Behavioural Asymmetries in the G7 Foreign Exchange Market

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Abstract

This paper examines the exchange rate disconnect puzzle of Obstfeld and Rogoff, (2000) from a behavioural perspective. It provides evidence on the existence of substantial asymmetries in the underlying loss preferences for the difference between the spot and forward nominal exchange rates between the G7 countries for one-week and four-week forecast horizons. We further perform forecast breakdown tests in forward markets during the Greek and the Portuguese sovereign debt crisis, and then re-estimate the loss preferences showing a mean-reverting transition from optimism to pessimism and vice versa. Finally, we attribute the evolution of preferences to economic fundamentals and risk indexes and find that together with significant endogenous dynamics, variables such as growth and deficit differentials, interest rate and legal risk assert some significant impact on asymmetry. This new set of information suggests that the puzzle could have its roots on an underlying asymmetric loss function that reflects variability in preferences over exchange rate movements due to a variety of episodes in economic fundamentals.

Keywords: Spot-forward exchange rates, Asymmetric preferences, Forecast breakdown, GMM estimation.

JEL Classifications: F31; F47; C53.

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1. Introduction

In their seminal paper Meese and Rogoff (1983) argue that *'exchange rate macroeconomic models, forecast exchange rates in the short- and medium-term no better than a random walk'*, whereas this puzzle was named as the *exchange rate disconnect puzzle* in (Obstfeld and Rogoff, 2000).

A simple model for testing the above puzzle is given as:

$$s_{t+1} - s_t = \alpha + \beta(f_t - s_t) + \varepsilon_{t+1} \quad (1)$$

where s_t, and f_t stands for the spot and one-period forward rate at time t respectively. The above equation is essentially an error-correction mechanism, which under the null hypothesis of forward rate forecast unbiasedness, should exhibit $\beta = 1$ and $\alpha = 0$. Empirical tests of the above equation failed to produce a silver bullet, see Clarida and Taylor (1997), and Clarida et al. (2001). Departing from this hypothesis would imply failure of rational expectations and market efficiency. Mark (1995) and Mark and Sul (2001), focus on the econometric issues and the underlying time series properties of the spot and forward exchange rate and show that the puzzle holds. However, Berkowitz and Giorgianni (2001) and Faust et al. (2003) provide evidence that tends to accept market efficiency and thus reject the puzzle. In a recent study, Lothian and Wu (2011) construct ultra-long time series that span two centuries of exchange rates to test the uncovered interest parity and document the presence of substantial biases in the formation of expectations.

The present paper fills a gap in the literature by offering an alternative path of investigation, employing a recent testing and estimation procedures proposed by Elliott et al (2005) and Giacomini and Rossi (2009). We view the forward exchange rate as a pure market forecast of the future spot rate and ask the following question: are asymmetries over the underlying loss function of the spot-forward forecast error responsible for the observed biases in equation (1)? The presence of such asymmetries could provide an alternative explanation of the disconnect puzzle, implying the presence of preference-based rational bias in the formation of expectations. Furthermore, we depart from the literature that attempts to identify the main determinants of the exchange rate and provide an analysis of the correlation between the preference asymmetry parameter estimate and a number of fundamental economic variables, thus identifying the main variables that affect the formation of preferences and thus expectations in the market as mirrored in the loss function.

Our findings suggest the presence of significant loss preference asymmetries in forward foreign exchange markets especially for longer horizons, which are shown to evolve over time in conjunction with detected forecast breakdowns, often in response to changes in economic fundamentals and risk indices. These results provide a new perspective to explain the exchange rate disconnect puzzle whilst offer a new information set for market participants in forward markets and policy makers alike. In some detail, to the extent that underlying preferences of forward markets are revealed and become common knowledge all participants could take advantage of this information and readjust their preferences if needed. The main reason of readjusting their preferences is that if all share the same symmetric or, indeed, asymmetric loss function this would contribute towards rationality in their behaviour. On the other hand, the absence of a common loss function could help explain why '*exchange rate disconnect puzzle'* prevails. It might be simply the case that not all participants in forward markets share the same loss function.

In section 2 we present a brief literature review, in section 3 we outline our methodological estimation and testing framework and in section 4 we present our data set and empirical results on forecast breakdown and preference parameter estimation. In section 5 we outline our analysis and results for the attribution of estimated preference parameters to economic fundamentals, and in section 6 we conclude.

2. Literature review

There is no consensus in the literature on the factors affecting exchange rates. The debate focused at the beginning on the role of macroeconomic fundamentals in short- and long-run forecasting versus random walk and later on the presence of non-linearities. In the first debate, three principal views have emerged in the literature: First, for macroeconomic versus random walk forecasts for short-time horizons and for countries without high inflation, macroeconomic fundamentals do not seem to perform better than a random walk in out-of-sample forecasting, see Meese and Rogoff (1983). Second, macroeconomic fundamentals do play an important role in explaining the behaviour of exchange rates, see McDonald (1999). For some authors such fundamentals are important in the long run but have little to offer in explaining short-run movements, whilst for others macroeconomic fundamentals contribute to both long run and short run dynamics. Last, neither macroeconomic fundamentals nor the random walk model adequately account for exchange rate behaviour at short horizons. This view attributes short-run exchange rate movements to market microstructure factors, such as inventory management and information aggregation, often reflecting adaptive learning processes about the economic fundamentals, see Lyons (2001).

Kilian and Taylor (2003) provide empirical evidence showing that the evolution of the real exchange rate is well approximated by a nonlinear, exponential smooth transition autoregressive (ESTAR) model, accounting for the presence of persistence and volatility of real exchange rates. Kilian and Taylor found strong evidence of predictability for horizons of 2 to 3 years, but not for shorter horizons. Furthermore, other research work documenting various nonlinearities in deviations of the spot exchange rate from economic fundamentals has been contributed by Balke and Fomby (1997), Taylor and Peel (2000), Taylor et al. (2001). These studies offer empirical support to exchange rate predictability and reconcile the presence of economic fundamentals, see also Allen and Taylor (1990, 1992), Taylor and Allen (1992), Cheung and Chinn (1999).

3. Methodology

The empirical testing of equation (1) has been based on statistical criteria penalising symmetrically over- and under-forecasting. We deviate fundamentally from this practice and focus on the structure of the market forecast decision-making process. We view the distance between a market-based forward rate and the corresponding future spot rate as a forecast error generated through a forecast decision making process: the market chooses at time t the forward rate referring to period $t + s$ which minimises the expected loss resulting in from mis-forecasting. It is known, see Granger (1969) and Christoffersen and Diebold (1997), that in the presence of asymmetric loss preferences, optimal forecasts are composed of the conditional expectation plus a rational bias component involving a non-linear interaction between the shape of the loss function and higher moments of the variable to be forecasted. It is exactly the presence of this rational bias that may explain the failure of testing procedures under equation (1). In the following we shall outline an estimation procedure for the underlying loss function, a statistical test for forecast rationality, as well as a statistical test for forecast breakdown in the presence of generalised loss preferences.

3.1 Estimation of Preferences

Observing time series of past exchange rate forecast errors we shall follow Elliott et al (2005) to devise a Method-of-Moments estimator for the parameter controlling the shape of the underlying loss function.

Consider a flexible loss function of the form:

$$L(p,\alpha) \equiv [\alpha + (1-2\alpha)\cdot \mathbf{1}_{(s_{t+s} f_{t+s} < 0)}] \left| s_{t+s} - f_{t+s} \right|^{p} \qquad (2)$$

where, $s_{t+s} - f_{t+s}$ is the s-period-ahead exchange rate forecast error, p = 1, 2, $\alpha \in (0,1)$, **1** is an indicator that takes value of 1 if $s_{t+s} - f_{t+s}$ negative and zero otherwise. For p = 1 the above equation nests the double linear function (Lin-Lin) and for p = 2 it nests the double quadratic function (Quad-Quad). For α = 1/2 the loss function is symmetric and for α < 1/2 (α > 1/2) the loss exhibits asymmetry towards a higher penalty for over-predictions (under-predictions).

By observing the sequence of spot – forward forecast errors { $s_{t+s} - f_{t+s}$ }, $\tau \leq t < T + \tau$ an estimate for α is constructed using a linear Instrumental Variable estimator $\hat{\alpha}_T$, as follows:

$$\hat{\alpha}_T = \frac{\left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t \left|s_{t+s} - \hat{f}_{t+s}\right|^{p-1}\right]' \hat{S}^{-1} \left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t \mathbf{1}_{(s_{t+s}-\hat{f}_{t+s}<0)} \left|s_{t+s} - \hat{f}_{t+s}\right|^{p-1}\right]}{\left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t \left|s_{t+s} - \hat{f}_{t+s}\right|^{p-1}\right]' \hat{S}^{-1} \left[\frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t \left|s_{t+s} - \hat{f}_{t+s}\right|^{p-1}\right]} \quad (3)$$

where v_t is a D x 1 vector of instruments, which is a subset of the full information set W_t used to generate $\hat{f}$, and $\hat{S}$ is given by:

$$\hat{S}(\bar{\alpha}_T) = \frac{1}{T}\sum_{t=\tau}^{T+\tau-1} v_t v_t' \left(\mathbf{1}_{(s_{t+s}-\hat{f}_{t+s}<0)} - \bar{\alpha}_T\right)^2 \left|s_{t+s} - \hat{f}_{t+s}\right|^{2p-2} \quad (4)$$

, where $\bar{\alpha}_T$ is a consistent initial estimate of α_0. Since S depends on $\hat{\alpha}_T$, estimation is performed iteratively. In the first iteration we assume $\hat{S} = I$, the identity matrix, to estimate $\hat{\alpha}_1$, which is then used to re-estimate $\hat{S}$ and $\hat{\alpha}_2$ for the second iteration. The process is then repeated until convergence for *S*. Elliott *et al* (2005) show that the estimator of $\hat{\alpha}_T$ is asymptotically normal and construct a J-statistic which under the joint null hypothesis of forecast rationality and flexible loss function is distributed as a $X^2(D-1)$ variable for D > 1, which takes the form:

$$J = \frac{1}{\mathrm{T}} \left[\begin{array}{l} \left(\sum_{t=\tau}^{\mathrm{T}+\tau-1} v_t \left[\mathbf{1}_{(s_{t+s} - \hat{f}_{t+s} < 0)} - \hat{\alpha}_T \right] \left| s_{t+s} - \hat{f}_{t+s} \right|^{p-1} \right)' \hat{S}^{-1} \\ \times \left(\sum_{t=\tau}^{\mathrm{T}+\tau-1} v_t \left[\mathbf{1}_{(s_{t+s} - \hat{f}_{t+s} < 0)} - \hat{\alpha}_T \right] \left| s_{t+s} - \hat{f}_{t+s} \right|^{p-1} \right) \end{array} \right] \sim X^2 (D-1) \quad (5)$$

For robustness in the empirical application, we apply equations (3) and (4) for both p = 1, 2 using two and three instruments (D = 2, 3), in particular a constant and lagged difference between spot and forward exchange rates as well as the latter two and the lagged spot.

In the context of asymmetric preferences given in equation (2) of our paper, f_{t+s} is an optimal forecast if and only if the first order forecast optimality conditions will be

$$E\left[W_t \left(\mathbf{1}_{(s_{t+s} - \hat{f}_{t+s} < 0)} - \alpha \right) \left| s_{t+s} - \hat{f}_{t+s} \right|^{p-1} \right] = 0 \quad (6)$$

where W_t is the full set of factors and are known to the forecaster at time t and a is the loss asymmetry parameter. If for given a and p the forecaster uses the above condition to determine f_{t+s} (Elliott et al show that this solution is unique), then for given f_{t+s} it is possible to use the same condition to uniquely back out a. Then, Lemma 2 of Elliott et al. proves that the above condition is sufficient to identify a using a sub vector V_t of W_t. Christodoulakis and Mamatzakis (2009) contribute an application for macroeconomic forecasts as well as robustness checks for this estimation methodology.

3.2 A Test for Forecast Breakdowns

When looking at the forecast decision making process for long time periods, one could reasonably argue that during this period there may have been events that could alter the shape parameter, *α,* of the underlying loss function. According to Credit Suisse Global Investment Returns Yearbook (2012), "… *investor behavior is a highly social phenomenon, and attitudes towards risk oscillate periodically from over-exuberance to excessive pessimism and back again* ...". The literature often refers to specific dates of important events that took place since the inception of the euro and asserted a crucial impact in the world market. We wish to assess the impact of such events on the shape of the underlying loss function of market forecasts. We employ the methodology proposed by Giacomini and Rossi (2009) to test for breakdowns in the forecasting ability of the market after the occurrence of major economic events. This is a newly established test building on the generalized loss function framework similar to the one used in section 3.1.

Given a sample of T observations and a forecast horizon *s*, we follow Giacomini and Rossi (2009) to distinguish between *m* in sample and $n = T - m - s + 1$ out-of-sample forecast errors. As in Giacomini and Rosi (2009) we allow for three schemes of forecast formation: (i) a fixed scheme, where the in-sample window at time *t* contains observations indexed 1,…,m; (ii) a rolling scheme, where in-sample window at time *t* contains observations indexed $t\text{-}m\text{+}1,\ldots,t$; and (iii) a recursive scheme, where the in-sample window includes observations indexed $1,\ldots,t$. We define a forecast breakdown as deterioration in the out-of sample performance of the forecast model relative to its in-sample performance. According to Giacomini and Rossi, this is formalized by defining a "surprise loss" SL_{t+s} at time $t + s$ as the difference between the out-of-sample loss L_{t+s} at time $t + s$ and the average in-sample loss $\overline{L}_t$ at time *t*

$$SL_{t+s} = L_{t+s} - \overline{L}_t \text{ for } t = m,...,T-s \tag{7}$$

, where the out-of-sample loss is given by

$$L_{t+s} = L(s_{t+s} - f_{t+s})$$

The term $\overline{L}_t$ is computed over the in-sample window implied by the respective forecasting scheme, that is

$$\text{Fixed Scheme:} \quad \overline{L}_t = \frac{1}{m}\sum_{j=1}^{m-s} L(s_{j+s} - f_{j+s})$$

$$\text{Rolling Scheme:} \quad \overline{L}_t = \frac{1}{m}\sum_{j=t-m+1}^{t-s} L(s_{j+s} - f_{j+s})$$

$$\text{Recursive Scheme:} \quad \overline{L}_t = \frac{1}{t}\sum_{j=1}^{t-s} L(s_{j+s} - f_{j+s})$$

Then, the average surprise loss is given by

$$\overline{SL}_{m,n} \equiv n^{-1}\sum_{t=m}^{T-s} SL_{t+s} \tag{8}$$

Based on equation (8), if the forecasting ability of the forward exchange rate is maintained from the in-sample to the out-of-sample prediction, then the average surprise loss should not differ significantly from zero. Otherwise, a forecast breakdown has taken place. Thus, the null hypothesis of no forecast breakdown takes the form:

$$H_0 : E\left(\overline{SL}_{m,n}\right) = 0 \tag{9}$$

which can be tested through the test statistic

$$t_{m,n,s} = \frac{\sqrt{n}\,\overline{SL}_{m,n}}{\hat{\sigma}_{m,n}} \tag{10}$$

where $\hat{\sigma}_{m,n}$ is the asymptotic variance estimator as given in section 2.6 of Giacomini and Rossi (2009). A level α test would reject the null hypothesis of no forecast breakdown when $t_{m,n,s} > z_{\alpha}$, that is when it exceeds the value of the (1-α)-th quintile of the standard normal distribution. For purposes of the current paper, we test for forecast breakdowns in forward exchange rate markets based on the above test statistic. The breakdown points are defined as unexpected events, exogenous, that could trigger–off a different behavioral pattern of the market in terms of providing accurate predictions.

4. Empirical Results

Our data set consists of weekly frequency series of one- and four-week spot and forward exchange rates for the G7 countries, 1/02/2002 to 26/10/2012. Therefore, this concerns five currencies (US Dollar-USD, Euro-EUR, Great Britain Pound-GBP, Japanese Yen-JPY, and Canadian Dollar-CAN) and thus ten exchange rates. The data were retrieved from Bloomberg.

4.1 Estimation of Loss Functions: 2002-2012

We estimate the parameter α of the generalized loss function (2) for both the linear (p = 1) and non-linear (p = 2) specification. To this effect, we do not impose any specific shape in the preference structure since both symmetric and asymmetric loss functions are included in the model as special cases. Our estimation is performed using three instruments (D = 3), in particular the lagged forecast error, lagged spot and lagged forward rate[3]. Our parameter of interest, α, determines the preference asymmetry of the loss function. For α = 0.5 the loss function is symmetric with respect to positive or

[3] The main results hold also in the case of one or two instruments. Results are available upon request

negative exchange rate premium ($s - f$), which implies unbiased expectations hypothesis under equation (1). For $\alpha < 0.5$ the loss function exhibits asymmetry towards a higher penalty for over-prediction, i.e. negative exchange rate premium, which in turn implies a rational bias to the direction of appreciation of the currency exchange rate. Likewise, for $\alpha > 0.5$ the loss function exhibits asymmetry towards a higher penalty for under-prediction, i.e. positive exchange rate premium, which in turn implies that a rational bias is present to the direction of depreciation of the currency exchange rate.

We report our empirical results in Table 1 for one-week horizon data and in Table 2 for four-week horizon data. Our estimated loss function parameters are all statistically different from zero as our estimated standard errors suggest. We also report the J-test for forecast rationality under four different null hypotheses, $H_0 : a = \hat{a}$ (from the estimation), $\alpha = 0.2$, $\alpha = 0.5$, and $\alpha = 0.8$. Our choice for the latter three values is ad hoc, reflecting clear cases of loss asymmetry towards currency appreciation, neutrality and loss asymmetry towards currency depreciation, respectively. It is evident from Table 1 that loss function parameters for one-week forecast horizon are close to symmetry, where in most of the cases their difference from 0.5 is not statistically significant, whilst J-tests for forecast rationality[4] suggest that it is generally not rejected, given the estimated parameters. These results remain fundamentally unchanged for both linear and quadratic specifications of the loss function. Reviewing Table 2 we observe that loss function parameters for four-week forecast horizon have moved towards asymmetry, where in all cases their difference from 0.5 is statistically significant. In most of the cases losses are higher for over-

[4] The test of forecast rationality refers to the formal testing procedure for the joint presence of optimal forecasts and asymmetric loss as shown in equation (5).

prediction of the exchange rate ($\alpha < 0.5$), that is negative exchange rate premium, thus leading to a rational bias towards currency appreciation. In two cases, JPY/USD and CAN/USD, we observe loss function parameters ($\alpha > 0.5$), generating losses that are higher for under-prediction of the exchange rate, positive exchange rate premium, thus leading to a rational bias towards currency depreciation. J tests suggest the striking result that, for four-week forecast horizon, rationality is strongly rejected in all cases. These results are intensified for quadratic specification of the loss function.

<<Tables 1 and 2 about here>>

Overall, we find strong evidence for symmetric preferences in one-week forecast horizon and asymmetric preferences in four-week forecast horizon. Our estimates of the loss function parameter α takes values of less than 0.5 for most exchange-rates, whilst for just two cases, α takes values higher than 0.5. These results suggest that for shorter horizons markets appear to project current data in an unbiased way, while at the same time for longer horizons appear to develop rational bias towards appreciation in most of the cases and depreciation in two cases.

4.2 Testing for Forecast Breakdowns

Our results in section 4.1 have uncovered preference asymmetries that reflect the sampling properties over a ten-year period. However, since the inception of the Euro, a number of major events have taken place in the international markets that may have caused forecast breakdowns. These are often interpreted as changes in the forecasting ability of the markets when judged on the basis of conventional criteria. Given the continuous revision of market forecasting models, we argue that such forecast breakdowns may instead reflect changes in the structure of the underlying market preferences rather than a failure of forecasting models. The emergence of a major event in the international economy often triggers a realignment in views on a number of fundamental variables or relationships in the economy. This often takes the form of a change in the probability weighting scheme that the markets assign to possible future events, reflecting the degree of optimism or pessimism about future events and in some cases the switch from one regime to the other. For example, the collapse of Lehman Brothers could have triggered a realization of risk under-estimation in the past. Likewise, bailouts for euro-area countries under enormous fiscal stress, such as in the case of Greece and Portugal, have raised uncertainties regarding the political economy aspects of the euro in relation to safeguarding the ability of all euro area countries to remain in the monetary union. In this section we shall test for forecast breakdowns using the methodology of Giacomini and Rossi (2009) outlined in section 3.2, focusing on three major events that may have caused breaking points: 15th September 2008, marking the date of Lehman Brother bankruptcy; 2nd May 2010, marking the bailout of Greece through an emergency financing mechanism from the European Union, the European Central Bank and the International Monetary Fund,; and 3rd May 2011 marking the bailout of Portugal through the same sovereign financing mechanism.

The three assumed breaking points split our sample into four sub-samples. Our testing procedure examines sequentially the three resulting pairs of sub-samples: First, from January 1, 2002, to Lehman Brothers collapse on September 15, 2008, to Greek bailout on May 2, 2010; second, from Lehman Brothers bankruptcy on September 15, 2008, to Greek bailout on May 2, 2010, to Portuguese bailout on May 5, 2011; and third, from Greek bailout on May 2, 2010, to Portuguese bailout on May 5, 2011, to

October 26, 2012. In every pair we view the first sub-sample as our in sample forecast error data and the second sub-sample as our out-of-sample forecast error data. We apply our testing procedures using a symmetric quadratic loss function and all three forecasting schemes, fixed, rolling and recursive, on both one-week and four-week forecast horizon data.

Our results are presented in Table 3. The empirical evidence suggests that the null hypothesis of no forecast breakdown is not rejected in the case of Lehman Brothers collapse. In particular, in Table 3 the first three columns report p-values of the Giacomini and Rossi (2009) forecast breakdown test for the case of possible structural break on 15th September 2009, that is the date of Lehman Brothers bankruptcy, for three forecasting schemes; fixed, rolling and recursive, on both one-week and four-week forecast horizons. One could not fail to notice that all reported p-values are taking values close to one and as such they suggest that, indeed, no structural break down has been triggered by the dramatic events in Lehman Brothers.

Interestingly, we find overwhelming evidence suggesting that the null hypothesis is rejected in most of the exchange rate cases in the presence of the Greek and the Portuguese bailouts. The effect is severe in the case of Greek bailout in which both one-week and four-week horizon forecasts breakdown. Note that in the case of Greece for all exchange rates, but CAN/EUR that exhibits remarkably stability, under all forecasting schemes for both 1 week and 4 weeks horizon structural breakdowns are detected. Similarly, in the case of Portuguese bailout, whereas the null hypothesis of no structural break is rejected for most exchange rates, except for the exchange rates of yen with respect to euro, USD, and GBP for the longer horizon of four weeks forecasts.

<< Table 3 around here >>

4.3 Estimation of Loss Functions in Sub-periods

Our evidence in section 4.2 suggests strong forecast breakdowns in the presence of Greek and Portuguese crises, pointing towards the possibility of temporal changes in the loss preferences of the market. In this section we present our loss function estimation and testing results in four sub-samples as defined in the introduction of section 4. The one-week-ahead results are presented in Tables 4-7 and the four-week-ahead results are presented in Tables 8-11. In all cases the estimated parameters are highly statistically significant. We observe severe inter-temporal fluctuations of the preference parameters away from symmetry $\alpha = 0.5$, for both forecast horizons, showing a mean-reverting transition from optimism to pessimism and vice versa. Preference changes between forecast horizons show significant positive correlation, however, the degree of variation of preference parameters along different sampling periods differs substantially between the two forecast horizons, indicatively for four-week-ahead they fluctuate between 0.13 and 0.89 whilst for one-week-ahead they fluctuate between 0.33 and 0.64 for the linear specification of the loss function. In addition, for a quadratic specification of the loss function we observe that the evolution of the preference parameters exhibits a very similar pattern to the one coming from the linear case for one-week-horizon forecasts, whilst for four-week-horizon forecasts the variation becomes even more extensive. Finally, it is worth noting that forecast rationality tests exhibit the same pattern with the full sample results, where rationality is maintained in all cases one-week-ahead and rejected in all cases four-week-ahead.

<<Tables 4-11 around here>>

5. Attribution of Loss Preferences to Economic Fundamentals

Studies on exchange rate forecasting, such as Meese and Rogoff (1983), show that exchange rate models that include macroeconomic fundamentals do not perform better than a random walk for short horizons, whilst McDonald (1999) argues that macroeconomic fundamentals play an important role in explaining the behaviour of exchange rates. Others suggest that market microstructure factors affect exchange rate, see Lyons (2001). Given the vague empirical evidence on exchange rate forecasting, in this section we shall focus on the attribution of preferences over forecasts, rather than forecasts themselves, on economic fundamentals. In the previous section we estimate over time the asymmetric loss parameter, α, for the four cases corresponding to linear or quadratic loss functions and to one-week or four-week forecast horizon. Then, given the estimated parameters in tables 4-11, our next step is to examine the main underlying explanatory variables. Specifically, as in Clarida and Taylor (1997) and Clarida et al. (2001) we include variables that reflect main macroeconomic development such as output, inflation, risk free rate as in Skinner and Mason (2011)[5], unemployment rate, balance of payments, terms of trade and budget deficit, obtained from Datastream. In addition, we choose some variables to reflect risks and uncertainty on a wider institutional, economic and political base, see for example Cosset and Rianderie (1985), Baily and Chung (1995), such as legal risk, tax risk, operational risk, political risk, economic risk and security risk, obtained from Global Insight. Since each data point, α_i, of our dependent variable is an estimate

[5] In a recent paper, the authors identify the role of credit risk for the covered interest rate parity.

derived from a sample with size T_i, for every explanatory variable we use summary information over the respective time period, so we calculate its mean. Then, since our dependent variable is a preference parameter over a relative variable, all explanatory variables are also converted to relative terms, i.e. the ratio of mean USD GDP growth to mean EUR GDP growth.

Given the evidence of the previous section on the dynamics of loss preference parameters, we adopt the Arellano-Bover (1995) Dynamic Panel modeling approach and GMM estimation of parameters along with robust standard errors. The i-th panel equation takes the form:

$$\alpha_{i,4w,t} = b_0 + b_1\alpha_{i,4w,t-1} + b_2\alpha_{i,1w,t} + \sum_{j=3}^{K} b_j \frac{Mean(X_{j,d})}{Mean(X_{j,f})} + \varepsilon_{it} \quad (7)$$

where $i = 1,...,10$ and $t = 1,...,4$. Variable $\alpha_{i,4w,t}$ is the sample-t estimate of Quad-Quad loss parameter of the i-th four-week exchange rate forecast error and $\alpha_{i,1w,t}$ is the corresponding estimate of Quad-Quad loss parameter of the i-th one-week exchange rate forecast error. Furthermore, $X_{j,d}$ denotes the j-th domestic explanatory variable which is expressed in relative terms with respect to the corresponding variable $X_{j,f}$ of the denominating foreign currency.

We present our empirical results in Table 12. We follow an empirical model building from specific to general, in which Model 1 presents a panel auto-regression, Model 2 augments Model 1 with the one-week estimate of α, Model 3 and 4 augments Model 2 with macroeconomic variables, Model 5 augments Model 2 with risk variables and finally Model 6 attempts to augment Model 2 with both macroeconomic and risk variables[6]. It appears that endogenous dynamics as captured by the panel auto-regressive parameter and spill over effects from one-week horizon preferences are statistically significant and positive. Moreover, as it is evident in Model 1 the AR component is highly statistical significant and is mean reverting around 0.5 that is the case of a symmetric underlying loss preferences. Regarding the impact of weekly alphas on monthly alphas, it is found to be highly significant and positive. This evidence holds across all six models in Table 12 and suggests the existence of spill over effects from short horizon preferences to long horizon ones.

<< Insert Table 12 around here >>

These effects are complemented in Models 3 and 4 with the statistically significant impact of macroeconomic variables, consistent with Balke and Fomby (1997), Taylor and Peel (2000) and Taylor et al. (2001),[7] which take economically meaningful parameter signs. In particular, when the sign of the parameter is positive, as in the case of growth differential and deficit differential across G7 countries, then an increase of such a differential will lead to higher asymmetry of the underlying loss function towards heavier penalty to under prediction, that is the case of the spot being higher than the forward. On the other hand, a negative sign will indicate the reverse effect. Turning our attention to Model 5, we introduce a group of risk indexes. We observe that among all risks, legal risk is the one asserting a significant and positive

[6] Note that our empirical model in eq. (7) does not impose the theoretical restriction $0 \leq \alpha \leq 1$. However, our diagnostic checks on in-sample fitted values of the dependent variable confirm that it always satisfies the theoretical bounds.

[7] Please note that our approach links macroeconomic fundamentals to the underlying preference parameters, that is to the rational bias of exchange rate forecasts, rather than to exchange rate itself as suggested by the traditional literature, see for example Allen and Taylor (1990, 1992), Taylor and Allen (1992), Cheung and Chinn (1999).

impact on alphas. However, risk variables cannot be combined successfully with economic variables as shown in Model 6.

Overall, our results suggest that preferences tend to correlate with economic fundamentals and shorter horizon and past preferences in a non-trivial way, pointing to the perception of analysts about oscillating market behaviour, see for example Credit Suisse (2012).

6. Concluding Remarks

This study has been motivated by the long-established inconclusive literature questioning the efficiency of the foreign exchange market, on the basis of empirical tests reflecting symmetric preferences. We relax this assumption and allow for generalized asymmetric preferences using a newly established methodology of Elliott et al (2005). This paper provides evidence on the existence of substantial asymmetries in the underlying loss preferences for the difference between the spot and forward nominal exchange rates between the G7 countries for one-week and four-week forecast horizons. For the full sample 2002-2012 we find that, in the context of both linear and non-linear loss functions, the underlying loss preferences for four-week-horizon data are predominantly asymmetric, whilst for one-week exchange rates asymmetry tends to weaken. Using a new test developed by Giacomini and Rossi (2009), we test for forecast breakdowns during this period. Breakdowns in forward market observed for the Greek and the Portuguese crisis, but interestingly not for the Lehman Brothers bankruptcy. This evidence provided motivation to re-estimate the loss preferences in subsamples according to the detected forecast breakdown points, leading to estimates exhibiting severe inter-temporal fluctuations of the preference parameters. The new preferences show strong mean-reverting transition from optimism to pessimism and vice versa. As a third stage analysis, we attribute the evolution of preferences to economic fundamentals and risk indexes using a dynamic panel approach of Arellano and Bover (1995) and uncover that together with significant endogenous dynamics, variables such as growth differential, interest rate and legal risk assert some significant impact on asymmetry.

The reported presence of asymmetries in the underlying loss function shed new light into the disconnect puzzle, implying the presence of preference-based rational bias in the formation of expectations. The revealed asymmetries in the loss function should be taken into account in any future modelling of foreign exchange rates whilst one should also take into account that the underlying preferences do not remain stable over time but shift from optimism to pessimism and vice versa.

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