International capital market integration

Readings

- Schmitt-Grohé et al. (2019), *International Macroeconomics*, Chapter 10, "International Capital Market Integration"

The foreign exchange market and international financial markets and instruments:

- Appleyard and Field (2014), Chapter 20 & 21

Additional readings:

- Lettau, M. and Madhavan, A. (2018) "Exchange-Traded Funds 101 for Economists," Journal of Economic Perspectives, 32(1): 135-54.

- Handbook of International Economics (2014), Chapter 8, "Exchange rates and interest parity"

Backdrop

- ▶ Idea: Can we infer the degree of international capital market integration from savings−investment correlations or from real interest rate differentials (i.e., interest rate parity)?

- ▶ Motivation: In a closed economy the correlation between savings and investment must be 1, but in an open economy they need not. Thus, if we observe low correlations, then we can conclude that that there is capital mobility across countries. Similarly, perfect capital mobility implies that interest rate parity must hold.

- ▶ Test I: Suppose we find a near perfect correlation between S and I. Does this necessarily mean that there is no capital mobility?

- ▶ Test II: Suppose interest rate parity does not hold, does this necessarily mean that there is imperfect (or weak) capital mobility?

Contents:

Measuring Capital Mobility I: Observed Savings-Investment Correlations (Chapter 10.6)
  Across countries
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Measuring Capital Mobility II: Interest Rate Differentials (Chapter 10.1-10.4)
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Measuring Capital Mobility III: Real interest rate parity (Chapter 10.5)

Measuring Capital Mobility I: Observed Savings-Investment Correlations (Chapter 10.6)

1. Across countries
   (a) The Feldstein-Horioka Regression: 1960−1974
   (b) Updates of the Feldstein-Horioka Regression: 1960−2003
2. Overtime within the same country
   (a) The United States, 1928−2015.
   (b) South Africa, 1946−2015

Saving and Investment Rates for 16 Industrial Countries
(1960-1974 Averages)
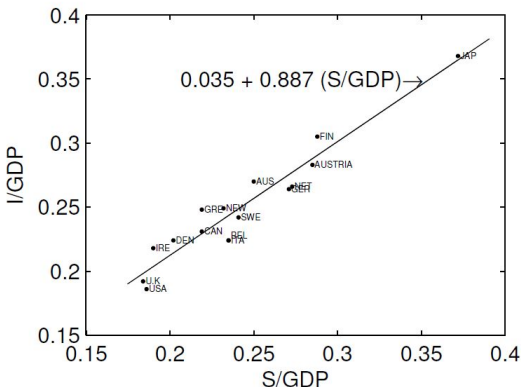
Source: M. Feldstein and C. Horioka, "Domestic Saving and International Capital Flows," *Economic Journal* 90, June 1980, 314-29.

The coefficient on (S_i/GDP_i) is 0.887 with a standard error of 0.07 $\Rightarrow$ highly unlikely that the true coefficient is zero. ($R^2 = 0.91$)

More recent evidence:[1]

- Sample of 64 countries with data from 1960 to 2003 find

$$\left(\frac{I}{GDP}\right)_i = \text{constant} + \underset{(0.06)}{0.52}\left(\frac{S}{GDP}\right)_i + \nu_i, \quad i = \text{country} \quad (1)$$

TABLE I

CROSS-COUNTRY REGRESSION COEFFICIENTS

| Group of Countries	FH Coefficient (s.e.)[a]		
	1960–2003	1960–1974	1974–2003
Full sample (64 countries)	0.52 (0.06)	0.60 (0.07)	0.46 (0.05)
Subsample (16 OECD countries)	0.67 (0.11)	0.61[b] (0.11)	0.56 (0.13)

[a]The term s.e. refers to the standard error.
[b]The new data source produces an FH coefficient different from Feldstein and Horioka's original estimate for the same sample. See Appendix A.3 for details.

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[1]Source: Yan Bai and Jing Zhang "Solving the Feldstein-Horioka Puzzle with Financial Frictions," Econometrica 78, March 2010, 603–632.
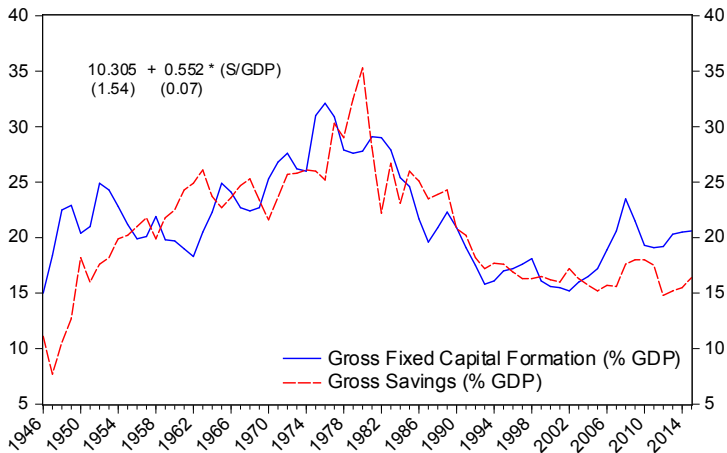
U.S. National Saving and Investment, 1928-2015
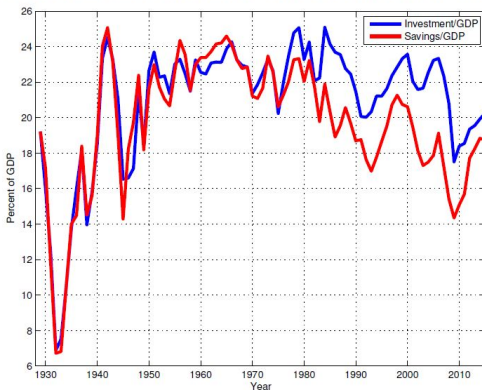
Data Source: Bureau of Economic Analysis, www.bea.gov.

$\text{corr}(s/y, i/y) = 0.98$ pre 1972 and 0.76 post 1972

RSA Savings and Investment, 1946 - 2015

10.305 + 0.552 * (S/GDP)
(1.54)   (0.07)

Gross Fixed Capital Formation (% GDP)
Gross Savings (% GDP)

corr($s/y, i/y$): 0.68 (full); 0.59 (pre-1985); 0.91 (1985−1999); 0.22 (2000−)

RSA Savings and Investment, 1960Q1 - 2016Q3

Legend:
— Gross Fixed Capital Formation (% GDP)
— Gross Savings (% GDP)

9.10 + 0.59 * (S/GDP)
(0.90) (0.04)
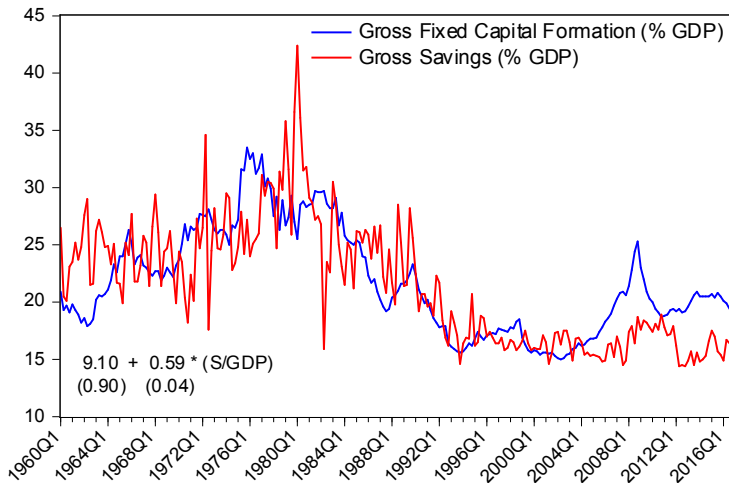
corr($s/y, i/y$): 0.69 (full); 0.27 (pre-1985Q1); 0.83 (1985Q1−1999Q4); 0.16 (2000−)

But do findings of high savings-investment correlations either across countries or across time, necessarily imply imperfect capital mobility?

No. Even under perfect capital market integration one could observe a high S-I correlation:

- ▶ common shocks shifting both S & I (Figure 10.6: persistent productivity shock in a SOE)
- ▶ large country effects (Figure 10.7: initial shock to ΔS in a large open economy)

∴ conclude that high S-I correlations are not evidence of low capital mobility.

Measuring Capital Mobility II: Interest Rate Differentials (Chapter 10.1-10.4)

1. Why are interest rate differentials informative about the degree of capital mobility?
2. Empirical Evidence on the size of interest rate differentials (see 10.2 & 10.3, pp. 397-407)

Asset Pricing in a small open economy model

Two important interest rate parity conditions derived are:

(1) covered interest rate parity (CIP)

$$(1 + i_t) = (1 + i_t^*)\frac{F_t}{\mathcal{E}_t} , \qquad (2)$$

i_t = domestic interest rate, i_t^* = foreign interest rate, F_t = forward exchange rate, and $\mathcal{E}_t$ = spot exchange rate (domestic price of foreign).

The use of the forward exchange rate "covers" the investor against exchange rate risk.

(2) uncovered interest rate parity (UIP)

$$(1 + i_t) = (1 + i_t^*)E_t\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \qquad (3)$$

where E_t is the expectations operator conditional on information available in period t.

Asset Pricing in a small open economy model

i. Under free capital mobility, CIP must hold.

$$(1 + i_t) - (1 + i_t^*)\frac{F_t}{\mathcal{E}_t} = 0$$

It is both a no arbitrage condition and an equilibrium condition.

ii. Even under free capital mobility UIP need not hold.

$$(1 + i_t) - (1 + i_t^*)\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \neq 0$$

It is not an equilibrium condition.

iii. UIP holds if and only if the forward rate equals the expected future exchange rate: $F_t = E_t \mathcal{E}_{t+1}$

Special case equilibrium condition: if the depreciation rate, $\mathcal{E}_{t+1}/\mathcal{E}_t$, is uncorrelated with the pricing kernel, M_{t+1}, i.e., cov $\left(\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t}, M_{t+1}\right) = 0$, then the forward rate equals the expected future spot rate (see 10.4.3)

Asset Pricing in a small open economy model: Assumptions

Consider our two-period small open economy with free capital mobility. We now introduce uncertainty in period 2:[2]

- ▶ In period 2, there are 2 states of the world, good (g) and bad (b), with probability π and $(1 - \pi)$;
- ▶ The representative household has access to domestic currency bonds (B), foreign currency bonds for which their is forward cover (B^*), and foreign currency bonds for which their is no forward cover ($\tilde{B}^*$);
- ▶ ($\tilde{B}^*$) implies exposure to exchange rate risk.
- ▶ The household's initial asset position is zero.

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[2]Chapter 6 in the next session deals with uncertainty in more detail.

Asset Pricing in a small open economy model: Dynamic problem

The household must now maximize their expected utility function

$$U(C_1) + \pi U(C_2^g) + (1 - \pi)U(C_2^b) \tag{4}$$

subject to the period-1 budget constraint and the period-2 budget constraints in the good and bad states:

$$P_1 C_1 + B_1 + \mathcal{E}_1 B_1^* + \mathcal{E}_1 \tilde{B}_1^* = P_1 Q_1 \tag{5}$$

$$P_2^g C_2^g = P_2^g Q_2^g + (1 + i)B_1 + F_1(1 + i^*)B_1^* + \mathcal{E}_2^g(1 + i^*)\tilde{B}_1^* \tag{6}$$

$$P_2^b C_2^b = P_2^b Q_2^b + (1 + i)B_1 + F_1(1 + i^*)B_1^* + \mathcal{E}_2^b(1 + i^*)\tilde{B}_1^* \tag{7}$$

We can use the binding constraints (5), (6), and (7) to eliminate consumption from (4) to obtain the following maximization problem:

$$\max_{\{B_1, B_1^*, \tilde{B}_1^*\}} U(C_1(B_1, B_1^*, \tilde{B}_1^*)) + \pi U(C_2^g(B_1, B_1^*, \tilde{B}_1^*))$$

$$+ (1 - \pi)U(C_2^b(B_1, B_1^*, \tilde{B}_1^*)) \tag{8}$$

Asset Pricing in a small open economy model:
Optimality/Equilibrium conditions

The first order condition for B_1 gives the Euler equation for domestic bonds:

$$1 = (1+i)\underbrace{\left[\pi\frac{U'(C_2^g)P_1}{U'(C_1)P_2^g} + (1-\pi)\frac{U'(C_2^b)P_1}{U'(C_1)P_2^b}\right]}_{\text{Expected value: } E_1\left\{\frac{U'(C_2)P_1}{U'(C_1)P_2}\right\} \equiv E_1\{M_2\}}$$

$$1 = (1+i)E_1\{M_2\} \qquad (9)$$

where M_2 is known as the pricing kernel.[3]

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[3]Multiplying any nominal payment in a given state in period 2 by M_2 returns the period-1 value of such payment.

Asset Pricing in a small open economy model:
Optimality/Equilibrium conditions

The first order condition for B_1^* gives the Euler equation for foreign bonds:

$$
\begin{aligned}
1 &= (1+i^*)\frac{F_1}{\mathcal{E}_1}\left[\pi\frac{U'(C_2^g)P_1}{U'(C_1)P_2^g} + (1-\pi)\frac{U'(C_2^b)P_1}{U'(C_1)P_2^b}\right] \\
1 &= (1+i^*)\frac{F_1}{\mathcal{E}_1}E_1\{M_2\}
\end{aligned}
\tag{10}
$$

The first order condition for $\tilde{B}_1^*$ gives the household's optimality condition for foreign bonds without forward cover:

$$
\begin{aligned}
1 &= (1+i^*)\frac{1}{\mathcal{E}_1}\left[\pi\frac{U'(C_2^g)P_1\mathcal{E}_2^g}{U'(C_1)P_2^g} + (1-\pi)\frac{U'(C_2^b)P_1\mathcal{E}_2^b}{U'(C_1)P_2^b}\right] \\
1 &= (1+i^*)E_1\left\{\left(\frac{\mathcal{E}_2}{\mathcal{E}_1}\right)M_2\right\}
\end{aligned}
\tag{11}
$$

CIP & UIP as equilibrium conditions?

Substituting (9) into (10) gives

$$(1 + i) = (1 + i^*)\frac{F_1}{\mathcal{E}_1}$$

which is the CIP condition. This shows that CIP is both a no arbitrage condition and also an equilibrium condition.

We can use the definition of conditional covariance between two random variables, denoted $\text{cov}_1(a, b) = E_1(ab) - E_1(a)E_1(b)$, to re-write (11) as

$$1 = (1 + i^*)\left[\text{cov}_1\left(\frac{\mathcal{E}_2}{\mathcal{E}_1}, M_2\right) + E_1\left(\frac{\mathcal{E}_2}{\mathcal{E}_1}\right)E_1(M_2)\right].$$

Setting (11) equal to (10) establishes that under free capital mobility, UIP fails ($F_1 \neq E_1\mathcal{E}_2$):

$$(1 + i) \neq (1 + i^*)E_1\frac{\mathcal{E}_2}{\mathcal{E}_1}.$$

CIP & UIP as equilibrium conditions?

Although UIP does not hold in general, it does hold in the special case in which the pricing kernel, M_2, is uncorrelated with the depreciation rate, $\mathcal{E}_2/\mathcal{E}_1$.

That is, if $\text{cov}_1\left(\frac{\mathcal{E}_2}{\mathcal{E}_1}, M_2\right) = 0$, we can use the optimality condition (9) to show that (11) becomes:

$$(1 + i) = (1 + i^*)E_1\frac{\mathcal{E}_2}{\mathcal{E}_1} \ ,$$

which is the UIP condition.

The "forward premium puzzle"

If $F_t > \mathcal{E}_t$, then the **foreign** currency is said to be at a *premium in the forward market*

That is, the foreign currency is "more expensive" in the forward market than in the spot market.

On average, low interest rate currencies tend to be at a premium in the forward market:

$$\frac{1 + i_t}{1 + i_t^*} > 1 \quad \text{by CIP} \Rightarrow \quad \frac{F_t}{\mathcal{E}_t} > 1 \tag{12}$$

Fama, Eugene (1984), *Forward and spot exchange rates*, Journal of Monetary Economics, 14 (3): 319-338
Frankel, Jeffrey & Poonawala, Jumana (2010), *The forward market in emerging currencies: Less biased than in major currencies*, Journal of International Money and Finance, 29 (3): 585-598.

What is the "Forward Premium Puzzle"?

If $F_t > \mathcal{E}_t$ (when the **foreign** country is at a premium in the forward market) we might expect that $\mathcal{E}_{t+1} > \mathcal{E}_t$

- ▶ i.e., that the domestic currency will depreciate and the foreign currency will appreciate

Using condition iii.: $F_t = E_t \mathcal{E}_{t+1}$, we can estimate the following equation by OLS:

$$\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} = a + b \frac{F_t}{\mathcal{E}_t} + \mu_{t+1} ,$$

where, under UIP, the null hypothesis is: $a = 0$ and $b = 1$.

This result is strongly rejected in the data:[4]

- ▶ Foreign currencies that trade at a forward premium tend to appreciate by less ($\mathcal{E}_{1,t+1}$) than the interest rate differential or even to depreciate ($\mathcal{E}_{2,t+1}$): $F_t > \mathcal{E}_{1,t+1} > \mathcal{E}_t > \mathcal{E}_{2,t+1}$.
- ▶ Clearly, this empirical finding implies that Uncovered Interest Rate Parity (UIP) does not hold in the data.

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[4]See Burnside (2018).

Carry Trade as a test of UIP

This observation suggests the following investment strategy:

▶ Borrow in the low interest rate currency, invest in the high interest rate currency, and do not hedge the exchange rate risk.

▶ This investment strategy is known as carry trade and is widely used by practitioners.

Burnside et al. (2006) and Burnside, Eichenbaum and Rebelo (2007)[5] document that the returns to carry trade have been on average positive.

The payoff from a carry trade. Suppose $i_t > i_t^*$

▶ Then borrow y from the foreign country at the rate i_t^* and invest in domestic country at rate i_t^*

▶ Payoff from Carry Trade:

$$\text{Payoff} = \left[(1 + i_t) - (1 + i_t^*)\frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} \right] y \tag{13}$$

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[5]Published in American Economic Review (AER) in 2007.

Burnside et al. (2006)

- ▶ compute the average payoff from carry trade—taking into account that there are some transaction costs
- ▶ monthly data from 1976m1 to 2005m12
- ▶ domestic country is the UK
  - ▶ i_t is either the 1-month or the 3-month pound sterling interest rate;
  - ▶ F_t is the 1-month and 3-month forward exchange rates of the pound on spot exchange rates $(\mathcal{E})$
  - ▶ i_t^* is the foreign 1-month and 3-month interest rates
- ▶ Findings: the average return to carry trade is **positive**.

Burnside, Eichenbaum and Rebelo (2007)

1. Sharpe ratio associated with the carry trade for EM currencies substantially larger
2. Bid-ask spreads are 2x to 4x larger in EMs than in developed countries (DC)
3. The carry trade payoffs for both EMs and DCs are uncorrelated with returns to the U.S. stock market

Observations on Table 4 of Burnside et al. (2006)

1. Consider the case with corrections for transactions cost, columns 5, 6, and 7 of the table. The average return to carry trade for an equally-weighted portfolio of the 10 currencies considered is 0.0029 per unit of currency invested for one month.

2. To generate substantial profits, speculators must wager very large sums of money. For example, suppose $y = 1\,000\,000\,000$, that is, you invest one billion pounds in carry trade, then after one month the carry trade had, over the sample period, an average payout of 2.9 million pounds per month.

3. The fact that the average payoff from carry trade is non-zero implies that UIP fails empirically.

Observations on Table 4 of Burnside et al. (2006) cont.

4. Columns 4 and 7 of the table report the Sharpe Ratio, which is defined as

$$\text{Sharpe ratio} = \frac{\text{mean(payoff)}}{\text{std(payoff)}}.$$

   The Sharpe Ratio is a measure of risk. The higher the Sharpe Ratio, the higher the risk adjusted return. For comparison, note that the Sharpe Ratio of investing in the S&P 500 index over the sample period was 0.14, which is comparable to the Sharpe Ratio of the carry trade.

5. Q: Suppose a speculator wants to generate a payoff of 1 million pounds on average per year. How large a carry trade must he engage in? A: He needs GBP 28.7 million each month.

6. Burnside et al. also compute covered interest rate differentials (not shown) and find that *CIP parity holds* in their sample.

Carry Trade returns are thought to have crash risk.

► The Economist article refers to carry trade returns as "picking up nickels in front of steamrollers."

► Example: large surprise appreciation of the Japanese Yen against the U.S. dollar on October 6-8, 1998. The Yen appreciated by 14 percent (or equivalently the U.S. dollar depreciated by 14 percent).

► Think about the risk associated with EMs like South Africa . . .

► Suppose that you were a carry trader with 1 billion dollars short in Yen and long in U.S. dollars. The payoff of that carry trade in the span of 2 days was -140 million dollars—that is, the steamroller caught up with the carry trader.

Measuring Capital Mobility III: Real interest rate parity

One might think that observed real interest rate differentials are a good measure of capital market integration.

In the model of chapter 3, for example:

► the domestic real interest rate, r, was equal to the world real interest rate, r^*, under free capital mobility.

BUT: that model abstracts from

i. Uncertainty. That is, no nominal exchange rate uncertainty: UIP=CIP.

ii. It does not allow for non-traded goods. That is, the relative price of consumption baskets (the real exchange rate) across countries does not change over time: $r_t - r_t^* = \%\Delta e_{t+1} = 0.$[6]

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[6]Written in percentage change terms: i.e., the log-difference.

Measuring Capital Mobility III: Real interest rate parity

Covered interest rate differential (λ)

$$\lambda = i - i^* - (f - s) = i - i^* - fd \tag{14}$$

where f and s are the current forward and spot rates. fd is the forward discount. CIP holds when $\lambda \approx 0$ (country risk premium ≈ 0).

International real interest rate differentials ($r - r^*$)

$$r - r^* = (i - i^*) + (\pi^{*e} - \pi^e) \tag{15}$$

where π^{*e} and π^e are the expected foreign and domestic inflation rates.

By adding and subtracting s, s^e, and f from Eq. (15), we can decompose (15) into three components:

(i) the degree of capital mobility ($i - i^* - fd$);

(ii) nominal ex. rate risk ($f - s^e$);

(iii) expected changes in relative prices across countries
$(s^e - s + \pi^{*e} - \pi^e)$, $\xrightarrow{\text{written as}}$ the expected percentage depreciation of the real ex. rate: $\%\Delta e^e$

The real interest rate differential, given as

$$r - r^* = (i - i^* - fd) + (f - s^e) + \%\Delta e^e , \qquad (16)$$

can be decomposed into the country risk premium, the exchange risk premium and the expected depreciation of the real exchange rate.

- ▶ If $i - i^* - fd > 0 \rightarrow$ country risk premium is +ve
- ▶ If $f - s^e > 0 \rightarrow$ exchange risk premium is +ve
- ▶ If $\%\Delta e^e > 0 \rightarrow$ expected real depreciation

Table 8.4: Decomposition of the real interest rate differential for selected countries: September 1982 to January 1988

Country	$r - r^*$	$i - i^* - fd$ (1)	$f - s^e$ (2)	$s^e - s + \pi^{*e} - \pi^e$ (3)
Germany	-1.29	0.35	4.11	-6.35
Switzerland	-2.72	0.42	3.98	-8.35
France	-0.48	-1.74	7.47	-6.26
Mexico	-20.28	-16.47	6.04	-3.32

Note: Columns (1), (2), and (3) do not add up to $r - r^*$ because in constructing (2) and (3) s^e, which is not directly observable, was proxied by the actual one-period-ahead spot exchange rate. Source: J. Frankel, *"Quantifying International Capital Mobility in the 1980s,"* in D. Das, *International Finance*, Routledge, 1993, tables 2.5, 2.6, 2.8, and 2.9.
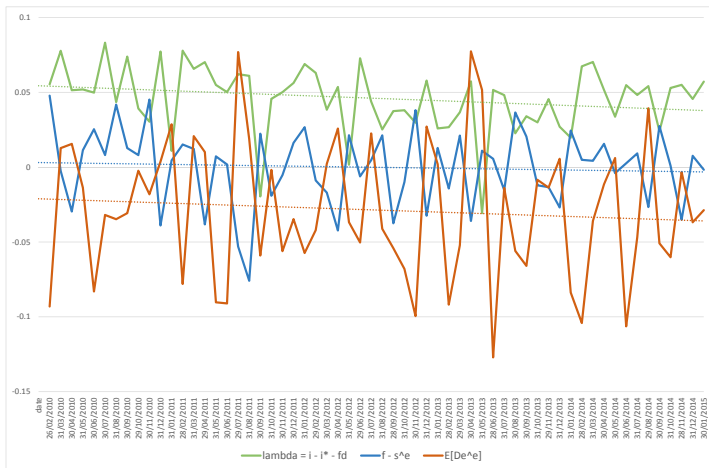
RSA decomp. of . $r - r^*$. Sample: $2010M2 - 2015M1$

	$(r - r^*)$	$(i - i^* - fd)$	$(f - s^e)$	$(\%\Delta e^e)$	sum	diff.
avg.	1.723	4.597	-0.010	-2.864	1.723	0.000
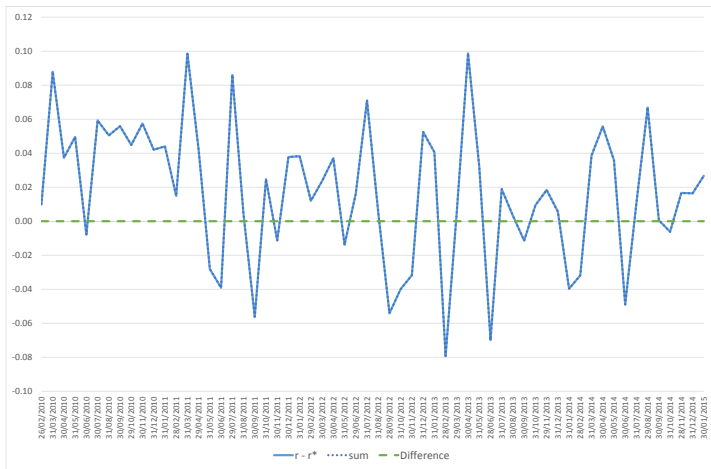
Summary

1. Under free capital mobility, CIP must hold.

2. When we observe violations of UIP, we cannot conclude that this is evidence against free capital mobility. For even under free capital mobility UIP need not hold. That is, the forward rate need not be the expected future spot rate.

3. Even when international capital markets are fully integrated, either uncertainty or the presence of non-traded goods can give rise to non-zero *real* interest rate differentials.

References

Appleyard, D., Field, A., 2014. International Economics. 8 ed., Mcgraw-Hill.

Schmitt-Grohé, S., Uribe, M., Woodford, M., 2019. International Macroeconomics. Columbia University. URL: http://www.columbia.edu/~mu2166/UIM/suw.pdf.