20,510	1.10	103.2	118.7	0.87
2012	20,828	1.12	105.3	129.5	0.81
2013	20,933	1.12	106.8	138.0	0.77
2014	21,148	1.14	108.6	143.6	0.76



Source: World Development Indicators and OECD online data

EXCHANGE RATES: Spot versus Forward Rates

- **Spot rates** are exchange rates for currency exchanges "on the spot," or when trading is executed in the present.
- **Forward rates** are exchange rates for currency exchanges that will occur at a future ("forward") date.

Forward dates are typically 30, 90, 180, or 360 days in the future. Rates are negotiated between two parties in the present, but the exchange occurs in the future.

We begin with an analysis of the spot exchange rate and later take up the forward exchange rate.

EXCHANGE RATES: How they are quoted

U.S. dollar foreign-exchange rates in late New York trading for February 6, 2012
(to be updated)

	In US $	Per US $
Americas		
Argentina peso*	0.2317	4.3168
Brazil real	0.5825	1.7169
Canada dollar	1.0066	0.9935
Chile peso	0.002087	479.1
Colombia peso	0.00056	1785.5
Ecuador US dollar	1	1
Mexico peso*	0.079	12.6588
Asia-Pacific		
Australian dollar	1.0772	0.9283
1-mos forward	1.073688	0.93
3-mos forward	1.066818	0.94
6-mos forward	1.056993	0.95
China yuan	0.1586	6.3066
Hong Kong dollar	0.129	7.7539
India rupee	0.02059	48.57495
Indonesia rupiah	0.000112	8963
Japan yen	0.013054	76.6
1-mos forward	0.013057	76.59
3-mos forward	0.013067	76.53
6-mos forward	0.013082	76.44
Malaysia ringgit§	0.3331	3.0023
New Zealand dollar	0.8357	1.1966
Philippines peso	0.0236	42.425
Singapore dollar	0.805	1.2422
South Korea won	0.000899	1112.25
Thailand baht	0.03249	30.78
Vietnam dong	0.00005	20985

	In US $	Per US $
Europe		
Denmark krone	0.177	5.65
Euro area euro	1.3159	0.7599
Norway krone	0.1725	5.7959
Russia ruble‡	0.0331	30.212
Sweden krona	0.1498	6.6766
Switzerland franc	1.0893	0.9181
1-mos forward	1.0896	0.9178
3-mos forward	1.0909	0.9167
6-mos forward	1.0928	0.9151
Turkey lira**	0.5704	1.7531
UK pound	1.5815	0.6323
1-mos forward	1.5812	0.6324
3-mos forward	1.5803	0.6328
6-mos forward	1.5788	0.6334
Middle East/Africa		
Bahrain dinar	2.6527	0.377
Eqypt pound*	0.1664	6.0096
Israel shekel	0.2696	3.709
Jordan dinar	1.4115	0.7085
Kenya shilling	0.01195	83.65
Kuwait dinar	3.6036	0.2775
Lebanon pound	0.000665	1503.45
Saudi Arabia riyal	0.2666	3.7505
South Africa rand	0.1329	7.5252
UAE dirham	0.2723	3.6731

Theories of the Equilibrium Spot Exchange Rate

The exchange rate is a price. Like any other commodity, the equilibrium price in the foreign exchange market is that rate which clears the market (i.e. where supply equals demand).

The demand and supply of foreign exchange arise from (1) trade in goods and service and (2) trade in financial assets.

- For countries whose financial markets are highly integrated, it is the supply and demand for foreign exchange that arises from international financial flows that principally determines the equilibrium exchange rate. The theory that explains the equilibrium exchange rate in financially integrated economies is known as the ASSET MARKET APPROACH to exchange rate determination.
- For countries whose capital accounts are closed, it is the supply and demand for foreign exchange arising from trade in goods and services that principally determines the exchange rate. The theory that explains the equilibrium exchange in countries that are not financially integrated is known as the ELASTICITIES APPROACH to exchange rate determination.

The latter is now out of fashion, but it is considered here before going on to the generally preferred asset-market approach.

Elasticities Approach to the Exchange Rate

Start with the Balance of Payments, which records receipts and payments of foreign exchange—in other words, supply and demand for foreign exchange. A simplified version of the BOP accounting identity is:

$$X - M - \Delta NFA - \Delta R = 0$$

If a country has no access to international financial markets, then the change in net foreign assets (ΔNFA) in any period depends on the generosity of aid donors, so we can treat ΔNFA as exogenous, i.e. not determined in the market, and can give ΔNFA any arbitrary value, for example zero (ΔNFA=0).

If a country does not fix its exchange rate (as we assume at his point) the ΔR is also arbitrary and exogenous, so we can also set ΔR=0 also.

Which leaves us with the equilibrium condition: $X - M = 0$. The equilibrium exchange rate in this case is the rate that achieves trade balance (X=M).

To find that exchange rate, we need a theory of X and M.

Elasticities Approach to the Exchange Rate

It is reasonable to hypothesize that the level of exports is a positive function of the relative price of home goods in the foreign markets ($E \cdot P^*/P$) and the level of income in the foreign markets (Y^*).

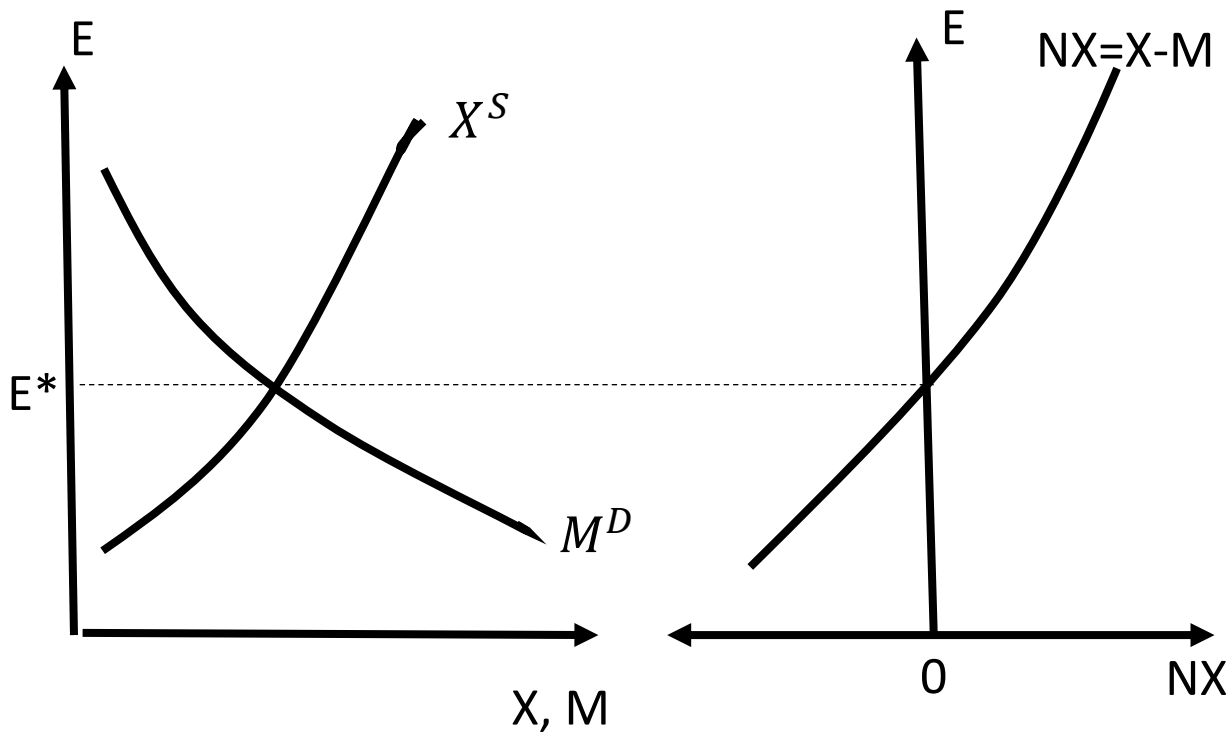
$$X = f(EP^*/P, Y^*) = f(e, Y^*)$$

If we make P*, P and Y* exogenous, then we have an export function (i.e. foreign exchange supply function X^S).

Similarly, we hypothesize that the demand for imports (i.e. demand for foreign exchange) is a negative function of the relative price of foreign goods and a positive function of domestic income:

$$M = f(EP^*/P, Y)$$

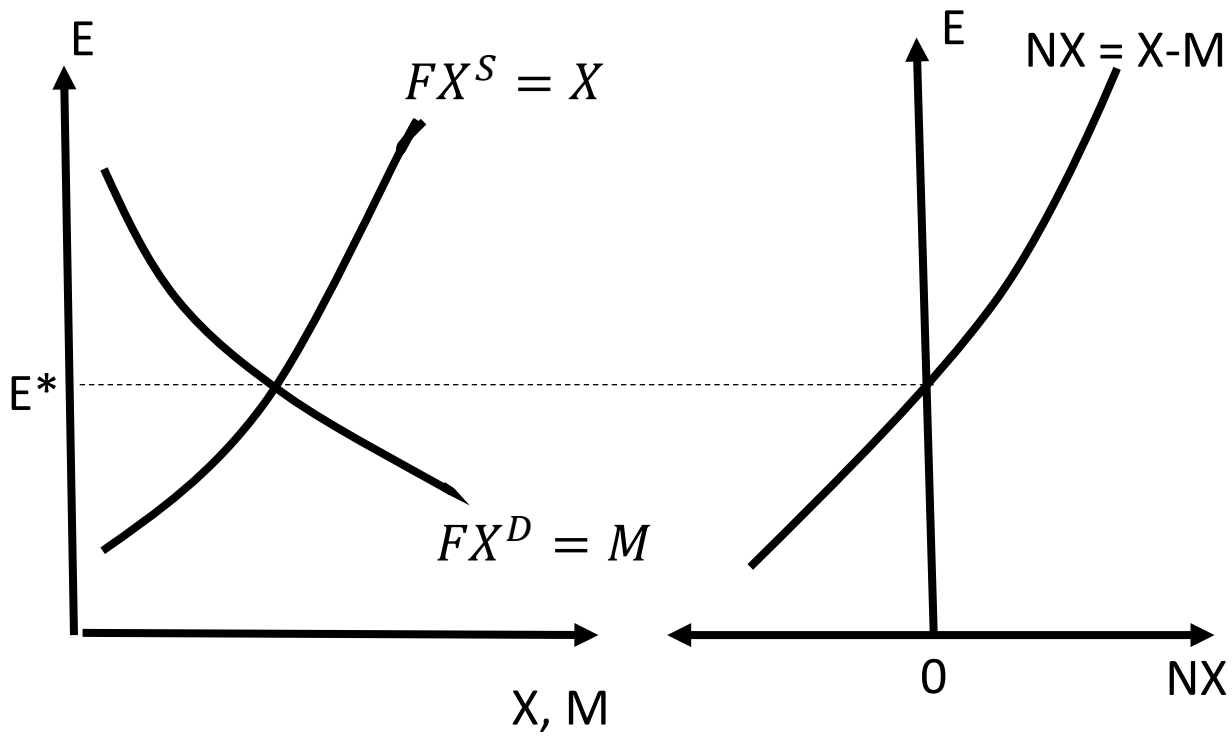
Again, if P*, P and Y are exogenous, we get an import (foreign exchange demand function (M^D)



Elasticities Approach to the Exchange Rate

This simple model can be used to analyze the effect of changes in the exogenous variables on the equilibrium exchange rate.

Exogenous Variable	Effect on FX^S & FX^D	Effect on E
$P \uparrow$	$FX^S \downarrow$ $FX^D \uparrow$	$E \uparrow$
$P^* \uparrow$	$FX^S \uparrow$ $FX^D \downarrow$	$E \downarrow$
Y↑	$FX^D \uparrow$	$E \uparrow$
$Y^* \uparrow$	$FX^S \uparrow$	$E \downarrow$



This exercise illustrates how the exchange rate adjusts to compensate (offset) exogenous shift in the relative competitiveness of countries in the global trading system.

Asset Market Approach to the Exchange Rate

The core principle of the Elasticities Approach to the exchange rate is the Law of One Price (i.e. purchasing power parity) in goods market. The core principle in the Asset-Market Approach is also the Law of One Price, but applied to assets instead of goods. The law of one price holds in asset markets when the risk adjust return to assets in the home market and the foreign market are the same. This is known as **Uncovered Interest Parity (UIP).**

$$R = R^* + \frac{E' - E}{E} + \rho$$

R is the interest rate on domestic assets (e.g. bank deposits)

R* is the interest rate on foreign assets (e.g. foreign bank deposits)

E is the nominal exchange rate (domestic currency per unit of foreign currency)

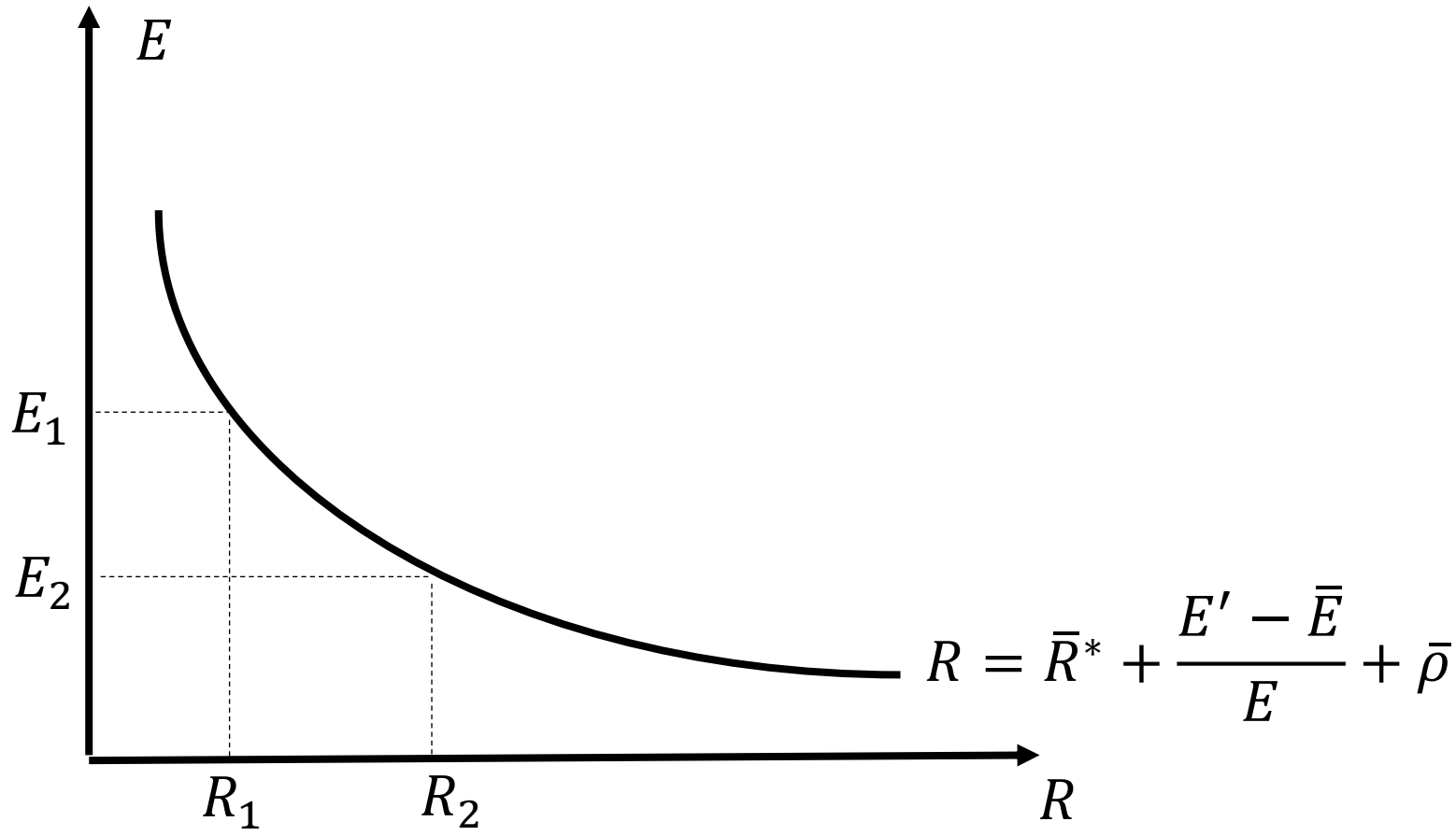
E' is the expected future (long-run) nominal exchange rate

ρ is a measure of the riskiness of domestic assets relative to foreign assets

Note: $(E - E')/E$ is the expected rate of depreciation of the domestic currency and hence the expected rate of appreciation of the foreign currency.

ASSET MARKET APPROACH

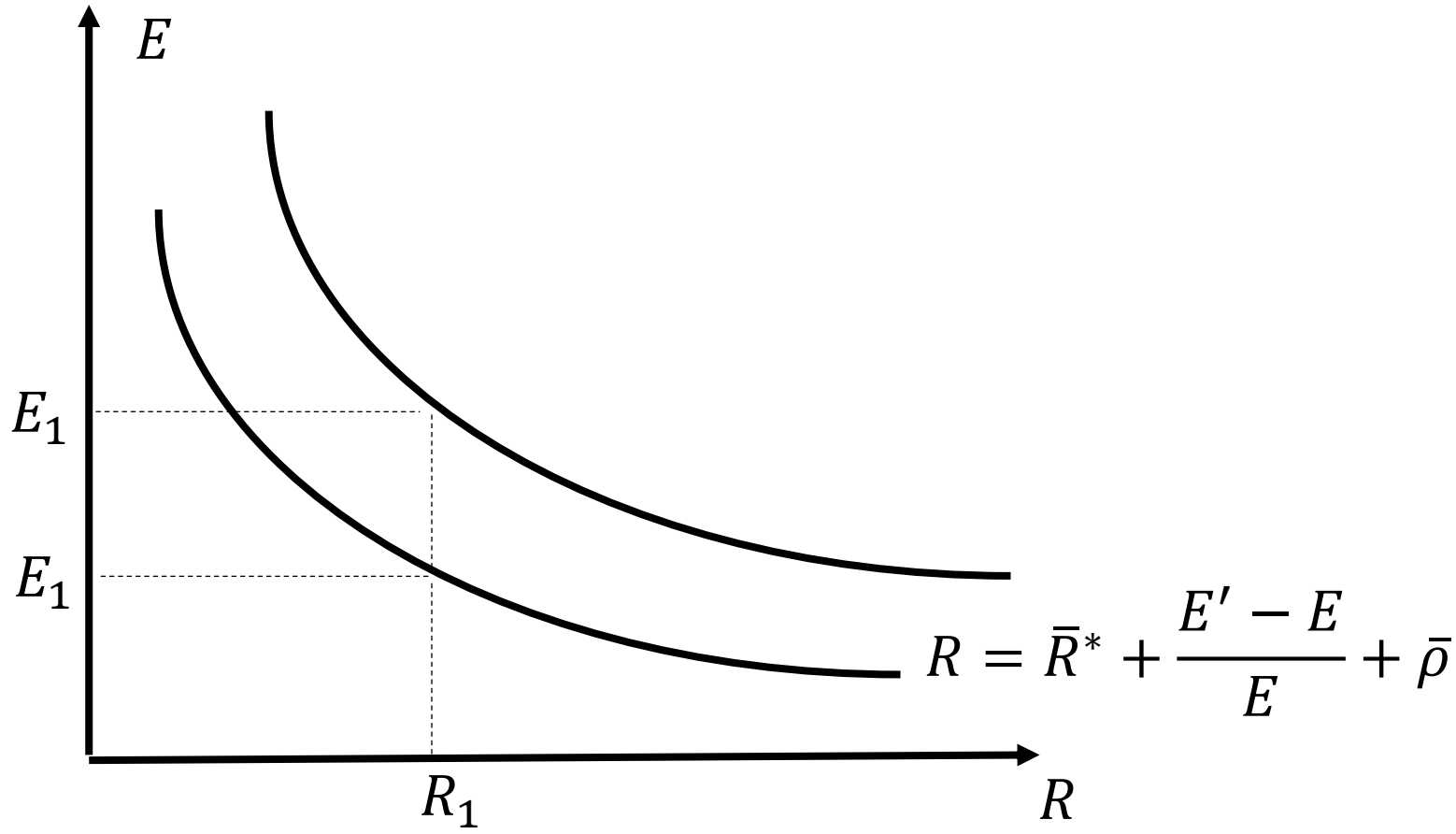
The diagrammatic illustration of UIP is shown below for given values of E', R* and ρ.



Why when R↑ must E↓ to satisfy UIP?

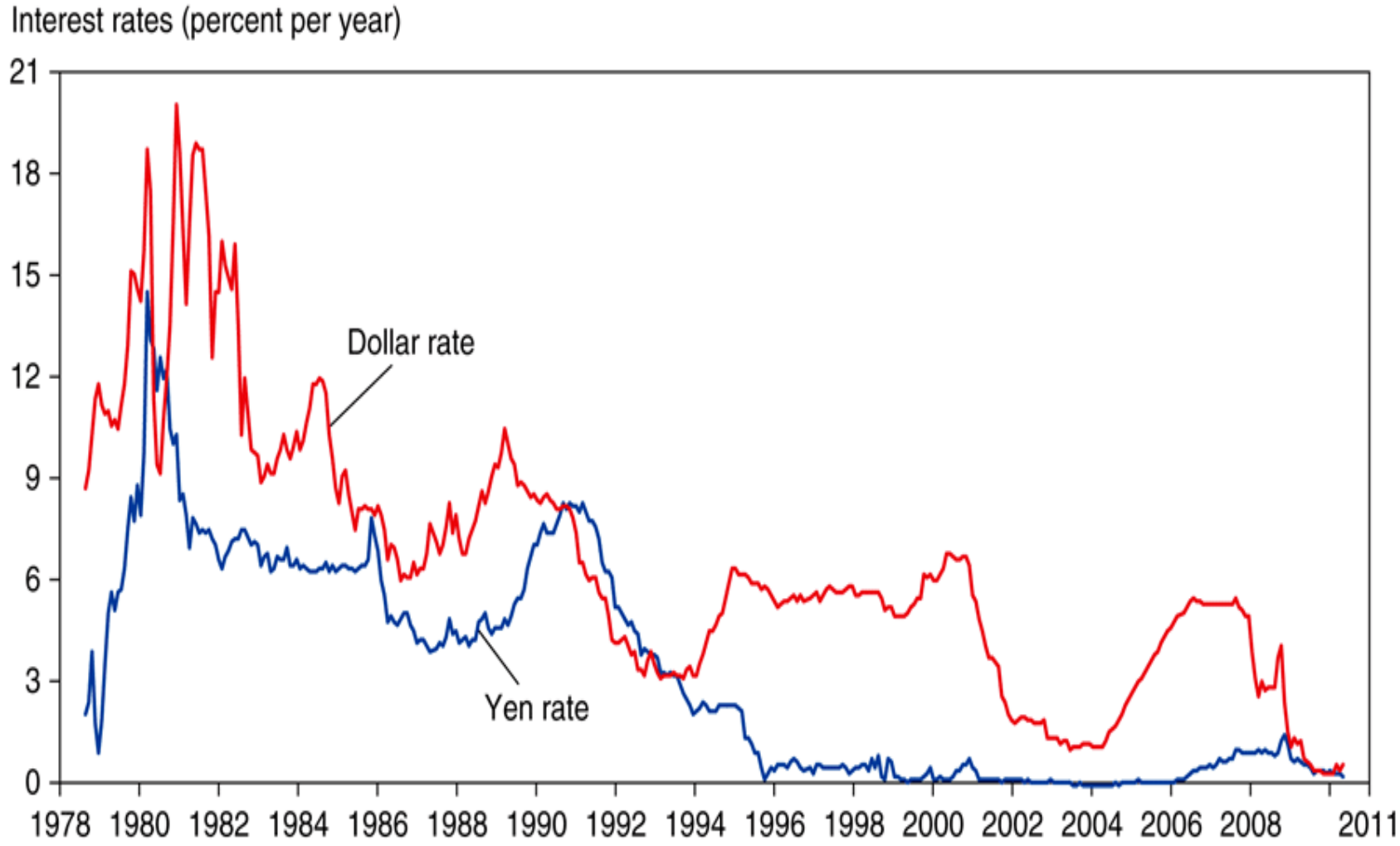
ASSET MARKET APPROACH

The UIP curve shifts up if either E'↑ or R* ↑ or ρ↑, all of which require either R↑ or E↑ or both.



ASSET MARKET APPROACH--Quiz

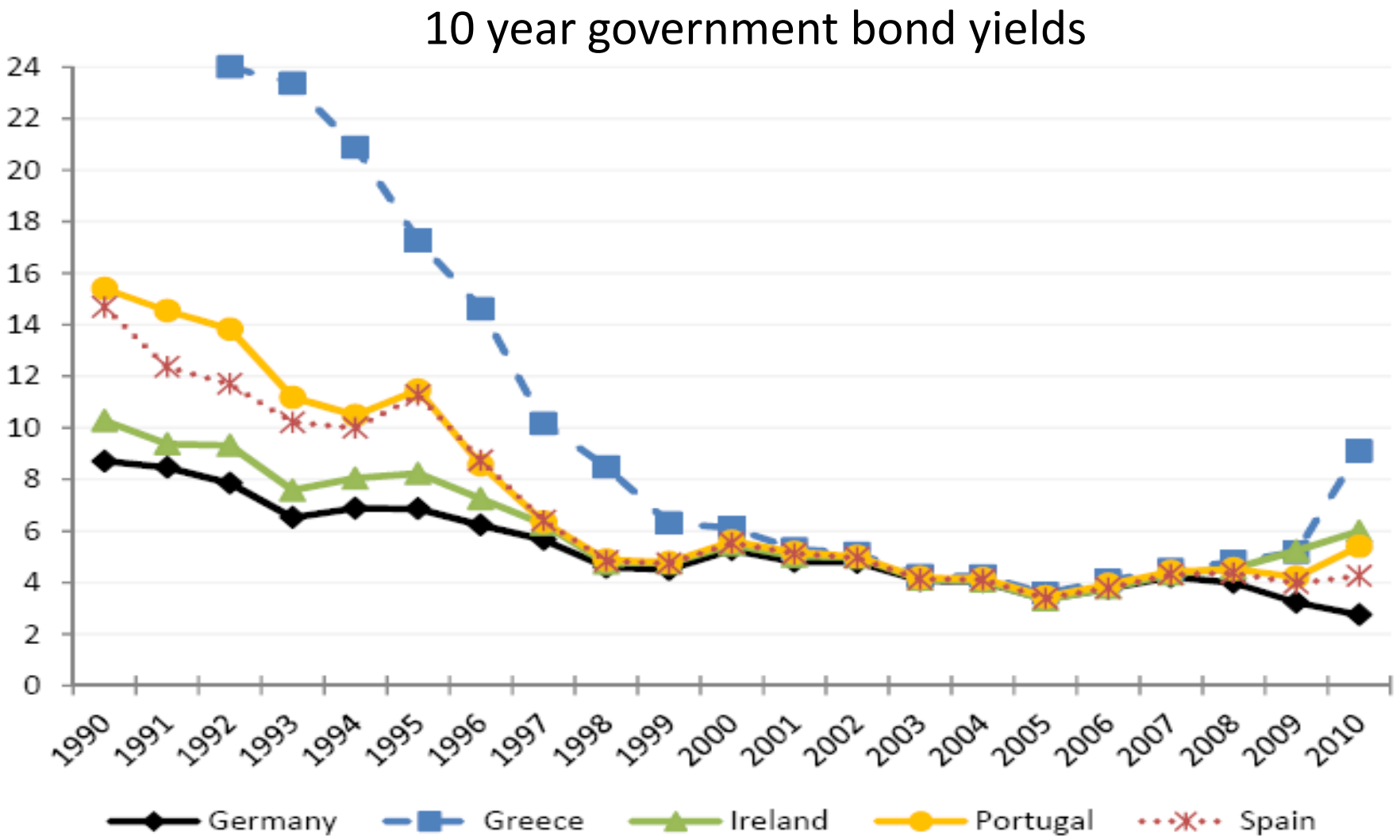
What does the dollar yen interest rate differential tell us?



Source: KOM, p. 333

ASSET MARKET APPROACH—Quiz #2

What explain the convergence and subsequent divergence of rates in Europe?



Forward Exchange Market

Three actors in the forward market:

(1) Hedgers (2) Arbitragers (3) Speculators

Hedgers:

You contract to import cheese from the UK that will be delivered and payment of £1 million made in 6 months. At the current spot rate $E_{\$/£} = 2.0$, the cheese costs $2 million, but what will it cost in 6 months. If the dollar depreciates, it will cost more; if it appreciates it will cost less. If you prefer to forego the chance the $ will appreciate to avoid the risk it will depreciate, then you have to hedge, either in the spot of forward market.

1. In the spot market buy £1 million (=M*) today; hold it in a UK bank for 6 months, earning the interest rate R_{UK}. The cost, net of interest earned, is: $E_{\$/£}M^*(1 - R_{UK})$.
2. In the forward market contract at the forward rate ($F_{\$/£}$) to buy £1 million in 6 month; hold your money for 6 months in a US bank, earning the interest rate R_{US}. The cost net of interest earned is $F_{\$/£}M^*(1 - R_{US})$.

Two are equivalent when: $E_{\$/£}M^*(1 - R_{UK}) = F_{\$/£}M^*(1 - R_{US}) \Rightarrow \frac{F_{\$/£}}{E_{\$/£}} = \frac{(1+R_{US})}{(1+R_{UK})}$

Forward Market—Covered Interest Arbitrage

Arbitragers

Arbitragers look for violations of the law of one price hoping to buy low and sell high. In financial markets they are looking for discrepancies in interest rate parity. Arbitragers can use the forward market to arbitrage away differences across countries in expected returns, without taking any exchange rate risk.

Suppose you have certain amount of money (A). The yield at the end of one period if invested at home is $A(1+R)$, where R is the home one-period interest rate.

Alternatively you can go in the spot market and buy an equivalent amount of foreign currency $A^* = A/E$. The yield (in foreign currency) at the end of one period is $(A/E)(1+R^*)$. To avoid exchange rate risk, you contract today to sell the yield in foreign currency at today's one-period forward rate F. So your risk-free yield in the foreign market (expressed in domestic currency) is $F \cdot (A/E) \cdot (1+R^*)$

Expected returns are the same when: $A(1+R) = F \cdot (A/E) \cdot (1+R^*) \Rightarrow \quad \frac{\mathrm{F}}{\mathrm{E}} = \frac{1+\mathrm{R}}{1+\mathrm{R}^*}$

This is the condition for COVERED INTEREST PARITY

The Forward Market

Speculators

Hedgers use the forward market to close an open position in the foreign exchange. Arbitragers use the forward market to profit from interest rate differentials without having to take an open position. Speculators use the forward market to take an open position in the hope (and expectation) that they understand the market better than others.

Speculators form an expectation of what the exchange rate will be one period forward. If the speculator's expected exchange rate one period forward (E'_{t+1}) is different from the one-period forward rate in the market (F_{t+1}), then the speculator expects to profit by taking an open position in the forward market.

If $E'_{t+1} > F_{t+1}$ the speculator will buy forward at F_{t+1} and one period later sell in the spot market at E'_{t+1} and enjoy a profit.

If $E'_{t+1} < F_{t+1}$ the speculator will sell forward at F_{t+1} and one period later buy in the spot market at E'_{t+1} and enjoy a profit.

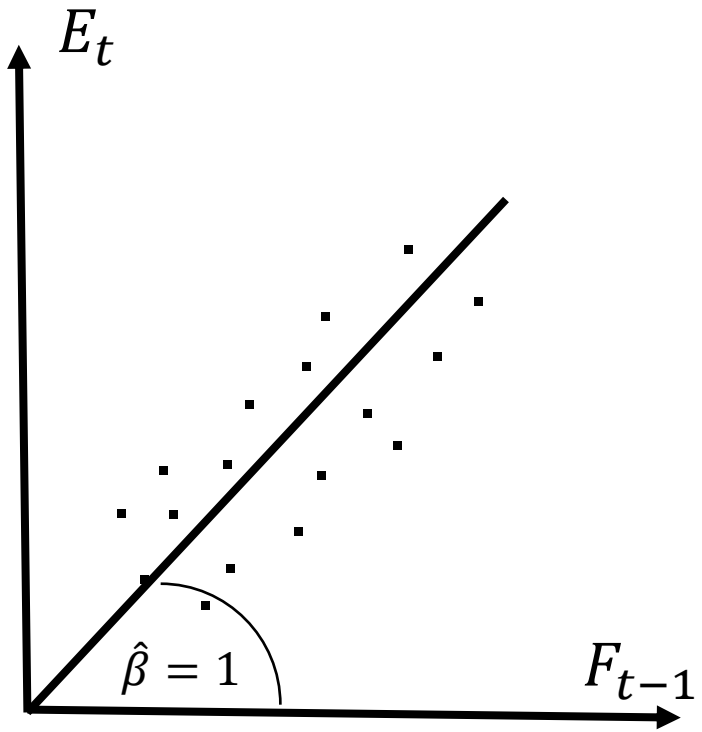
If there are many well-informed, rational speculators, then in equilibrium $E'_{t+1} = F_{t+1}$

The Forward Market

The previous result suggests that the forward rate is what the market predicts the future exchange will be. This result can be tested empirically by regressing the spot rate on the forward rate one period earlier:

$$E_t = \alpha + \beta \cdot F_{t-1} + \varepsilon_t$$

The null hypothesis is that: $\hat{\alpha} = 0, \quad and \quad \hat{\beta} = 1 \ \ where \ \varepsilon_t$ is a random error term.

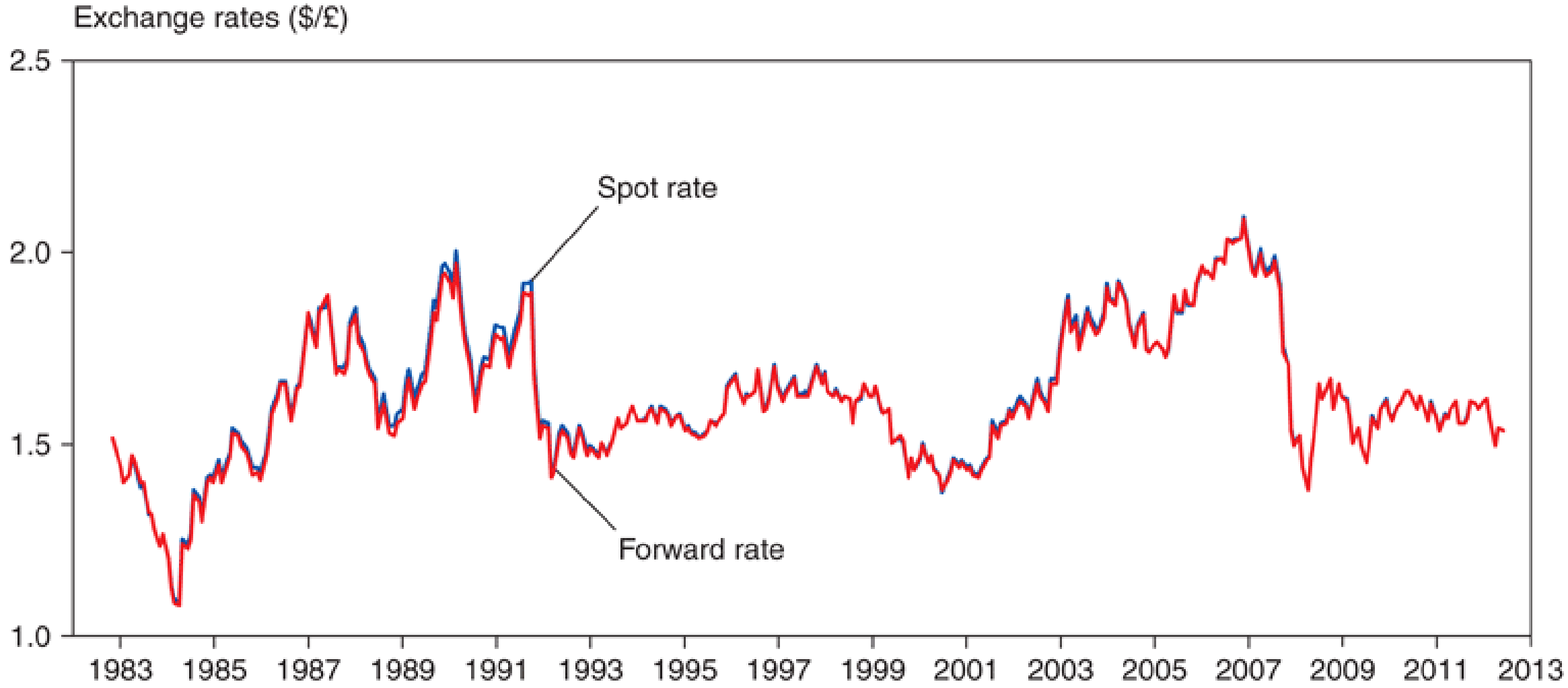


Country	$\hat{\alpha}$	$\hat{\beta}$	R^2	DW
Canada	-0.008 (-0.420)	1.01 (0.714)	0.98	1.64
France	0.37 (1.83)	0.93 (1.86)	0.87	1.2
Germany	0.01 (1.73)	0.94 (1.71)	0.88	1.25
Japan	4.40 (1.52)	0.94 (1.60)	0.94	1.21
UK	0.05 (.35)	0.91 (2.35)	0.87	1.37

t-statistics in parentheses

EXCHANGE RATES: Spot versus Forward Rates

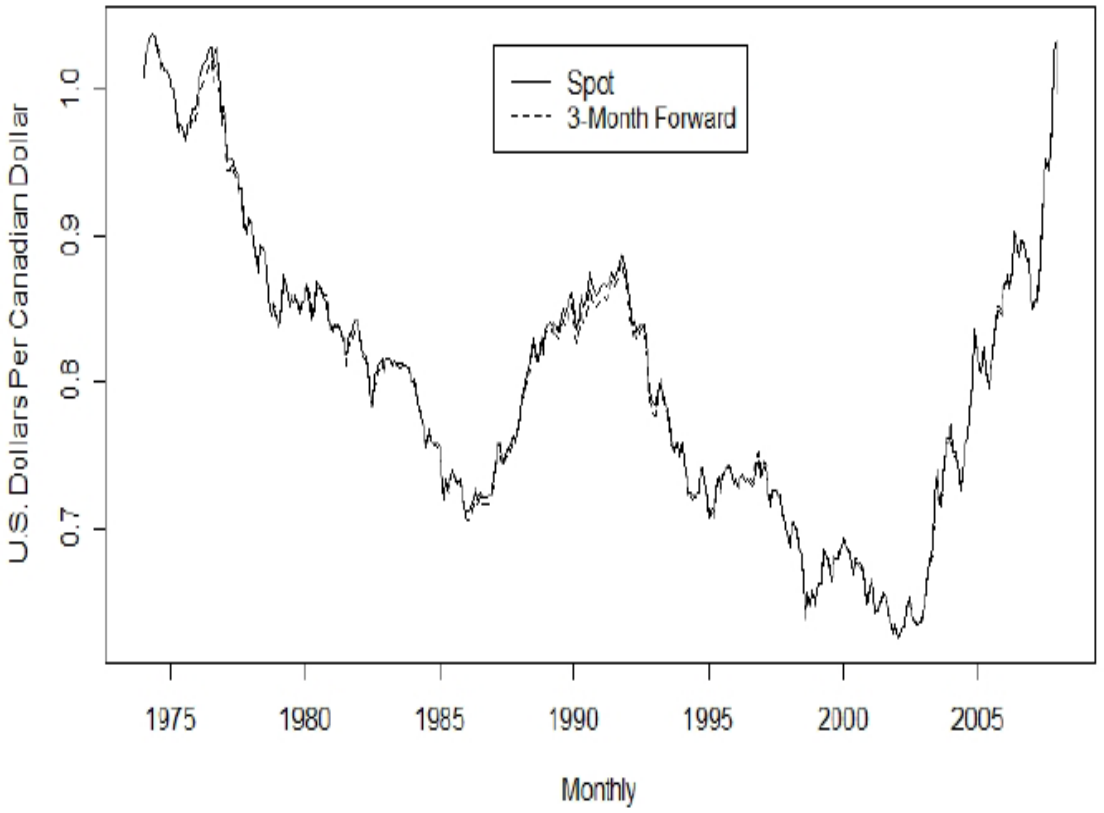
Although spot and future rates differ, as shown above, they tend to move together closely.



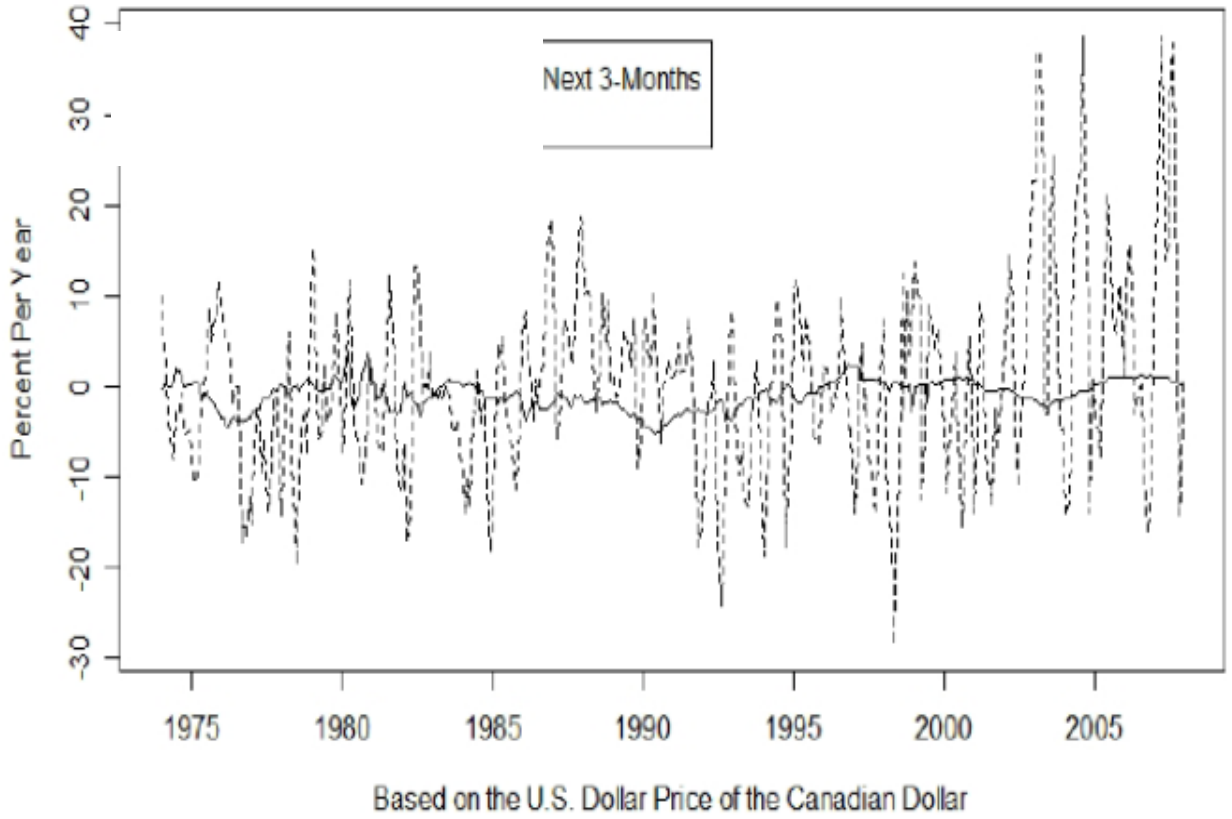
Source: *Datastream*. Rates shown are 90-day forward exchange rates and spot exchange rates, at end of month.

COVERED INTEREST PARITY (CIP)

The spot and forward rates move almost identically, but the forward premium does not anticipate changes in the spot rate, which is why the forward rate, although a fairly unbiased predictor of the spot, is not a good predictor of the spot rate.



Source: http://www.economics.utoronto.ca/jfloyd/modules/evfx.html



Source: http://www.economics.utoronto.ca/jfloyd/modules/evfx.html

Note: A “naïve” forecast that the spot in 3 months will be the same as today is just as accurate as one based on the forward rate.

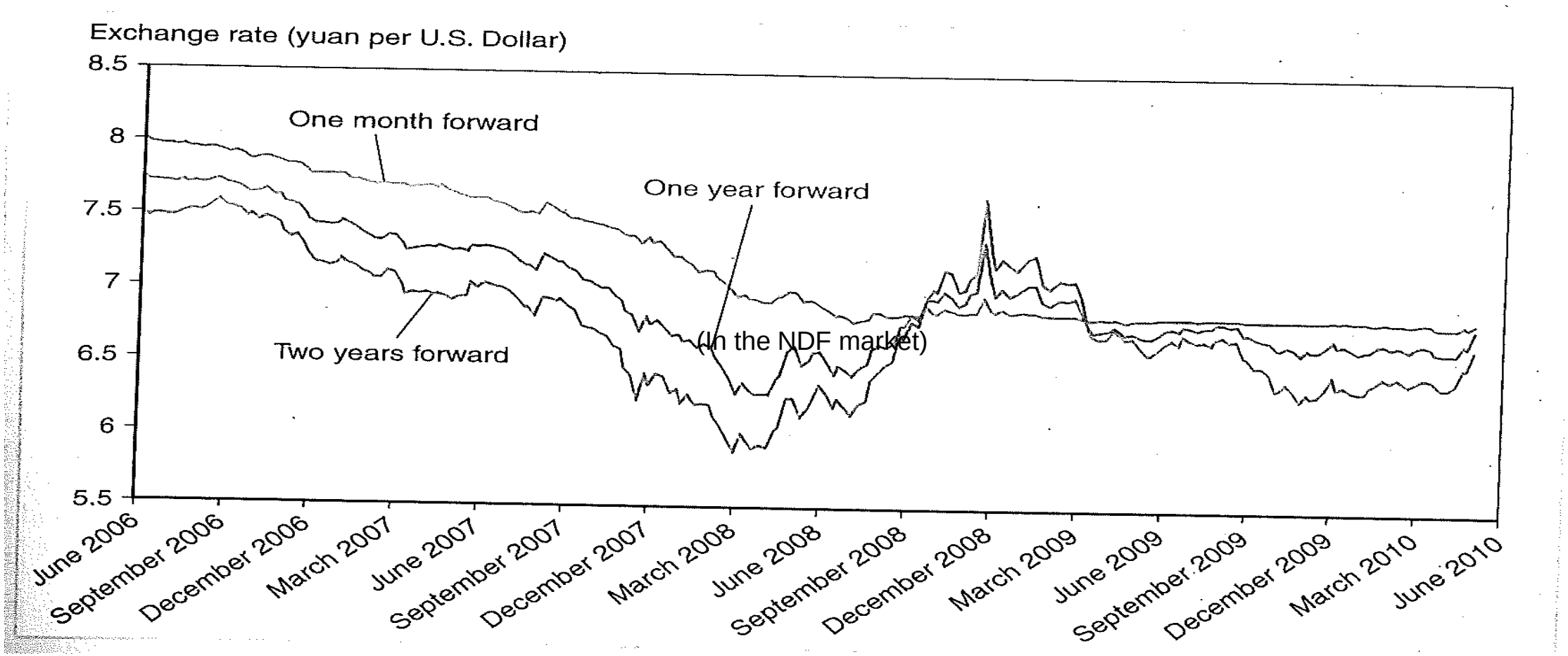
EXCHANGE RATES: Non-Deliverable Forward Exchange Market

Forward markets allow traders to hedge against exchange rate risk, but many major trading countries in Asia do not have convertible currencies and hence do not have forward markets. Since the early 1990s, markets in non-deliverable forward exchange have emerged in Hong Kong and Singapore for currencies such as the Chinese RMB, Indian rupee, the Vietnam dong.

Definition of NDF contract: "A cash-settled, short-term forward contract on a thinly traded or non-convertible foreign currency, where the profit or loss at the time at the settlement date is calculated by taking the difference between the agreed upon exchange rate and the spot rate at the time of settlement, for an agreed upon notional amount of funds." (Source: Investopedia)

Illustration: Suppose a US company will receive payment of RMB 10 million in 3 months. The company faces exchange rate risk. If the RMB appreciates in the next three months the dollar equivalent of RMB 10m will decline. The company can go into the NDF market and make a deal with another company that will need RMB in 3 month on what the exchange rate will be in 3 months.

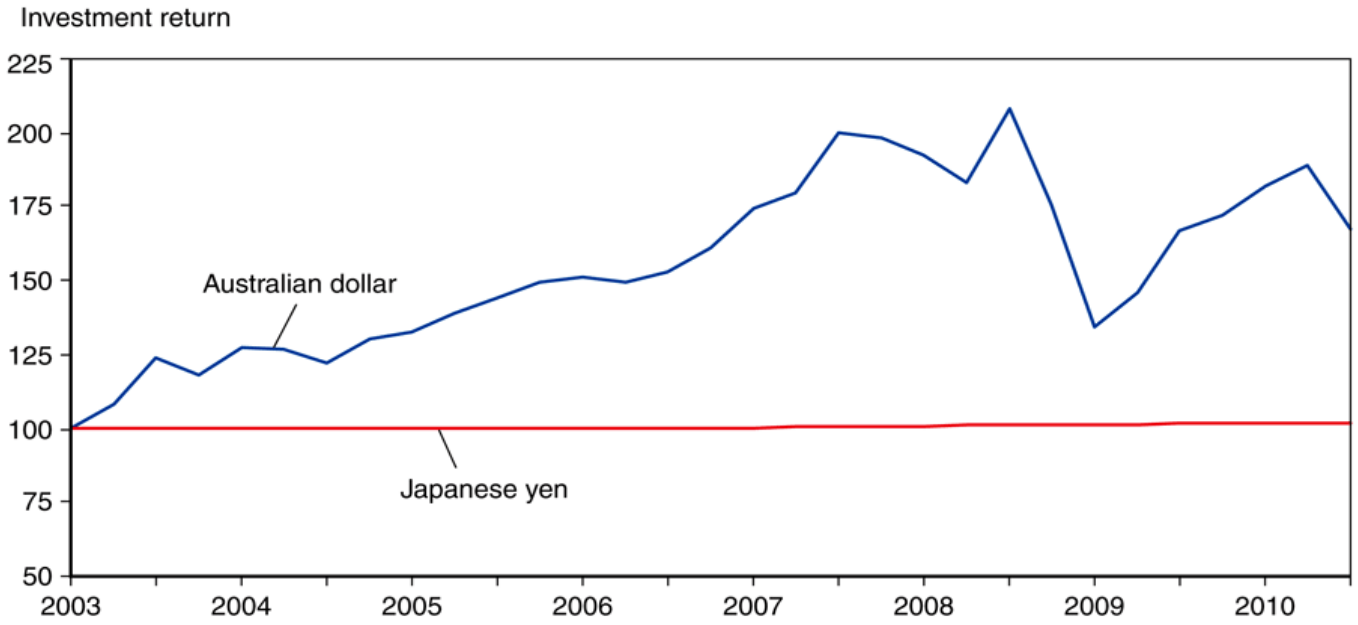
THE NON-DELIVERABLE FORWARD MARKET



Why the NDF rate is lower farther out? Why did it rise in late 2008?

WHAT EXPLAINS CARRY TRADE?

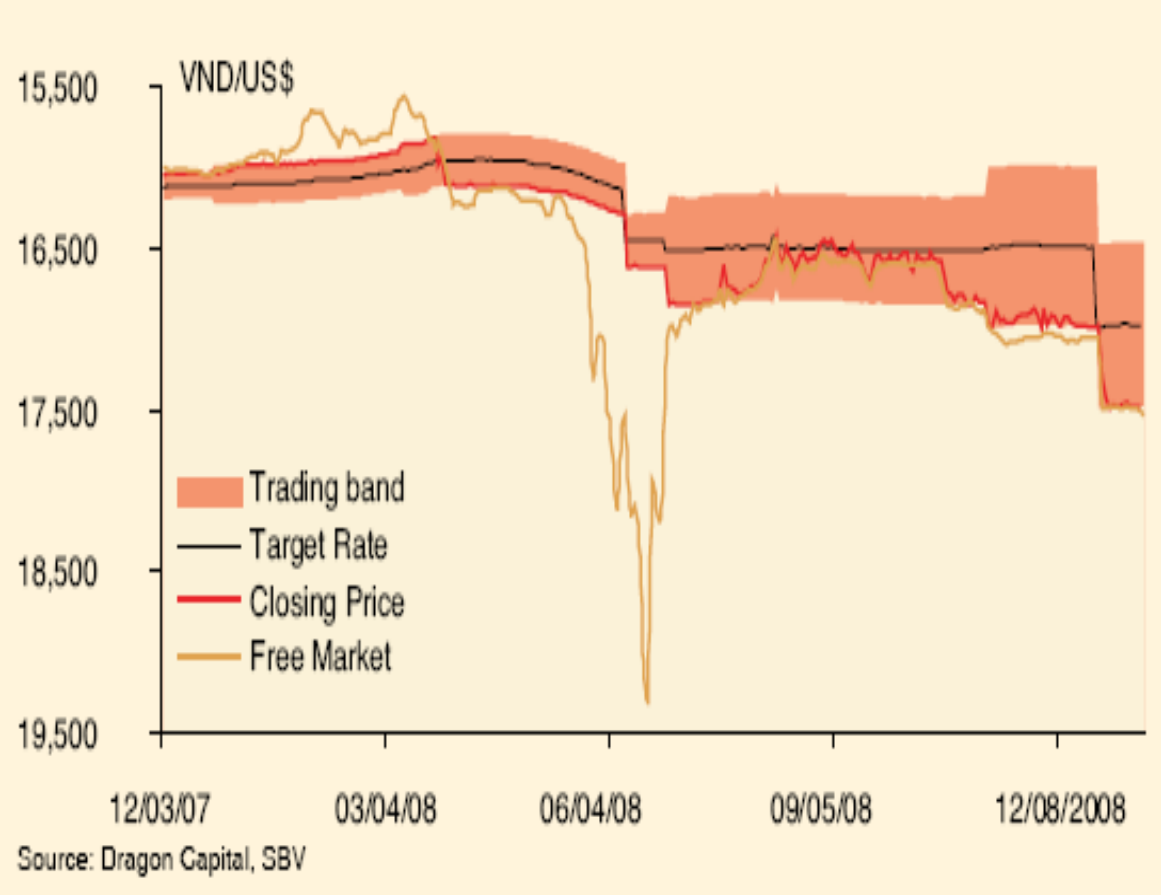
Is it profitable to borrow in low interest rate countries and invest in high interest rate countries? No, not according to UIP: $R-R^*=[(E'-E)/E]+\rho$. Nonetheless, hedge funds make a lot of money from carry trade…and sometimes big losses when the investment currency crashes.



The figure shows the cumulative return from investing ¥100 in yen bonds and in Australian dollar bonds over different investment horizons. In 2008, the Australian $ crashed, the yen price of Australian dollars falling from ¥104 to ¥61. KOM p.344

CARRY TRADE AND CURRENCY CRASH IN VIETNAM

Exchange rate effect of a carry trade in Vietnam: appreciation followed by a massive depreciation!



The effect of the crash in the Non-Deliverable Forward Market (NDF)