

Forecaster Rationality and Expectation Formation in Foreign Exchange Markets: Do Emerging Markets Differ from Industrialized Economies?

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Abstract

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JEL-Classification:

F31, D48, C33

Keywords:

Foreign exchange, forecast bias, expectation formation, chartist, fundamentalist, Balassa-Samuelson

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This paper uses the Consensus Economic Forecast poll to investigate how forecasters in the foreign exchange market form expectations. In order to explain the expectation formation of forecasters, around 50,000 forecasts for 22 OECD-member currencies are analyzed. The results indicate that forecasters do not form expectations rationally when tested for unbiasedness and orthogonality. The results also suggest that forecasts for industrialized economies show a mix of trend-following and fundamentally-oriented behavior. By contrast, forecasts for emerging markets show significantly more destabilizing expectations. We find forecasting tendencies to strengthen in the short-run and medium-run when controlling for the Balassa-Samuelson effect. For long-run forecasts however this can not be confirmed.

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1 Introduction

The turmoil of financial markets during the global financial crisis has increased the interest of researchers to study the behavior of financial agents in various sectors of the economy. Exchange rate expectations which are at the heart of modern open-macroeconomic models became one of the topics of intense discussions. Understanding the expectation formation process for tomorrow's exchange rate is important for practitioners and policy-makers alike. Researchers often use the rational choice hypothesis, claiming that market participants form informed, rational expectations at each point in time. In practice the assumption of rational choice is a cornerstone of many econometric analyses of exchange rate determination and empirically examining a model means testing the joint hypothesis of the validity of the model as well as the rational expectations hypothesis. Survey based forecasts allow to test if the assumption of rational expectations holds and how individual forecasts are formed.

The empirical open-economy literature has often found very little empirical support for expectation-based exchange rate models, one of the possible reasons being the violation of the rational expectation assumption in the foreign exchange market. This led several researchers to develop models in which the rational expectation assumption is relaxed and different types of actors in the currency market are considered. The first analyses go back to Frankel and Froot (1987) and Froot and Thaler (1990). The research that raises doubts about the validity of the rational expectations assumption in this market has prospered in recent years. It also tries to find alternative approaches to describe how market participants form expectations. Researchers nowadays focus in particular on trend and fundamental values as main drivers of exchange rate forecasts (Menkhoff, 2001; Menkhoff et al., 2008; Verschoor and Zwinkels, 2013).

This paper contributes to the discussion on the process of how market participants form exchange rate expectations by using a significantly larger data set than is usually the case and by examining it a wider range of questions about how expectations are formed. For the purpose of this study we use the Consensus Foreign Exchange Forecast dataset containing 22 countries and nearly 20 years of survey based forecasts. The data set also allows to analyze a variety of currencies using a homogeneous data set and to differentiate between emerging and industrialized economies.

Using this rich data set, this paper addresses several questions: First, the rational expectation hypothesis is tested by controlling for unbiasedness and orthogonality. Second, the paper aims at differentiating between trend-following or *chartist* behavior in the short-run and fundamentally oriented or *fundamentalist* behavior in the long-run. Third, the Consensus Dataset allows to differentiate between forecasters' expectation formation in emerging markets vis-à-vis established market economies. Fourth, individual estimates are used to analyze the structure of currency-specific forecasts in order to analyze the underlying structure of forecasting behavior.

The remainder of the paper is structured as follows. Section 2 explains the data set and its properties. Section 3 illustrates stylized facts of the foreign exchange market. Section 4 analyzes the question of whether expectations in foreign exchange markets are formed rationally. Section 5 investigates to what extent exchange rate forecasts reflect chart-following and fundamentally-oriented expectations. It further analyzes the different forecasting patterns for industrialized countries and emerging markets. Section 6 concludes.

2 The Data Set

We use survey data of the Consensus Economic Forecast poll for 22 currencies over three different horizons: One-month forecasts (1m) which we refer to as short-run forecasts, three-month forecasts (3m), which we refer to as medium-run forecasts and twelve-month forecasts (12m), which we refer to, for simplicity, as long-run forecasts.¹ The focus here is on the different time horizons, by months. The labeling is for practical reasons only, as one may for example argue that the long run is typically longer than twelve months. The markets for these currencies together cover almost 95% of the trading volume in the foreign exchange market (Galati et al., 2008). The Consensus Economic Forecast regularly asks financial market participants and experts about their one-month, three-month, and twelve-month forecasts.

¹They include forecasts of the Australian dollar, Brazilian real, Canadian dollar, Chilean peso, Chinese renminbi, euro, Japanese yen, Mexican peso, New Zealand dollar, Russian ruble, South African rand, South Korean won, Turkish lira, and the UK pound sterling vis-à-vis the US dollar. In addition, the data set includes forecasts of Czech koruna, Danish krona, Hungarian forint, Norwegian krone, Polish zloty, Slovakian koruna, Swedish krona and Swiss franc vis-à-vis the euro.

TABLE 1: Summary of the Data Set

Currency	Time Span	No. of Months	1m	3m	12m	Classification
Australian Dollars	01/1996 - 11/2014	226	586	566	492	Industrialized
British Pound	11/1995 - 12/2014	218	2182	2197	1978	Industrialized
Brazilian Real	02/1996 - 09/2014	223	418	409	382	Emerging
Canadian Dollar	12/1995 - 12/2014	228	802	777	639	Industrialized
Chilean Peso	01/1999 - 07/2014	186	319	315	298	Emerging
Chinese Renminbi	09/2000 - 10/2014	169	413	409	308	Emerging
Czech Koruna	06/1998 - 11/2014	197	380	353	293	Emerging
Danish Krona	06/1999 - 11/2001	29	66	67	66	Industrialized
Euro	01/1999 - 12/2014	191	3734	3758	3510	Industrialized
Hungarian Forint	07/1996 - 08/2014	222	388	361	305	Emerging
Japanese Yen	11/1995 - 12/2014	230	4398	4483	4235	Industrialized
Mexican Peso	11/1995 - 12/2014	230	439	435	400	Emerging
Norwegian Krone	08/1998 - 06/2014	190	333	316	296	Industrialized
New Zealand Dollar	05/1997 - 04/2013	191	351	327	324	Industrialized
Polish Zloty	01/1997 - 04/2014	207	397	372	324	Emerging
Russian Rubel	10/1995 - 12/2014	231	380	358	297	Emerging
Slovakian Koruna	08/1997 - 02/2008	126	146	146	146	Emerging
South African Rand	04/1998 - 10/2010	150	340	347	331	Emerging
South Korean Won	02/1996 - 08/2014	222	310	305	292	Industrialized
Swedish Krone	01/1996 - 10/2014	225	358	351	327	Industrialized
Swiss Franc	11/1996 - 02/2014	207	385	358	340	Industrialized
Turkish Lira	06/1999 - 10/2014	184	424	394	313	Emerging

Note: The classification of ‘Emerging Markets’ follows the classification of International Monetary Fund (2015). Czech Republic and Slovakia were listed as for the majority of the time period under consideration.

Our data set begins in November 1995, when the survey was initially launched and ends in December 2014. Data is published only with a 12 months delay. While monthly surveys are available for the US dollar/euro and yen/US dollar exchange rate, other exchange rates are surveyed on a bi-monthly, quarterly, semi-annual and annual basis. In total, the data consist of 49,823 exchange rate forecasts. A total of 69 different institutes from the financial, non-financial and research sector submitted forecasts to the Consensus Dataset.²

Table 1 gives an overview of the data characteristics showing the period examined for each of the currencies of our study and the number of months in question as well as the amount of individual observations and classification of the 22 currencies. The data set includes an equal number of emerging market currencies and industrialized country currencies and covers significant international financial events like the Asian

²The participants of the poll are working for investment banks, commercial banks and consultancies. Not all institutes forecast all currencies, resulting in 30 – 40 institutes to forecast a given currency. A complete list of participants for each exchange rate pair is available upon request.

crisis, the introduction of the euro and the crisis in the euro area, as well as national events, such as the pegging of the Swiss franc. Hence it covers a very rich and heterogeneous period of time, allowing for a general interpretation of forecasting behavior.

The Consensus data set has several advantages over other survey data sets and is not subject to some of the weaknesses often pointed out for survey data: Firstly, the forecasts are published together with the names of the institutions the forecasts are affiliated with. This allows for a performance tracking of each respective institution. Hence, this is likely to motivate forecasters to submit their best forecast (Keane et al., 1990). This is confirmed by Batchelor (2001) and Frenkel et al. (2012), who show that the Consensus Economics forecasts are more accurate in terms of mean absolute error and root mean square error compared to, for example, OECD and IMF forecasts.

Secondly, unlike other surveys used in the literature (Keane et al., 1990; Menkhoff, 1998; Dick et al., 2014), forecasters participating in the Consensus Economic Forecast poll do not only submit the direction of the expected change of the macroeconomic variable, but forecast a specific level allowing for greater differentiation between individual forecasts. Thirdly, the survey data are readily available to the public so that our results can easily be verified. Fourth, the data set at hand covers a period of nearly 20 years, thus providing a number of forecasts and making it independent of a particular shock or a specific phase of the business cycle. In order to take into account price developments in our analysis and to resist any arbitrary construction of the PPP exchange rate level, we use data on purchasing power parity (PPP) as published by the OECD. The PPP-data provided by the OECD are widely used in empirical studies on exchange rates (Bettendorf and Chen, 2013), fiscal policy (Monacelli and Perotti, 2010) and monetary policy (Molodtsova and Papell, 2009).³

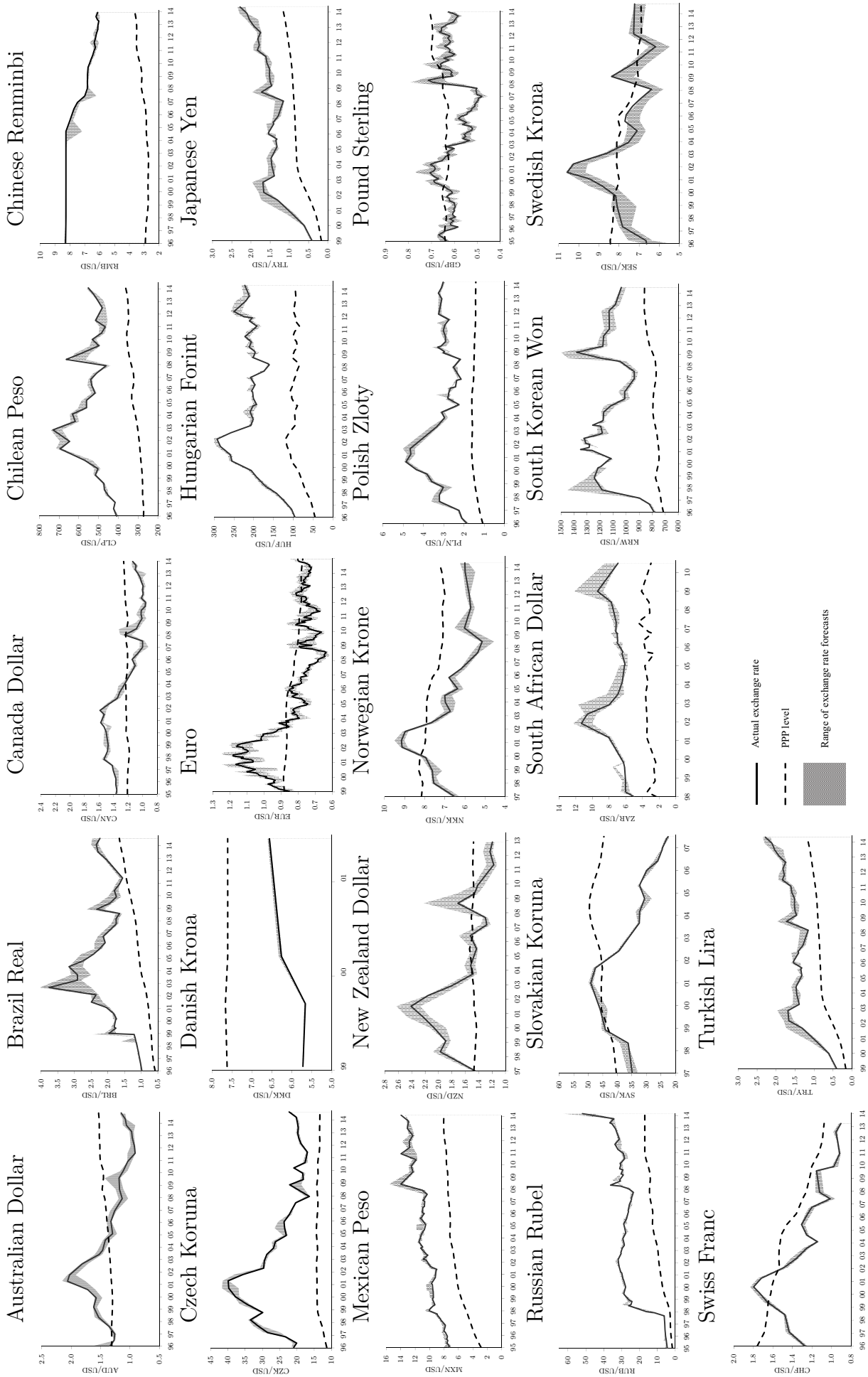
³In order to determine the PPP, the OECD (Eurostat and Oecd, 2015) first calculates relative prices at the lowest possible level (i.e. product level), where relative group prices are calculated for individual goods and services. The prices of goods are then combined at the product group level, where the averages of the respective prices are calculated and averaged to obtain the PPP level for the respective group. Lastly, the PPP for the product groups covered are weighted and averaged to obtain weighted PPP for the aggregation level up to GDP, where weights are derived from relative expenditure shares in the economy.

3 Stylized Facts

For all 22 exchange rates, Figures 1 - 3 show the actual exchange rate (solid line), the PPP exchange rate (dotted line), and the cross-sectional range of the forecasts (shaded area) for the one-month, three-month, and twelve-month horizon, respectively. The graphs indicate that the forecasted exchange rate and the actual exchange rate are moving in tandem in the short run. Whilst most industrialized economies tend to display a stabilizing trend towards the fundamental PPP values for all forecast horizons, the curves diverge significantly from the prevailing exchange rate for emerging markets and for some exchange rates in times of crisis. The forecasts for the South Korean won for example show a bandwidth of 1150 to 1450 won per US dollar during the Asian crisis, thus expressing the vast heterogeneity of forecasters' beliefs. During the Russian financial crisis in 1998, forecasters showed a strong divergence from the current state for the ruble's one-year horizon and continue to do so over time. Moreover, forecasters seem to adapt slower to changes in the *status quo* the longer the forecast horizon is. Other exchange rates display persistent deviations of the actual exchange rate from PPP. For instance, the data support that the Chilean peso was consistently undervalued against the US dollar. Forecasters may have an incentive to use recent trends to forecast exchange rate developments of the currency of an emerging market and so far, the literature on comparative analyses between industrialized and emerging OECD-economies provides only very few examples⁴.

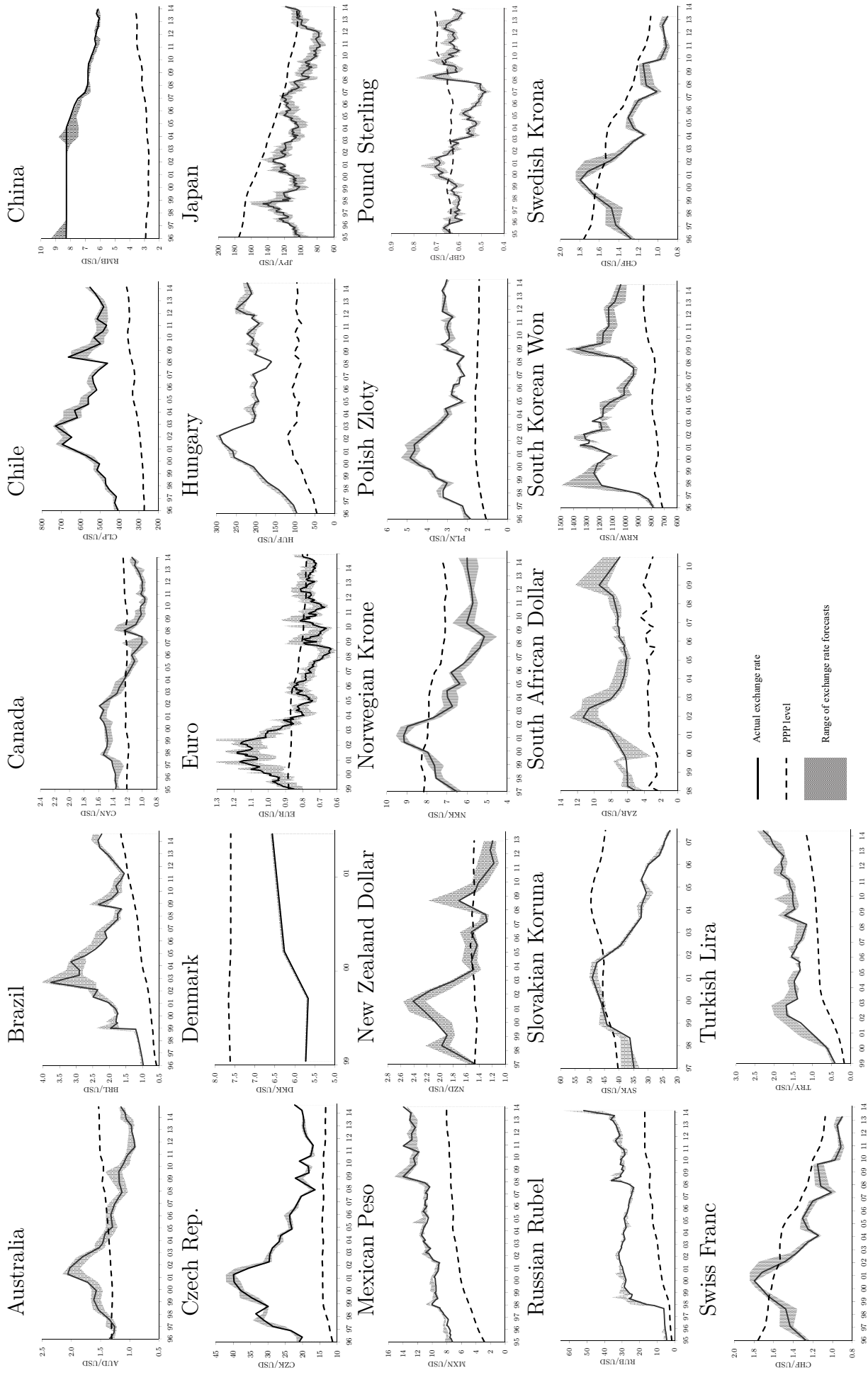
⁴Tsuchiya (2015) investigates if forecasters hold asymmetric loss functions in South Africa and Pierdzioch (2010) provide some evidence on general forecasting behavior in emerging markets. Due to data availability, empirical evidence on the subject is scarce.

FIGURE 1: Exchange Rate Forecasts (1-Month Horizon), Actual Exchanges and PPP



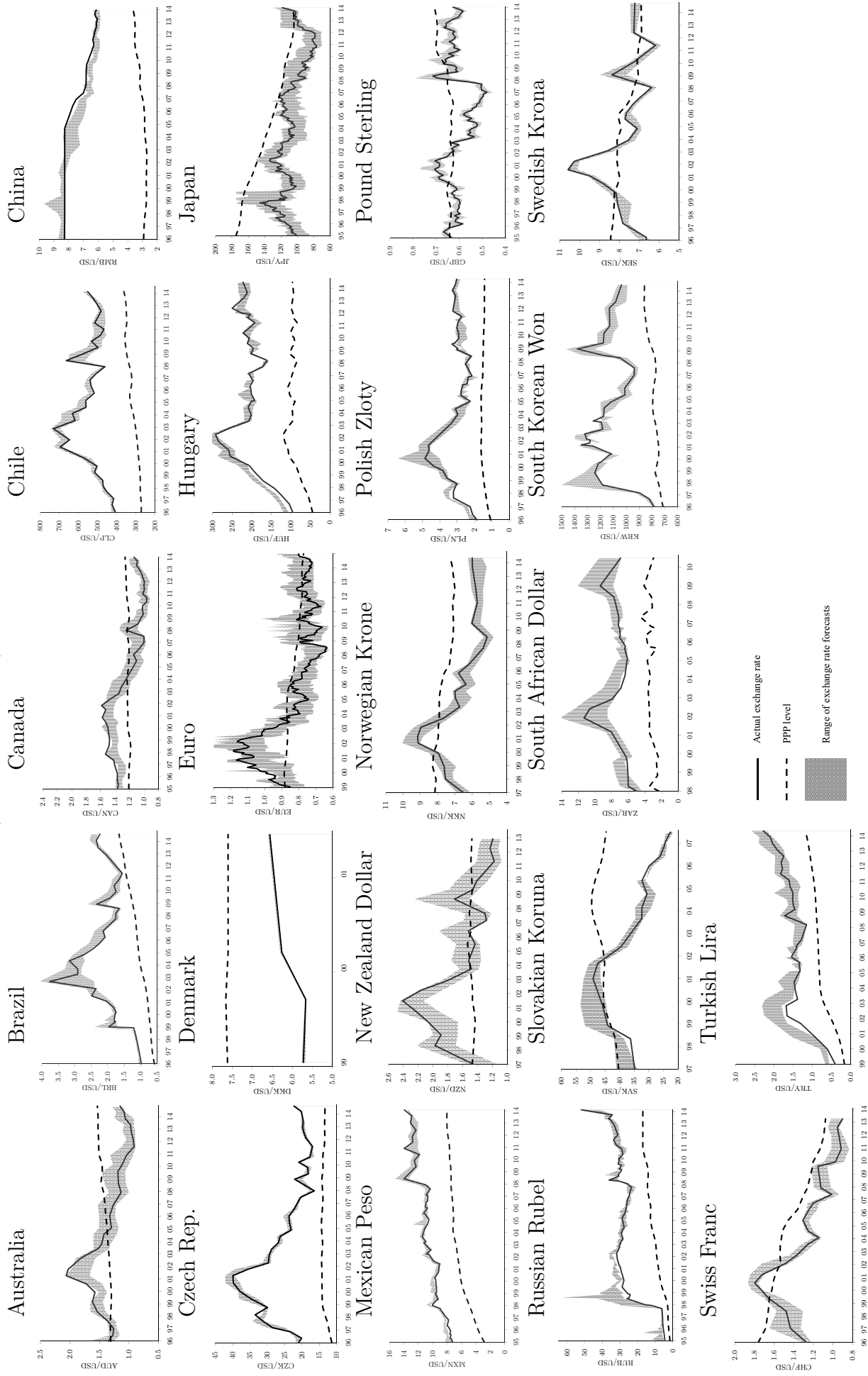
Note: The solid lines show actual exchange rate (s_t) of the different currencies in price quotation (price of dollar or the euro in units of the currencies of the diagrams). The dotted lines show the PPP values and the shaded areas show the range between minimum and maximum forecasts at t , given a one month horizon ($k = 1$). All currencies are drawn vis-à-vis the US dollar.

FIGURE 2: Exchange Rate Forecasts (3-Month Horizon), Actual Exchanges and PPP Values



Note: The solid lines show actual exchange rate (s_t) of the different currencies in price quotation (price of dollar or the euro in units of the currencies of the diagrams). The dotted lines show the PPP values and the shaded areas show the range between minimum and maximum forecasts at t , given a one month horizon ($k = 3$). All currencies are drawn vis-à-vis the US dollar.

FIGURE 3: Exchange Rate Forecasts (12-Month Horizon), Actual Exchanges and PPP Values



Note: The solid lines show actual exchange rate (s_t) of the different currencies in price quotation (price of dollar or the euro in units of the currencies of the diagrams). The dotted lines show the PPP values and the shaded areas show the range between minimum and maximum forecasts at t , given a one month horizon ($k = 12$). All currencies are drawn vis-à-vis the US dollar.

4 Tests for Rationality of Expectations

The literature on forecasting of exchange rates is largely based on the assumption that agents form their expectations in a rational choice process, based on individual utility functions. However several studies emphasize, that the formation of expectations on exchange rates can hardly be explained by utility-maximizing behavior (Verschoor and Zwinkels, 2013). Another strand of research questioning rational choice stresses that market participants can be shown to use trend and fundamental values in heterogeneous ways (Ito, 1990; Macdonald and Marsh, 1996; Jongen et al., 2012) with the weighting possibly shifting from chartist to fundamentalist behavior with increasing forecast horizons (Goldbaum and Zwinkels, 2013): Whilst trend-following behavior may have been prevalent during a certain time for a given currency, forecasters may use a different pattern once the forecast horizon expands. In doing so, forecasters undermine the assumption of rationality.

Testing for rationality allows us to test whether forecasted exchange rate changes diverge in a systematic way from actual exchange rate changes. Following the research of Elliott and Ito (1999), two criteria are applied to analyze forecaster rationality: In a first step, we test forecasts for unbiasedness. More specifically, we investigate whether forecasts represent unbiased predictors of the future and whether market participants hold biased forecasts of future exchange rates. In a second step, we test the efficiency of forecasts by exploring the orthogonality of forecasts to recent exchange rate developments. If forecasts can be shown to be orthogonal to previous actual exchange rate changes, it can be concluded that the forecast errors are unrelated to information available at the time when a forecast was made. If it turns out that forecasts are both unbiased and orthogonal to previous changes, it can be assumed that the assumption of rational expectations can be upheld.

4.1 Unbiasedness Condition

Forecasts are called unbiased if no significant relationship can be found between the realized change between $t+k$ and t and the estimated changes for the time period of time.

As performed in previous studies⁵ the following relationship is tested for unbiasedness

$$s_{t+k} - s_t = \alpha + \beta(E_{i,t}[s_{t+k}] - s_t) + \epsilon_{i,t}. \quad (1)$$

Thereby s_t and $E_{i,t}[s_{t+1}]$ denote the log of the exchange rate at time t and the log of the expected exchange rate of forecaster i at time t for time $t + k$, respectively. In addition, $\epsilon_{i,t}$ denotes the error term and k refers to the forecast horizon, (i.e., in our study $k = 1, 3$, and 12 months). Unbiasedness prevails if $\alpha = 0$ and $\beta = 1$. Note that in this case exchange rate changes are not necessarily predicted accurately, but the forecast errors do not show any systematic pattern.

Table 2 reports the results based on the Newey-West panel estimator, which accounts for autocorrelation, heteroscedasticity, and correlation among the forecasters. The results show that in 61 out of 66 cases the null hypothesis of unbiased forecasts, $H_0: \alpha=0 \wedge \beta=1$, can be rejected on a one percent error probability level. Interestingly, the β coefficient which, in the majority of cases, is below unity, decreases with the forecast horizon reflecting that one-month ahead forecasts are less biased than longer-term forecasts. For instance, in the case of the Slovak koruna and the Mexican peso, the β coefficient for the one-month forecast is not different from unity indicating unbiased one-month forecasts. By contrast, the β coefficient for three-month and twelve-month forecasts is significantly smaller than one. Moreover, exchange rates which have properties of fixed rates, like the Chinese renminbi/US dollar, the Turkish Lira/US dollar and the Danish krona/euro, show a β coefficient that is insignificant for some forecast horizons. This implies that realignments of exchange rates are difficult to predict, as forecasters appear to misinterpret, when the realignment may happen.

Our results show that forecasts are biased the more, the longer the forecast horizon is. This suggests that expectations are not an unbiased predictor of the future exchange rate, thus confirming the results of Frenkel et al. (2011). The implication however that forecasters are not rational would lead a step too far: Rationality can be consistent with biased forecasts under a variety of circumstances, as shown by Pierdzioch et al. (2012). Unbiasedness constitutes a necessary but not a sufficient

⁵The paper follows the studies of Ito (1990), Macdonald and Marsh (1996), and Elliott and Ito (1999) are commonly used as a yardstick for the analysis and were developed further by Frenkel et al. (2009), Ruelke et al. (2010) and ter Ellen et al. (2013).

TABLE 2: Tests for Unbiasedness

	Australian Dollar			British Pound			Brazilian Real			Canadian Dollar			Chilean Peso			Chinese Renminbi			
	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	
Specification																			
α	-0.03** (0.0136)	0.166*** (0.0268)	0.703*** (0.0343)	0.0334*** (0.00452)	0.0976*** (0.00755)	0.323*** (0.0120)	4.438 (4.514)	0.0262 (0.0341)	0.397*** (0.0861)	11.08 (10.97)	0.243*** (0.0278)	0.416*** (0.0256)	181.8*** (19.93)	125.7*** (12.61)	47.59*** (15.11)	0.474*** (0.0838)	1.352*** (0.151)	0.961*** (0.275)	
β	1.020*** (0.0105)	0.861*** (0.0197)	0.479*** (0.0254)	0.950*** (0.00764)	0.848*** (0.0127)	0.473*** (0.0203)	1.202*** (0.427)	0.988*** (0.0199)	0.839*** (0.0472)	-6.859 (7.738)	0.788*** (0.0198)	0.666*** (0.0186)	0.660*** (0.0375)	0.767*** (0.0239)	0.934*** (0.0268)	0.925*** (0.0113)	0.820*** (0.0192)	0.870*** (0.0337)	
$H_0: \alpha=0 \wedge \beta=1$	0.05	0.00	0.00	0.00	0.00	0.00	0.61	0.64	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$H_0: \alpha=0$	0.03	0.00	0.00	0.00	0.00	0.00	0.33	0.44	0.00	0.31	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	
$H_0: \beta=1$	0.05	0.00	0.00	0.00	0.00	0.00	0.64	0.56	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
R^2	0.96	0.77	0.43	0.00	0.61	0.21	0.00	0.85	0.49	0.00	0.61	0.68	0.44	0.63	0.73	0.85	0.61	0.58	
No. of Obs.	586	566	492	418	409	382	418	409	382	802	777	639	319	315	298	413	409	308	
No. of Institutes	40	38	35	27	25	25	27	25	25	36	34	33	26	26	26	25	24	22	
	Czech Koruna			Danish Krona			Euro			Hungarian Forint			Japanese Yen			Mexican Peso			
Specification																			
α	4.566*** (1.415)	5.217*** (1.456)	11.76*** (2.304)	-1.227 (1.960)	7.449*** (1.561)	11.25*** (1.359)	0.0488*** (0.00403)	0.131*** (0.00657)	0.395*** (0.00870)	5.514 (3.570)	27.23*** (6.119)	59.83*** (12.42)	2.398*** (0.470)	9.963*** (0.768)	60.08*** (1.267)	0.825*** (0.160)	1.819*** (0.268)	5.259*** (0.284)	
β	0.826*** (0.0522)	0.806*** (0.0535)	0.600*** (0.0813)	1.165*** (0.263)	-6.77e-06 (0.210)	-0.510*** (0.182)	0.942*** (0.00502)	0.843*** (0.00830)	0.523*** (0.0112)	0.982*** (0.0152)	0.896*** (0.0253)	0.750*** (0.0486)	0.976*** (0.00447)	0.906*** (0.00730)	0.441*** (0.0117)	0.924*** (0.0164)	0.830*** (0.0274)	0.519*** (0.0273)	
$H_0: \alpha=0 \wedge \beta=1$	0.00	0.00	0.00	0.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$H_0: \alpha=0$	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$H_0: \beta=1$	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
R^2	0.61	0.56	0.25	0.93	0.00	0.18	0.93	0.80	0.39	0.90	0.77	0.48	0.91	0.73	0.15	0.90	0.78	0.41	
No. of Obs.	380	353	293	66	67	66	3734	3758	3510	388	361	305	4398	4483	4235	439	435	400	
No. of Institutes	25	24	22	23	23	23	34	34	32	27	27	26	36	36	34	29	28	28	
	Norwegian Krone			NZ Dollar			Polish Zloty			Russian Rubel			Slovakian Koruna			South African Rand			
Specification																			
α	0.436 (0.304)	3.019*** (0.557)	9.891*** (0.454)	0.204*** (0.0226)	0.396*** (0.0368)	0.993*** (0.0468)	-0.00713 (0.0158)	-0.0309 (0.0188)	-0.0472 (0.0358)	2.910*** (0.644)	3.793*** (0.800)	1.079 (0.963)	-0.723 (0.565)	2.036*** (1.000)	2.839* (1.498)	0.555*** (0.147)	0.815* (0.487)	5.433*** (0.423)	
β	0.938*** (0.0379)	0.622*** (0.0700)	-0.228*** (0.0559)	0.886*** (0.0142)	0.773*** (0.0213)	0.408*** (0.0291)	0.909*** (0.0158)	0.790*** (0.0359)	0.723*** (0.0457)	0.862*** (0.0273)	0.823*** (0.0337)	0.958*** (0.0407)	1.013*** (0.0147)	0.956*** (0.0271)	0.966*** (0.0427)	0.947*** (0.0206)	0.920*** (0.0705)	0.323*** (0.0583)	
$H_0: \alpha=0 \wedge \beta=1$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.01	0.00	0.00	0.00	0.00	0.00	
$H_0: \alpha=0$	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.20	0.04	0.06	0.01	0.26	0.00	
$H_0: \beta=1$	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.37	0.10	0.43	0.00	0.09	0.00	
R^2	0.68	0.20	0.04	0.92	0.77	0.32	0.88	0.61	0.39	0.89	0.83	0.67	0.95	0.87	0.75	0.83	0.51	0.04	
No. of Obs.	333	316	296	351	327	324	397	372	324	380	358	297	146	146	146	340	347	331	
No. of Institutes	31	27	27	34	32	32	26	26	25	24	24	21	23	23	23	33	33	33	
	South Korean Won			Swedish Krone			Swiss Franc			Turkish Lira									
Specification																			
α	306.4*** (57.50)	197.7*** (43.02)	570.0*** (87.78)	2.317*** (0.322)	0.0569 (0.580)	5.484*** (0.606)	0.0770*** (0.0218)	0.427*** (0.0565)	0.741*** (0.0518)	0.116*** (0.0217)	0.420*** (0.0502)	0.778*** (0.137)	0.0770*** (0.0218)	0.427*** (0.0565)	0.741*** (0.0518)	0.116*** (0.0217)	0.420*** (0.0502)	0.778*** (0.137)	
β	0.727*** (0.0531)	0.826*** (0.0401)	0.471*** (0.0808)	0.742*** (0.0417)	0.742*** (0.0417)	0.158*** (0.0474)	0.949*** (0.0141)	0.724*** (0.0360)	0.530*** (0.0338)	0.926*** (0.0142)	0.726*** (0.0321)	0.522*** (0.0920)	0.949*** (0.0141)	0.724*** (0.0360)	0.530*** (0.0338)	0.926*** (0.0142)	0.726*** (0.0321)	0.522*** (0.0920)	
$H_0: \alpha=0 \wedge \beta=1$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$H_0: \alpha=0$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
$H_0: \beta=1$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
R^2	0.74	0.75	0.14	0.78	0.58	0.05	0.92	0.78	0.53	0.90	0.66	0.15	0.92	0.78	0.53	0.90	0.66	0.15	
No. of Obs.	310	305	292	358	351	327	385	358	340	424	394	313	385	358	340	424	394	313	
No. of Institutes	24	24	24	33	28	28	31	27	27	32	30	27	31	27	27	32	30	27	

Note: The table shows the regression results for Equation (4.1) $s_{t+k} - s_t = \alpha + \beta[E_{t,t+k}[s_{t+k}] - s_t] + \epsilon_{t,t+k}$; robust standard error in parentheses; *** and * indicate the significance of parameters on a 1 percent and 10 percent significance level, respectively. H_0 shows the significance of the null hypothesis to hold.

condition of rationality, as forecasters may hold a bias when forecasting, yet perform consistently. Hence, the next section analyzes whether forecast errors are orthogonal to the information of the forecasters, which would then allow us to draw conclusions on the rationality of forecasters given the traditional assumptions on forecasting behavior.

4.2 Orthogonality Condition

The orthogonality condition focuses on whether forecast errors are unrelated to information on exchange rate changes available at the time of forecasting. Given that forecasters use the available information at time t efficiently to forecast the foreign exchange for time $t + k$, they should use any variable in such a way, that it proves to be unrelated to the forecast error. Given that a variable and the error are uncorrelated, the variables are described as independent, if they are orthogonal (Athanasios Papoulis, 2002). We argue that in this case, at least two arguments should be included in the information set: The previous exchange rate change ($s_t - s_{t-1}$) and the degree of overvaluation or undervaluation compared to the equilibrium exchange rate. Hence, we estimate

$$s_{t+k} - E_{i,t}[s_{t+k}] = \alpha + \beta(s_t - s_{t-1}) + \gamma(s_t - f_t) + \epsilon_{i,t}. \quad (2)$$

Again, all exchange rate variables are in logs. In this setup, orthogonality means that neither the constant term nor any past exchange rate changes nor deviations from exchange rate from the long-run equilibrium rate can explain the forecast error. Table 3 shows that in 61 out of 66 cases the null hypothesis $H_0: \alpha = \beta = \gamma = 0$ of orthogonality cannot be rejected on a one percent error level. This is because in most cases the lagged exchange rate change as well as the misalignment is correlated with the forecast error. Interestingly, these results are more pronounced for the one-month and three-month ahead forecasts. When examining the differences of emerging and industrialized OECD members, no significant differences can be found. These results are in line with the current literature.

The analyses show that for most currencies and forecast horizons the hypothesis of orthogonality has to be rejected: Forecasters tend to exhibit biased behavior and tend not to use the information at hand - i.e. actual exchange rates at time t to predict future values for $t + k$ - efficiently. When considering the differences between

emerging and industrialized countries, we find forecasters to persistently deviate from rational forecasts. In only three cases, the assumption of rationality can be upheld overall, namely for the one-month forecasts for the Brazilian real, the Canadian dollar and the Danish krona, thus suggesting that forecasters do not seem to perform efficiently more often when forecasting industrialized currencies than emerging currencies.

TABLE 3: Orthogonality of Forecasts

	Australian Dollar			British Pound			Brazilian Real			Canadian Dollar			Chilean Peso			Chinese Renminbi		
Specification	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12
α	-0.00291 (0.00255)	0.0244*** (0.00566)	0.0540*** (0.0105)	-0.00428*** (0.000662)	-0.0107*** (0.00110)	-0.0217*** (0.00145)	-16.56 (16.55)	0.111*** (0.0309)	0.233*** (0.0538)	-0.00328 (0.00532)	-1.164 (1.207)	0.0361*** (0.00331)	26.21** (10.34)	-48.76*** (12.69)	-33.54*** (8.273)	0.451* (0.249)	0.00155 (0.0507)	0.130 (0.0865)
β	0.262*** (0.0686)	0.947*** (0.121)	0.287*** (0.0635)	0.170*** (0.0204)	0.133*** (0.0224)	0.166*** (0.0153)	-74.16 (75.76)	0.412** (0.161)	0.548*** (0.118)	-0.415 (1.139)	0.832*** (0.0600)	-0.0717*** (0.0300)	164.0*** (61.45)	237.9*** (31.62)	35.98** (16.73)	-0.485*** (0.143)	-7.870*** (1.231)	0.0923 (0.325)
γ	-0.0425*** (0.0105)	-0.112*** (0.0258)	0.125*** (0.0496)	-0.0182*** (0.00481)	-0.0747*** (0.00883)	-0.272*** (0.0171)	19.50 (19.54)	-0.175*** (0.0434)	-0.421*** (0.0833)	0.139 (0.389)	0.0579*** (0.0186)	0.120*** (0.0414)	89.69*** (23.18)	63.94*** (15.51)	-74.40*** (23.35)	0.0820 (0.0762)	-0.307** (0.126)	-0.439** (0.177)
$H_0: \alpha = \beta = \gamma = 0$	0.06	0.13	0.06	0.05	0.05	0.17	0.01	0.07	0.07	0.00	0.43	0.02	0.14	0.27	0.06	0.00	0.06	
R^2	581	560	450	2179	2167	1887	416	409	364	799	754	578	319	315	286	410	407	308
No. of Obs.	39	35	34	35	34	32	26	25	24	35	34	32	26	26	26	25	22	22
No. of Institutes	39	35	34	35	34	32	26	25	24	35	34	32	26	26	25	22	22	22
	Czech Koruna			Danish Krona			Euro			Hungarian Forint			Japanese Yen			Mexican Peso		
Specification	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12
α	-3.905*** (1.286)	-2.941** (1.143)	0.785 (1.512)	-0.150 (0.127)	-0.248** (0.124)	0.127 (0.114)	-0.000448 (0.000591)	-0.000101 (0.00104)	-0.0107*** (0.00191)	-3.324 (4.784)	0.920 (8.661)	64.83*** (12.34)	-0.164 (0.124)	-1.949*** (0.223)	-11.14*** (0.466)	0.175** (0.0794)	0.661*** (0.149)	1.990*** (0.321)
β	14.93*** (2.976)	22.76*** (4.977)	13.64*** (3.556)	-7.202*** (3.123)	13.12*** (3.999)	-6.869*** (1.473)	0.041*** (0.0200)	-0.00426 (0.0212)	0.181*** (0.0185)	114.6*** (23.05)	-33.32 (27.57)	39.13*** (12.16)	15.39*** (2.241)	10.66*** (2.296)	46.06*** (2.257)	-4.842*** (0.763)	-1.505* (0.841)	-1.079 (0.748)
γ	5.881*** (1.868)	4.493*** (1.651)	-0.591 (2.150)	-1.196 (1.001)	-1.866* (0.974)	1.005 (0.908)	0.00812 (0.00544)	0.0214** (0.0107)	-0.0759*** (0.0161)	1.883 (6.405)	-1.056 (11.30)	-82.38*** (16.26)	-1.561*** (0.467)	-8.978** (0.797)	-49.82*** (2.064)	-0.413*** (0.142)	-1.371*** (0.255)	-4.187*** (0.675)
$H_0: \alpha = \beta = \gamma = 0$	0.00	0.00	0.00	0.16	0.00	0.00	0.02	0.12	0.00	0.00	0.54	0.00	0.00	0.00	0.00	0.00	0.00	
R^2	0.09	0.18	0.05	0.09	0.20	0.34	0.00	0.00	0.03	0.12	0.01	0.10	0.01	0.02	0.15	0.16	0.07	
No. of Obs.	377	349	279	66	67	66	3731	3709	3283	377	358	294	4395	4431	3994	438	431	
No. of Institutes	25	22	22	23	23	23	34	34	30	27	27	26	34	36	34	34	28	
	Norwegian Krone			NZ Dollar			Polish Zloty			Russian Rubel			Slovakian Koruna			South African Rand		
Specification	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12
α	-0.0501 (0.0378)	-0.128* (0.0730)	-0.0579 (0.0865)	-0.0197*** (0.00427)	-0.0658*** (0.0118)	-0.0174 (0.0203)	-0.0438 (0.0889)	0.703*** (0.159)	1.226*** (0.177)	2.917*** (0.449)	5.343*** (0.642)	8.161*** (0.968)	0.386 (0.278)	-0.213 (0.470)	-0.265 (0.592)	-0.308*** (0.0978)	1.049*** (0.188)	3.579*** (0.346)
β	0.310 (0.509)	-0.716 (0.766)	-1.612*** (0.461)	0.949*** (0.283)	-0.772*** (0.197)	0.235* (0.127)	1.078*** (0.273)	1.222*** (0.376)	0.378** (0.187)	7.010** (3.444)	10.89*** (2.332)	-0.198 (1.592)	-1.862 (6.128)	-0.745 (4.362)	-24.65*** (4.675)	4.806*** (0.590)	3.724*** (0.520)	2.299*** (0.294)
γ	-1.007*** (0.314)	-1.604*** (0.594)	-1.175 (0.788)	0.0869*** (0.0294)	0.224*** (0.0356)	0.174* (0.0895)	0.0808 (0.113)	-0.873*** (0.204)	-1.494*** (0.241)	-2.604*** (0.344)	-5.441*** (0.603)	-8.330*** (0.864)	0.551 (0.790)	0.390 (1.277)	5.978*** (1.794)	0.157 (0.130)	-1.709*** (0.230)	-5.074*** (0.450)
$H_0: \alpha = \beta = \gamma = 0$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	
R^2	0.04	0.05	0.11	0.14	0.14	0.03	0.07	0.11	0.13	0.05	0.19	0.31	0.00	0.00	0.00	0.23	0.14	
No. of Obs.	329	316	296	349	327	324	377	370	305	374	346	275	146	146	137	340	347	
No. of Institutes	28	27	27	33	32	32	26	25	25	34	22	21	23	23	22	34	33	
	South Korean Won			Swedish Krona			Swiss Franc			Turkish Lira								
Specification	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12			
α	-51.29*** (7.462)	14.98 (9.635)	261.1*** (34.29)	0.1066*** (0.0135)	0.0396** (0.0177)	0.255*** (0.0326)	-0.00389 (0.00456)	0.00105 (0.00654)	-0.0126*** (0.00608)	0.0468*** (0.0148)	0.187*** (0.0284)	0.474*** (0.0581)	0.0468*** (0.0148)	0.187*** (0.0284)	0.474*** (0.0581)			
β	1.383*** (133.7)	520.1*** (96.69)	290.9*** (75.46)	-1.410 (1.267)	2.862*** (0.659)	3.079*** (0.807)	0.990*** (0.152)	0.329*** (0.150)	0.824*** (0.0898)	0.560*** (0.0691)	0.399*** (0.0863)	0.819*** (0.0895)	0.560*** (0.0691)	0.399*** (0.0863)	0.819*** (0.0895)			
γ	143.0*** (23.62)	-70.98** (27.97)	-670.9*** (86.22)	0.974*** (0.400)	-0.253 (0.319)	-1.959*** (0.606)	-0.0422 (0.0284)	0.123*** (0.0406)	0.0318 (0.0431)	-0.0982*** (0.0247)	-0.329*** (0.0424)	-1.009*** (0.100)	-0.0982*** (0.0247)	-0.329*** (0.0424)	-1.009*** (0.100)			
$H_0: \alpha = \beta = \gamma = 0$	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
R^2	0.59	0.21	0.27	0.12	0.03	0.07	0.16	0.03	0.26	0.15	0.11	0.20	0.15	0.11	0.20			
No. of Obs.	308	304	284	353	351	291	381	358	340	420	388	313	420	388	313			
No. of Institutes	24	24	24	28	28	28	30	27	27	31	28	27	31	28	27			

Note: Regression results for the Equation (2) $s_{t+k} - s_t = \alpha + \beta(E_{i,t}[s_{t+k}] - s_t) + \epsilon_{i,t+k}$; robust standard error in parentheses; ***, ** and * indicate the significance of parameters on a 1 percent and 10 percent significance level, respectively. H_0 shows the significance of the null hypothesis to hold.

TABLE 4: Extrapolative Forecasts

	Australian Dollar			Brazilian Real			Canadian Dollar			Chilean Peso			Chinese Renminbi			Czech Koruna			
	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	
Forecast Horizon																			
α	0.0013 (0.0013)	-0.0048** (0.0021)	-0.0183*** (0.0025)	0.0829 (0.0539)	0.0356*** (0.0075)	0.0640*** (0.0098)	-0.0081 (0.0082)	-0.0229*** (0.0028)	-0.0204*** (0.0031)	0.115*** (0.0206)	0.0774*** (0.017)	0.113*** (0.021)	0.0270*** (0.0055)	0.0304*** (0.0064)	-0.0475*** (0.0145)	0.013*** (0.005)	-0.000 (0.005)	-0.047*** (0.008)	
β	-0.154*** (0.0344)	-0.0286 (0.0280)	-0.0099 (0.0206)	0.0296 (0.254)	-0.204*** (0.0391)	-0.120*** (0.0201)	-0.756*** (0.0406)	-0.533*** (0.0529)	-0.204*** (0.029)	-0.277*** (0.0958)	-0.643*** (0.0599)	-0.233*** (0.127)	0.0642*** (0.0189)	0.513*** (0.0877)	-0.312*** (0.127)	-0.179*** (0.028)	-0.122*** (0.020)	-0.200*** (0.022)	
γ	-0.0349*** (0.0048)	-0.0714*** (0.0060)	-0.198*** (0.0093)	-0.0787 (0.0642)	-0.0065 (0.0110)	0.0031 (0.0143)	-0.180*** (0.0631)	-0.161*** (0.0148)	-0.228*** (0.0154)	-0.208*** (0.0383)	-0.134*** (0.0329)	-0.162*** (0.0384)	-0.0429*** (0.0062)	-0.0482*** (0.0072)	0.013 (0.0161)	-0.016** (0.007)	0.001 (0.008)	0.054*** (0.012)	
R^2	0.11	0.12	0.47	0.00	0.09	0.07	0.08	0.36	0.33	0.18	0.33	0.26	0.05	0.05	0.06	0.128	0.114	0.058	
Observations	609	632	583	428	445	428	824	827	780	327	337	317	424	457	459	391	388	371	
Groups	40	38	35	27	25	24	36	34	32	26	26	26	25	24	22	25	24	22	

	Danish Krona			Euro			Hungarian Forint			Japanese Yen			Mexican Peso			Norwegian Krone			
	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	
Forecast Horizon																			
α	0.000 (0.000)	0.001 (0.000)	0.002*** (0.001)	0.0008 (0.0005)	-0.0009 (0.0007)	-0.0056*** (0.0012)	0.013*** (0.005)	0.025*** (0.006)	0.037*** (0.014)	-0.0031*** (0.0009)	-0.0017 (0.00131)	0.0016 (0.0029)	0.0027 (0.0054)	-0.0209*** (0.006)	-0.0827*** (0.0159)	-0.000 (0.001)	0.002 (0.002)	0.002 (0.003)	
β	0.004 (0.017)	-0.003 (0.009)	-0.008** (0.003)	-0.131*** (0.0204)	0.0477*** (0.0152)	-0.0084 (0.0133)	-0.158*** (0.027)	-0.045* (0.024)	0.025 (0.024)	-0.179*** (0.0177)	-0.0573*** (0.0145)	-0.0975*** (0.0134)	-0.219*** (0.0686)	-0.233*** (0.0528)	-0.283*** (0.053)	-0.194*** (0.034)	-0.109*** (0.030)	-0.156*** (0.022)	
γ	0.004 (0.004)	0.000 (0.006)	-0.006 (0.006)	-0.0312*** (0.0039)	-0.0930*** (0.0061)	-0.290*** (0.018)	-0.010* (0.005)	-0.023*** (0.007)	-0.043** (0.015)	-0.0082*** (0.0031)	-0.008 (0.0049)	-0.0005 (0.012)	0.0199* (0.0106)	0.0812*** (0.0114)	0.286*** (0.0366)	0.018** (0.009)	0.061*** (0.013)	0.152*** (0.018)	
R^2	0.016	0.009	0.162	0.04	0.07	0.23	0.06	0.037	0.18	0.04	0.01	0.02	0.09	0.15	0.11	0.103	0.086	0.174	
Observations	66	68	68	3757	3794	3596	400	399	384	4421	4515	4306	443	460	432	348	358	358	
Groups	23	23	23	34	34	30	27	27	26	36	36	34	28	28	27	31	27	27	

	NZ Dollar			Polish Zloty			Pound Sterling			Russian Rubel			Slovakian Koruna			South African Rand			
	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12	
Forecast Horizon																			
α	0.0067*** (0.0017)	0.0168*** (0.0032)	0.0261*** (0.0047)	-0.008 (0.008)	-0.023** (0.011)	-0.081*** (0.020)	0.0036*** (0.0007)	0.0041*** (0.001)	-0.0064*** (0.0015)	-0.0235*** (0.0063)	-0.0560*** (0.0097)	-0.0858*** (0.0122)	-0.004 (0.003)	0.008** (0.004)	0.019*** (0.006)	0.0595*** (0.0103)	0.0604*** (0.0131)	0.0900*** (0.0194)	
β	-0.413*** (0.0861)	0.121* (0.0626)	0.0789*** (0.0309)	-0.041 (0.036)	-0.021 (0.031)	-0.026 (0.028)	-0.152*** (0.0260)	-0.0663*** (0.0244)	-0.0391** (0.0179)	-0.166 (0.105)	-0.0496 (0.0777)	0.141*** (0.0346)	-0.205** (0.086)	-0.069 (0.053)	0.124*** (0.042)	-0.230*** (0.0577)	-0.306*** (0.0551)	-0.165*** (0.0265)	
γ	-0.0214** (0.010)	-0.0865*** (0.0105)	-0.262*** (0.0164)	0.010 (0.010)	0.029** (0.014)	0.090*** (0.027)	-0.0042 (0.0052)	-0.0244*** (0.0073)	-0.168*** (0.0140)	0.0302*** (0.007)	0.0786*** (0.0112)	0.126*** (0.0126)	0.002 (0.005)	0.026*** (0.008)	0.031** (0.015)	-0.0444*** (0.0129)	-0.0310* (0.0176)	-0.0273 (0.0253)	
R^2	0.17	0.15	0.38	0.006	0.015	0.038	0.03	0.01	0.10	0.10	0.10	0.36	0.060	0.035	0.184	0.08	0.12	0.19	
Observations	375	383	383	408	410	390	2203	2245	2169	385	383	361	146	146	137	340	347	347	
Groups	34	32	32	26	26	25	35	35	33	24	24	21	23	23	22	33	33	33	

	South Korean Won			Swedish Krone			Swiss Franc			Turkish Lira		
	1	3	12	1	3	12	1	3	12	1	3	12
Forecast Horizon												
α	-0.0135*** (0.0035)	-0.0115*** (0.0043)	-0.0201*** (0.0079)	-0.006*** (0.001)	-0.012*** (0.001)	-0.032*** (0.002)	0.001 (0.001)	0.004** (0.002)	0.013*** (0.002)	-0.0144* (0.0078)	-0.0577*** (0.0104)	-0.200*** (0.0229)
β	0.184*** (0.0630)	0.216*** (0.0431)	0.0755* (0.0429)	-0.009 (0.034)	-0.002 (0.022)	0.004 (0.027)	-0.029 (0.0465)	-0.008 (0.0363)	-0.036 (0.0428)	-0.149*** (0.0527***)	-0.182*** (0.062)	-0.137*** (0.0456***)
γ	0.0477*** (0.0122)	0.0243* (0.0135)	-0.0306 (0.0242)	-0.017** (0.008)	-0.044*** (0.011)	-0.035*** (0.016)	0.014*** (0.005)	0.032*** (0.009)	0.067*** (0.014)	0.0527*** (0.0131)	0.154*** (0.0169)	0.456*** (0.0434)
R^2	0.14	0.20	0.02	0.015	0.053	0.015	0.015	0.015	0.042	0.09	0.20	0.34
Observations	322	345	339	373	380	344	408	411	411	443	440	440
Groups	24	24	24	33	28	28	31	27	27	32	30	28

Note: The table shows the regression results for Equation (3) $s_{t+k} - s_t = \alpha + \beta(E_{i,t}[s_{t+k}] - s_t) + \epsilon_{i,t+k}$; all exchange rates are in logs; robust standard error in parentheses.

5 Expectation Formation in the Foreign Exchange Market

5.1 Extrapolative and Regressive Expectations

In this section, we examine the expectation formation process in more detail. We begin by investigating to what extent exchange rate forecasts reflect chart-following and fundamentally oriented expectation. In the former case, market participants have extrapolative expectations, which means that the forecasted exchange rate changes are a function of past exchange rate changes. In the latter case, forecasts are based on regressive expectations, which means that they are a function of the deviation of the exchange rate from a reference value. This reference value can be a moving average, a constant, or a fundamental value f . In this study we use the assumption that the reference value is the PPP value.

In order to examine chart-following and fundamentally oriented expectation formation, we estimate the following expectation formation process using a Newey-West panel estimation:

$$E_{i,t}[s_{t+k}] - s_t = \alpha + \beta(s_t - s_{t-1}) + \gamma(s_t - f_t) + \epsilon_{i,t}. \quad (3)$$

Here, $E_{i,t}[s_{t+k}]$, s_t and f_t denote the log of the expected, the actual and the fundamental exchange rate at time t , respectively. Again, subscript i denotes the individual forecaster and ϵ the error term. If $\beta > 0$, this indicates that, whenever the currency depreciates, forecasters expect a further depreciation. In this case, expectations are extrapolative, as they follow a trend. This behavior is also often referred to as bandwagon behavior. By the same token, $\beta < 0$ indicates that a depreciation during the period preceding the time of the forecast leads market participants to expect an appreciation during the next period. This is referred to as contrarian behavior. The coefficient γ measures to

which extent forecasters expect the exchange rate to return to its fundamental value and represents regressive expectations. If $\gamma < 0$, forecasters expect the exchange rate to move towards the equilibrium, which we refer to as stabilizing behavior. Likewise, values of $\gamma > 0$ point to destabilizing behavior. If γ equals zero, forecasters do not respond to deviations from the equilibrium exchange rate.

Table 4 reports the results of regressing Equation 3 based on the Newey and West (1987) panel estimator. An individual panel estimation was performed for the 1, 3 and 12 month horizon of all 22 currencies. The results can be read as follows: The β coefficients for the one-month forecast of -0.152 in the case of the pound sterling reflects that if the pound depreciated by 10% during the preceding month, forecasters expect an appreciation of 1.52% for the next month. Similarly for the case of the γ coefficient, the estimated value of 0.067 for Switzerland for the twelve-month horizon means that forecasters expect that a ten percent deviation of the Swiss franc from the fundamental value will lead to a further increase of this difference, by 0.67 percentage points over the next 12 months.

TABLE 5: Share of Significant Estimation Results by Parameter and Forecast Horizon

Forecasting Behavior	1m	3m	12m	Total
Contrarian Behavior ($\beta < 0$)	68%	59%	55%	61%
Bandwagon Behavior ($\beta > 0$)	9%	18%	18%	15%
Stabilizing Behavior ($\gamma < 0$)	50%	45%	41%	45%
Destabilizing Behavior ($\gamma > 0$)	27%	32%	36%	32%

Note: The table shows the share of forecasts displaying mean-reverting (negative coefficients) or explosive behavior (positive coefficients) for each parameter in Equation 3, respectively. The column ‘Total’ shows the share of significant positive and negative results over all horizons combined. Insignificant results are not included, therefore the positive and negative values do not add up to 100 % for β and γ , respectively.

Table 5 shows the share of significant estimates for the β and γ parameters for different forecast horizons. Three findings appear particularly interesting: First, the β coefficients are found to be significantly negative (positive) in 61% (15%) out of 66 cases⁶ implying that exchange rate forecasters exhibit more contrarian behavior rather than bandwagon behavior. Table 5 also reports that the γ coefficient is significantly negative (positive) in 45% (32%) out of 66 cases⁷ implying that the majority of forecasters showed stabilizing behavior. Both results suggest, that foreign exchange forecasters tend to revert their estimation into the opposite direction of yesterday's developments, thus accounting for a correction of potential misalignments in the trend and the fundamentals.

Second, for the vast majority of currencies the panel of forecasters holds persistent beliefs over all forecasting horizons, only in 3 instances we find forecasters to switch from contrarian to bandwagon behavior.⁸ For example, forecasters of the euro exchange rate switch behavior for the β coefficient once the forecast horizon k is extended from 1 to 3 months although the estimated parameters remain close to zero. Currencies that show strong contrarian behavior of the forecasts with β of at least -0.2 comprise the Chilean peso, the Czech koruna, the South African rand and the Mexican peso. When analyzing the persistence of the γ coefficient, we find forecasters to hold highly persistent beliefs as forecasters do not switch between stabilizing and destabilizing expectations. Rather, the forecast horizon seems to not only influence the sign but to increase parameter strength, too, as most coefficients increase in size with increasing forecasting horizon.

With regards to the dependency on trends and fundamentals it may be argued, that the panel of forecasters classifies the development of a currency as, say, explosive,

⁶Note: 16 (24%) regressions did not show significant results for the analysis of trends and were thus excluded.

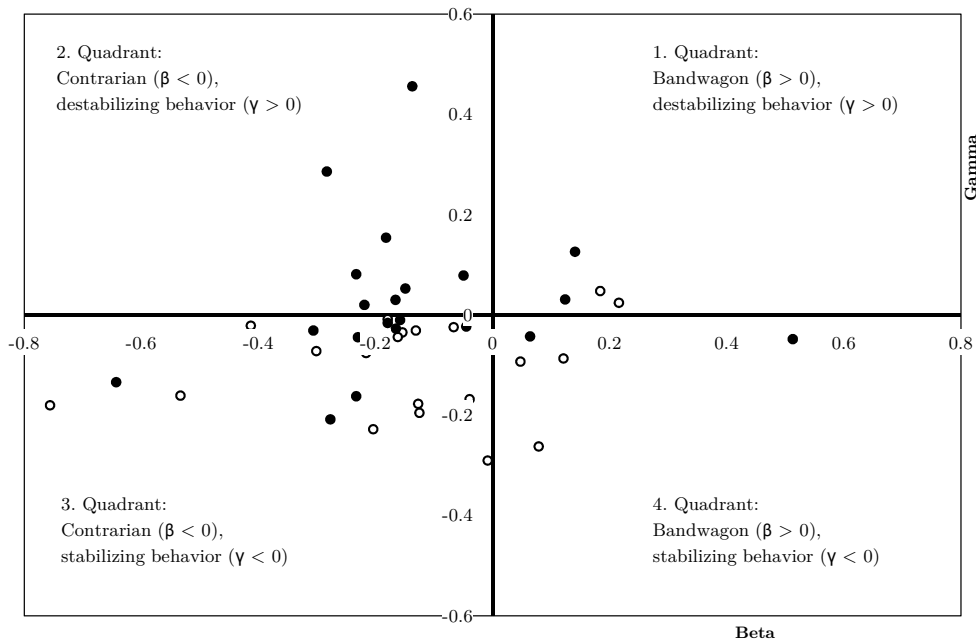
⁷Note: 15 (23%) regressions did not show significant results for the analysis of fundamentals and were thus excluded.

⁸The only currency showing a change from bandwagon behavior to contrarian behavior with increasing forecasting horizon is the Chinese renminbi. A potential reason therefore may be found in the credible peg of renminbi to the US dollar.

irrespective of the forecast horizon. Whilst the results show stabilizing behavior for most exchange rate forecasts, destabilizing expectations are centered on the Mexican peso, the Russian ruble, the Slovakian koruna, the South Korean won and the Turkish lira, most of which we consider as emerging markets.⁹

Third, the strength of forecast parameters over the forecast horizon shows a clear pattern for the trend variable while expectations for the fundamental variable depend on the currency rather than the forecast horizon. The trend-following β parameter typically declines with the length of the forecast horizon and forecasters seem to hold country-specific expectations with regard to fundamentals. Whilst trends are considered a typical forecasting method for the short-run, this can not be said for fundamentals.

FIGURE 4: Forecasting Patterns by Country Group



Note: The black dots in Figure 4 represent forecast estimates for emerging markets, white dots represent industrialized economies. Forecasts in the first quadrant show bandwagon ($\beta > 0$), destabilizing ($\gamma > 0$) behavior, forecasts in the second quadrant show bandwagon ($\beta > 0$), stabilizing behavior, ($\gamma < 0$), forecasts in the third quadrant show contrarian ($\beta < 0$), stabilizing behavior ($\gamma < 0$) and forecasts in the fourth quadrant show contrarian ($\beta < 0$), destabilizing ($\gamma < 0$) behavior.

⁹The South Korean won is the only currency of an industrialized economy showing destabilizing expectations. As a result of the Asian crisis, the won deviated strongly from the fundamental values thus offering a potential explanation for destabilizing expectations.

All results are put into context in Figure 4 and forecasting behavior regarding trends and fundamentals can be analyzed. The figure separates forecasts into four quadrants along the axes, each representing a different pattern. Forecasts in the first quadrant show bandwagon ($\beta > 0$), destabilizing ($\gamma > 0$) behavior, forecasts in the second quadrant show bandwagon ($\beta > 0$), stabilizing behavior, ($\gamma < 0$), forecasts in the third quadrant show contrarian ($\beta < 0$), stabilizing behavior ($\gamma < 0$) and forecasts in the fourth quadrant show contrarian ($\beta < 0$), destabilizing ($\gamma < 0$) behavior. Black dots represent forecasts patterns for emerging markets, white small circles represent industrialized economies.

Regarding the overall forecasting behavior, Figure 4 shows that the majority of significant estimates lies in the third quadrant of the coordinate system, as forecasts present negative β and γ values. Forecasters hold contrarian, stabilizing behavior in 19 out of a total of 39 significant cases.¹⁰ Destabilizing, as well as bandwagon behavior occurs less frequently and seems to result often from a prolonged period of continued deviations of the exchange rate from the fundamental rate. Most prominently, bandwagon, destabilizing behavior only occurs in emerging markets, reflected in all dots in the second quadrant. This indicates that emerging market forecasts tend to stabilize towards the trend but deviate increasingly from the long-run equilibrium. Resulting from relatively higher productivity increases, the currencies of emerging markets are often subject to an appreciation towards the US dollar. Fully explosive behavior, the case in which forecasters hold bandwagon, destabilizing behavior represents the rarest form of forecasting behavior, occurring only 4 times in the dataset, twice for emerging markets and twice for industrialized economies. Similarly, the case of bandwagon ($\beta > 0$), contrarian ($\gamma < 0$) behavior occurs rarely and does not show any systematic patterns.

Regarding individual currencies, we find that the main floating currencies, namely

¹⁰In 27 of 66 forecast, at least one of the estimated parameters - β or γ - was not significant leading to an exclusion of the observation.

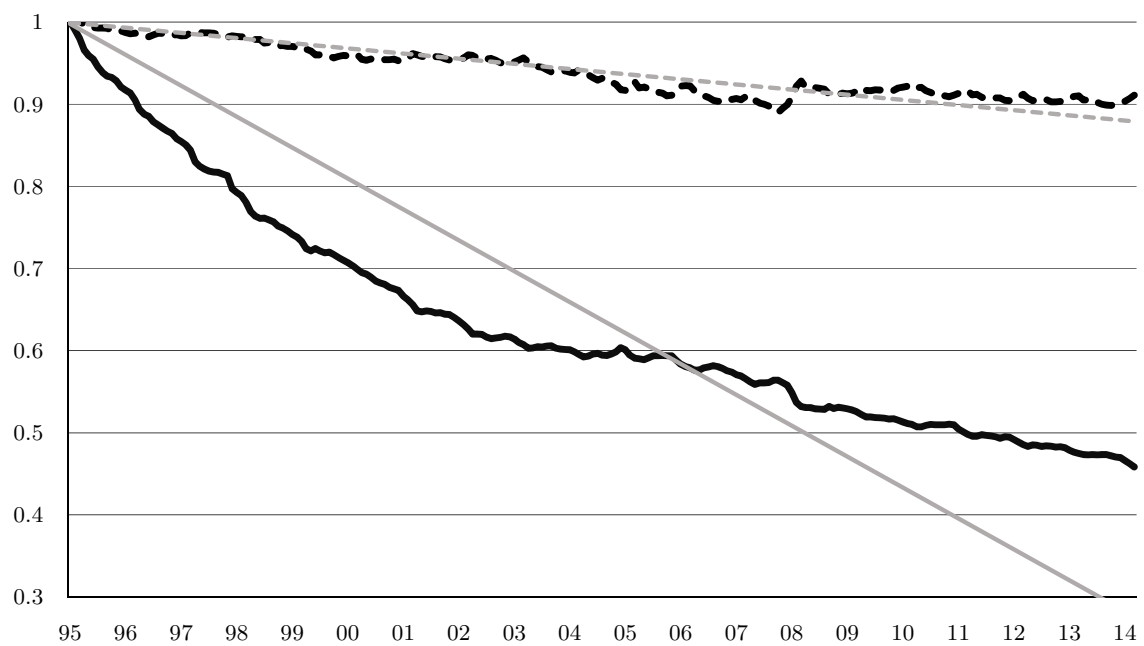
the euro, the pound sterling and the Japanese yen show a negative β coefficient in 7 out of 9 cases. Only the three-month forecast of the euro show a small positive β value of 0.048, while the estimate for the twelve-month forecast is insignificant. The yen, by contrast, shows significant contrarian coefficients for all horizons, whereas the magnitude is significantly stronger in the short run. On the other hand, forecasters seem to also believe in an adjustment towards the long run equilibrium in 30 out of 66 cases, despite the fact that some currencies continuously deviate from the long run average. At the same time, 21 cases indicate that forecasters believe in a deviation from the PPP.

Overall we find higher volatility of forecast coefficients in emerging markets than in the industrialized countries; the latter is indicated by the circles scattered around the origin. The results of our analysis can be interpreted as a confirmation of similar results in the literature that are based on a small number of industrialized countries (Verschoor and Zwinkels, 2013; Ince et al., 2015; Tsuchiya, 2016) but they indicate differences between the group of industrialized and emerging markets which need to be investigated. In order to evaluate the behavior towards fundamentals more carefully, we investigate the differences between emerging markets and industrialized economies in more detail in chapter 5.2.

5.2 Emerging Markets and Industrialized Economies

The real exchange in emerging markets and industrialized economies has been identified as a major driver of forecasting behavior in the literature (Tsuchiya, 2016). The fundamental real exchange values reveal systematic differences between both groups, as can be found in Figure 5. Whilst the real exchange rates for the group of industrialized countries appreciated marginally towards the US dollar, the real exchange rate index for the group of emerging markets shows a strong appreciation towards the dollar which

FIGURE 5: Real Exchange Rates Indices Compared to the US Dollar in Price Quotation

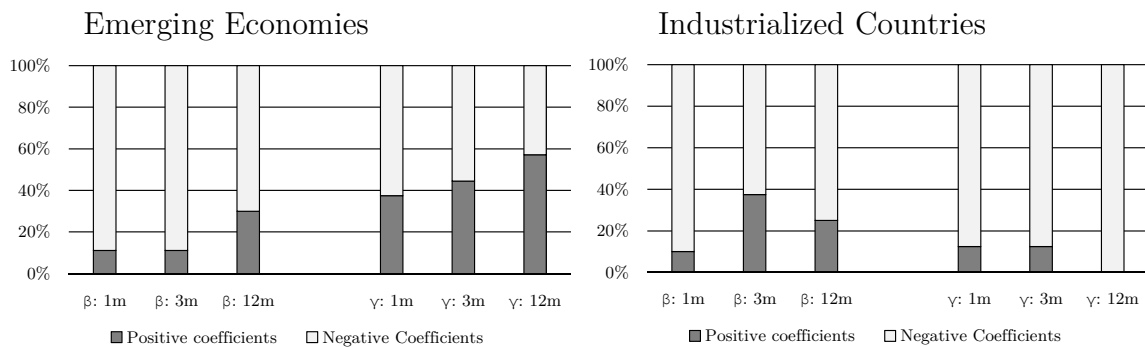


Note: The graph shows the development of real exchange rate of the two country groups towards the US dollar. The dotted line indicates the development of the exchange rate of industrialized countries towards the US, the straight line indicates the development of the group of emerging economies. The grey lines represent the respective trends between 1995 and 2014. Source: OECD Database (2016).

may influence forecasters' expectation formation.

Figure 6 shows the share of significant results for each time horizon and country group and illustrates the results in more detail. When controlling for patterns of chartist behavior, the β -coefficients indicate that bandwagon behavior (i.e. $\beta > 0$) dominates the short run forecasts for industrialized countries. In emerging markets, bandwagon behavior seems to hold particularly in the long run. Contrarian behavior (i.e., $\beta < 0$) is equally common in both country groups for the one-month and the twelve-horizon. For the three-month horizon, however, the majority of trend-following behavior is displayed in emerging markets. Additionally, we find that forecasts in emerging markets show destabilizing behavior for all forecast horizons, with rates between 50% (1-month horizon) and 75% (12-month horizon) of destabilizing coefficients estimated for emerging markets. Industrialized economies on the other hand are subject to stabilizing behavior in the medium run, for most forecast horizons.

FIGURE 6: Forecasting Behavior in Emerging and Industrialized Economies



Note: The graph differentiates between explosive (positive coefficient) and reverting behavior (negative coefficient) as estimated by Equation 3: $E_{i,t}[s_{t+k}] - s_t = \alpha + \beta(s_t - s_{t-1}) + \gamma(s_t - f_t) + \epsilon_{i,t}$. It shows the respective shares of industrialized and emerging markets for each coefficient and the time horizon separately. The combined shares of industrialized and emerging markets add up to 100% for each bar.

Regarding individual emerging markets, we find the forecasts for some more important currencies, like the South African rand to display characteristics of mean-reverting behavior like the euro and the pound sterling, whilst the forecasting behavior for other

countries is affected by crisis effects. For the Russian ruble in particular, we find bandwagon behavior on the trend variable β for two out of three forecast horizons, with the other parameters being insignificant. Moreover the γ coefficients show significant destabilizing behavior for all forecast horizons. Possible reasons for this detachment of the ruble may be found in a long-lasting devaluation and detachment from the PPP due to the Asian crisis, followed by a high resource dependency of the Russian economy, leaving the ruble exposed to significant volatility over the period examined here.

The data suggest an inherent difference between emerging markets and industrialized economies. The difference in forecasting behavior between emerging and industrialized economies may be explained by a variety of factors. Emerging markets may be subject to exogenous shocks and rare events. Another possible explanation may be, that the emerging markets within our panel exhibit strong growth patterns over the last decades. As emerging markets catch up, productivity and wages increase faster than in industrialized economies, leading to appreciation of the currency in real terms and asymptotic deviation from PPP. We examine this effect in the next section.

5.3 Do Forecasters Account for the Balassa-Samuelson Effect?

The constant appreciation of emerging markets' real exchange rates over time on the one hand and the stagnating development of real exchange rates in industrialized countries on the other hand is consistent with the Balassa-Samuelson effect. The Balassa-Samuelson effect emphasizes, that a catching-up process triggered by relatively strong productivity increases in the tradable goods sector is accompanied by a real appreciation of the currency. This phenomenon raises the question whether forecasters systematically take this effect into account. One could imagine different ways how the trend of a real appreciation can be integrated into a forecast function.

TABLE 6: Extrapolative Model II: Controlling for Emerging Market Based RERs

	Brazilian Real			Chilean Peso			Chinese Renminbi			Czech Koruna			Hungarian Forint		
Forecast Horizon	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12
α	0.064** (0.029)	0.046*** (0.008)	0.093*** (0.011)	0.012*** (0.002)	0.022*** (0.003)	0.061*** (0.005)	0.009 (0.006)	0.021*** (0.008)	0.087*** (0.011)	-0.003 (0.006)	0.021*** (0.005)	0.034*** (0.010)	0.008*** (0.003)	0.017*** (0.004)	0.026** (0.011)
β	0.007 (0.228)	-0.197*** (0.039)	-0.106*** (0.021)	-0.352*** (0.045)	-0.224*** (0.030)	-0.131*** (0.026)	-0.133 (0.094)	0.237*** (0.065)	0.662*** (0.059)	-0.240*** (0.050)	-0.206*** (0.052)	0.035 (0.035)	0.017 (0.053)	0.137*** (0.030)	0.176*** (0.024)
γ	-0.052* (0.028)	-0.024** (0.012)	-0.044*** (0.016)	-0.017*** (0.005)	-0.027*** (0.006)	-0.079*** (0.010)	-0.015** (0.007)	-0.031*** (0.009)	-0.106*** (0.012)	0.001 (0.001)	-0.006*** (0.001)	-0.008*** (0.002)	-0.000 (0.001)	-0.002 (0.001)	-0.001 (0.003)
R^2	0.001	0.102	0.094	0.329	0.275	0.234	0.028	0.054	0.145	0.122	0.169	0.114	0.001	0.059	0.206
Observations	428	445	428	365	375	355	424	457	459	167	167	154	156	156	145
Groups	27	25	24	26	26	26	25	24	22	21	21	21	23	23	23

	Mexican Peso			Polish Zloty			Russian Ruble			Slovakian Koruna			South African Rand		
Forecast Horizon	1	3	12	1	3	12	1	3	12	1	3	12	1	3	12
α	0.049*** (0.005)	0.082*** (0.005)	0.193*** (0.008)	0.013* (0.007)	0.045*** (0.009)	0.116*** (0.020)	-0.004 (0.008)	-0.010 (0.014)	0.014 (0.019)	-0.013*** (0.005)	0.010 (0.009)	0.044** (0.019)	0.086*** (0.012)	0.068*** (0.017)	0.114*** (0.022)
β	-0.248*** (0.060)	-0.192*** (0.035)	0.052 (0.034)	-0.053 (0.058)	-0.029 (0.052)	-0.020 (0.043)	-0.151 (0.109)	-0.013 (0.082)	0.223*** (0.037)	0.011 (0.086)	0.048 (0.076)	0.168** (0.073)	-0.288*** (0.056)	-0.319*** (0.052)	-0.159*** (0.025)
γ	-0.079*** (0.011)	-0.135*** (0.011)	-0.319*** (0.016)	-0.003 (0.002)	-0.011*** (0.003)	-0.028*** (0.006)	0.007 (0.010)	0.024 (0.016)	0.001 (0.021)	0.004*** (0.001)	-0.002 (0.003)	-0.007 (0.007)	-0.080*** (0.015)	-0.043** (0.022)	-0.061** (0.030)
R^2	0.229	0.329	0.469	0.028	0.066	0.129	0.065	0.009	0.315	0.027	0.048	0.250	0.110	0.120	0.203
Observations	443	460	432	147	147	129	385	383	361	70	70	61	340	347	347
Groups	28	28	27	22	22	22	24	24	21	21	21	19	33	33	33

	Turkish Lira		
Forecast Horizon	1	3	12
α	-0.002 (0.011)	-0.038*** (0.014)	0.070* (0.038)
β	-0.124** (0.051)	-0.144*** (0.046)	0.234*** (0.063)
γ	0.029* (0.016)	0.107*** (0.021)	-0.046 (0.063)
R^2	0.046	0.072	0.105
Observations	443	449	440
Groups	32	30	28

Note: The table shows the regression results for the Equation (4) $E_{i,t}[s_{t+k}] - s_t = \alpha + \beta(s_t - s_{t-1}) + \gamma(st - \psi_t f_t) + \epsilon_{i,t}$; all exchange rates are in logs; robust standard error in parentheses.

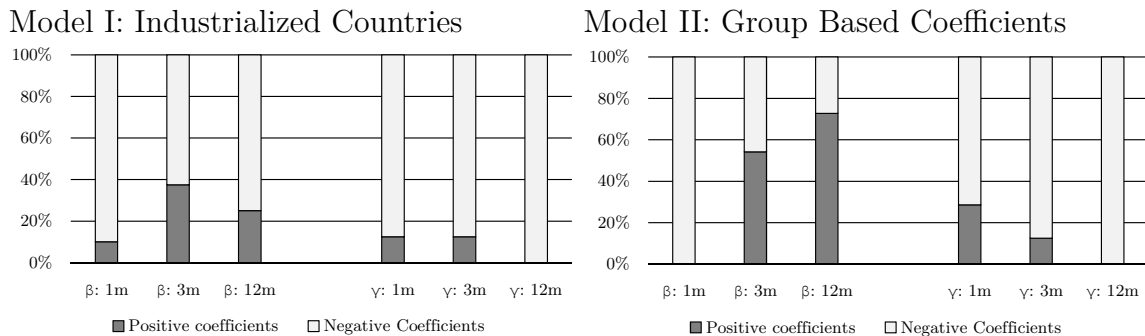
One possibility is to adjust the fundamental value that forecasters consider by a factor that reflects the trend of the real appreciation of the currency of the emerging market. A second possibility is to use as an adjustment factor the real appreciation trend of the group of emerging markets. More specifically, this leads to the following specification of our model:

$$E_{i,t}[s_{t+k}] - s_t = \alpha + \beta(s_t - s_{t-1}) + \gamma(s_t - \psi_t f_t) + \epsilon_{i,t}. \quad (4)$$

where ψ_i is the adjustment factor. We perform the estimation process using alternatively both approaches for the adjustment of the fundamental value as described above.

As the modification of our estimation model only affects emerging markets, the results for industrialized countries remain unchanged, the detailed results for the new estimations are shown in Table 6. Figure 7 compares the earlier estimation results for industrialized countries with the new estimation results for the emerging markets to compare forecasting behavior once the Balassa-Samuelson effect is being controlled for. We find, that the estimation of Equation 4 using group based coefficients of emerging markets adapts to the results obtained for industrial countries, as can be found in Figure 7. In both cases, the majority of forecasters holds reverting behavior towards the trends and the fundamentals in the short run, for the trend, as well as the fundamental variable. Additionally the β coefficients show increasing bandwagon behavior with increasing forecast horizons. Only for the 12-month horizons, we find forecasters to display increasing bandwagon behavior regarding the trend variable β for the group of emerging countries, whilst only around a third of forecasters does so in industrialized countries. At the same time, the γ coefficients of the group based coefficients resemble the γ coefficients for the group of industrial countries. Overall, the γ coefficients indicate stabilizing behavior for 19 out of 22 significant regressions over all forecasting horizons for Model II.

FIGURE 7: Robustness of Model: Controlling for the Balassa-Samuelson Effect



Note: Figure 7 differentiates the results of the original model (Model I) as presented in Figure 6 from the adjusted results as estimated by Equation 4 : $E_{i,t}[s_{t+k}] - s_t = \alpha + \beta(s_t - s_{t-1}) + \gamma(s_t - \psi_t f_t) + \epsilon_{i,t}$ (Model II). The graph differentiates between explosive (positive coefficient) and reverting behavior (negative coefficient). It shows the respective shares of industrialized and emerging markets for each coefficient and the time horizon separately. The combined shares of industrialized and emerging markets add up to 100% for each bar.

More precisely, the adjustment of the γ coefficient for the Balassa-Samuelson effect leads to a very similar structure as can be found for the panel of industrialized countries. Accounting for the Balassa-Samuelson effect increases the goodness of fit significantly in 8 out of 11 emerging economies. Additionally, we find the γ coefficients to strengthen significantly in 7 out of 11 cases. Interestingly, once the Balassa-Samuelson effect is taken into account forecasters for the Mexican peso and the Polish zloty switch forecasting behavior from destabilizing behavior to stabilizing behavior for the majority of forecasting horizons. When compared to the forecasting behavior in industrialized countries, we find a clear adjustment to the panel results of industrialized countries. For the γ -coefficient we find significant, stabilizing behavior for 7 currencies, as well. After correcting for the Balassa-Samuelson effect, only very few forecasters show destabilizing behavior for the 3-month horizon in both groups. Forecasters in both groups show purely stabilizing behavior for the 12-month horizon.

Concluding, we find the panel of forecasters for emerging economies to adjust forecasting behavior to the behavior of forecasters in industrialized countries once we account for the Balassa-Samuelson effect. This suggests, that forecasters are aware of emerging

economies' catching-up process. Thus it appears that forecasters correctly assume the following real appreciation of currencies in emerging economies. When correcting the fundamental variable for group based coefficients, we find forecasters to exhibit nearly identical behavior for the panel of emerging markets and industrialized countries. This suggests that forecasters do perceive the Balassa-Samuelson correctly and account for this phenomenon accordingly.

6 Summary and Conclusion

In this paper, professional economists' forecasts for 22 exchange rates are used in order to test forecaster rationality, analyze the expectation formation process, and distinguish forecasting patterns in industrialized and emerging markets. Our test results suggest that the rationality hypothesis of unbiased, consistent forecasting cannot be upheld. Our findings confirm the stylized fact that forecasters can be regarded as heterogeneous rather than homogeneous. Additionally, our results suggest that expectations in most countries tend to be influenced by both, chartist and fundamentalist behavior. Thereby long-term concepts gain importance with increasing forecast horizons. Over time, the strength of this effect tends to increase over time.

Forecasters are found to exhibit significantly different behavior in industrialized countries and emerging markets. Whilst most forecasts for industrialized economies show reverting behavior, destabilizing and stabilizing behavior is nearly equally common for the group of emerging markets. When controlled for the Balassa-Samuelson effect we find forecasters in emerging economies to display a similar forecasting behavior as forecasters in industrialized economies: In both cases, forecasters display reverting behavior towards the trend and the fundamental variable.

References

- Athanasios Papoulis, S. U. P. (2002). *Probability, Random Variables and Stochastic Processes*. McGraw-Hill.
- Batchelor, R. (2001). How useful are the forecasts of intergovernmental agencies? The IMF and OECD versus the consensus. *Applied Economics*, 33(2):225–235.
- Bettendorf, T. and Chen, W. (2013). Are There Bubbles in the Sterling-dollar Exchange Rate?
- Dick, C. D., Macdonald, R., Menkhoff, L., Dick, C. D., Macdonald, R., and Menkhoff, L. (2014). Exchange Rate Forecasts and Expected Fundamentals. *Kiel Working Paper*, (1974).
- Elliott, G. and Ito, T. (1999). Heterogeneous expectations and tests of efficiency in the yen/dollar forward exchange rate market. *Journal of Monetary Economics*, 43(2):435–456.
- Eurostat and Oecd (2015). Eurostat-OECD Methodological Manual on Purchasing Power Parities.
- Frankel, J. A. and Froot, K. A. (1987). Using survey data to test some standard propositions regarding exchange rate expectations. *American Economic Review*, 77(1):133–153.
- Frenkel, M., Lis, E. M., and Rülke, J.-C. (2011). Has the economic crisis of 2007-2009 changed the expectation formation process in the Euro area? *Economic Modelling*, 28(4):1808–1814.
- Frenkel, M., Rülke, J. C., and Stadtmann, G. (2009). Two currencies, one model? Evidence from the Wall Street Journal forecast poll. *Journal of International Financial Markets, Institutions and Money*, 19(4):588–596.
- Frenkel, M., Rülke, J.-C., and Zimmermann, L. (2012). Do Current Account Forecasters Herd? Evidence from the Euro Area and the G7 Countries. *Review of International Economics*, 20(2):221–236.
- Froot, K. A. and Thaler, R. H. (1990). Anomalies: Foreign Exchange.
- Galati, G., Poelhekke, S., and Zhou, C. (2008). Did the anchor of inflation expectations in the euro area turn adrift? (191).
- Goldbaum, D. and Zwinkels, R. C. J. (2013). An empirical examination of heterogeneity and switching in foreign exchange markets. *Journal of Economic Behavior and Organization*.
- Ince, O., Molodtsova, T., and Papell, D. H. (2015). Taylor Rule Deviations and Out-of-Sample Exchange Rate Predictability. *SSRN Electronic Journal*.
- International Monetary Fund (2015). *Annual Report on Exchange Arrangements and Exchange Restrictions, 2014*, volume 2015. International Monetary Fund.

- Ito, T. (1990). Foreign exchange rate expectations: micro survey data. *American Economic Review*, 80(3):434–449.
- Jongen, R., Muller, a., and Verschoor, W. F. C. (2012). Using survey data to resolve the exchange risk exposure puzzle: Evidence from U.S. multinational firms. *Journal of International Money and Finance*, 31(2):148–169.
- Keane, M. P., Keane, M. P., Runkle, D. E., and Runkle, D. E. (1990). Testing the Rationality of Price Forecasts: New Evidence from Panel Data. *The American Economic Review*, 80(4):714–735.
- Macdonald, R. and Marsh, I. W. (1996). Currency forecasters are heterogeneous: Confirmation and consequences. *Journal of International Money and Finance*, 15(5):665–685.
- Menkhoff, L. (1998). The noise trading approach – questionnaire evidence from foreign exchange. *Journal of International Money and Finance*, 17(3):547–564.
- Menkhoff, L. (2001). Short-Term Horizons in Foreign Exchange? Survey Evidence from Dealers and Fund Managers. *Kyklos*, 54(1):27–47.
- Menkhoff, L., Rebitzky, R. R., and Schröder, M. (2008). Do dollar forecasters believe too much in PPP? *Applied Economics*, 40(July 2012):261–270.
- Molodtsova, T. and Papell, D. (2009). Out-of-sample exchange rate predictability with Taylor rule fundamentals. *Journal of International Economics*.
- Monacelli, T. and Perotti, R. (2010). Fiscal Policy, the Real Exchange Rate and Traded Goods*. *The Economic Journal*.
- Newey, W. and West, K. D. (1987). A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix. *Econometrica*, 55(3):703–08.
- Pierdzioch, C. (2010). Forecasting Emerging Market Exchange Rates $\hat{\tau}$ Evidence of Address : Forecasting Emerging Market Exchange Rates $\hat{\tau}$ Evidence of Anti-Herding. (September).
- Pierdzioch, C., Rülke, J.-C., and Stadtmann, G. (2012). Exchange-rate forecasts and asymmetric loss: empirical evidence for the yen/dollar exchange rate. *Applied Economics Letters*, 19(18):1759–1763.
- Ruelke, J. C., Frenkel, M. R., and Stadtmann, G. (2010). Expectations on the yen/dollar exchange rate - Evidence from the Wall Street Journal forecast poll. *Journal of the Japanese and International Economies*, 24(3):355–368.
- ter Ellen, S., Verschoor, W. F. C., and Zwinkels, R. C. J. (2013). Dynamic expectation formation in the foreign exchange market. *Journal of International Money and Finance*, 37:75–97.
- Tschiya, Y. (2015). Herding behavior and loss functions of exchange rate forecasters over interventions and financial crises. *International Review of Economics and Finance*, 39:266–276.

- Tsuchiya, Y. (2016). Assessing macroeconomic forecasts for Japan under an asymmetric loss function. *International Journal of Forecasting*, 32(2):233–242.
- Verschoor, W. F. C. and Zwinkels, R. C. J. (2013). Do foreign exchange fund managers behave like heterogeneous agents? *Quantitative Finance*, 13(7):1125–1134.