

Fundamental exchange rate trading performances

Gianfranco Forte

DEA, University of Milano Bicocca, Faculty of Economics, Via Bicocca degli Arcimboldi n.8, Milano, Italy

Jacopo Mattei[♦]

DEIT, University of Ferrara, Faculty of Economics, via Voltapaletto, 11 - Ferrara, Italy

Edmondo Tudini

SDA Bocconi School of Management, Bocconi University, via Bocconi 8, Milano, Italy

This draft: 2011 July 15th

Abstract

The question on the predictive power of different exchange rate equilibrium models is one of the oldest and most intriguing in international finance and assets trading. On one side there is evidence – starting from Meese and Rogoff (1983) to Cheung, Chinn and Pascual (2005) - about the poor performance of fundamental models such as purchasing power parity (PPP) or covered interest parity (CIP). On the other side, practitioner asset managers often trade with a very simple rule - carry trade (CT) – assuming that currencies with high interest rates will appreciate against those with low interest rates, which goes exactly the opposite way than what predicted by CIP. Many studies, for example Gyntelberg and Remolona (2007) or McGuire P. et al. (2007) revealed a good performance of CT models in recent years, but some authors underlined that returns exhibit a strong (left) asymmetry in their distribution - Gagnon and Chaboud (2007) - and are negative in periods of high volatility, such as market crises – Brunnermeier, Nagel and Pedersen (2009), Cairns, Ho and McCauley (2007). In the light of these new findings and relying on recent evidence - by De Zwart et al. (2009), Jordà and Taylor (2009) - that fundamentals have informative power we reconsider the main fundamental relations on exchange rates comparing the trading performance obtained going long the under-valued currency and short the over-valued one. Our sample is made of G-10 currencies plus 8 currencies of minor/emerging countries with deliverable forward contracts. We tested the performance of simple trading rules based on mispricing signals from three different exchange rate fundamental relations: PPP, UIP in terms of real interest rates, GDP growth differentials through the so called Taylor Rule (TR). Models are estimated with monthly data and trading performances evaluated in terms of return, volatility and Sharp ratio over the entire sample and portfolios made of selections of currencies. Henceforth the comparison between fundamental trading strategies takes into account differences across the sample, potentially linked to the different nature of the three equilibrium relations employed. Results are supportive for Purchasing Power Parity and for the Taylor Rule.

[♦] Corresponding author: e-mail address jacopo.mattei@unife.it.

1. Introduction

The foreign exchange market continuously increased in traded volumes in the last 10 years (Table 1), and it constitutes the major market of financial assets. Nonetheless currencies still nowadays are somehow disregarded as an asset class and there is an high variability among market players and institutions about the equilibrium level of the exchange rate of a given currency against another.

In fact, the question on the predictive power of different exchange rate equilibrium models is one of the oldest and most intriguing in international finance and assets trading. On one side there is a quite large – although differentiated - empirical consensus (from Meese and Rogoff, 1983 to Cheung, Chinn and Pascual, 2005) about the poor performance of fundamental models such as purchasing power parity (PPP) or covered interest parity (CIP). On the other side, practitioner asset managers often trade with a very simple rule - carry trade (CT) – assuming that currencies with high interest rates will appreciate against those with low interest rates, which goes exactly the opposite way than what predicted by one of the main exchange rate equilibrium models (Uncovered Interest Parity). Many studies, for example Gyntelberg and Remolona (2007) or Galati, Heath and McGuire (2007) revealed a good performance of CT models in recent years, but some authors underlined that returns exhibit a strong (left) asymmetry in their distribution - Gagnon and Chaboud (2007) - and are negative in periods of high volatility, such as market crises – Brunnermeier, Nagel and Pedersen (2009), Cairns, Ho and McCauley (2007). In the light of these new findings and relying on the evidence - by De Zwart, Markwat, Swinkels and van Dijk (2009), Jordà and Taylor (2009) - that fundamentals have informative power we reconsider the main fundamental relations on exchange rates comparing means of the trading performances obtained going long the under-valued currency and short the over-valued one, as signaled by fundamental equilibrium models (FEM). We concentrate our attention on three main and widely acknowledged FEM: Purchasing Power Parity (PPP), Uncovered Interest Parity (UIP) and the Taylor Rule (TR)

In the remainder the paper is organized as follows: section 2 reviews theoretical literature and empirical evidence on selected models, section 3 explains data used and methodology, section 4 clarifies trading rules implemented in order to invest in currencies, section 5 presents and discusses results, section 6 concludes.

Table 1. Spot foreign exchange global turnover¹.

April 1995	April 1998	April 2001	April 2004	April 2007	April 2010
679,756	761,928	518,614	839,608	1304,942	1832,302

Daily averages, in billions of US dollars

2. Exchange rate fundamentals

Exchange rate has been extensively considered in the classical economic literature a macroeconomic variable, determined by agents – supposed to be “rational” – in the international markets. Thus, depending on what considered determinant in those agents’ behavior, exchange rate has been modeled with reference now to prices of goods and services in the economy, now to differential financial returns among countries, now to the effects of Central Banks’ interventions. All these define the large family of structural models, in which the exchange rate depends by one or more “fundamental” variables – directly observable – of the economies. We will refer to three FEM of the exchange rate (namely PPP, CIP-UIP and Taylor rule),

¹ Source: BIS, “Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity in 2010”, Annex table D.19.

due to the fact that they (i) although controversial, have shown in many cases some fit to market data and in some cases a non negligible predictive power, and (ii) are related to variables easily observable in real life market activity, often composing the basic set of news considered by agents both in international trade and in financial investments. These models are described and discussed here after.

a. Purchasing Power Parity (PPP)

The purchasing power parity (PPP) principle was stated the first time by Cassel (1918), but it was already implicit in the work of many economists of the previous century. In its absolute version the principle refers to the so called “law of one (international) price”, by which domestic and foreign prices of goods and services should be equalized by international arbitrage:

$$P_D = \frac{P_F}{s}$$

Where P_D is the level of domestic prices, P_F is the level of foreign prices and s is the exchange rate expressed as the price of the domestic currency in terms of the foreign one. As it is well known, there are several strong hypothesis to be satisfied in order for the above equation to hold, such as, for example, the absence of transportation costs and of trade barriers, or the perfect information on prices. By the way, on the basis of the absolute version of PPP, the equilibrium exchange rate should fix at the theoretical level of:

$$\tilde{s} = \frac{P_F}{P_D} \quad [1]$$

Relaxing the hypotheses, the relative version of PPP considers that there exists a proportionality between domestic and foreign prices (k is a scale factor):

$$\tilde{s} = k * \frac{P_F}{P_D}$$

This, taking logarithmic differences, gives the more known relative PPP equation, which postulates that the exchange rate appreciates if foreign inflation is higher than the domestic one:

$$\Delta s = \pi_F - \pi_D \quad [2]$$

Where Δs is the variation in the spot exchange rate, π_F is the inflation rate abroad and π_D is the domestic inflation.

Both versions of PPP imply that the real exchange rate (R) is constant over time:

$$\bar{R} = \tilde{s} * \frac{P_D}{P_F} \quad [3]$$

PPP, in either specification, is supposed to hold especially in the long run and, despite some controversial evidence², many recent contributions point at its reliability, starting with the evidence from the huge data set of Frankel and Rose (1996) and the findings of Edison, Gagnon and Melick (1997) that³ “*The failure of most empirical studies to find evidence for PPP in the post-Bretton-Woods era can be attributed largely to the low power of the tests employed*”. For example Lothian (1997) stated that PPP performs well in the long run for the US dollar and other 22 OECD currencies. Indeed, MacDonald and Marsh (2004) found a strong predictive power of PPP on the three currency long run equilibrium of US dollar, German mark and

² In this sense Adler and Lehmann (1983) refuted PPP as an exchange rate equilibrium relation.

³ Page 13.

Japanese yen, and Papell (2006) documented a strong evidence⁴ of PPP for 20 USD exchange rates over the period 1973-1998.

b. Covered (Uncovered) Interest Parity (CIP-UIP)

Another exchange rate equilibrium expression is defined in the capital markets and relates its level to interest rates. It abstracts from risk premiums and taxes, and it was first exposed by Keynes. The Covered Interest Parity (CIP) links the forward exchange rate to the corresponding spot, via the level of domestic and foreign interest rates:

$$f_t = \frac{(1+i_F)}{(1+i_D)} * s_t \quad [4]$$

or, in logarithms:

$$f_t - s_t = i_F - i_D \quad [4.1]$$

Where s_t and f_t are respectively the spot and the forward exchange rate in (t), i_F and i_D the levels of the foreign and the domestic interest rate on homogeneous financial assets.

The parity originates from the idea that there couldn't be arbitrage opportunities between foreign and domestic financial returns, under the assumptions that international capital flows are free and information is complete. Moreover, if it's assumed that investor don't hedge against exchange rate risk by means of the forward rate, the relation could be expressed in the form of the Uncovered Interest Parity (UIP), where f is substituted by the expected value in (t) of the spot rate in ($t + 1$):

$$E_t(s_{t+1}) = \frac{(1+i_F)}{(1+i_D)} * s_t \quad [5]$$

In logarithms, and assuming rational expectations:

$$s_{t+1} - s_t = i_F - i_D \quad [5.1]$$

The CIP formulation was generally confirmed by empirical studies (Frenkel and Levich,1975), as there is no evidence of unexploited arbitrage opportunities between forward and spot exchange markets, apart occasional windows during periods of market turbulence (Taylor, 1989). Much more troubles arise about UIP, which was acknowledged to explain only a small portion of spot rate variance at short horizons and to produce systematically biased estimates⁵. More recently, by the way, Chinn and Meredith (2004) have found that the interest rate differential couldn't be refused as an explanation of spot exchange rate movements at longer time horizons⁶.

In what follows we will use UIP with the additional idea – originally suggested by Frankel (1979) – that investors choices are determined not by nominal but real interests. This is named the Uncovered Real Interest Parity (URIP) and could be modeled with reference to the real exchange rate (Meese and Rogoff, 1988), or – following de Zwart et al (2009) – to the nominal spot exchange rate (in logs):

$$s_{t+1} - s_t = (i_{Ft} - \pi_{F(t-i)}) - (i_{Dt} - \pi_{D(t-i)}) \quad [6]$$

⁴ The evidence strengthens when the dollar appreciates, what the author calls the “panel purchasing power parity puzzle”.

⁵ Frenkel (1981), Meese (1990).

⁶ In the same direction were the contribution by Flood and Taylor (1996) and the hint by Mussa (1979).

For the inflation rate, with $(t - i)$ we indicate the need to take the lagged value i -months backwards, in order to properly consider the information availability and the announcement effect⁷.

c. Taylor Rule (TR)

A relevant stream of literature⁸ discussed the so called monetary models, where the equilibrium exchange rate is considered to be the result of equilibrium in the supply and demand of both domestic and foreign currencies. An extension of this models was to treat the exchange rate as one of the macroeconomic variables determined in the system in response to monetary policy interventions. Following Taylor (1993) a monetary policy rule followed by central banks can be specified as:

$$i_t^* = \pi_t + \varphi(\pi_t - \pi^*) + \gamma y_t + r^* \quad [7]$$

Where (π^*) denotes the target/desired level of the variable, y_t is the deviation of GDP from its estimated potential level and r^* is the equilibrium real exchange rate.

Assuming that both domestic and foreign central banks adopt the above [7] specification of the Taylor rule (TR) – targeting inflation – and that UIP doesn't hold in the short run, we can refer to Clarida and Waldman (2008) and link interest rates in the home country and abroad in order to obtain the variation in the spot exchange rate as:

$$\Delta s_{t+1} = \alpha + \beta_1(\pi_{Dt} - \pi_{Ft}) + \beta_2(i_{Dt} - i_{Ft}) + \beta_3(y_{Dt} - y_{Ft}) \quad [8]$$

Where s_t is the logarithm of the spot exchange rate, β_1 , β_2 and β_3 are assumed to be all positive, as – neglecting UIP in the short run – a restrictive intervention of the Central Bank in the domestic country, when inflation is higher than what desired or when the output gap is expansive, causes interest rates to rise and the domestic currency to appreciate.

TR was found to have a very good explanatory power by recent studies. For example Molodtsova and Papell (2009) report a strong evidence supporting TR on a huge dataset with monthly data from March 1973 to June 2006 for 11 currencies against the US dollar. In the same direction Passari (2009), with data on two samples, one ranging from 1975 to 2009 for 4 major currencies and the other with data on 4 different countries from 1989 to 2009.

3. Data and methodology

Our analysis is relevant for exchange rates under a free float, where currency prices are determined by their demand and supply, in turn affected by the fundamental variables – discussed earlier – via the investors' behaviour or the Central Bank's intervention. We considered 16 exchange rates of emerging markets, European and G-10 currencies against the US dollar over the time range from January 2000 to May 2011. Currencies are selected in order to be all under a free float regime– apart few exceptions in the first part of it – and to have deliverable forward, so that interest parities are not prevented nor constrained by any capital control or convertibility restriction. This is the reason why many emerging markets currencies, such as for example the Brazilian real, the Korean won or the Taiwanese dollar, have been excluded. Data have been obtained as monthly rates from Reuters, quoted as spot exchange rates, forward 1 month and forward 3 months for each currency. All exchange rates are expressed as the price of the USD in terms of the foreign currency.

⁷ This is as to say that investors will adjust their estimates of the real interest differential only when data on both inflation rates are available.

⁸ See Frenkel (1976), Dornbush (1976) and Bilson (1978).

Table 2. Currencies with summary statistics over the period Jan.2000-May.2011.

Currency	Exchange rate regime	FX return	FX volatility	Interest differential	Inflation differential	GDP growth
<i>Emerging</i>						
Mexican peso (MXN)	Free float	2,15%	9,59%	2,04%	5,86%	11,41%
South African rand (ZAR)	Free float	2,19%	18,00%	3,25%	6,24%	4,14%
Thai baht (THB)	Free float	-1,64%	6,53%	0,20%	-0,06%	5,18%
<i>European non euro</i>						
Czech koruna (CZK)	Free float	-5,98%	13,70%	0,00%	0,04%	3,74%
Danish krone (DKK)	Free float	-2,73%	10,98%	-0,29%	0,35%	0,69%
Hungarian forint (HUF)	Free float from May 2001	-1,88%	15,77%	3,13%	5,94%	2,02%
Polish zloty (PLN)	Free float from April 2000	-2,77%	15,20%	0,68%	4,61%	9,69%
<i>G10</i>						
Australian dollar (AUD)	Free float	-3,52%	13,84%	0,59%	2,47%	9,44%
Canadian dollar (CAD)	Free float	-3,28%	9,39%	-0,25%	-1,33%	2,20%
European euro (EUR)	Free float	-2,75%	11,00%	-0,33%	0,00%	1,60%
Japanese yen (JPY)	Free float	-1,44%	10,00%	-11,55%	-2,53%	0,59%
New Zealand dollar (NZD)	Free float	-2,73%	14,94%	0,15%	3,02%	7,44%
Norwegian Krone (NOK)	Free float	-3,00%	11,85%	-0,47%	1,49%	2,56%
Swedish krone (SEK)	Free float	-2,18%	12,75%	-1,59%	0,09%	1,84%
Swiss franc (CHF)	Free float	-4,68%	11,07%	1,99%	-1,59%	5,81%
UK sterling (GBP)	Free float	0,23%	9,86%	-0,20%	1,18%	4,99%
US dollar (USD)	Free float	0,00%	0,00%	0,00%	0,00%	1,93%

For every country we also gathered data on interest rates, prices, inflation, and GDP. We opted, in line with relevant literature, for 1 month interbank rates as provided by Datastream, apart Mexico for which the reference is to the "Mexico balance interbank rate" (TIIE) available through the named source. Inflation was obtained from official national statistical sources as monthly data on the consumer price index (CPI). GDPs are quarterly data from official national statistical sources. Then, as we needed reference to the price level in each country in order to estimate the theoretical exchange rate for the Purchasing Power Parity, we adopted data and definitions given by the Penn World Table (PWT 7.0⁹), where 2005 is the base year¹⁰. As for the Euroland price level we computed average prices for constituent countries and then applied inflation derived by the Eurostat harmonized CPI.

Table 2 reports for all currencies:

- the annualised average return resulting from one month long rolling positions in the USD with – in parenthesis – its volatility; at this regard it has to be noted that results are different among currencies, especially in terms of volatility;
- the annualised monthly average interest rate differential;
- the annualised monthly inflation differential;
- the annualised quarterly GDP growth rate.

⁹ See Heston A., Summers R., Aten B. (2011).

¹⁰ We got prices backwards and forwards on the base of inflation rates and then checked their consistency with what reported by the PWT.

In order to TR inputs, the problem - extensively discussed in the literature (see de Zwart et al (2009) for an example) - of estimation of the output gap, which refers to a deviation of the GDP from the Central Bank's desired level or estimate, was solved taking the difference between actual GDP and its trend fitted value.

In the end we chose not to estimate any parameter for equilibrium equations, because our exercise wasn't to evaluate forecast accuracy, but to translate them into simple trading rules (discussed in the following paragraph), so as to appreciate their power to produce returns significantly different from zero— both for each currency and for portfolios of currencies.

4. Fundamentalist trading rules

All three equilibrium equations discussed earlier (namely equations [1], [6] and [8]) have been translated in appropriate trading rules. That is as to say that we considered fundamental equilibrium equations in order to obtain signals for going long/short the foreign currency (USD is the base). Investments are performed by means of the forward contract, so that the interest differential is an additive component of each single position. In fact through interest parity, the investment return in a foreign currency is:

$$\frac{s-f}{f} = i_D - \frac{s}{f} * i_F \quad [9]$$

The first strategy is derived from PPP and it considers signals deriving from the ratio $\frac{P_F}{P_D} * \frac{1}{s}$ – we call it the valuation factor (VF) –, following the idea that VFs smaller than one call for overvaluation of the base currency and, vice versa, that values greater than one indicate undervaluation of the same currency. Henceforth we adopted the following simple rule to generate trading signals (1 stands for a long position in the foreign currency, -1 for a short position):

$$\begin{cases} 1 \text{ if } VF < 1 \\ -1 \text{ if } VF > 1 \end{cases} \quad [t1]$$

VF values are then also ranked in order to select subsamples of currencies.

The second strategy takes move from the UIP in terms of real interest rates differential (URIP from equation [6] above), and considers that the currency with the advantage of a positive real interest differential would depreciate. Thus the trading rule is:

$$\begin{cases} 1 \text{ if } (i_{USDt} - \pi_{USD(t-i)}) - (i_{FCt} - \pi_{FC(t-i)}) > 0 \\ -1 \text{ if } (i_{USDt} - \pi_{USD(t-i)}) - (i_{FCt} - \pi_{FC(t-i)}) < 0 \end{cases} \quad [t2]$$

Values of the difference are then also ranked in order to select subsamples of currencies.

The lag for the inflation rate is taken both of 1 month ($i = 1$) and of 3 months ($i = 3$), so as to compare trading performances and (indirectly) best fit.

The third trading rule considers predictions generated by the Taylor Rule (equation [8]), which three right hand side blocks generate three different signals:

$$\begin{cases} 1 \text{ if } \pi_{Dt} - \pi_{Ft} < 0 \\ -1 \text{ if } \pi_{Dt} - \pi_{Ft} > 0 \end{cases} \quad [t3.1]$$

$$\begin{cases} 1 \text{ if } i_{Dt} - i_{Ft} < 0 \\ -1 \text{ if } i_{Dt} - i_{Ft} > 0 \end{cases} \quad [t3.2]$$

$$\begin{cases} 1 \text{ if } y_{Dt} - y_{Ft} < 0 \\ -1 \text{ if } y_{Dt} - y_{Ft} > 0 \end{cases} \quad [t3.3]$$

Also in this case values of the three differences are one by one ranked in order to select subsamples of currencies.

The investment strategy is then implemented taking positions on the basis of each one of the three rules ([t3.1], [t3.2], [t3.3]), and then combining the investment in an equally weighted (1/3 each) portfolio.

In the end, we evaluate the reliability of the three exchange rate fundamental equilibrium relations by means of the performances of investments in foreign exchange market, made in accord with trading rules designed on the basis of the same equilibrium equations. In practice, then, for each rule we implement investments following two different strategies:

1. building a portfolio with only the first n – long or short the foreign currency depending on each rule’s features - and the last n currencies – long or short the foreign currency depending on each rule’s features –;
2. investing long in all currencies assigned the weight 1 from the trading rule, and short all those assigned weight -1;

5. Results

Table 3 reports the summary statistics of performances obtained implementing fundamentalist trading rules. Each single block of the table corresponds to one of the previously discussed equilibrium models. Thus PPP results are shown first, then URIP with 1 month lag for the inflation (URIP1M) and URIP with 3 months lag for the inflation (URIP3M), finally Taylor Rule for the portfolio of the aggregate strategy (TR complete), and for each single component taken per se (TR Inflation, TR Interest Rates and TR Output). In detail models are evaluated through:

1. the strategy “Portfolio”, which derives from the application of:
 - [t1] for PPP,
 - [t2] for URIP1M and URIP3M,
 - [t3.1] for TR Inflation,
 - [t3.2] for TR Interest Rates,
 - [t3.3] for TR Output,
 - [t3.1], [t3.2] and [t3.3] for TR Complete, which overall return is obtained combining investments from the three rules with equal weights.
2. the strategies “Best n (L/S)”, which select the n first and last currencies on the basis of signals for taking corresponding positions.

PPP results to have a very good power in generating positive performances, as Sharpe values are significantly¹¹ different from zero, apart for the strategy “Best 1 (L/S)”. URIP generally produces negative returns for both lag specifications, but not statistically significant in terms of Sharpe Ratio – only the strategy “Best 1 (L/S)” for URIP1M is at the limit of the acceptance region. “TR Complete” behaves very well in terms of return and significance of the Share Ratio, but only when evaluated through the strategies “Best

¹¹ In Table 3 we indicate significance at 95% confidence (*) and at 99% (**).

2 (L/S)", and Best 4 (L/S)". In the end, by decomposing TR in its three blocks, it is worth to note that good results come especially from TR Inflation and TR Interest Rates.

6. Discussion

Our analysis highlights that fundamental variables retain some power in generating positive performances by trading in the currency market. The notable exception is URIP, that goes in the opposite direction than what predicted by the theory. In particular it seems that interest parity not only doesn't hold, but generates negative returns, which is an indirect proof that carry trade is predominant with reference to the relation of interest differential and the exchange rate.

The TR gives positive returns, so as to seem a very good fundamental equilibrium relation, particularly when associated with extreme differences in its inflation and interest building blocks. It is worth to note that also PPP show an appreciable performance. By the way, because its equilibrium predicts exactly the opposite of the inflation block in TR (which in turn seems to be highly correlated with the interest block), future research should investigate how signals coming from the two are possibly related to different time frames (long run for the PPP, short for the TR).

Table 3. Fundamental trading rules performances.

PPP				
Strategy	R	σ	Sharpe	t-stat.
Best 1 (L/S)	0,691%	5,106%	0,135	0,456
Best 2 (L/S)	2,237%	3,793%	0,590	1,986 *
Best 4 (L/S)	2,353%	2,917%	0,807	2,715 **
Portfolio	2,714%	3,953%	0,687	2,303 *
URIP 1M				
Strategy	R	σ	Sharpe	t-stat.
Best 1 (L/S)	-3,670%	6,250%	-0,587	-1,962 *
Best 2 (L/S)	-2,186%	4,685%	-0,467	-1,559
Best 4 (L/S)	-1,214%	2,915%	-0,417	-1,392
Portfolio	-2,141%	6,030%	-0,355	-1,187
URIP 3M				
Strategy	R	σ	Sharpe	t-stat.
Best 1 (L/S)	0,377%	6,275%	0,060	0,199
Best 2 (L/S)	-1,631%	4,598%	-0,355	-1,176
Best 4 (L/S)	0,305%	2,993%	0,102	0,338
Portfolio	-2,775%	6,261%	-0,443	-1,470
TR Complete				
Strategy	R	σ	Sharpe	t-stat.
Best 1 (L/S)	2,291%	4,570%	0,501	1,663
Best 2 (L/S)	3,145%	2,974%	1,058	3,508 **
Best 4 (L/S)	2,205%	2,500%	0,882	2,926 **
Portfolio	-0,024%	2,387%	-0,010	-0,034
TR Inflation				
Strategy	R	σ	Sharpe	t-stat.
Best 1 (L/S)	3,223%	6,604%	0,488	1,619
Best 2 (L/S)	2,833%	4,321%	0,656	2,175 *
Best 4 (L/S)	2,982%	3,175%	0,939	3,114 **
Portfolio	-1,808%	3,032%	-0,596	-1,977
TR Interest Rates				
Strategy	R	σ	Sharpe	t-stat.
Best 1 (L/S)	5,119%	9,001%	0,569	1,886
Best 2 (L/S)	5,504%	5,889%	0,935	3,100 **
Best 4 (L/S)	1,973%	4,432%	0,445	1,477
Portfolio	1,980%	3,464%	0,572	1,896
TR Output				
Strategy	R	σ	Sharpe	t-stat.
Best 1 (L/S)	-1,469%	6,262%	-0,235	-0,778
Best 2 (L/S)	1,098%	4,705%	0,233	0,774
Best 4 (L/S)	1,661%	3,455%	0,481	1,594
Portfolio	-0,245%	2,481%	-0,099	-0,328

References

- Adler M and Lehmann B (1983) "Deviations from Purchasing Power Parity in the Long Run" in *The Journal of Finance*. Vol. 38 (5), pp 1471-1487.
- Bilson J.F.O. (1978) "The Monetary Approach to the Exchange Rate: Some Empirical Evidence" in *IMF Staff Papers* –Vol. 25 (1), pp. 48-75.
- Bilson J.F.O. (1984) "Purchasing Power Parity as a Trading Strategy" in *The Journal of Finance*. Vol. 39 (3), pp. 715-724.
- Brunnermeier M. K., Nagel S., Pedersen L.H. (2009) "Carry Trades and Currency Crashes" in "NBER Macroeconomics Annual 2008", Volume 23, ed. by Acemoglu D et al., University of Chicago Press.
- Cairns J., Ho C. and McCauley, R. N. (2007) "Exchange Rates and Global Volatility: Implications for Asia-Pacific Currencies" in *BIS Quarterly Review*, Mar. 2007, pp. 41-52.
- Cassel G. (1918) "Abnormal Deviations in International Exchanges", in *The Economic Journal* Vol. 28, (112), pp. 413-415.
- Cheung Y-W., Chinn M.D. and Pascual A.G. (2005) "Empirical exchange rate models of the nineties: Are any fit to survive?" in *Journal of International Money and Finance*. Vol. 24 (7), pp. 1150-1175.
- Chinn M.D. and Meredith G. (2004) "Monetary Policy and Long-Horizon Uncovered Interest Parity" in *International Monetary Fund*. Vol. 51 (3), pp. 409-430.
- Clarida R., Galí J. and Gertler M. (1998) "Monetary policy rules in practice Some international evidence" in *European Economic Review*. Vol. 42, pp. 1033-1067.
- Clarida R.H. and Waldman D. (2008) "Is Bad News About Inflation Good News for the Exchange Rate? And, If So, Can That Tell US Anything about the Conduct of Monetary Policy" in "Asset Prices and Monetary Policy", ed. by The National Bureau of Economic Research pp. 371-396.
- De Zwart G. et al. (2009) "The economic value of fundamental and technical information in emerging currency markets" in *Journal of International Money and Finance*. Vol. 28 (4), pp. 581-604.
- Dornbusch R. (1976) "Expectations and Exchange Rate Dynamics" in *The Journal of Political Economy*. Vol. 84 (6), pp. 1161-1176.
- Edison H.L., Gagnon J.E. and Melick W.R. (1997) "Understanding the empirical literature on purchasing power parity: the post-Bretton Woods era" in *Journal of International Money and Finance*. Vol. 16 (1), pp. 1-17.
- Flood, R.P., Taylor, M.P., (1996), "Exchange rate economics: what's wrong with the conventional macro approach?" In: Frankel, J.A., Galli, G., Giovannini, A. (Eds.), *The Microstructure of Foreign Exchange Markets*. Chicago University Press, Chicago, for NBER.
- Frankel J.A. (1979) "On the Mark: A Theory of Floating Exchange Rates Based on Real Interest Differentials", in *The American Economic Review*, Vol. 69 (4), pp. 610-622.
- Frankel J.A. and Rose A.K. (1996) "A panel project on purchasing power parity: Mean reversion within and between countries" in *Journal of International Economics*. Vol. 40 (1-2), pp. 209-224.
- Frenkel J.A. and Levich R.M. (1975) "Covered Interest Arbitrage: Unexploited Profits?" in *Journal of Political Economy*. Vol. 83 (2), pp. 325-338.
- Frenkel J.A. (1976) "A Monetary Approach to the Exchange Rate: Doctrinal Aspects and Empirical Evidence" in *The Scandinavian Journal of Economics*. Vol. 78 (2), pp.200-224.
- Frenkel J.A. (1981) "Flexible Exchange Rates, Prices, and the Role of "News": Lessons from the 1970s" in *The Journal of Political Economy*. Vol. 89 (4),pp. 665-705.
- Gagnon J. E. and Chaboud A., (2007) "What Can the Data Tell Us About Carry Trades in Japanese Yen?" (July 2007). FRB International Finance Discussion Paper No. 899

- Gyntelberg J. and Remolona E.M. (2007), "Risk in carry trades: a look at target currencies in Asia and the Pacific", in *BIS Quarterly Review*, Dec. 2007, pp73-82.
- Heston A, Summers R. , Aten B. (2011), "Penn World Table Version 7.0", Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, May 2011.
- Jordà, O. and Taylor A. M. (2009), "The Carry Trade and Fundamentals: Nothing to Fear But FEER Itself", NBER Working Paper No. 15518.
- Lothian J.R. (1997) "Multi-country evidence on the behavior of purchasing power parity under the current float" in *Journal of International Money and Finance*. Vol. 16 (1), pp. 19-35.
- MacDonald R. and Marsh I.W. (2004) "Currency spillovers and tri-polarity: a simultaneous model of the US dollar, German mark and Japanese yen" in *Journal of International Money and Finance*. Vol. 23 (1), pp. 99-111.
- McGuire P., Heath A., Galati G. (2007), "Evidence of carry trade activity" in *BIS Quarterly Review*, Sep. 2007, pp. 27-41.
- Meese R. (1990) "Currency Fluctuations in the Post-Bretton Woods Era", in *The Journal of Economic Perspectives*, Vol. 4 (1), pp. 117-134.
- Meese R. and Rogoff K. (1983) "Empirical exchange rate models of the seventies: Do they fit out of sample?", *Journal of International Economics*, Volume 14.(1-2), pp.3-24.
- Meese R. and Rogoff K. (1998) "Was It Real? The Exchange Rate-Interest Differential Relation over the Modern Floating-Rate Period" in *The Journal of Finance*. Vol. 43 (4), pp. 933-948.
- Molodtsova T. and Papell D.H. (2009), "Out-of-sample exchange rate predictability with Taylor rule fundamentals" in *Journal of International Economics*, Vol.77 (2), pp. 167-180.
- Mussa M. (1979), "Empirical regularities in the behavior of exchange rates and theories of the foreign exchange market", in *Carnegie-Rochester Conference Series on Public Policy*, vol. 11 (1), pp. 9-57.
- O'Connell P.G.J. (1998) "The overvaluation of purchasing power parity" in *The Journal of International Economics*. Vol. 44, pp. 1-19.
- Papell D.H. (2006) "The Panel Purchasing Power Parity Puzzle" in *Journal of Money, Credit, and Banking*. Vol. 38 (2), pp. 447-467.
- Passari E. (2009) "Revisiting the Chartist and Fundamentalist Model for the Exchange Rate: A Forecast Combinations Approach", mimeo, Cass Business School, London.
- Taylor J.B. (1993) "Discretion versus policy rules in practice" in *Carnegie-Rochester Conference Series on Public Policy*. Vol. 39, pp.195-214.
- Taylor M.P. (1989) "Covered Interest Arbitrage and Market Turbulence" in *The Economic Journal*. Vol. 99 (396), pp. 376-391.