Lecture 7: The Foreign Exchange Market

Gregory Corcos

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Lecture 7: Outline

1. Introduction to Foreign Exchange Markets
2. Nominal and Real Exchange Rates
3. The Monetary Approach and PPP
4. Interest-Rate Parities

Suggested reading: Feenstra and Taylor, chapters 13 and 14.1

What is The Foreign Exchange (FX) Market?

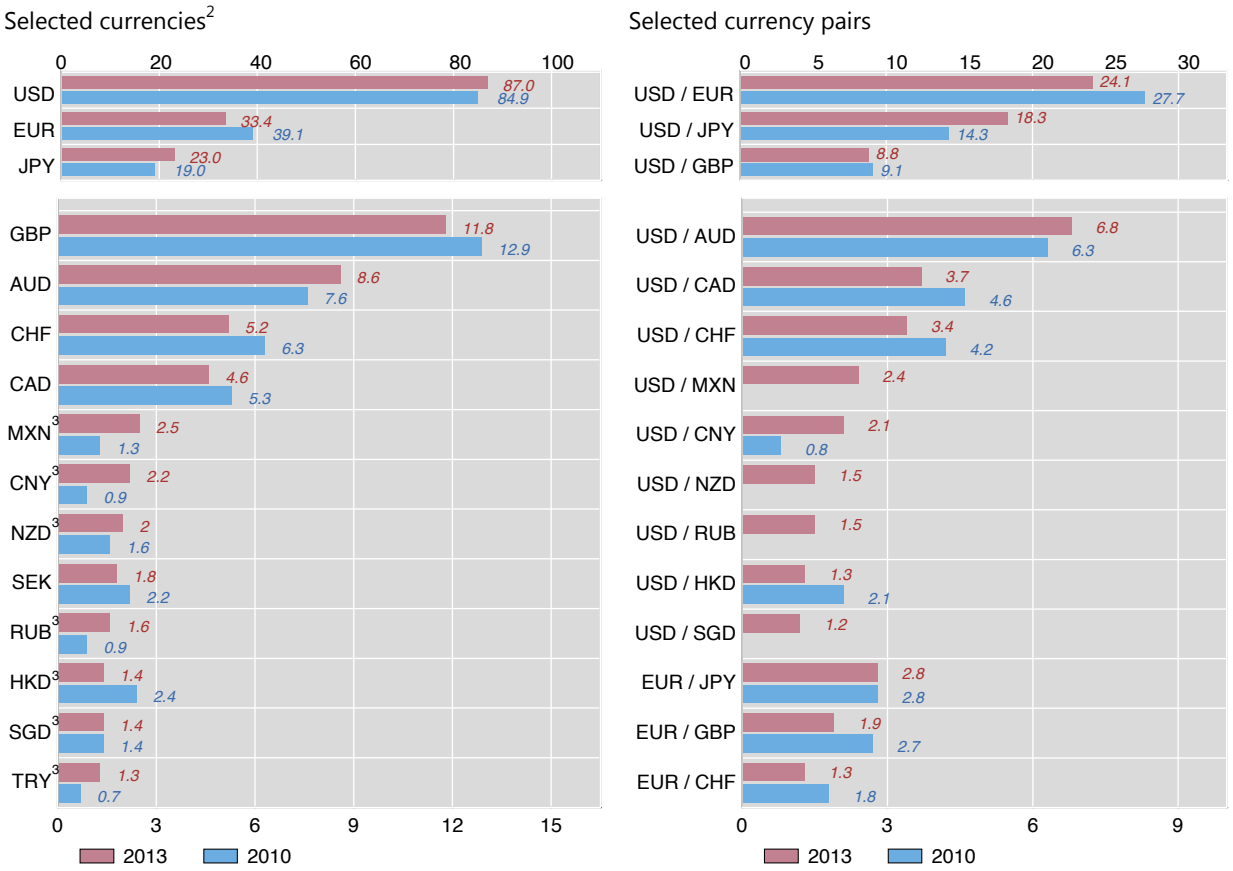
- a market where (convertible) currencies are traded
- a large and growing market: USD 5.3tn turnover/day in April 2013, USD 3.3tn in April 2007
- an over-the-counter market: less than 1% on organized exchanges, mostly interbank, no consolidation of positions
- a concentrated market: few currencies (USD, JPY, EUR, GBP), few market places (London, NY), few banks

Further reading: BIS Survey on FX Markets

Facts About FX Markets

Foreign exchange market turnover by currency and currency pairs[1]

Net-net basis, daily averages in April, in per cent Graph 1



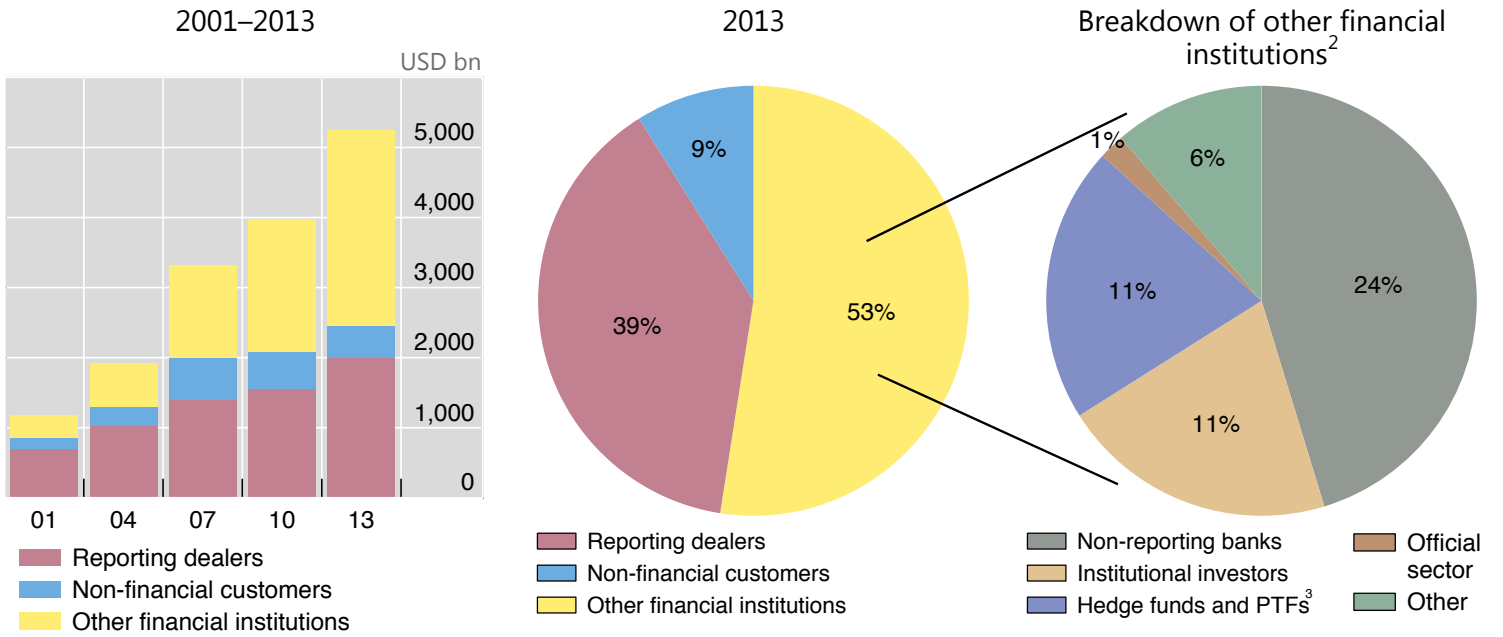
[1] Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis. [2] As two currencies are involved in each transaction, the sum of shares in individual currencies will total 200%. The share of currencies other than the ones listed is 12.2% for 2013 and 13.7% for 2010. [3] Turnover for 2010 may be underestimated owing to incomplete reporting of offshore trading. Methodological changes in the 2013 survey ensured a more complete coverage of the indicated currencies.

Source: BIS Triennial Central Bank Survey. For additional data by currency and currency pairs, see Tables 2 and 3 on pages 10-11.

Facts About FX Markets

Foreign exchange market turnover by counterparty[1]

Net-net basis, daily averages in April — Graph 2



[1] Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis. [2] For definitions of counterparties, see page 19. [3] Proprietary trading firms.

Source: BIS Triennial Central Bank Survey. For additional data by counterparty, see Tables 4 and 5 on pages 12-13.

Facts About FX Markets

Global foreign exchange market turnover

Net-net basis,[1] daily averages in April, in billions of US dollars — Table 1

Instrument	1998	2001	2004	2007	2010	2013
Foreign exchange instruments	1,527	1,239	1,934	3,324	3,971	5,345
Spot transactions	568	386	631	1,005	1,488	2,046
Outright forwards	128	130	209	362	475	680
Foreign exchange swaps	734	656	954	1,714	1,759	2,228
Currency swaps	10	7	21	31	43	54
Options and other products[2]	87	60	119	212	207	337
Memo:						
Turnover at April 2013 exchange rates[3]	*1,718*	*1,500*	*2,036*	*3,376*	*3,969*	*5,345*
Exchange-traded derivatives[4]	*11*	*12*	*26*	*80*	*155*	*160*

[1] Adjusted for local and cross-border inter-dealer double-counting (ie "net-net" basis). [2] The category "other FX products" covers highly leveraged transactions and/or trades whose notional amount is variable and where a decomposition into individual plain vanilla components was impractical or impossible. [3] Non-US dollar legs of foreign currency transactions were converted into original currency amounts at average exchange rates for April of each survey year and then reconverted into US dollar amounts at average April 2013 exchange rates. [4] Sources: FOW TRADEdata; Futures Industry Association; various futures and options exchanges. Foreign exchange futures and options traded worldwide.

Types of FX Transactions and Motivations

- Different types of transactions
  - spot: delivery within 24 hours
  - forward: future delivery at price set in advance
  - option: possible future delivery at price set in advance
  - swap: two transactions in opposite directions at different points in time
    - cross-currency swap: swap principal and interest payments in different currencies, swap principal at the end of the period
    - often to exploit lower interest rates in home currency
    - used by banks to raise funds from money markets in different currencies
- Different types of motivations:
  - Insurance: hedging FX risk of cross-border trade or financial transactions.
  - Arbitrage: taking advantage of spread differences across marketplaces
  - Speculation: mostly intraday, covered (assets and liabilities in same currency) or uncovered.

Exchange Rates: Definitions

- Nominal bilateral ER S_{ijt}, e.g. 1 EUR/USD=1.37
- Real bilateral ER: $Q_{ijt} = \frac{S_{ijt} P_{it}}{P^*_{jt}}$
- Effective ER: against a basket of currencies.
  REER: $Q_{it} = \prod_j Q_{ijt}^{\alpha_j}$.
  The BIS computes NEERs and REERs using weights based on a country's share in another country's exports.

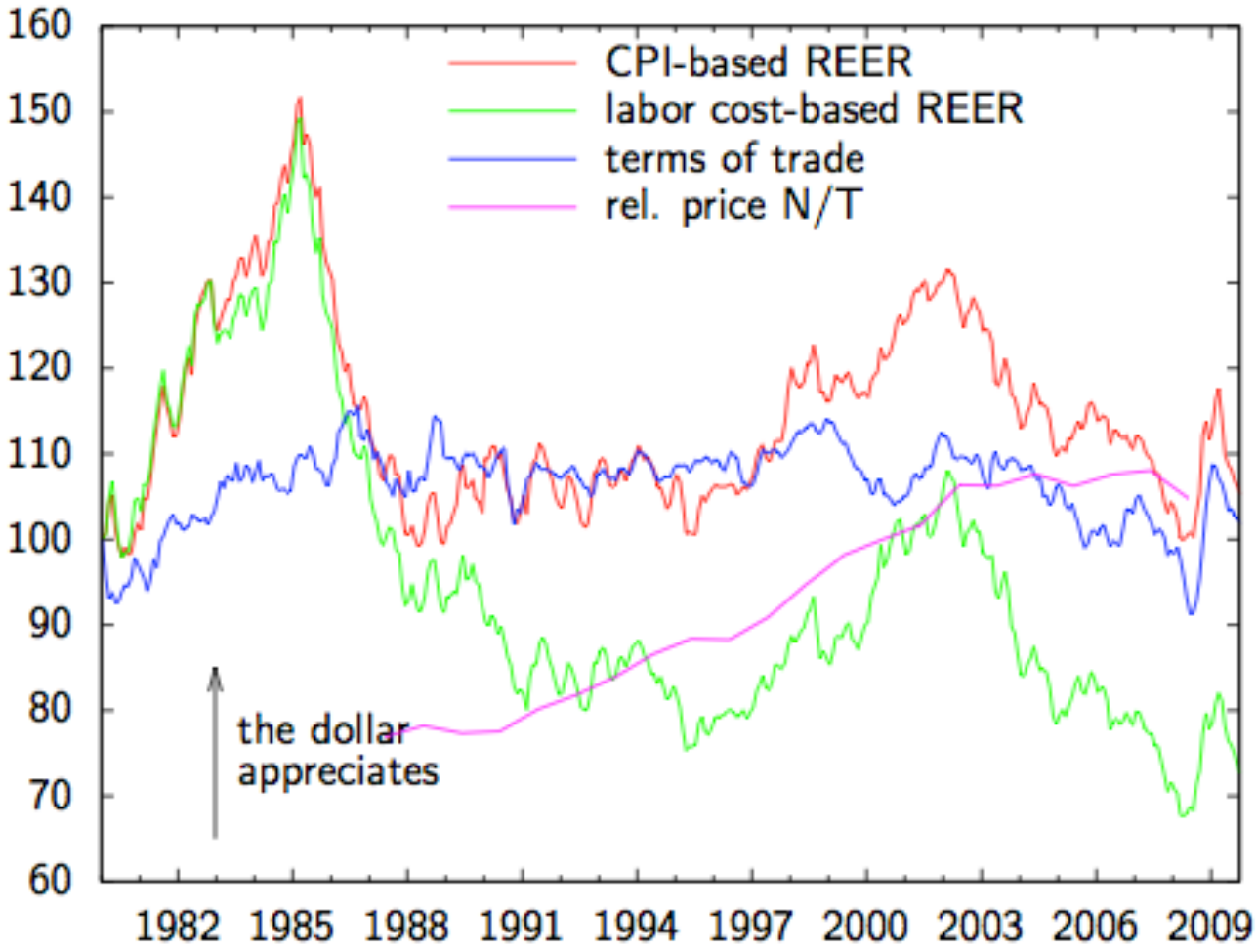
Two views of the RER

1. the relative-price-of-nontradables view (see previous lecture)
   - 2-sector model, tradables and nontradables, income shares γ and $1-\gamma$
   - small open economy, homogenous tradable good
   - RER given by $\frac{S_t P_t}{P_t^*} = Q^{1-\gamma}$
2. the terms-of-trade view
   - 2-country model, 1 tradable good per country, no nontradables
   - tradable varieties are substitutes: $p^T = (p^H)^{\alpha}(Sp^F)^{1-\alpha}$, $p^{T*} = (p^{F*})^{\alpha^*}(\frac{p^H}{S})^{1-\alpha^*}$
   - RER given by $\left(\frac{p_H}{Sp_F^*}\right)^{\alpha+\alpha^*-1}$

A full model with 2 countries and 4 goods would have:

$$RER = \frac{\left(\frac{p^N}{p^T}\right)^{\gamma}}{\left(\frac{p^{N*}}{p^{T*}}\right)^{\gamma^*}} \left(\frac{p_H}{Sp_F^*}\right)^{\alpha+\alpha^*-1}$$

Measures of the US REER, 1980-2010



Exchange Rate Regimes

- Fixed: the Central Bank defends a fixed value of the currency (peg) by trading foreign currency reserves.
- Floating: currencies are freely traded on FX markets.
- Intermediate cases:
  - crawling peg (Mexico 1990's)
  - soft peg with fluctuation band (Denmark)
  - managed float (China since 2005)

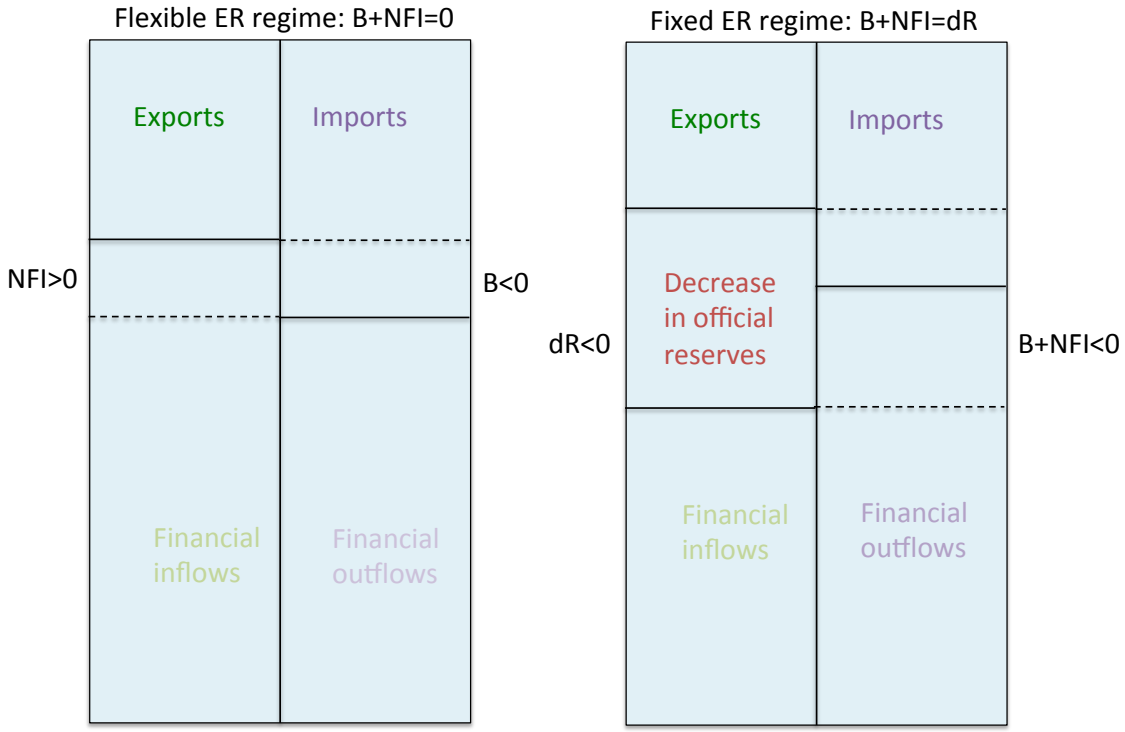
Money and Adjustment in a Fixed ER Regime

David Hume's price-specie flow mechanism, based on a quantitative theory of money:

- Suppose domestic prices are higher than world prices (incl. transport costs).
  - then the country incurs a trade deficit
  - then official reserves (gold or foreign currency) fall
  - then money supply contracts
  - then prices of home goods and wages decline (deflation)
  - then the trade deficit is eliminated.

- In the long run, the price-specie flow mechanism causes **Purchasing Power Parity** (Cassel, 1918): deviations will lead to movements in gold/reserves and adjustments.
- The price-specie flow mechanism
  - originally was a response to mercantilism's defence of persistent CA surpluses
  - can explain deflation episodes under the Gold Standard
  - is still relevant in fixed exchange rate regimes with CA imbalances: deflation ('internal devaluation') is the only way to cause adjustment.

Adjustment Under Fixed and Floating ER Regimes



Floating: CA equals Net Financial Outflows

Fixed : CA equals Net Financial Outflows Plus Change in Reserves

Adjustment Under Fixed and Floating ER Regimes

Consider the following stylized model:

$$p = m$$
$$m = r$$
$$b = \beta(p^* - p - s), \beta > 0$$

p: domestic price. p^*: world price. s: nominal spot exchange rate. m: money. r: official reserves. b: current account. (all variables in logs)

- Under a Fixed ER regime $dr = b, s = 0$

$$dp = dm = dr = b = \beta(p^* - p)$$

$dp > 0$ as long as $p^* - p > 0$, so that p converges to p^* in the long run.

- Under a Floating ER regime $dr = 0$

$$dp = dm = dr = 0 \Rightarrow s = p^* - p$$

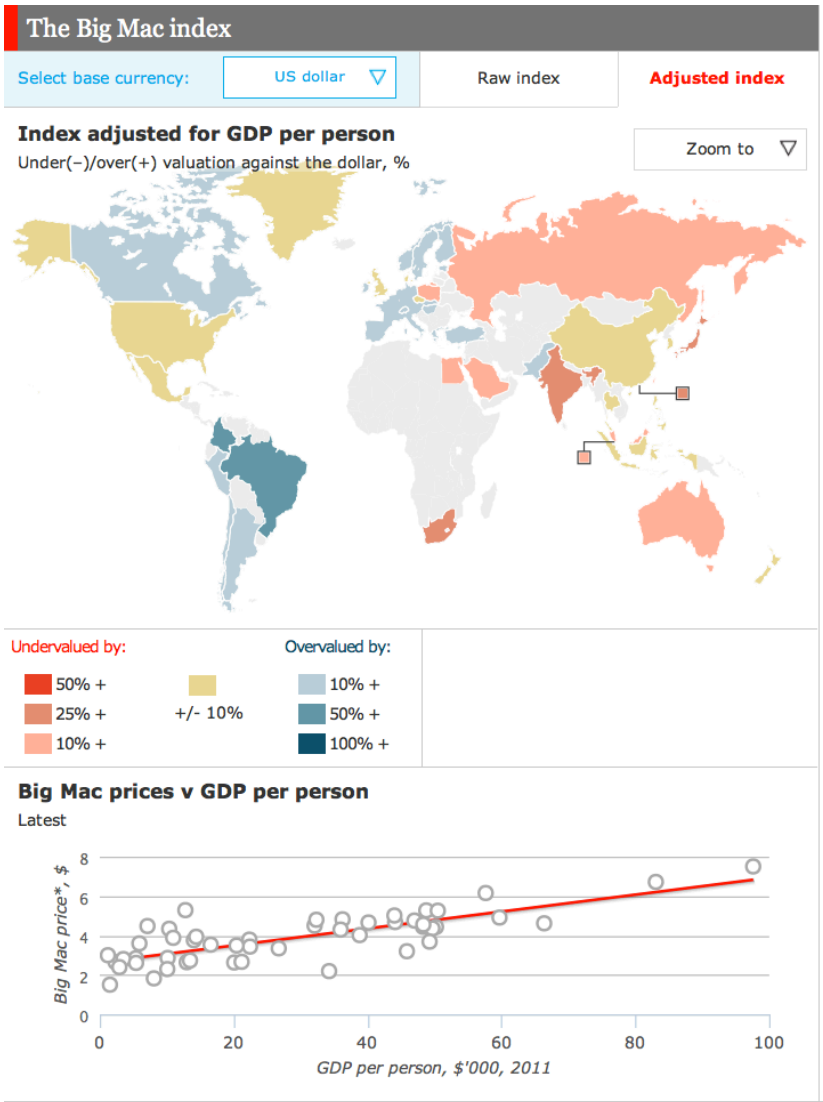
Adjustment is instantaneous.

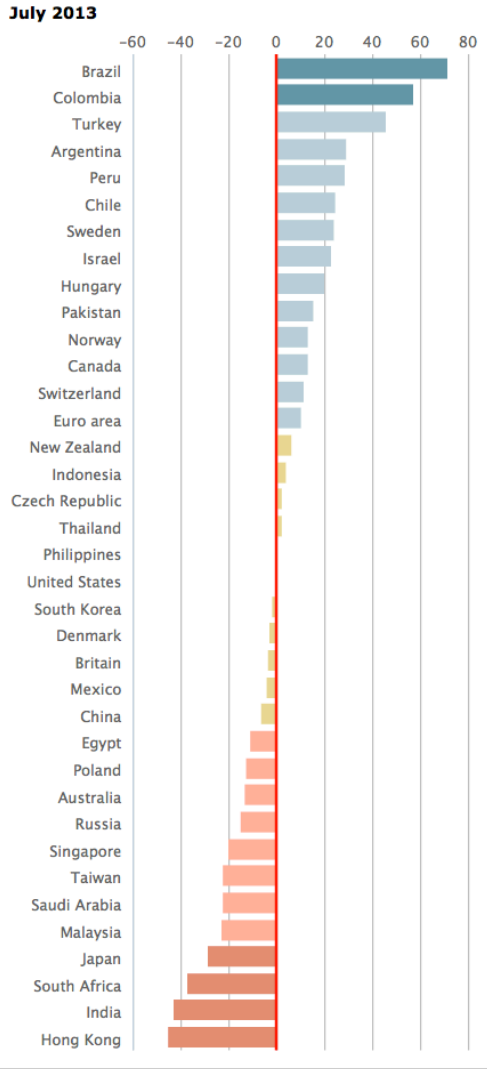
PPP in Practice

- Two versions of PPP:
  - absolute: same prices for the same basket of goods when expressed in the same currency
  - relative: prices for the same basket of good have the same inflation rate when expressed in the same currency
- Problem: CPIs use typically different baskets!
- Solution 1: International Comparison Program (ICOP) measures prices at 5-year intervals.
- Solution 2: Big Mac Index. Big Macs are comparable and capture local prices of both tradables and nontradables.

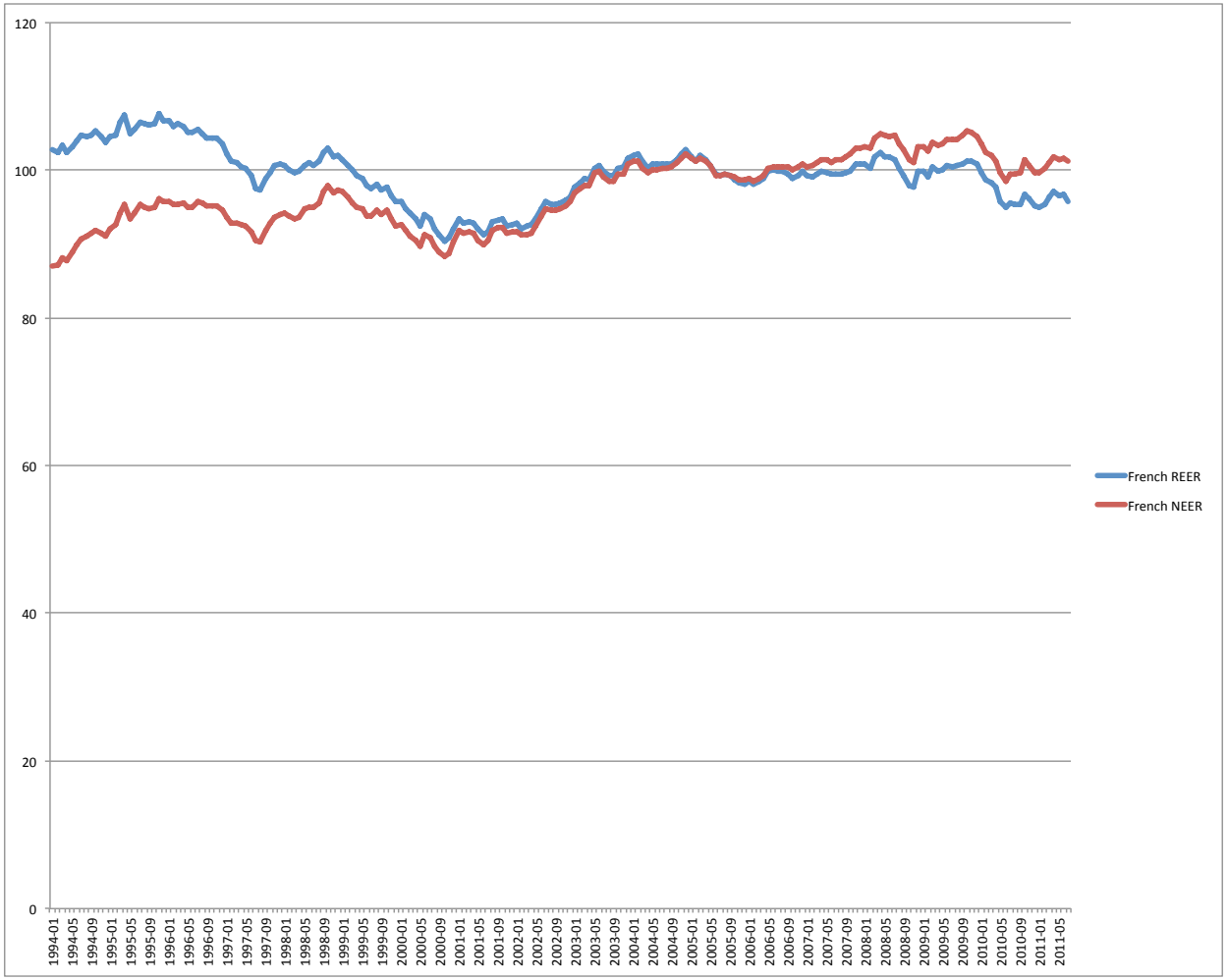
Further reading: ICOP 2011, Big Mac Index

PPP in Practice: the Big Mac Index





PPP in Practice: French NEER and REER, 1994-2011



Source: Bank of International Settlements.

Testing for PPP

- Test: if RER has a unit root, its deviations are permanent, and PPP fails. If not, RER is mean-reverting and PPP holds.
- Hypothesis H_0: $\rho = 0$ in

$$\Delta \ln Q_t = \rho \ln Q_{t-1} + \varepsilon_t$$

- Empirically H_0 is rejected against $H_1 : \rho < 0$. Consistent with long-term PPP: $\ln Q_t$ tends to zero.
- Convergence speed:
  - at PPP $\ln Q_t = \ln Q^* = 0$
  - $E[\ln Q_t] - \ln Q^* = (1+\rho)^t \ln Q_0 = (1+\rho)^t (\ln Q_0 - \ln Q^*)$
  - denote by T the half-life of the convergence process: $(1+\rho)^T = \frac{1}{2}$. Then $T = \frac{-\ln 2}{\ln(1+\rho)}$
  - Empirically Rogoff (1995) finds $\rho \approx -0,15$ for developed countries, implying $T \approx 4$ years.

PPP and the Balassa-Samuelson Effect

- The Balassa-Samuelson effect describes how price levels rise as countries grow, which explains long-term deviations from PPP.
- Intuition:
  - suppose a country's productivity is below world average
  - the law of one price implies implies that wages in the tradable sector are below world average
  - worker mobility and labor market competition imply equal wages in the non-tradable sector
  - non-tradable prices are lower than world average
  - domestic prices are lower than world prices, the currency is undervalued relative to PPP
  - catching-up in the tradables sector causes a wage increase, a rise in nontradables prices, and a RER appreciation

PPP and the Balassa-Samuelson Effect

Model assumptions:

- Tradables: $y^T = a^T L^T$
- Nontradables: $y^N = a^N L^N$
- Perfect labor mobility and competition on labor markets
- Perfect competition in product markets $p_i = \frac{w}{a_i}, i = T, N$
- Law of one price: $p^T = \frac{p^{T*}}{S}$

- solving for wages

$$p^N = \frac{a^T}{a^N} p^T, p^{N*} = \frac{a^{T*}}{a^{N*}} p^{T*}$$

- the law of one price implies

$$p^T = \frac{p^{T*}}{S} \Rightarrow \frac{p^N}{\frac{p^{N*}}{S}} = \frac{\frac{a^T}{a^{T*}}}{\frac{a^N}{a^{N*}}}$$

- the RER equals

$$Q \equiv \frac{P}{\frac{P^*}{S}} \equiv \frac{\left(p^T\right)^\alpha \left(p^N\right)^{1-\alpha}}{\left(p^{T*}/s\right)^\alpha \left(p^{N*}/S\right)^{1-\alpha}} = \left(\frac{\frac{a^T}{a^{T*}}}{\frac{a^N}{a^{N*}}} \right)^{1-\alpha}$$

- RER dynamics (hats denote proportional changes $\frac{dx}{x}$):

$$\widehat{Q} = (1-\alpha)\left[\left(\widehat{a^T} - \widehat{a^{T*}}\right) - \left(\widehat{a^N} - \widehat{a^{N*}}\right)\right]$$

- A poor country catching up should have $Q < 1$ and $\widehat{Q} > 0$

The Balassa-Samuelson Effect in the Data

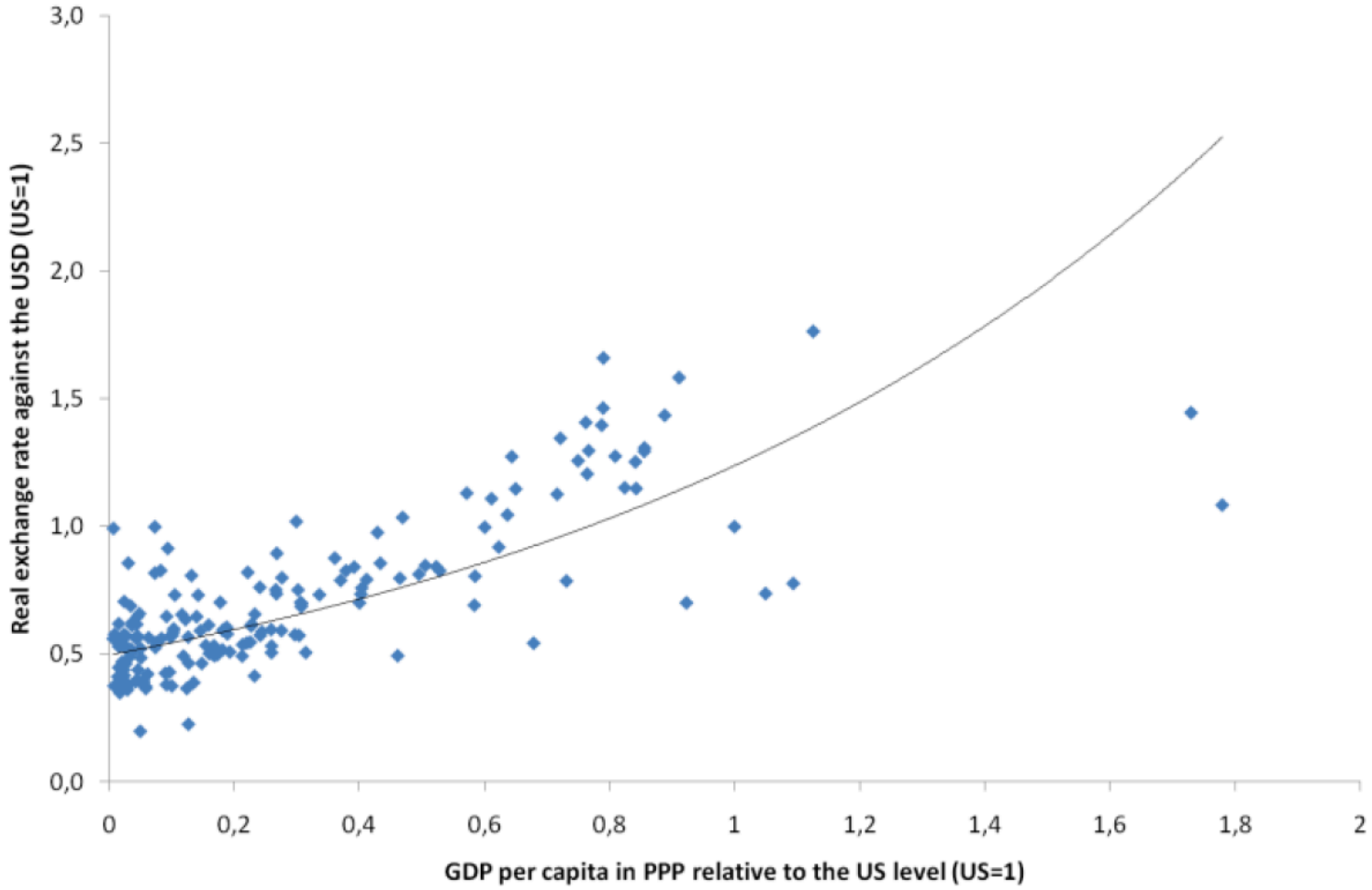


Figure: RER and PPP GDP per capita, 2009. Source: IMF, CEPII.

Covered Interest Rate Parity (CIP)

- Investing x euros at rate i yields $(1+i)^t x$ after t years.
- Converting x in USD at spot ER S_0, investing at rate i^* and selling at the forward USD/EUR rate F_t, yields $x(1+i^*)^t \frac{S_0}{F_t}$.
- No-arbitrage when

$$\left(\frac{1+i}{1+i^*}\right)^t = \frac{S_0}{F_t}$$

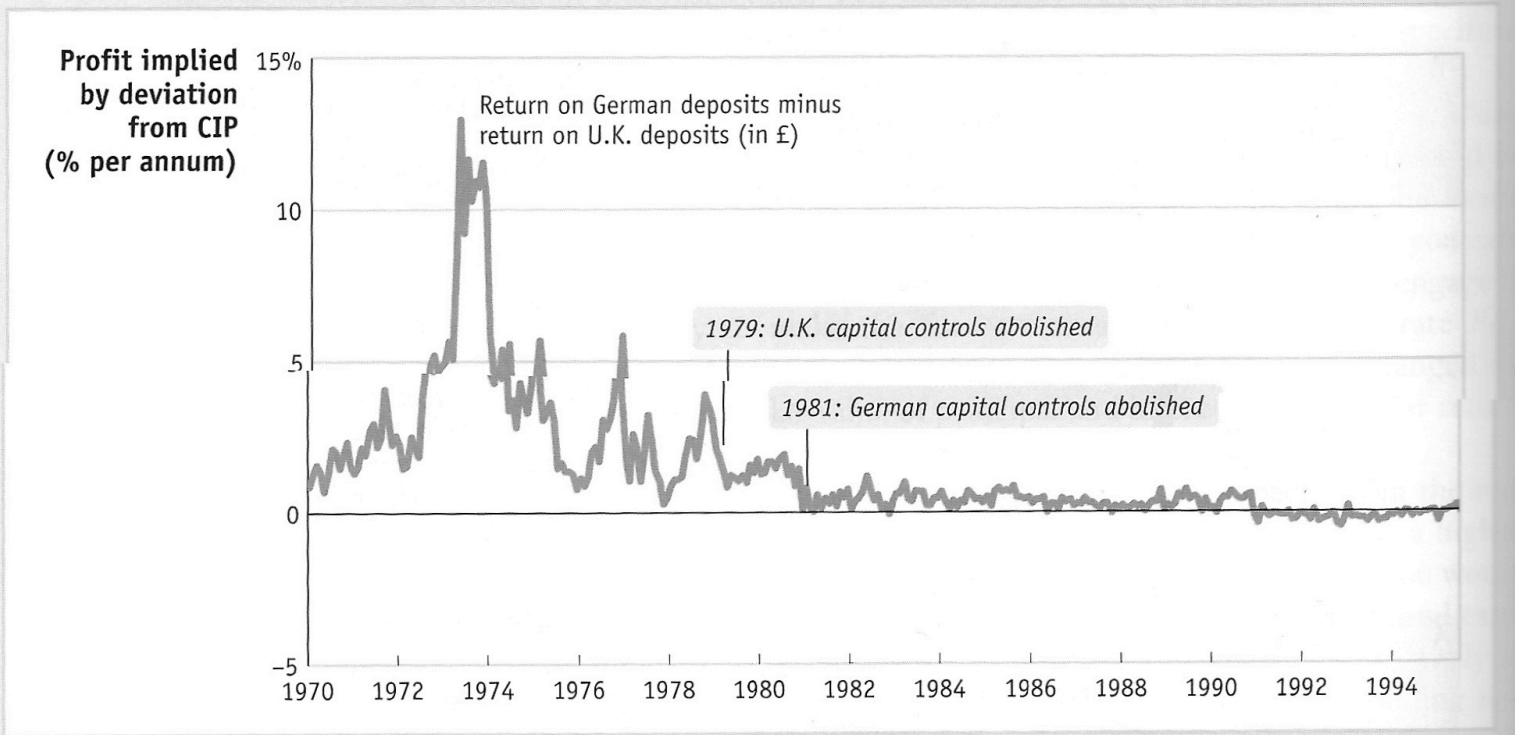
- Sometimes this formula is expressed in logs with $t = 1$.

$$i - i^* = s - f$$

- CIP offers a benchmark forward exchange rate.
- In practice, deviations will come from transaction costs, country risk, and barriers to capital flows.

Evidence for CIP

FIGURE 13-9



Financial Liberalization and Covered Interest Parity: Arbitrage between the United Kingdom and Germany The chart shows the difference in monthly pound returns on deposits in British pounds and German marks using forward cover from 1970 to 1995. In the 1970s, the difference was positive and often large: traders would have profited from arbitrage by moving money from pound deposits to mark deposits, but capital controls prevented them from freely doing so. After financial liberalization, these profits essentially vanished, and no arbitrage opportunities remained. The CIP condition held, aside from small deviations resulting from transactions costs and measurement errors.

Source: Maurice Obstfeld and Alan M. Taylor, 2004, Global Capital Markets: Integration, Crisis, and Growth, *Japan-U.S. Center Sanwa Monographs on International Financial Markets (Cambridge, UK: Cambridge University Press).*

Uncovered Interest-Rate Parity (UIP)

- Investing x euros at rate i yields $(1+i)^t x$ euros after t years.
- Converting x in USD at spot ER S_0, investing at rate i^*, selling at expected spot ER $S^e_{0,t}$, yields $x(1+i^*)^t \frac{S}{S^e_{0,t}}$.
- No-arbitrage when

$$\left(\frac{1+i}{1+i^*}\right)^t = \frac{S_0}{S^e_{0,t}}$$

- Sometimes this formula is expressed in logs with $t = 1$.

$$i - i^* = s - s^e$$

- 'uncovered' means investors are willing to bear ER risk.

Evidence on UIP: Indirect Test

- If CIP and UIP hold simultaneously, then

$$\frac{S_0}{F_t} = \left(\frac{1+i}{1+i^*}\right)^t = \frac{S_0}{S^e_{0,t}} \Leftrightarrow F_t = S^e_{0,t}$$

- Data on exchange rate expectations are rare. Indirect test:
  - assuming rational expectations, $S^e = E(S/\mathcal{I})$ where $\mathcal{I}$ is the available information set. Then $F = E(S/\mathcal{I})$
  - empirical model

$$s_t - s_{t-1} = a + b(f_{t-1,t} - s_{t-1}) + u_t$$

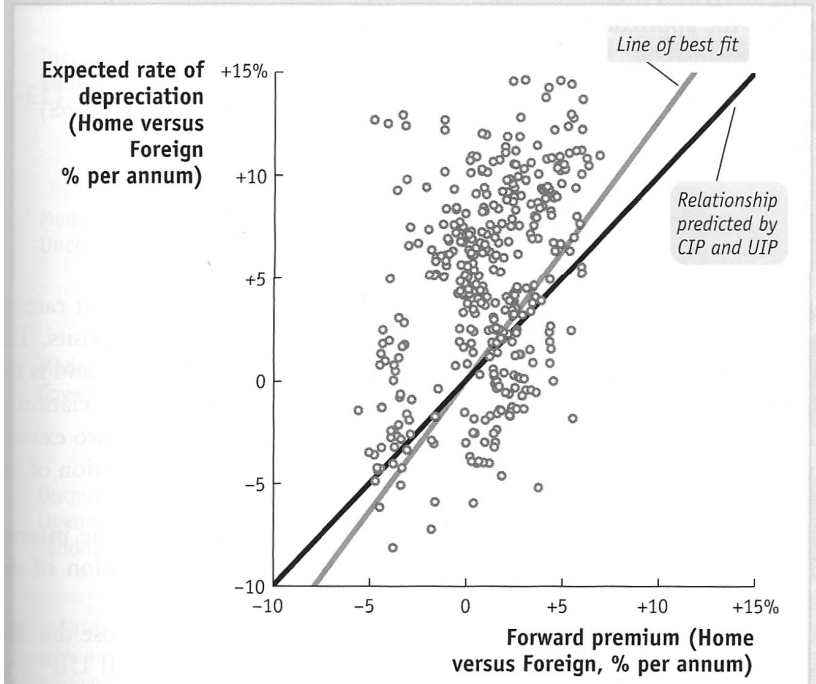
  - Hypothesis to test: $a = 0, b = 1$
- Empirical failure: $a \neq 0$, $b < 0$ in the short run, $b > 0$ only in the long run
- Possible explanations: endogenous short-term interest rate, variable risk premium, non-rational expectations

Empirical Evidence on UIP: Expectations Data

Chinn and Frankel (2002) use a survey on exchange rate expectations (S^e) to test whether:

$$\underbrace{\frac{F_t}{S_t} - 1}_{\text{'forward premium'}} = \underbrace{\frac{S_t^e}{S_t} - 1}_{\text{'expected rate of depreciation'}}$$

FIGURE 13-11



Evidence on Interest Parity When UIP and CIP hold, the 12-month forward premium should equal the 12-month expected rate of depreciation. A scatterplot showing these two variables should be close to the diagonal 45-degree line. Using evidence from surveys of individual forex traders' expectations over the period 1988 to 1993, UIP finds some support, as the line of best fit is close to the diagonal.

Notes: Line of best fit is through the origin. Data are monthly for the German mark, Swiss franc, Japanese yen, British pound, and Canadian dollar against the U.S. dollar from February 1988 to October 1993.

Source: Menzie Chinn and Jeffrey A. Frankel, 2002, "Survey Data on Exchange Rate Expectations: More Currencies, More Horizons, More Tests." In W. Allen and D. Dickinson, eds., Monetary Policy, Capital Flows and Financial Market Developments in the Era of Financial Globalisation: Essays in Honour of Max Fry *(London: Routledge), pp. 145–167.*

Implications of Interest-Rate Parities For ER Dynamics

- Floating ER regimes

$$s_t = s^e_{t,t+1} + i_t - i^*_t = ... = s^e_{t,+\infty} + \sum_{k=0} (i^e_{t+k} - i^{e*}_{t+k})$$

  - the spot ER is forward-looking: it reflects expectations on monetary policy and long-term ERs
  - the spot ER is more volatile than the interest rate differential, because it captures all future interest-rate changes

- Fixed ER regimes (using the n-year UIP formula)

$$i_t = i^*_t - \frac{1}{n}(s^e_{t,t+n} - s_t)$$

  - to defend a fixed ER can be very costly for a Central Bank
  - suppose the ER is expected to depreciate by 10% in a month. Then the CB must raise interest rates by 120% ($= \frac{0.1}{1/12}$)).

Conclusions

- The FX market is decentralized, mostly OTC and shows large volumes and high volatility.
- In theory, PPP should hold in the long-run. Evidence in support of convergence in about 4 years.
- The Balassa-Samuelson effect predicts RER appreciation in developing countries.
- According to no-arbitrage principles, forward ERs should follow UIP and CIP. Mixed empirical evidence.
- CA Adjustment works differently under fixed and flexible ER regimes.