Essays in International Finance

by Evgenia Passari

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Contents

List of Tables

List of Figures

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Declaration

I declare that any material contained in this thesis has not been submitted for a degree to any other university. I further declare that the paper titled "Purchasing Power Parity in Tradable Goods", drawn from Chapter Two of this thesis, is co-authored with Ian Marsh and Lucio Sarno and is published in the Handbook of Exchange Rates, edited by Jessica James, Ian W. Marsh, and Lucio Sarno. Finally, I grant powers of discretion to the City University Librarian to allow this thesis to be copied in whole or in part without further reference to me.

Evgenia Passari

December 2013

Abstract

The present thesis comprises three essays in international finance, with a focus on the foreign exchange market. The first chapter assesses the predictive ability of a comprehensive set of empirical models of exchange rates, in addition to a standard technical trading strategy, on monthly exchange-rate returns for four developed and four emerging countries across different horizons. I implement a rolling window approach to the estimation and forecasting of the models, and construct an encompassing forecast. I also assess the economic value of the out-of-sample forecasting power of the empirical models using a simple dynamic allocation strategy, and find three key results: (1) the Taylor rule model consistently outperforms, economically and statistically, all the other models at the 1-month horizon. (2) The technical rule has superior predictive power over the random walk benchmark, across horizons, particularly for developed markets. (3) There are statistical gains from an unrestricted combined forecasting model at the 1-month horizon. The second chapter constitutes a survey that focuses on internationally tradable goods and services. Our motivation is that while excellent surveys exist in the literature on this topic, they focus largely on broad baskets of prices and, most commonly, on the consumer price index. We instead focus on the specific subset of the relevant literature that analyses deviations from the LOP applied to individual goods and services and specific sectors. The emphasis is hence on tradable items rather than broad baskets that also include a substantial nontradable component. Specifically, the objective is to distil the literature on the properties of deviations from the LOP applied to internationally tradable goods or sectors. We conclude that a careful reading of the literature suggests that this notion of PPP holds in the long run for a broad range of tradable goods and services and for a broad set of currencies. In the third chapter, I build a "commodity currency strategy" for exchange rate forecasting that conditions on changes in the global prices of commodity indices. The risk-return profile of this strategy reveals that the predictive ability of commodity prices for the exchange rate appears to be significant, and the returns appear to be uncorrelated to popular exchange rate strategies such as the carry trade and currency momentum. The market factor captures more than 70% of the cross-sectional returns of the proposed strategy and suggests a negative relation between equity returns and currency returns that are driven by commodity price changes. The commodity currency strategy is prone to high transaction costs which can only be circumvented by investing in developed markets with low costs and high liquidity.

Introduction

The present thesis comprises three essays in international finance, with a focus on the foreign exchange market. The first chapter assesses the predictive ability of a comprehensive set of empirical models of exchange rates, in addition to a standard technical trading strategy, on monthly exchange-rate returns for four developed and four emerging countries across different horizons. My motivation is the large gap that exists between the models used by academics and those adopted by market practitioners. The former tend to employ long run equilibrium equations based on fundamental variables and use standard distribution theory in their modeling approach. In contrast, the majority of market practitioners adopt chartism, which is essentially the use of technical trading rules that lack a theoretical foundation. However, none of these two competing approaches has managed, so far, to provide a model of exchange rate behaviour that performs well at different frequencies. The aim of this chapter is to provide a statistical and economic investigation of a comprehensive menu of fundamental models and a chartists' rule, across different forecast horizons, in an attempt to shed some light on this long-standing debate.

Academics have tried to address the modeling of exchange rates by employing different approaches and equilibrium relationships. Studies on foreign exchange market efficiency normally entail tests on parity conditions such as the Covered and Uncovered Interest Rate Parity. Also, an important strand of the literature assesses long-run real exchange rate behaviour by employing Purchasing Power Parity as a benchmark, a law with important international economic implications. Other theories devoted to the study of the mechanisms of exchange rate determination include tests on standard macroeconomic models, such as the flexible and sticky price monetary model, equilibrium and liquidity models, as well as the portfolio balance model and the more sophisticated new open economy models. More recent work carried by Molodtsova and Papell (2009) focuses on variants of the Taylor Rule model, testing the performance of specifications with richer dynamics and providing promising results. Finally, a strand of foreign exchange literature targets microstructural issues of the foreign exchange market in an attempt to rationalize the observed deviations from economic fundamentals. Nevertheless, there has not been a single theory that has managed to provide a fully satisfactory description of exchange rate dynamics, or present robust empirical success across horizons.

On the other hand, market practitioners tend to believe that exchange rate behaviour is, to some extent, predictable with simple rules. Their forecasting methods include technical trading rules, ad hoc techniques and patterns, such as moving average crossovers, oscillators and range breakouts. The majority of academics has long considered these techniques of no value as they lack intuition and objectivity. Interestingly enough, the empirical evidence suggests that technical analysis not only shows no tendency to disappear in the long run but is indeed profitable (Menkhoff and Taylor, 2007). Besides, survey papers report that the vast majority of foreign exchange market participants use chartism at the short-term horizon, while fundamentals are considered more important in the long run, citing the work of Taylor and Allen (1992), Cheung and Chinn (2001), Gehrig and Menkhoff (2004) and Menkhoff (2010). Given that the purpose of this study is to explore the dynamics of the foreign exchange market, a market that is highly dominated by market makers (mainly commercial and investment banks), one tends to think that the incorporation of the practitioners' view into the model is a potentially meaningful endeavour.

At the same time, it is hard to envisage that one should discard the information contained in fundamentals for exchange rate prediction at short horizons.

An extensive literature on forecast combinations (Timmermann, 1995) provides a promising avenue for research towards this direction.

In the present chapter, I attempt to provide a comprehensive investigation of a large menu of standard models for the exchange rate, including a conventional Moving Average (MA) rule, a rich specification of the Taylor Rule model and a forecast encompassing of all the models, on monthly exchange-rate returns, for four developed and four emerging countries across different horizons. For this purpose, I implement a rolling window approach to the estimation and forecasting of the models, along with a standard, full sample estimation. The performance of the combined strategies, in- and out-of-sample, constitutes one of the main contributions of this chapter and offers a novel way to carry out model evaluation both statistically and economically.

I further examine whether the weight given to chartism relative to fundamental analysis decreases with the forecast horizon as it has been well documented by both survey data papers and empirical studies (Menkhoff and Taylor, 2007). I also explore how the relative importance of the MA model evolves over time and investigate whether technical analysis tends to matter more for emerging market currencies, as the documented profitability of volatile currencies potentially indicates that chartism has a greater impact on developing markets relative to developed markets.

Finally, an important contribution is the assessment of the economic value of the out-of-sample forecasting power of the empirical models using a simple dynamic allocation strategy, which entails the computation of out-of-sample performance fees (as in Della Corte, Sarno and Sestieri, 2010), originally proposed by Goetzmann, Ingersoll, Spiegel and Welch (2007), an attractive measure that assumes neither a specific utility function nor a specific distribution of portfolio returns.

As the main aim of this chapter is to offer an empirical investigation of the relative performance of a comprehensive menu of models across forecast horizons, over time and across a panel of developed and emerging countries, a number of questions fall beyond the scope of the present analysis. First, I am not testing the profitability of sophisticated technical trading rules, such as psychological barriers, and support and resistance levels. As a result, I do not build on the evidence documented by De Grauwe and Decupere (1992), and Osler (2000, 2003). Second, my work does not constitute a contribution on the extensive literature of forecast combination techniques. Instead, I focus on implementing a benchmark model of exchange rates. Finally, I do not and cannot make a statement on the efficiency of the currency market.

To preview my results, I find that the Taylor rule model consistently outperforms, economically and statistically, the interest rate parity, purchasing power parity, and monetary fundamental models as well as the technical trading strategy at the 1-month horizon. This is an important result that adds evidence on the performance of the model beyond the findings of Molodtsova and Papell (2009). I further maintain that the technical rule has superior predictive power over the random walk benchmark, across horizons, and document evidence of statistical gains from a forecast encompassing of the models at the 1-month horizon, findings that justify what practitioners do.

In the second chapter we provide a discussion of the law of one price (LOP), the basic building block of purchasing power parity (PPP). The LOP relates to the common-currency prices of similar goods at a disaggregated level, postulating that similar tradable goods, once their national prices are expressed in a common currency, should sell for the same price across different international locations. Aggregating across different tradable goods and services in a sector and then across different sectors, one obtains that the resulting baskets of tradable goods should trade at the same price: this is the notion of PPP in tradable goods. Further aggregating across other goods and services, including nontradables, leads to the conventional PPP hypothesis, which states that national price levels should be equal when expressed in a common currency.

While several surveys exist on PPP, this chapter focuses mainly on internationally tradable goods and services, rather than broad baskets of goods and services that also include a substantial nontradable component. Specifically, the objective is to understand the properties of deviations from the LOP applied to internationally tradable goods or sectors, on the basis of the existing empirical evidence published in the leading academic literature. To anticipate our conclusions, we show that a careful reading of the literature suggests that the LOP holds over long periods of time for the relevant tradable goods and services, and that adjustment occurs in a nonlinear fashion such that the larger the current deviation from parity the faster the adjustment towards parity in the future.

The core of the chapter focuses on the specific subset of the relevant literature that analyses deviations from the LOP applied to individual goods and services and specific sectors. The emphasis is therefore on tradable items. This literature, while less voluminous than the literature on PPP, is nevertheless substantial and it has not been summarized in a survey article to date. This is exactly the gap that this chapter fills, with the ultimate goal to describe the current state of knowledge on the properties of deviations from the LOP, including the persistence of deviations from the LOP across currencies (the speed of reversion to the LOP), and the nature of the shocks.

The discussion of this chapter follows similar steps to the leading surveys on PPP, but with a more specific focus on internationally tradable goods and a specific description of some of the key studies that have best addressed this topic.

In the third chapter, I build a "commodity currency strategy" for the exchange rate that takes into account changes in the global prices of commodity indices.

One of the most debatable issues in international finance is the link between exchange rates and economic fundamentals. Although commodity currencies offer an attractive laboratory for the study of this link[1], the literature has generally focused on the forecasting power of commodities for the exchange rate, establishing the existence of a relationship but reporting limited predictability success. I deviate from this traditional approach motivated by two observations. First, so far it has yet to be established whether a currency investor could benefit from the information embedded in commodity price changes; second, when it comes to the relationship dynamics, the forecasting framework renders the assessment of different variables and markets an arduous task.

In the present chapter, I examine the implications of the documented relationship between currencies and commodities for an investor's currency allocation decisions. For this purpose, I build a country-specific commodity currency strategy by taking into account the countries' most important commodity imports and exports given a certain threshold. I further extend my country panel to include commodity importers as well as exporters in order to study whether this relationship holds for commodity currencies only. Throughout the empirical exercise, I employ tradable commodity price indices in order to circumvent potential liquidity issues. I, then, study the risk-return profile of the proposed commodity currency strategy. In this way, I offer a different perspective in the debate regarding the dynamics between the countries' exchange rate movements and the corresponding changes in the world price of commodity imports and exports.

In my empirical analysis I follow the recent literature (Lustig and Verdelhan (2007), Lustig, Roussanov, and Verdelhan (2011)) and allocate currencies into portfolios in accordance with the predictions of the proposed commodity currency strategy on a daily frequency. I construct five such portfolios. Going long in the

[1]As Chen, Rogoff and Rossi (2010) observe, a simple model of exchange rates and commodities is less impaired by endogeneity issues as compared to other exchange rate models that employ standard macroeconomic fundamentals.

portfolio with the highest predicted returns, i.e. portfolio 5, and shorting the portfolio with the lowest predicted returns, i.e. portfolio 1, hence, generates a corner commodity portfolio. This strategy yields significant unconditional spot excess returns, greater than 6% p.a., that appear to be uncorrelated to standard strategies such as the carry trade. Furthermore, these returns cannot be explained in a linear asset pricing framework (e.g. Ang, Hodrick, Xing, and Zhang (2006)) by measures of risk that have been found to fare well in the exchange rate literature such as global FX volatility risk and currency momentum; e.g. see Menkhoff, Sarno, Schmeling, and Schrimpf (2012a and b). Furthermore, I test whether standard risk factors can price the cross section of commodity portfolios.

The present chapter relates to two strands of the recent literature. First, my work contributes to the literature that investigates the relationship between exchange rates and fundamentals and in particular, commodities. In line with this literature, I find a strong relationship between commodities and currencies; however, my results are of a different nature as I focus on economic value instead of statistical predictability. Second, as in Lustig, Roussanov, and Verdelhan (2011), I cross-sectionally relate the commodity currency strategy returns to a set of risk factors.

The most important aspect of the analysis is the design of a novel strategy for the exchange rate that appears to be uncorrelated to popular currency strategies such as the carry trade and currency momentum. This is also of particular interest in the context of the long standing debate regarding the information flow between commodities and exchange rates by providing an original way of evaluating this often-documented lead-lag relationship. Given the emerging importance of factors such as the level of interest rates and the equity market, one can argue that trying to identify a causal relationship between exchange rates and commodities could be indeed misleading. The results of this chapter, hence, constitute a middle ground in this debate by using a less conventional framework for the assessment of this link which is however, no less realistic. In this context, it is natural to employ the portfolio approach given its emerging popularity and success in the study of currency behaviour.

The second set of my results relates to the determinants of the strategy's success which are hard to precisely identify in an asset pricing framework. At the same time, the findings of the asset pricing exercise underline the complexity of dynamics that pertains to the examined relationship. For instance, although the equity market factor explains more than 70% of the cross-sectional returns of the commodity currency strategy, I find a negative relation between equity returns and currency returns that are driven by commodity price changes.

On the downside, the high transaction costs of the commodity currency strategy constitute a serious pitfall as they can erode profitability completely. This is particularly true when the strategy is implemented using a number of emerging market currencies which display large bid-ask spreads. The exploitability problem can, however, be circumvented if the investor trades only developed market currencies. The later finding further showcases the validity of the strategy for different exchange rates panels.

CHAPTER 1

In Quest for a Robust Model of the Exchange Rate: A Collective Approach

1.1. Introduction

A large gap exists between the models used by academics and those adopted by market practitioners. The former tend to employ long run equilibrium equations based on fundamental variables and use standard distribution theory in their modeling approach. In contrast, the majority of market practitioners adopt chartism, which is essentially the use of technical trading rules that lack a theoretical foundation. However, none of these two competing approaches has managed, so far, to provide a model of exchange rate behaviour that performs well at different frequencies. The aim of this chapter is to provide a statistical and economic investigation of a comprehensive menu of fundamental models and a chartists' rule, across different forecast horizons, in an attempt to shed some light on this long-standing debate.

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The remainder of the chapter is organized as follows. In Section 1.2, I present a selective review of the strands of literature that motivate my approach. Section 1.3 discusses the framework employed in the analysis of exchange rate predictability. Section 1.4 describes the data set and discusses the results from the rolling regressions. Section 1.6 presents the framework for assessing the economic value of exchange rate predictability and the results of the employed dynamic portfolio allocation strategy. Section 1.7 concludes.

1.2. Selective Literature Review

1.2.1. Fundamental Models

1.2.1.1. The Puzzles in Exchange Rate Economics: UIP, PPP and the Disconnect Puzzle. Throughout the literature it has been non-trivial to empirically document the significance of the link between the exchange rate and fundamentals and various anomalies have emerged. The puzzles in exchange rate economics relate to the most prominent fundamental models, namely the Uncovered Interest rate Parity (UIP), Purchasing Power Parity (PPP) and Monetary Fundamentals model (MF).

Empirical work on UIP for a large set of currencies and time horizons, as a general rule, rejects UIP and the risk-neutral efficient markets hypothesis (Hodrick, 1987; Lewis, 1995; Engel, 1996; Froot and Thaler, 1990). The 'forward bias puzzle', first articulated by Fama (1984), states that the forward market systematically predicts exchange rate movements in the opposite direction than predicted by UIP. Recent developments in this extensive literature suggest that although the forward rate is probably a biased predictor of the future nominal exchange rate, the term structure of forward premia possibly contains some information regarding future exchange rate changes (Clarida and Taylor, 1997; Sarno and Valente, 2005). Furthermore, there has been a theoretical and empirical motivation for the employment of nonlinearities (Clarida, Sarno, Taylor and Valente, 2003) and, more recently, attempts to understand the forward bias in cross-sectional asset pricing settings (Lustig, Roussanov, and Verdelhan, 2011; Burnside, Eichenbaum, and Rebelo, 2011; Menkhoff, Sarno, Schmeling, and Schrimpf, 2012a).

Numerous studies over the past half century have shaped, and reshaped, academics' and practitioners' views on the validity of PPP. Friedman and Schwartz (1963) advocate the existence of a long-run PPP, a view that was widely held until the '70s. Opinion started to shift in the '70s towards the view of a continuous

PPP mainly due to two factors: the prominence of the monetary approach and the end of Bretton Woods. However, by the late '80s, the excess volatility of the nominal exchange rate and poor empirical performance had resulted in the rejection of the parity. The failure of the unit root and cointegration studies to confirm the validity of PPP led researchers to adopt new techniques in their attempts to address the issue such as using longer data windows and panel data. Along with the recent incorporation of nonlinearities (Taylor, Peel and Sarno, 2001), many researchers have shifted their attention to the relation between real shocks and the real exchange rate, such as the Harrod-Balassa-Samuelson effect (Lothian and Taylor, 2008). As the main conclusion remains that PPP could still be considered as a valid long term condition applicable to developed countries' bilateral exchange rates, an explanation for the discrepancy between short and long run exchange rate expectations could indeed be that market participants use different forecasting techniques for different horizons.

On the other hand, many studies on the relationship between exchange rates and fundamentals have been targeting the departure of the nominal exchange rate from its fundamental value: $z_t = f_t - s_t$, where f_t is the long-run equilibrium level of the nominal exchange rate governed by macroeconomic fundamentals and s_t stands for the log-level of the nominal exchange rate (the domestic price of foreign currency). In these studies, f_t is usually approximated by a group of monetary fundamentals, which include the differential in money supply and the differential in output as in Mark (1995), but can also take different specifications to account e.g. for deviations from equilibria defined by the difference of national price level, providing this way a measure for Purchasing Power Parity as in Molodtsova and Papell (2009). The more recent research takes the view that macroeconomic fundamentals comove with the nominal exchange rate through extended time periods (Groen 2000, 2005; Mark and Sul 2001; Rapach and Wohar 2002; Sarno, Valente, and Wohar 2004; Abhyankar, Sarno and Valente 2005), while the study of exchange rate predictability, in general, depends on long-horizon regressions.

1.2.1.2. Taylor Rule. More recently, a strand of literature has employed Taylor rules in order to model exchange rates. Engel and West (2005) employ the Taylor rule model as an illustration of present value models where asset prices (exchange rates inclusive) approximate a random walk when the discount factor moves towards the value of one. In their 2006 paper, the authors further build a "model-based" real exchange rate employing the difference between home and foreign output gaps and inflation rates, and report a positive relation between the "model-based" rate and the real exchange rate for the dollar-mark. Mark (2009) indicates that there is a link between the interest rate differential and the Taylor rule differential and suggests that the real dollar-mark exchange rate relates to the Taylor rule fundamentals, while Groen and Matsumoto (2004) and Gali (2008) incorporate Taylor rules in open economy dynamic stochastic general equilibrium models. In this line of reasoning, Molodtsova and Papell (2009) assess the predictability of models that feature Taylor rule fundamentals and report short term predictability for a big panel of countries through the post-Bretton Woods period.

1.2.2. Technical Analysis

The empirical failure of exchange rate models that incorporate fundamentals since the early 1980s has been at least a partial motivation for studies that incorporated chartist techniques along with fundamental analysis. Frankel and Froot (1986) build an exchange-rate forecasting model where chartists only anchor their future expectations on the rate's past behaviour. Despite the appeal of this approach, there has been a lack of direct empirical evidence, mainly because the relative importance of each technique is both time-varying and unobservable.

De Grauwe and Dewachter (1993) extend the model of Frankel and Froot and provide some modifications. De Long, Shleifer, Summers, and Waldmann (1990a) describe why chartists or 'noise traders' are not driven out of the market by fundamentalists, identified as 'sophisticated traders' using an overlapping generations model. Youssefmir, Huberman and Hogg (1998) further expand the model to continuous time and relate the degree of chartism to the frequency of trading, while Vigfusson (1996) estimates a Markov regime-switching model for the exchange rate. This switching model approximates the chartist-and-fundamentalist model in that it has two forecasting equations corresponding to the two elements of the model.

Further developments include the use of bootstrapping (Levich and Thomas 1994; LeBaron 1999; Osler 2000, 2003) and the use of data-snooping bias testing methods, while a strand of literature studies the link between nonlinearities and technical analysis (Clyde and Osler 1997; Fiess and MacDonald 1999; Kilian and Taylor 2003; De Grauwe and Grimaldi 2006a, 2006b). A number of papers (Curcio and Goodhart, 1992; Osler 2000, 2003; Neely and Weller 2003; Kozhan and Salmon 2008) also investigate the profitability of technical analysis on high-frequencies, reporting inconclusive evidence. Finally, Menkhoff, Sarno, Schmeling, and Schrimpf (2012b) provide fresh evidence that technical rules are profitable in a large cross-section of 48 currencies.

Overall, the literature on the profitability of technical analysis suggests the existence of significant profits in the foreign exchange market. Menkhoff and Taylor (2007) provide a comprehensive survey on the use of technical analysis in the foreign exchange market. In addition to the analysis of the stylized facts the authors further present the arguments that have been proposed to justify the prevalent use of chartism.

1.2.3. Combining Forecasts

The hypothesis that the information contained in fundamentals is of no value for the forecasting of exchange rates seems rather implausible and it is hard to imagine why market participants would fail to incorporate macroeconomic information in their models. Bacchetta and van Wincoop (2004), in their model of exchange rate prediction, embrace the view that foreign exchange practitioners often update the weight they place on different fundamental variables. Their 'scapegoat' theory suggests that market practitioners, in search for a rational explanation of the actual exchange rate movements, may attribute them to a certain macroeconomic fundamental variable that subsequently has an effect on trading strategies. As different variables are eligible to become the 'scapegoat', the weights placed on different economic variables are expected to vary over time. Sarno and Valente (2009) suggest that the challenge in selecting the optimal predictive model lies mainly in the frequent shifts in the set of fundamentals governing exchange rates, which they interpret as reflecting shifts in market expectations over time (Frankel, 1996), or departures from rationality. They further state that the strength of the relationship between exchange rates and fundamentals varies across different currencies.

I argue that these shifts are further enforced by the nature of the trading activity. While market participants trade continuously, macroeconomic news arrive at discrete intervals for most economic variables. Therefore, it might be that traders are not irrational but need to account somehow for this lack of information between macroeconomic announcements. Following this line of reasoning, one can visualize each model as producing a signal of variable strength at each point in time. This, in turn, motivates the employment of a richer structure that will incorporate a comprehensive set of predictive variables allowing, at the same time, for parameter instability.

Moreover, in a purely econometric context, as Timmermann (1995) notes, several arguments motivate the use of forecast combinations. Bates and Granger (1969) suggest that the forecast combination idea is motivated by a diversification argument. Furthermore, individual forecasts can be affected in a dissimilar way by structural breaks (Figlewski and Urich, 1983; Diebold and Pauly,1987; Makridakis, 1989; Hendry and Clements, 2004 and Aiolfi and Timmermann, 2004 among others), while individual models might as well suffer from the effects of misspecification bias (Stock and Watson 1998, 2004).

1.3. The Models

1.3.1. The Random Walk

The benchmark model is the random walk (RW) model. Since the landmark paper of Meese and Rogoff (1983), the RW model represents the prevalent assumption in international finance literature that maintains that exchange rates are not forecastable using economic fundamentals, particularly in the short term:

$$\Delta s_{t+1} = \alpha + \varepsilon_{t+1}, \tag{1.1}$$

where $\Delta s_{t+1} \equiv s_{t+1} - s_t$, s_t denotes the logarithm of the spot exchange rate (defined as the domestic price of foreign currency) at time t, and ε_{t+1} is the rational expectations forecast error.

1.3.2. The Fama Regression

The UIP condition is the fundamental parity condition for foreign exchange market efficiency under risk neutrality, which postulates that the difference in interest rates between two countries should match the expected change in exchange rates between the countries' currencies:

$$\Delta_h s^e_{t+h} = i_{t,h} - i^*_{t,h}, \tag{1.2}$$

where $i_{t,h}$ and $i^*_{t,h}$ are the nominal interest rates on domestic and foreign securities with h periods to maturity; $\Delta_h s_{t+h} \equiv s_{t+h} - s_t$; and the superscript e indicates the market expectation based on the information set at time t. UIP is not an arbitrage condition as the expected exchange rate, is not known at time t. The foreign exchange risk related to future exchange rate changes, therefore, renders the existence of profits uncertain in the event of UIP violation.

Using Covered Interest Parity (CIP), an arbitrage relationship between two countries' interest rates and the spot and forward currency values, and substituting the interest rate differential using the forward premium (or forward discount) $f^h_t - s_t$, UIP has been often tested by estimating the following regression:

$$\Delta_h s_{t+1} = \alpha + \beta(f^h_t - s_t) + \varepsilon_{t+1}. \tag{1.3}$$

If UIP holds, $\alpha = 0$, $\beta = 1$, and the rational expectations forecast error ε_{t+1} should be uncorrelated with the information set at time t (Fama, 1984). Nevertheless, empirical work carried on the estimation of the UIP equation, for different currencies and time periods, generally rejects UIP (Hodrick, 1987; Lewis, 1995; Engel, 1996). The forward bias puzzle, in fact, refers to the observation that β estimates, for exchange rates, are as a general rule closer to minus one than plus one (Froot and Thaler, 1990).

I employ the interest rate differential in the following forecasting equation:

$$\Delta_h s^e_{t+h} = \alpha_h + \omega_h(i_{t,h} - i^*_{t,h}) + u_{t+h,t}. \tag{1.4}$$

1.3.3. The Purchasing Power Parity

In the PPP literature, the real exchange rate is usually modelled as:

$$q_t \equiv s_t - p_t + p_t^*, \tag{1.5}$$

where q_t is the logarithm of the real exchange rate, and p_t and p_t^* indicate the logarithms of the domestic and foreign price levels. The null hypothesis for testing long-run PPP typically assumes that the process governing the real exchange rate series has a unit root, with the alternative assumption being the one of series stationarity. As mentioned earlier, throughout the years, the validity of the law has been questioned, led by the fact that many studies carried for the post-Bretton Woods period have failed to reject the unit root null of the real exchange rate, shaping this way the first PPP puzzle. A second puzzle was later formed in view of the 'glacial rate' at which deviations from the parity seem to die out (Rogoff, 1996; Sarno and Taylor 2002).

In the present setting, following Mark (1995) and Molodtsova and Papell (2009), I model the h-period ahead change in the log exchange rate as a function of its present deviation from the fundamental value as follows:

$$\begin{aligned} \Delta_h s_{t+h} &= \alpha_h + \beta_h z_t + u_{t+h,t} \\ z_t &= f_t - s_t, \end{aligned} \tag{1.6}$$

where f_t is the long-run equilibrium level of the nominal exchange rate governed by macroeconomic fundamentals. At this point, it must be mentioned that when the exchange rate is lower than its fundamental value it is anticipated to appreciate, and vice versa. Also, the rate of change, captured by the coefficient β, is expected to increase with the time horizon, as noted by Mark (1995). Under PPP fundamentals:

$$f_{PPP,t} = (p_t - p_t^*). \tag{1.7}$$

1.3.4. Monetary Fundamentals

Once again, following Mark (1995) and Molodtsova and Papell (2009), the h-period-ahead change in the log exchange rate could be modelled as a function of its present discrepancy from its fundamental value, the latter being governed by monetary fundamentals:

$$\Delta_h s_{t+h} = \alpha_h + \beta_h z_t + u_{t+h,t}, \tag{1.8}$$

where

$$z_t = f_t - s_t$$

and f_t is the long-run equilibrium level of the nominal exchange rate. With respect to the fundamentals, f_t, I employ the flexible-price monetary model:

$$f_{MF,t} = (m_t - m_t^*) - (x_t - x_t^*), \tag{1.9}$$

where m_t and x_t stand for money supply and an aggregate measure of output, respectively; both variables m_t and x_t are in logs and the asterisk stands for foreign country variables (taking the U.S. as the foreign country).

1.3.5. Taylor Rule Fundamentals

The Taylor rule states that a central bank modifies the short-run nominal interest rate in order to respond to inflation and output gap. Postulating Taylor rules for two countries and subtracting one from the other, following Taylor (1993), the monetary policy rule is:

$$i_t^T = \pi_t + \phi(\pi_t - \pi^T) + \gamma y_t + r^E, \tag{1.10}$$

where i_t^T is the short-term nominal interest rate target, π_t is the inflation rate, π^T is the target inflation level, y_t is the output gap, and r^E is the equilibrium level of the real interest rate.

Provided that at least one of the two central banks also targets the PPP level of the exchange rate, the real exchange rate also appears on the right hand side of the equation (Clarida, Gali, and Gertler, 1998). Applying UIP and solving expectations forward, one arrives at the following asymmetric specification:

$$i_t^T = \mu + \lambda \pi_t + \gamma y_t + \delta q_t. \tag{1.11}$$

where q_t is the real exchange rate as before.

If one assumes that the interest rate partly adjusts to its target within the period, a model with interest rate smoothing should be used and the lagged interest rate differential should now appear on the right hand side of the equation. Following the findings of Molodtsova and Papell (2009), who report that the strongest evidence is provided for asymmetric specifications that incorporate heterogeneous coefficients and interest rate smoothing, I employ a richer specification of the model. Hence, in order to allow for the two central banks to have different response coefficients I employ an heterogeneous model in which the variables (inflation, output gap and lagged interest rates) appear separately. Finally, a constant is added to account for the case that the two central banks have different target inflation and equilibrium real interest rates:

$$\Delta_h s_{t+h} = \alpha_h - \omega_{u\pi,h}\pi_t + \omega_{f\pi,h}\pi_t^* - \omega_{uy,h}y_t + \omega_{fy,h}y_t^* + \omega_{q,h}q_t - \omega_{ui,h}i_{t-1} + \omega_{fi,h}i_{t-1}^* + u_{t+h,t}, \tag{1.12}$$

where the asterisk stands for foreign country variables (taking the U.S. as the foreign country) and the subscripts u and f describe domestic and foreign variables respectively.

1.3.6. The Chartists' function - MA Rules

A moving average trading rule combines a short- and a long-run moving-average and generates a long signal once the short-run moving average "cuts" the long-run moving average from below and vice versa. Apparently, these rules are highly sensitive to the time windows selected for each moving average. I employ the 5-day and the 150-day moving averages following Saacke (2002, p. 464). The 5-150 day combination appears to be the most profitable from the practitioners' point of view, also emerging as the prevailing pair in academic studies. This choice is also compatible with the view that technical analysis might be able to capture a sluggish and subsequently overshooting shorter-term adjustment of exchange rates to fundamental equilibria (Menkhoff and Taylor 2007).

Thus, in the present framework, the h-period ahead change in the log exchange rate is modelled as follows:

$$\Delta_h s_{t+h} = a_h + \omega_5 MA_{5,t} + \omega_{150} MA_{150,t} + u_{t+h,t}, \tag{1.13}$$

where MA_5 is the 5-day moving average of foreign exchange rate levels and MA_{150} is the 150-day moving average of foreign exchange rate levels.

The MA rule values are computed on a daily basis and the monthly series is subsequently constructed by sampling the data points at the 15th of each month.

1.3.7. Combined Regressions

The employment of static, equal weights dominates the forecast combination literature, proving an established benchmark, following the remarkable empirical past performance of equally-weighted forecast combinations (Timmermann, 1995). In the present setting, however, I build a combination of the individual forecasts by estimating the model weights, as follows:

$$\Delta_h s_{t+h} = a_h + \omega_{FR} FR_t + \omega_{MA} MA_t + \omega_{PPP} PPP_t + \omega_{MF} MF_t + \omega_{TR} TR_t + u_{t+h,t}, \tag{1.14}$$

where FR equals the forecast of the Fama regression; MA represents the forecast from the chartists' function; PPP stands for the forecast of the PPP model; MF is given by the forecast of the Monetary Fundamentals model, and TR is the forecast provided by the Taylor Rule model. All forecasts are genuine out-of-sample forecasts using a rolling window of ten years.

In essence, I am estimating an encompassing regression with a constant. Following Granger and Ramanathan (1984), I decide not to restrict the weights to sum to unity given that a constrained combination, albeit neat, can be suboptimal.

1.4. Empirical Results

1.4.1. Data

The data sample comprises 408 monthly observations ranging from August 1975 to July 2009 for the UK, Japan, Germany and Canada and 241 observations ranging from July 1989 to July 2009 for Singapore, South Africa, Hungary and Taiwan from the IMF's International Financial Statistics (IFS) database. The country choice for the emerging market panel was largely driven by data availability given the number of macroeconomic variables that had to be obtained for estimation and prediction purposes; the time series length, hence, constituted the only selection criterion.

I use M1 to approximate money supply for most countries, except for the UK where I employ M0, and Taiwan, for which the data are obtained from the M2 series. I further use the seasonally adjusted industrial production index to account for the countries' national income since GDP data are only available at the quarterly frequency. The price levels are measured by the corresponding consumer price indices. For the output gap, I consider deviations of actual output from a Hodrick-Prescott (1997) trend. I use the Eurodeposit rates as a measure of the 1 month, 3 month, 6 month and 1 year interest rates and the swap rates to account for the 2 year, 3 year, 4 year and 5 year interest rates that the central bank sets every period. Finally, the data sample comprises eight exchange rates relative to the US Dollar: the UK Pound Sterling (GBP/USD), the Japanese Yen (JPY/USD), the Deutsche Mark/Euro (DEMEURO/USD), the Canadian Dollar (CAD/USD), the Singapore Dollar (SGD/USD), the South African Rand (ZAR/USD), the Hungarian Florint (HUF/USD) and the Taiwanese Dollar (TWD/USD). After the Euro introduction in January 1999, the Deutsche Mark rate is replaced by the Euro for the rest of the period (January 1999 to July 2009). All the data are taken from Datastream.

1.4.2. Predictive Rolling Regressions

The motivation for the rolling estimation method is the hypothesis that the relative participation of fundamentalists and chartists in the market evolves over time.

In the same way, the weighting of the macro fundamentals could be dynamic rather than static (Sarno and Valente 2009). Hence, by allowing for parameter instability, I take into account the possibility that agents periodically revise the importance they place on different models. For this purpose, I estimate each model using the first 120 data points for the initial one-period-ahead forecast to be generated. Subsequently, the first data point is discarded while an additional data point at the end of the sample is added and the model is re-estimated. For each of the aforementioned models I construct a one-month-ahead forecast at each step. For the developed markets panel, the data from February 1975 to January 1984 are employed for estimation and the rest are saved for out-of-sample forecasting. Likewise, my estimation window for the emerging markets panel ranges from July 1989 until June 1998. The MSPE results are calculated over a period of four years. A one can observe in Figures 1.3-1.8, they are indicative of the time-varying forecasting performance of the models across windows, countries and horizons. The plots of the models' coefficients, which clearly display evidence of parameter instability, further justify the implementation of rolling windows estimation (i.e. Figures 1.1-1.2).

1.4.3. Developed Markets Panel: Out-of-Sample Forecasting, Rolling Regressions Results

The full sample estimation results are reported in the chapter's appendix. The in-sample findings, document that the Taylor rule model emerges as the best model, across countries and horizons. Although this is not perfectly consistent with the output of the rolling out-of-sample exercise, some common patterns emerge. The Taylor rule model outperforms the FR, MA, PPP as well as the MF model at the 1-month horizon. However, the forecasting performance of the model at 1-year horizon is poor, but slightly improves at the 5-year horizon. This is evident from the study of Tables 1.1 and 1.2. According to the same tables, the technical rule appears to be, overall, the best model across horizons for the developed markets panel by beating the RW for almost all developed countries. The PPP model seems to perform better in the medium and long run. On the other hand, the MF model is found to forecast better at the 1-month horizon. The FR performs poorly across horizons except for the case of Japan. In general, the MSPEs become larger with longer horizons.

1.4.4. Emerging Markets Panel: Out-of-Sample Forecasting, Rolling Regressions Results

The rolling out-of-sample exercise does not display identical results for the emerging markets panel. The overall picture suggests that it is more difficult to forecast the emerging market currencies using either fundamental models or technical analysis. However, the model ranking with respect to forecasting performance is largely maintained. The FR model is consistently the worst performer in both panels with the MA model being the best across horizons. The TR model appears, again, to be very successful at the 1-month horizon. Finally, both the PPP and MF model performances appear notably weaker relative to the developed markets case. Again, the MSPEs get bigger with the forecasting horizon.

1.4.5. Forecast Combination: Rolling Regressions Results

An inspection of the out-of-sample results of the forecast encompassing regression reveals evident time variation in both the coefficients and their statistical significance. The encompassing regression offers a new perspective to the model selection procedure. In essence, to the extent that one employs the correct t-statistics (Hodrick-corrected statistics are applied for the purposes of this exercise), it is possible to assess the contribution of each model in a statistical significance metric, over time and across horizons. The results for the 1-month horizon appear on Figures 1.9 - 1.11. The picture is rather mixed; the p-values of the models' coefficients display an evident time variation; in general one can see that different models are statistically significant over time, providing further evidence to the hypothesis that market agents periodically revise the importance they assign to each model. As expected, as one moves to longer horizons the coefficients tend to become more significant.

Finally, the MSPE of the encompassing regression appears lower than the MSPE of the RW model, suggesting the existence of statistical gains from the combination of the models at 1-month horizon (see Table 1.3). When it comes to the robustness of this result, I refer to the inference procedure, developed by Clark and West (2006, 2007), for testing the null of equal predictive ability of two nested models. This methodology accounts for the fact that under the null the MSPE of the alternative model is projected to be larger than the one of the RW benchmark. This is due to the fact that the alternative model generates noise in the forecasting process by estimating a parameter vector that is not useful.

1.4.6. Is Technical Analysis a method of information processing?

Figure 1.9 suggests that there is a time-varying comovement between the MA coefficient and other fundamental coefficients during certain time periods. This leads to the question whether technical analysis could be interpreted as a method of information processing (Menkhoff and Taylor 2007), providing an explanation to the long debate around the mechanism through which fundamental news are conveyed to market prices. From the long articulated statement that "learning takes time" to the theory that foreign exchange professionals reveal bandwagon expectations (Froot and Ito 1989; Frankel and Froot 1990a, 1990b; Ito 1990), this is not an unfamiliar concept. The present work, in line with Molodtsova and Papell (2009), contradicts the statement that exchange rates converge toward fundamental values only over longer horizons (Mark, 1995; Lothian and Taylor, 1996), as the TR model is found to display predictability even at 1-month ahead forecasts. Nevertheless, it is also true that there are often statistical gains from the combination of forecasts. It is, therefore, possible that these gains originate from chartism, since the TR specification already incorporates a comprehensive set of fundamentals.

Figures 1.3-1.8 report the MSPE results. The comovement of the MA MSPE with the MSPE of other models is evident. The definition of the long-short MA pair itself embraces an error correction concept with the long MA element standing for the "fundamental" value as determined by the market, consistent to the construction of other fundamental models. However, the inspection of the rolling regression plots of the MA model (Figure 1.1) rather complicates the picture. Although the coefficients are consistently correctly signed and moving in opposite directions, statistical significance is rarely gained. The most striking result is that this rarely happens when the long and short regression coefficients cross, i.e. at the most informative points. In fact, significance appears to be stronger when the coefficient values diverge. In addition, as previously mentioned, the MA model does not fall in the MSPE rankings at longer forecasting horizons.

For these reasons, one tends to conclude that technical analysis might as well represent nonfundamental elements of exchange rate determination such as self-fulfilling expectations or market psychology (Taylor and Allen, 1992). The evidence, however, is far from systematic.

1.5. Economic Value

1.5.1. The Framework

This section details the framework employed for the economic evaluation of different exchange rate (FX) strategies based on the models examined above. The exercise is conducted by evaluating the performance of a dynamically rebalanced portfolio following these strategies relative to a random walk benchmark. The economic analysis is again compiled out of sample. The in-sample period ranges from July 1989 until June 1998 and the out-of-sample period moves forward by successively updating the parameter estimates of the forecasting equation on a monthly basis using a 10-year rolling window.

For the purposes of the exercise, I take the view of a US investor who builds a portfolio by allocating her wealth among eight assets that are identical in every aspect apart from the currency of denomination (GBP, JPY, EUR, CAD, SGD, ZAR, HUF and TWD). The main aim of this exercise is, thus, to establish whether there is economic value in predicting FX returns using each FX model separately, as well as their forecast combination. Throughout this analysis, I maintain the hypothesis that the risky assets constitute a zero-cost investment, and thus, the investor's net balances gain interest at the domestic risk-free rate. This assumes that the return from each of the risky assets equals the domestic risk-free rate plus the currency return $(i_t + \Delta_1 s_{t+1})$. The return to a domestic risk-free investment is approximated by the 1-month US Eurodeposit rate.

The investor rebalances her portfolio on a monthly basis by taking a long position on the three currencies that she predicts to appreciate the most, simultaneously shorting the three currencies that she projects to depreciate the most, over a horizon of one month. This way, she always drops two currencies from her portfolio allocation[1]. Each month she takes two steps. First, she uses the respective model to forecast the cumulative long-short portfolio return. Second, conditional on the forecast, she dynamically reshuffles her portfolio following the long-short strategy described above.

In order to measure the economic value of each strategy, I rely on the computation of out-of-sample performance fees (as in Della Corte, Sarno and Sestieri, 2010), originally proposed by Goetzmann, Ingersoll, Spiegel and Welch (2007). This measure assumes neither a specific utility function nor a specific distribution of portfolio returns and it is defined as follows:

$$\widehat{\Theta} \equiv \frac{1}{(1-\rho)\Delta t} \ln \left(\frac{1}{T} \sum_{t=1}^{T} [(1+r_t)/(1+r_{ft})]^{1-\rho} \right),$$

where the $\widehat{\Theta}$ statistic is an estimate of the portfolio's premium return after adjusting for risk. T is the total number of observations, and Δt is the length of time between observations. These two variables annualize the measure. The portfolio's un-annualized rate of return at time t is r_t, and the risk-free rate is r_{ft}.The coefficient of risk aversion ρ should be selected to make holding the benchmark optimal for an uninformed manager.

Finally, when evaluating the profitability of the dynamic strategies, I don't take into account the impact of transaction costs.

The out of sample predictions refer to the period between August 1999 and July 2009. The results indicate that there appears to be some economic value associated with the TR model, which outperforms all the other models, offering an annualized performance fee of 105 basis points.

[1]This is a standard practice to market participants which is generally associated with hedge funds and is further documented in the literature (Alexander and Dimitriu, 2002; Barra RogersCasey Research, 2000).

The results are displayed in Table 1.4, for a coefficient of risk aversion $\rho = 3$. Different risk aversion values do not change my results and hence I do not report them. The combined model (calculated over a shorter sample, between July 2002 and July 2009), the MA rule, the PPP model and the MF model, are all found to outperform the RW model but the economic gains appear to be small, except for the case of the combined model which provides an annualized performance fee of 89 basis points.

I finally construct a combination strategy, allowing the investor to reassess her model choice on a monthly basis. Every period, she selects the best model in terms of statistical significance (the one that displays the minimum average p-value across the eight currency pairs). The out-of-sample performance fees for this "p-value" combined model refer to the period between July 2002 and July 2009. The results show that the TR model is still ranked first, with the MA model being second beating the RW benchmark by 36 basis points. Nevertheless, it must be noted that due to data scarcity, the presented window is limited to few years and mainly covers the crisis period, something that could potentially distort the real picture.

1.6. Conclusion

Exchange rate forecasting has been a non-trivial endeavour throughout the literature as it has been difficult to empirically establish a link between fundamentals and exchange rate movements. Recent work in this field has employed Taylor rules to model exchange rate determination reporting promising results, as well as evidence of short term predictability. Furthermore, numerous studies have examined the profitability of chartist techniques suggesting the existence of significant profits in the foreign exchange market.

In the present chapter, having assessed the forecasting ability of a comprehensive set of models for exchange rate determination, including a standard menu of fundamentals, a rich Taylor Rule specification and a simple technical trading strategy, along with a model motivated by the literature on forecast combinations, I document three results. First, the Taylor rule model emerges as the best model, economically and statistically, at the 1-month horizon, displaying good performance across different countries. To my knowledge, this is the first time that the performance of this model has been assessed across different horizons, with a further emphasis put on the economic value of its predictions. The fact that the Taylor rule model appears to provide reliable short-term forecasts is an encouraging result that appears to be robust both in the developed markets and the emerging markets under examination.

A second finding of this study, is that the technical rule displays superior predictive power over the random walk benchmark across horizons. The contribution of this result lies on the estimation frequency and the simplicity of the model employed. Although the literature on the profitability of technical analysis suggests the existence of profits, the majority of these studies target the implementation of these techniques at high frequency, or employs more sophisticated models. However, my evidence suggests that there does not appear to be a horizon pattern in the performance of technical analysis. The finding that traditional MA rules do not appear to be very profitable in the 1990s is in line with the documented result that profits from technical analysis are declining over time (Dooley and Shafer, 1983 and Sweeney, 1986 among others).

A final contribution is that there appear to be statistical gains from a simple forecast combination of the individual models at the 1-month horizon. As this result is robust across different countries, further research should be carried out in the direction of identifying a more powerful forecast combination strategy, which will allow for time varying weights according to underlying market conditions and the level of fundamental variables. In this line of reasoning, understanding the mechanism of interaction of different types of market participants also remains a big challenge in this research agenda.

Appendix:In-Sample Estimation of the Models

In total, I estimate six models at eight horizons (1-month, 3-month, 6-month, 1-year, 2-year, 3-year, 4-year and 5-year ahead), for each of the eight countries. To illustrate whether the impact of technical analysis is stronger for emerging market currencies, I present the results for the emerging markets panel (Singapore Dollar, South African Rand, Hungarian Florint and Taiwanese Dollar) separately. The models are estimated by OLS rolling regressions using the Hodrick correction procedure (Hodrick, 1992) for the calculation of the standard errors of the long run regressions. As the data are sampled more finely than the compound return interval, serial correlation of the error term is induced even if the null hypothesis of no predictability is true (Hansen and Hodrick, 1980). Consequently, the statistical inference in long horizons crucially relies on the choice of the standard errors. The Hodrick correction procedure corrects for heteroskedasticity and eliminates the moving average structure in the error terms, providing a reliable assessment of the statistical significance of the estimated parameters. I, hence, evaluate the models' predictive power by looking at the significance of the estimated coefficients. This constitutes a novel method of model assessment given the robustness of the procedure; essentially, by looking at the statistical significance of the Combined model's coefficients, one is able to evaluate the models across horizons. Subsequently, the models are ranked in terms of the mean square prediction error (MSPE).

Overall, three results are apparent. First, the Taylor rule model consistently outperforms the interest rate parity, purchasing power parity, and monetary fundamental models as well as the technical trading strategy. Second, the technical rule has superior predictive power over the random walk benchmark. Third, there appears to be statistical value from a simple, forecast combination of the models. These results are robust across different countries and horizons.

Tables 1A.1, 1A.2, 1A.3 and 1A.4 display the full sample estimated coefficients for the developed markets panel for the 1-month horizon. The Fama regression is, as expected, consistent with carry trade activity, displaying a negative coefficient which is statistically significant for Japan. As far as the MA model is concerned, one can notice that the coefficients are correctly signed though insignificant and moving in opposite directions. The same is true for the PPP model, while the coefficients of the MF appear both inconclusive and insignificant. Finally, the real exchange rate coefficient displays some consistency in the TR model but significance is still not gained at this horizon.

The combined model results are inconclusive, as different models perform best for different countries. However, an important issue that emerges at this stage is that one can extract statistical value from potentially all the models, at least for particular forecasting horizons. This finding is more evident during the examination of the rolling estimation results. Inspection of Tables 1A.5, 1A.6, 1A.7 and 1A.8 reveals similar results for the emerging market panel.

Tables 1A.9 and 1A.10 present the relative ranking of the models in terms of MSPE for the developed and the emerging markets panel respectively. The TR model is overall ranked first for all the countries, and across horizons. Furthermore, there appears to be a horizon effect, in the sense that the forecast gain from employing the TR specification is greater between the 1-year and 3-year horizons.

Another result that emerges from the inspection of the full sample results is that the MA model, as a general rule, beats the RW benchmark (in the cases of Japan, Germany, Canada and Hungary, this result is robust across horizons). The MA rule is overall ranked second in terms of MSPE. Surprisingly enough, there is not a clear horizon pattern here although it has been well documented in the literature that *"the relative weight given to technical analysis as opposed to fundamental analysis rises as the trading or forecast horizon declines"* (Menkhoff and Taylor, 2007).

When it comes to the standard menu of fundamentals, the picture is mixed. The PPP model displays better statistical performance that the FR and the MF model. However, one is not able to make conclusive statements about the predictability of the parity condition, which outperforms the RW model only for Japan and South Africa (across horizons), and for Germany and Taiwan at horizons greater than two years. Finally, there is little evidence of predictability coming from the FR and MF models, the former showing some good performance for Japan, at short horizons.

Appendix Tables

Table 1A.1. Full Sample Results for the Developed Markets Panel: Regression Coefficients for the FR, PPP and MF Model

	FR	
	Constant	**Interest Rate Differential**
UK	0.002753	-0.0991
Japan	-0.008016*	-0.1453*
Germany	-0.002481	-0.0633
Canada	0.000598	-0.0473
	PPP	
	Constant	**ZPPP**
UK	-0.007964	0.019022
Japan	0.076053	0.016861
Germany	0.005295	0.014344
Canada	0.002598	0.011987
	MF	
	Constant	**ZMF**
UK	0.001809	-0.000005
Japan	-0.004664	0.000005
Germany	-0.001870	0.000001
Canada	0.003574	-0.000012

The table reports the estimated coefficients for the FR, PPP and MF specifications with a constant at 1 month horizon. The asterisk denotes significance.

Table 1A.2. Full Sample Results for the Developed Markets Panel: Regression Coefficients for the MA Model

	MA		
	Constant	**MA5**	**MA150**
UK	-0.017637*	0.039045	-0.07338
Japan	0.037552	0.00526	-0.01332
Germany	0.007464	0.025638	-0.03978
Canada	0.003297	0.054901	-0.06854

The table reports the estimated coefficients for the MA specification with a constant at 1 month horizon. The asterisk denotes significance.

Table 1A.3. Full Sample Results for the Developed Markets Panel: Regression Coefficients for the TR Model

Taylor Rule								
	Constant	**p**	**p***	**y**	**y***	**q**	**i**	**i***
UK	-0.039802	-0.045681	0.051856	-0.003045*	0.002375	-0.025016	-0.000523	0.000685
Japan	0.391160	-0.092982	0.043369	0.000167	-0.002628	-0.036628*	-0.001341	0.002896*
Germany	-0.129352	0.044612	-0.016111	-0.000895	0.000711	-0.020848	0.000547	0.001367
Canada	0.020294	0.006317	-0.010212	0.000027	0.001164	-0.010042	-0.000623	0.000393

The table reports the estimated coefficients for the TR specification with a constant at 1 month horizon. The asterisk denotes significance.

Table 1A.4. Full Sample Results for the Developed Markets Panel: Regression Coefficients for the Combined Model

Combined Model						
	Constant	**FR**	**MA**	**PPP**	**MF**	**TR**
UK	-0.000082	-1.658465*	0.264569	-0.002191	-0.473578	0.023336
Japan	0.484045	-0.145764	0.724338	0.151052	0.151052	-1.682664
Germany	0.331359	-0.001126	-0.777185*	-0.259003	0.000147	0.697276*
Canada	-1.196255	-0.964475*	-0.195935	-0.461072	-0.402442	-0.174180

The table reports the estimated coefficients for the combined specification with a constant at 1 month horizon. The asterisk denotes significance.

Table 1A.5. Full Sample Results for the Emerging Markets Panel: Regression Coefficients for the FR, PPP and MF Model

	FR	
	Constant	**Interest Rate Differential**
Singapore	-0.003512	-0.1567
South Africa	0.005115*	-0.0219
Hungary	0.005239*	-0.0098
Taiwan	0.000954	-0.0251
	PPP	
	Constant	**ZPP**
Singapore	0.004074	0.015415
South Africa	0.031720	0.017076
Hungary	-0.022302	-0.005191
Taiwan	0.027454	0.008023
	MF	
	Constant	**ZMF**
Singapore	-0.001906	0.000002
South Africa	0.006207	-0.000006
Hungary	0.012432*	-0.000003
Taiwan	0.002175	0.000000

The table reports the estimated coefficients for the FR, PPP and MF specifications with a constant at 1 month horizon. The asterisk denotes significance.

Table 1A.6. Full Sample Results for the Emerging Markets Panel: Regression Coefficients for the MA Model

MA			
	Constant	**MA5**	**MA150**
Singapore	0.011016	-0.027794	0.002482
South Africa	0.015859	0.037096	-0.044406
Hungary	0.053845*	0.032864	-0.042705
Taiwan	0.052113	0.039274	-0.054316

The table reports the estimated coefficients for the MA specification with a constant at 1 month horizon. The asterisk denotes significance.

Table 1A.7. Full Sample Results for the Emerging Markets Panel: Regression Coefficients for the TR Model

	TR							
	Constant	**p**	**p***	**y**	**y***	**q**	**i**	**i***
Singapore	-0.224338	0.094582	-0.047495	-0.000056	-0.000187	-0.002285	-0.001896	0.001502
South Africa	-0.073294	0.013788	0.012909	0.001661	-0.001679	-0.037257	0.000416	0.003226
Hungary	1.159206*	0.024430	-0.205808	-0.000191	-0.000972	-0.068495*	0.000061	0.003186
Taiwan	-0.064798	0.015067	0.020099	0.000276	-0.000747	-0.028863	-0.000068	0.000631

The table reports the estimated coefficients for the TR specification with a constant at 1 month horizon. The asterisk denotes significance.

Table 1A.8. Full Sample Results for the Emerging Markets Panel: Regression Coefficients for the Combined Model

	Combined Model					
	Constant	**FR**	**MA**	**PPP**	**MF**	**TR**
Singapore	-0.002562	0.749451	0.804480	-0.021708	-0.851484	2.9392091*
South Africa	2.123094*	0.80614138*	1.579366	-0.996874	1.2467491*	2.6705427*
Hungary	-0.058931	-0.002622	0.325215	2.5918868*	-0.004568	-1.045729
Taiwan	2.3316166*	-2.490704	1.0625556*	0.387007	0.941339	1.0770411*

The table reports the estimated coefficients for the combined specification with a constant at 1 month horizon. The asterisk denotes significance.

Table 1A.9. Full Sample Results for the Developed Markets Panel: Model Ranking across Horizons

UK								
Model Ranking	**1M**	**3M**	**6M**	**1 Year**	**2 Year**	**3 Year**	**4 Year**	**5 Year**
1	TR	TR	TR	TR	TR	TR	TR	TR
2	MA	MA	MA	MA	MA	MA	RW	RW
3	RW	RW	RW	RW	RW	RW	MA	MA
4	FR	PPP	PPP	PPP	PPP	PPP	PPP	PPP
5	PPP	FR	FR	MF	MF	MF	MF	FR
6	MF	MF	MF	FR	FR	FR	FR	MF

Japan								
Model Ranking	**1M**	**3M**	**6M**	**1 Year**	**2 Year**	**3 Year**	**4 Year**	**5 Year**
1	TR	TR	TR	TR	TR	TR	TR	TR
2	FR	PPP	PPP	PPP	PPP	PPP	PPP	PPP
3	PPP	FR	FR	MA	MA	MA	MA	FR
4	MA	MA	MA	RW	RW	RW	RW	MA
5	RW	RW	RW	FR	MF	FR	MF	RW
6	MF	MF	MF	MF	FR	MF	FR	MF

Germany								
Model Ranking	**1M**	**3M**	**6M**	**1 Year**	**2 Year**	**3 Year**	**4 Year**	**5 Year**
1	TR	TR	TR	TR	TR	TR	TR	TR
2	MA	FR	MA	MA	PPP	PPP	PPP	PPP
3	RW	MA	RW	RW	MA	MA	MA	MA
4	PPP	RW	PPP	PPP	RW	RW	RW	RW
5	FR	PPP	FR	FR	FR	MF	FR	MF
6	MF	MF	MF	MF	MF	FR	MF	FR

Canada								
Model Ranking	**1M**	**3M**	**6M**	**1 Year**	**2 Year**	**3 Year**	**4 Year**	**5 Year**
1	TR	TR	TR	TR	TR	TR	TR	TR
2	MA	MA	MA	MA	MA	MA	MA	MA
3	MF	RW	RW	RW	MF	RW	RW	RW
4	RW	PPP	PPP	PPP	RW	PPP	PPP	PPP
5	PPP	MF	MF	MF	PPP	MF	MF	MF
6	FR	FR	FR	FR	FR	FR	FR	FR

Ranking based on RMSPE calculations; sample period ranges from February 1975 to July 2009.

Table 1A.10. Full Sample Results for the Emerging Markets Panel: Model Ranking across Horizons

Singapore								
Model Ranking	**1M**	**3M**	**6M**	**1 Year**	**2 Year**	**3 Year**	**4 Year**	**5 Year**
1	TR	TR	TR	TR	TR	TR	TR	TR
2	FR	FR	MA	MA	MA	MA	MA	MA
3	RW	RW	RW	RW	RW	RW	RW	RW
4	MA	MA	PPP	FR	PPP	PPP	PPP	PPP
5	PPP	PPP	FR	PPP	FR	FR	FR	FR
6	MF	MF	MF	MF	MF	MF	MF	MF

South Africa								
Model Ranking	**1M**	**3M**	**6M**	**1 Year**	**2 Year**	**3 Year**	**4 Year**	**5 Year**
1	TR	TR	TR	TR	TR	TR	TR	TR
2	MA	PPP	PPP	PPP	PPP	PPP	PPP	PPP
3	PPP	MA	MA	MA	MA	RW	RW	RW
4	RW	RW	RW	RW	RW	MA	MA	MA
5	FR	FR	FR	FR	FR	MF	MF	MF
6	MF	MF	MF	MF	MF	FR	FR	FR

Hungary								
Model Ranking	**1M**	**3M**	**6M**	**1 Year**	**2 Year**	**3 Year**	**4 Year**	**5 Year**
1	TR	TR	TR	TR	TR	TR	TR	TR
2	MF	MA	MA	MA	MF	MA	MA	MA
3	MA	MF	RW	MF	MA	MF	RW	RW
4	RW	RW	MF	RW	RW	RW	MF	MF
5	PPP	PPP	PPP	FR	FR	FR	FR	FR
6	FR	FR	FR	PPP	PPP	PPP	PPP	PPP

Taiwan								
Model Ranking	**1M**	**3M**	**6M**	**1 Year**	**2 Year**	**3 Year**	**4 Year**	**5 Year**
1	TR	TR	TR	TR	TR	TR	TR	TR
2	MA	MA	MA	MA	PPP	PPP	PPP	PPP
3	RW	RW	RW	RW	MA	RW	RW	MA
4	PPP	PPP	PPP	PPP	RW	MA	MA	RW
5	MF	MF	MF	FR	FR	FR	FR	FR
6	FR	FR	FR	MF	MF	MF	MF	MF

Ranking based on RMSPE calculations; sample period ranges from July 1989 to July 2009.

Tables

Table 1.1. Out-of-Sample Forecasting Ability: Developed Markets

Developed Markets, 1M Horizon							
UK	**JAPAN**	**GERMANY**	**CANADA**	**UK**	**JAPAN**	**GERMANY**	**CANADA**
UIP	**UIP**	**UIP**	**UIP**	**MA**	**MA**	**MA**	**MA**
0.050	0.122*	0.066	0.094	0.139*	0.111*	0.111*	0.121
0.368	0.007	0.177	0.061	0.003	0.014	0.014	0.059
PPP	**PPP**	**PPP**	**PPP**	**ZMF**	**ZMF**	**ZMF**	**ZMF**
0.121*	0.102	0.077	0.119*	0.085	0.105*	0.100*	0.140*
0.008	0.550	0.056	0.008	0.100	0.015	0.024	0.002
TR	**TR**	**TR**	**TR**				
0.180*	0.203*	0.262*	0.196*				
0.000	0.000	0.000	0.001				
Developed Markets, 1Y Horizon							
UK	**JAPAN**	**GERMANY**	**CANADA**	**UK**	**JAPAN**	**GERMANY**	**CANADA**
UIP	**UIP**	**UIP**	**UIP**	**MA**	**MA**	**MA**	**MA**
0.089	-0.019	-0.187	0.049	0.307*	0.529*	0.495*	0.268*
0.155	0.425	0.025	0.294	0.001	0.000	0.000	0.010
PPP	**PPP**	**PPP**	**PPP**	**ZMF**	**ZMF**	**ZMF**	**ZMF**
0.170*	0.521*	0.434*	0.191	0.072	-0.016	0.057	-0.115
0.037	0.000	0.000	0.056	0.250	0.447	0.302	0.138
TR	**TR**	**TR**	**TR**				
0.133	0.035	-0.210	0.178				
0.084	0.391	0.025	0.052				
Developed Markets, 5Y Horizon							
UK	**JAPAN**	**GERMANY**	**CANADA**	**UK**	**JAPAN**	**GERMANY**	**CANADA**
UIP	**UIP**	**UIP**	**UIP**	**MA**	**MA**	**MA**	**MA**
0.246	0.589*	-0.578	0.635*	0.470*	0.594*	0.886*	0.491*
0.051	0.000	0.000	0.000	0.001	0.000	0.000	0.001
PPP	**PPP**	**PPP**	**PPP**	**ZMF**	**ZMF**	**ZMF**	**ZMF**
0.478*	0.382*	0.898*	0.525*	0.013	0.353*	0.198	-0.281
0.001	0.006	0.000	0.000	0.467	0.010	0.102	0.038
TR	**TR**	**TR**	**TR**				
0.291*	0.068	0.286*	0.297*				
0.022	0.322	0.034	0.018				

The table reports re-scaled MSFE differences between the models (UIP, MA, PPP, MF and TR) and the random walk forecasts. Positive values imply that the model forecasts better than the random walk. Asterisks denote rejections of the null hypothesis that random walk is better in favour of the alternative hypothesis that the alternative model is better. Asterisk denotes rejection at the 5% significance level. Clark and West (2007) p-values are also presented below (one-sided test).

Table 1.2. Out-of-Sample Forecasting Ability: Emerging Markets

Emerging Markets, 1M Horizon							
SIN'PORE	**S. AFRICA**	**HUNGARY**	**TAIWAN**	**SIN'PORE**	**S. AFRICA**	**HUNGARY**	**TAIWAN**
UIP	**UIP**	**UIP**	**UIP**	**MA**	**MA**	**MA**	**MA**
0.092	0.074	0.088	0.040	-0.034	0.160*	0.217*	0.236*
0.159	0.359	0.151	0.621	0.597	0.025	0.029	0.010
PPP	**PPP**	**PPP**	**PPP**	**ZMF**	**ZMF**	**ZMF**	**ZMF**
0.081	0.095	0.102	0.187*	0.160*	0.122	0.223*	0.138
0.325	0.099	0.130	0.007	0.014	0.060	0.002	0.060
TR	**TR**	**TR**	**TR**				
0.228*	0.200*	0.279*	0.214*				
0.006	0.005	0.000	0.004				
Emerging Markets, 1Y Horizon							
SIN'PORE	**S. AFRICA**	**HUNGARY**	**TAIWAN**	**SIN'PORE**	**S. AFRICA**	**HUNGARY**	**TAIWAN**
UIP	**UIP**	**UIP**	**UIP**	**MA**	**MA**	**MA**	**MA**
0.32*	-0.369	0.457*	-0.746	0.007	-0.323	0.440*	0.915*
0.002	0.017	0.012	0.000	0.480	0.033	0.013	0.000
PPP	**PPP**	**PPP**	**PPP**	**ZMF**	**ZMF**	**ZMF**	**ZMF**
0.381*	-0.316	-0.082	1.147*	0.100	0.166	0.694*	0.369*
0.002	0.053	0.345	0.000	0.257	0.174	0.000	0.019
TR	**TR**	**TR**	**TR**				
-0.298	0.013	-0.092	-0.294				
0.030	0.471	0.319	0.036				
Emerging Markets, 5Y Horizon							
SIN'PORE	**S. AFRICA**	**HUNGARY**	**TAIWAN**	**SIN'PORE**	**S. AFRICA**	**HUNGARY**	**TAIWAN**
UIP	**UIP**	**UIP**	**UIP**	**MA**	**MA**	**MA**	**MA**
1.078*	-0.845	-0.605	-0.792	1.189*	-1.221	0.415*	0.715*
0.000	0.001	0.008	0.001	0.000	0.000	0.050	0.003
PPP	**PPP**	**PPP**	**PPP**	**ZMF**	**ZMF**	**ZMF**	**ZMF**
0.956*	-0.477	-0.524	0.373	-0.448	-0.780	0.769*	-0.255
0.000	0.030	0.018	0.070	0.035	0.001	0.002	0.155
TR	**TR**	**TR**	**TR**				
0.056	-1.076	3.059*	-2.179				
0.409	0.000	0.000	0.000				

The table reports re-scaled MSFE differences between the models (UIP, MA, PPP, MF and TR) and the random walk forecasts. Positive values imply that the model forecasts better than the random walk. Asterisks denote rejections of the null hypothesis that random walk is better in favour of the alternative hypothesis that the alternative model is better. Asterisk denotes rejection at the 5% significance level. Clark and West (2007) p-values are also presented below (one-sided test).

Table 1.3. Out-of-Sample Forecasting Ability: Combined Model, Developed and Emerging Markets

Developed Markets, 1M Horizon				**Emerging Markets, 1M Horizon**			
UK	**JAPAN**	**GERMANY**	**CANADA**	**SIN'PORE**	**S. AFRICA**	**HUNGARY**	**TAIWAN**
Combined	**Combined**	**Combined**	**Combined**	**Combined**	**Combined**	**Combined**	**Combined**
0.264*	0.406*	0.480*	0.331*	0.557*	0.591*	0.508*	0.543*
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Developed Markets, 1Y Horizon				**Emerging Markets, 1Y Horizon**			
UK	**JAPAN**	**GERMANY**	**CANADA**	**SIN'PORE**	**S. AFRICA**	**HUNGARY**	**TAIWAN**
Combined	**Combined**	**Combined**	**Combined**	**Combined**	**Combined**	**Combined**	**Combined**
-0.116	0.337*	-0.025	0.116	-0.262	0.261	-0.059	0.168
0.165	0.002	0.415	0.180	0.089	0.096	0.381	0.155
Developed Markets, 5Y Horizon				**Emerging Markets, 5Y Horizon**			
UK	**JAPAN**	**GERMANY**	**CANADA**	**SIN'PORE**	**S. AFRICA**	**HUNGARY**	**TAIWAN**
Combined	**Combined**	**Combined**	**Combined**	**Combined**	**Combined**	**Combined**	**Combined**
0.390*	0.154*	0.225*	-0.010	-0.555	-0.022	-0.136	-0.250
0.000	0.035	0.004	0.453	0.004	0.454	0.201	0.081

The table reports re-scaled MSFE differences between the combined model and the random walk forecasts. Positive values imply that the model forecasts better than the random walk. Asterisks denote rejections of the null hypothesis that random walk is better in favour of the alternative hypothesis that the alternative model is better. Asterisk denotes rejection at the 5% significance level. Clark and West (2007) p-values are also presented below (one-sided test).

Table 1.4. Calculation of Performance Fees

Performance Fees, Aug 1999-July 2009					
FR	MA	PPP	MF		TR
-8	37	24	20		105
Performance Fees, Jul 2002-July 2009					
FR	MA	PPP	MF	Combined	TR
-10	36	13	20	89	105
Performance Fees, Jul 2002-July 2009					
FR	MA	PPP	MF	Combined, Min p-val	TR
-10	36	13	20	18	105

The table displays the calculation of performance fees, a measure of out-of-sample performance of the different currency strategies investing in GBP, JPY, DEM, CAD, SGD, ZAR, HUF and TWD relative to the USD. I look at a dynamic investment strategy which exploits the forecasting information of the models to forecast nominal exchange rate returns. Each strategy considers a US investor who dynamically rebalances her wealth every month between the domestic bond in US dollar and eight foreign bonds in foreign currencies. The exchange rate forecasts are used to convert the foreign bond returns in US dollar. The values denote the excess premium return of models in annualized basis points relative to RW model for a risk aversion coefficient of 3.

Figures

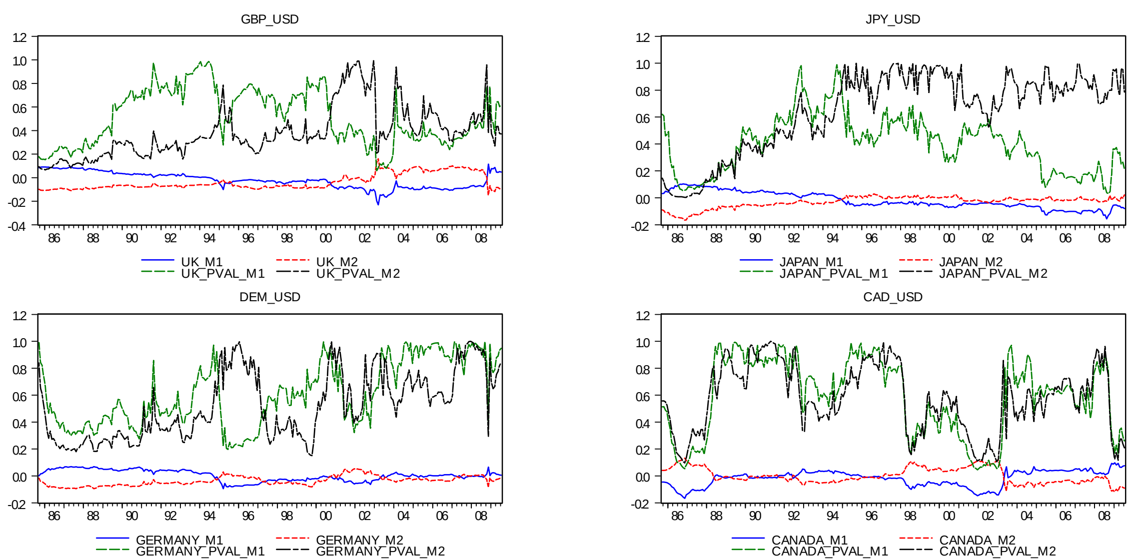

Figure 1.1. Developed Markets panel: Coefficients and p-values for the MA model at the 1-month horizon.

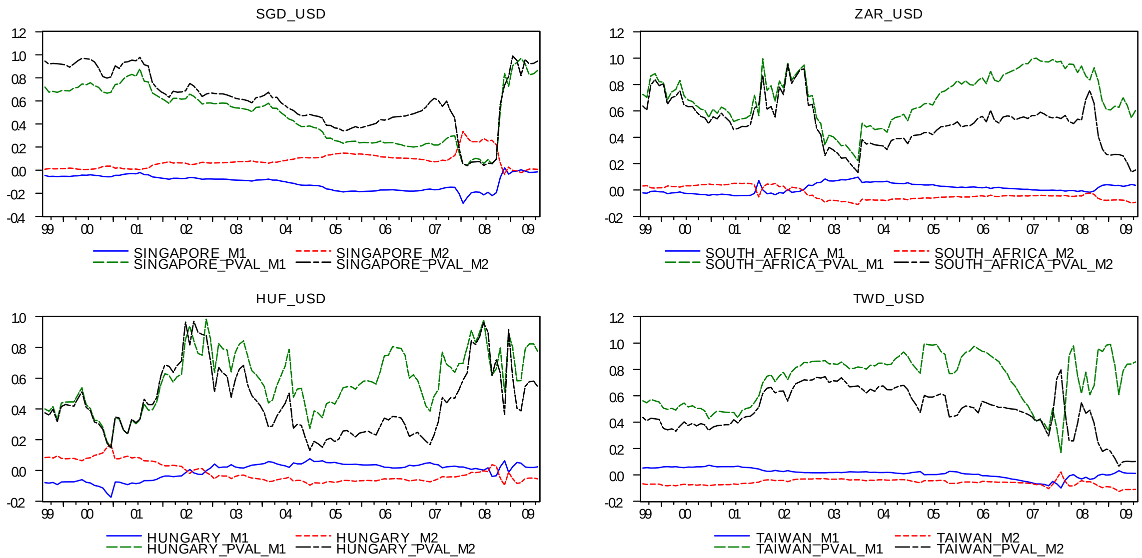

Figure 1.2. Emerging Markets panel: Coefficients and p-values for the MA model at the 1-month horizon.

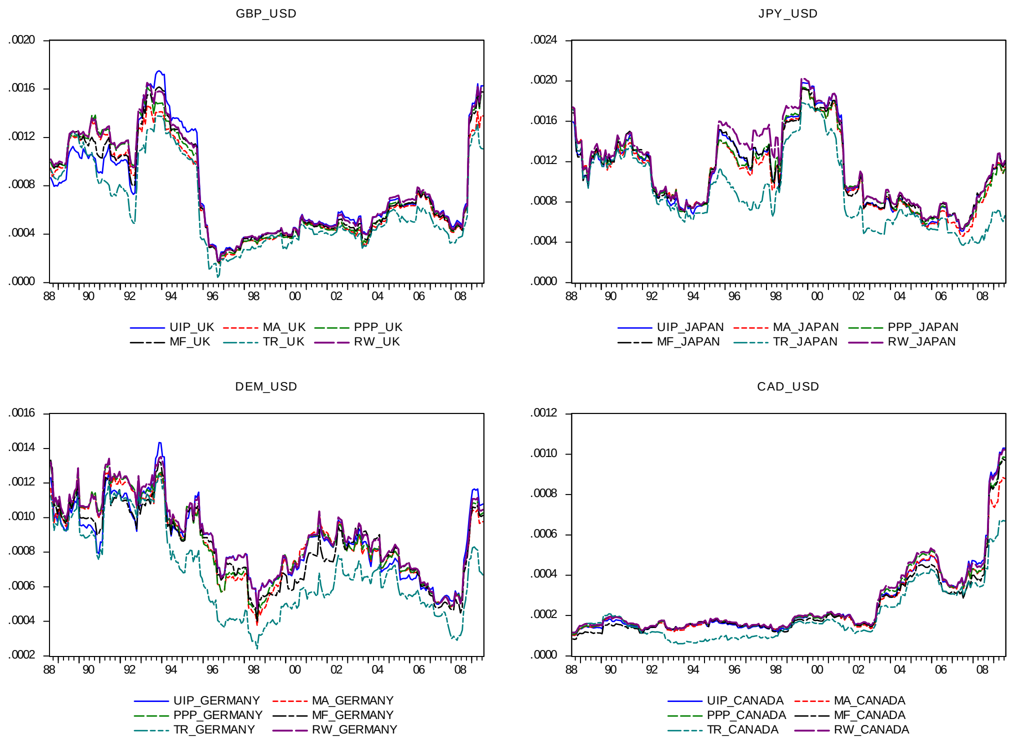

Figure 1.3. Rolling Regression Results for the Developed Markets panel: RMSPEs at the 1-month horizon.

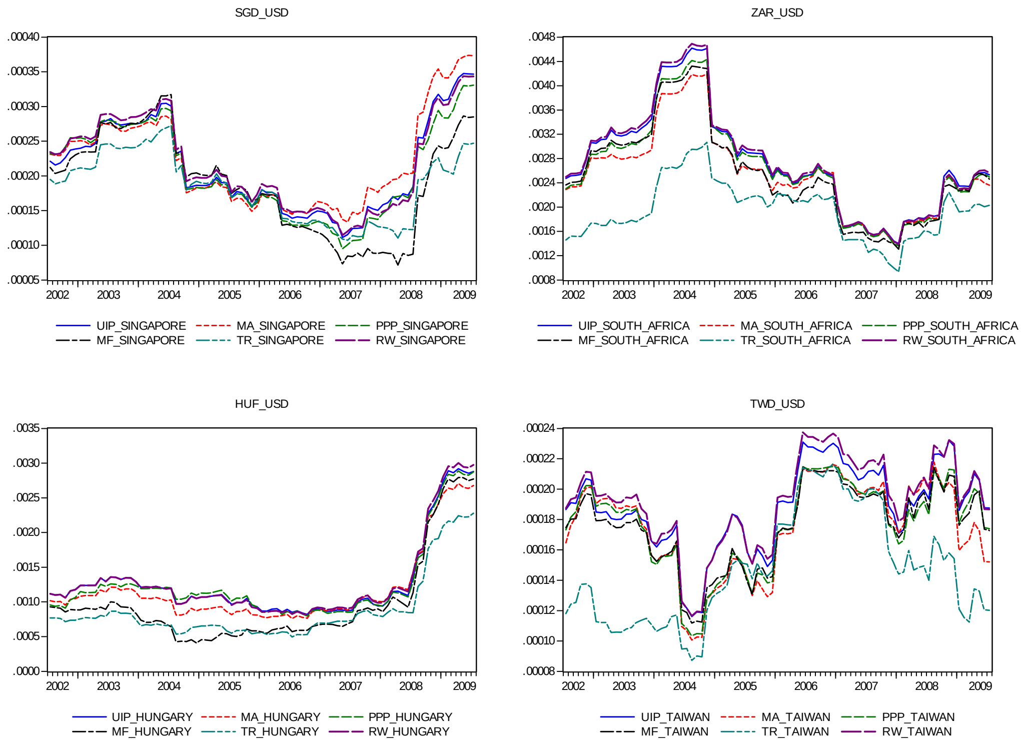

Figure 1.4. Rolling Regression Results for the Emerging Markets panel: RMSPEs at the 1-month horizon.

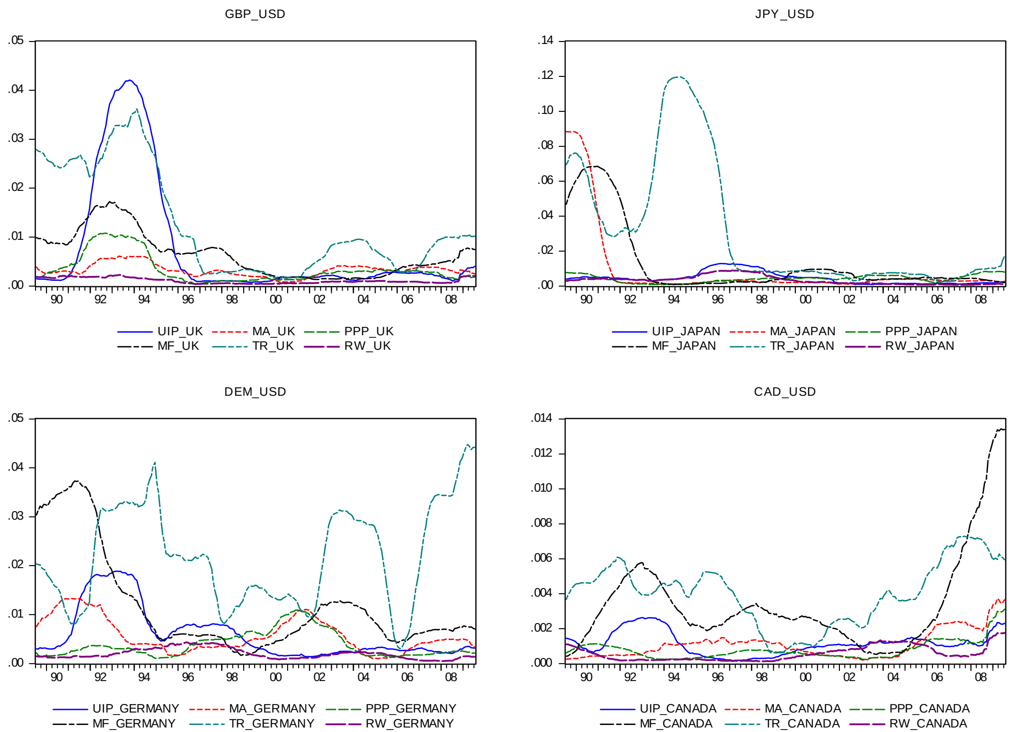

Figure 1.5. Rolling Regression Results for the Developed Markets panel: RMSPEs at the 1-year horizon.

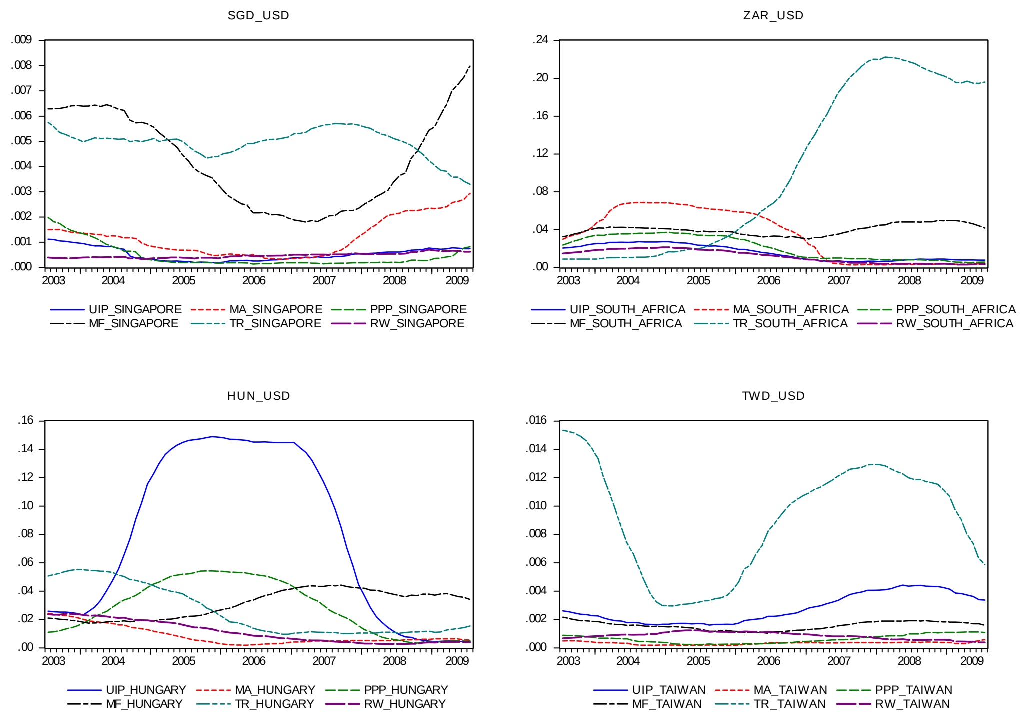

Figure 1.6. Rolling Regression Results for the Emerging Markets panel: RMSPEs at the 1-year horizon.

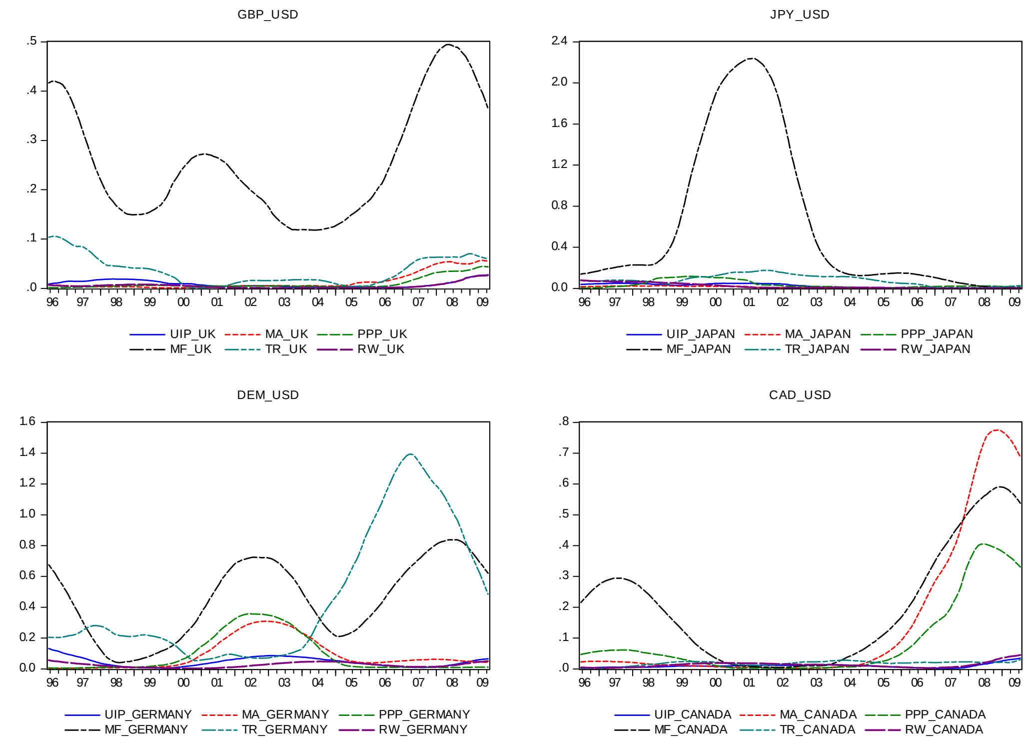

Figure 1.7. Rolling Regression Results for the Developed Markets panel: RMSPEs at the 5-year horizon.

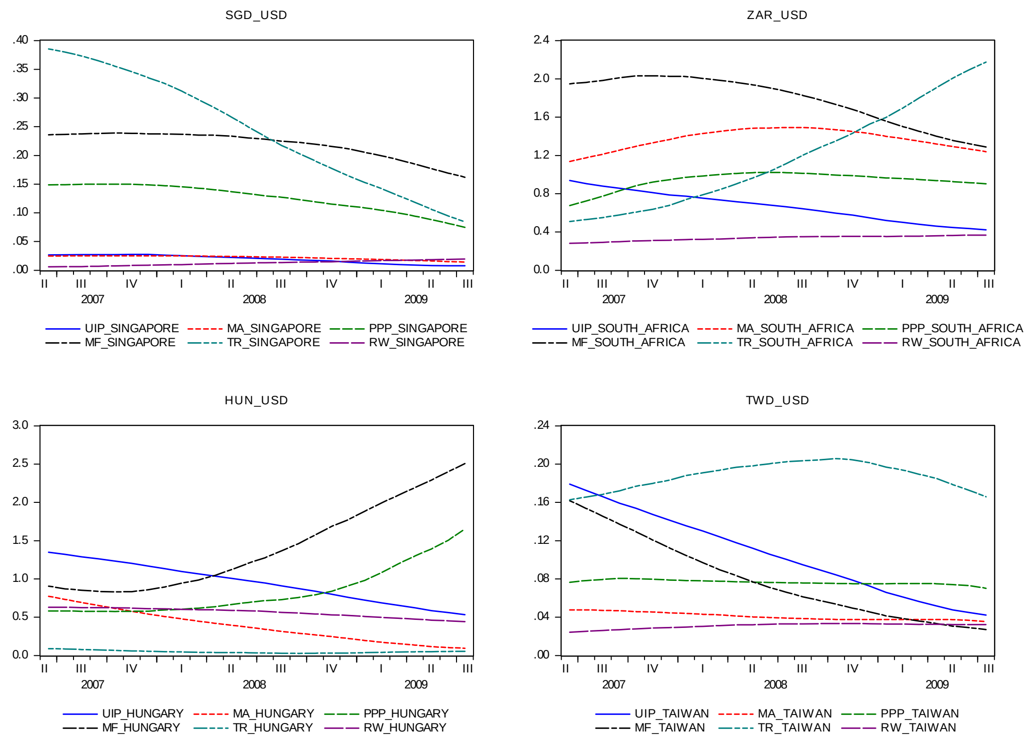

Figure 1.8. Rolling Regression Results for the Emerging Markets panel: RMSPEs at the 5-year horizon.

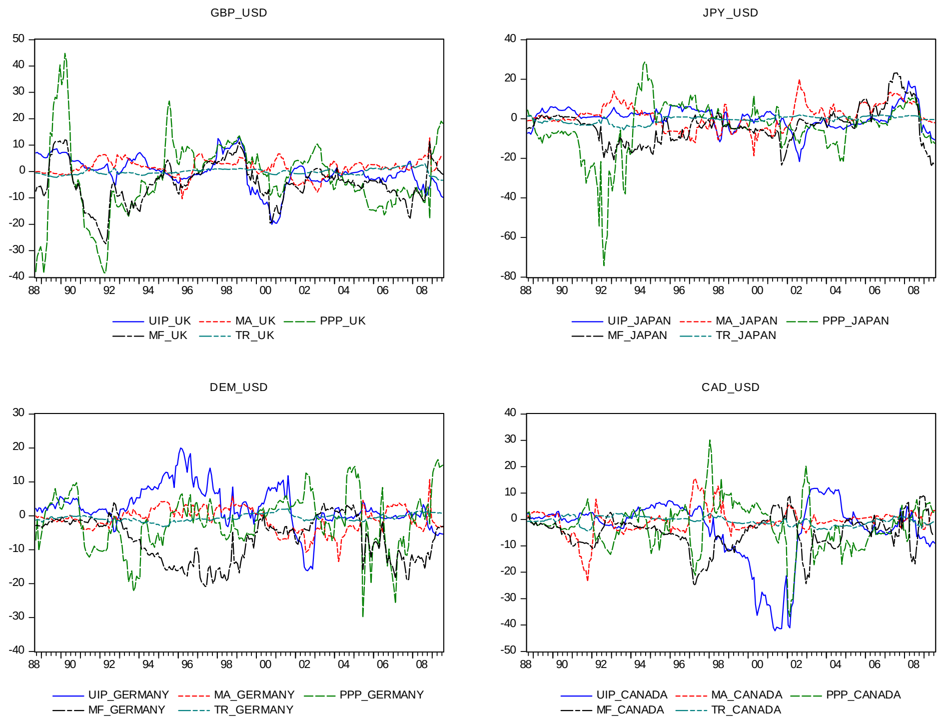

Figure 1.9. Developed Markets panel: Coefficients for the Combined model at the 1-month horizon.

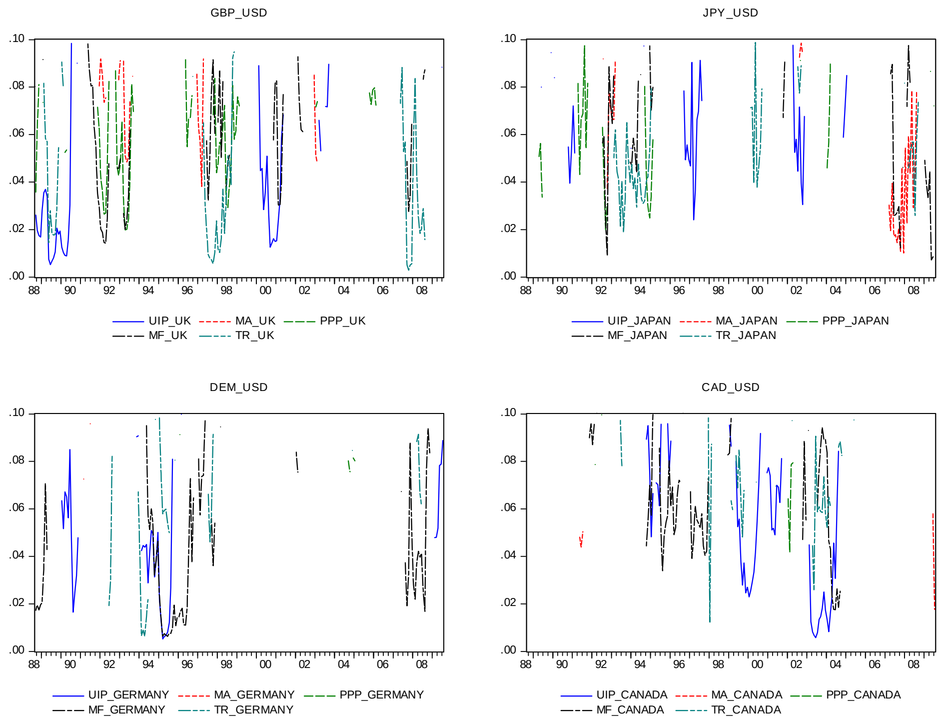

Figure 1.10. Developed Markets panel: P-values for the Combined model at the 1-month horizon.

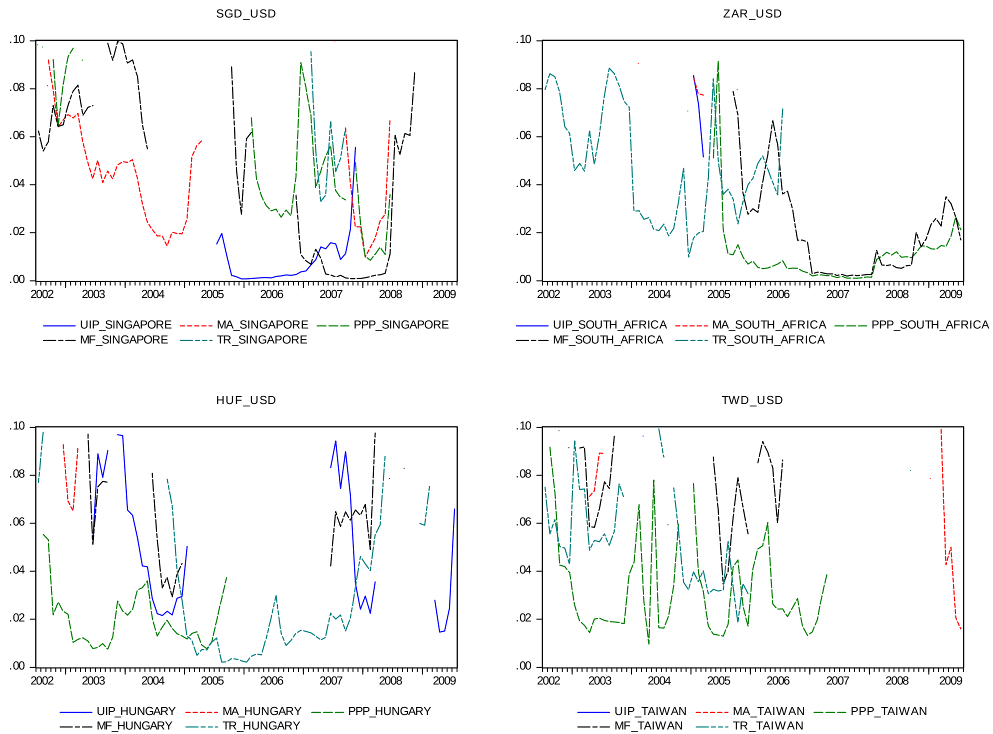

Figure 1.11. Emerging Markets panel: P-values for the Combined model at the 1-month horizon.

CHAPTER 3

Commodity Currencies Revisited

3.1. Introduction

One of the most debatable issues in international finance is the link between exchange rates and economic fundamentals. Although commodity currencies offer an attractive laboratory for the study of this link[1], the literature has generally focused on the forecasting power of commodities for the exchange rate, establishing the existence of a relationship, yet reporting limited predictability success. I deviate from this traditional approach motivated by two observations. First, so far it has yet to be established whether a currency investor could benefit from the information embedded in commodity price changes; second, when it comes to the relationship dynamics, the forecasting framework renders the assessment of different variables and markets an arduous task.

In the present chapter, I examine the implications of the documented relationship between currencies and commodities for an investor's currency allocation decisions. For this purpose, I build a country-specific commodity currency strategy by taking into account the countries' most important commodity imports and exports given a certain threshold. I further extend my country panel to include commodity importers as well as exporters in order to study whether this relationship holds for commodity currencies only. Throughout the empirical exercise I employ tradable commodity price indices in order to circumvent potential liquidity

[1]As Chen, Rogoff and Rossi (2010) observe, a simple model of exchange rates and commodities is less impaired by endogeneity issues as compared to other exchange rate models that employ standard macroeconomic fundamentals.

issues. I, then, study the risk-return profile of the proposed commodity currency strategy. In this way, I offer a different perspective in the debate regarding the dynamics between the countries' exchange rate movements and the corresponding changes in the world price of commodity imports and exports.

In my empirical analysis I follow the recent literature (Lustig and Verdelhan (2007), Lustig, Roussanov, and Verdelhan (2011)) and allocate currencies into portfolios in accordance with the predictions of the proposed commodity currency strategy on a daily frequency. I construct five such portfolios. Going long in the portfolio with the highest predicted returns, i.e. portfolio 5, and shorting the portfolio with the lowest predicted returns, i.e. portfolio 1, hence, generates a corner portfolio. This strategy yields significant unconditional spot excess returns, greater than 6% p.a., that appear to be uncorrelated to standard strategies such as the carry trade. Furthermore, these returns cannot be explained in a linear asset pricing framework (e.g. Ang, Hodrick, Xing, and Zhang (2006)) by measures of risk that have been found to fare well in the exchange rate literature such as global FX volatility risk and currency momentum; e.g. see Menkhoff, Sarno, Schmeling, and Schrimpf (2012a and b). Furthermore, I test whether standard risk factors can price the cross section of commodity portfolios.

The present chapter relates to two strands of the recent literature. First, my work contributes to the literature that investigates the relationship between exchange rates and fundamentals and in particular, commodities. In line with this literature, I find a strong relationship between commodities and currencies; however, my results are of a different nature as I focus on economic value instead of statistical predictability. Second, as in Lustig, Roussanov, and Verdelhan (2011), I cross-sectionally relate the returns to the commodity currency strategy to a set of risk factors.

The most important aspect of the present analysis is the design of a novel strategy for the exchange rate that appears to be uncorrelated to popular currency strategies such as the carry trade and currency momentum. This is also of particular interest in the context of the long standing debate regarding the information flow between commodities and exchange rates by providing an original way of evaluating this often-documented lead-lag relationship. Given the emerging importance of factors such as the level of interest rates and the equity market, one can argue that trying to identify a causal relationship between exchange rates and commodities could be indeed misleading. The results of this paper, hence, constitute a middle ground in this debate by using a less conventional framework for the assessment of this link which is however, no less realistic. In this context, it is natural to employ the portfolio approach here given its emerging popularity and success in the study of currency behaviour.

The second set of my results relates to the determinants of the strategy's success which are hard to precisely identify in an asset pricing framework. At the same time, the findings of the asset pricing exercise underline the complexity of dynamics that pertains to the examined relationship. For instance, although the equity market factor explains more than 70% of the cross-sectional returns of the commodity currency strategy, I find a negative relation between equity returns and currency returns that are driven by commodity price changes.

On the downside, the high transaction costs of the commodity currency strategy constitute a serious pitfall as they can erode profitability completely. This is particularly true when the strategy is implemented using a number of emerging market currencies which display large bid-ask spreads. The exploitability problem can, however, be circumvented if the investor trades only developed market currencies. The later finding further showcases the validity of the strategy for different exchange rates panels.

The remainder of the chapter is organized as follows. Section 3.2 presents a selective review of the literature that motivates my approach. Section 3.3 sets the framework employed in the construction of the proposed commodity currency strategy. Section 3.4 describes the data and presents descriptive statistics for the formed currency portfolios. In Section 3.5, I compare the commodity currency strategy to the carry trade. Section 3.6 presents the results from the asset pricing exercise. Section 3.7 discusses the potential importance of other factors such as the interest rate and the equity market. In Section 3.8, I report the robustness checks. Section 3.9 concludes.

3.2. Commodities and the Exchange Rate: Selective Literature Review

Studies on the foreign exchange (FX) market efficiency normally entail tests on parity conditions such as the Covered and Uncovered Interest Rate Parity. Nevertheless, throughout the literature it has been non-trivial to empirically document the significance of the link between fundamentals and the exchange rate and various anomalies have emerged. The puzzles in exchange rate economics relate to the most prominent fundamental models, namely the Uncovered Interest rate Parity (UIP), Purchasing Power Parity (PPP) and Monetary Fundamentals model (MF), and have been extensively studied by the finance scholars (Obstfeld and Rogoff (2000)).

On the other hand, research work on commodity currencies provides some empirical evidence regarding the forecasting ability of commodity prices for the exchange rate. Chen and Rogoff (2003) document that the US dollar price of commodity exports has a significant effect on the real exchange rates of Australia, New Zealand, and to a lesser extend, Canada. More recently, Ferraro, Rogoff and Rossi (2012) explore the predictive ability of oil prices for the Canadian/U.S. dollar nominal exchange rate and find robust evidence at the daily frequency. However, they report no systematic relationship for the monthly and quarterly frequencies.

At the same time, currencies are found to forecast commodity price changes with relative success (Chen, Rogoff and Rossi (2010) and Clements and Fry (2006)). The theoretical explanation that has been put forward is that exchange rates are forward looking, while commodity price fluctuations are more prone to short-term demand imbalances.

The relationship between currencies and commodities was first observed by Amano and Norden (1993) and Gruen and Kortian (1996). Despite the likely omission of other explanatory variables, a simple, empirical model of commodity prices and exchange rates has shed some light on the relationship between commodities and expected exchange rate returns. Follow-up research also includes the work of Cashin, Cespedes and Sahay (2004), who test if the real exchange rates of commodity-exporting countries comove with the real prices of their commodity exports. They report supportive evidence of a long run relationship between real exchange rates and real commodity prices for approximately a third of the commodity-exporting countries of their sample. The long-run real exchange rate of these "commodity currencies" is also found to be time-varying rather than constant, driven by the changes in the real price of commodity exports.

Clements and Fry (2006) study the concurrent developments of commodity and currency markets, using the Kalman filter to jointly estimate the price drivers of currencies and commodities. Their findings suggest that there is less indication that currencies are influenced by commodities than that commodities are influenced by the commodity currencies. In the same lines, Chen, Rogoff and Rossi (2010) argue that "commodity currency exchange rates have remarkably robust power in predicting global commodity prices, both in-sample and out-of-sample, and against a variety of alternative benchmarks". The authors maintain that the reverse relationship is significantly less powerful.

Finally, existing papers that look into the importance of other variables and markets include the work of Basher, Haug and Sadorsky (2010) who explore the dynamic relationship among exchange rates, oil prices and emerging market stock prices. One interesting finding is that positive shocks to oil prices generally have a negative effect for US dollar exchange rates and emerging market stock prices in the short run. Chen and Tsay (2011) also investigate the relationship among exchange rate, commodity, and equity markets using data of different frequencies.

Summing up the findings of the papers on commodity currencies, commodity prices emerge as a variable of significance for the exchange rate. In this line of reasoning, there could exist a positive or negative price of commodity risk as investors become preoccupied with the changes in potential investment opportunities. This observation motivates my approach of building and subsequently pricing commodity ordered portfolios as in Lustig and Verdelhan (2007). In the present chapter I show that commodities has more to say about currency returns. Furthermore, these returns appear to be of different nature to the returns of standard FX strategies such as the carry trade or momentum strategies.

3.3. Framework for the Commodity Currency Strategy

This section describes how the proposed commodity currency strategy is constructed. The estimation equation is based on a standard model of commodity prices and exchange rates, with the difference that I allow the regressions to be country-specific, according to the most "important" commodity imports or exports for each country. Since the scope of my analysis is to compile a country panel that consists both of commodity importers and exporters, it is important to be accurate about the commodities that could have an actual impact on the exchange rate of each country. I therefore distinguish among 25 different specifications of the basic regression equation by including on the right-hand-side of the equation the commodities that account for five per cent or above of the total imports or exports of each country (see Table 3.1.).

$$\Delta s_{k,t+1} = a_k + \sum_{m \in M} \beta_{k,m} * \Delta P_{t,m} + u_{k,t+1}, \tag{3.1}$$

where $\Delta s_{t+1} \equiv s_{t+1} - s_t$, s_t stands for the logarithm of the spot exchange rate (domestic price of foreign currency) at time t, ΔP_t is the commodity price change, k denotes the country in my sample, m denotes the commodities that constitute five per cent or more of the commodity imports or exports for each country, and u_{t+1} is the rational expectations forecast error.

As a first check, the currencies are ranked in terms of their betas from an estimated regression of the currencies on the composite Spot Commodity Index from the Standard & Poors, Goldman Sachs Commodity Index spot price series (formerly the Goldman Sachs Commodity Index series)[2], by using both the US dollar and the British pound as a numeraire. This constitutes the only non-country specific estimation and is employed for purely illustrative purposes. The rankings are displayed in Table 3.2. In both cases, the commodity currencies are found at the top of the table, corresponding to betas which are higher in value, providing a first indication that the estimated relationship between currencies and commodities yields meaningful betas.

Subsequently, I estimate country-specific regressions using a rolling window of three years. As Chen, Rogoff and Rossi (2008) note, one should keep in mind that many commodity exporters underwent big shifts in policy regimes or market conditions. Hence, the importance of allowing for time-varying parameters should not be undermined. For this purpose, I estimate each model using the first 780 data points (four years of data) for the initial one-period-ahead forecast to be generated. Subsequently, the first data point is discarded while an additional data

[2]This index tracks the prices of important physical commodities which have active and liquid futures markets.

point at the end of the sample is added and the model is re-estimated. For each of the models described above I construct a one-day-ahead forecast at each step. The data from January 2000 to December 2002 are employed for estimation and the rest are saved for out-of-sample forecasting. The out of sample predictions, hence, refer to the period between January 2003 and November 2011.

Then, as in Lustig and Verdelhan (2007), I order currencies according to the forecasted returns of the commodity currency strategy and allocate them to portfolios. Unlike their work, I focus on daily investment horizons and perform the exercise using both spot and excess returns. In both cases, portfolio 1 contains the currencies with the highest sell signal and portfolio 5 contains the currencies with the highest buy signal. I further construct an average portfolio that contains all the currencies and a corner portfolio which essentially invests in the long-short strategy: portfolio 5 - portfolio 1. A typical example is the following. Assume a US investor who creates a portfolio by dividing her wealth among 25 assets that are identical in all respects apart from the currency of denomination (GBP, CHF, JPY, CAD, AUD, NZD, SEK, NOK, EUR, ZAR, SGD, CZN, HUF, INR, IDR, MXN, PHP, THB, PLN, BRL, RUB, HRK, ILS, BGN, and CLP). The primary target of the exercise is, to decide whether there is economic value in forecasting the FX returns using commodity price changes as a criterion for portfolio selection. The investor rebalances her portfolio daily by taking a long position on the five currencies that she expects to appreciate the most, simultaneously shorting the five currencies that she projects to depreciate the most, over the horizon of one day. Each day she takes two steps. First, she employs the respective model to forecast the cumulative long-short portfolio return. Second, based on the forecast, she dynamically rebalances her portfolio following the long-short strategy described above. The return from domestic riskless investing is approximated by the 1-month US Eurodeposit rate. All portfolios are equally weighted and the excess returns for each one of them are constructed as follows:

$$r_t = \ln(S_{t+1}) - \ln(F_t) \tag{3.2}$$

where F_t is the one-day forward exchange rate.

In order to measure the economic value of each strategy, I rely on the Sharpe Ratio, which is a standard measure of economic value in the context of mean-variance analysis. In assessing the profitability of the abovementioned strategies, at this stage, the impact of transaction costs is not taken into account.

3.4. Data and Currency Portfolios

The present section details the currency and price data used in the empirical exercise. The data for spot exchange rates and 1-month forward exchange rates versus the US dollar (USD) and the British pound (GBP) cover the sample period from January 2000 to November 2011, and are obtained from Reuters (via Datastream). The reason I choose to restrict my sample to the past decade is that I wish to restrict the periods of inflation and exchange rate turmoil, relevant for some of the countries in my sample prior to the 90's. The empirical analysis is carried out at the daily frequency and I work in logarithms of spot and forward rates. My panel comprises the following 25 countries: Australia, Brazil, Bulgaria, Canada, Chile, Croatia, Czech Republic, Euro area, Hungary, India, Indonesia, Israel, Japan, Mexico, New Zealand, Norway, Philippines, Poland, Russia, Singapore, South Africa, Sweden, Switzerland, Thailand and the United Kingdom.

With respect to the commodity price series, I employ the Standard & Poors, Goldman Sachs Commodity Index spot price series (formerly the Goldman Sachs Commodity Index series) which serve as a benchmark for investment in the commodity markets, for the following commodities: agriculture, aluminium, brent crude, copper, energy, gold, industrial metals, livestock, natural gas, precious metals, silver and wheat. I construct the commodity shares using data from the United Nations Commodity Trade Statistics Database.

3.4.0.1. Descriptive Statistics for Commodity Portfolios. The descriptive statistics for the seven commodity portfolios are displayed in Tables 3.3 and 3.4 for the spot and excess returns cases respectively. The results show that there appears to be significant economic value associated with the corner portfolio strategy. Additionally, the returns and the Sharpe Ratios of the strategies are monotonically increasing as one moves from portfolio 1 to portfolio 5 using either the spot or excess returns series. There is not a clear monotonic pattern regarding the standard deviations, and the skewness and kurtosis measures. However, one can observe that the extreme values with respect to the second, third and fourth moments consistently appear in portfolios 1 and 5.

At this point one should note that the inspection of Tables 3.3 and 3.4 reveals something more important. Although the average portfolio's spot return is lower than the average portfolio's excess return, (2.89% versus 4.67%), the corner portfolio's spot return is greater than the corner portfolio's excess return (6.03% versus 5.32%), which is in stark contrast to what the literature in carry trades tells us about the return nature of the carry strategy. This result offers a clear, first indication that the returns to the commodity currency strategy are potentially uncorrelated with the returns to standard exchange rate strategies such as the carry trade. In order to test for this, as a first step, I construct five carry trade portfolios with the exchange rates allocated into portfolios according to their lagged forward premium, as in Lustig and Verdelhan (2007).

3.5. Comparing the Commodity Currency Strategy to Carry Trade

It is of great importance to know whether the constructed commodity currency strategy does nothing more than simply replicating the nature of returns of other popular exchange rate strategies such as the carry trade. My findings point out that is not the case.

For this purpose, I build a standard carry trade strategy and repeat the portfolio formation process. The currencies are again allocated to five portfolios according to their forward discounts at the end of each day. Ranking currencies on forward discounts is equivalent to ranking them according to interest rate differentials since Covered Interest Parity is valid in the data at the daily frequency (see e.g. Akram, Rime, and Sarno (2008)). I re-balance the portfolios at the end of each day and repeat this process day by day during the corresponding period. The currencies are ordered from low to high: portfolio 1 comprises currencies with the lowest interest rates and portfolio 5 comprises currencies with the highest interest rates. Daily excess returns for holding foreign currency are again calculated as before.

The properties of carry trade portfolios are displayed in Tables 3.5 and 3.6. The tables present descriptive statistics for the seven carry trade portfolios (portfolios 1-5, average and corner portfolio) using both spot and excess returns.

Table 3.5 displays the results for the spot carry trade returns; a first remark one can make is that there is not a monotonically increasing pattern in average returns. The corner portfolio appears to be loss-making, yielding an annualized return of -1.23%. The higher moments of the return distribution also present a mixed picture and no pattern emerges. This does not necessarily constitute a puzzling finding since the literature on carry trades focuses on the study of excess returns. Indeed, an inspection of Table 3.6 which presents the excess returns for the carry trade strategy, reveals that the returns and Sharpe Ratios of the carry trade and commodity corner portfolios are comparable. However, the higher moments patterns appear to be quite dissimilar. In particular, the carry trade strategy, when implemented on excess returns displays almost monotonically increasing annualized standard deviations moving from portfolio 1 to 5. Skewness also displays a decreasing pattern.

Furthermore, Table 3.7, presents the correlation coefficients between the spot returns to the commodity currency strategy and the spot returns to the carry trade strategy[3]. Correlations are reported between corresponding portfolios. It is evident that despite the fact that correlations between the spot returns for portfolios 1-5 are positive and quite substantial in magnitude, there is a marginally negative correlation of -0.084 between the returns of the two corner portfolios. Therefore, the returns to the two strategies are not only uncorrelated but there should be diversification benefits when the commodity currency strategy is used in conjunction with the carry trade strategy.

Finally, following Menkhoff, Sarno, Schmeling, and Schrimpf (2012b), I double-sort currencies into two portfolios contingent on whether their lagged forward discount is above or below the panel median, and subsequently into two portfolios according to their forecasted value with respect to the commodity currency strategy regression. The rebalancing frequency is always daily. The results of this exercise appear in Table 3.8. The inspection of the findings reveals that it makes a big difference if the commodity currency strategy is implemented in high or low interest rate currencies. In particular, in the high interest rate currency environment the strategy yields negative returns while in the low interest rate currency environment the revenues amount to a positive return of 4.42% per annum. Likewise, the carry trade appears to be profitable only in the subsample of the currencies that are predicted to depreciate by the commodity currency strategy. In contrast, the carry trade is loss making in the subsample of the currencies that are predicted to appreciate by the commodity currency strategy.

Once again, the results suggest a hedging relationship between the commodity currency strategy and the carry trade. As a result, it seems that one cannot

[3]Correlation coefficients between the excess returns to the commodity strategy and the carry trade strategy are equal to the second decimal digit and are not, therefore, reported seperately.

achieve greater returns than those of the corner portfolios of the two strategies taken individually by following a double-sorting strategy.

As a following, natural step, I will attempt to identify common factors in the cross-section of the commodity currency strategy's currency returns (spot and excess).

3.6. Empirical Results

3.6.1. Common Factors in Currency Returns

Stepping on the steps of Lustig, Roussanov and Verdelhan (2011) who adopt a data-driven approach following the Arbitrage Pricing Theory of Ross (1976), I conduct a principal component analysis on portfolios 1-5 of the commodity currency strategy. The results, portrayed in Table 3.9 (Panels I and II), show that the first two factors explain 87 per cent of the return variation of the commodity portfolios. The first 5 rows of the two panels reveal the factor loadings of the five commodity portfolios on principal components 1-5. The first principal component accounts for 75 per cent of the return variation. As in Lustig, Roussanov and Verdelhan (2011) who study the principal component analysis of the carry trade, the first principal component can be viewed as a level factor given that the loading of the portfolios always lies between 42 per cent and 47 per cent. The second principal component, accounts for 12 percent of the common variation. The loadings increase in a monotonic fashion across portfolios for the second principal component, which behaves as the "slope factor" of Lustig, Roussanov and Verdelhan (2011) and is hence, the sole candidate risk factor which can explain the cross-section of commodity portfolio returns. As in Lustig, Roussanov and Verdelhan (2011), I employ the average currency return as my first factor, which I denote DOL. The correlation of the first principal component with DOL is found to be 0.99 which again constitutes a standard result.

3.6.2. Asset Pricing Methodology

The present section briefs the cross-sectional asset pricing methodology. I follow a standard Stochastic Discount Factor (SDF) approach (Cochrane, 2005) as well as a traditional Fama MacBeth two-pass OLS methodology (Fama and MacBeth, 1973) in order to estimate the factor risk prices and portfolio betas.

3.6.2.1. SDF Approach. The no-arbitrage relation holds so that risk-adjusted currency excess returns have a price of zero and satisfy the Euler equation:

$$E[m_{t+1} rx^i_{t+1}] = 0,$$

where $m_t = 1 - b'(h_t - em)$, is the linear SDF , h stands for the risk factor vector, b is the SDF parameter vector and em stands for the vector of factor means.

The setting suggests:

$$E[rx^i] = \lambda' \beta_i,$$

a beta pricing model, in which expected excess returns are subject to factor risk prices λ and risk quantities β_i for every portfolio i, where $\lambda = \sum_h b$ (Cochrane (2005)).

The Euler Equation is estimated using the generalized method of moments (GMM) of Hansen (1982). I do not employ instruments apart from a constant vector of ones. The factor means em and the elements of the covariance matrix of h are estimated together with the SDF parameters by adding the respective moment conditions to the asset pricing moment conditions implied by the Euler equation. The one-step specification allows one to sufficiently account for estimation uncertainty as Burnside (2009) notes.

Tables 3.10-3.11 present β and λ estimates with Newey and West (1987) standard errors, cross-sectional R^2s,and the Hansen-Jagannathan (HJ) distance metric (Hansen and Jagannathan (1997)) with simulated p-values.

3.6.2.2. Fama MacBeth Approach. I also employ the FMB two-pass OLS methodology for consistency. A constant is not included in the second stage of the FMB regressions, i.e. I do not allow a common over- or under-pricing in the cross-section of returns. Consistent with the findings of Menkhoff, Sarno, Schmeling, and Schrimpf (2012a), since DOL has no cross-sectional relation to the strategy's portfolio returns, it appears to behave as a constant that allows for a common mispricing. I report standard errors with Newey and West (1987) adjustment.

3.6.3. Asset Pricing Results

3.6.3.1. Carry HmL as a Pricing Factor. It follows from the previous section that the corner portfolio of the carry trade strategy (henceforth termed CHML for simplicity) should be tested as a candidate second factor for the pricing kernel. Panels A1 and B1 of Table 3.10 presents the cross-sectional pricing results of the tests using the commodity portfolios 1-5 as test assets and DOL and CHML as factors.

The results indicate that the DOL factor is highly correlated with the returns of portfolios 1-5. The betas of the DOL factor are all close to the value of one, and statistically significant. The betas of the CHML factor decline, although not monotonically, from 0.11 for portfolio1 to 0.02 for portfolio 5. They are statistically significant for three out of five portfolios. While the R^2s for the five regressions appear to be quite large, this does not constitute a novel finding as ranking portfolios with respect to the commodity price predictions yields a monotonic ordering of the expected returns. The R^2s of the cross-sectional regression are in the range of

0.28 but the factor risk price λ for CHML is negative (again suggesting a hedging relationship) and not statistically significant.

3.6.3.2. The Volatility Proxy. Following Menkhoff, Sarno, Schmeling, and Schrimpf (2012a) and Burnside, Eichenbaum and Rebelo (2011), I employ a metric of global currency volatility, denoted by VOL. The measure is effectively the average sample standard deviation of the daily log changes in the values of the currencies versus the USD. It is measured monthly and is given by:

$$\sigma_t^{FX} = \frac{1}{T_t} \sum_{\tau \in T_t} \left[\sum_{k \in K_\tau} \left(\frac{|r_\tau^k|}{K_\tau} \right) \right],$$

where K denotes the number of available currencies on day τ and T_t denotes the total number of trading days in month t.

Keeping DOL as a first factor and replacing CHML by innovations to global FX volatility (henceforth termed VOL) the pricing kernel yields the results detailed in Panels A2 and B2 of Table 3.10. The VOL factor does not fare well in terms of coefficients' significance or monotonicity patterns for portfolios 1-5. In addition, the cross-section results reveal that the VOL factor, clearly, does not price the cross section of commodity portfolio returns.

3.6.3.3. Exchange Rate Momentum. I further examine a momentum factor for the exchange rate. In line with the results of Menkhoff, Sarno, Schmeling, and Schrimpf (2012b), I form five portfolios on the basis of the currencies' lagged returns over the past month which are held for one month. The constructed factor is essentially the momentum corner portfolio i.e. portfolio 5-portfolio 1. The results for the momentum factor (FXMOM) are presented in Panels A3 and B3 of Table 3.10. Similarly to the volatility proxy, the momentum factor does not yield significant coefficients, neither does it price the cross-section of commodity portfolio returns.

3.6.3.4. The Fama-French Factors. Finally, a employ a comprehensive set of factors that relate to the equity market motivated by the findings of Chen and Tsay (2011) and Ferraro, Rogoff and Rossi (2012). In particular, I collect six different factors computed on a daily basis from Kenneth French's website and namely the market (MKT), small minus big (SMB), high minus low (EHML), equity momentum (EMOM), short-term reversal (STREV) and long-term reversal (LTREV). Table 3.11 summarizes the results of the asset pricing exercise when the Fama-French factors are employed.

The Fama-French factors in general fare a lot better than the standard exchange rate factors in explaining the cross section of commodity returns with the market factor being the best. In particular, the betas of the MKT factor decline, almost monotonically, from portfolios 1 to portfolio 5. They are statistically significant for three out of five portfolios. In addition, the R^2 of the cross-sectional regression is large and the factor risk price λ for MKT is significant using the FMB method; however, it is not significant according to the SDF approach. Again, as in the case of CHML, the price of risk appears to be negative The SMB factor is probably the least successful displaying little significance and no patterns for portfolios 1-5 and no significance and zero R^2 in the cross section. EHML also fares poorly, while EMOM, on the other hand, gives good cross section results but provides less information in the individual portfolio regressions. Last but not least, STREV and LTREV appear to contain some information about the cross section of commodity returns while providing some meaningful spreads in the individual portfolio regressions.

Hence, although I do not manage to price the test assets, the employment of the equity market factors appears to shed some light on the commodity currency strategy dynamics.

3.7. Discussion

The asset pricing results of the previous section look rather incoherent at a first glance. Although it is possible to identify few factors that appear to contain some information about the constructed commodity currency strategy, they tend to display a negative correlation with a plausible risk factor. In other words, according to the empirical evidence, exchange rate returns stemming from a simple commodity currency strategy appear to be negatively related to the equity market factor as well as to the returns from other popular exchange rate strategies such as the carry trade. How does this finding fit in the commodities literature?

Gorton and Rouwenhorst (2006) note that commodities displays high Sharpe ratios and low correlations with other asset classes. They suggest that this argument is compatible with the theory of backwardation and market segmentation. Bessembinder and Chan (1992) further maintain that variables that have predictive power over bond and stock returns and namely Treasury bill yields, equity dividend yield and the "junk" bond premium, are also able to forecast commodity returns. They attribute the negative correlation between commodities and other asset classes to a certain extent to different behaviour over the business cycle. Hence, it could be that the proposed commodity currency strategy appears to be a hedge to the equity market portfolio as well as to the carry trade because of this negative correlation of commodities and equities as well as the negative relationship between the short rate and commodity future returns respectively. This hypothesis is also in line with the findings of Büyükşahin, Haigh and Robe (2008), who report that commodities yield benefits to equity investors in the form of portfolio diversification. The authors also find that even during the more recent years that investors have sought bigger exposure to commodities, there has not been an increase in the co-movement between the returns on the two investment classes.

The issue, however, remains to identify the priced factor of the proposed commodity currency strategy. In other words, could the returns of the commodity currency strategy be understood as a compensation for risk? The empirical results of this paper are not adequate to answer this question.

3.8. Robustness

3.8.1. Exploitability of the Commodity Currency Strategy

My analysis has so far ignored the exploitability of the proposed commodity currency strategy. This is an important concern given that the rebalancing frequency is daily and the employed currency universe includes emerging market currencies which are known to display high bid-ask spreads. In order to address this issue, I calculate net spot returns for the five portfolios based on the commodity currency strategy predictions, for all the 25 currencies, by adjusting spot returns for bid-ask spreads. Following Goyal and Saretto (2009) and Menkhoff, Sarno, Schmeling, and Schrimpf (2012), I employ the 50% of the quoted bid-ask spread as the actual spread. This is still a conservative choice given that Gilmore and Hayashi (2011) report that actual transaction costs stemming from bid-ask spreads probably constitute a lot less than 50% of the quoted bid-ask spread. Tables 3.12 and 3.13 display the results of this exercise for spot and excess returns respectively.

I find that, at first glance, it does not seem possible to exploit the information arising from the commodity currency strategy. The spot returns to portfolios 1-5 are all negative and, hence, economically unappealing. In the light of these results, there does not appear to be any need to construct the corner portfolio as it will evidently be loss making. However, the inspection of Tables 3.12 and 3.13 reveals some additional information. In particular, the monotonicity of portfolio returns is slightly disrupted compared to the results of Tables 3.3 and 3.4. Furthermore, portfolio 1 appears to fare particularly badly when transaction costs are incorporated, for both the spot and excess return cases, indicating a higher participation of emerging market currencies.

Figures 3.1 and 3.2 indicate the relative participation of currencies in portfolios 1 and 5. A first observation is that both portfolios are dominated by commodity exporters suggesting consistency of the strategy mechanics. The second remark pertains to the fact that emerging market currencies (such as the South African Rand, the Brazilian Real, the Chilean Peso and the Mexican Peso), which display on average higher bid-ask spreads, constitute a non-trivial portion of these portfolios.

A natural step will therefore be to carry the analysis in the developed market space. This will act as an additional robustness exercise by showcasing whether the predictability of the commodity currency strategy is mainly driven by less liquid currencies, and most importantly, by shedding more light in the exploitability issue.

3.8.2. The Commodity Currency Strategy in Developed Markets

For this part of the analysis I restrict my currency universe to GBP, CHF, JPY, CAD, AUD, NZD, SEK, NOK, EUR, SGD, CZN, and HRK versus the USD. Again, I sort the currencies according to the forecasted returns of the commodity currency strategy and reallocate them to three portfolios this time, on a daily basis, for both the spot and excess return cases. Following the same logic as before, portfolio 1 contains the currencies with the highest sell signal and portfolio 3 contains the currencies with the highest buy signal. The average portfolio contains all the currencies and each portfolio is equally weighted. Given that the exploitability of the strategy is the key focus here, I also report spot and excess returns net of transaction costs. The results, displayed in Tables 3.14 and 3.15, paint a much brighter picture; not only is the commodity currency strategy valid for developed markets but one can also make a net excess return of 3 per cent annually by investing in the "long portfolio".

The portfolios again display monotonically increasing annualized returns when one moves from portfolio 1 to portfolio 3. The reported standard deviations are slightly higher compared to the benchmark case when all 25 currencies are employed. Although there is no clear skewness and kurtosis pattern, portfolio 3 displays almost zero skewness and a coefficient of kurtosis close to three, unlike portfolio 1, the returns of which are positively skewed but leptokurtic.

3.9. Conclusion

The present chapter proposes a novel "commodity currency strategy" for the exchange rate that employs changes in the global prices of tradable commodity indices. The risk-return profile of this strategy reveals that the predictive ability of commodity prices for the exchange rate appears to be significant, while the returns appear to be uncorrelated to popular exchange rate strategies such as the carry trade and currency momentum. This has important implications for an investor's currency portfolio allocation decisions, and the latter could benefit from taking into account commodity price movements when investing in currencies.

The relationship between commodity prices and exchange rates is also found to be relevant for a broader set of currencies besides this of commodity currencies. This indicates that there could be a bigger contribution in the literature that documents a lead-lag relationship between commodity exporters' exchange rates and price of exports.

An additional aspect of this work is the finding that the proposed commodity currency strategy appears to be uncorrelated with popular currency strategies such as the carry trade and currency momentum. As the importance of factors such as the level of interest rates and the equity market emerges from the asset pricing exercise, new dynamics become important for the relationship between exchange rates and commodities which have been, to a certain extent, overlooked by the existing literature.

Despite the emergence of potentially important variables, a priced factor for the proposed commodity currency strategy remains to be identified. The empirical results of the present work fall sort of detecting the source of risk for which the investor gets compensated by the returns of the commodity currency strategy and future work in this area is highly encouraged.

Last but not least, as the validity of the strategy has been established across different currency markets, the exploitability issue could be further researched as different portfolio combinations could amount to higher realised returns by mitigating the effect of transaction costs.

Tables

Table 3.1. Countries and Commodities

Country	**Commodity Indices**			
Australia	Gold	Wheat	Aluminium	Brent
Brazil	Agriculture	Brent		
Bulgaria	Copper	Energy	Brent	
Canada	Natural Gas	Brent		
Chile	Copper	Brent		
Croatia	Natural Gas	Brent		
Czech Republic	Brent			
Germany	Brent			
Hungary	Brent			
India	Precious Metals	Brent		
Indonesia	Natural Gas	Brent		
Israel	Brent			
Japan	Brent			
Mexico	Silver	Brent		
New Zealand	Livestock	Aluminium	Brent	
Norway	Natural Gas	Brent	Industrial Metals	
Philippines	Brent			
Poland	Brent			
Russian Federation	Natural Gas	Brent		
Singapore	Brent			
South Africa	Gold	Brent		
Sweden	Brent			
Switzerland	Industrial Metals	Brent		
Thailand	Brent			
United Kingdom	Brent			

This table presents the commodities that form a 5% (or greater) share of a country's imports or exports, according to data collected from the United Nations Commodity Trade Statistics Database, for which there exist tradable commodity index series.

Table 3.2. Currency Beta Rankings versus the USD and GBP

CURRENCY	**BETA**	**CURRENCY**	**BETA**
USD_AUD	0.184***	GBP_BRL	0.150***
USD_ZAR	0.168***	GBP_AUD	0.127***
USD_PLN	0.165***	GBP_MXN	0.127***
USD_HUF	0.161***	GBP_CAD	0.125***
USD_NZD	0.155***	GBP_ZAR	0.123***
USD_BRL	0.150***	GBP_PLN	0.101***
USD_NOK	0.146***	GBP_CLP	0.101***
USD_SEK	0.142***	GBP_NZD	0.096***
USD_CAD	0.131***	GBP_RUB	0.091***
USD_CZN	0.123***	GBP_NOK	0.085***
USD_MXN	0.104***	GBP_HUF	0.084***
USD_HRK	0.091***	GBP_SEK	0.080***
USD_GBP	0.090***	GBP_INR	0.078***
USD_BGN	0.089***	GBP_SGD	0.075***
USD_EUR	0.089***	GBP_PHP	0.073***
USD_CLP	0.081***	GBP_IDR	0.073***
USD_RUB	0.073***	GBP_ILS	0.069***
USD_CHF	0.059***	GBP_THB	0.065***
USD_SGD	0.052***	GBP_CZN	0.063***
USD_INR	0.042***	GBP_GBP	0.059***
USD_ILS	0.041***	GBP_HRK	0.043***
USD_IDR	0.033***	GBP_BGN	0.041***
USD_PHP	0.030***	GBP_EUR	0.040***
USD_THB	0.023***	GBP_CHF	0.024***
USD_JPY	-0.022*	GBP_JPY	0.016

This table presents the rankings of the currencies versus the USD (left panel) and the GBP (right panel) according to the betas from the regression of the nominal exchange rates on the GSCI index. Asterisk denotes statistical significance at the 1% (***), 5% (**) and 10% (*) level. Returns are daily and the sample period is 01/2000-11/2011.

Table 3.3. Descriptive Statistics: Commodity Strategy, Spot Returns

	Spot Returns				
(Commodities Strategy)	**RET**	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	-0.24%	9.69%	-0.31	9.56	-0.21
Portfolio 2	2.58%	8.43%	0.10	8.77	0.09
Portfolio 3	2.70%	8.53%	0.07	3.90	0.10
Portfolio 4	3.64%	8.69%	-0.08	2.99	0.21
Portfolio 5	5.79%	9.66%	-0.14	4.73	0.41
Avg Portfolio	2.89%	7.79%	-0.02	4.07	0.14
Corner Portfolio	6.03%	9.32%	0.02	3.98	0.45

The table reports mean returns, standard deviations (both annualised), skewness, and kurtosis of currency portfolios sorted daily on the predictions of the proposed commodity strategy. I also report annualized Sharpe Ratios. Portfolio 1 contains the 20% of all currencies with the lowest predicted return according to the commodity strategy while Portfolio 5 contains currencies with the highest predicted return according to the commodity strategy. All returns are spot returns in US dollar. Avg Portfolio denotes the average return of the five currency portfolios and Corner Portfolio denotes a long-short portfolio that is long in Portfolio 5 and short in Portfolio 1. Returns are daily and the sample period is 01/2003-11/2011.

Table 3.4. Descriptive Statistics: Commodity Strategy, Excess Returns

Excess Returns					
(Commodities Strategy)	**RET**	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	2.29%	9.69%	-0.30	9.56	0.05
Portfolio 2	4.28%	8.43%	0.11	8.79	0.29
Portfolio 3	4.05%	8.53%	0.08	3.90	0.26
Portfolio 4	5.09%	8.69%	-0.07	2.98	0.38
Portfolio 5	7.61%	9.66%	-0.13	4.72	0.60
Avg Portfolio	4.67%	7.79%	-0.02	4.08	0.37
Corner Portfolio	5.32%	9.32%	0.02	3.97	0.38

The table reports mean returns, standard deviations (both annualised), skewness, and kurtosis of currency portfolios sorted daily on the predictions of the proposed commodity strategy. I also report annualized Sharpe Ratios. Portfolio 1 contains the 20% of all currencies with the lowest predicted return according to the commodity strategy while Portfolio 5 contains currencies with the highest predicted return according to the commodity strategy. All returns are excess returns in US dollar. Avg Portfolio denotes the average return of the five currency portfolios and Corner Portfolio denotes a long-short portfolio that is long in Portfolio 5 and short in Portfolio 1. Returns are daily and the sample period is 01/2003-11/2011.

Table 3.5. Descriptive Statistics: Carry Trade, Spot Returns

Spot Returns					
(Carry Trade Strategy)	**RET**	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	3.69%	7.39%	0.35	3.38	0.25
Portfolio 2	4.38%	9.00%	0.12	2.77	0.29
Portfolio 3	3.59%	9.21%	0.04	6.82	0.19
Portfolio 4	0.34%	8.59%	-0.81	7.47	-0.17
Portfolio 5	2.46%	9.64%	-0.39	4.59	0.07
Avg Portfolio	2.89%	7.79%	-0.02	4.07	0.14
Corner Portfolio	-1.23%	8.49%	-0.47	4.83	-0.36

The table reports mean returns, standard deviations (both annualised), skewness, and kurtosis of currency portfolios sorted daily on time $t-1$ forward discounts. I also report annualized Sharpe Ratios. Portfolio 1 contains the 20% of all currencies with the lowest forward discounts while Portfolio 5 contains currencies with the highest forward discounts. All returns are spot returns in US dollar. Avg Portfolio denotes the average return of the five currency portfolios and Corner Portfolio denotes a long-short portfolio that is long in Portfolio 5 and short in Portfolio 1. Returns are daily and the sample period is 01/2003-11/2011.

Table 3.6. Descriptive Statistics: Carry Trade, Excess Returns

Excess Returns					
(Carry Trade Strategy)	**RET**	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	2.89%	7.39%	0.35	3.39	0.15
Portfolio 2	4.55%	9.00%	0.13	2.78	0.31
Portfolio 3	4.90%	9.21%	0.05	6.83	0.34
Portfolio 4	3.06%	8.59%	-0.80	7.47	0.15
Portfolio 5	7.94%	9.64%	-0.38	4.60	0.64
Avg Portfolio	4.67%	7.79%	-0.02	4.08	0.37
Corner Portfolio	5.04%	8.49%	-0.47	4.83	0.38

The table reports mean returns, standard deviations (both annualised), skewness, and kurtosis of currency portfolios sorted daily on time $t-1$ forward discounts. I also report annualized Sharpe Ratios. Portfolio 1 contains the 20% of all currencies with the lowest forward discounts while Portfolio 5 contains currencies with the highest forward discounts. All returns are excess returns in US dollar. Avg Portfolio denotes the average return of the five currency portfolios and Corner Portfolio denotes a long-short portfolio that is long in Portfolio 5 and short in Portfolio 1. Returns are daily and the sample period is 01/2003-11/2011.

Table 3.7. Correlation of Commodity Strategy and Carry Trade Returns

Commodity Str./Carry Trade	**1**	**2**	**3**	**4**	**5**	**Avg**	**Corner**
1	0.64						
2		0.79					
3			0.85				
4				0.77			
5					0.73		
Avg						1	
Corner							-0.08

This table displays correlation coefficients between portfolio returns. In particular it shows correlation coefficients between spot returns (or excess returns as the results remain the same at the second decimal digit) based on the proposed commodity strategy and forward discount-sorted portfolio returns. The returns are based on five portfolios and a long-short portfolio for both the commodity strategy and the carry trade. I only report correlations for corresponding portfolio pairs.

Table 3.8. Commodity Strategy and Carry Trade: Double Sorts

	Carry Trade and Commodities		
	Commodity Low	**Commodity High**	**D_Commodity**
FD Low	1.84%	6.26%	4.42%
FD High	6.01%	5.09%	-0.92%
D_FD	4.17%	-1.17%	-5.34%

This table shows annualized mean spot returns for double-sorted portfolios. All currencies are first sorted on lagged forward discounts into two portfolios along the median. Then, currencies within each of the two groups are allocated into two commodity portfolios depending on their predictions of the proposed commodity strategy. Therefore, row FD Low stands for the 50% of all currencies with the lowest lagged forward discount whereas FD High stands for the 50% of all currencies with the highest lagged forward discounts. Columns Commodity Low, and Commodity High stand for the 50% of all currencies with the lowest, and the highest predictions of the commodity strategy, respectively. Column D_Commodity denotes the return difference between high and low commodity portfolios (Commodity Low, Commodity High) for each subgroup of currencies while row D_FD shows the return difference between the forward discount-sorted portfolios for each commodity subgroup. The lower-right cell gives the return difference between the commodity high minus low portfolios of each forward discount category. Returns are daily and the sample period is 01/2003-11/2011.

Table 3.9. Principal Components

Panel I: Spot Returns					
	1	2	3	4	5
Portfolio 1	0.43	-0.53	0.59	-0.43	0.03
Portfolio 2	0.45	-0.44	-0.22	0.72	0.21
Portfolio 3	0.47	-0.03	-0.56	-0.31	-0.60
Portfolio 4	0.46	0.41	-0.22	-0.30	0.70
Portfolio 5	0.42	0.60	0.49	0.35	-0.33
% Var.	75%	12%	5%	4%	3%
Panel II: Excess Returns					
	1	2	3	4	5
Portfolio 1	0.43	-0.53	0.59	-0.43	0.03
Portfolio 2	0.45	-0.44	-0.22	0.72	0.20
Portfolio 3	0.47	-0.03	-0.56	-0.32	-0.60
Portfolio 4	0.46	0.41	-0.22	-0.30	0.70
Portfolio 5	0.42	0.60	0.49	0.34	-0.33
% Var.	75%	12%	5%	4%	3%

This table reports the principal component coefficients of the commodity portfolios 1-5. The last row displays the share of the total variance (%) explained by each common factor. Returns are daily and the sample period is 01/2003-11/2011.

Table 3.10. Asset Pricing Exercise: Currency Factors

	Panel A1 (Spot Returns)				Panel B1 (Excess Returns)			
	Factor Prices and Loadings							
GMM	**DOL**	**CHML**	**R2**	**HJ**	**DOL**	**CHML**	**R2**	**HJ**
b	12.085	-23.374	0.28	0.040	12.439	-15.132	0.15	0.043
s.e	7.134	18.182		0.210	7.134	18.197		0.240
lambda	0.000	-0.001			0.000	0.000		
s.e	0.000	0.001			0.000	0.011		
FMB								
lambda	0.000	-0.001	0.28		0.000	0.000	0.15	
HAC NW	0.000	0.000			0.000	0.000		
	Factor Betas							
PF	**a**	**DOL**	**CHML**	**R2**	**a**	**DOL**	**CHML**	**R2**
1	0.000	1.014	0.111	0.72	0.000	1.014	0.111	0.72
HAC NW	0.000	0.027	0.020		0.000	0.027	0.020	
2	0.000	0.932	0.019	0.75	0.000	0.932	0.019	0.75
HAC NW	0.000	0.025	0.017		0.000	0.025	0.017	
3	0.000	1.019	-0.073	0.83	0.000	1.020	-0.073	0.83
HAC NW	0.000	0.018	0.017		0.000	0.018	0.017	
4	0.000	1.009	-0.073	0.78	0.000	1.009	-0.074	0.78
HAC NW	0.000	0.024	0.014		0.000	0.024	0.014	
5	0.000	1.026	0.016	0.69	0.000	1.026	0.016	0.69
HAC NW	0.000	0.030	0.027		0.000	0.030	0.027	

This table reports the results from the GMM and Fama-McBeth asset pricing procedures b denotes the vector of factor loadings and *lambda* is the market prices of risk. $HAC\ Newey-West$ standard errors are reported. I also report the R^2s, and the Hansen-Jagannathan distance measure, $HJ-Dist$, with its p-value. Spot and Excess returns used as test assets (Panels A and B respectively). I do not include a constant in the second step of the FMB procedure. OLS estimates of the factor betas, R^2s and $HAC\ Newey-West$ standard errors are also reported for the Fama-McBeth time series regressions. DOL stands for the average currency return, CHML stands for the corner portfolio of the carry trade strategy, VOL is the measure of global currency volatility a la Menkhoff, Sarno, Schmeling, and Schrimpf (2012a), and FXMOM denotes the momentum factor. Returns are daily in panels A1 and B1, and monthly in panels A2, B2, A3, and B3. The sample period is 01/2003-11/2011.

Table 3.10. Asset Pricing Exercise: Currency Factors (cont.)

	Panel A2 (Spot Returns)				Panel B2 (Excess Returns)			
	Factor Prices and Loadings							
GMM	**DOL**	**VOL**	**R2**	**HJ**	**DOL**	**VOL**	**R2**	**HJ**
b	9.078	169.626	0	0.200	14.174	267.367	0	0.190
s.e	10.384	296.888		0.180	10.604	310.988		0.280
lambda	0.002	0.000			0.004	0.001		
s.e	0.003	0.001			0.007	0.002		
FMB			0					
lambda	0.002	0.000			0.004	0.001	0	
HAC NW	0.001	0.001			0.001	0.001		

	Factor Betas							
PF	**a**	**DOL**	**VOL**	**R2**	**a**	**DOL**	**VOL**	**R2**
1	-0.004	1.124	0.141	0.75	-0.003	1.122	0.105	0.75
HAC NW	0.004	0.078	0.837		0.004	0.077	0.822	
2	0.000	0.913	0.071	0.82	0.000	0.913	0.087	0.82
HAC NW	0.004	0.031	0.842		0.004	0.031	0.838	
3	-0.001	1.003	0.139	0.86	-0.001	1.003	0.152	0.86
HAC NW	0.003	0.046	0.553		0.003	0.045	0.546	
4	0.006	0.989	-1.134	0.83	0.006	0.990	-1.096	0.83
HAC NW	0.003	0.051	0.534		0.003	0.050	0.526	
5	-0.001	0.971	0.784	0.69	-0.001	0.973	0.753	0.69
HAC NW	0.005	0.072	1.045		0.005	0.072	1.035	

	Panel A3 (Spot Returns)				Panel B3 (Excess Returns)			
	Factor Prices and Loadings							
GMM	**DOL**	**FXMOM**	**R2**	**HJ**	**DOL**	**FXMOM**	**R2**	**HJ**
b	1.273	-14.359	0	0.170	4.632	-6.859	0	0.170
s.e.	6.533	11.839		0.380	5.594	9.225		0.310
lambda	0.002	-0.015			0.004	-0.009		
s.e.	0.002	0.014			0.007	0.012		
FMB			0					
lambda	0.002	-0.015			0.004	-0.009	0	
HAC NW	0.001	0.012			0.001	0.006		

	Factor Betas							
PF	**a**	**DOL**	**FXMOM**	**R2**	**a**	**DOL**	**FXMOM**	**R2**
1	-0.003	1.123	0.018	0.75	-0.002	1.123	0.015	0.75
HAC NW	0.001	0.061	0.043		0.001	0.059	0.038	
2	0.000	0.901	-0.058	0.83	0.000	0.891	-0.082	0.83
HAC NW	0.001	0.036	0.032		0.001	0.030	0.023	
3	0.000	1.006	0.042	0.86	-0.001	1.007	0.038	0.86
HAC NW	0.001	0.035	0.022		0.001	0.036	0.023	
4	0.000	1.034	0.052	0.83	0.000	1.032	0.040	0.82
HAC NW	0.001	0.048	0.040		0.001	0.050	0.044	
5	0.003	0.937	-0.053	0.69	0.003	0.948	-0.012	0.69
HAC NW	0.002	0.069	0.055		0.002	0.068	0.038	

Table 3.11. Asset Pricing Exercise: Fama-French Factors

	Panel A1 (Spot Returns)				Panel B1 (Excess Returns)			
	Factor Prices and Loadings							
GMM	**DOL**	**MKT**	**R2**	**HJ**	**DOL**	**MKT**	**R2**	**HJ**
b	23.293	-0.210	0.74	0.036	23.236	-0.176	0.66	0.035
s.e	12.868	0.139		0.470	12.574	0.135		0.480
lambda	0.000	-0.326			0.000	-0.266		
s.e	0.000	0.270			0.000	0.242		
FMB								
lambda	0.000	-0.326	0.73		0.000	-0.265	0.66	
HAC NW	0.000	0.094			0.000	0.079		
Factor Betas								
PF	**a**	**DOL**	**MKT**	**R2**	**a**	**DOL**	**MKT**	**R2**
1	0.000	1.023	0.000	0.71	0.000	1.022	0.000	0.71
HAC NW	0.000	0.029	0.000		0.000	0.029	0.000	
2	0.000	0.931	0.000	0.75	0.000	0.931	0.000	0.75
HAC NW	0.000	0.026	0.000		0.000	0.026	0.000	
3	0.000	0.993	0.000	0.83	0.000	0.993	0.000	0.83
HAC NW	0.000	0.021	0.000		0.000	0.020	0.000	
4	0.000	1.009	0.000	0.78	0.000	1.008	0.000	0.78
HAC NW	0.000	0.026	0.000		0.000	0.026	0.000	
5	0.000	1.045	0.000	0.69	0.000	1.046	0.000	0.69
HAC NW	0.000	0.031	0.000		0.000	0.031	0.000	

This table reports the results from the GMM and Fama-McBeth asset pricing procedures b denotes the vector of factor loadings and *lambda* is the market prices of risk. $HAC\ Newey-West$ standard errors are reported. I also report the R^2s, and the Hansen-Jagannathan distance measure, $HJ-Dist$, with its p-value. Spot and Excess returns used as test assets (Panels A and B respectively). I do not include a constant in the second step of the FMB procedure. OLS estimates of the factor betas, R^2s and $HAC\ Newey-West$ standard errors are also reported for the Fama-McBeth time series regressions. DOL stands for the average currency return, MKT stands for the market factor, SMB stands for the small minus big factor, EHML denotes the high minus low equity factor, EMOM stands for the equity momentum factor, STREV stands for the short-term reversal factor, and LTREV stands for the long-term reversal factor. Returns are daily and the sample period is 01/2003-11/2011.

Table 3.11. Asset Pricing Exercise: Fama-French Factors (cont.)

	Panel A2 (Spot Returns)				Panel B2 (Excess Returns)			
	Factor Prices and Loadings							
GMM	**DOL**	**SMB**	**R2**	**HJ**	**DOL**	**SMB**	**R2**	**HJ**
b	4.243	0.163	0	0.041	7.349	0.108	0	0.038
s.e	4.623	0.509		0.320	4.642	0.512		0.380
lambda	0.000	0.055			0.000	0.037		
s.e	0.000	0.185			0.000	0.206		
FMB								
lambda	0.000	0.056	0		0.000	0.037	0	
HAC NW	0.000	0.168			0.000	0.137		
	Factor Betas							
PF	**a**	**DOL**	**SMB**	**R2**	**a**	**DOL**	**SMB**	**R2**
1	0.000	1.049	0.000	0.71	0.000	1.049	0.000	0.71
HAC NW	0.000	0.031	0.000		0.000	0.031	0.000	
2	0.000	0.937	0.000	0.75	0.000	0.937	0.000	0.75
HAC NW	0.000	0.025	0.000		0.000	0.025	0.000	
3	0.000	0.997	0.000	0.83	0.000	0.997	0.000	0.83
HAC NW	0.000	0.021	0.000		0.000	0.021	0.000	
4	0.000	0.986	0.000	0.78	0.000	0.986	0.000	0.78
HAC NW	0.000	0.025	0.000		0.000	0.025	0.000	
5	0.000	1.031	0.000	0.69	0.000	1.032	0.000	0.69
HAC NW	0.000	0.031	0.000		0.000	0.031	0.000	

	Panel A3 (Spot Returns)				Panel B3 (Excess Returns)			
	Factor Prices and Loadings							
GMM	**DOL**	**EHML**	**R2**	**HJ**	**DOL**	**EHML**	**R2**	**HJ**
b	-12.971	0.869	0.1	0.049	-5.570	0.651	0.07	0.045
s.e	23.682	1.131		0.360	21.572	1.029		0.370
lambda	0.000	0.286			0.000	0.216		
s.e	0.000	0.371			0.000	0.338		
FMB								
lambda	0.000	0.288	0.1		0.000	0.217	0.07	
HAC NW	0.000	0.278			0.000	0.276		
	Factor Betas							
PF	**a**	**DOL**	**EHML**	**R2**	**a**	**DOL**	**EHML**	**R2**
1	0.000	1.050	0.000	0.71	0.000	1.050	0.000	0.71
HAC NW	0.000	0.033	0.000		0.000	0.033	0.000	
2	0.000	0.940	0.000	0.75	0.000	0.940	0.000	0.75
HAC NW	0.000	0.025	0.000		0.000	0.025	0.000	
3	0.000	0.994	0.000	0.83	0.000	0.994	0.000	0.83
HAC NW	0.000	0.021	0.000		0.000	0.021	0.000	
4	0.000	0.987	0.000	0.78	0.000	0.987	0.000	0.78
HAC NW	0.000	0.026	0.000		0.000	0.026	0.000	
5	0.000	1.029	0.000	0.69	0.000	1.030	0.000	0.69
HAC NW	0.000	0.030	0.000		0.000	0.031	0.000	

Table 3.11. Asset Pricing Exercise: Fama-French Factors (cont.)

	Panel A4 (Spot Returns)				Panel B4 (Excess Returns)			
	Factor Prices and Loadings							
GMM	**DOL**	**EMOM**	**R2**	**HJ**	**DOL**	**EMOM**	**R2**	**HJ**
b	18.291	0.616	0.45	0.046	18.291	0.616	0.45	0.046
s.e	15.757	0.674		0.500	15.757	0.674		0.500
lambda	0.000	0.606			0.000	0.606		
s.e	0.000	0.713			0.000	0.713		
FMB								
lambda	0.000	0.628	0.448		0.000	0.628	0.4482	
HAC NW	0.000	0.291			0.000	0.291		
	Factor Betas							
PF	**a**	**DOL**	**EMOM**	**R2**	**a**	**DOL**	**EMOM**	**R2**
1	0.000	1.048	0.000	0.71	0.000	1.048	0.000	0.71
HAC NW	0.000	0.031	0.000		0.000	0.031	0.000	
2	0.000	0.937	0.000	0.75	0.000	0.937	0.000	0.75
HAC NW	0.000	0.024	0.000		0.000	0.024	0.000	
3	0.000	0.995	0.000	0.83	0.000	0.995	0.000	0.83
HAC NW	0.000	0.021	0.000		0.000	0.021	0.000	
4	0.000	0.988	0.000	0.78	0.000	0.988	0.000	0.78
HAC NW	0.000	0.025	0.000		0.000	0.025	0.000	
5	0.000	1.033	0.000	0.69	0.000	1.033	0.000	0.69
HAC NW	0.000	0.029	0.000		0.000	0.029	0.000	

	Panel A5 (Spot Returns)				Panel B5 (Excess Returns)			
	Factor Prices and Loadings							
GMM	**DOL**	**STREV**	**R2**	**HJ**	**DOL**	**STREV**	**R2**	**HJ**
b	15.290	-0.356	0.55	0.043	16.055	-0.265	0.44	0.041
s.e	10.315	0.305		0.380	9.666	0.265		0.370
lambda	0.000	-0.303			0.000	-0.253		
s.e	0.000	0.537			0.000	0.681		
FMB								
lambda	0.000	-0.302	0.55		0.000	-0.237	0.44	
HAC NW	0.000	0.121			0.000	0.102		
	Factor Betas							
PF	**a**	**DOL**	**STREV**	**R2**	**a**	**DOL**	**STREV**	**R2**
1	0.000	1.041	0.000	0.71	0.000	1.040	0.000	0.71
HAC NW	0.000	0.029	0.000		0.000	0.029	0.000	
2	0.000	0.935	0.000	0.75	0.000	0.935	0.000	0.75
HAC NW	0.000	0.024	0.000		0.000	0.024	0.000	
3	0.000	0.998	0.000	0.83	0.000	0.998	0.000	0.83
HAC NW	0.000	0.020	0.000		0.000	0.020	0.000	
4	0.000	0.994	0.000	0.78	0.000	0.994	0.000	0.78
HAC NW	0.000	0.023	0.000		0.000	0.023	0.000	
5	0.000	1.033	0.000	0.69	0.000	1.034	0.000	0.69
HAC NW	0.000	0.030	0.000		0.000	0.031	0.000	

Table 3.11. Asset Pricing Exercise: Fama-French Factors (cont.)

	Panel A6 (Spot Returns)				Panel B6 (Excess Returns)			
	Factor Prices and Loadings							
GMM	**DOL**	**LTREV**	**R2**	**HJ**	**DOL**	**LTREV**	**R2**	**HJ**
b	9.374	0.784	0.64	0.040	11.454	0.639	0.55	0.040
s.e	5.942	0.673		0.460	5.741	0.623		0.430
lambda	0.000	0.232			0.000	0.188		
s.e	0.000	0.195			0.000	0.184		
FMB								
lambda	0.000	0.232	0.645		0.000	0.188	0.55	
HAC NW	0.000	0.073			0.000	0.068		
	Factor Betas							
PF	**a**	**DOL**	**LTREV**	**R2**	**a**	**DOL**	**LTREV**	**R2**
1	0.000	1.047	0.000	0.71	0.000	1.046	0.000	0.71
HAC NW	0.000	0.030	0.000		0.000	0.030	0.000	
2	0.000	0.936	0.000	0.75	0.000	0.936	0.000	0.75
HAC NW	0.000	0.024	0.000		0.000	0.024	0.000	
3	0.000	0.997	0.000	0.83	0.000	0.997	0.000	0.83
HAC NW	0.000	0.021	0.000		0.000	0.021	0.000	
4	0.000	0.988	0.000	0.78	0.000	0.987	0.000	0.78
HAC NW	0.000	0.024	0.000		0.000	0.024	0.000	
5	0.000	1.032	0.000	0.69	0.000	1.033	0.000	0.69
HAC NW	0.000	0.030	0.000		0.000	0.030	0.000	

Table 3.12. Descriptive Statistics: Commodity Strategy, Net Spot Returns

Commodities Strategy: Net Spot Returns					
	RET	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	-9.86%	9.96%	-0.23	8.38	-1.17
Portfolio 2	-3.98%	8.78%	0.06	7.67	-0.66
Portfolio 3	-2.86%	8.80%	0.07	3.40	-0.53
Portfolio 4	-3.03%	9.08%	-0.11	2.51	-0.53
Portfolio 5	-2.18%	9.98%	-0.12	4.26	-0.40
Avg Portfolio	-4.38%	8.14%	0.00	3.42	-0.76

The table reports mean returns, standard deviations (both annualised), skewness, and kurtosis of currency portfolios sorted daily on the predictions of the proposed commodity strategy, this time incorporating transaction costs which amount to the 50% of the quoted bid-ask spread. I also report annualized Sharpe Ratios. Portfolio 1 contains the 20% of all currencies with the lowest predicted return according to the commodity strategy while Portfolio 5 contains currencies with the highest predicted return according to the commodity strategy. All returns are spot returns in US dollar. Avg Portfolio denotes the average return of the five currency portfolios. Returns are daily and the sample period is 01/2003-11/2011.

Table 3.13. Descriptive Statistics: Commodity Strategy, Net Excess Returns

Commodities Strategy: Net Excess Returns					
	RET	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	-7.83%	9.81%	-0.23	9.05	-0.98
Portfolio 2	-2.60%	8.61%	0.08	8.25	-0.51
Portfolio 3	-1.73%	8.67%	0.1	3.50	-0.41
Portfolio 4	-1.82%	8.92%	-0.09	2.66	-0.41
Portfolio 5	-0.77%	9.85%	-0.14	4.46	-0.26
Avg Portfolio	-2.95%	7.96%	0.03	3.62	-0.60

The table reports mean returns, standard deviations (both annualised), skewness, and kurtosis of currency portfolios sorted daily on the predictions of the proposed commodity strategy, this time incorporating transaction costs which amount to the 50% of the quoted bid-ask spread. I also report annualized Sharpe Ratios. Portfolio 1 contains the 20% of all currencies with the lowest predicted return according to the commodity strategy while Portfolio 5 contains currencies with the highest predicted return according to the commodity strategy. All returns are excess returns in US dollar. Avg Portfolio denotes the average return of the five currency portfolios. Returns are daily and the sample period is 01/2003-11/2011.

Table 3.14. Descriptive Statistics: Commodity Strategy, Spot and Net Spot Returns: Developed Markets

Commodities Strategy: Spot Returns					
	RET	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	0.51%	10.11%	0.19	6.69	-0.13
Portfolio 2	4.11%	9.85%	0.17	3.03	0.23
Portfolio 3	7.20%	10.08%	-0.01	3.43	0.53
Avg Portfolio	3.94%	9.23%	0.27	3.73	0.23
Commodities Strategy: Net Spot Returns					
	RET	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	-3.64%	10.10%	0.19	6.68	-0.54
Portfolio 2	0.57%	9.85%	0.17	3.03	-0.13
Portfolio 3	2.47%	10.09%	-0.02	3.46	0.07
Avg Portfolio	-0.20%	9.23%	0.26	3.73	-0.22

The table reports mean returns, standard deviations (both annualised), skewness, and kurtosis of currency portfolios sorted daily on the predictions of the proposed commodity strategy, this time also incorporating transaction costs (Net Spot Returns panel) which amount to the 50% of the quoted bid-ask spread. I also report annualized Sharpe Ratios. Portfolio 1 contains one third of all currencies with the lowest predicted return according to the commodity strategy while Portfolio 3 contains currencies with the highest predicted return according to the commodity strategy. All returns are spot returns in US dollar. Avg Portfolio denotes the average return of the three currency portfolios. Returns are daily and the sample period is 01/2003-11/2011.

Table 3.15. Descriptive Statistics: Commodity Strategy, Excess and Net Excess Returns: Developed Markets

Commodities Strategy: Excess Returns					
	RET	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	0.87%	10.05%	0.2	6.73	-0.09
Portfolio 2	4.79%	9.75%	0.19	3.28	0.31
Portfolio 3	7.45%	10.01%	-0.01	3.55	0.56
Avg Portfolio	4.37%	9.14%	0.28	3.92	0.28
Commodities Strategy: Net Excess Returns					
	RET	**STDEV**	**SKEW**	**KURT**	**Sharpe Ratio**
Portfolio 1	-3.35%	10.09%	0.19	6.72	-0.51
Portfolio 2	0.85%	9.76%	0.2	3.17	-0.1
Portfolio 3	2.88%	10.04%	-0.01	3.51	0.11
Avg Portfolio	0.13%	9.18%	0.28	3.83	-0.18

The table reports mean returns, standard deviations (both annualised), skewness, and kurtosis of currency portfolios sorted daily on the predictions of the proposed commodity strategy, this time also incorporating transaction costs (Net Excess Returns panel) which amount to the 50% of the quoted bid-ask spread. I also report annualized Sharpe Ratios. Portfolio 1 contains one third of all currencies with the lowest predicted return according to the commodity strategy while Portfolio 3 contains currencies with the highest predicted return according to the commodity strategy. All returns are excess returns in US dollar. Avg Portfolio denotes the average return of the three currency portfolios. Returns are daily and the sample period is 01/2003-11/2011.

Figures

This figure displays the relative participation of currencies in the "short portfolio" i.e. Portfolio 1, which in theory contains the currencies which are expected to depreciate the most at each point in time according to the commodity currency strategy. The portfolio composition is not indicative about the depreciation of the currencies over the sample period 01/2003-11/2011 as a whole. It rather suggests that the currencies that stand out are predicted to depreciate more with the price fall of their most important commodity exports (or with the price rise of their most important commodity imports).

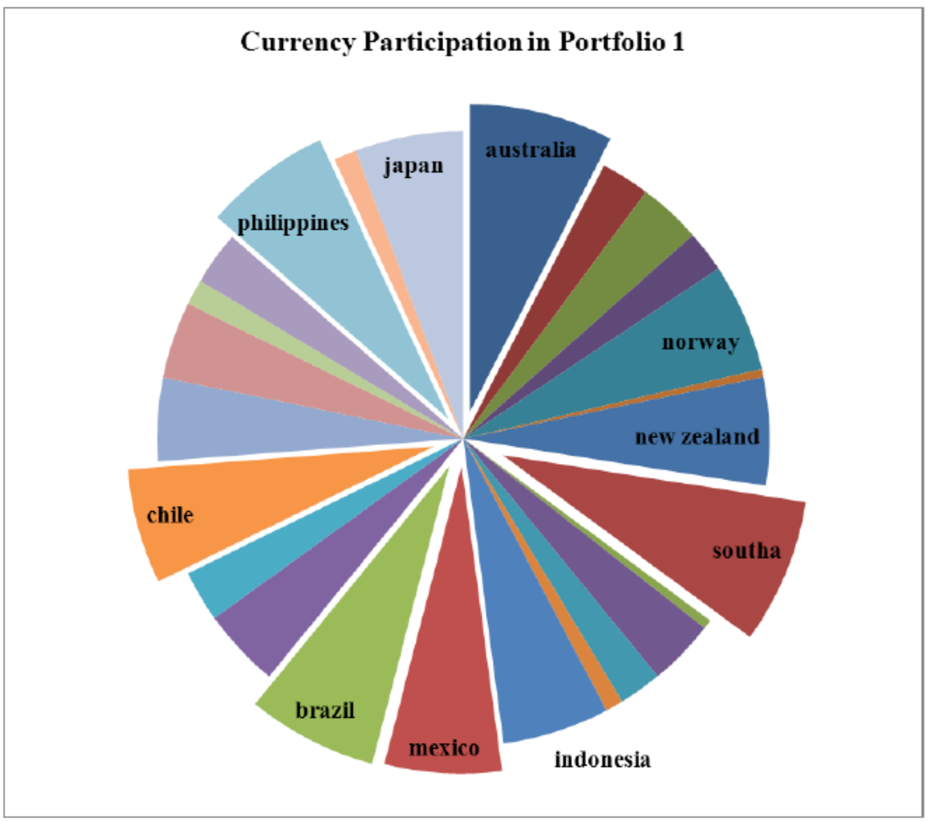

Figure 3.1. Currency Participation in Portfolio 1.

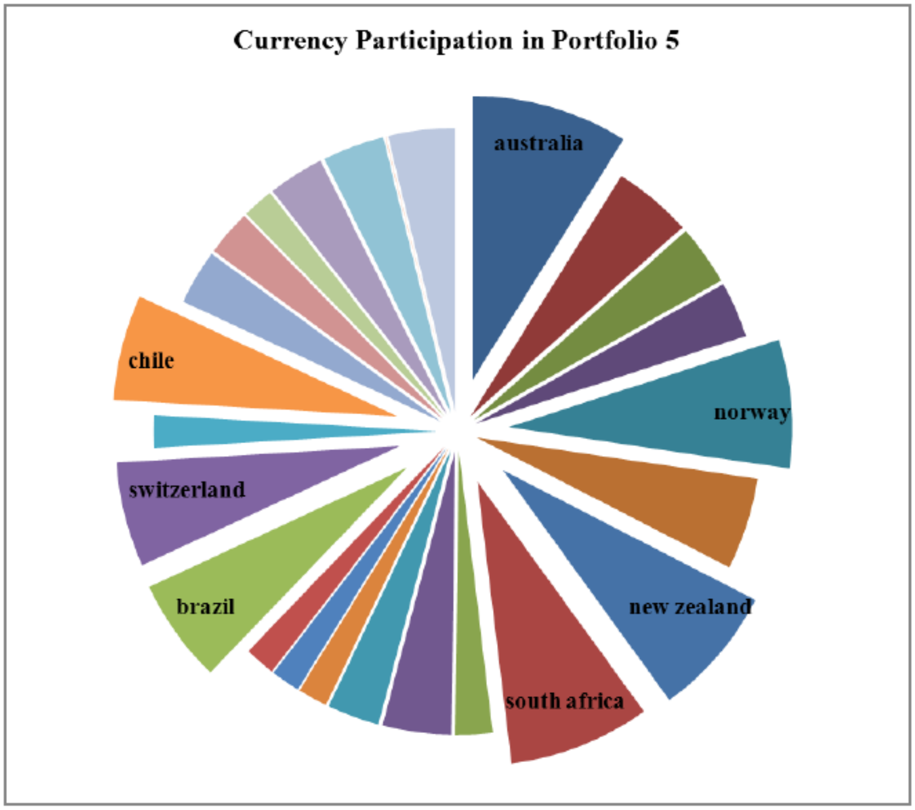

Figure 3.2. Currency Participation in Portfolio 5.

This figure displays the relative participation of currencies in the "long portfolio" i.e. Portfolio 5, which in theory contains the currencies which are expected to appreciate the most at each point in time according to the commodity currency strategy. The portfolio composition is not indicative about the appreciation of the currencies over the sample period 01/2003-11/2011 as a whole. It rather suggests that the currencies that stand out are predicted to appreciate more with the price rise of their most important commodity exports (or with the price fall of their most important commodity imports).

CHAPTER 4

Concluding remarks

Exchange rate forecasting has been a non-trivial endeavour throughout the literature as it has been difficult to empirically establish a link between fundamentals and exchange rate movements. Recent work in this field has employed Taylor rules to model exchange rate determination reporting promising results, as well as evidence of short term predictability. Furthermore, numerous studies have examined the profitability of chartist techniques suggesting the existence of significant profits in the foreign exchange market.

In the present chapter, having assessed the forecasting ability of a comprehensive set of models for exchange rate determination, including a standard menu of fundamentals, a rich Taylor Rule specification and a simple technical trading strategy along with a model motivated by the literature on forecast combinations, I document three results. First, the Taylor rule model emerges as the best model, economically and statistically, at the 1-month horizon, displaying good performance across different countries. To my knowledge, this is the first time that the performance of this model has been assessed across different horizons, with a further emphasis put on the economic value of its predictions. The fact that the Taylor rule model appears to provide reliable short-term forecasts is an encouraging result that appears to be robust both in the developed markets and the emerging markets under examination.

A second finding of this study, is that the technical rule displays superior predictive power over the random walk benchmark across horizons. The contribution of this result lies on the estimation frequency and the simplicity of the model employed. Although the literature on the profitability of technical analysis suggests the existence of profits, the majority of these studies target the implementation of these techniques at high frequency, or employs more sophisticated models. However, my evidence suggests that there does not appear to be a horizon pattern in the performance of technical analysis. The finding that traditional MA rules do not appear to be very profitable in the 1990s is in line with the documented result that profits from technical analysis are declining over time (Dooley and Shafer, 1983 and Sweeney, 1986 among others).

A final contribution is that there appear to be statistical gains from a simple forecast combination of the individual models at the 1-month horizon. As this result is robust across different countries, further research should be carried out in the direction of identifying a more powerful forecast combination strategy, which will allow for time varying weights according to underlying market conditions and the level of fundamental variables. In this line of reasoning, understanding the mechanism of interaction of different types of market participants also remains a big challenge in this research agenda.

The second chapter surveys the empirical evidence on the properties of deviations from the LOP and PPP for tradable goods. While it is fair to say that a universal consensus may not exist yet, the emerging consensus at the present time is converging towards the view that deviations from the LOP are transitory and therefore the LOP holds in the long-run among a broad range of tradable goods and currencies.

In our view, a promising strand of research which goes some way towards understanding the behaviour of LOP deviations is the literature that has investigated the role of nonlinearities in the adjustment towards the long-run equilibrium implied by the LOP (e.g. Obstfeld and Taylor, 1997; Sarno, Taylor and Chowdhury, 2004; Blavy and Juvenal, 2009). For example, Sarno, Taylor and Chowdhury (2004) provide evidence of nonlinear reversion towards the LOP in a number of major sectoral exchange rates during the post Bretton Woods period. However, they also provide evidence of price stickiness and heterogeneity across goods and currencies, as one would expect.

While it would be overly simplistic to believe that all that drives exchange rates is goods prices, the empirical evidence surveyed here suggests that the LOP is at least a good first approximation to the link between exchange rates and goods prices across countries. Put another way, if price differentials of individual goods do not converge to the same number over time (once expressed in the same currency), the drift must be small enough to be statistically and economically insignificant. We also examine some direct measures of absolute PPP using data from the OECD and illustrate that such direct measures lend clear support to PPP as a valid international parity condition.

The third chapter proposes a novel "commodity currency strategy" for the exchange rate that employs changes in the global prices of tradable commodity indices. The risk-return profile of this strategy reveals that the predictive ability of commodity prices for the exchange rate appears to be significant, while the returns appear to be uncorrelated to popular exchange rate strategies such as the carry trade and currency momentum. This has important implications for an investor's currency portfolio allocation decisions, and the latter could benefit from taking into account commodity price movements when investing in currencies.

The relationship between commodity prices and exchange rates is also found to be relevant for a broader set of currencies besides this of commodity currencies. This indicates that there could be a bigger contribution in the literature that documents a lead-lag relationship between commodity exporters' exchange rates and price of exports. An additional aspect of this work is the finding that the proposed commodity currency strategy appears to be uncorrelated with popular currency strategies such as the carry trade and currency momentum.

As the importance of factors such as the level of interest rates and the equity market emerges from the asset pricing exercise, new dynamics become important for the relationship between exchange rates and commodities which have been, to a certain extent, overlooked by the existing literature.

Despite the emergence of potentially important variables, a priced factor for the proposed commodity currency strategy remains to be identified. The empirical results of the present work fall sort of detecting the source of risk for which the investor gets compensated by the returns of the commodity currency strategy and future work in this area is highly encouraged.

Last but not least, as the validity of the strategy has been established across different currency markets, the exploitability issue could be further researched as different portfolio combinations could amount to higher realised returns by mitigating the effect of transaction costs.

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