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Individual exchange rate forecasts and expected fundamentals

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Discussion Paper No. 11-062

Individual Exchange Rate Forecasts and Expected Fundamentals

Christian D. Dick, Ronald MacDonald,
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Zentrum für Europäische
Wirtschaftsforschung GmbH

Centre for European
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Non-technical Summary

Exchange rates are one of the most important prices in open economies. Despite their great importance for many enterprises, surprisingly little is known about the economic factors influencing the ups and downs of exchange rates at intermediate horizons. Although several theoretical macroeconomic models do identify potential determinants of exchange rates, empirical studies since the mid-1980s have found that these models do not make more accurate medium-term forecasts than random forecasts. This empirical finding has led to the conclusion that exchange rates and fundamentals are unrelated in the medium term. However, the complexity of currency markets (with heterogeneous market participants or time-variant influencing factors) could conceal a potential relation between economic fundamentals and exchange rates.

The present study takes an indirect approach to investigating whether exchange rates are formed based on fundamentals. The defining idea behind our study is to analyze individual forecasts without making assumptions regarding the forecaster's macroeconomic models. Instead, we judge individual forecasts by their forecast ability only. We assume that good exchange rate forecasts are generally based on better information, and analyze whether this information is macroeconomic. To this end, we take a look at the forecast ability of individual forecasts for the USD/EUR exchange rate in conjunction with the forecast ability of associated short-term interest rate forecasts.

We view the significant, positive relationship between good exchange rate forecasts (on a one-month horizon) and good interest rate forecast as evidence that exchange rate forecasts benefit from a better interpretation of the macroeconomic reality. This requires a fundamental linkage between exchange rates and macroeconomic variables.

If this linkage exists, it should vary in its importance across different market phases. Our further analyses indeed indicate that a correlation between exchange rates and interest rates is especially important when there is an obvious fundamental misalignment between the respective countries. This is the case when there is a great difference between exchange rates and their fundamental values (based on purchasing power parity), when interest rate differences between the two currencies are large, and when exchange rates do not exhibit a strong trend. This variability of the importance of fundamental influencing factors could explain why existing studies struggle to identify the correlation between fundamentals and exchange rates.

Nicht-technische Zusammenfassung

Wechselkurse gehören zu den wichtigsten Preisen in offenen Volkswirtschaften. Trotz ihrer besonderen Bedeutung für viele Unternehmen ist bemerkenswert wenig darüber bekannt, welche ökonomischen Einflussfaktoren das Auf- und Ab der Wechselkurse über mittlere Fristen letztlich erklären. Zwar treffen theoretische Makromodelle durchaus Aussagen über mögliche Determinanten von Wechselkursen; allerdings weisen empirische Arbeiten seit etwa Mitte der 1980er Jahre nach, dass diese Modelle keine besseren mittelfristige Vorhersagen für Wechselkurse treffen können als Zufallsprognosen. Aus diesem empirischen Befund ist vielfach gefolgert worden, dass ein Zusammenhang zwischen Wechselkursen und Fundamentalwerten auf mittlere Sicht nicht bestehe. Alternativ könnte aber auch die Komplexität von Währungsmärkten (u.a. mit heterogenen Marktteilnehmern oder zeitvariablen Einflussgrößen) einen möglicherweise vorhandenen Zusammenhang zwischen volkswirtschaftlichen Fundamentalgrößen verdecken.

In der vorliegenden Studie untersuchen wir deswegen mit einem indirekten Ansatz, ob Wechselkurse auf Grundlage von Fundamentalwerten gebildet werden. Die besondere Idee unserer Studie besteht darin, Individualprognosen zu betrachten, ohne Annahmen über die makroökonomischen Modelle einzelner Prognostiker zu treffen. Stattdessen beurteilen wir die individuellen Prognosen ausschließlich im Hinblick auf ihre Vorhersagefähigkeit. Wir unterstellen, dass gute Wechselkursprognosen im Durchschnitt auf besserer Information beruhen, und untersuchen, ob diese Information makroökonomischer Natur ist. Dazu betrachten wir die Vorhersagekraft individueller Prognosen für den USD/EUR Wechselkurs und für kurzfristige Zinsen im Zusammenhang.

Wir interpretieren den signifikant positiven Zusammenhang zwischen guten Wechselkursprognosen (auf einem Ein-Monats-Horizont) und guten Zinsprognosen als ein starkes Indiz dafür, dass Wechselkursprognosen von einer besseren Interpretation makroökonomischer Gegebenheiten profitieren. Dies setzt voraus, dass ein grundlegender Zusammenhang zwischen Wechselkursen und makroökonomischen Variablen besteht.

Wenn dieser Zusammenhang besteht, dann sollte er allerdings in unterschiedlichen Marktphasen von unterschiedlich ausgeprägter Bedeutung sein. Unsere weitergehende Untersuchung legt in der Tat nahe, dass ein Zusammenhang zwischen Wechselkursen und Zinsen insbesondere dann eine Rolle spielt, wenn fundamentale Ungleichgewichte zwischen den jeweiligen Ländern offenkundig erscheinen. Dies ist der Fall, wenn sich Wechselkurse relativ stark von ihren Fundamentalwerten (auf Grundlage der Kaufkraftparität) unterscheiden, wenn die Zinsdifferenzen zwischen den beiden Währungen ausgeprägt sind, und wenn die Wechselkurse gerade nicht starken Trends unterliegen. Diese Variabilität der Bedeutung fundamentaler Einflussgrößen könnte die Schwierigkeiten existierender Studien erklären, den Zusammenhang zwischen Fundamentalgrößen und Wechselkursen aufzuzeigen.

INDIVIDUAL EXCHANGE RATE FORECASTS AND EXPECTED FUNDAMENTALS[*]

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INDIVIDUAL EXCHANGE RATE FORECASTS AND EXPECTED FUNDAMENTALS

Abstract

This paper suggests that exchange rates are related to economic fundamentals over medium-term horizons, such as a month or longer. We find from a large panel of individual professionals' forecasts that good exchange rate forecasts benefit from the proper understanding of fundamentals, specifically good interest rate forecasts. This relation is robust to individual fixed effects and further controls. Reassuringly, this relation is stronger during obvious fundamental misalignment. This occurs when exchange rates substantially deviate from their PPP values, when interest rate differentials are high and when exchange rates are less influenced by strong momentum.

JEL-Classification: F31, F37, E44.

Keywords: Exchange Rate Determination, Individual Expectations, Macroeconomic Fundamentals.

1 Introduction

Exchange rates are among the most important prices in open economies. In contrast, however, to their importance for firms, investors, and policy-makers, there is a considerable lack of understanding on the underlying determinants of exchange rates. At intermediate horizons, such as a month or half a year ahead, exchange rates seem to be hardly explained and, in particular, seem to be disconnected from fundamentals (Obstfeld and Rogoff, 2000). This disconnect is surprising, given the fact that foreign exchange markets react to changes in economic fundamentals within minutes (Andersen, Bollerslev, Diebold, and Vega, 2003) and that exchange rates reflect long-term changes in purchasing power (Taylor and Taylor, 2004). At intermediate horizons, however, the relationship between fundamentals and exchange rates seems to be largely unobservable, possibly even non-existent (Frankel and Rose, 1995; Rogoff, 2007). In this paper we suggest a new approach to uncovering potential connections, and provide evidence that fundamentals may indeed shape exchange rates.

Our motivation rests on the notion that the relation between exchange rates and fundamentals is quite complex for several reasons: the asset market approach to exchange rates emphasizes that *expected* fundamentals can have a greater impact on today's exchange rates than actual observed fundamentals, as emphasized e.g. by Engel and West (2005). Moreover, it is known that market participants possess and use fundamentals in heterogeneous ways (see Ito, 1990; MacDonald and Marsh, 1996), and that the use of fundamentals may change over time (e.g. Sarno and Valente, 2009). Finally, market participants do not only use fundamentals but also non-fundamentals as information in their decision making (Menkhoff and Taylor, 2007). Each of these sources of complexity may explain why conventional tests of exchange rate models in the spirit of Meese and Rogoff (1983) - regressing exchange rate changes on changes in fundamentals - fail (Cheung, Chinn, and Pascual, 2005): the reason is not necessarily the above mentioned ”disconnect” but possibly the use of a ”false” model, i.e. a model that cannot account well enough for existing complex relations.

To circumvent this obstacle, we propose a research strategy which aims at making potential links between exchange rates and fundamentals visible without requiring an exchange rate model: the basic idea is to use *individual* forecasting data and examine whether there is a positive relationship between good exchange rate forecasting and good forecasting of exchange rate fundamentals by the same individual. This approach relies on survey data, i.e. on *expected* rather than *realized* data. Moreover, we do not make structural assumptions on forecasting *behavior*, but consider forecasting *performance* as an objective criterion. The reliance on performance requires little information on how (time-varying) fundamentals are used.

For our sample of more than 1,050 German-based professionals, we find that good US Dollar-Euro forecasts coincide with good interest rate forecasts for the U.S. and the Euro area, which indicates that a good understanding of the determinants of fundamentals helps in understanding exchange rate behavior. If the anticipated formation of exchange rates is supported by knowledge about fundamentals, this ultimately suggests that fundamentals do indeed contribute to shaping exchange rates. This is our main result.

This result is derived from a panel approach with individual fixed effects, taking account of unobserved heterogeneity between professional forecasters. We are aware of a potential endogeneity between interest rates and exchange rates; thus, we also use an IV approach. Further exploiting more information in the underlying data set, we find that our main result is robust to the consideration of further fundamentals and time-specific effects; the main result also tentatively holds for additional available currencies.

Finally, we test the implication of our main result that the impact of correctly expected fundamentals on exchange rates depends on market phases: the strength of our exchange rate-fundamentals-expectations relation should be more important during phases in which an obvious fundamental misalignment occurs. In characterizing relevant market phases with different degrees of obvious misalignment, we distinguish (i) between market phases in which nominal exchange rates deviate strongly or not from their fundamental PPP value (FX value phases), (ii) between market phases in which exchange rate movements exhibit a strong or weak trend during the preceding thirty trading days which may deviate attention away from fundamentals (FX momentum phases), and (iii) between market phases in which interest rate differentials between the US and the Eurozone are relatively large or rather small (FX interest differential phases). It transpires that stronger fundamental misalignments seem to increase the benefit of good fundamentals forecasts, which is our second finding. More specifically, the relation between the quality of interest rate forecasts and FX forecasts is more pronounced when exchange rates deviate more strongly from their PPP value, when there has not been a strong trend (less momentum), and when interest rate differentials are rather large. This last result regarding the interest rate differential is consistent with the interpretation that the US-Euro differential is seen as a fundamental determinant of the exchange rate rather than a basis for carry trades.

We are not aware that the procedure proposed in this paper has been used before. Nevertheless, this research is based on and related to a number of earlier studies which we still selectively refer to in Section 2. Our study is based on the Centre for European Economic Research's (ZEW, Mannheim) monthly survey among financial market professionals, who give their forecasts about several variables, including exchange rates, interest rates and other macroeconomic fundamentals. As responses are marked by a personal identification number, every single forecast response during the 18-year history of the survey can be related to a concrete individual. We decided to include individuals with a minimum of 10 responses, i.e. considering holidays etc. equal to about one year. This leaves us with more than 1,050 professionals and more than 63,000 responses.

For the measurement of FX forecasting performance, we follow several authors who have argued that forecasts about marketable assets should be evaluated from an investor's perspective by a zero net investment trading rule (Leitch and Tanner, 1991; Anatolyev and Gerko, 2005; Jordà and Taylor, 2011). Accordingly, we translate the qualitative forecasts of respondents into a long/short position, i.e., we translate an appreciation expectation into a buy (including the interest rate differential) etc., as suggested, for example, by Elliot and Ito (1999). We find that the return of the median forecaster is 0.076% per month and thus slightly above zero. The best 5% realize more than 0.7% per month but the worst 5% lose more than 0.6% per month. The result is similar when we focus on Sharpe ratios of trading strategies (such that volatility is accounted for), as the median forecaster realizes a Sharpe ratio of 0.14. It becomes obvious that excess returns from these trading strategies are very difficult to obtain (markets function efficiently in this respect), but it is important for our research that forecasters are very heterogeneous in their performance. Thus we aim to learn from such performance differences.

The paper is structured as follows. Section 2 introduces related literature, Section 3 presents data used and Section 4 documents our measurement of forecasting performance. Results are discussed in Section 5. Section 6 presents robustness exercises and Section 7 concludes.

2 Literature

In this section of the paper we provide a very selective review of two exchange rate issues in order to position our research: first, we discuss the state of empirical research regarding exchange rate determination, in particular at the medium-term horizon and, second, we review studies concerning individual exchange rate forecasting.

Subsequent to the devastating result of Meese and Rogoff (1983), which showed the failure of exchange rate models in an out-of-sample forecasting context in comparison to a random walk model, the linkage of exchange rates to fundamentals has now been demonstrated to hold at very short and at the long horizon: at very short-term horizons, exchange rates clearly and systematically react to fundamentals, as many event studies have examined in detail (e.g., Andersen, Bollerslev, Diebold, and Vega, 2003), while at long-term horizons, exchange rates are attracted to the purchasing power parity level and, related to this, seem to be tentatively in line with the monetary model (e.g., Mark, 1995; Taylor and Taylor, 2004). Thus, it is the medium-term horizon where it is most difficult to show a clear relationship between fundamentals and exchange rates (Rogoff, 2007).

There are several approaches which try to obtain new insights in this respect, and there are three that we are particularly close to. First, it has been demonstrated that conventional tests of exchange rate models may fail because coefficients in these models seem to vary over time (e.g., Rossi, 2005). Bacchetta and Van Wincoop (2004) and (2009) argue that market participants attach too much weight to a certain ”scapegoat” variable whose expected changes then impact on trading and market outcomes. This excessive focus diminishes the importance of other exchange rate fundamentals. ter Ellen, Verschoor, and Zwinkels (2011) also find evidence for time-varying forecasting strategies. A second approach is the consideration of dispersed heterogeneous information which is incorporated over time into exchange rates (e.g. Bacchetta and Van Wincoop, 2006). Order flow is interpreted as an empirical proxy for dispersed information flows and can indeed explain exchange rate changes over medium-term horizons (Evans and Lyons, 2002). Also the relation of order flow to macroeconomic information has been demonstrated recently (e.g., Evans, 2010). According to the order flow approach, there is private information about how to anticipate and interpret fundamental information which drives a wedge between published fundamentals and exchange rates.

A third approach is that of Engel and West (2005). They highlight the fact that exchange rates as financial market prices are determined by expectations about future fundamentals and show that under reasonable assumptions, exchange rates are close to a random walk even when they behave according to conventional exchange rate models. The argument runs that expectations may look far ahead, that such long-horizon expectations about fundamentals may differ markedly from current realizations, and that small changes in long-term expectations, as well as in the corresponding discount factors, can cause major changes in present exchange rates. Due to these characteristics of a financial market price, exchange rates cannot be related to contemporaneous fundamentals.

Thus, the Meese and Rogoff-result may occur even if expected fundamentals are indeed the driving forces of exchange rates. As an empirical test for identifying this relationship, Engel and West (2005) suggest examining whether exchange rates reflect information about expected fundamentals to a degree that they may even predict future fundamentals. There is evidence supporting this hypothesis and thus a link between exchange rates and expected fundamentals (Engel, Mark, and West, 2007).

These three strands of literature show that the relation between exchange rates and fundamentals may be time-varying, may be losened by the role of order flow and may be difficult to detect because expectations about fundamentals dominate realizations.

Due to the important role of expectations, in general and for our approach in particular, we now selectively review studies focusing on exchange rate expectations. The important early studies, such as Frankel and Froot (1987), examine averages of forecasters, finding, among others, that they form bandwagon expectations in the short run and have regressive expectations over medium horizons. In subsequent work, Frankel and Froot (1990) also use the degree of heterogeneity in their analysis, although still as a measure for the whole market. Ito (1990) is the first to examine individual exchange rate forecasters, finding that they differ from each other and that part of this difference may be biased by their professional position. Further studies have analyzed heterogeneity, either for different groups of forecasters or for investigating different purposes. Such studies include MacDonald and Marsh (1996), who found heterogeneity for more forecasters than Ito (1990) and for various exchange rates. This line of examination culminates in the work of Bénassy-Quéré, Larribeau, and MacDonald (2003), who demonstrate in detail individual heterogeneities in the process of exchange rate formation. Elliot and Ito (1999) take a new course in that they show individual differences in forecasting performance. Another new direction is taken by Dreger and Stadtmann (2008), who find that the consideration of individual expectations about fundamentals improves the explanation of individual exchange rate forecasts beyond the consideration of conventional forms of expectation formation.

In order to identify structure within the heterogeneity of forecasts, Frankel and Froot (1990) suggest an interplay of chartists and fundamentalists. Characteristics of these groups are surveyed in Menkhoff and Taylor (2007), the interplay of these groups and how this impacts market outcome has been modeled, for example, by De Grauwe and Grimaldi (2006). A direct and measurable implication of expectation heterogeneity is examined by Beber, Breedon, and Buraschi (2010) who find *inter alia* that heterogeneity has a significant effect on implied volatility, which is a major pricing determinant of currency options.

What we learn from these studies is that there are various dimensions of heterogeneity among individual exchange rate forecasters and that heterogeneity is important for modeling and pricing in foreign exchange. This motivates us to base our analysis on individual data and to consider potentially rivaling influences from non-fundamental forces, such as chartism.

Taking the insights from both exchange rate issues together, i.e. (i) complex relations between exchange rates and fundamentals at medium-term horizons and (ii) complex kinds of exchange rate expectations, we prefer to stay agnostic about the specific form of relation between exchange rates and fundamentals. Instead, we simply focus on individual performance in forecasting both, exchange rates and fundamentals, and then examine the relation between individual exchange rate forecasts and expected fundamentals. This focus on individual expectation data takes account of major concerns raised in earlier studies; moreover, we implicitly consider time-varying relations between exchange rates and fundamentals, we do not rule out the possibility of private information (as in the order flow literature) and of an impact from non-fundamental analysis.

Thus, it is our approach - demonstrating a link between forecasting performance in exchange rates and economic fundamentals - which is new to the literature, according to our knowledge. Beyond that, we provide more conventional contributions on examining exchange rate expectations, due to the unusually long and broad sample, covering several exchange rates.

3 Data

Microdata of forecasts We consider USD/EUR exchange rate forecasts by financial professionals as collected in a unique panel spanning 18 years of individual forecasts made in the context of the Financial Market Survey by the Centre for European Economic Research (ZEW) in Mannheim, Germany. These forecasters work in various areas of the financial industry or in financial departments of industrial companies. The forecasts collected in the ZEW Financial Market Survey have been used in various recent empirical studies in finance and macroeconomics, such as Schmeling and Schrimpf (2011). The reason for the popularity of this data set lies in the relatively high frequency of survey point (monthly), and the relatively high number of responses per point: the data set comprises 216 survey points from 12.1991 to 11.2009, with an average number of responses of 307; hence, the microeconomic panel is both relatively long and broad, summing up to a total of more than 1,700 forecasters and 66,000 observations. As a meaningful measurement of forecasting performance requires a certain minimum number of responses per forecaster, we omit forecasters with less than 10 USD/EUR forecasts. This reduces the sample to 1,056 forecasters. Table 1 provides more details on the structure of the survey responses. The US Dollar forecasts are of a qualitative nature; i.e., forecasters indicate whether the USD is expected to appreciate, remain unchanged or depreciate compared to the Euro within the subsequent six months.[1]

TABLE 1 ABOUT HERE

This data set is well suited for the particular research topic of this paper for three reasons: firstly, and similar to, for example, Consensus Forecasts, the ZEW Financial Market Survey includes a variety of targeted macroeconomic and financial variables, and the forecasters tend to respond to all of the central questions when they take part (there are only 1.3% missing responses for USD/EUR forecasts, and even less than 0.5% for European interest rate forecasts). This allows us

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[1] The relevant survey question was (after 01.1999) "*In the medium-term (6 months), the following currencies compared to the Euro will appreciate/stay constant/depreciate.*" or (before 01.1999) "*The exchange rate (D-Mark per one unit foreign currency) of the following currencies will increase/not change/decrease.*".

to consider the USD/EUR forecasts in connection with the interest rate forecasts of the identical forecaster at the same point in time, which is the main focus of our study; in addition, we also have simultaneous forecasts with respect to other exchange rates (GBP/EUR, JPY/EUR), inflation rates and economic activity, which we use as control variables in our regressions. Secondly, we have access to the *individual* forecasters' predictions rather than the consensus forecasts and as the observations are associated with person-specific IDs, we are able to study the heterogeneity in forecasting performance across forecasters. Thirdly, we have exact information about the date on which an individual forecaster replies to the survey, which allows us to relate forecasts to precise FX realizations, such as the reference point of a forecast, or the trend of the last 30 days before the forecast was made.

Exchange rates The period of interest between 12.1991 and 11.2009 includes the transition from national currencies to the Euro. We therefore consider the US Dollar (USD) with respect to the D-Mark (DM, before 01.1999) and the Euro (EUR, after 01.1999). Hence, we convert the DM/USD exchange rates into USD/EUR rates for the period before 01.1999.[2] We consider both spot exchange rates as well as the one-month forward exchange rates on a daily basis. We replace missing exchange rates (e.g. from weekends) with those recorded on the preceding trading day.

4 Forecasting performance

Measuring forecasting performance with respect to exchange rates In order to measure forecasting performance, we follow Elliot and Ito (1999) who formulate a trading strategy in which a sophisticated investor takes a long position in the foreign currency using the forward market when she expects the foreign currency to appreciate, such that $F_{t,k} > E_{i,t}[S_{t+k}]$, and takes a short position in the foreign currency when she expects the currency to depreciate, such that

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[2] Before the introduction of the Euro, the exchange rate of the D-Mark was usually expressed by direct representation (e.g., 1.40 DM/USD). The indirect representation of the Euro chosen in this paper is nowadays more common from the European perspective; more importantly, it makes the representation for the USD/EUR rate consistent with those in, e.g. Fama (1984), Backus, Gregory, and Telmer (1993) or Burnside, Han, Hirshleifer, and Wang (2010).

$F_{t,k} < E_{i,t}[S_{t+k}]$, where $E_{i,t}[S_{t+k}]$ represents the subjective expectation of forecaster i.[3]

The usage of trading rules is easily adaptable in the context of monthly qualitative forecasts. In the underlying survey, the professional forecasters have to respond to the question: do they expect a foreign currency to appreciate or depreciate compared to the Euro with the current *spot* rate as reference point. A natural trading strategy, T_{ind}, triggers a trade in the forward market according to the expected direction of change of spot exchange rates. The one-month forward contract will then be settled one month later in the spot market, and a new trade will be made in the forward market according to the new forecast made in the current month. As forward rates are linked to interest rates differentials through covered interest rate parity, the log returns of the trading rule take account of refinancing costs.[4] We consider the log returns of T_{ind} based on the prediction of forecaster j, i.e.

$$r_{j,t,t+k} = I_t(s_t > E_{j,t}[s_{t+1}])(f_{t,1} - s_{t+1}) + I_t(s_t < E_{j,t}[s_{t+1}])(s_{t+1} - f_{t,1}) \tag{1}$$

performance measure for FX forecasts. $r_{j,t,t+k}$ varies across forecasters and time and may thus be used in the context of panel regressions.

Compared to alternative measures, there are important advantages to using trading rules as a forecast performance measure: firstly, conventional statistical measures (such as the mean squared error) underlie narrow assumptions about a forecasters' loss function (e.g., quadratic). To achieve a more realistic evaluation of the usefulness of forecasts of market variables for investors, several studies have suggested the use of the profitability of trading rules as a natural performance measure (e.g. Leitch and Tanner, 1991; Anatolyev and Gerko, 2005; Jordà and Taylor, 2011). Secondly, this approach avoids the loss of information by a categorization of continuous realizations of exchange rate movements into an *appreciate*, a *constant* and a *depreciate* range. Thirdly, we are able to

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[3] Note that $F_{t,k}$ and S_t are given as units of foreign currency per Euro, which implies that $S_{t+1} - S_t > 0$ corresponds to a depreciation of the foreign currency with respect to the Euro.

[4] As the paper aims at comparing forecasting performance rather than establishing evidence for profitable trading strategies for investors, *transaction* costs (e.g., bid/ask spreads) are ignored.

compute the average profit and the Sharpe ratio for each forecaster. The latter is relevant in cross sectional analysis as profits from trading strategies typically depend on their risk, which may be different for several forecasters.[5] Sharpe ratios can also be linked to other studies on exchange rate models (Jordà and Taylor, 2009; Rime, Sarno, and Sojli, 2010) or carry trade strategies (Burnside, Eichenbaum, Kleshchelski, and Rebelo, 2010; Menkhoff, Sarno, Schmeling, and Schrimpf, 2011). For example, Jordà and Taylor (2009) compare Sharpe ratios in their analysis of carry trades to the Sharpe Ratio for the S&P 500 of 0.4. These authors also point out that, in practice, marginal investors require the Sharpe ratio to be at least close to 1. For the sake of comparability with our results, we also provide monthly Sharpe ratios in Table 2.

TABLE 2 ABOUT HERE

It can be seen that the annual Sharpe ratio of the median forecaster amounts to 0.114, which is rather low. This indicates that a trading strategy based on some average FX forecast is unlikely to be profitable in practice, in particular as transaction costs are not yet taken into account. However, the annual Sharpe ratio for the forecaster at the 95% percentile amounts to 1.159, which is substantial. Table 2 also shows that Sharpe ratios of greater than 0.4 can be achieved by the forecasts of almost 30% of the forecasters. Overall, these statistics demonstrate the heterogeneity in forecasting performance across the sample, which is central to the strategy followed in our analysis.[6]

Measuring forecasting performance with respect to fundamentals Unlike currencies, macroeconomic fundamentals are not tradeable assets. As performance measures based on trading rules are not available, we rely on a measure of *forecast errors* by comparing forecasts with their respective realizations. For this purpose, the directional forecasts (e.g., the interest rate rises, stays

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[5] The choice of the neutral ("no change") category provides an opportunity to reduce the risk by following a trading strategy. Furthermore, we are considering an unbalanced panel, such that some forecasters may have been active in phases with higher volatility (and higher profit opportunities at the same time).

[6] Elliot and Ito (1999) present their results in terms of t-values, a performance measure closely related to the Sharpe ratio, which we also report in the Online Appendix, Table A1.

constant, or decreases)[7] are coded for simplicity in $X^e_{i,t+6} \in \{1, 0, -1\}$, an approach also applied by, for example, Souleles (2004). Likewise, the realizations (observed interest rates, inflation rates, growth rates of industrial production) are also categorized into three corresponding groups. It has to be noted, however, that the latter step depends on the choice of threshold values for a no-change category. We choose symmetric threshold values such that, over the entire time span, the share of observations in the no-change category for *realizations* is equally large as the share of *forecasts* in this category.[8] In this setting, a forecaster can be wrong to two different extents: she makes a *small* mistake when she predicts an unchanged variable, whereas the actual outcome is an increase, but a *large* mistake if she predicts a decline. We take account of the severity of these errors by computing absolute forecast errors by $|_t\varepsilon_{i,t+6}(X)| = |_tX^e_{i,t+6} -_t X_{t+6}|$, which takes on 2 for a severe error, 1 for a small error and 0 for a correct prediction.

Table 3 presents the cross-section of average absolute forecast errors, $|\varepsilon(\bar{X}_{j,t}|$ for different macroeconomic fundamentals, including US and Eurozone interest rates. It can be seen that the forecasters tend to commit less severe forecast errors for the interest and inflation rate in the Eurozone compared to the United States, while this is reverse for industrial production.

TABLE 3 ABOUT HERE

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[7] For economic activity, the Financial Market Survey asks whether the *economic situation* will improve, remain unchanged, will worsen over 6 months.

[8] The share of forecasts in the no-change category is 40 percent for short-term interest rates, 44 percent for industrial production, and 45 percent for inflation in the Eurozone/Germany. The figures are similar for the US for inflation and interest rates; for industrial production, however, the unchanged category contains 53 percent of the observations. Note that we take different threshold values for the Eurozone and the Unites States, respectively. For example, we group realizations into this category if industrial production yoy rates (inflation rates) six months ahead are not more than 2.2 (0.345) percentage points different from the current ones. Short-term interest rates are categorized into this middle category if they have not changed by more than 10.5 percent within a six-month horizon.

5 Empirical analysis

5.1 Exchange rate and fundamentals

The model To identify the effect of a good fundamental forecast on the validity of interest rate forecasts made by an individual forecaster over time, we conduct fixed effects panel regressions of the individual return of a trading strategy, T_{ind} ($r_{j,t,t+1}$), based on an individual forecast by forecaster j in period t on the absolute error the forecaster makes with respect to the interest rates in the Eurozone ($\varepsilon_{j,t}(i^{EUR})$) or the United States ($\varepsilon_{j,t}(i^{USD})$), as well as on a battery of control variables $\Phi_{j,t}$ and $\Psi_{j,t}$ in different specifications, i.e.

$$r_{j,t,t+1} = \mu_j + \beta_1 |\varepsilon_{j,t}(i^{EUR})| + \beta_2 |\varepsilon_{j,t}(i^{USD})| + \gamma \Phi_{j,t} + \delta \Psi_{j,t} + \epsilon_{j,t}. \tag{2}$$

By following the fixed effects methodology, we rule out that unobserved heterogeneity across forecasters drives our results, such that we can attribute a change in FX performance (compared to an individual forecaster's average performance) to changes in $|\varepsilon_{j,t}(i^{EUR})|$, $\Phi_{j,t}$ or $\Psi_{j,t}$. In line with this idea, the Breusch-Papan tests reject the null of no individual-specific effects particularly for the simpler specifications (i.e. (i)-(iv) from Table 4). Hausman tests confirm that a fixed effects estimator should be applied, as random effects are inconsistent for virtually all specifications.[9]

In Eq. 2, we regress the return by a trading strategy (which evaluates the performance of FX forecasts) on a contemporaneous performance measure with respect to interest rates ($\varepsilon_{j,t}(i)$) or, as control variables, with respect to other fundamentals (in $\Phi_{j,t}$). While this setting allows us to focus on the connection between interest rate and exchange rates forecasts, it generates a potential endogeneity problem, as it is not *a priori* clear that interest rate forecast errors cause FX errors and not vice versa: for example, if exchange rates and fundamentals are related, there could be a third factor affecting both the USD/EUR exchange rate as well as the interest rate in one of these

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[9] See Table A2 in the Online Appendix for detailed results.

countries. To eliminate this problem, we rely on IV estimation using the first lagged value of the forecasting errors with respect to interest rates and other fundamentals as external instruments for forecast errors; this IV approach is preferable to an estimator without instruments according to the results from Davidson and MacKinnon (1989)'s test in the majority of specifications.[10]

The effect of interest rate forecasts Table 4 reports the results of the fixed effects regression of the return earned from T_{ind} (i.e., our forecasting performance measure) on the absolute forecast error with respect to interest rates as well as various control variables: *negative* coefficients for the error variables $|\varepsilon(i)|$ indicate that *more severe* errors in the predictions of interest rates are associated with *lower* success in predicting exchange rates.

TABLE 4 ABOUT HERE

Specifications (i) and (ii) only consider the influence of absolute interest rate forecast errors on returns, and find a negative and significant relationship. This effect is economically important as, for example, an increase in US interest rate forecast error by one error point is associated with a decrease of the monthly return by 14 basis points. A similar relationship (11 basis points) holds for the forecast error with respect to the Eurozone interest rates.

Controlling for other fundamentals Depending on the specification, the vector of control variables $\Phi_{j,t}$ includes individual forecast errors with respect to other fundamentals than interest rates, i.e. inflation ($|\varepsilon(\pi)|$) and industrial production growth forecast errors $|\varepsilon(y)|$. These control variables are chosen to single out the effect of *interest rate* forecasts while at the same time acknowledging that inflation and economic activity are further important fundamentals to exchange rates.

As columns (iii) and (iv) in Table 4 show, the coefficients for the interest rate forecast errors remain virtually unchanged when further fundamentals are controlled for. The results are also

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[10] See also Table A2 in the Online Appendix for further details.

stable and even more pronounced when we control for year dummies in addition in specifications (v) to (ix). In addition, we also find a relatively robust negative relationship between forecasting errors made for European inflation rates and FX forecasting performance, while the coefficient estimates for the remaining fundamental forecast errors are either insignificant or inconclusive in direction across the different specifications (iii) to (ix).

5.2 Exchange rate and fundamentals: interactions in different market phases

In the following, we test an implication of our main result, i.e. that the impact of correctly expected fundamentals on exchange rates depends on *market phases*, which is motivated by the many studies mentioned above finding a time-varying influence of fundamentals on exchange rates (e.g., Rossi, 2005; Bacchetta and Van Wincoop, 2004, 2009). In order to define relevant market phases, we build on insights from the empirical literature about exchange rate behavior as well as market participants' behavior. Accordingly, following several studies on PPP (e.g. Taylor, Peel, and Sarno, 2001; Christopoulos and Leon-Ledesma, 2010) we hypothesize that fundamentals are more important for exchange rate forecasts when there is a strong obvious misalignment of the nominal exchange rate from its PPP value. By contrast, circumstances where technical trading is particularly pronounced may reduce the impact of fundamentals on exchange rates (see, for example, De Grauwe and Grimaldi, 2006). Finally, large interest rate differentials may have an ambiguous impact, as they either signal an exchange rate readjustment according to uncovered interest rate parity, or invite carry trades, which would rather reduce the role of fundamentals. We define market phases on the basis of the prevailing market conditions: we interpret a historically large deviation from PPP to be a signal for a value phase, the prevalence of high recent trends to indicate a momentum phase, and evaluate interest differential phases according to the absolute value of an interest rate differential between the United States and the Eurozone. Note that on an individual point in time, the market phases are not necessarily mutually exclusive.

Defining market phases When the nominal exchange rate deviates strongly from its PPP value, the exchange rate can be expected to revert to its fundamental value. Thus, we capture such *value phases* by a dummy variable F_t. More specifically, following the concept of real exchange rates, we compute a ratio of the CPI in Germany compared to the CPI in the United States,[11] i.e. (in logs)

$$q_t = s_t + p_t^{EUR} - p_t^{US}, \tag{3}$$

where p_t represent the CPIs, s_t the log exchange rate and q_t the ratio. If q_t is relatively large (small), the USD is relatively undervalued (overvalued) compared to the EUR in real terms. We take a recursive approach by comparing q_t to its distribution over the preceding ten years at each point in time. F_t equals unity if q_t belongs to the bottom or top quartile, and zero otherwise.

We consider the size of the trend of the USD/EUR exchange rate over the previous 30 days as a signal for a prevailing *momentum phase*. Again, we carry out a recursive approach and classify past absolute trends into three equally large subgroups: a phase in which the prevailing trend is relatively low ("low-momentum-phase", belonging to the lowest 33 percent during the 10 years prior to the respective date), a "normal momentum phase" and a "high-momentum-phase" (belonging to the top 33 percent).[12] We capture these phases by dummy variables D^L and D^H which are one for low and high momentum phases, respectively, and zero otherwise (the normal momentum phase will be considered the benchmark).

Finally, market conditions may differ in terms of the *interest differential phase*. To take this into account, we measure the absolute size of the differential between US and European short term interest rates, $|i^{USD} - i^{EUR}|$.

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[11] To avoid a structural break, we take the German CPI as reference base for the entire time span. Using the CPI for the entire Eurozone for the entire time span yields similar results.

[12] As we have the exact date of each individual forecast in our data, we are able to attach such a trend-phase as well as a contemporaneous interest rate differential to every forecast.

The interaction model To investigate how the impact of correctly anticipated fundamentals depends on the market phases introduced above, we consider interaction models following regressions of the type

$$r_{j,t,t+1} = \mu_j + \beta_1 |\varepsilon_{j,t}(i)| + \beta_2 S_{j,t} + \beta_3 \left(|\varepsilon_{j,t}(i)| \times S_{j,t} \right) + \epsilon_{j,t} \tag{4}$$

where $S_{j,t}$ represents the signal for the respective market phase; we conduct the regressions for $|\varepsilon_{j,t}(i^{EUR})|$ and $|\varepsilon_{j,t}(i^{USD})|$ separately and without instruments. Controlling for different states of the value, momentum or interest rate differential phases, respectively, we focus on the estimate of the marginal effect of an interest rate forecast (error) on the return earned by the FX forecast, i.e. $\frac{\partial r}{\partial |\varepsilon(i)|} = \hat{\beta}_1 + \hat{\beta}_3 \times S_{j,t}$.[13]

Forecasting fundamentals depending on value phases We model interaction effects of the absolute interest rate forecast error in dependence of the value market phase by setting $S_{j,t} = F_t$ in Eq. 4. Table 5 shows the coefficient estimates and the computed marginal effects.

TABLE 5 ABOUT HERE

Table 5, (i)-(ii), shows that the negative marginal effects of an interest rate forecast errors are larger when $F_t = 1$, i.e. when the exchange rate deviates substantially from its fundamental value according to PPP: the marginal effect of an error with respect to Eurozone interest rates is almost twice as large in these market phases with fundamental mispricing. The average return from T_{ind} decreases by 20 basis points for each increase in error points with respect to US interest rates when currencies are fundamentally mispriced; in contrast, this effect only amounts to 13 basis points in market phases when exchange rates are more aligned to fundamental values. To illustrate this

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[13] The standard error of this marginal effect can be obtained by

$$\left(Var(\hat{\beta}_1) + S_{j,t}^2 Var(\hat{\beta}_3) + 2 S_{j,t} Cov(\hat{\beta}_1, \hat{\beta}_3) \right)^{\frac{1}{2}}.$$

finding, Figure 1 shows predictions of returns conditional on the forecast error and the degree of deviation of the current nominal exchange rate from its PPP level.

Figure 1 about here

While these findings suggest that it is more important to understand *interest rates* in times in which a severe mispricing of exchange rates calls for value strategies, it is worth noting that a similar effect cannot be documented for other fundamentals, such as inflation rates or industrial production: Table 5, (iii)-(vi), shows a rather mixed pattern for these variables.

Forecasting fundamentals depending on momentum phases Similarly, we model interaction effects of the absolute interest rate forecast error in dependence of the momentum market phase by setting $S_{j,t} = \left(D^H_{j,t}\ D^L_{j,t}\right)'$ and $\beta_2 = (\beta_{21}\ \beta_{22})$ and $\beta_3 = (\beta_{31}\ \beta_{32})$ in Eq. 4.[14]

Table 6, (i) and (ii), shows that the marginal effects of interest rate forecast errors vary substantially across momentum phases: they matter most when the momentum is not particularly pronounced.

Table 6 about here

The marginal effect of a deterioration of a Euro interest rate forecast by one error point corresponds, on average, to a decline of the monthly trading return of 0.213 percentage points when the forecasts were made in normal momentum phases (see (i)). This value is not far away from the marginal effect in low momentum phases (-0.223), but differs substantially from the marginal effects observed in high momentum phases (0.025). While the former two marginal effects are significantly different from zero, this is not the case for the latter. These results indicate that a good prediction of European interest rates helps improve the FX forecasts unless momentum

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[14] The marginal effect is now computed by $\frac{\partial r}{\partial|\varepsilon(i)|} = \hat{\beta}_1 + \hat{\beta}_{31} \times D^L + \hat{\beta}_{32} \times D^H$ and its standard error by

$$\left(Var(\hat{\beta}_1) + (D^L)^2 Var(\hat{\beta_{31}}) + (D^H)^2 Var(\hat{\beta_{32}}) + 2(D^L)Cov(\hat{\beta}_1, \hat{\beta_{31}}) + 2(D^H)Cov(\hat{\beta}_1, \hat{\beta_{32}})\right)^{\frac{1}{2}}.$$

trading dominates markets. To illustrate this issue further, Figure 2 depicts predictions of returns conditional on the forecast error and the momentum phase.

Figure 2 about here

Figure 2(a) shows that returns decrease with increasing Euro interest rate forecast error for both low and normal momentum phases, leading to a positive expected return if the interest rates are predicted correctly, and to a negative expected return if the interest rates are anticipated in a (severely) wrong way. In contrast, the expected return is positive in high momentum phases regardless of the quality of the Euro interest rate forecast. As can be seen from the marginal effects in Table 5, (ii), and from subfigure 2(b), the results are very similar (and maybe even more pronounced) when the relationship between the forecast of the US interest rate and the FX forecasting performance is considered. There even is a significantly positive association of forecast errors with expected returns in high momentum phases, but this economic effect is much weaker than the opposite effect for low and normal momentum phases.

For comparison, Table 6 also shows that the marginal effects of the other fundamental forecast errors (w.r.t inflation, industrial production) are smaller in absolute value compared to those of the interest rate forecast errors: to mention the most pronounced effect, an increase of one error point with respect to the forecast of the European industrial production (see (v) in Table 6) leads to a return decrease of 0.155 percentage points in low momentum phases. The marginal effects of the industrial production forecast errors for both the US and the Eurozone have a negative sign for low and normal momentum phases. In high momentum phases, the effects of industrial production forecast errors are not found to be significantly different from zero. In low momentum phases, European inflation forecast errors appear to be significantly negatively related to FX returns from the trading rules, while there are, in contrast, significantly positive effects of inflation forecast errors in normal and high momentum phases.

Forecasting fundamentals and interest differential phases Finally, we also consider interaction models of the absolute forecast error with interest differential phases; hence, we set $S_t = |i_t^{USD} - i_t^{EUR}|$, and we focus on the marginal effects, i.e. $\frac{\partial r}{\partial |\varepsilon_{j,t}(i)|} = \hat{\beta}_1 + \hat{\beta}_3 \times |i_t^{USD} - i_t^{EUR}|$. Table 7 presents the coefficient estimates as well as the marginal effects evaluated at the average absolute interest rate differential over the sample period.

Table 7 about here

For this particular value, there are relatively large negative effects of prediction errors in interest rates forecasts (see (i) and (ii)). Figure 3 shows the state-dependent marginal effects in more detail.

Figure 3 about here

The effects of errors in interest rate forecasts (for both US and EUR interest rates) on FX forecasts are significantly negative; the marginal effects even decrease with increasing interest rate differentials. These results indicate that the ability to predict interest rates and industrial production growth is even more pronounced in phases in which interest rate differentials are large in absolute terms. This suggests that large interest rate differentials are rather a sign of a fundamental misalignment (in which fundamental analysis becomes more important) than an opportunity for carry trades.

For comparison, Table 7, (iii)-(vi), also reports similar exercises for the other fundamental forecasts besides interest rates. For growth and inflation forecast errors, unlike for interest rates, both significance and direction of effects differ depending on the size of interest rate differentials: as Figure 3, (c)-(f), illustrates, errors in predicting economic growth are detrimental to FX forecasts when interest rate differentials are large in absolute value, while these effects are insignificant or even reverse for interest rate differentials smaller than 1.3 percentage points with respect to European industrial production (or 1.7 percentage points with respect to US industrial production). This picture is the inverse for inflation forecast errors, which are only negatively related to FX forecasts when the interest rate differential is not too large.

6 Robustness

This section documents some of our robustness calculations showing that the main findings are not unique to the USD/EUR exchange rate (Section 6.1) and do not depend on the specific trading rule (Section 6.2) or on the usage of trading rules as a performance measure in general (Section 6.3).

6.1 Further currencies

As our panel data set also includes forecasts for the GBP/EUR and JPY/EUR exchange rates, British and Japanese interest rates and further fundamentals, we can easily extend the analysis above to further currencies. In doing so, we show that the overall relationship between interest rate forecasts and FX forecasts demonstrated above is not unique to the USD/EUR exchange rate.

As introduced in Eq. 2, we run fixed effects regressions of the type

$$r_{j,t,t+1} = \mu_j + \beta_1|\varepsilon_{j,t}(i^{EUR})| + \beta_2|\varepsilon_{j,t}(i^{\star})| + \gamma\Phi_{j,t} + \delta\Psi_{j,t} + \epsilon_{j,t},$$

i.e., we regress the return of a trading rule based on an individual's forecasts of the GBP/EUR rate (and separately, the JPY/EUR rate) on the forecast error with respect to the European interest rate and the foreign (i.e. British or Japanese) interest rate $i^{\star}$ and corresponding control variables. Table 8 displays the results. Strikingly, the negative and significant coefficients of absolute interest rate forecast errors remain a common feature in all specifications, while there are larger differences across currencies and specifications for the other fundamentals considered control variables.

Table 8 about here

The β coefficients differ in size across currencies, as they are largest for the Japanese, and smallest for the British interest rate forecast errors: an increase of the Japanese interest rate forecast error by one standard deviation (0.5529) decreases the return for the JPY/EUR investment according to T_{ind} by 37 basis points (in (iv)), which is even relatively larger than the documented relationship for the US interest rate and the USD/EUR exchange rate. In contrast, it appears that the influence of a valid Eurozone interest rate forecast is more important than a British interest rate forecast, as a one standard deviation increase in the Eurozone interest rate decreases the return for the GBP/EUR investment according to T_{ind} by 18 basis points, which is in a similar range to the US interest rate for the USD/EUR exchange rate. In contrast, an increase in absolute forecast error with respect to UK interest rates decreases the FX forecast return by only 8 basis points.

6.2 A different specification of the trading rule

To operate with a market-based loss function for the evaluation an individual's forecasting performance, we have introduced the returns on a zero net investment trading rule as our central performance measure in Eq. 1, which we repeat here for convenience:

$$r_{j,t,t+k} = I_t(s_t > E_{j,t}[s_{t+1}])(f_{t,1} - s_{t+1}) + I_t(s_t < E_{j,t}[s_{t+1}])(s_{t+1} - f_{t,1}).$$

Eq. 1 implies that the investor uses the forward market when taking a long/short position, which is (through covered interest rate parity) equivalent to borrowing in one currency and investing the same amount in the other currency at market interest rates. While this approach is natural for an investor, it has to be noted that the FX forecasts are made with respect to spot rates only whereas the returns $r_{j,t,t+k}$ depend on changes in the spot rates *and* the current levels of refinancing costs (i.e., the interest rate differential). In the following, we demonstrate that the results are very similar when we consider the returns of a trading rule according to which an investor takes her position in the spot market (ignoring the costs and revenues of borrowing and investing), which may be written as

$$r^{alt}_{j,t,t+k} = I_t(s_t > E_{j,t}[s_{t+1}])(s_t - s_{t+1}) + I_t(s_t < E_{j,t}[s_{t+1}])(s_{t+1} - s_t). \tag{5}$$

For the intuition of our results, one should bear in mind that the considered spot rates and one-month-forward rates are highly correlated ($\rho > 0.99$) on a monthly frequency. Moreover, the absolute difference of log USD/EUR spot rates and forward rates is on average (over the sample period) 14 basis points, while the average absolute change of log spot rates from one month to the next amounts to 229 basis points. These proportions suggest that $r_{j,t,t+k}$ should primarily be driven by changes in exchange rates rather than refinancing costs. Our estimates confirms this view as the coefficients of interest are very similar compared to those in the main part; it appears that the differences between these two return definitions is mainly captured in the individual fixed effects and year dummies.[15]

6.3 An alternative to *trading rules* as measures of forecasting performance

Average absolute forecasting errors This paragraph documents that our findings do not depend on the use of trading rules to measure FX forecast performance; in contrast, the main insights are similar when the analysis is based on absolute forecasting errors $|\varepsilon_{j,t}(FX)|$ instead (computed as above for the interest rate forecasts).[16] These two measures are negatively related, as a *large* error corresponds to *poor* forecasting performance, which implies low returns. In fact, there is a negative correlation coefficient of -0.8 when considering the entire panel of data over time for all forecasters.

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[15] For further details, see Table A3 in the Appendix.

[16] We group the one-month-ahead realizations of FX log changes into "appreciation", "no-change" and "depreciation" categories. The bounds of the "unchanged" category are chosen symmetrically around zero such that the share of realizations in the no-change category equals the share of expectations in that category: the size of the medium category for the USD/EUR forecasts is 27%, leading to a threshold of ±1.1% for the medium category of realizations. The absolute errors are then obtained by taking the difference, such that a severe error is counted as 2, and a smaller one as 1.

An ordered response model When using FX forecast errors, we have to deal with the categorical nature of the dependent variable, i.e., the 0, 1 or 2 score of the forecast error. Ordered probit models provide a common way to compute $P[(|\varepsilon_{j,t}(FX)| = 0) \big| |\varepsilon_{j,t}(i)|]$, i.e. the probability of making a correct FX forecast in dependence of $|\varepsilon_{j,t}(i)|$;[17] as we are interested in phase-dependent effects of interest rate forecasts on FX forecasts, we specify the models with interaction terms (as also done in Eq. 4), i.e.

$$\varepsilon^{\star} = \beta' X = \beta_1 |\varepsilon_{j,t}(i)| + \beta_2 S_{j,t} + \beta_3 \left(|\varepsilon_{j,t}(X)| \times S_{j,t} \right) + \epsilon_{j,t}, \tag{6}$$

where the respondents‘ FX forecast errors $|\varepsilon_{j,t}(FX)|$ are related to the unobserved $\varepsilon^{\star}$ with the treshold parameters κ_1 and κ_2. $S_{j,t}$ is the short-cut for the variables $|\varepsilon_{j,t}(i)|$ is interacted with; as before, this may be a dummy signalling fundamental mispricing phases, low/high momentum trading phases or the size of interest rate differential.

Results Table 9 displays the results from the ordered probit regressions, where the probability of making a correct forecast $P(|\varepsilon_{j,t}(FX)| = 0)$ is computed by $\Phi(\kappa_1 - \beta' X)$, with $\Phi(\cdot)$ being the cumulative standard normal density.

Table 9 about here

The marginal effects of an interest rate forecast error on the probability of a correct FX forecast are computed by $-\phi(\kappa_1 - \beta' X) \times [\beta_1 + \beta_3 x_1]$ (with $\phi(\cdot)$ being the standard normal density). Table 9 also presents these marginal effects, where columns (i) and (ii) contain the interaction models with momentum signals. The marginal effects of interest rate forecasts observed in the low and normal momentum phases are significantly negative for both the US and Eurozone interest rates (while the effects are more pronounced for the US interest rates), indicating that a worse interest rate forecast decreases the probability of making correct FX forecasts. In high trend phases, these

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[17] For brevity, we focus on $P[(|\varepsilon_{j,t}(FX)| = 0) \big| |\varepsilon_{j,t}(i)|]$. The argumentation could obviously also be made on $P[(|\varepsilon_{j,t}(FX)| = 2) \big| |\varepsilon_{j,t}(i)|]$, i.e. the probability of making a severe error. Those results would tell the same story.

effects are smaller in absolute size or even insignificant, confirming our results from the main section that the relationship between interest rates and FX forecasting performance breaks down when the signals for momentum strategies are strong. Columns (iii) and (iv) show the results from the interaction models including the interest rate differential phase, taking two different levels of absolute interest rate differentials as illustrative examples. As in the baseline analysis above, it can be seen that higher forecast errors decrease the probability of making a good FX forecast and that this effect is more pronounced when interest rate differentials are larger. Columns (v) and (vi) show that the probability of making a correct USD forecast decreases more strongly with more severe interest rate errors when the exchange rate deviates substantially from its fundamentally fair value according to PPP.

6.4 Different estimators

As described in more detail in Section 5.1, we conduct panel IV fixed effects regressions. Our main result, i.e. a significantly negative relationship between short term interest forecast errors on FX forecasting performance, however, is also found when using pooled OLS with (Table A4) or without (Table A5) instruments or fixed effects without instruments (Table A6).

7 Conclusions

The research reported in this paper suggests an affirmative answer to the question of whether exchange rates are related to economic fundamentals at medium-term horizons, such as a month ahead or longer. As is now widely accepted, it is difficult to obtain a conclusive set of results from conventional tests of exchange rate models at this horizon (Cheung, Chinn, and Pascual, 2005; Engel and West, 2005) and so in this paper we propose another route.

The starting point of our research is the hypothesis that expected fundamentals determine exchange rates. Accordingly, we rely on a large data set of individual expectations on fundamentals and exchange rates. Analyzing these expectations shows enormous heterogeneity, a fact that is well documented in the literature and it demonstrates therefore that in this sense our data are conventional. In order to learn about the formation of exchange rates, we make use of the heterogeneity with respect to forecasting performance. Given the assumption that individuals who can forecast exchange rates should have a correct understanding about exchange rate determinants, we investigate whether the quality of fundamental forecasts is related to the ability to predict exchange rates. As interest rates can be seen as the most important determinant of exchange rates over medium-term horizons, we analyze the connection between interest rate and FX forecast performance. We find that good exchange rate forecasting performance is robustly related to good interest rate forecasts.

While our results indicate that there is an important role of interest rate forecasts in general, we also investigate in which respect the importance of fundamentals varies over market phases, i.e. FX value, momentum or interest differential phases. We find evidence that signals for momentum strategies make fundamental considerations dispensable, while good fundamental forecasts of interest rates and economic growth become even more important when exchange rates substantially deviate from their PPP value or when interest rate differentials are high.

Overall, we provide evidence based on a large sample of professional forecasters that their forecasting performance at the one month horizon is positively related to their performance in forecasting short term interest rates. This robust relationship suggests that understanding fundamentals helps to understand exchange rates. We also find, however, that this determination is potentially rivaled by other time-varying influences, such as stronger trends in exchange rates which may lead to a non-fundamentally motivated momentum trading. This rivalry may be one of the reasons why it is so difficult to reveal the impact of fundamentals on exchange rates in conventional tests.

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Table 1: Structure of survey responses

This table reports the number of participants and observations with different minimum number of USD/EUR forecasts. (While the entire database consists of 1747 forecasters with USD/EUR forecasts, we consider those forecasters who responded at least 10 times to the survey in the remainder of this analysis.)

Min # of responses	# of forecasters	% of all participants	# of observations
1	1,747	100.00	64,813
10	1,056	60.45	63,222
25	763	43.40	59,511
50	519	29.52	50,705
100	208	11.83	28,310
150	62	3.53	11,333
200	11	0.63	2,264

Table 2: Average FX forecasting performance in the cross section: Mean returns and Sharpe ratios of T_{ind}

This table reports statistics on the cross section of forecasters with respect to the average performance of a forecaster over time when she follows the trading rule T_{ind} according to her forecasts. Panel A includes the performance measures for the 95-percentile, median and 5-percentile forecaster, sorted by mean returns and Sharpe ratios, respectively. These values are compared to the average value T_0 of a simulation experiment which repeats 10,000 purely random (coin toss) strategies (an investor buys or sells USD against the Euro in the forward market according to a coin toss, and settles her position one month later). Panel B reports the number and percentage share of forecasters with Sharpe ratios larger or smaller than specific threshold values.

Panel A	Percentile of forecasters	Mean return	Sharpe ratio
T_{ind}	X_{95}	0.746	1.159
	X_{50}	0.076	0.114
	X_{05}	-0.673	-0.856
T_0	Average	-0.002	-0.001

Panel B	Sharpe ratio	# of forecasters	in %
T_{ind}	<-1.0	40	3.7
	<0.4	171	16.0
	>0.4	315	29.5
	>1.0	80	7.5

Table 3: Macroeconomic fundamentals: average absolute forecast errors

This table reports the distribution of forecasts (median and quartiles) of the average absolute forecast errors $|\varepsilon_i(X)|$ across the cross section with respect to different macroeconomic variables X, i.e. the short term interest rate i, inflation rate π, and industrial production yoy growth rate y. A severe forecast error (wrong direction of change) is counted as 2, a small forecast error (e.g., constant instead of increase or decrease) is counted as 1.

	$\vert\varepsilon_i(i)\vert$ Eurozone	$\vert\varepsilon_i(i)\vert$ USA	$\vert\varepsilon_i(\pi)\vert$ Eurozone	$\vert\varepsilon_i(\pi)\vert$ USA	$\vert\varepsilon_i(y)\vert$ Eurozone	$\vert\varepsilon_i(y)\vert$ USA
X_{25}	0.58	0.65	0.53	0.58	0.62	0.48
X_{50}	0.71	0.77	0.63	0.69	0.73	0.57
X_{75}	0.83	0.90	0.73	0.79	0.84	0.68

Table 4: Panel Fixed Effects Regression

This table reports the results of panel regressions with individual fixed effects of the trading rule T_{ind}'s period forecast return, $r_{j,t,t+1}$ (based on the USD/EUR forecast of the forecaster j in t), on the absolute forecast error made for European and US-American interest rates ($|\varepsilon_{j,t}(i^{EUR})|$ and $|\varepsilon_{j,t}(i^{USD})|$, respectively) as well as a battery of control variables $\Phi_{j,t}$ and $\Psi_{j,t}$, i.e.

$$r_{j,t,t+1} = \mu_j + \beta_1|\varepsilon_{j,t}(i^{EUR})| + \beta_2|\varepsilon_{j,t}(i^{USD})| + \gamma\Phi_{j,t} + \delta\Psi_{j,t} + \epsilon_{j,t}.$$

Depending on the specification (i) to (vii), $\Phi_{j,t}$ includes forecast errors with respect to other fundamentals than interest rates, i.e. inflation ($|\varepsilon(\pi)|$) and industrial production growth forecast errors $|\varepsilon(y)|$. We use lagged values as external instruments for $|\varepsilon_{j,t}(i^{EUR})|$, $|\varepsilon_{j,t}(i^{USD})|$ and $\Phi_{j,t}$. $\Psi_{j,t}$ represents purely exogenous control variables such as year specific dummy variables. Significance: ***:1%, **: 5%, *: 10%.

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)
$\|\varepsilon_{j,t}(i^{EUR})\|$	-0.107		-0.105		-0.184		-0.159
	***(0.031)		***(0.031)		***(0.039)		***(0.041)
$\|\varepsilon_{j,t}(i^{USD})\|$		-0.134		-0.148		-0.162	-0.123
		***(0.036)		***(0.038)		***(0.054)	**(0.057)
$\|\varepsilon_{j,t}(\pi^{EUR})\|$			-0.095		-0.145		-0.190
			**(0.044)		***(0.052)		***(0.056)
$\|\varepsilon_{j,t}(\pi^{USD})\|$				0.177		0.021	0.082
				***(0.045)		(0.056)	(0.060)
$\|\varepsilon_{j,t}(y^{EUR})\|$			-0.040		0.088		0.116
			(0.065)		(0.085)		(0.096)
$\|\varepsilon_{j,t}(y^{USD})\|$				-0.066		-0.170	-0.201
				(0.056)		***(0.060)	***(0.069)
$\bar{\mu}$	0.182	0.213	0.269	0.137	0.421	0.450	0.594
	***(0.025)	***(0.031)	***(0.058)	**(0.057)	***(0.094)	***(0.095)	***(0.111)
Year dummies	NO	NO	NO	NO	YES	YES	YES
$N \times T$	51,512	50,793	51,155	50,084	51,155	50,084	49,872
R^2_B	0.003	0.008	0.001	0.012	0.130	0.121	0.089
R^2_O	0.001	0.002	0.001	0.001	0.021	0.023	0.021
R^2_W	0.001	0.002	0.001	0.002	0.018	0.019	0.017

Table 5: Interaction model: signals for value trade phases

This table reports the results of a panel regression with individual fixed effects of the trading rule T_{ind}'s period forecast return, $r_{j,t,t+1}$ (based on the forecast of the forecaster j in t), on a fundamental forecast error (in absolute terms) $|\varepsilon_{j,t}(X)|$, a dummy variable F_t taking on unity if the exchange rate strongly deviates from its PPP value and zero otherwise, and an interaction of the these two variables, i.e.,

$$r_{j,t,t+1} = \mu_j + \beta_1|\varepsilon_{j,t}(X)| + \beta_2 F_t + \beta_3\left(|\varepsilon_{j,t}(X)| \times F_t\right) + \epsilon_{j,t}.$$

Depending on the specification (i) to (vi), X represents the interest rates i, the industrial production growth rate (yoy) y and the inflation rate π projections for the US and the Eurozone, respectively, made by j in t. Clustering-robust standard errors (by observational unit) are provided in parentheses. We also report the covariance between $\hat{\beta}_1$ and $\hat{\beta}_4$ or $\hat{\beta}_1$ and $\hat{\beta}_5$, respectively. The table also provides the marginal effects of a fundamental forecast error in both value phases ($F_t = 1$) and non-value phases ($F_t = 0$). Significance: ***:1%, **: 5%, *: 10%.

	(i)- $X : i_{EUR}$	(ii)- $X : i_{USD}$	(iii)- $X : \pi_{EUR}$	(iv)- $X : \pi_{USD}$	(v)- $X : y_{EUR}$	(vi)- $X : y_{USD}$
$\lvert\varepsilon_{j,t}(X)\rvert$	-0.085	-0.129	-0.080	0.261	-0.055	-0.022
	***(0.028)	***(0.037)	***(0.028)	***(0.027)	**(0.028)	(0.030)
F_t	-0.048	-0.065	-0.186	0.153	-0.103	-0.124
	(0.032)	(0.040)	***(0.034)	***(0.039)	***(0.036)	***(0.032)
$\lvert\varepsilon_{j,t}(X)\rvert \times F_t$	-0.061	-0.070	0.104	-0.354	-0.030	-0.003
	*(0.032)	*(0.041)	***(0.035)	***(0.036)	(0.033)	(0.036)
$\bar{\mu}$	0.220	0.279	0.226	-0.036	0.217	0.193
	***(0.024)	***(0.0335)	***(0.025)	(0.029)	(0.028)	(0.025)
$N \times T$	63,693	62,940	63,675	62,832	63,760	63,070
R^2_{corr}	0.002	0.003	0.001	0.003	0.002	0.001
$Cov(\hat{\beta}_1, \hat{\beta}_3)$	-0.0008	-0.0013	-0.0008	-0.0008	-0.0008	-0.0009
$\left.\frac{\partial r}{\partial\lvert\varepsilon_{j,t}(X)\rvert}\right\rvert_{F_t=0}$	-0.085	-0.129	-0.080	0.261	-0.055	-0.022
	***(0.028)	***(0.037)	***(0.028)	***(0.028)	**(0.028)	(0.030)
$\left.\frac{\partial r}{\partial\lvert\varepsilon_{j,t}(X)\rvert}\right\rvert_{F_t=1}$	-0.147	-0.199	0.025	-0.094	-0.085	-0.025
	***(0.017)	***(0.018)	(0.019)	***(0.094)	***(0.018)	(0.021)

Table 6: Interaction model: signals for momentum trade phases

This table reports the results of a panel regression with individual fixed effects of the trading rule T_{ind}'s period forecast return, $r_{j,t,t+1}$ (based on the forecast of the forecaster j in t), on a fundamental forecast error (in absolute terms) $|\varepsilon_{j,t}(X)|$, a trend-phase dummy (for low and high trend phases, D^L and D^H) and an interaction of the forecast error with the trend-phase, i.e.,

$$r_{j,t,t+1} = \mu_j + \beta_1|\varepsilon_{j,t}(X)| + \beta_{21}D^L_{j,t} + \beta_{22}D^H_{j,t} + \beta_{31}\left(|\varepsilon_{j,t}(X)| \times D^L_{j,t}\right) + \beta_{32}\left(|\varepsilon_{j,t}(X)| \times D^H_{j,t}\right) + \epsilon_{j,t}.$$

Note that the "normal" trend phase is taken as reference. Depending on the specification (i) to (vi), X represents the interest rates i, the industrial production growth rate (yoy) y and the inflation rate π projections for the US and the Eurozone, respectively, made by j in t. Clustering-robust standard errors (by observational unit) are provided in parentheses. We also report the covariance between $\hat{\beta}_1$ and $\hat{\beta}_4$ or $\hat{\beta}_1$ and $\hat{\beta}_5$, respectively. $\frac{\partial r}{\partial|\varepsilon_{j,t}(X)|}$ represents the marginal effects of a fundamental forecast error on $r_{j,t,t+1}$. Significance: ***:1%, **: 5%, *: 10%.

	(i)- $X : i_{EUR}$	(ii)- $X : i_{USD}$	(iii)- $X : \pi_{EUR}$	(iv)- $X : \pi_{USD}$	(v)- $X : y_{EUR}$	(vi)- $X : y_{USD}$
$\|\varepsilon_{j,t}(X)\|$	-0.214	-0.208	0.070	0.048	-0.118	-0.063
	***(0.026)	***(0.030)	**(0.028)	*(0.026)	***(0.028)	**(0.028)
$D^L_{j,t}$	-0.120	0.010	0.010	-0.092	-0.094	-0.150
	***(0.032)	(0.036)	(0.033)	***(0.034)	***(0.033)	***(0.032)
$D^H_{j,t}$	-0.233	-0.276	-0.053	-0.074	-0.189	-0.121
	***(0.037)	***(0.039)	(0.034)	*(0.038)	***(0.036)	***(0.033)
$\|\varepsilon_{j,t}(X)\| \times D^L_{j,t}$	-0.009	-0.177	-0.197	-0.040	-0.037	0.044
	(0.036)	***(0.041)	***(0.038)	(0.036)	(0.039)	(0.038)
$\|\varepsilon_{j,t}(X)\| \times D^H_{j,t}$	0.240	0.268	-0.013	0.012	0.183	0.099
	***(0.037)	***(0.038)	(0.040)	(0.038)	***(0.041)	**(0.042)
$\bar{\mu}$	0.304	0.316	0.109	0.120	0.232	0.193
	***(0.023)	***(0.026)	***(0.020)	***(0.023)	***(0.022)	***(0.021)
$N \times T$	63,693	62,940	63,675	62,832	63,760	63,070
R^2_{corr}	0.003	0.005	0.001	0.006	0.002	0.001
$Cov(\hat{\beta}_1, \hat{\beta}_4)$	-0.0007	-0.0009	-0.0008	-0.0007	-0.0008	-0.0008
$Cov(\hat{\beta}_1, \hat{\beta}_5)$	-0.0007	-0.0008	-0.0008	-0.0006	-0.0009	-0.0008
$\frac{\partial r}{\partial\|\varepsilon_{j,t}(X)\|}$ (Low momentum phase)	-0.224	-0.385	-0.127	0.007	-0.155	-0.020
	***(0.026)	***(0.028)	***(0.028)	(0.025)	***(0.026)	(0.026)
$\frac{\partial r}{\partial\|\varepsilon_{j,t}(X)\|}$ (Normal momentum phase)	-0.214	-0.208	0.070	0.048	-0.118	-0.063
	***(0.026)	***(0.030)	**(0.028)	*(0.026)	***(0.028)	**(0.028)
$\frac{\partial r}{\partial\|\varepsilon_{j,t}(X)\|}$ (High momentum phase)	0.026	0.060	0.058	0.060	0.065	0.036
	(0.026)	**(0.027)	**(0.028)	**(0.029)	(0.027)	(0.033)

Table 7: Interaction model: interest rate differential phases

This table reports the results of a panel regression with individual fixed effects of the trading rule T_{ind}'s period forecast return, $r_{j,t,t+1}$ (based on the forecast of the forecaster j in t), on a fundamental forecast error (in absolute terms) $|\varepsilon_{j,t}(X)|$, the absolute differential between the US and Euro interest rates, $|i_t^{USD} - i_t^{EUR}|$, and an interaction of the these two variables, i.e.,

$$r_{j,t,t+1} = \mu_j + \beta_1 |\varepsilon_{j,t}(X)| + \beta_2 |i_t^{USD} - i_t^{EUR}| + \beta_3 \left(|\varepsilon_{j,t}(X)| \times |i_t^{USD} - i_t^{EUR}| \right) + \epsilon_{j,t}.$$

Depending on the specification (i) to (vi), X represents the interest rates i, the industrial production growth rate (yoy) y and the inflation rate π projections for the US and the Eurozone, respectively, made by j in t. Clustering-robust standard errors (by observational unit) are provided in parentheses. We also report the covariance between $\hat{\beta}_1$ and $\hat{\beta}_4$ or $\hat{\beta}_1$ and $\hat{\beta}_5$, respectively. The table also provides the marginal effects of a fundamental forecast error on $r_{j,t,t+1}$ evaluated at the average absolute interest rate differential between 1991.12 and 2009.11, $\overline{|i_t^{USD} - i_t^{EUR}|} = 2.84118$. Significance: ***:1%, **: 5%, *: 10%.

	(i)- $X: i_{EUR}$	(ii)- $X: i_{USD}$	(iii)- $X: \pi_{EUR}$	(iv)- $X: \pi_{USD}$	(v)- $X: y_{EUR}$	(vi)- $X: y_{USD}$
$\|\varepsilon_{j,t}(X)\|$	-0.083	-0.113	-0.195	-0.067	0.119	0.149
	**(0.033)	***(0.035)	***(0.033)	*(0.036)	***(0.035)	***(0.037)
$\|i_t^{USD} - i_t^{EUR}\|$	-0.047	-0.048	-0.142	-0.109	0.010	-0.003
	***(0.018)	***(0.019)	***(0.016)	***(0.016)	(0.018)	(0.017)
$\|\varepsilon_{j,t}(X)\| \times \|i_t^{USD} - i_t^{EUR}\|$	-0.040	-0.056	0.120	0.068	-0.124	-0.112
	**(0.017)	***(0.019)	***(0.018)	***(0.020)	***(0.019)	***(0.020)
$\bar{\mu}$	0.269	0.323	0.321	0.239	0.131	0.112
	***(0.032)	***(0.034)	***(0.027)	***(0.028)	***(0.032)	***(0.030)
$N \times T$	63,693	62,940	63,675	62,832	63,760	63,070
R^2_{corr}	0.002	0.004	0.002	0.001	0.002	0.002
$Cov(\hat{\beta}_1, \hat{\beta}_3)$	-0.0005	-0.0006	-0.0005	-0.0006	-0.0006	-0.0006
$\left.\frac{\partial r}{\partial \|\varepsilon_{j,t}(X)\|}\right\|_{\overline{\|i_t^{USD} - i_t^{EUR}\|}}$	-0.196	-0.271	0.146	0.126	-0.234	-0.169
	***(0.025)	***(0.029)	***(0.026)	***(0.028)	***(0.027)	***(0.028)

Table 8: Robustness: GBP/EUR and JPY/EUR exchange rates

This table reports the results of panel regressions with individual fixed effects of the trading rule T_{ind}'s period forecast return, $r_{j,t,t+1}$ (based on the GBP/EUR and JPY/EUR forecast of the forecaster j in t), on the absolute forecast error made for European, British and Japanese interest rates ($|\varepsilon_{j,t}(i^{EUR})|$, $|\varepsilon_{j,t}(i^{GBP})|$ and $|\varepsilon_{j,t}(i^{JPY})|$, respectively) as well as a battery of control variables $\Phi_{j,t}$ and $\Psi_{j,t}$, i.e.

$$r_{j,t,t+1} = \mu_j + \beta_1|\varepsilon_{j,t}(i^{EUR})| + \beta_2|\varepsilon_{j,t}(i^{EUR})| + \gamma\Phi_{j,t} + \delta\Psi_{j,t} + \epsilon_{j,t}.$$

Depending on the specification (i) to (viii), $\Phi_{j,t}$ includes forecast errors with respect to other fundamentals than interest rates, i.e. inflation ($|\varepsilon(\pi)|$) and industrial production growth forecast errors $|\varepsilon(y)|$. We use lagged values as external instruments for $|\varepsilon_{j,t}(i^{EUR})|$, $|\varepsilon_{j,t}(i^{GBP})|$, $|\varepsilon_{j,t}(i^{JPY})|$, and $\Phi_{j,t}$. $\Psi_{j,t}$ represents year specific dummy variables as purely exogenous control variables. Significance: ***:1%, **: 5%, *: 10%.

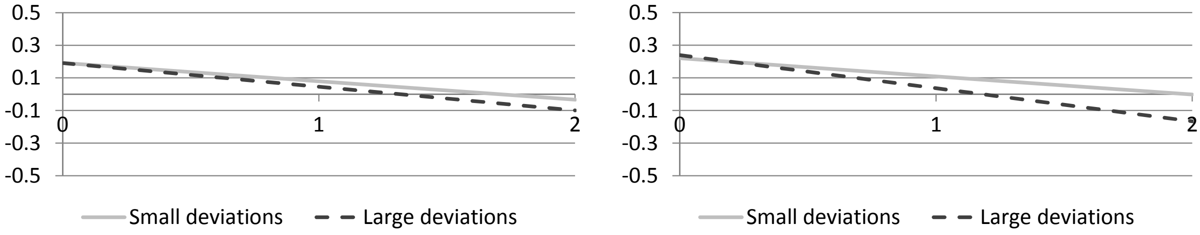
	(i): GBP/EUR	(ii): GBP/EUR	(iii): GBP/EUR	(iv): GBP/EUR	(v): JPY/EUR	(vi): JPY/EUR	(vii): JPY/EUR	(viii): JPY/EUR
$\lvert\bar{\varepsilon}(i_{EUR})\rvert$	-0.194		-0.264		-0.157		-0.235	
	***(0.021)		***(0.026)		***(0.031)		***(0.038)	
$\lvert\bar{\varepsilon}(i_{GBP})\rvert$		-0.068		-0.125				
		**(0.028)		***(0.033)				
$\lvert\bar{\varepsilon}(i_{JPY})\rvert$						-0.786		-0.671
						***(0.071)		***(0.091)
$\lvert\bar{\varepsilon}(\pi_{EUR})\rvert$	-0.040		-0.073		0.199		0.240	
	(0.029)		**(0.034)		***(0.043)		***(0.050)	
$\lvert\bar{\varepsilon}(\pi_{GBP})\rvert$		0.028		-0.041				
		(0.034)		(0.041)				
$\lvert\bar{\varepsilon}(\pi_{JPY})\rvert$						0.082		0.292
						(0.065)		***(0.079)
$\lvert\bar{\varepsilon}(y_{EUR})\rvert$	-0.059		-0.160		0.378		0.147	
	(0.043)		***(0.057)		***(0.063)		*(0.083)	
$\lvert\bar{\varepsilon}(y_{GBP})\rvert$		-0.061		0.102				-0.049
		(0.049)		*(0.059)				(0.072)
$\lvert\bar{\varepsilon}(y_{JPY})\rvert$						0.027		
						(0.054)		
const.	0.262	0.125	0.705	0.454	-0.130	0.465	0.181	0.974
	***(0.038)	***(0.038)	***(0.062)	***(0.067)	**(0.057)	***(0.056)	*(0.094)	***(0.144)
Year dummies	NO	NO	YES	YES	NO	NO	YES	YES
N	51,175	46,531	51,175	46,531	51,161	38,703	51,258	38,703
R^2	0.001	0.001	0.009	0.019	0.001	0.002	0.015	0.003

Table 9: Robustness: absolute forecast errors

This table reports the results from an ordered-probit regression of the type $\varepsilon^{\star} = \beta' X = \beta_1 |\varepsilon_{j,t}(i)| + \beta_2 x_1 + \beta_3 \left(|\varepsilon_{j,t}(X)| \times x_1\right) + \epsilon_{j,t}$ where the respondents‘ FX forecast errors $|\varepsilon_{j,t}(FX)|$ are related to the unobserved $\varepsilon^{\star}$ with the treshold parameters κ_1 and κ_2. $|\varepsilon_{j,t}(i)|$ represents the absolute interest rate forecast error, x_1 is a short-cut for the variables that $|\varepsilon_{j,t}(i)|$ is interacted with, e.g. the dummy variables for a fundamental mispricing according to PPP ($F_t = 1$ if mispriced), low or high trend phases D^L and D^h, respectively, or the interest rate differential $|i_t^{USD} - i_t^{EUR}|$. Marginal effects of an interest rate forecast error on the probability of making a correct FX forecast ($\left.\frac{\partial P(|\varepsilon(FX)|=0)}{\partial |\varepsilon_{j,t}(X)|}\right|_{\varepsilon_{j,t}(X)=1}$) are computed by $-\phi(\kappa_1 - \beta' X) \times [\beta_1 + \beta_3 x_1]$, whereas the corresponding standard errors are obtained by the delta method. Standard errors are provided in parentheses. Significance: ***:1%, **: 5%, *: 10%.

	(i) EUR	(ii) USD	(iii) EUR	(iv) USD	(v) EUR	(vi) USD
$\|\varepsilon_{j,t}(i)\|$	0.070	0.148	0.030	0.077	0.033	0.103
	***(0.011)	***(0.012)	**(0.012)	***(0.013)	**(0.013)	***(0.014)
$D_{j,t}^L$	0.050	0.035				
	***(0.015)	**(0.017)				
$D_{j,t}^H$	0.113	0.143				
	***(0.016)	***(0.018)				
$\|\varepsilon_{j,t}(i)\| \times D_{j,t}^L$	0.001	0.021				
	(0.016)	(0.017)				
$\|\varepsilon_{j,t}(i)\| \times D_{j,t}^H$	-0.082	-0.116				
	***(0.016)	***(0.017)				
$\|i_t^{USD} - i_t^{EUR}\|$			0.010	0.004		
			(0.007)	(0.007)		
$\|\varepsilon_{j,t}(i)\| \times \|i_t^{USD} - i_t^{EUR}\|$			0.012	0.030		
			*(0.007)	***(0.007)		
F_t					0.013	0.013
					(0.014)	(0.016)
$\|\varepsilon_{j,t}(i)\| \times F_t$					0.013	0.019
					(0.015)	(0.016)
κ_1	-0.300	-0.235	-0.332	-0.280	-0.342	-0.282
	***(0.011)	***(0.012)	***(0.013)	***(0.014)	***(0.011)	***(0.014)
κ_2	0.737	0.804	0.704	0.756	0.694	0.756
	***(0.011)	***(0.012)	***(0.013)	***(0.014)	***(0.011)	***(0.014)
$N \times T$	63,055	62,552	63,055	62,552	63,055	62,552
R^2_{corr}	0.001	0.002	0.001	0.003	0.000	0.002
$\left.\frac{\partial P(\|\varepsilon(FX)\|=0)}{\partial \|\varepsilon(i)\|}\right\|_{\varepsilon(i)=1}$ (Low trend)	-0.026 ***(0.004)	-0.061 ***(0.004)				
$\left.\frac{\partial P(\|\varepsilon(FX)\|=0)}{\partial \|\varepsilon(i)\|}\right\|_{\varepsilon(i)=1}$ (Normal trend)	-0.027 ***(0.004)	-0.055 ***(0.004)				
$\left.\frac{\partial P(\|\varepsilon(FX)\|=0)}{\partial \|\varepsilon(i)\|}\right\|_{\varepsilon(i)=1}$ (High trend)	0.004 (0.004)	-0.012 ***(0.004)				
$\left.\frac{\partial P(\|\varepsilon(FX)\|=0)}{\partial \|\varepsilon(i)\|}\right\|_{\varepsilon(i)=1, \|i_t^{USD} - i_t^{EUR}\|=0.1}$			-0.011 **(0.005)	-0.030 ***(0.005)		
$\left.\frac{\partial P(\|\varepsilon(FX)\|=0)}{\partial \|\varepsilon(i)\|}\right\|_{\varepsilon(i)=1, \|i_t^{USD} - i_t^{EUR}\|=2.84188}$			-0.023 ***(0.004)	-0.059 ***(0.004)		
$\left.\frac{\partial P(\|\varepsilon(FX)\|=0)}{\partial \|\varepsilon(i)\|}\right\|_{\varepsilon(i)=1, \|F=0}$					-0.012 **(0.005)	-0.038 ***(0.005)
$\left.\frac{\partial P(\|\varepsilon(FX)\|=0)}{\partial \|\varepsilon(i)\|}\right\|_{\varepsilon(i)=1, \|F=1}$					-0.017 ***(0.005)	-0.045 ***(0.005)

Figure 1: Expected effects of fundamental forecast errors under different FX value phases



(a) i_{EUR}

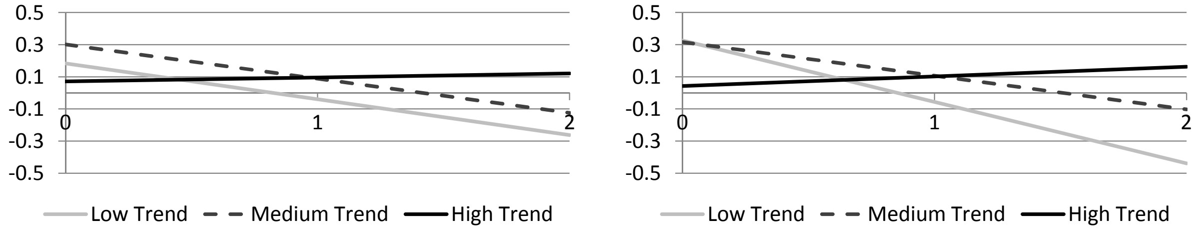
(b) i_{USD}

This figure depicts predictions of the average returns conditional on 1) the forecast quality of an interest rate forecast and 2) the FX value phase phase based on the fixed effects panel regression

$$r_{j,t,t+1} = \mu_j + \beta_1 |\varepsilon_{j,t}(i)| + \beta_2 F_t + \beta_3 \left(|\varepsilon_{j,t}(i)| \times F_t \right) + \epsilon_{j,t}.$$

The x-axis shows the absolute forecast error (0 for no error, 2 for a severe error), while the y-axis displays the returns. In each graph, there is a different line for each a value phase in which the exchange rate strongly deviates from the PPP value, and a market phase with small deviations from PPP.

Figure 2: Expected effects of fundamental forecast errors under different momentum phases



(a) i_{EUR}

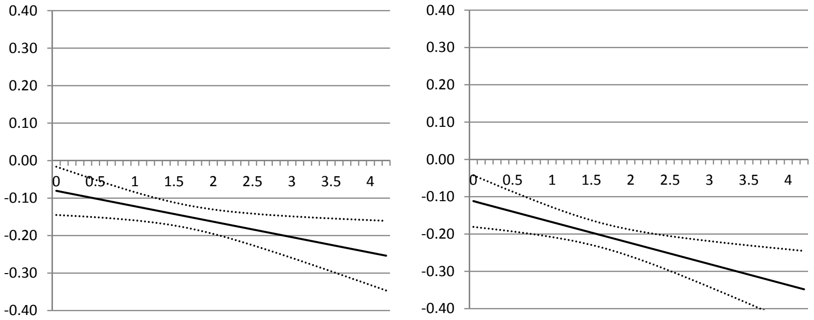
(b) i_{USD}

This figure depicts predictions of the average returns conditional on 1) the forecast quality of an interest rate forecast and 2) the momentum phase based on the fixed effects panel regression

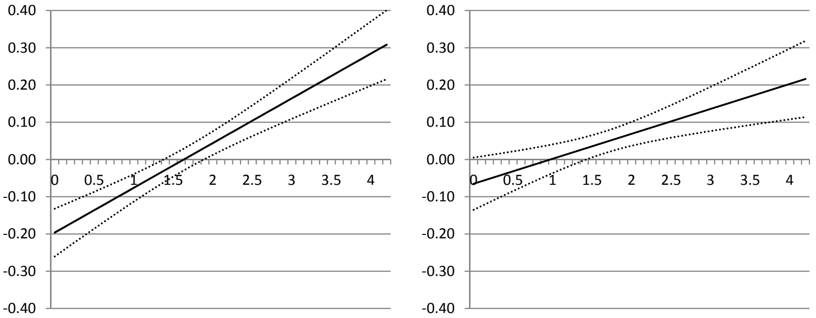
$$r_{j,t,t+1} = \mu_j + \beta_1 |\varepsilon_{j,t}(i)| + \beta_2 D^L_{j,t} + \beta_3 D^H_{j,t} + \beta_4 \left(|\varepsilon_{j,t}(i)| \times D^L_{j,t} \right) + \beta_5 \left(|\varepsilon_{j,t}(i)| \times D^H_{j,t} \right) + \epsilon_{j,t}.$$

The x-axis shows the absolute forecast error (0 for no error, 2 for a severe error), while the y-axis displays the returns. In each graph, there is a different line for each the low momentum phase, normal momentum phase and the high momentum phase.

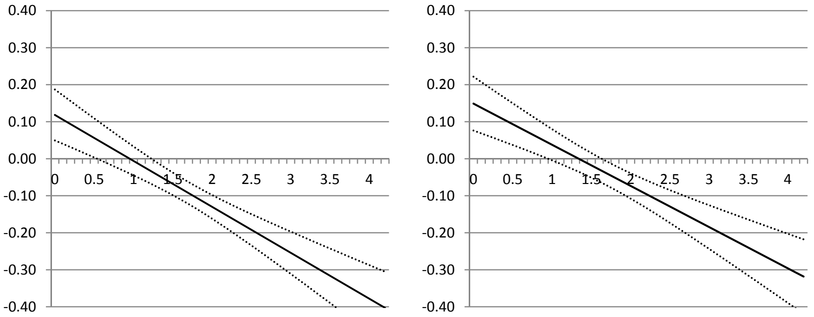
Figure 3: Marginal effects of forecast errors depending on absolute size of the interest rate differential



(a) i_{EUR} (b) i_{USD}



(c) π_{EUR} (d) π_{USD}



(e) y_{EUR} (f) y_{USD}

This figure displays how marginal effects of a fundamental forecast error point (zero for a correct forecast, 2 for a forecast of the wrong direction of change) on the return from a trading strategy using FX forecasts depend on the absolute level of the interest rate differential between US and EUR interest rates. The marginal effects are based on an interaction model, i.e.

$$r_{j,t,t+1} = \mu_j + \beta_1|\varepsilon_{j,t}(X)| + \beta_2|i_t^{USD} - i_t^{EUR}| + \beta_3\left(|\varepsilon_{j,t}(X)| \times |i_t^{USD} - i_t^{EUR}|\right) + \epsilon_{j,t},$$

where the marginal effects $\frac{\partial r}{\partial|\varepsilon_{j,t}(X)|} = \beta_1 + \beta_3 \times |i_t^{USD} - i_t^{EUR}|$ depend on the absolute interest rate differential. The y-axis show the marginal effects, the x-axis the size of the interest rate differential $|i_t^{USD} - i_t^{EUR}|$. The dotted lines are the 95% confidence bounds.

Data appendix

Exchange Rates To obtain a long-time series of daily exchange rates (from 01.1976 to 07.2010), we follow Burnside, Eichenbaum, Kleshchelski, and Rebelo (2010), drawing on a set of spot rates and forward rates denominated in terms of FCU/GBP. We then convert Pound quotes into Euro quotes by dividing the GBP/FCU quote by the EUR/GBP quote.[18] These data are taken from Datastream, and were originally collected by WM Company/Reuters. The mnemonics of the considered spot rates are DMARKER (used until 12.1998), ECURRSP (since 01.1999), JAPAYEN, SWISSFR, USDOLLR. The mnemonics of the considered forward rates are DMARK1F (until 01.1998), UKEUR1F (since 01.1999), JAPYN1F, SWISF1F, USDOL1F (all until 01.2007), and UKJPY1F, UKCHF1F, and USGBP1F (after 01.2007). In order to transform the GBP-denominated exchange rates with respect to the DM or Euro, we also make use of the spot rates DMARKER and ECURRSP, respectively. The spot and the forward rates are both midquotes sampled at the same point in time.

Interest Rates We use the same the data sources used by Burnside, Eichenbaum, Kleshchelski, and Rebelo (2010) and download three-month interbank interest rates for Germany (until 12.1998), the Eurozone (starting 01.1999), the United States, the United Kingdom, Japan and Switzerland from Datastream. These data were originally collected by the Financial Times and ICAP. The mnemonics are ECWGM3M, ECJAP3M, ECSWF3M, ECUKP3M, ECUSD3M, ECEUR3M.

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[18] *Spot* rates which measure directly the foreign value of the Euro/the D-Mark (without making a transformation from GBP) are also available on a daily basis from other sources. To make sure that our results on the forecasting performance of forecasters do not depend on this transformation, we compare our spot rate data with these directly obtained exchange rates. In particular, these are the D-Mark quotes from the historical database of the Frankfurt Stock Exchange provided by the Deutsche Bundesbank, as well the Euro rates downloadable in Datastream (mnemonics EMJPYSP. EMUSDSP,EMCHFSP, EMGBPSP). All those spot rates have a correlation with those from our data sample of > 0.999.

Appendix The following pages are meant to be provided online.

Table A1: Average FX forecasting performance in the cross section: t-values of T_{ind}

Elliot and Ito (1999) present their results in terms of t-values, a performance measure closely related to the Sharpe ratio, where the mean returns are divided by their standard errors instead of the standard deviation. We report statistics about these t-values in the cross section of forecasters underneith. The table reports the t-values and the associated mean returns for the individual trading strategies. It displays the respective values for the 95%, 90%, 50%, 5% and 1% percentile forecaster, sorted by t-values. These values are compared to the average values T_0 of a simulation experiment which repeats 10,000 purely random (coin toss) strategies (an investor buys or sells USD against the Euro in the forward market according to a coin toss, and settles her position one month later).

		t-values	Mean
T_{ind}	X_{99}	2.845	1.087
	X_{95}	2.108	0.387
	X_{90}	1.711	0.432
	X_{50}	0.210	0.149
	X_{05}	-1.447	-0.266
	X_{01}	-2.214	-0.422
T_0	Average	-0.010	-0.002

As the t-values of a purely random strategy can be approximated by a standard normal distribution, the t-values computed for the individual forecasters can be directly compared to critical values for two-sided tests of the hypothesis that an individual's average profit equals zero. For example, a t-value of 2.108 (which can be observed for the forecaster at the 95% percentile) points to a significantly positive average return, as this value is above the critical value of 1.96 at the 5% significance level. In contrast, the forecaster at the 5% percentile has a t-value of -1.447, which is consistent with the hypothesis of zero average profits at the 5% significance level (and does *not* imply that this particular forecaster makes predictions which are significantly *worse* then those from a random strategy at the 5% significance level.

Table A2: Diagnostics

This table reports the diagnostics about the correct estimator for our panel regression of interest,

$$r_{j,t,t+1} = \mu_j + \beta_1|\varepsilon_{j,t}(i^{EUR})| + \beta_2|\varepsilon_{j,t}(i^{USD})| + \gamma\Phi_{j,t} + \delta\Psi_{j,t} + \epsilon_{j,t}.$$

We proceed in three steps. In a first step, we conduct Breusch and Pagan (1980)-tests to determine for each specification reported in Table 4 whether or not individual-specific effects are present. Under the null, individual-specific effects are absent. In a second step, we compare the fixed effects and random effects estimators by the means of Hausman tests. If the null can be rejected, there are systematic differences between the coefficient estimates, indicating that random effects does not estimate consistently and hence, fixed effects should be used. Ultimately, we perform regressions in which we take the lagged variables to instrument for $|\varepsilon_{j,t}(i^{EUR})|$, $|\varepsilon_{j,t}(i^{USD})|$ and $\Phi_{j,t}$ and make use of Davidson and MacKinnon (1989)'s test of the null hypothesis that OLS can consistently estimate the model (i.e. there is no need to instrument for $|\varepsilon_{j,t}(i^{EUR})|$, $|\varepsilon_{j,t}(i^{USD})|$ and $\Phi_{j,t}$).

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
Breusch/Pagan LM	5.60	3.83	3.08	3.97	0.01	0.00	0.02	0.02	0.01
df	1	1	1	1	1	1	1	1	1
p-value	**0.018	*0.050	*0.079	**0.046	0.920	0.987	0.900	0.898	0.914
Hausman									
$(\beta^{FE} - \beta^{RE})'[V_{\beta^{FE}} - V_{\beta^{RE}}](\beta^{FE} - \beta^{RE})$	5.23	6.48	80.02	22.58	43.76	26.79	46.95	45.82	46.98
df	1	1	3	3	21	21	24	25	26
p-value	**0.022	**0.011	***0.000	***0.000	***0.003	0.178	***0.003	***0.007	***0.007
Davidson-MacKinnon									
F-Statistic	0.09	1.02	1.82	6.93	3.20	2.08	3.53	3.619	3.478
p-value	0.761	0.313	0.142	***0.000	**0.022	0.100	***0.002	***0.001	***0.002

Table A3: Panel Fixed Effects Regression with the trading rule based on spot exchange rates only

This table reports the results of panel regressions with individual fixed effects of the alternative trading rule's period forecast return, $r^{alt}_{j,t,t+1}$ (which does not take account of refinancing costs) based on the USD/EUR forecast of the forecaster j in t), on the absolute forecast error made for European and US-American interest rates ($|\varepsilon_{j,t}(i^{EUR})|$ and $|\varepsilon_{j,t}(i^{USD})|$, respectively) as well as a battery of control variables $\Phi_{j,t}$ and $\Psi_{j,t}$, i.e.

$$r^{alt}_{j,t,t+1} = \mu_j + \beta_1|\varepsilon_{j,t}(i^{EUR})| + \beta_2|\varepsilon_{j,t}(i^{USD})| + \gamma\Phi_{j,t} + \delta\Psi_{j,t} + \epsilon_{j,t}.$$

Depending on the specification (i) to (x), $\Phi_{j,t}$ includes forecast errors with respect to other fundamentals than interest rates, i.e. inflation ($|\varepsilon(\pi)|$) and industrial production growth forecast errors $|\varepsilon(y)|$. We use lagged values as external instruments for $|\varepsilon_{j,t}(i^{EUR})|$, $|\varepsilon_{j,t}(i^{USD})|$ and $\Phi_{j,t}$. $\Psi_{j,t}$ represents purely exogenous control variables such as dummy variables for low and high trend phases (D^L and D^H, the "normal" trend phase is taken as reference.), the contemporaneous absolute interest rate differential $|i^{USD}_t - i^{EUR}_t|$ as well as year specific dummy variables. Significance: ***:1%, **: 5%, *: 10%.

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)	(x)
$\lvert\varepsilon_{j,t}(i^{EUR})\rvert$	-0.104		-0.102		-0.180		-0.156	-0.157	-0.151	-0.167
	***(0.031)		***(0.031)		***(0.039)		***(0.041)	***(0.041)	***(0.041)	***(0.041)
$\lvert\varepsilon_{j,t}(i^{USD})\rvert$		-0.143		-0.154		-0.164	-0.124	-0.123	-0.131	-0.124
		***(0.036)		***(0.038)		***(0.054)	**(0.056)	**(0.056)	**(0.056)	**(0.056)
$\lvert\varepsilon_{j,t}(\pi^{EUR})\rvert$			-0.083		-0.135		-0.176	-0.182	-0.177	-0.177
			*(0.044)		***(0.051)		***(0.056)	***(0.058)	***(0.056)	***(0.056)
$\lvert\varepsilon_{j,t}(\pi^{USD})\rvert$				0.169		0.022	0.078	0.082	0.081	0.085
				***(0.045)		(0.056)	(0.060)	(0.061)	(0.060)	(0.060)
$\lvert\varepsilon_{j,t}(y^{EUR})\rvert$			-0.045		0.088		0.108	0.107	0.107	0.124
			(0.053)		(0.085)		(0.096)	(0.096)	(0.096)	(0.097)
$\lvert\varepsilon_{j,t}(y^{USD})\rvert$				-0.046		-0.149	-0.178	-0.176	-0.182	-0.160
				(0.055)		**(0.059)	***(0.068)	**(0.069)	**(0.069)	***(0.068)
$F_{j,t}$								0.027		
								(0.036)		
$D^L_{j,t}$									-0.116	
									***(0.028)	
$D^H_{j,t}$									-0.121	
									***(0.030)	
$\lvert i^{USD}_t - i^{EUR}_t\rvert$										-0.125
										***(0.029)
$\bar{\mu}$	0.206	0.247	0.290	0.163	0.409	0.437	0.576	0.329	0.657	0.596
	***(0.025)	***(0.031)	***(0.058)	**(0.057)	***(0.096)	*(0.094)	***(0.111)	***(0.102)	***(0.112)	***(0.111)
Year dummies	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES
$N \times T$	51,512	50,793	51,155	50,084	51,155	50,084	49,872	49,872	49,872	49,872
R^2_B	0.002	0.020	0.003	0.013	0.095	0.096	0.070	0.069	0.069	0.077
R^2_O	0.001	0.002	0.001	0.001	0.021	0.022	0.021	0.204	0.021	0.021
R^2_W	0.001	0.002	0.001	0.002	0.019	0.020	0.019	0.018	0.019	0.019

Table A4: Panel Pooled OLS Regression, no instruments

This table reports the results of panel pooled OLS regressions of the trading rule T_{ind}'s period forecast return, $r_{j,t,t+1}$ (based on the forecast of the forecaster j in t), on the absolute forecast error made for European and US-American interest rates ($|\varepsilon_{j,t}(i^{EUR})|$ and $|\varepsilon_{j,t}(i^{USD})|$, respectively) as well as a battery of control variables $\Phi_{j,t}$ and $\Psi_{j,t}$, i.e.

$$r_{j,t,t+1} = \beta_0 + \beta_1|\varepsilon_{j,t}(i^{EUR})| + \beta_2|\varepsilon_{j,t}(i^{USD})| + \gamma\Phi_{j,t} + \delta\Psi_{j,t} + \epsilon_{j,t}.$$

Depending on the specification (i) to (ix), $\Phi_{j,t}$ includes forecast errors with respect to other fundamentals than interest rates, i.e. inflation ($|\varepsilon(\pi)|$) and industrial production growth forecast errors $|\varepsilon(y)|$. Unlike in Table 4, we do not use instruments for $|\varepsilon_{j,t}(i^{EUR})|$, $|\varepsilon_{j,t}(i^{USD})|$ and $\Phi_{j,t}$. $\Psi_{j,t}$ represents purely exogenous control variables such as dummy variables for low and high trend phases (D^L and D^H, the "normal" trend phase is taken as reference.), the contemporaneous absolute interest rate differential $|i_t^{USD} - i_t^{EUR}|$ as well as year specific dummy variables. Significance: ***:1%, **: 5%, *: 10%.

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
$\lvert\varepsilon_{j,t}(i^{EUR})\rvert$	-0.129		-0.130		-0.160		-0.131	-0.133	-0.133
	***(0.015)		***(0.015)		***(0.016)		***(0.016)	***(0.016)	***(0.016)
$\lvert\varepsilon_{j,t}(i^{USD})\rvert$		-0.191		-0.192		-0.171	-0.146	-0.145	-0.147
		***(0.017)		***(0.017)		***(0.019)	***(0.019)	***(0.019)	***(0.019)
$\lvert\varepsilon_{j,t}(\pi^{EUR})\rvert$			0.008		-0.035		-0.034	-0.031	-0.034
			(0.015)		**(0.017)		**(0.017)	*(0.017)	**(0.017)
$\lvert\varepsilon_{j,t}(\pi^{USD})\rvert$				0.056		-0.034	-0.026	-0.027	-0.024
				***(0.015)		**(0.016)	*(0.015)	*(0.015)	(0.015)
$\lvert\varepsilon_{j,t}(y^{EUR})\rvert$			-0.105		-0.030		-0.021	-0.022	-0.020
			***(0.016)		*(0.016)		(0.016)	(0.016)	(0.016)
$\lvert\varepsilon_{j,t}(y^{USD})\rvert$				-0.023		-0.072	-0.064	-0.064	-0.061
				(0.017)		***(0.017)	***(0.017)	***(0.017)	***(0.017)
$D_{j,t}^L$								-0.123	
								***(0.023)	
$D_{j,t}^H$								-0.069	
								**(0.026)	
$\lvert i_t^{USD} - i_t^{EUR}\rvert$									-0.068
									***(0.021)
β_0	0.185	0.244	0.255	0.220	0.645	0.649	0.775	0.829	1.124
	***(0.015)	***(0.016)	***(0.021)	***(0.021)	***(0.234)	***(0.239)	***(0.242)	***(0.242)	***(0.261)
Year dummies	NO	NO	NO	NO	YES	YES	YES	YES	YES
$N \times T$	63,693	62,940	63,414	62,401	63,414	62,401	62,257	62,257	62,257
R^2	0.001	0.003	0.002	0.003	0.026	0.026	0.027	0.028	0.027

Table A5: Panel Pooled OLS Regression, with instruments

This table reports the results of panel pooled OLS regressions of the trading rule T_{ind}'s period forecast return, $r_{j,t,t+1}$ (based on the forecast of the forecaster j in t), on the absolute forecast error made for European and US-American interest rates ($|\varepsilon_{j,t}(i^{EUR})|$ and $|\varepsilon_{j,t}(i^{USD})|$, respectively) as well as a battery of control variables $\Phi_{j,t}$ and $\Psi_{j,t}$, i.e.

$$r_{j,t,t+1} = \beta_0 + \beta_1|\varepsilon_{j,t}(i^{EUR})| + \beta_2|\varepsilon_{j,t}(i^{USD})| + \gamma\Phi_{j,t} + \delta\Psi_{j,t} + \epsilon_{j,t}.$$

Depending on the specification (i) to (ix), $\Phi_{j,t}$ includes forecast errors with respect to other fundamentals than interest rates, i.e. inflation ($|\varepsilon(\pi)|$) and industrial production growth forecast errors $|\varepsilon(y)|$. We use lagged values as external instruments for $|\varepsilon_{j,t}(i^{EUR})|$, $|\varepsilon_{j,t}(i^{USD})|$ and $\Phi_{j,t}$. $\Psi_{j,t}$ represents purely exogenous control variables such as dummy variables for low and high trend phases (D^L and D^H, the "normal" trend phase is taken as reference.), the contemporaneous absolute interest rate differential $|i_t^{USD} - i_t^{EUR}|$ as well as year specific dummy variables. Significance: ***:1%, **: 5%, *: 10%.

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
$\lvert\varepsilon_{j,t}(i^{EUR})\rvert$	-0.056		-0.056		-0.140		-0.114	-0.111	-0.126
	**(0.028)		**(0.028)		***(0.037)		***(0.038)	***(0.038)	***(0.038)
$\lvert\varepsilon_{j,t}(i^{USD})\rvert$		-0.134		-0.143		-0.156	-0.128	-0.135	-0.128
		***(0.034)		***(0.035)		***(0.053)	**(0.053)	***(0.053)	**(0.053)
$\lvert\varepsilon_{j,t}(\pi^{EUR})\rvert$			-0.060		-0.148		-0.180	-0.178	-0.181
			(0.042)		***(0.048)		***(0.051)	***(0.051)	***(0.051)
$\lvert\varepsilon_{j,t}(\pi^{USD})\rvert$				0.198		0.025	0.082	0.084	0.088
				***(0.040)		(0.047)	*(0.050)	*(0.050)	*(0.050)
$\lvert\varepsilon_{j,t}(y^{EUR})\rvert$			-0.162		0.043		0.065	0.064	0.079
			***(0.051)		(0.068)		(0.075)	(0.075)	(0.075)
$\lvert\varepsilon_{j,t}(y^{USD})\rvert$				-0.038		-0.150	-0.162	-0.164	-0.144
				(0.054)		**(0.060)	**(0.066)	**(0.066)	**(0.064)
$D_{j,t}^L$								-0.123	
								***(0.026)	
$D_{j,t}^H$								-0.115	
								***(0.030)	
$\lvert i_t^{USD} - i_t^{EUR}\rvert$									-0.123
									***(0.031)
β_0	0.145	0.213	0.298	0.103	-0.032	0.018	0.108	0.197	0.581
	***(0.023)	***(0.029)	***(0.050)	**(0.052)	(0.080)	(0.075)	(0.088)	**(0.090)	***(0.141)
Year dummies	NO	NO	NO	NO	YES	YES	YES		YES
$N \times T$	50,793	51,512	51,155	50,084	51,155	50,084	49,872	49,872	49,872
R^2	0.000	0.002	0.001	.	0.022	0.023	0.022	0.222	0.022

Table A6: Panel Fixed Effects Regression, no instruments

This table reports the results of panel regressions with individual fixed effects of the trading rule T_{ind}'s period forecast return, $r_{j,t,t+1}$ (based on the forecast of the forecaster j in t), on the absolute forecast error made for European and US-American interest rates ($|\varepsilon_{j,t}(i^{EUR})|$ and $|\varepsilon_{j,t}(i^{USD})|$, respectively) as well as a battery of control variables $\Phi_{j,t}$ and $\Psi_{j,t}$, i.e.

$$r_{j,t,t+1} = \mu_j + \beta_1|\varepsilon_{j,t}(i^{EUR})| + \beta_2|\varepsilon_{j,t}(i^{USD})| + \gamma\Phi_{j,t} + \delta\Psi_{j,t} + \epsilon_{j,t}.$$

Depending on the specification (i) to (ix), $\Phi_{j,t}$ includes forecast errors with respect to other fundamentals than interest rates, i.e. inflation ($|\varepsilon(\pi)|$) and industrial production growth forecast errors $|\varepsilon(y)|$. Unlike in Table 4, we do not use instruments for $|\varepsilon_{j,t}(i^{EUR})|$, $|\varepsilon_{j,t}(i^{USD})|$ and $\Phi_{j,t}$. $\Psi_{j,t}$ represents purely exogenous control variables such as dummy variables for low and high trend phases (D^L and D^H, the "normal" trend phase is taken as reference.), the contemporaneous absolute interest rate differential $|i_t^{USD} - i_t^{EUR}|$ as well as year specific dummy variables. Significance: ***:1%, **: 5%, *: 10%.

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)	(ix)
$\lvert\varepsilon_{j,t}(i^{EUR})\rvert$	-0.139		-0.140		-0.169		-0.141	-0.143	-0.143
	***(0.015)		***(0.015)		***(0.016)		***(0.016)	***(0.016)	***(0.016)
$\lvert\varepsilon_{j,t}(i^{USD})\rvert$		-0.182		-0.184		-0.171	-0.145	-0.144	-0.146
		***(0.017)		***(0.017)		***(0.019)	***(0.019)	***(0.019)	***(0.019)
$\lvert\varepsilon_{j,t}(\pi^{EUR})\rvert$			-0.002		-0.033		-0.032	-0.029	-0.032
			(0.016)		*(0.017)		*(0.017)	*(0.017)	*(0.017)
$\lvert\varepsilon_{j,t}(\pi^{USD})\rvert$				0.044		-0.035	-0.028	-0.029	-0.026
				***(0.015)		**(0.016)	*(0.016)	*(0.016)	*(0.016)
$\lvert\varepsilon_{j,t}(y^{EUR})\rvert$			-0.074		-0.022		-0.013	-0.014	-0.012
			***(0.016)		(0.016)		(0.017)	(0.017)	(0.017)
$\lvert\varepsilon_{j,t}(y^{USD})\rvert$				-0.030		-0.073	-0.067	-0.067	-0.064
				*(0.017)		***(0.018)	***(0.017)	***(0.017)	***(0.017)
$D^L_{j,t}$								-0.112	
								***(0.023)	
$D^H_{j,t}$								-0.070	
								**(0.026)	
$\lvert i_t^{USD} - i_t^{EUR}\rvert$									-0.065
									***(0.022)
$\bar{\mu}$	0.192	0.237	0.246	0.225	0.714	0.694	0.837	0.885	1.151
	***(0.011)	***(0.014)	***(0.018)	***(0.020)	***(0.248)	***(0.252)	***(0.255)	***(0.256)	***(0.272)
Year dummies	NO	NO	NO	NO	YES	YES	YES	YES	YES
$N \times T$	63,693	62,940	63,414	62,401	63,414	62,401	62,257	62,257	62,257
R^2_B	0.006	0.050	0.032	0.056	0.177	0.179	0.171	0.172	0.176
R^2_O	0.001	0.003	0.002	0.003	0.026	0.026	0.027	0.028	0.027
R^2_W	0.001	0.002	0.002	0.002	0.023	0.023	0.025	0.025	0.025