Exchange rate expectations since the financial crisis: Performance evaluation and the role of exchange rate regimes, monetary policy and safe haven*

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Abstract

This study provides a new perspective on exchange rate expectations by analyzing data for more than 60 economies and different horizons, focusing on the period after the collapse of Lehman Brothers. We establish a discrepancy between statistical and economic measures in the sense that market expectations are superior to relying on past values based on economic evaluation criteria despite a weak statistical performance. Professionals also frequently expect exchange rate changes beyond the announced exchange rate regime in case of a managed or fixed float, implying a significant degree of exchange rate uncertainty. Overall, countries with managed exchange rate flexibility seem to be successful in importing market credibility and avoiding currency turbulence over the recent period. Expectation and forecast errors are affected by several factors in a time-varying fashion. We find that monetary policy has triggered expected US dollar appreciations via lower shadow interest rates over the recent period. Finally, our results show that safe haven effects are time-varying and depend on the uncertainty measure. The safe haven status of the US dollar after 2009 was not expected by market professionals.

Keywords: Exchange rates, expectations, financial crisis, monetary policy

JEL classification: F31, G15

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1 Introduction

The notable discrepancy between theoretical exchange rate models and empirical results remains one of the major puzzles in international economics. Several explanations for the weak and unstable link between exchange rates and fundamentals, the exchange rate disconnect puzzle, are discussed (Sarno, 2005). One frequent finding in this regard is that exchange rate expectations are detached from actual future exchange rates, contradicting a common assumption embedded in models such as uncovered interest rate parity (Jongen *et al.*, 2008). Expectations also play a crucial role in the context of fixed exchange rates. Arrangements which are considered to be not credible by markets participants potentially suffer speculative attacks, require central bank interventions and are hard to obtain in the long-run.

Monetary policy is an important driver of both financial market expectations and exchange rates. Many theoretical models rely on interest rate and money supply changes as a determinant of exchange rate fluctuation.[1] At the same time, several studies have demonstrated that the conducted and announced path of monetary policy affects expectations on financial markets. Such effects are even more important for monetary policy transmission since unconventional monetary policy has emerged.[2] It is therefore somehow surprising that the effect of monetary policy on aggregated exchange rate expectations has not been explicitly addressed. Instead, most approaches for modeling expectations use disaggregated data on exchange rate expectations to explain characteristics of exchange rate markets, such as heterogeneity across expectations and the microstructure of currency markets (Jongen *et al.*, 2008).

The contribution of this paper to the literature is threefold. First, we assess exchange rate forecasts for both 30 major and 35 minor currencies (classified by FX4casts) after the start of the financial crisis. While previous studies have argued that the performance of professional forecasters varies both over horizons and for emerging and industrial economies based on a small subset of currencies (Ince and Molodtsova, 2013), neither the performance for minor currencies with flexible exchange rates nor the performance over the recent period has yet been fully analyzed. We compare expected

[1] Monetary exchange rate models were introduced after the breakdown of Bretton Woods and rest on the assumption that supply and demand for currencies are a result of transactions in international financial markets, relying on purchasing power parity as equilibrium condition for goods markets (Dornbusch, 1976a; Frenkel, 1976). Dornbusch (1976b) introduces a sticky-price version of the monetary model to explain overshooting behavior of exchange rates. Recent models by Molodtsova *et al.* (2008) rely on a Taylor rule approach which states that a central bank adjusts the short-run nominal interest rate in order to respond to inflation and output gap.

[2] The famous "whatever it takes" speech by Mario Draghi on July 2012 has highlighted the importance of policy announcements for the paths of exchange rates. In addition, policy announcements have already been identified as a potential driver of exchange rate volatility in the previous literature (Conrad and Lamla, 2010).

and realized exchange rates and test for unbiased expectations after the collapse of Lehman brothers for countries with both fixed and flexible exchange rate arrangements. Taking five different forecasting horizons into account also enables us to test for the credibility of fixed exchange rate arrangements according to professionals. We also go beyond the usual country perspective and analyze the capacity of professionals to manage currency portfolios and compare their performance to usual benchmarks.

Second, our analysis focuses on potential driver of exchange rate expectations and the resulting forecast errors. We determine which currencies are expected to serve as 'safe havens' relative to the US dollar in the aftermath of the financial crises.[3] The safe haven status is examined in a time-varying fashion. We also go beyond the usual VIX measure by considering the impact of uncertainty resulting from various financial variables while relying on a measure proposed by Jurado *et al.* (2015). Finally, we also address the time-varying role of unconventional monetary policy in both the US and the euro area. In this regard, we provide a new perspective on monetary transmission effects to exchange rates during and after the crisis by disentangling expected and unexpected monetary policy effects based on the consideration of shadow rates. We also account for the time-varying impact of domestic inflation and interest rates relative to the US as well as the stance of monetary policy via shadow rates.

Our main data set runs from 2004 until 2016 with several sub-sample periods under investigation. Survey data on exchange rate expectations are obtained from FX4casts formerly known as the Financial Times Currency Forecaster. The consensus is based on 42 individual responses and is calculated as the geometric mean in order to reduce distortion due to extremes outliers. Although previous studies such as Fratzscher *et al.* (2015), Bacchetta *et al.* (2009) and Cavusoglu and Neveu (2015) also base their analysis on FX data, we are the first to analyze the full data set of exchange rate expectations which includes both minor and major currencies and explicitly puts exchange rate expectations after the collapse of Lehman Brothers into account. We analyze expected and unexpected effects for 1, 3, 6, 12 and 24 months forecasting horizons.

The rest of this paper is organized as follows. Section 2 summarizes theoretical considerations and previous literature. Section 3 provides data and our empirical approach. Finally, Section 4 presents our empirical results. We start by summarizing descriptive evidence and currency-specific regressions and also evaluate forecasts under fixed and managed exchange rates. We then

[3] A safe haven is usually defined as an asset whose returns are negatively correlated to global stock market returns in times of market turmoil (Hossfeld and MacDonald, 2015).

turn to an economic evaluation of professional exchange rate expectations before analyzing drivers of expectations and forecast errors in the context of monetary policy and uncertainty. Section 5 concludes.

2 Theoretical background and literature review

2.1 Exchange rate expectations

The literature on exchange rate expectations can be roughly divided into studies evaluating the adequacy of professional forecasts and explaining the formulation of expectations on an aggregated and disaggregated level. Generally, macroeconomic survey data is potentially useful for forecasting, for example in the context of inflation (Ang *et al.*, 2007). However, the evidence for exchange rates has been mostly disappointing in the sense that survey-based expectations are unable to predict future spot rates. A conventional test in this context is based on the following regression

$$s_{t+h} - s_t = \alpha + \beta(E_t(s_{t+h}) - s_t) + u_{t+h}, \tag{1}$$

where s_t denotes the natural logarithm of the spot exchange rate and $E_t(s_{t+h})$ represents the expected exchange rate at t for $t+h$ (Jongen *et al.*, 2008). The joint null hypothesis $\alpha = 0$ and $\beta = 1$ has been rejected in various studies such as Blake *et al.* (1986), Chinn and Frankel (1994), MacDonald and Marsh (1996) and Jongen *et al.* (2008). In line with the general evidence on exchange rates, the findings depend on evaluation criteria, time horizon and currency choices. Cavusoglu and Neveu (2015) provide slightly more encouraging results by also considering the most optimistic and pessimistic forecasts but also fail to overturn the overall pattern while Ince and Molodtsova (2013) identify different patterns across horizons as well as for industrialized and emerging economies.

Marsh and Power (1996) and Elliott and Ito (1999) were the first to argue that statistical adequacy is not necessarily an effective evaluation measure of exchange rate expectations.[4] Even biased expectations which fail to beat a random walk benchmark are potentially still useful for an investor. In this spirit, other studies have considered different approaches for evaluating and analyzing exchange expectations based on trading strategies. This takes into account the fact that traders on currency markets manage a portfolio and are more interested in the overall return which depends

[4] A similar point has been raised in the context of uncovered interest rate parity (UIP) where rejections of UIP do no imply profitability of carry trades (Olmo and Pilbeam, 2011).

on the accuracy of direction forecasts rather than point forecasts. The finding $E_t(s_{t+h}) \neq s_{t+h}$ therefore potentially reflects different scenarios and is not equivalent to a general failure of professional forecasts.

While several studies analyze the dispersion of forecasts for a specific currency, less is known about the determinants of aggregated expectations and the resulting forecast errors. The frequent rejection of unbiased expectations has been attributed to different factors such as time-varying risk premia or irrational expectations (Jongen *et al.*, 2008). A formal test for rational expectations based on orthogonality is built on the idea that forecast errors should not be affected by previous forecast errors and the forward discount if expectations are formed rational (Jongen *et al.*, 2008; Frankel and Froot, 1986, 1987)

$$E_t(s_{t+h}) - s_{t+h} = \alpha + \beta_1(E_{t-h}(s_t) - s_t) + \beta_2(f_{t,t+h} - s_t) + \beta_3(s_t - s_{t-h}) + u_{t+h}. \tag{2}$$

Test of this kind frequently reject weak orthogonality for horizons over three months. Partly obtained negative estimates of β_2 even suggest that forecasters can improve their performance by taking the forward premium puzzle into account. Such findings mirror the fact that exchange rates are random walks and essentially not predictably based on simple models which for example include fundamentals besides the current exchange rate. $E_t(s_{t+h}) \neq s_{t+h}$ might simply reflect the notorious Meese and Rogoff (1983) puzzle and the established link between the predictability of returns on financial markets and expectation errors of professionals (Bacchetta and van Wincoop, 2006). We argue that, in contrast to linear models, determinants of both exchange rate expectations and forecast errors are time-varying due to the continuously changing economic environment, in particular after the financial crisis.

2.2 Safe haven currencies and monetary policy

The financial crisis has also changed the dynamics across worldwide currency markets. While negative news resulted in a depreciation of the US dollar prior to the crisis, negative news during the crisis resulted in an appreciation of the dollar. One explanation is that market participants consider news about a weakening of the US economy to have even worse effects for other countries (Fratzscher, 2009). Despite reaching the zero lower bound, monetary policy has been an important driver of financial markets and the corresponding expectations. For this reason, we explicitly

incorporate monetary policy shadow rates.

Hossfeld and MacDonald (2015) define a safe haven (hedge) as a currency whose effective returns are negatively related to global stock market returns in times of financial stress (on average). Fundamental drivers of currency appreciations in times of financial stress include net foreign asset positions and the size of stock markets (Habib and Stracca, 2012). Since we focus on exchange rate expectations via the dollar, we argue that a safe haven currency is expected to appreciate against the US dollar in times of uncertainty while a hedge currency is expected to appreciate on average. A general link between uncertainty and expectations can be derived based on the idea of bounded rationality. Market expectations are vulnerable to and significantly affected by uncertainty which reflects a stochastic component and results in forecast errors even if expectations regarding the mean (and possible the variance of such a shock) are correct (Heiner, 1983; Conlisk, 1996). This impact of uncertainty often varies over time.

Hossfeld and MacDonald (2015) have shown that safe haven characteristics of effective exchange rates can be characterized by threshold dynamics which depend on the level of financial stress. Considering the focus of our sample on the recent crisis period which includes several changes in the stance of economic policy, we adopt a framework which allows for a time-varying impact of uncertainty in each period. Although this does not enable us to identify a specific threshold, we are able to access effects over the recent period. In addition, we rely on the idea of using a shadow policy rate to calibrate monetary policy at the zero lower bound (Wu and Xia, 2016).

Hence, we argue that both expected exchange rate changes $E_t(s_{t+h}) - s_t$ and the resulting forecast errors $E_{t-h}(s_t) - s_t$ are driven by uncertainty and extend Eq. (2) accordingly in a time-varying fashion

$$E_t(s_{t+h}) - s_t = \theta_{0,t} + \theta_{1,t}(r_t - r_t^*) + \theta_{2,t}(\pi_t - \pi_t^*) + \theta_{3,t}\mathrm{pr}_t^{\mathrm{ECB}} + \theta_{4,t}\mathrm{pr}_t^{\mathrm{FED}} + \theta_{5,t}\mathrm{FU}_t + \theta_{6,t}\mathrm{VIX}_t + \eta_t, \quad (3)$$

and

$$E_{t-h}(s_t) - s_t = \theta_{0,t} + \theta_{1,t}(r_t - r_t^*) + \theta_{2,t}(\pi_t - \pi_t^*) + \theta_{3,t}\mathrm{pr}_t^{\mathrm{ECB}} + \theta_{4,t}\mathrm{pr}_t^{\mathrm{FED}} + \theta_{5,t}\mathrm{FU}_t + \theta_{6,t}\mathrm{VIX}_t + \eta_t, \quad (4)$$

where the interest rate $(r_t - r_t^*)$ and inflation differential relative to the US $(\pi_t - \pi_t^*)$ are included in each model as fundamentals. The federal funds rate has been close to zero after 2008 while the Federal Reserve conducted unconventional policy, such as asset purchases, to affect the economy.

Wu and Xia (2016) introduce a shadow rate measure based on a nonlinear term structure model to account for effects near the zero lower bound for interest rates. They find that such a measure reflects the underlying information of unconventional monetary policy at the zero lower bound. We therefore rely on shadow interest rates in the United States pr_t^{FED} and the Eurozone pr_t^{ECB} to account for an impact stemming from unconventional monetary policy. Finally, we also include two uncertainty measures. The usual VIX benchmark (VIX_t) to account for stock market volatility and the financial uncertainty measure proposed by Jurado *et al.* (2015) (FU_t) which controls for a unpredictable component rather than relying on pure volatility, providing an alternative uncertainty measure based on a common consideration of 147 financial market variables.

3 Data and empirical framework

3.1 Data

Survey data on exchange rate expectations are obtained from FX4casts formerly known as the Financial Times Currency Forecaster. The consensus is based on 42 individual responses and is calculated as the geometric mean in order to reduce distortion due to extremes outliers. Spot rates and their expectations are measured in units of domestic currency per one unit of the US dollar (i.e. a decrease corresponds to an appreciation of the domestic currency) and are provided for 30 major and 35 minor currencies according to the FX4casts classification.[5] Forecasts are provided for 1, 3, 6, 12 and 24 months horizons and our full data set of expectations including all horizons runs from 2008:10 until 2016:03.[6] Table 11 in the Appendix summarizes the whole data set under observation which also includes the regressors mentioned in the previous subsection.

The large number of currencies we are analyzing implies that we also cover a wide range of exchange rate regimes against the US dollar. Our data set includes managed, fixed and flexible exchange rates. Tables 12 and 13 in the Appendix summarize the exchange rate regimes of the countries under investigation according to the IMF classification. The fact that we also consider long-term forecasts enables us to address expected changes of the exchange rate regime, for example if long-run expectations exceed announced fluctuation bands of the exchange rates. This part of our analysis is therefore related to the credibility of fixed exchange rate regimes.

[5]The classification into major and minor currencies relies on the trading volume of the currencies and has no effect on the results of our study. The currencies have been separated according to this definition for illustrative purpose. The full list of currencies included in our study can be found e.g. in Tables 12 and 13.

[6]Data on 3, 6 and 12 months horizons is also available prior to 2008:10.

4 Empirical results

4.1 Descriptive analysis

Throughout the analysis, we distinguish between major and minor currencies. For both sets of currencies, we analyze the longest available sample period. The full sample period for major currencies starts in October 2001 while the sample for most of the minor currencies begins in December 2003.[7] To achieve comparability between major and minor currencies, we have often synchronized the sample period.

A natural starting point for our analysis is a comparison of expected and actual future exchange rates. Tables 1 to 2 provide correlation coefficients for both currency sets and the corresponding sample period. Starting with a comparison for major currencies for two sample periods, our results suggest that the performance of professional forecasters has worsened significantly after the onset of the financial crisis. Correlations over the full sample period (2002/10-2016/03) for three months horizon are never below 80%, in many cases even exceeding 90%. The findings for the second sample period (2010/07-2016/03) frequently display a weaker relationship with correlations resulting in e.g. 55% for the British pound. The same pattern materializes even stronger if we compare the 12 months horizon. While the correlation is always positive over the full sample, correlations are partly negative and mostly less pronounced over the second sample period. The additional perspective of 24 months forecasts over the second sample provides several negative correlations and shows that even forecasters struggle to get the direction of exchange rate changes right. The findings for minor currencies resembles this pattern, also showing decreasing correlation coefficients. In particular, the decrease in correlation from 6 to 12 months is quite remarkable.

*** Insert Tables 1 and 2 about here ***

To put the link between expected and realized future exchange rate under closer scrutiny, we have applied a formal test for evaluation the adequacy of forecast power among the lines of Eq. (1) for the second sample period (2010/07-2016/03). The corresponding results are presented in Tables 3 and 4. In line with previous findings (e.g. Jongen *et al.*, 2008), we observe that the null hypothesis

[7] The sample periods of several minor currencies start later. In addition, the calculation of e.g. forecast errors at the 24 month horizon results in a loss of two years of data. Therefore, the effective sample period is shorter and also varies to some extend due to the issue of observation. The exact effective sample period can be found below each table and figure.

of unbiasedness for major currencies is frequently not rejected for the one month horizon. The most rejections are detected for 12 months forecasts. We keep in mind that the potential power over the 24 months horizon might be quite low owing to the small number of observations since an evaluation of 24 months forecasts is not possible over the full sample period. The findings for minor currencies even display a higher rejection rate of the unbiasedness hypothesis despite more exchange rates are pegged. We will turn to this issue in the next subsection. Overall, we only observe four cases where the null is not rejected. Interestingly, we also find cases where the slope coefficient β is significantly negative, suggesting that professional forecasters are significantly wrong.

*** Insert Tables 3 and 4 about here ***

Overall, our findings resemble previous empirical results by showing that expectations are biased in most cases. As outlined previously, this is not surprising and potentially reflects the unpredictability of exchange rates. To gain an understanding of the expectations mechanism, we will evaluate the link between current spot rate and expectations in the following. Figures 1 and 2 provide the graphs for the major currencies under investigation while Figures 3 and 4 show the plots for the minor currencies.

*** Insert Figures 1 to 4 about here ***

For both major and minor currencies, we observe that 24 months forecasts are strongly disconnected from the current spot rate while short-term forecasts are closely linked to the current exchange rate. A quite interesting picture emerges from these graphs if we focus on the period after 2008. Most major currencies were expected to depreciate against the US dollar after the crisis emerged, pointing to a possible status of the dollar as a safe haven currency. However, this pattern has somehow reversed after 2012 when the dollar is expected to depreciate against most major currencies over all horizons. The same pattern becomes evident for most minor currencies which can be explained based on their exchange rate peg in many cases. Countries like Bulgaria, which peg their currency against the euro experience also fluctuations against the dollar.

Finally, we graphically evaluate the evolution of absolute forecast errors over time for all currencies

shown in Figures 5 to 8. In line with our previous findings, we find forecast errors to be quite substantial across all countries and horizons and increasing after the financial crisis. The higher the forecast horizon the higher the variation of the corresponding forecast errors (see also the box plot diagrams of the forecast errors reported in the Appendix, Figures 29 to 32).

*** Insert Figures 5 to 8 about here ***

4.2 Expectations across regimes and crisis expectations

Due to the large number of currencies analyzed, we also incorporate different exchange rate regimes. The IMF classification provided in Tables 12 and 13 shows that most currencies allow for floating exchange rates with many of them classified as floating in the context of inflation targeting. Exceptions are European countries which fix their exchange rate against the euro as well as Venezuela, Argentina and Russia before the recent crisis. In contrast, our set of minor currencies includes a large number of countries where exchange rates are not fully floating. For those currencies, future expectations are directly related to the credibility of the exchange rate arrangement. Some economies have pegged their exchange rate, giving up monetary independence. While some African economies have pegged their exchange rate to the euro, economies in Middle and South America as well as Asia (still) rely on the US dollar as the anchor currency. Other countries, such as Israel, rely on a floating to an inflation-targeting framework and intervene based on the stabilization of the effective exchange rate.

Expectations have a prominent role in the literature on currency crisis since the traditional model has been proposed by Krugman (1996). In a nutshell, expectations and resulting speculations can potentially force authorities to give up a non-credible exchange rate peg which is not in accordance with macroeconomic fundamentals. Reconsidering the graphical evidence provided in Figures 1 to 4 shows that professionals are mostly not very successful in forecasting changes in exchange rate regimes and currency crises over the recent sample period. The Venezuelan bolivar appears to be an exception where professionals expected a strong depreciation. However, such a crisis was widely expected considering the recent problems the Venezuelan economy is facing. In contrast to that, the Russian crisis that started in the second half of 2014 and the recent depreciation of the Mexican

peso were not expected by professionals. Forecasts regarding adjustments of the Kuwaiti dinar also turn out to be wrong on many occasions. Another interesting example is the Lebanese pound, for which professionals expected a strong depreciation over different horizons throughout the sample period. Despite this pressure the country still benefits from the past dollarization regime which still provides credibility and allows a remarkably stable exchange rate path. The case of the Korean won shows that forecasters partly resemble existing depreciation patterns, possible due to sluggish adjustment of expectations.

To analyze the performance of forecasters in the context of exchange rate regimes and large exchange rate changes, we will summarize the empirical findings of correctly and falsely expected devaluations across all currencies and horizons in the following. We choose a somehow arbitrary benchmark of 5% depreciations. This allows us to disregard comparably small actual and expected depreciations.[8] Panel A and B of Table 5 report expected and actual depreciations above 5% for 3 and 6 as well as 12 and 24 months, respectively, for major and minor currencies and also separated into both fixed and flexible regimes. This distinction allows us to compare expectations in the short- and medium-run with the long-run. Panel C additionally provides results for 15% depreciations over 24 months as a proxy measure of long-run expected currency crisis with the US dollar as a benchmark.[9]

We focus on cases where a depreciation of at least 5% is expected correctly and label the resulting conditional relative frequency as the success rate. This is the case in less than 5% of the periods for the 3 and 6 months horizon for both major and minor currencies. The picture for the 12 and 24 months horizon is quite different with around 7-24% of correctly expected devaluations for both major and minor currencies. The success rate over 3 and 6 months is below 50% in all cases. In contrast, a large number of unexpected depreciations can be observed. The findings for the 12 and 24 months horizon again lead to a different conclusion. For both minor and major currencies, the overall success rate is above 50%. Only fixed exchange rate regimes for minor currencies display a success rate below 50% while nearly 60% in case of fixed exchange rate regimes for major currencies is observed. Hence, expectations are significantly more but still only moderately successful over the long-run.

Finally, we focus on depreciation expectations of at least 15% over a two year horizon. In such

[8] Several other configurations which include alternative benchmarks and/or both depreciations and appreciations are available upon request.

[9] Crawling peg to composite and currency board to euro are defined as floating relative to the US dollar.

a scenario correctly expected devaluation is overall observed in around 4% of all cases and is practically non-existent under flexible exchange rates in case of major currencies. The success rate for minor currencies is below 50%. However, the picture is significantly different for fixed regimes where the success rate is around 80% for both major and minor currencies. This implies that an expected depreciation of at least 15% results in actual depreciation in 4 out of 5 cases.

*** Insert Table 5 about here ***

Two findings stand out for economies which operate under fixed exchange rates: On the one hand, professionals hardly expect exchange rate changes beyond the announced exchange rate regime. In addition, they frequently fail to provide adequate forecasts under fixed exchange rates regimes over the short- and medium-run. This uncertainty has increased significantly for most minor currency forecasts after the financial crisis. However, the encouraging news is that fixed exchange rate regimes have prevailed in many cases despite depreciation expectations. Professionals are more successful over the long-run even in case of larger depreciation against the US dollar. Moreover, most exchange rates are expected to appreciate against the US dollar over recent years, in particular over the long-run. Overall, smaller economies and some emerging markets have been mostly successful in avoiding large turbulence on currency markets by fixing their exchange rates and importing credibility. An issue which is not explicitly covered here is the loss of monetary autonomy and the possible need for capital controls, i.e. the costs of adopting a fixed exchange rate regime.

4.3 On the economic value of professional forecasts

Our analysis has so far analyzed forecasts from a single currency perspective based on statistical tests. Elliott and Ito (1999) show that a weak statistical forecasting performance is potentially still valuable in terms of generating profits compared to simple benchmarks. This reflects the general argument raised by Leitch and Tanner (1991) that statistical evaluation and economic gains from survey forecasts potentially contradict each other. The reason is that conventional statistical measures rely on narrow assumptions about a forecasters' loss function while trading rules take the economic gains and the practical use of forecasts into account. We therefore turn to the question whether exchange rate forecasts are useful from an economic perspective based on trading rules. We therefore start with a very simple question: Are professionals doing a better job in predicting

exchange rate changes than recent history? To answer this question from an economic perspective, we compare the performance of expectations over different horizons relative to a simple trend following strategy. In the first scenario, the investor buys a currency which is expected to appreciate over the forecast horizon ($E_t(s_{t+h}) - s_t < 0$) and sells a currency which is expected to depreciate ($E_t(s_{t+h}) - s_t > 0$). The corresponding return based on professional forecasters expectations can thus be calculated as

$$r^E_{t,t+h} = I(E_t(s_{t+h}) - s_t > 0)(s_{t+h} - s_t)/h - I(E_t(s_{t+h}) - s_t < 0)(s_{t+h} - s_t)/h, \tag{5}$$

where $I(.)$ represents a Heaviside indicator function, $E_t(.)$ stands for expectation formed in t, and s_t denotes the natural logarithm of the spot exchange rate measured in units of domestic currency per one unit of the US dollar (i.e. a decrease of s_t means an appreciation of the domestic currency). h gives the forecast horizon.

In the second scenario, the investor uses a simple momentum strategy and buys a currency which has appreciated over the last month ($s_t - s_{t-1} < 0$) while he sells a currency which has depreciated over the last month ($s_t - s_{t-1} > 0$). The return of a momentum strategy can be expressed as

$$r^M_{t,t+h} = I(s_t - s_{t-1} > 0)(s_{t+h} - s_t)/h - I(s_t - s_{t-1} < 0)(s_{t+h} - s_t)/h. \tag{6}$$

If we additionally include interest rate differentials between the domestic economy and the US ($i_t - i^*_t$) into account, the returns given in Eqs. (5) and (6) can be expressed as

$$r^{E,i}_{t,t+h} = I(E_t(s_{t+h}) - s_t > i_t - i^*_t)((s_{t+h} - s_t)/h - (i_t - i^*_t)) - I(E_t(s_{t+h}) - s_t < i_t - i^*_t)((s_{t+h} - s_t)/h - (i_t - i^*_t)), \tag{7}$$

and

$$r^{M,i}_{t,t+h} = I(s_t - s_{t-1} > i_t - i^*_t)((s_{t+h} - s_t)/h - (i_t - i^*_t)) - I(s_t - s_{t-1} < i_t - i^*_t)((s_{t+h} - s_t)/h - (i_t - i^*_t)), \tag{8}$$

where i_t and i^*_t gives the domestic interest rate and its US counterpart, respectively. Due to data availability we only analyze selected major currencies at a 3 months horizon where adequate three months interest rates are available.

Tables 6 and 7 compare returns of expectation based trading with the simple momentum strat-

egy for 30 major currencies. The findings clearly show that professional expectations outperform momentum trading in most of the cases. This is in particular true for longer horizons where momentum trading partly accumulates significant losses but is successful in case of the Venezuelan bolivar and the Argentine peso. Interestingly, the findings for the Japanese yen are mixed with expectations being more successful over the short-run and momentum strategy being superior over longer horizons. Overall, expectations outperform momentum trading in roughly 70% of all cases. Although we disregard trading costs and assume that all currencies are tradable, this exercise discovers a significant discrepancy between statistical measures, such as the unbiasedness test and economic measures. Table 8 confirms this finding for selected economies by taking the interest rate differential into account where expectation trading again outperforms momentum in 9 out of 14 cases. Due to data availability, we perform this analysis solely for the 3 months horizon.

*** Insert Tables 6 to 8 about here ***

4.4 Portfolio trading

Having looked at individual currency forecasts with and without interest rate differentials, we turn to a portfolio perspective looking at an US investor who manages a portfolio based on aggregated expectations in the following. We again include interest rate differentials relative the US to calculate returns based on trading strategies. However, comparable interest rates over three months are not available for some countries under observation, in particular in the case of most minor currencies. In addition, some currencies are not fully tradable or not de facto used for investments and trading. For this reason, we only use currencies where adequate interest rates are available. As already done in Table 8, we therefore only rely on a basket of 14 major currencies for which three month interest rates are available. Forward rates are linked to interest rates differentials through covered interest rate parity, so that we implicitly include information in the forward rates as well (Taylor and Sarno, 2004; Sarno, 2005).

We compare a portfolio based on expectations with trend and carry trade portfolios as two alternative benchmarks. The expected return from investing in each of the risky assets is equal to the domestic riskless rate plus the currency return. In the spirit of Melvin *et al.* (2013), we generate a

trend portfolio as follows:

1. Currencies are ranked by spot exchange rate appreciation (or depreciation) versus US dollar minus interest rate differential over the previous 3 months
2. For the next month hold a portfolio of +30% of the three currencies that are highest ranked instep 1 and -30% of the three currencies that are ranked lowest.

In a similar vein, the investor rebalances his portfolio on a monthly basis by taking a long position on the three currencies expected to appreciate most while reducing those who are expected to depreciate most. The choice of 30% positions is somewhat arbitrary but a standard choice. The findings are insensitive regarding assumptions related to the size and structure of the original portfolio (Melvin *et al.*, 2013).

Table 9 compares expectation based portfolio sorting, momentum trading and a carry trade strategy based on returns and risk-adjusted returns calculated by the Sharpe ratio. Figure 33 in the Appendix also shows the time series pattern of the annualized returns of momentum and expectation based portfolios. Professionals once again do a better job, generating a significant return and outperforming both a momentum and a carry trade strategy in terms of the Sharpe ratio. However, one has to take into account that the result relative to carry trades reflects the low interest rate differentials over the recent sample period and the well-known fact that carry trades have become less profitable as a result. In addition, Sharpe ratios for both momentum and expectation based trading are small, reflecting the turbulence on currency markets over the sample period. Nevertheless, the results confirm that expectations are useful from an economic perspective despite their weak statistical performances illustrated before.

*** Insert Table 9 about here ***

4.5 Expected exchange rate changes and monetary policy

In the following we turn to the identification of potential drivers of exchange rate expectations and resulting forecast errors over the recent sample period. To tackle this question, we adopt the

following time-varying coefficient models already discussed in Section 2.2 (see Eqs. (3) and (4))

$$E_t(s_{t+h}) - s_t = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}}$$

$$+\theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t, \tag{9}$$

and

$$E_{t-h}(s_t) - s_t = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}}$$

$$+\theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t, \tag{10}$$

where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ and the professionals forecast error $(E_{t-h}(s_t) - s_t)$, respectively, is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty (FU_t) and the CBOE volatility index (VIX_t). Figure 34 in the Appendix shows the time series behavior of the latter four regressors and Table 10 reports the correlation coefficients between them.

*** Insert Table 10 about here ***

We adopt a rolling-window regression approach with a window size of 30 months to account for the overwhelming evidence of a time-varying and unstable relationship between exchange rates and fundamentals (Sarno and Taylor, 2002). All variables are stationary according to unit root tests, so that standard OLS estimation can be applied. Putting both expectations and expectation errors under closer scrutiny enables us to address expected and unexpected effects due to financial stress, monetary policy and macroeconomic fundamentals.[10]

When analyzing the role of inflation and interest rate differentials via the US, we expect that currencies with higher inflation rates are expected to depreciate if forecasters believe in purchasing power parity. The impact of interest rates is less clear with uncovered interest rate parity (UIP) suggesting that higher interest rate currencies depreciate while the established forward premium

[10] Alternative specifications which include lagged variables are available upon request but do not change the main findings to a significant degree.

puzzle indicates a reversed pattern. There is also evidence that it might pay off to bet against the validity of UIP through carry trades based on the forward premium puzzle (Jongen *et al.*, 2008).

In addition, we examine the role of monetary policy shocks in the US and the eurozone based on the consideration of shadow interest rates. Finally, we focus on a possible time-varying impact on stock market volatility and financial uncertainty to identify expected and unexpected safe haven currencies. We focus on the period from 2004 until the end of 2015 to include a large number of currencies and account for the period before the financial crisis. Figures 9 to 28 provide the time-varying coefficients for expectations and expectation errors for major and minor currencies. Statistical significance at the 10% level is shown in red. An obvious observation is that the drivers of both expectations and forecast errors are time-varying and different across currencies. While a detailed discussion of all currency effects is beyond the scope of our paper, we discuss some main patterns in the following starting with drivers of expectations before analyzing the resulting forecast errors where a positive value mirrors an unexpected appreciation against the US dollar.

*** Insert Figures 9 to 28 about here ***

Interest rate and inflation differentials A first common pattern across currencies is that the interest rate differential is an important driver of expectations after the onset of the financial crisis between 2008 and 2010. In line with theory, currencies of economies with higher interest rates are expected to appreciate which suggests that forecasters do not incorporate the forward premium puzzle when building expectations and stick with uncovered interest rate parity instead. Currencies of economies with higher inflation rates should depreciate according to purchasing power parity. Unsurprisingly, this long-run belief is hardly reflected in expectations. The inflation differential is hardly significant and partly displays a reversed sign. For some currencies like the Japanese yen, the effect is in line with theory at the end of the sample period. Interest rates and inflation become less important after 2010 but continue to have the same sign in case of significance. The pattern for minor currencies is slightly different with inflation often becoming important slightly later and overall showing more theory-conform effects which probably reflect higher inflation differentials relative to the US. The interpretation is more tricky since some expectations are abruptly changing, making a causal interpretation harder. This also complicates the identification of interest

rate effects which vary across currencies with different times being important. The findings on expectation errors mostly display the same signs and are more frequently significant, suggesting that fundamentals affect exchange rates in a non-predictable fashion as mirrored by the exchange rate disconnect puzzle.

Uncertainty and safe haven currencies When looking at the impact of uncertainty on exchange rate expectations, we again find that effects are frequently significant between 2009 and 2010. Despite the correlation between the VIX and the Jurado *et al.* (2015) uncertainty measures, both are included into the regression equation in order to compare the resulting effect. The conventional VIX measure displays a negative impact on most currencies if significant, implying an expected appreciation against the US dollar. An exception is the South Korean won between 2011 and 2012. On the opposite, the measure of financial uncertainty proposed by Jurado *et al.* (2015) which is based on common unpredictable components partly displays slightly different patterns. For example the pound and the euro are expected to depreciate and hardly any currency besides the Chinese renminbi provides a safe haven status, essentially implying that the US dollar is expected to serve as a safe haven. This shows that a clear identification of safe haven currencies relative to the US dollar is not straightforward and depends on the measure of uncertainty.

Minor currencies are affected more frequently at the end of the sample period, expected to depreciate against the dollar. Some economies with pegged exchange rates against the euro are expected to depreciate. This possibly reflects imported credibility rather than expected safe haven status. Another explanation is that some minor currencies are simply determined by cross-rates and co-movements with major exchange rates due to their low trading volume. The effects on forecast errors essentially display unexpected links to safe haven effects. In opposite to the effects on expectations, both uncertainty measures mostly display a negative impact on forecast errors. This implies that the US dollar appreciates stronger than expected in case of high uncertainty. Effects again mostly materialize between 2008 and 2011. Interestingly, we find that both the Japanese yen and the Swiss franc experienced an unexpected appreciation against the US dollar. The findings for minor currencies resemble the same pattern with some currencies pegged to the US dollar experiencing an unexpected appreciation which is probably due to co-movements with other exchange rates.

Monetary policy, shadow rates and expectations The final effects we are analyzing stem from monetary policy shocks reflected by shadow rates. Starting with effects of unconventional monetary policy of the Fed, there is a strong impact on expectations when unconventional monetary policy and the zero lower bound emerged after the collapse in 2008. Many major currencies are expected to depreciate against the US dollar in case of lower shadow rates in the US with opposite effects for decreasing shadow rates in the euro area. This highlights the importance of monetary policy effects for building expectations and convincing markets of the dollar status as a safe haven currency via lower interest rates.

The findings for minor currencies are also different for the Fed and the ECB shadow rate. This is not surprising since many currencies are fixed or managed against the US dollar and the euro and import the corresponding bilateral expectations. In many cases, countries with fixed exchange rates against the US dollar (euro) are expected to appreciate in case of higher shadow rates in the US (the eurozone) and vice versa. The effects on forecast errors mostly show a similar pattern but vary across currencies, suggesting that monetary policy effects are frequently underestimated by markets.

5 Conclusion

This study has analyzed exchange rate expectation data for more than 60 currencies over 1, 3, 6, 12 and 24 months forecasting horizons, covering fixed, managed and flexible exchange rate regimes and focusing on the recent financial crisis. We have established a discrepancy between statistical and economic measures in the sense that market expectations are superior to relying on past trends based on economic evaluation criteria despite a weak statistical performance. Expectation based strategies also outperform simple benchmarks if a portfolio of major currencies is managed. Overall, the additional information embedded in fundamentals increase over longer horizons.

Professionals frequently expect exchange rate changes beyond the announced exchange rate regime in case of managed or fixed float but also fail to provide adequate forecasts under fixed exchange rates regimes over the short- and the medium-run. Overall, countries with managed exchange rate flexibility or fixed exchange rates often seem to be successful in importing market credibility, anchoring expectations and avoiding currency turbulence over the recent period. If observed, expectations of large depreciation are often not fulfilled so central banks are frequently able to

defend their exchange rate regime in case of exchange rate uncertainty. At the same point in time, recent currency crisis like in case of Russia were unexpected. Only long-run expectations of large depreciations over more than a year are frequently fulfilled.

Our second stage analysis has illustrated the time-varying impact of monetary fundamentals and central bank interest rates on expectations which reflect theoretical considerations, in particular after the onset of the subprime crisis. Monetary policy and the resulting shadow rates are important drivers of expectations. Unconventional monetary policy has triggered expected US dollar appreciations via lower interest rates. While this mirrors the unpredictability of exchange rates and their link to fundamentals, another surprising pattern is that past exchange rate changes drive expectations even if they refer to extraordinary events like large depreciation. Finally, we find that the safe haven status of currencies is both time-varying and depending on the uncertainty measure and we identify a largely unexpected safe haven status of the US dollar after the year 2009.

The time-varying impact on expectation building and forecast errors does not contradict market efficiency and is perfectly in line with the idea of bounded rationality. The unpredictability of exchange rates in the short-run makes it more efficient to rely on the current exchange rate for predictions. The conventional test of unbiasedness is therefore unrelated to both market efficiency and economic utility as discussed above and therefore misleading. Unbiased expectations under uncertainty still generate significant prediction errors. However, they are useful as long as they add value compared to solely relying on the current exchange rate which should incorporate all available information.

The current study can be extended in various ways. Our evaluation of expectation based trading could easily be conducted over a different sample and by including risk measures and transaction costs. One open issue in the context of exchange rate regimes is the importance of currency reserves, their relationship to public debt and the resulting impact on expectations and exchange rate stability under fixed exchange rates.

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Tables

TABLE 1 **Correlation between expectations and spot rates for major currencies**

	2002/10-2016/03			2010/07-2016/03				
	$h = 3$	$h = 6$	$h = 12$	$h = 1$	$h = 3$	$h = 6$	$h = 12$	$h = 24$
GBP/USD	0.8532	0.6853	0.5876	0.8523	0.5542	0.0860	-0.2080	-0.0596
CZK/USD	0.9308	0.8662	0.8321	0.9599	0.8928	0.8220	0.6714	0.3548
DKK/USD	0.8696	0.7332	0.6152	0.9558	0.8726	0.7154	0.3757	0.3529
EUR/USD	0.8714	0.7337	0.6178	0.9545	0.8661	0.7099	0.3778	0.3408
HUF/USD	0.8689	0.7280	0.6082	0.9597	0.8854	0.7932	0.6520	0.4571
NOK/USD	0.8756	0.7440	0.5203	0.9820	0.9527	0.9001	0.7830	0.0432
PLN/USD	0.8684	0.7205	0.6043	0.9353	0.8356	0.7037	0.4774	0.1800
RUB/USD	0.9237	0.8904	0.8244	0.9710	0.9048	0.8771	0.8435	0.4885
SEK/USD	0.8280	0.6344	0.4770	0.9643	0.9046	0.7811	0.4453	-0.2364
CHF/USD	0.9404	0.8865	0.8365	0.8345	0.6190	0.3699	-0.1029	-0.0565
TRY/USD	0.9591	0.9134	0.6866	0.9868	0.9648	0.9390	0.9259	0.8159
AUD/USD	0.9038	0.7802	0.6878	0.9707	0.9161	0.8404	0.7099	-0.2078
CNY/USD	0.9961	0.9906	0.9763	0.9673	0.9205	0.8777	0.7674	0.3544
INR/USD	0.9548	0.9087	0.7852	0.9699	0.9313	0.8976	0.8376	0.6163
IDR/USD	0.9290	0.8487	0.6868	0.9883	0.9688	0.9314	0.8909	0.1921
JPY/USD	0.9260	0.8491	0.6698	0.9841	0.9494	0.8869	0.7217	0.0459
NZD/USD	0.8624	0.6992	0.5880	0.9037	0.7629	0.6242	0.1502	-0.0895
PHP/USD	0.9587	0.9168	0.7871	0.9143	0.7873	0.6786	0.4916	-0.1484
SGD/USD	0.9754	0.9528	0.9247	0.9309	0.8370	0.7223	0.4013	-0.1862
KRW/USD	0.8270	0.6099	0.3087	0.8277	0.6162	0.4017	0.1799	-0.0486
TWD/USD	0.8654	0.7073	0.6441	0.9395	0.7982	0.6165	0.4807	-0.3136
THB/USD	0.9436	0.8853	0.7998	0.9419	0.8369	0.6776	0.3616	-0.2546
ARS/USD	0.9671	0.9455	0.9092	0.9801	0.9389	0.9061	0.8757	0.9389
BRL/USD	0.9244	0.7996	0.5936	0.9800	0.9553	0.9190	0.9035	0.5175
CAD/USD	0.9286	0.8508	0.7745	0.9744	0.9484	0.9183	0.8731	-0.2151
CLP/USD	0.8936	0.7702	0.6254	0.9786	0.9473	0.9080	0.8622	-0.1561
COP/USD	0.9154	0.8120	0.5820	0.9761	0.9414	0.9016	0.8228	-0.0664
MXN/USD	0.9100	0.8160	0.6272	0.9649	0.9088	0.8398	0.6062	-0.1091
VEF/USD	0.9213	0.8560	0.8026	0.8888	0.7702	0.6755	0.6309	0.7127
ZAR/USD	0.9412	0.8620	0.5722	0.9822	0.9716	0.9546	0.9105	0.5074

Note: The table reports correlation coefficients between spot rates and expectations formed 1- ($h = 1$), 3- ($h = 3$), 6- ($h = 6$), 12- ($h = 12$) or 24-months ($h = 24$) before for the following exchange rates: British Pound (GBP/USD), Czech Koruna (CZK/USD), Danish Krone (DKK/USD), Euro (EUR/USD), Hungarian Forint (HUF/USD), Norwegian Krone (NOK/USD), Polish Zloty (PLN/USD), Russian Rouble (RUB/USD), Swedish Krona (SEK/USD), Swiss Franc (CHF/USD), Turkish Lira (TRY/USD), Australian Dollar (AUD/USD), Chinese Renminbi (CNY/USD), Indian Rupee (INR/USD), Indonesian Rupiah (IDR/USD), Japanese Yen (JPY/USD), New Zealand Dollar (NZD/USD), Philippine Peso (PHP/USD), Singapore Dollar (SGD/USD), South Korean Won (KRW/USD), Taiwan Dollar (TWD/USD), Thai Baht (THB/USD), Argentine Peso (ARS/USD), Brazilian Real (BRL/USD), Canadian Dollar (CAD/USD), Chilean Peso (CLP/USD), Colombian Peso (COP/USD), Mexican Peso (MXN/USD), Venezuelan Bolivar (VEF/USD), and South African Rand (ZAR/USD).

TABLE 2 **Correlation between expectations and spot rates for minor currencies**

	2004/12-2016/03			2010/07-2016/03				
	$h = 3$	$h = 6$	$h = 12$	$h = 1$	$h = 3$	$h = 6$	$h = 12$	$h = 24$
DZD/USD	0.9670	0.9139	0.7172	0.9904	0.9643	0.9137	0.6813	0.4561
BDT/USD	0.9650	0.9219	0.8101	0.9604	0.8911	0.7898	0.5054	0.1596
BOB/USD	0.9838	0.9628	0.9266	0.5786	0.3124	0.1642	0.1660	0.4022
BWP/USD	NA	NA	NA	0.9901	0.9712	0.9542	0.9309	0.6174
BGN/USD	0.8274	0.6017	0.3178	0.9555	0.8663	0.7100	0.3705	0.2651
CRC/USD	NA	NA	NA	0.9301	0.7486	0.5559	0.1242	-0.3611
HRK/USD	0.8645	0.6860	0.4997	0.9568	0.8872	0.7645	0.5467	0.4751
DOP/USD	0.9865	0.9715	0.6223	0.9963	0.9910	0.9852	0.9640	0.9134
EGP/USD	0.9778	0.9524	0.8852	0.9808	0.9671	0.9390	0.8966	0.9211
GHC/USD	NA	NA	NA	0.9827	0.9652	0.9291	0.9186	0.9196
ISK/USD	NA	NA	NA	0.9020	0.6843	0.3028	-0.1874	-0.1350
ILS/USD	0.8881	0.7334	0.5248	0.9252	0.7314	0.3965	-0.2958	-0.4528
XOF/USD	NA	NA	NA	0.9535	0.8572	0.6765	0.1206	-0.2365
JMP/USD	0.9929	0.9805	0.9556	0.9978	0.9922	0.9766	0.9214	0.6711
KZT/USD	NA	NA	NA	0.9781	0.9393	0.8257	0.8152	0.5785
KES/USD	0.9228	0.8340	0.7121	0.9613	0.8046	0.5988	0.3211	0.0723
KWD/USD	0.8003	0.6240	0.1237	0.9223	0.8430	0.6828	0.2857	0.1761
LBP/USD	NA	NA	NA	0.7319	0.4542	0.3905	0.2112	-0.0583
MYR/USD	0.9152	0.8131	0.5963	0.9768	0.9261	0.8604	0.7030	-0.0505
MAD/USD	0.8269	0.5788	0.1793	0.9603	0.8727	0.6918	0.1473	-0.2609
NGN/USD	0.9626	0.9077	0.7783	0.9881	0.9367	0.8377	0.6449	0.3388
PKR/USD	0.9895	0.9764	0.9536	0.9752	0.9405	0.8930	0.8370	0.6763
PYG/USD	0.9197	0.8033	0.6381	0.9644	0.8609	0.6568	0.3729	-0.0347
PEN/USD	0.9421	0.8614	0.7154	0.9797	0.9597	0.9168	0.7416	0.2056
RON/USD	0.9066	0.7994	0.6906	0.9437	0.8518	0.7065	0.4612	0.4618
RSD/USD	0.9442	0.8534	0.7271	0.9779	0.9089	0.7606	0.5392	0.6122
LKR/USD	NA	NA	NA	0.9814	0.9234	0.7834	0.5920	0.3599
SYP/USD	0.9795	0.9641	0.9291	0.9918	0.9707	0.9507	0.9127	0.8116
TZS/USD	NA	NA	NA	0.9702	0.9203	0.8384	0.7018	0.4647
TTD/USD	NA	NA	NA	0.4834	-0.0823	-0.3286	-0.1421	0.1795
UGX/USD	NA	NA	NA	0.9767	0.8930	0.7920	0.5472	0.3774
UAH/USD	0.9611	0.9342	0.8570	0.9673	0.9454	0.9115	0.8054	0.2873
UYU/USD	0.9085	0.7803	0.5269	0.9857	0.9515	0.9246	0.8260	0.1082
VND/USD	0.9923	0.9859	0.9676	0.9566	0.9001	0.8646	0.7812	0.5849
ZMK/USD	NA	NA	NA	0.9755	0.9020	0.9023	0.8445	0.4389

Note: The table reports correlation coefficients between spot rates and expectations formed 1- ($h = 1$), 3- ($h = 3$), 6- ($h = 6$), 12- ($h = 12$) or 24-months ($h = 24$) before for the following exchange rates: Algerian Dinar (DZD/USD), Bangladeshi Taka (BDT/USD), Bolivian Boliviano (BOB/USD), Botswana Pula (BWP/USD), Bulgarian Lev (BGN/USD), Costa Rican Colon (CRC/USD), Croatian Kuna (HRK/USD), Dominican Republic Peso (DOP/USD), Egyptian Pound (EGP/USD), Ghanaian Cedi (GHC/USD), Icelandic Krona (ISK/USD), Israeli Shekel (ILS/USD), Ivory Coast Franc (XOF/USD), Jamaican Dollar (JMP/USD), Kazakhstan Tenge (KZT/USD), Kenyan Shilling (KES/USD), Kuwaiti Dinar (KWD/USD), Lebanese Pound (LBP/USD), Malaysian Ringgit (MYR/USD), Moroccan Dirham (MAD/USD), Nigerian Naira (NGN/USD), Pakistani Rupee (PKR/USD), Paraguayan Guarani (PYG/USD), Peruvian Peso (PEN/USD), Romanian Leu (RON/USD), Serbian Dinar (RSD/USD), Sri Lankan Rupee (LKR/USD), Syrian Pound (SYP/USD), Tanzanian Shilling (TZS/USD), Trinidad & Tobago Dollar (TTD/USD), Ugandan Shilling (UGX/USD), Ukrainian Hryvnia (UAH/USD), Uruguayan Peso (UYU/USD), Vietnamese Dong (VND/USD), and Zambian Kwacha (ZMK/USD). NA means that the currency is not available for the corresponding sample period.

TABLE 3 **Unbiasedness test for major currencies**

	$h=1$			$h=3$			$h=6$			$h=12$			$h=24$		
	α	β	F-Stat.	α	β	F-Stat.	α	β	F-Stat.	α	β	F-Stat.	α	β	F-Stat.
GBP/USD	0.0016	-0.2831	4.8228**	0.0026	-0.0107	1.9842	0.0110	-0.6769	7.2980***	0.0105	-0.1206	6.3180***	-0.0001	0.5221**	2.2059
CZK/USD	0.0057	-0.5659	1.9546	0.0103	-0.1592	1.4137	0.0118	0.3257	0.9894	-0.0047	1.4560***	1.0449	0.0470**	0.7555*	3.7578**
DKK/USD	-0.0004	0.4293	0.8171	0.0013	0.3903	1.3849	0.0092	0.2976	1.5387	0.0033	1.2580***	0.6905	0.0206	1.3268***	4.7680**
EUR/USD	-0.0001	0.3266	1.0211	0.0050	0.0661	1.9843	0.0088	0.3189	1.3015	-0.0028	1.5137***	1.2833	0.0194	1.3437***	4.6356**
HUF/USD	-0.0003	0.5965	0.2487	0.0071	0.3403	0.3403	0.0137	0.5121	0.2724	-0.0055	1.7445***	2.8499*	0.0478**	1.3931***	10.0233***
NOK/USD	0.0035	1.6003**	0.8637	0.0162***	2.5409***	5.1250***	0.0400***	2.6682***	13.9038***	0.0912***	3.2465***	37.4265***	0.0842***	0.8027	9.8872***
PLN/USD	-0.0017	0.6904	0.3230	0.0096	-0.0260	0.7656	0.0021	0.8489	0.0407	-0.0222	1.8838***	1.9761	0.0079	1.8325***	4.6315**
RUB/USD	0.0092	0.5893	0.6074	0.0302	1.2128	2.5283*	0.0325	2.2473**	6.2983***	0.0433	3.3997***	20.3497***	0.1777***	1.0243	13.6519***
SEK/USD	0.0003	0.9824*	0.0049	0.0049	1.9147***	1.1548	0.0160*	1.7552***	2.3863*	0.0571***	2.7864***	13.4859***	0.0465**	1.1135**	2.7702*
CHF/USD	-0.0033	0.4072	1.3468	-0.0178**	1.3225**	3.0596*	-0.0334***	1.2503****	6.3201***	-0.0561***	1.3778***	8.6674***	-0.0599***	0.3829	17.8387***
TRY/USD	0.0065	0.4354	0.7368	0.0207**	0.7531	3.8573**	0.0491***	0.3401	9.7614***	0.0775***	1.0354**	26.1177***	0.1925***	-0.2900	54.4306***
AUD/USD	-0.0030	0.8528	0.4899	0.0114	-0.2499	1.5679	-0.0033	1.2370**	0.1084	-0.0080	2.3391***	9.9578***	0.0023	0.9979*	0.0040
CNY/USD	0.0003	0.5799	1.2219	0.0037*	1.3619***	1.8712	0.0053*	0.9725***	3.5076**	0.0044	0.7569***	4.6920**	-0.0303***	-0.0285	17.7346***
INR/USD	0.0034	-1.0195	4.7471**	0.0107*	-1.7822**	15.3787***	0.0249***	-0.7446	23.4547***	0.0615***	0.1183	39.1924***	0.0574**	-1.0966**	66.7020***
IDR/USD	0.0059**	0.5352	2.7942*	0.0178***	0.4543	8.0169***	0.0383***	0.5476	16.8004***	0.0954***	1.8238***	36.7680***	-0.0368	-3.6120***	30.1480***
JPY/USD	0.0034	0.0311	19.6635***	0.0184*	-0.8183	3.5644**	0.0304	-0.3202	1.6853	0.1334***	-1.9455**	6.1019***	0.0819*	-0.3076	1.4897
NZD/USD	0.0010	-0.0285	1.5893	0.0127	-0.9207	3.8259**	-0.0182	1.4134***	1.2922	-0.0235*	1.8582***	3.3625**	-0.0449**	0.5474	3.5795**
PHP/USD	-0.0001	-0.0652	3.7838**	0.0025	0.4010	2.2635	0.0083*	0.7310***	4.0629**	0.0237***	1.2232***	6.8845***	-0.0371**	-0.6494*	15.0377***
SGD/USD	0.0005	0.5071	1.0808	0.0019	0.9029**	0.2272	0.0106**	1.6044***	2.9750*	0.0329***	2.1877***	8.9401***	-0.0405*	-0.4990	3.6024**
KRW/USD	0.0011	0.9128	0.0898	0.0029	0.6530*	0.7384	0.0120*	0.9653***	2.4342*	0.0349***	1.5642***	7.9665***	-0.0786***	-0.8496**	11.5682***
TWD/USD	0.0011	0.5784	1.0717	0.0041	1.0173**	0.9190	0.0084*	0.8144**	2.8313*	0.0314***	1.8338***	11.2846***	-0.0436***	-0.9749**	15.2400***
THB/USD	0.0016	-0.4056	6.5250***	0.0042	0.0722	2.2957	0.0078	0.2463	3.1336*	0.0110	0.2616	4.2709**	-0.0089	-1.5571***	64.6768***
ARS/USD	0.0166**	0.2790	2.3953*	0.0218	1.0165***	2.3100	0.0563**	0.5170*	2.6062*	0.0835***	0.6871***	4.9280**	0.1433***	1.2340***	58.8797***
BRL/USD	0.0102*	0.1460	1.7747	0.0310***	0.9262	5.6227***	0.0653***	1.1953**	13.7166***	0.1387***	3.0256***	49.2658***	0.1964***	1.1991	21.3104***
CAD/USD	0.0035	0.2430	1.6990	0.0115***	0.8862*	3.5988**	0.0237***	1.2858***	9.6092***	0.0474***	1.6832***	21.7008***	0.0257	-0.6745	10.9430***
CLP/USD	0.0017	0.9954	0.1252	0.0078	1.7983***	2.6676*	0.0226***	1.5379***	6.3908***	0.0502***	2.3375***	26.9739***	0.0425	-0.1609	7.6564***
COP/USD	0.0073	1.8943*	1.5479	0.0242***	3.4876***	10.1719***	0.0496***	3.0366***	16.5959***	0.1028***	3.5692***	25.9596***	0.0508	-0.5626	7.4879***
MXN/USD	0.0047	-0.0349	2.7114*	0.0184**	0.4938	6.3332***	0.0407***	0.9806	13.2253***	0.0959***	2.1100***	20.0759***	0.0156	-1.4102***	30.7039***
VEF/USD	-0.0002	0.2361***	52.6965***	0.0146	0.0861	106.9121***	0.0382**	0.0092	177.8802***	0.1739***	-0.1663	64.9410***	0.4662***	-0.6581**	23.1956***
ZAR/USD	0.0117**	-0.2611	5.1899***	0.0323***	0.0070	5.5076***	0.0469**	0.5176	7.1828***	0.0823***	0.5668	12.0270***	0.1707***	-0.6391	8.4437***

Note: The table reports OLS estimates for the following test equation: $s_{t+h} - s_t = \alpha + \beta(E_t(s_{t+h}) - s_t) + u_{t+h}$, where s_t denotes the natural logarithm of the spot rate. F-Stat. represents the F-test statistic for testing the joint hypothesis $\alpha = 0$ and $\beta = 1$. h gives the forecast horizon. *, **, and *** indicate significance at the 10, 5, and 1% level, respectively. Unbiasedness is tested for the following currencies (sample period 2010/07-2016/03): British Pound (GBP/USD), Czech Koruna (CZK/USD), Danish Krone (DKK/USD), Euro (EUR/USD), Hungarian Forint (HUF/USD), Norwegian Krone (NOK/USD), Polish Zloty (PLN/USD), Russian Rouble (RUB/USD), Swedish Krona (SEK/USD), Swiss Franc (CHF/USD), Turkish Lira (TRY/USD), Australian Dollar (AUD/USD), Chinese Renminbi (CNY/USD), Indian Rupee (INR/USD), Indonesian Rupiah (IDR/USD), Japanese Yen (JPY/USD), New Zealand Dollar (NZD/USD), Philippine Peso (PHP/USD), Singapore Dollar (SGD/USD), South Korean Won (KRW/USD), Taiwan Dollar (TWD/USD), Thai Baht (THB/USD), Argentine Peso (ARS/USD), Brazilian Real (BRL/USD), Canadian Dollar (CAD/USD), Chilean Peso (CLP/USD), Colombian Peso (COP/USD), Mexican Peso (MXN/USD), Venezuelan Bolivar (VEF/USD), and South African Rand (ZAR/USD).

TABLE 4 **Unbiasedness test for minor currencies**

	$h=1$			$h=3$			$h=6$			$h=12$			$h=24$		
	α	β	F-Stat.	α	β	F-Stat.	α	β	F-Stat.	α	β	F-Stat.	α	β	F-Stat.
DZD/USD	0.0041	0.4659	1.3678	0.0106*	0.7083*	2.1050	0.0252***	0.6021*	5.3154***	0.0719***	-0.4708	15.1494***	0.1250***	-0.9930***	42.3554***
BDT/USD	0.0016	0.1674	5.9395***	0.0046*	0.2181	8.0140***	0.0080*	0.3199*	6.5162***	0.0199***	0.0924	9.4937***	0.0470***	-0.1518	16.4512***
BOB/USD	-0.0004	-0.2026	1.1154	-0.0010	-0.0897	7.2050***	-0.0018	-0.0737	23.2136***	-0.0037**	-0.0888	66.1463***	-0.0050***	0.0206	308.4108***
BWP/USD	0.0017	0.9481	0.1507	0.0251***	-0.2654	3.9234**	0.0448***	-0.1524	8.2681***	0.0643***	0.2793	13.7567***	0.1660***	-0.7739**	20.7656***
BGN/USD	-0.0030	1.0864	0.3818	-0.0142	1.7238**	1.1895	-0.0160	1.5168**	0.6079	-0.0271	1.8868***	1.8455	0.0062	1.2322***	1.2530
CRC/USD	-0.0001	-0.1304	3.7942**	-0.0004	-0.5719*	15.1319***	-0.0008	-0.5716**	18.9225***	-0.0035	-1.1262***	46.1909***	-0.0042	-1.2297***	110.6536***
HRK/USD	0.0004	0.4111	0.4659	-0.0104	1.6011**	0.6517	-0.0006	0.9693*	0.0155	-0.0125	1.6418***	1.7187	0.0232	1.2128***	5.1674***
DOP/USD	0.0041***	-0.3088	12.3804***	0.0111***	-0.1862	18.4568***	0.0186***	0.0172	12.4854***	0.0469***	-0.2678*	36.5255***	0.0970***	-0.4188***	105.5842***
EGP/USD	0.0153***	-1.5506**	6.1393***	0.0090	0.5726	0.8329	0.0497***	-0.7606	8.5058***	0.0950***	-0.9309***	41.9922***	0.0834***	0.5373***	85.1972***
GHC/USD	0.0005	1.4251*	0.4616	0.0515***	-0.3156	4.4493**	0.1132***	-0.5414	13.3696***	0.1295***	0.6153	20.5280***	0.2047***	1.3643**	60.0621***
ISK/USD	-0.0054	1.3902*	1.1026	-0.0022	0.2427	2.4373*	0.0141	-0.7112	9.5758***	0.0011	0.1354	6.2784***	0.0287	-0.2216	10.3492***
ILS/USD	-0.0006	0.6775	0.3620	0.0012	0.0295	2.5060*	0.0042	-0.5545*	12.5074***	0.0131*	-1.3179***	54.3468***	0.0052	-1.3674***	144.0484***
XOF/USD	0.0016	-0.1832	2.4525*	0.0085	-0.3540	6.4706***	0.0231***	-0.5292*	12.1734***	0.0611***	-1.1544***	33.1280***	0.0908***	-1.1187***	87.2043***
JMP/USD	0.0039***	0.4380*	5.6987***	0.0090***	0.5787***	5.9137***	0.0155***	0.6199***	5.1452***	0.0350***	0.4605**	6.8434***	0.1249***	-0.3017	28.6796***
KZT/USD	0.0061	1.5725	1.2072	0.0219	1.4619	3.0941*	0.0285	2.1222	4.4682**	0.0330	2.0225*	5.4695***	0.1301***	0.5535	10.1620***
KES/USD	0.0015	0.3473	0.7440	0.0233*	-0.9425	2.2429	0.0448**	-0.9355	3.4084**	0.1046***	-1.5823**	8.8069***	0.1289***	-0.8378**	14.1737***
KWD/USD	0.0018	0.7125***	2.7848*	0.0017	0.7921***	0.7145	0.0021	0.3289*	5.9999***	0.0063	0.3398*	6.2888***	0.0112**	0.2738	10.9710***
LBP/USD	0.0001	0.0113	33.5090***	0.0012	-0.2098	79.3508***	0.0007	-0.0268	174.6821***	0.0035**	-0.1747*	584.1510***	0.0026***	-0.0361	1733.6512***
MYR/USD	0.0040	1.2384*	0.9524	0.0125**	0.7592	3.4158**	0.0275***	1.5508***	8.5429***	0.0599***	2.6251***	29.3553***	0.0143	-0.4598	10.1121***
MAD/USD	0.0012	0.1447	1.2899	0.0057	-0.0559	3.9188**	0.0161**	-0.3066	9.4820***	0.0450***	-0.9714***	28.3798***	0.0666***	-1.2085***	110.2567***
NGN/USD	0.0013	0.6291	0.1764	0.0122	-0.0071	1.4292	0.0355***	-0.4819	5.8317***	0.0548***	-0.1888	5.7053***	0.1599***	-1.1948***	40.3303***
PKR/USD	0.0002	0.5389	0.8773	0.0092	0.0065	3.4454**	0.0162*	0.1046	3.6092**	0.0502***	-0.3108	14.9608***	0.1706***	-1.2186***	76.6646***
PYG/USD	0.0021	0.9775	0.1812	0.0074	0.4804	0.9112	0.0136	0.8160*	0.8959	0.0172	1.1056***	1.0167	0.0157	-0.1693	6.4027***
PEN/USD	0.0026	1.1529***	1.0810	0.0097***	0.8142***	6.5836***	0.0163***	0.9147***	8.0414***	0.0241***	0.9524***	6.2664***	0.0159	0.3177	4.9893***
RON/USD	-0.0002	0.6783	0.1027	-0.0088	1.7218**	0.4363	-0.0027	1.2046*	0.0655	-0.0053	1.5443***	1.3556	0.0206	1.6171***	8.6454***
RSD/USD	0.0001	0.5299	0.5010	0.0186	-0.1937	0.9686	0.0814**	-1.4235	3.8775**	0.1402***	-1.1368	5.3311***	0.2168***	-1.0211**	26.6119***
LKR/USD	0.0026	0.5107	1.0923	0.0115***	-0.2049	7.4164***	0.0233***	-0.5557*	15.7673***	0.0421***	-0.9492***	33.0271***	0.0730***	-0.9746***	108.1858***
SYP/USD	0.0120	1.0248	1.4688	0.0523**	0.5796	5.1496***	0.0833***	1.0439**	11.0437***	0.1921***	0.8371**	27.0575***	0.3451***	1.1699***	41.6769***
TZS/USD	-0.0025	1.4966**	0.2245	0.0204	-0.1012	0.9360	0.0337*	0.2224	2.4732*	0.0684**	0.2976	8.6855***	0.2050***	-1.2998***	36.5552***
TTD/USD	0.0006	-0.2344	18.9420***	0.0013	-0.0741	42.3441***	0.0014	0.0430	51.7999***	0.0012	0.1700**	82.7416***	0.0064***	0.1845***	82.7582***
UGX/USD	-0.0024	1.2017*	0.0879	0.0217	-0.0904	1.0265	0.0530**	-0.2870	3.2908**	0.1927***	-1.8902***	14.5011***	0.3084***	-1.9310***	32.8843***
UAH/USD	0.0052	1.6450	0.7218	-0.0049	2.8854***	5.9802***	-0.0233	3.7727***	17.3401***	-0.0110	3.6585***	18.7160***	0.4091***	-1.4548	17.7284***
UYU/USD	0.0062*	0.6001	1.9570	0.0186***	0.6019	4.1224**	0.0332***	0.8552***	8.3935***	0.0543***	0.9338***	11.9268***	0.0725***	-0.6375*	17.6791***
VND/USD	0.0023*	0.3460	3.4538**	0.0066***	0.3403	7.5105***	0.0123***	0.4598***	13.7284***	0.0233***	0.6578***	14.9674***	0.0560***	0.5894***	28.4250***
ZMK/USD	0.0024	1.3284*	0.4100	0.0238	0.7082	1.3400	0.0077	2.2492***	7.8960***	0.0241	1.8591***	8.7233***	0.2349***	-0.6721	12.8835***

Note: The table reports OLS estimates for the following test equation: $s_{t+h} - s_t = \alpha + \beta(E_t(s_{t+h}) - s_t) + u_{t+h}$, where s_t denotes the natural logarithm of the spot rate. F-Stat. represents the F-test statistic for testing the joint hypothesis $\alpha = 0$ and $\beta = 1$. h gives the forecast horizon. *, **, and *** indicate significance at the 10, 5, and 1% level, respectively. Unbiasedness is tested for the following currencies (sample period 2010/07-2016/03): Algerian Dinar (DZD/USD), Bangladeshi Taka (BDT/USD), Bolivian Boliviano (BOB/USD), Botswana Pula (BWP/USD), Bulgarian Lev (BGN/USD), Costa Rican Colon (CRC/USD), Croatian Kuna (HRK/USD), Dominican Republic Peso (DOP/USD), Egyptian Pound (EGP/USD), Ghanaian Cedi (GHC/USD), Icelandic Krona (ISK/USD), Israeli Shekel (ILS/USD), Ivory Coast Franc (XOF/USD), Jamaican Dollar (JMP/USD), Kazakhstan Tenge (KZT/USD), Kenyan Shilling (KES/USD), Kuwaiti Dinar (KWD/USD), Lebanese Pound (LBP/USD), Malaysian Ringgit (MYR/USD), Moroccan Dirham (MAD/USD), Nigerian Naira (NGN/USD), Pakistani Rupee (PKR/USD), Paraguayan Guarani (PYG/USD), Peruvian Peso (PEN/USD), Romanian Leu (RON/USD), Serbian Dinar (RSD/USD), Sri Lankan Rupee (LKR/USD), Syrian Pound (SYP/USD), Tanzanian Shilling (TZS/USD), Trinidad & Tobago Dollar (TTD/USD), Ugandan Shilling (UGX/USD), Ukrainian Hryvnia (UAH/USD), Uruguayan Peso (UYU/USD), Vietnamese Dong (VND/USD), and Zambian Kwacha (ZMK/USD).

TABLE 5 **Expected vs. unexpected devaluation**

Panel A: Major currencies				
	3+6 months		**12+24 months**	
	Expected devaluation of 5%	Unexpected devaluation of 5%	Expected devaluation of 5%	Unexpected devaluation of 5%
Overall				
Devaluation of 5%	76 (0.87%)	1536 (17.61%)	537 (9.04%)	1461 (24.59%)
No devaluation	129 (1.48%)	6980 (80.04%)	487 (8.20%)	3456 (58.17%)
Floating				
Devaluation of 5%	10 (0.14%)	1418 (19.25%)	370 (7.37%)	1364 (27.19%)
No devaluation	45 (0.61%)	5893 (80.00%)	358 (7.14%)	2925 (58.30%)
Fixed				
Devaluation of 5%	66 (4.87%)	118 (8.71%)	167 (18.07%)	97 (10.50%)
No devaluation	84 (6.20%)	1087 (80.22%)	129 (13.96%)	531 (57.47%)
Panel B: Minor currencies				
	3+6 months		**12+24 months**	
	Expected devaluation of 5%	Unexpected devaluation of 5%	Expected devaluation of 5%	Unexpected devaluation of 5%
Overall				
Devaluation of 5%	97 (1.08%)	1412 (15.78%)	930 (14.04%)	1728 (26.08%)
No devaluation	118 (1.32%)	7320 (81.82%)	791 (11.94%)	3177 (47.95%)
Floating				
Devaluation of 5%	67 (1.78%)	888 (23.65%)	675 (23.98%)	739 (26.25%)
No devaluation	74 (1.97%)	2726 (72.60%)	451 (16.02%)	950 (33.75%)
Fixed				
Devaluation of 5%	30 (0.58%)	524 (10.09%)	255 (6.69%)	989 (25.95%)
No devaluation	44 (0.85%)	4594 (88.48%)	340 (8.92%)	2227 (58.44%)
Panel C: 24 months				
	Major currencies		**Minor currencies**	
	Expected devaluation of 15%	Unexpected devaluation of 15%	Expected devaluation of 15%	Unexpected devaluation of 15%
Overall				
Devaluation of 15%	56 (3.11%)	420 (23.36%)	35 (1.45%)	616 (25.51%)
No devaluation	16 (0.89%)	1306 (72.64%)	23 (0.95%)	1741 (72.09%)
Floating				
Devaluation of 15%	1 (0.07%)	392 (25.96%)	15 (1.41%)	348 (32.68%)
No devaluation	0 (0.00%)	1117 (73.97%)	17 (1.60%)	685 (64.32%)
Fixed				
Devaluation of 15%	55 (19.10%)	28 (9.72%)	20 (1.48%)	268 (19.85%)
No devaluation	16 (5.55%)	189 (65.63%)	6 (0.44%)	1056 (78.22%)

Note: The table shows the absolute (relative) frequencies for the matrix consisting of expected and unexpected devaluation as well as actually observed devaluation and no devaluation. Panel A (Panel B) reports the results for devaluations of at least 5% for major (minor) currencies with aggregated forecast horizons 3 and 6 as well as 12 and 24. Panel C shows the corresponding findings for devaluations of at least 15% for major and minor currencies and forecast horizon 24. The currencies have also been separated into floating and fixed exchange rates.

TABLE 6 **Descriptive statistics for professional expectations based annualized returns for major currencies in %**

	$h=1$		$h=3$		$h=6$		$h=12$		$h=24$	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
GBP/USD	1.4787	24.1090	1.0037	13.8411	0.2186	9.7183	0.4259	5.7108	-0.3867	3.7113
CZK/USD	3.8897	41.8127	3.8370	22.4701	2.3550	14.5916	3.5978	10.4072	3.3066	6.2290
DKK/USD	1.1251	31.7649	3.6567	17.4501	1.8227	13.1411	2.4989	9.9403	1.8637	5.0963
EUR/USD	1.9044	31.9514	3.3350	17.6608	2.1058	13.2123	2.4084	10.0097	1.8240	5.1387
HUF/USD	5.7659	44.3383	4.8287	24.8660	3.4093	17.0596	4.5928	11.5081	4.1742	6.9927
NOK/USD	10.7576	35.8473	8.9897	18.8494	5.6830	15.1797	6.4041	10.8985	1.6473	8.8527
PLN/USD	8.4833	44.4359	4.4158	23.1518	2.2260	16.1386	2.7171	10.9711	2.2329	7.2100
RUB/USD	15.0488	72.2611	12.8885	48.2130	10.9918	31.2383	10.5318	20.7416	8.5219	15.2358
SEK/USD	8.5964	35.3082	8.0491	18.1711	5.1164	14.1079	5.3042	10.3696	1.8582	7.8439
CHF/USD	-0.6932	37.5327	1.0074	20.8701	-1.2675	14.1171	-1.3869	9.8351	-0.3356	6.2000
TRY/USD	13.6676	38.4659	10.0918	22.5921	8.7532	15.5983	9.1339	11.3266	7.0142	8.3873
AUD/USD	9.7043	39.1462	4.2198	21.5168	2.5966	15.6654	2.8897	11.6994	-0.9806	10.5855
CNY/USD	2.0652	8.9151	2.5112	5.0490	2.3687	3.2722	2.1862	2.1841	2.1388	1.2100
INR/USD	-9.5151	36.4287	-8.1451	18.1051	-1.7433	13.2197	-1.2572	9.6676	-2.9206	6.8929
IDR/USD	3.2345	28.6904	-0.3410	17.4111	-1.3956	13.8078	0.5558	10.8226	0.2394	9.7905
JPY/USD	4.4977	29.2960	2.6602	20.6203	3.2111	16.0470	4.2742	11.7212	2.9068	9.8042
NZD/USD	7.5836	43.0646	0.5802	22.1330	1.2052	14.3851	1.1546	10.3225	-1.8343	8.0193
PHP/USD	0.5851	18.8937	1.8080	10.2105	1.2653	6.7992	2.1130	4.6692	2.1575	2.8881
SGD/USD	3.2313	21.2663	3.2885	10.7640	3.3668	7.2428	3.5567	4.8458	3.0748	3.5017
KRW/USD	4.4012	30.7166	4.3851	15.0781	2.6231	9.4204	2.4859	5.8031	2.6852	4.2895
TWD/USD	2.0121	16.5542	2.9698	9.8803	2.2520	6.7600	2.5986	3.9431	2.0914	2.9596
THB/USD	-1.1800	22.1024	-0.5560	12.8175	3.0276	8.3740	3.0632	5.4884	2.0336	3.7544
ARS/USD	22.0304	58.6843	22.7388	36.4339	19.3849	21.7032	17.2603	14.4869	16.4413	9.7960
BRL/USD	9.8045	58.2658	6.9851	32.7691	-1.8573	25.1751	0.8437	20.2489	0.4203	14.3749
CAD/USD	6.3183	27.9087	4.7108	14.5527	0.5780	10.9603	1.1513	8.1530	-1.8064	6.7429
CLP/USD	9.5831	33.4795	8.5185	17.4763	1.0723	13.7756	1.6853	10.4453	2.1158	8.6532
COP/USD	8.1813	47.1640	11.0562	26.8042	3.5683	20.7717	3.7643	16.1465	1.8775	11.1458
MXN/USD	0.4095	36.1598	-2.5942	20.6636	-2.6786	14.1801	-1.7352	10.6554	-1.8735	6.6652
VEF/USD	14.6777	87.1366	9.3208	38.2915	7.9816	24.1119	13.4393	23.0256	16.0682	13.8816
ZAR/USD	10.7947	48.4639	11.1145	24.3658	9.6186	17.1525	8.0257	13.0606	6.4718	11.1767

Note: The table reports the means and standard deviations (SD) for professional expectations based returns formed 1- ($h=1$), 3- ($h=3$), 6- ($h=6$), 12- ($h=12$) or 24-months ($h=24$) before for the following exchange rates (sample period 2010/07-2016/03): British Pound (GBP/USD), Czech Koruna (CZK/USD), Danish Krone (DKK/USD), Euro (EUR/USD), Hungarian Forint (HUF/USD), Norwegian Krone (NOK/USD), Polish Zloty (PLN/USD), Russian Rouble (RUB/USD), Swedish Krona (SEK/USD), Swiss Franc (CHF/USD), Turkish Lira (TRY/USD), Australian Dollar (AUD/USD), Chinese Renminbi (CNY/USD), Indian Rupee (INR/USD), Indonesian Rupiah (IDR/USD), Japanese Yen (JPY/USD), New Zealand Dollar (NZD/USD), Philippine Peso (PHP/USD), Singapore Dollar (SGD/USD), South Korean Won (KRW/USD), Taiwan Dollar (TWD/USD), Thai Baht (THB/USD), Argentine Peso (ARS/USD), Brazilian Real (BRL/USD), Canadian Dollar (CAD/USD), Chilean Peso (CLP/USD), Colombian Peso (COP/USD), Mexican Peso (MXN/USD), Venezuelan Bolivar (VEF/USD), and South African Rand (ZAR/USD). Professional expectations based returns have been calculated based on the following trading rule: $r^{E}_{t,t+h} = I(E_t(s_{t+h}) - s_t > 0)(s_{t+h} - s_t)/h - I(E_t(s_{t+h}) - s_t < 0)(s_{t+h} - s_t)/h$, where $I(.)$ represents a Heaviside indicator function, $E_t(.)$ stands for expectation formed in t, and s_t denotes the natural logarithm of the spot exchange rate measured in units of domestic currency per one unit of the US dollar (i.e. a decrease of s_t means an appreciation of the domestic currency).

TABLE 7 **Descriptive statistics for momentum strategy based annualized returns for major currencies in %**

	$h=1$		$h=3$		$h=6$		$h=12$		$h=24$	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
GBP/USD	2.0542	24.0661	7.6530	40.9141	11.9757	57.0638	-5.4709	68.5012	-7.5992	89.2321
CZK/USD	-2.4003	41.9262	-10.3950	67.5941	-8.0364	88.3287	-23.0198	130.1934	-44.2965	163.5482
DKK/USD	2.8444	31.6557	4.5475	53.3076	5.4732	79.4210	-8.6861	122.7371	-35.6221	125.3108
EUR/USD	3.3799	31.8273	6.5939	53.5219	8.4424	79.8376	-2.6908	123.5642	-35.4733	126.0057
HUF/USD	-0.8380	44.7091	0.1915	76.0117	-0.1801	104.4112	-14.4466	148.1253	-25.9644	194.0751
NOK/USD	1.9882	37.3958	4.2524	62.5891	6.4264	97.1243	-2.2011	151.9595	-1.4710	216.1596
PLN/USD	3.2898	45.1286	11.4123	69.7851	7.6808	97.4550	-0.0608	135.6880	-14.8744	180.6455
RUB/USD	19.7815	71.0943	22.9230	148.0009	11.2196	198.5338	22.6469	278.6346	-39.3883	417.8258
SEK/USD	3.1184	36.2186	10.3679	58.7732	16.7812	88.5193	13.3102	139.3383	-20.0258	192.4844
CHF/USD	-1.6378	37.5029	-0.2115	62.6839	-5.4835	84.8689	-7.2824	118.9799	-29.2724	146.0751
TRY/USD	4.9549	40.5496	5.8562	74.0871	10.9519	106.9400	12.6511	174.6483	-5.6593	263.1412
AUD/USD	-0.6493	40.3430	1.1710	65.7874	7.3967	95.0015	2.9045	144.6437	20.7614	254.2962
CNY/USD	1.5285	9.0242	1.5830	16.8663	1.6851	24.2393	-1.7269	37.1785	-9.7901	58.4767
INR/USD	-0.1078	37.6684	0.5658	59.6296	1.0385	80.0079	1.1650	116.9963	1.0224	179.8645
IDR/USD	3.8934	28.6073	7.5998	51.6795	22.5777	80.1095	45.7739	121.5961	71.9469	223.5899
JPY/USD	1.0778	29.6244	8.0811	61.8476	7.0949	97.9583	16.6018	148.9079	32.4071	243.3913
NZD/USD	-4.9901	43.4471	-5.5134	66.1896	-9.3282	86.1064	0.4589	124.6523	-12.2065	197.1232
PHP/USD	0.8759	18.8823	2.5637	31.0075	2.3341	41.4390	6.1877	61.2612	3.3035	86.6840
SGD/USD	-0.8630	21.4964	2.0086	33.7260	6.5210	47.5333	11.3422	71.4097	10.8936	111.6613
KRW/USD	-0.7606	31.0255	-2.2410	47.0814	-6.1637	58.3744	-2.7333	75.7946	-25.3767	118.9917
TWD/USD	3.3137	16.3404	3.3527	30.7851	1.3530	42.7612	5.8410	56.4887	-0.5504	87.1860
THB/USD	3.1711	21.9026	2.5588	38.4028	3.6690	53.3448	0.8585	75.5515	-2.6720	102.6091
ARS/USD	22.1908	58.6229	67.4310	109.7951	112.9169	133.2151	198.0632	184.2456	349.9454	298.3335
BRL/USD	5.8926	58.7981	1.7947	100.5319	17.6994	150.4141	31.6638	241.1002	25.4376	344.1936
CAD/USD	-1.4210	28.5894	7.1340	45.3547	10.4931	65.0005	21.6382	96.3869	21.3469	166.2343
CLP/USD	-1.4171	34.8141	3.6398	58.2925	10.2589	82.2605	18.3960	125.6287	32.2280	211.4057
COP/USD	7.1356	47.3359	4.9646	86.9339	6.6215	126.3066	26.0994	197.2858	37.8343	268.6322
MXN/USD	2.8002	36.0520	9.6741	61.7199	15.3390	85.2177	13.8843	128.8161	-1.2346	166.2488
VEF/USD	14.6777	87.1366	27.9624	114.8746	31.8186	149.0958	161.2718	276.3067	385.6367	333.1585
ZAR/USD	-2.8884	49.5835	-3.2564	80.3780	-3.7810	118.1380	-15.2491	183.6823	-17.5204	310.0356

Note: The table reports the means and standard deviations (SD) for momentum strategy based returns formed 1- ($h=1$), 3- ($h=3$), 6- ($h=6$), 12- ($h=12$) or 24-months ($h=24$) before for the following exchange rates (sample period 2010/07-2016/03): British Pound (GBP/USD), Czech Koruna (CZK/USD), Danish Krone (DKK/USD), Euro (EUR/USD), Hungarian Forint (HUF/USD), Norwegian Krone (NOK/USD), Polish Zloty (PLN/USD), Russian Rouble (RUB/USD), Swedish Krona (SEK/USD), Swiss Franc (CHF/USD), Turkish Lira (TRY/USD), Australian Dollar (AUD/USD), Chinese Renminbi (CNY/USD), Indian Rupee (INR/USD), Indonesian Rupiah (IDR/USD), Japanese Yen (JPY/USD), New Zealand Dollar (NZD/USD), Philippine Peso (PHP/USD), Singapore Dollar (SGD/USD), South Korean Won (KRW/USD), Taiwan Dollar (TWD/USD), Thai Baht (THB/USD), Argentine Peso (ARS/USD), Brazilian Real (BRL/USD), Canadian Dollar (CAD/USD), Chilean Peso (CLP/USD), Colombian Peso (COP/USD), Mexican Peso (MXN/USD), Venezuelan Bolivar (VEF/USD), and South African Rand (ZAR/USD). Momentum strategy based returns have been calculated based on the following trading rule: $r^{M}_{t,t+h} = I(s_t - s_{t-1} > 0)(s_{t+h} - s_t)/h - I(s_t - s_{t-1} < 0)(s_{t+h} - s_t)/h$, where $I(.)$ represents a Heaviside indicator function and s_t denotes the natural logarithm of the spot exchange rate measured in units of domestic currency per one unit of the US dollar (i.e. a decrease of s_t means an appreciation of the domestic currency).

TABLE 8 **Descriptive statistics for annualized returns at $h = 3$ for selected currencies when accounting for interest rate differentials in %**

	Professional expectations		Momentum strategy	
	Mean	**SD**	**Mean**	**SD**
GBP/USD	0.2215	16.8655	2.9378	16.6060
EUR/USD	2.2528	19.8231	3.8772	19.5672
NOK/USD	6.6797	21.1835	2.3333	22.0996
SEK/USD	8.3766	21.4673	1.7193	22.9973
CHF/USD	1.1429	20.8690	0.3274	20.8980
AUD/USD	-0.2955	27.9937	5.6381	27.4146
IDR/USD	13.4088	20.5402	9.2045	22.7625
JPY/USD	1.6020	19.2556	3.3953	19.0186
NZD/USD	-4.8148	19.6290	5.2182	19.5244
SGD/USD	2.2996	10.7246	0.1361	10.9705
KRW/USD	7.9645	18.7398	1.9205	20.2893
TWD/USD	2.1593	9.9913	0.3057	10.2201
CAD/USD	4.1106	16.0541	1.1136	16.5403
ZAR/USD	5.5774	28.7893	4.5885	28.9655

Note: The table reports the means and standard deviations (SD) for professional expectations based returns and momentum strategy based returns at a 3-months ($h = 3$) horizon for the following exchange rates (sample period 2009/05-2016/03): British Pound (GBP/USD), Euro (EUR/USD), Norwegian Krone (NOK/USD), Swedish Krona (SEK/USD), Swiss Franc (CHF/USD), Australian Dollar (AUD/USD), Indonesian Rupiah (IDR/USD), Japanese Yen (JPY/USD), New Zealand Dollar (NZD/USD), Singapore Dollar (SGD/USD), South Korean Won (KRW/USD), Taiwan Dollar (TWD/USD), Canadian Dollar (CAD/USD), and South African Rand (ZAR/USD). Professional expectations based returns have been calculated based on the following trading rule: $r^{E,i}_{t,t+h} = I(E_t(s_{t+h}) - s_t > i_t - i^*_t)((s_{t+h} - s_t)/h - (i_t - i^*_t)) - I(E_t(s_{t+h}) - s_t < i_t - i^*_t)((s_{t+h} - s_t)/h - (i_t - i^*_t))$, where $I(.)$ represents a Heaviside indicator function, $E_t(.)$ stands for expectation formed in t, and s_t denotes the natural logarithm of the spot exchange rate measured in units of domestic currency per one unit of the US dollar (i.e. a decrease of s_t means an appreciation of the domestic currency). i_t and i^*_t gives the domestic interest rate and its US counterpart, respectively. Momentum strategy based returns have been calculated based on the following trading rule: $r^{M,i}_{t,t+h} = I(s_t - s_{t-1} > i_t - i^*_t)((s_{t+h} - s_t)/h - (i_t - i^*_t)) - I(s_t - s_{t-1} < i_t - i^*_t)((s_{t+h} - s_t)/h - (i_t - i^*_t))$, where $I(.)$ represents a Heaviside indicator function and s_t denotes the natural logarithm of the spot exchange rate measured in units of domestic currency per one unit of the US dollar (i.e. a decrease of s_t means an appreciation of the domestic currency).

TABLE 9 **Descriptive statistics for annualized returns at $h = 3$ for portfolio strategies in %**

	Professional expectations	Momentum strategy	Carry trade strategy
Mean	2.60	2.77	-5.92
SD	6.72	8.08	6.35
Sharpe ratio = Mean/SD	0.39	0.34	-0.93
Skewness	-0.37	0.32	0.71
Kurtosis	2.99	3.22	3.79

Note: The table reports the means, standard deviations (SD), Sharpe ratios (Mean/SD), Skewness and Kurtosis for portfolio returns based on professional expectations, momentum strategy and interest rate differentials at a 3-months ($h = 3$) horizon (sample period 2009/05-2016/03). The portfolios have been constructed from the following exchange rates: British Pound (GBP/USD), Euro (EUR/USD), Norwegian Krone (NOK/USD), Swedish Krona (SEK/USD), Swiss Franc (CHF/USD), Australian Dollar (AUD/USD), Indonesian Rupiah (IDR/USD), Japanese Yen (JPY/USD), New Zealand Dollar (NZD/USD), Singapore Dollar (SGD/USD), South Korean Won (KRW/USD), Taiwan Dollar (TWD/USD), Canadian Dollar (CAD/USD), and South African Rand (ZAR/USD). For the portfolio construction currencies have been ranked based on the three strategies: (1) $E_t(s_{t+h}) - s_t - (i_t - i_t^*)$, (2) $s_t - s_{t-1} - (i_t - i_t^*)$ and (3) $-(i_t - i_t^*)$. For the next month the portfolio is constructed by buying the three highest ranked currencies and selling the three lowest ranked currencies.

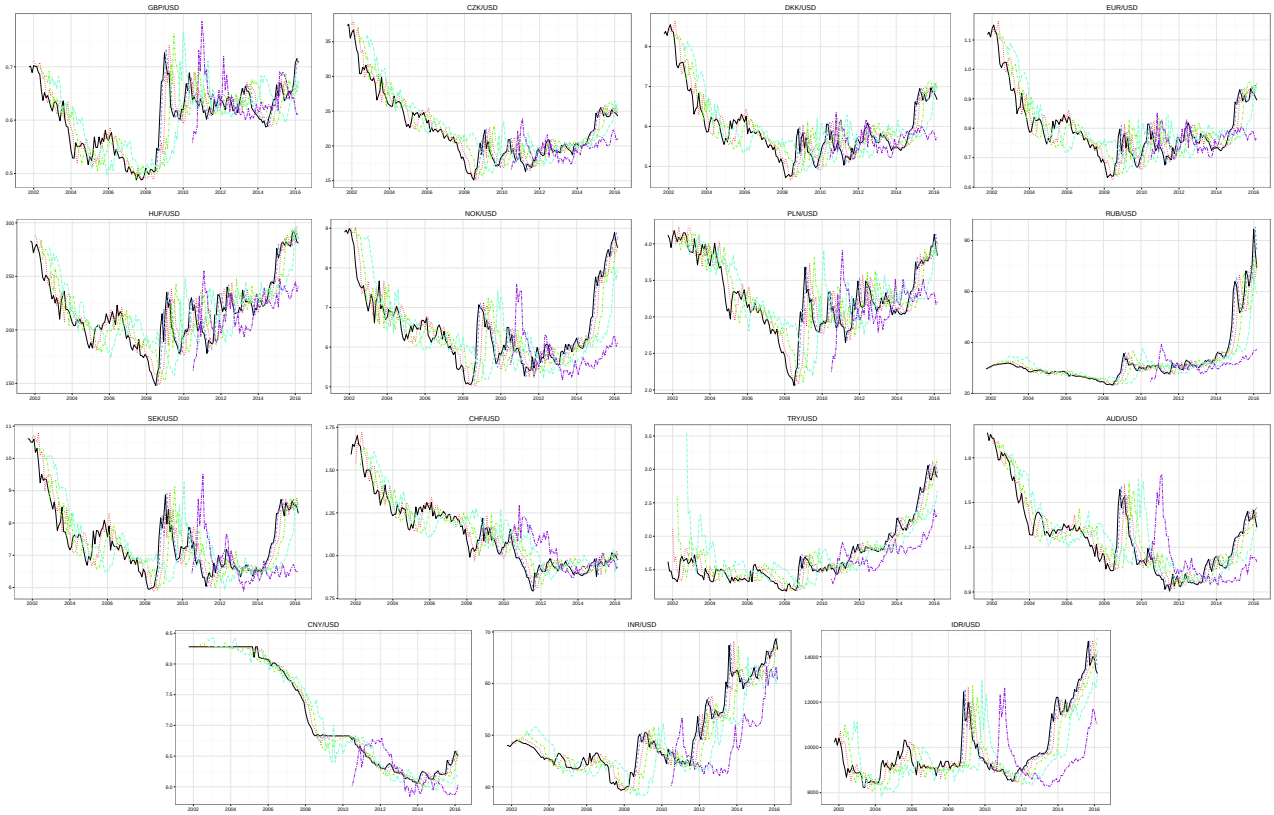
TABLE 10 **Correlation between shadow rates and uncertainty measures**

	ECB rate	FED rate	FU	VIX
ECB rate	1.000000000	0.7993320	-0.006654643	0.02725558
FED rate	0.799331968	1.0000000	-0.216362165	-0.11303492
FU	-0.006654643	-0.2163622	1.000000000	0.87596641
VIX	0.027255579	-0.1130349	0.875966407	1.00000000

Note: The table reports the simple correlation coefficient between the shadow policy rates of the ECB and the US Fed provided by Wu and Xia (2016) and the two uncertainty measures, i.e. financial uncertainty (FU) proposed by Jurado *et al.* (2015) and the conventional CBOE volatility index (VIX) which measures the volatility of the S&P500 (sample period 2004/09-2015/11).

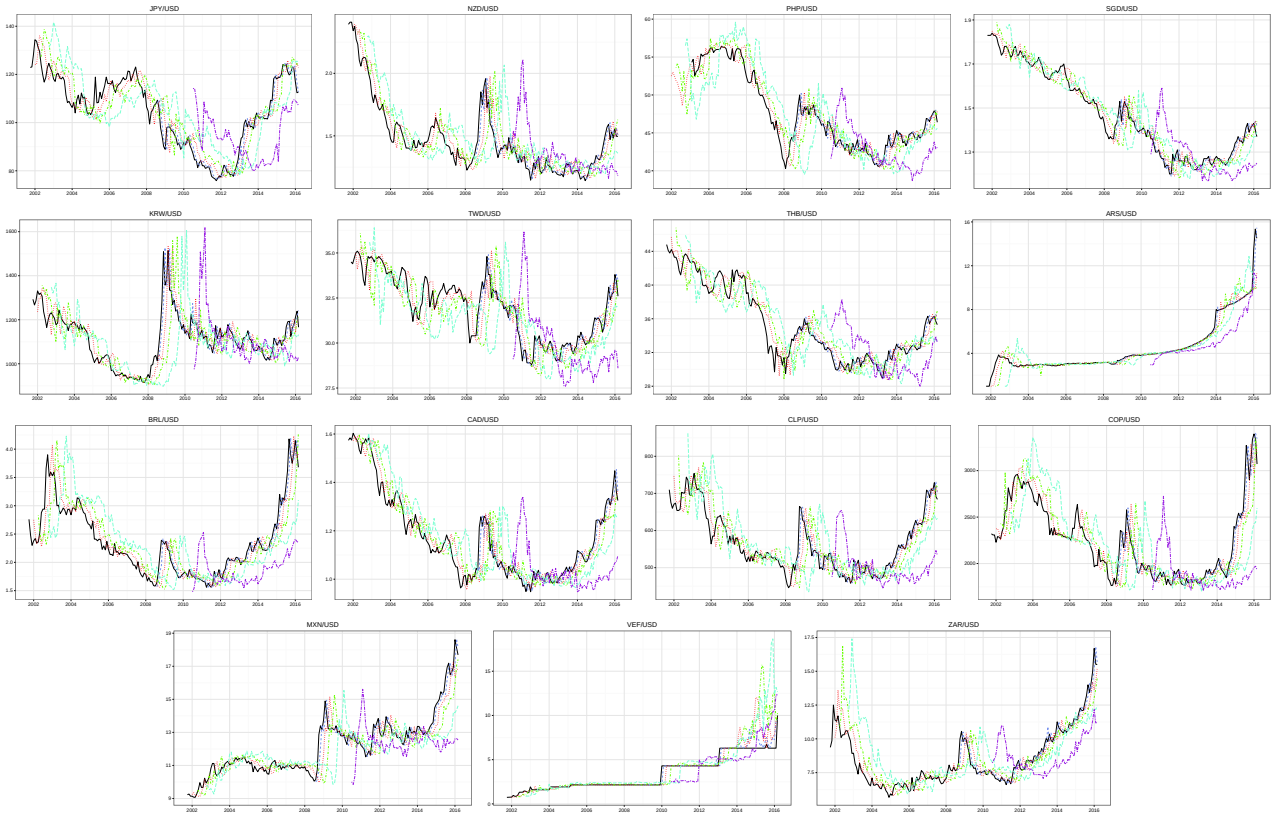
Figures

FIGURE 1 **Spot rates vs. expectations for major currencies (part I)**



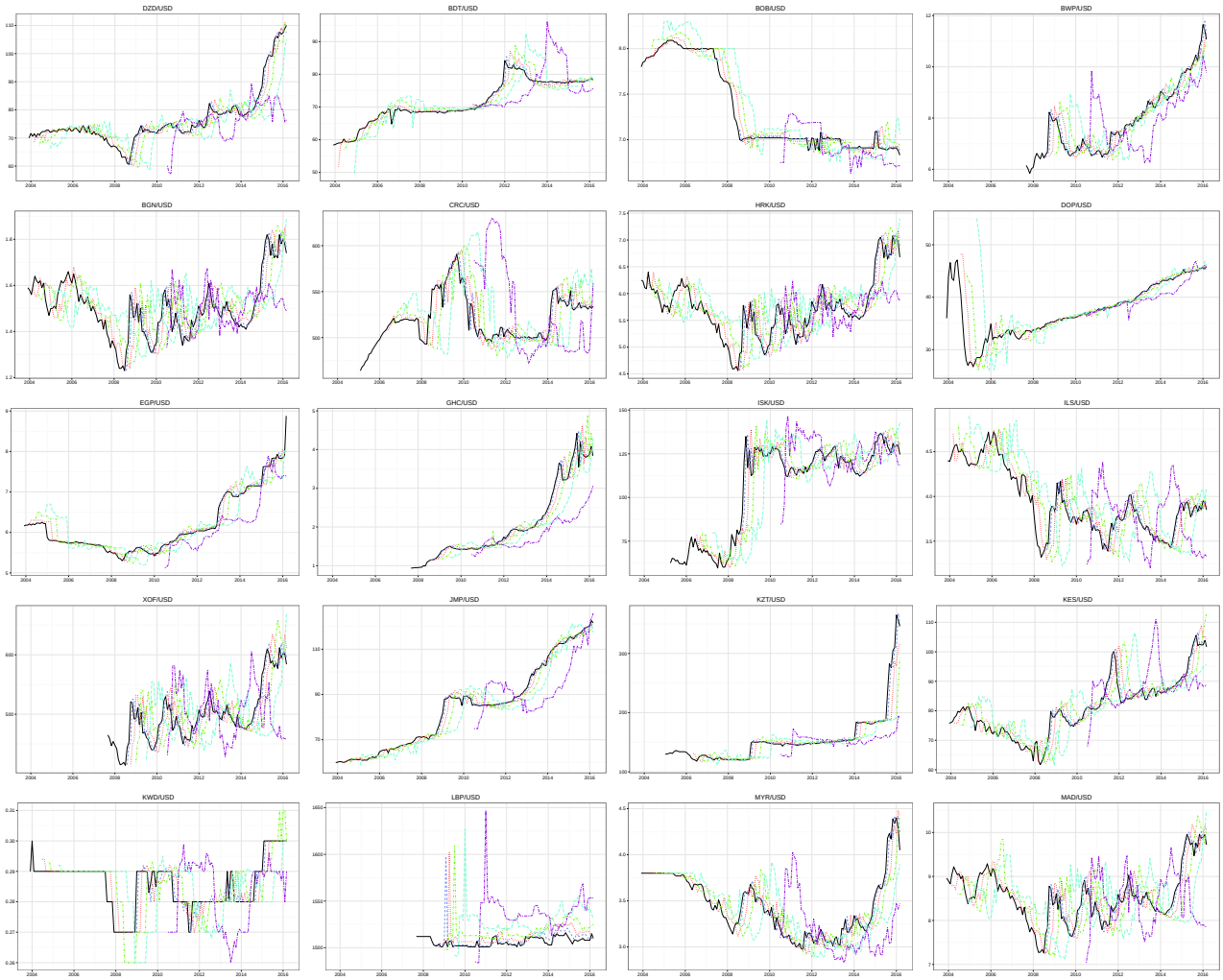
Note: The figure shows spot rates plotted against expectations formed 1- (blue), 3- (red), 6- (green), 12- (cyan) or 24-months (violet) before for the following exchange rates (sample period 2002/10-2016/03): British Pound (GBP/USD), Czech Koruna (CZK/USD), Danish Krone (DKK/USD), Euro (EUR/USD), Hungarian Forint (HUF/USD), Norwegian Krone (NOK/USD), Polish Zloty (PLN/USD), Russian Rouble (RUB/USD), Swedish Krona (SEK/USD), Swiss Franc (CHF/USD), Turkish Lira (TRY/USD), Australian Dollar (AUD/USD), Chinese Renminbi (CNY/USD), Indian Rupee (INR/USD), and Indonesian Rupiah (IDR/USD).

FIGURE 2 **Spot rates vs. expectations for major currencies (part II)**



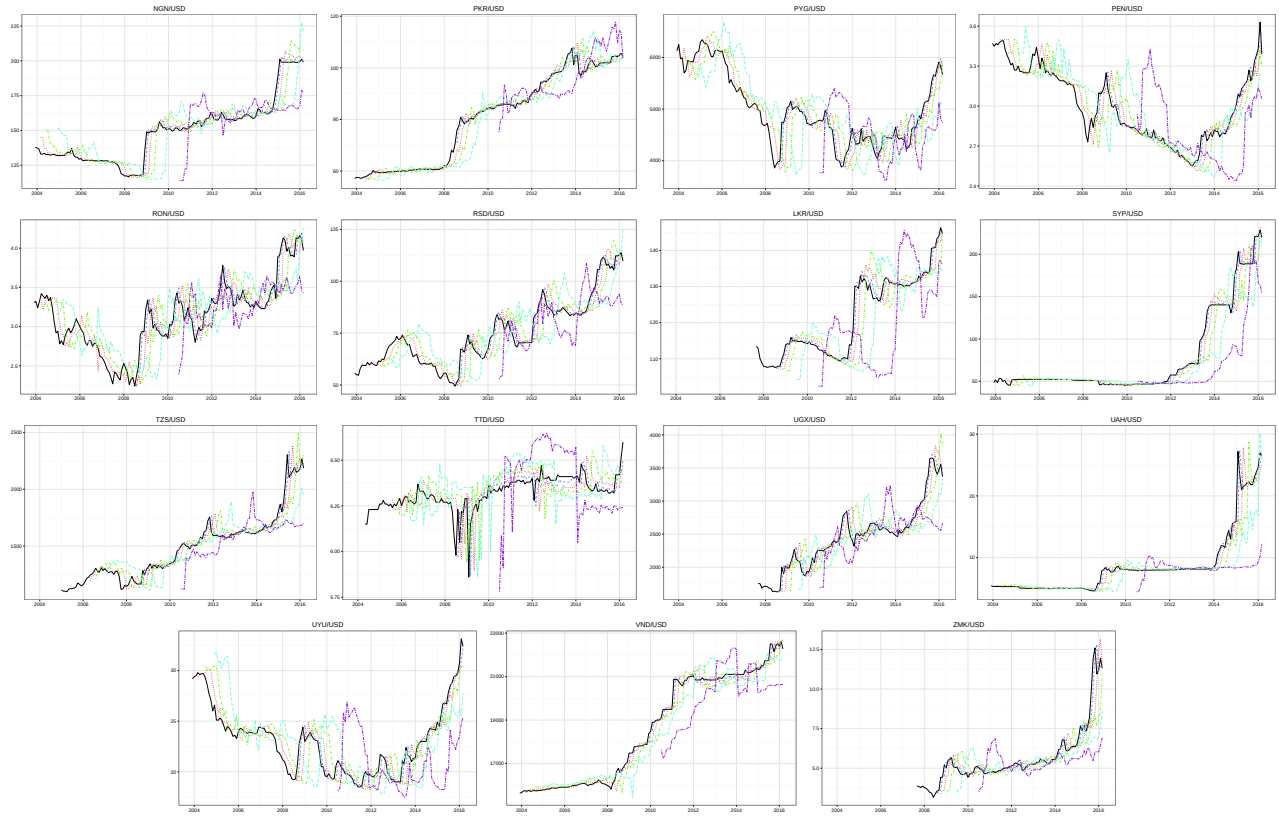
Note: The figure shows spot rates plotted against expectations formed 1- (blue), 3- (red), 6- (green), 12- (cyan) or 24-months (violet) before for the following exchange rates (sample period 2002/10-2016/03): Japanese Yen (JPY/USD), New Zealand Dollar (NZD/USD), Philippine Peso (PHP/USD), Singapore Dollar (SGD/USD), South Korean Won (KRW/USD), Taiwan Dollar (TWD/USD), Thai Baht (THB/USD), Argentine Peso (ARS/USD), Brazilian Real (BRL/USD), Canadian Dollar (CAD/USD), Chilean Peso (CLP/USD), Colombian Peso (COP/USD), Mexican Peso (MXN/USD), Venezuelan Bolivar (VEF/USD), and South African Rand (ZAR/USD).

FIGURE 3 **Spot rates vs. expectations for minor currencies (part I)**



Note: The figure shows spot rates plotted against expectations formed 1- (blue), 3- (red), 6- (green), 12- (cyan) or 24-months (violet) before for the following exchange rates (sample period 2004/12-2016/03): Algerian Dinar (DZD/USD), Bangladeshi Taka (BDT/USD), Bolivian Boliviano (BOB/USD), Botswana Pula (BWP/USD), Bulgarian Lev (BGN/USD), Costa Rican Colon (CRC/USD), Croatian Kuna (HRK/USD), Dominican Republic Peso (DOP/USD), Egyptian Pound (EGP/USD), Ghanaian Cedi (GHC/USD), Icelandic Krona (ISK/USD), Israeli Shekel (ILS/USD), Ivory Coast Franc (XOF/USD), Jamaican Dollar (JMP/USD), Kazakhstan Tenge (KZT/USD), Kenyan Shilling (KES/USD), Kuwaiti Dinar (KWD/USD), Lebanese Pound (LBP/USD), Malaysian Ringgit (MYR/USD), and Moroccan Dirham (MAD/USD).

FIGURE 4 **Spot rates vs. expectations for minor currencies (part II)**



Note: The figure shows spot rates plotted against expectations formed 1- (blue), 3- (red), 6- (green), 12- (cyan) or 24-months (violet) before for the following exchange rates (sample period 2004/12-2016/03): Nigerian Naira (NGN/USD), Pakistani Rupee (PKR/USD), Paraguayan Guarani (PYG/USD), Peruvian Peso (PEN/USD), Romanian Leu (RON/USD), Serbian Dinar (RSD/USD), Sri Lankan Rupee (LKR/USD), Syrian Pound (SYP/USD), Tanzanian Shilling (TZS/USD), Trinidad & Tobago Dollar (TTD/USD), Ugandan Shilling (UGX/USD), Ukrainian Hryvnia (UAH/USD), Uruguayan Peso (UYU/USD), Vietnamese Dong (VND/USD), and Zambian Kwacha (ZMK/USD).

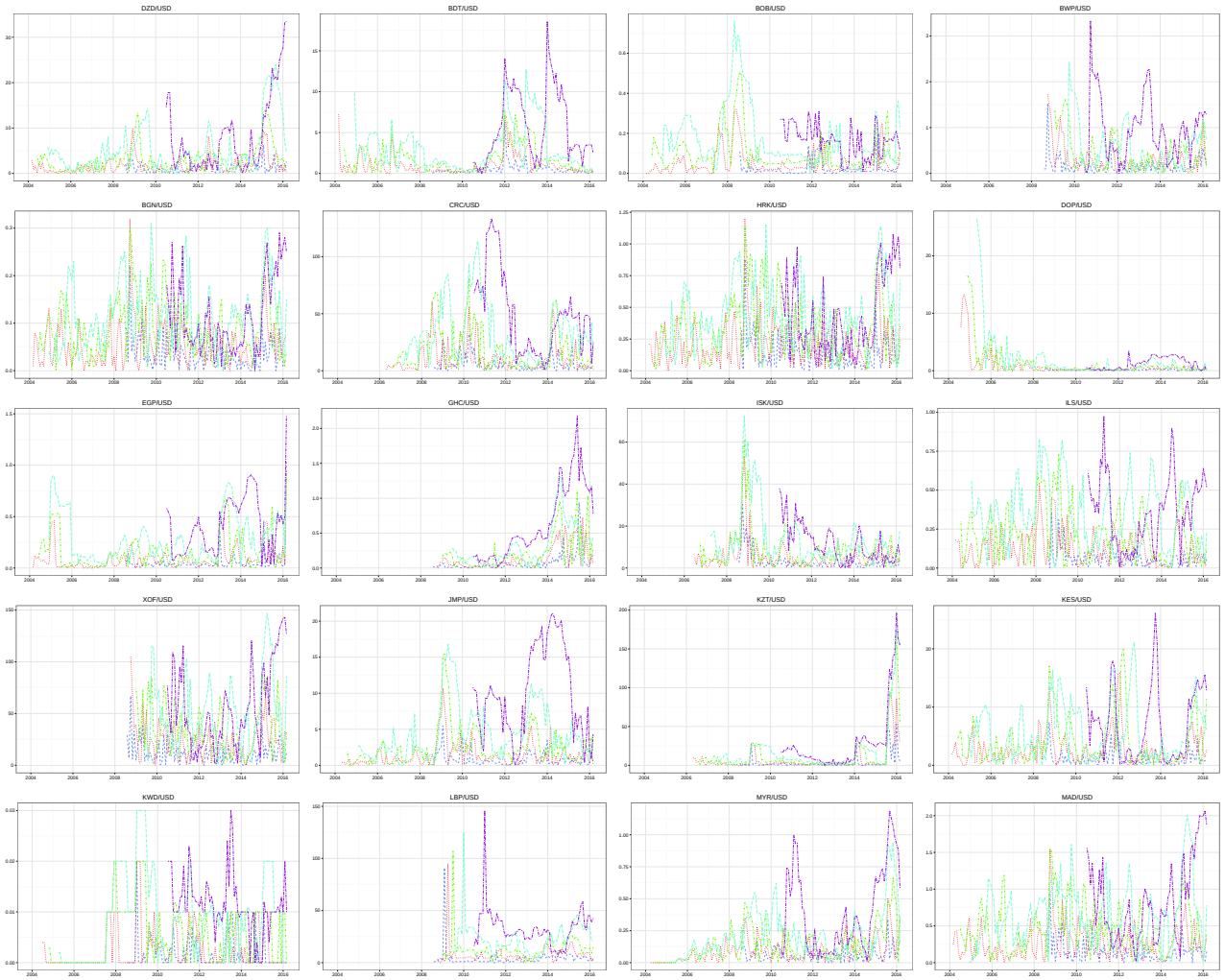
FIGURE 5 **Forecast errors for major currencies (part I)**

Note: The figure shows forecast errors for expectations formed 1- (blue), 3- (red), 6- (green), 12- (cyan) or 24-months (violet) before for the following exchange rates (sample period 2002/10-2016/03): British Pound (GBP/USD), Czech Koruna (CZK/USD), Danish Krone (DKK/USD), Euro (EUR/USD), Hungarian Forint (HUF/USD), Norwegian Krone (NOK/USD), Polish Zloty (PLN/USD), Russian Rouble (RUB/USD), Swedish Krona (SEK/USD), Swiss Franc (CHF/USD), Turkish Lira (TRY/USD), Australian Dollar (AUD/USD), Chinese Renminbi (CNY/USD), Indian Rupee (INR/USD), and Indonesian Rupiah (IDR/USD).

FIGURE 6 **Forecast errors for major currencies (part II)**

Note: The figure shows forecast errors for expectations formed 1- (blue), 3- (red), 6- (green), 12- (cyan) or 24-months (violet) before for the following exchange rates (sample period 2002/10-2016/03): Japanese Yen (JPY/USD), New Zealand Dollar (NZD/USD), Philippine Peso (PHP/USD), Singapore Dollar (SGD/USD), South Korean Won (KRW/USD), Taiwan Dollar (TWD/USD), Thai Baht (THB/USD), Argentine Peso (ARS/USD), Brazilian Real (BRL/USD), Canadian Dollar (CAD/USD), Chilean Peso (CLP/USD), Colombian Peso (COP/USD), Mexican Peso (MXN/USD), Venezuelan Bolivar (VEF/USD), and South African Rand (ZAR/USD).

FIGURE 7 **Forecast errors for minor currencies (part I)**

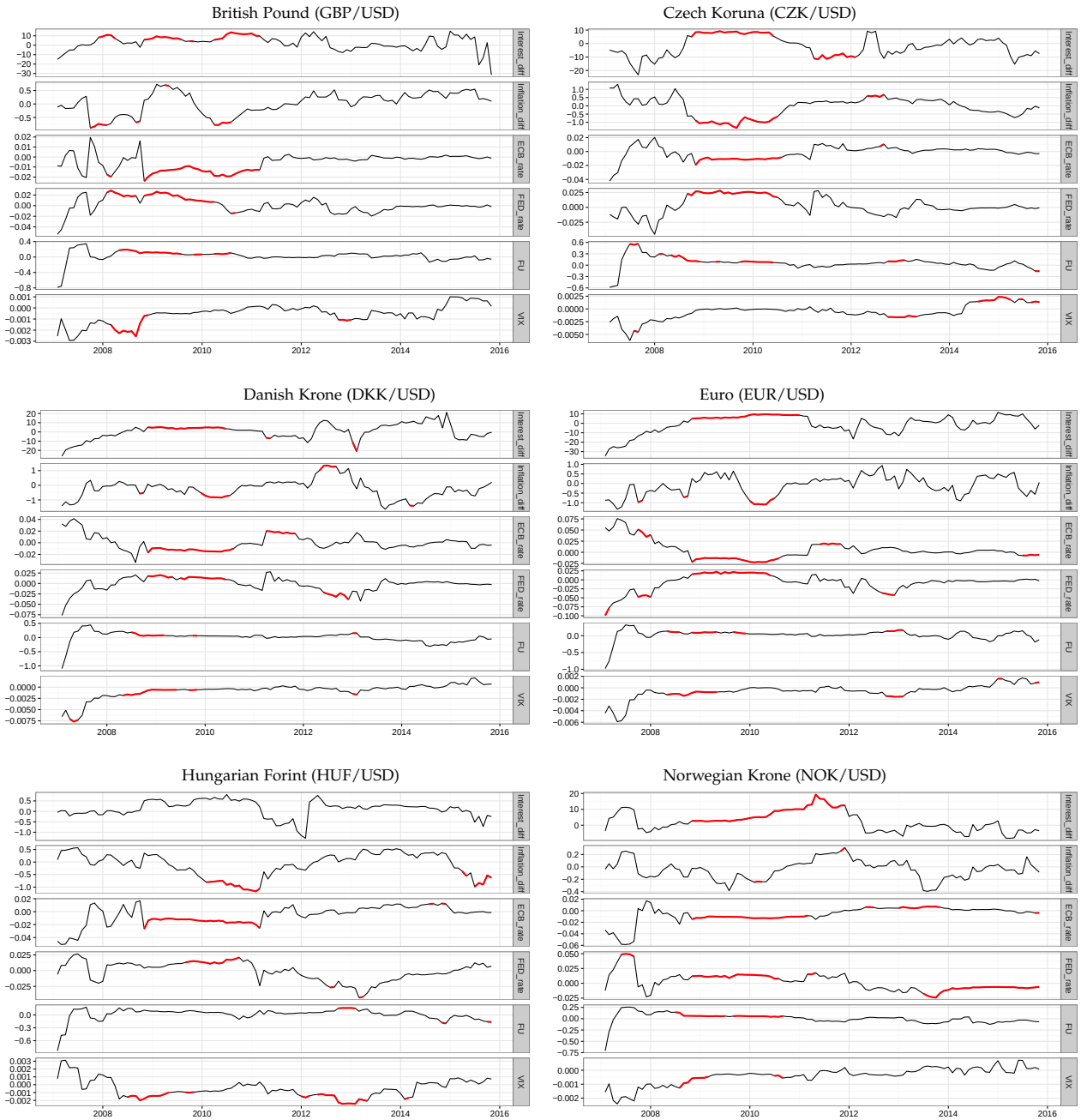


Note: The figure shows forecast errors for expectations formed 1- (blue), 3- (red), 6- (green), 12- (cyan) or 24-months (violet) before for the following exchange rates (sample period 2004/12-2016/03): Algerian Dinar (DZD/USD), Bangladeshi Taka (BDT/USD), Bolivian Boliviano (BOB/USD), Botswana Pula (BWP/USD), Bulgarian Lev (BGN/USD), Costa Rican Colon (CRC/USD), Croatian Kuna (HRK/USD), Dominican Republic Peso (DOP/USD), Egyptian Pound (EGP/USD), Ghanaian Cedi (GHC/USD), Icelandic Krona (ISK/USD), Israeli Shekel (ILS/USD), Ivory Coast Franc (XOF/USD), Jamaican Dollar (JMP/USD), Kazakhstan Tenge (KZT/USD), Kenyan Shilling (KES/USD), Kuwaiti Dinar (KWD/USD), Lebanese Pound (LBP/USD), Malaysian Ringgit (MYR/USD), and Moroccan Dirham (MAD/USD).

FIGURE 8 **Forecast errors for minor currencies (part II)**

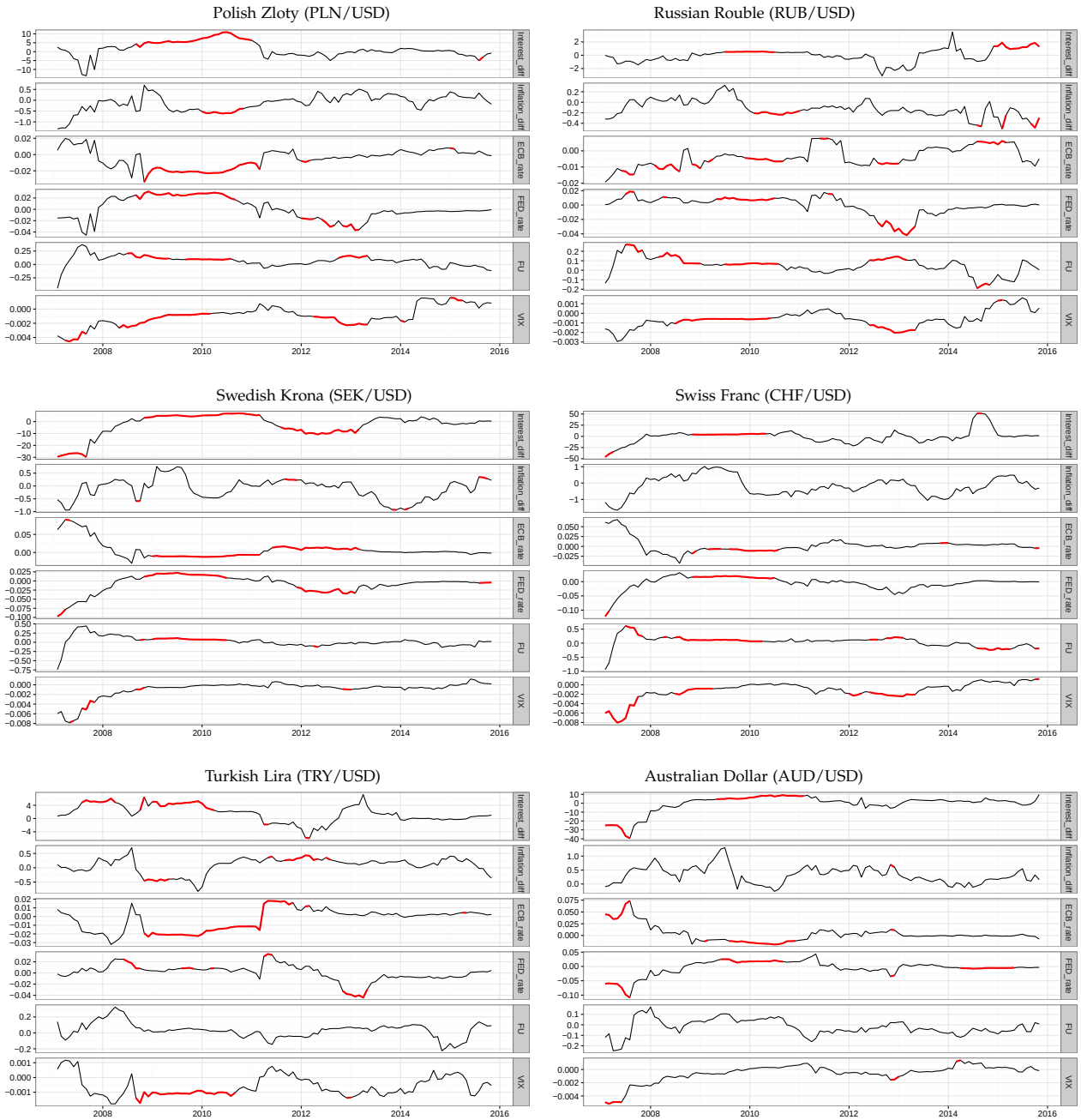
Note: The figure shows forecast errors for expectations formed 1- (blue), 3- (red), 6- (green), 12- (cyan) or 24-months (violet) before for the following exchange rates (sample period 2004/12-2016/03): Nigerian Naira (NGN/USD), Pakistani Rupee (PKR/USD), Paraguayan Guarani (PYG/USD), Peruvian Peso (PEN/USD), Romanian Leu (RON/USD), Serbian Dinar (RSD/USD), Sri Lankan Rupee (LKR/USD), Syrian Pound (SYP/USD), Tanzanian Shilling (TZS/USD), Trinidad & Tobago Dollar (TTD/USD), Ugandan Shilling (UGX/USD), Ukrainian Hryvnia (UAH/USD), Uruguayan Peso (UYU/USD), Vietnamese Dong (VND/USD), and Zambian Kwacha (ZMK/USD).

FIGURE 9 **Time-varying coefficients for expected exchange rate changes of major currencies (part I)**



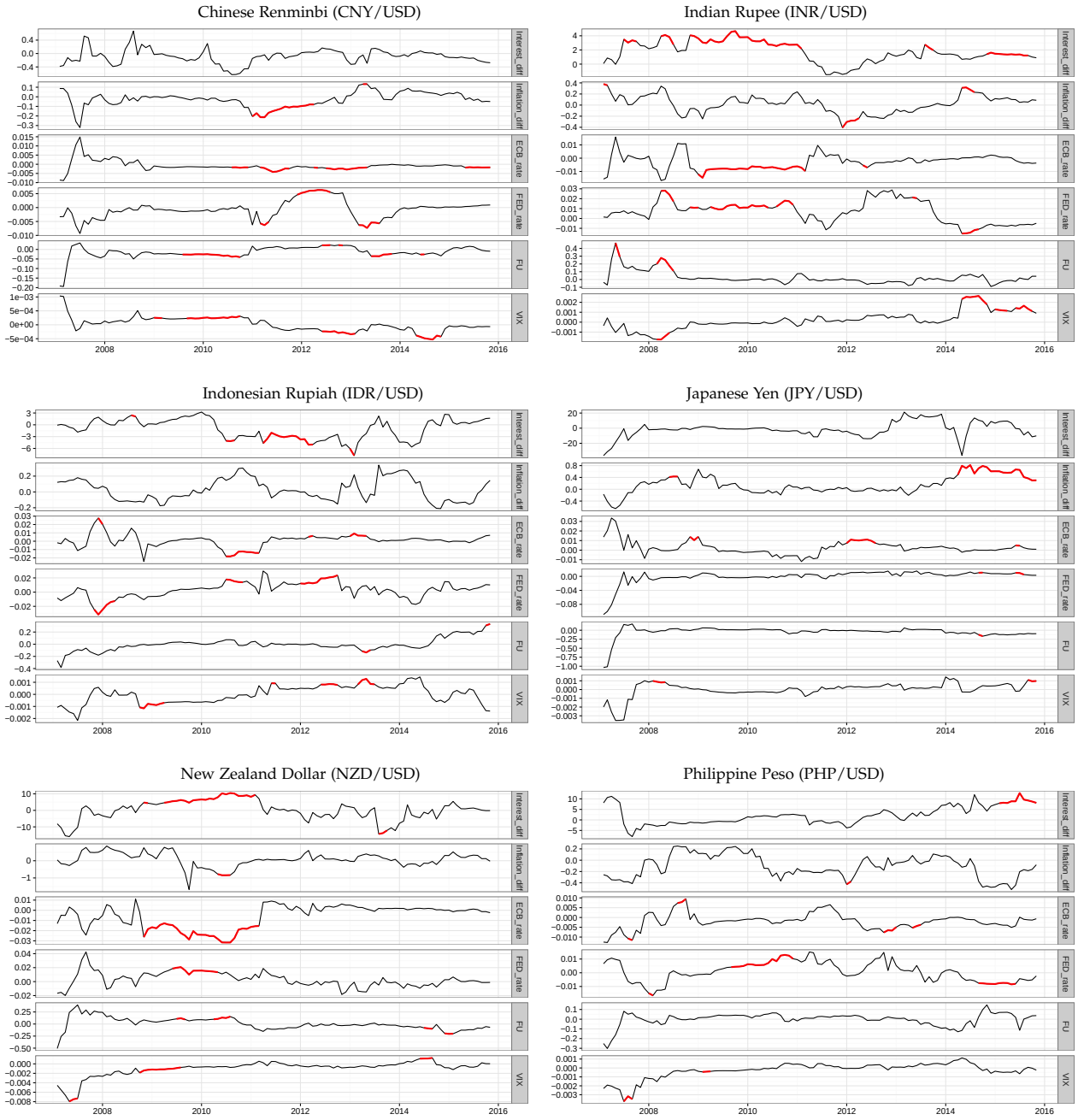
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_t(s_{t+h}) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 10 **Time-varying coefficients for expected exchange rate changes of major currencies (part II)**



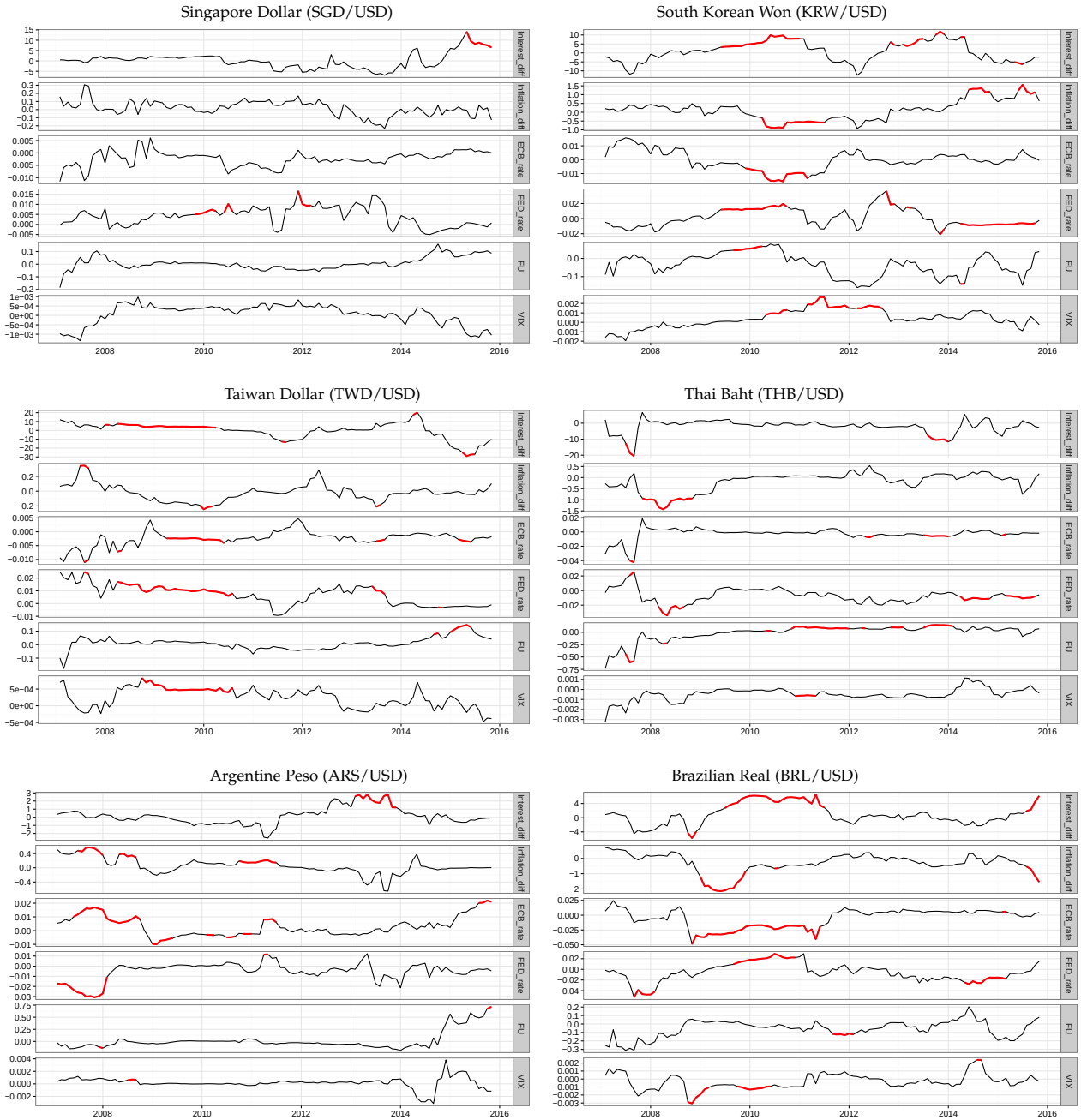
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_t(s_{t+h}) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 11 **Time-varying coefficients for expected exchange rate changes of major currencies (part III)**



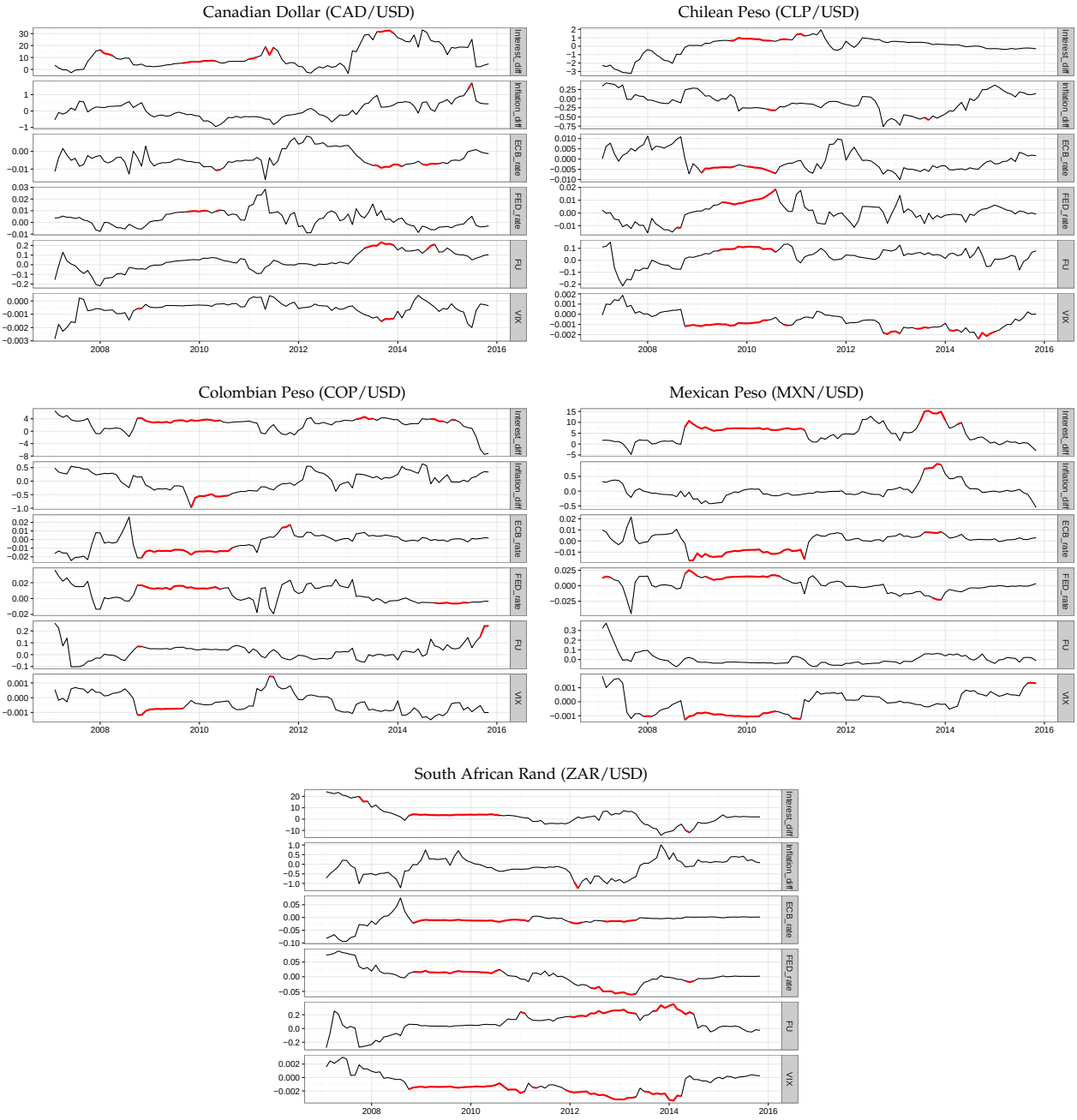
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_t(s_{t+h}) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 12 **Time-varying coefficients for expected exchange rate changes of major currencies (part IV)**



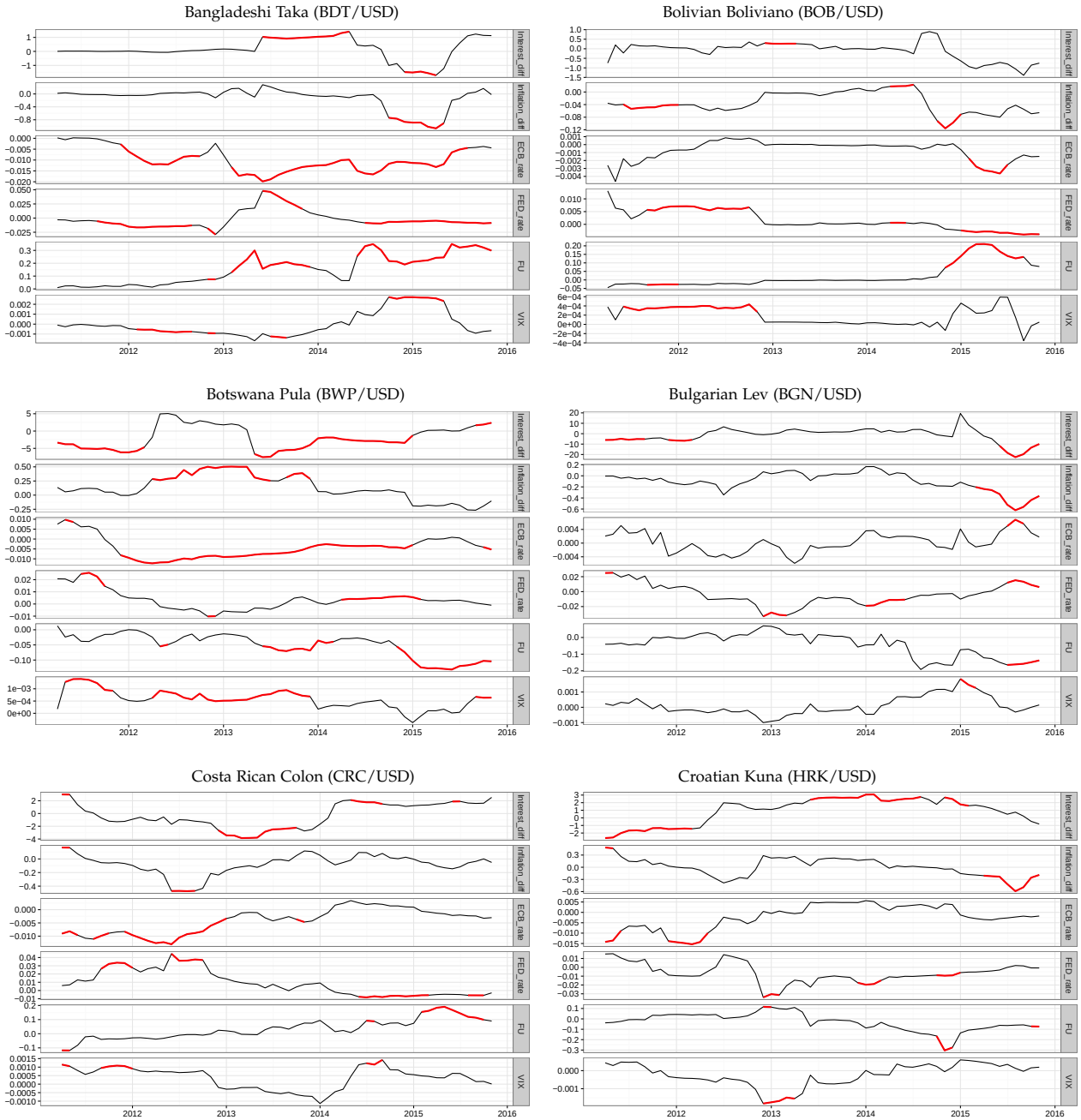
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_t(s_{t+h}) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 13 **Time-varying coefficients for expected exchange rate changes of major currencies (part V)**



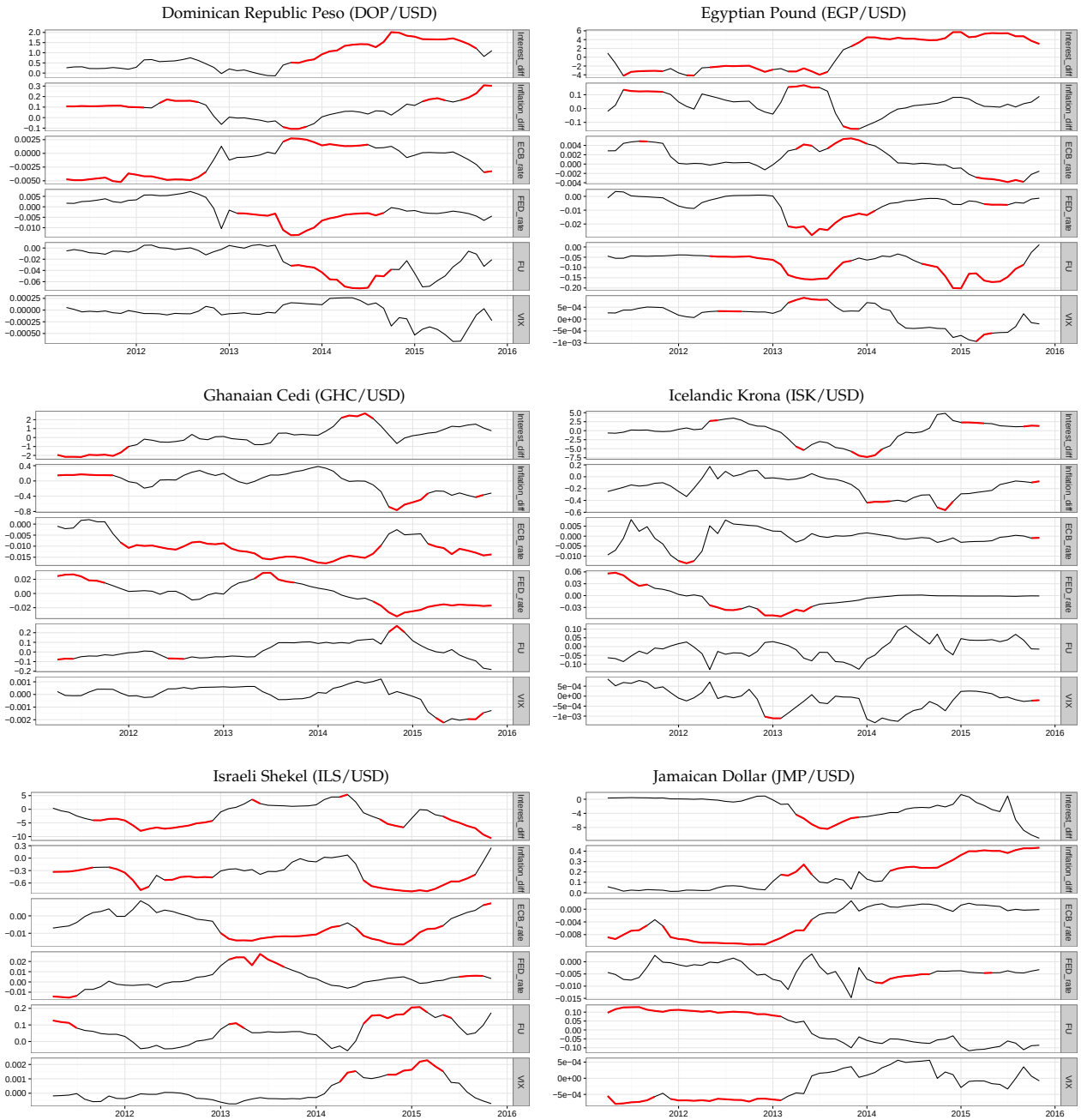
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_t(s_{t+h}) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 14 **Time-varying coefficients for expected exchange rate changes of minor currencies (part I)**



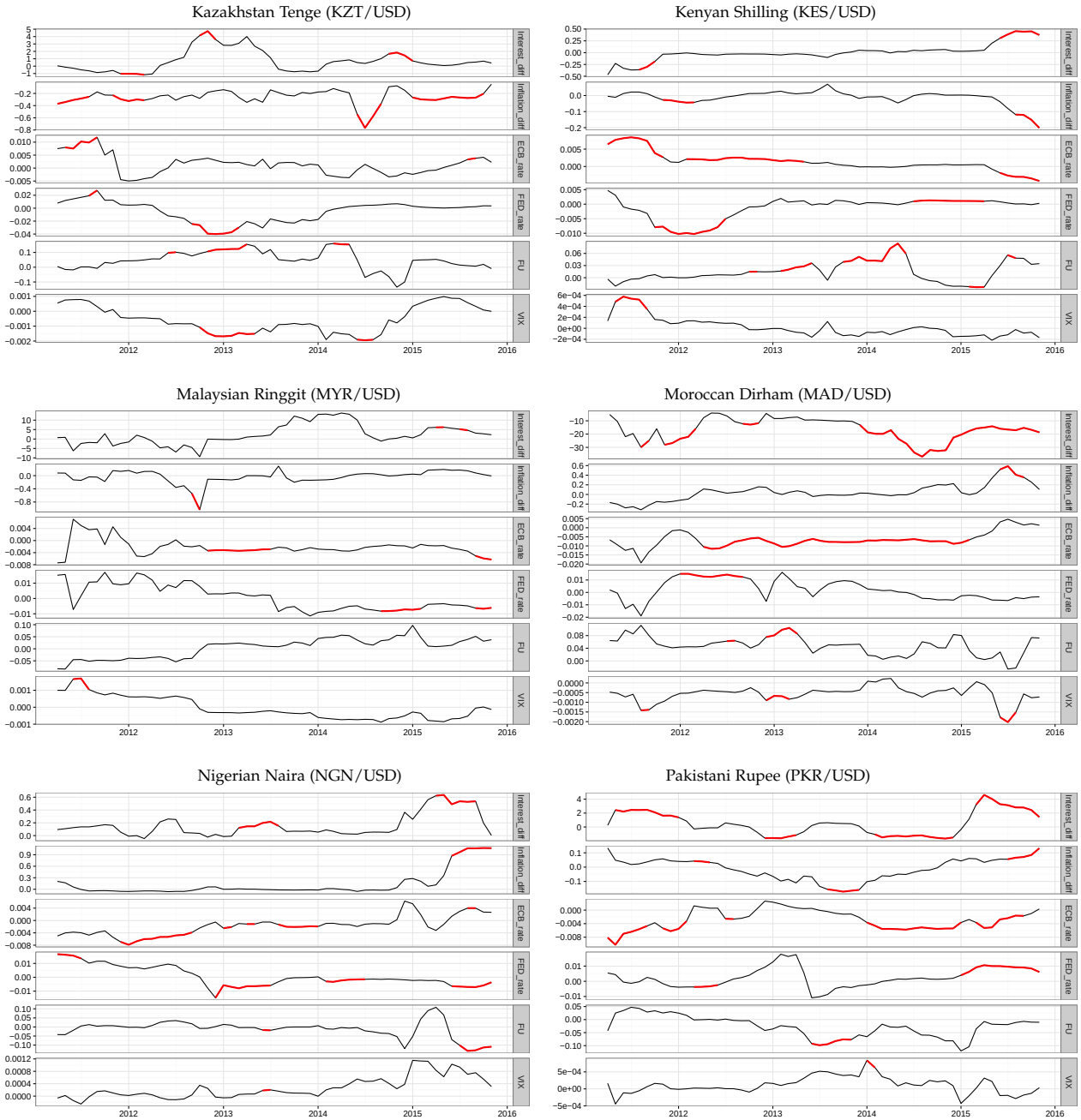
Note: The graphs show rolling window regression estimates for the sample period running from 2008/11-2015/11 based on the following regression equation (for $h = 3$): $(E_t(s_{t+h}) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 15 **Time-varying coefficients for expected exchange rate changes of minor currencies (part II)**



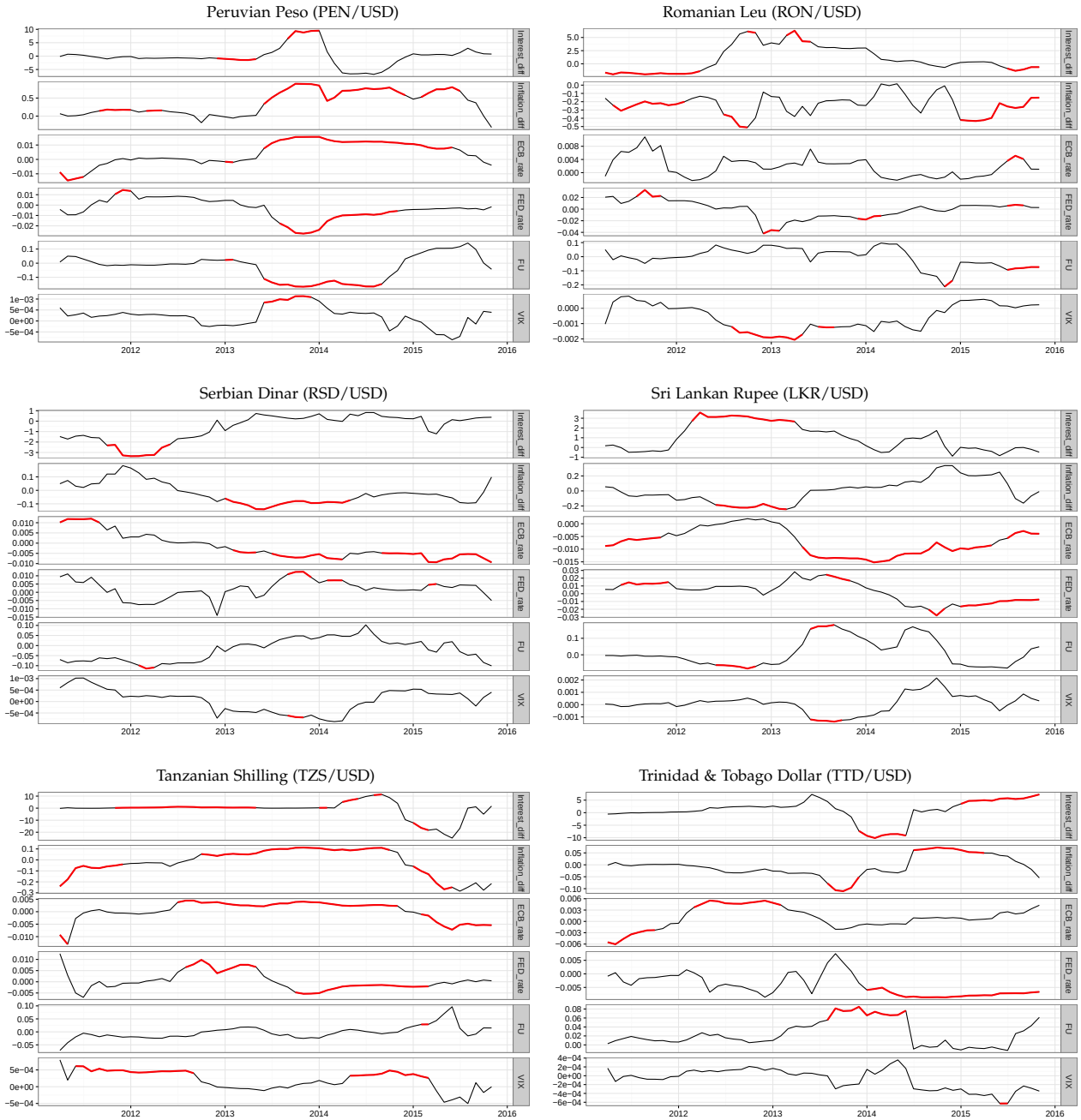
Note: The graphs show rolling window regression estimates for the sample period running from 2008/11-2015/11 based on the following regression equation (for $h = 3$): $(E_t(s_{t+h}) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 16 **Time-varying coefficients for expected exchange rate changes of minor currencies (part III)**



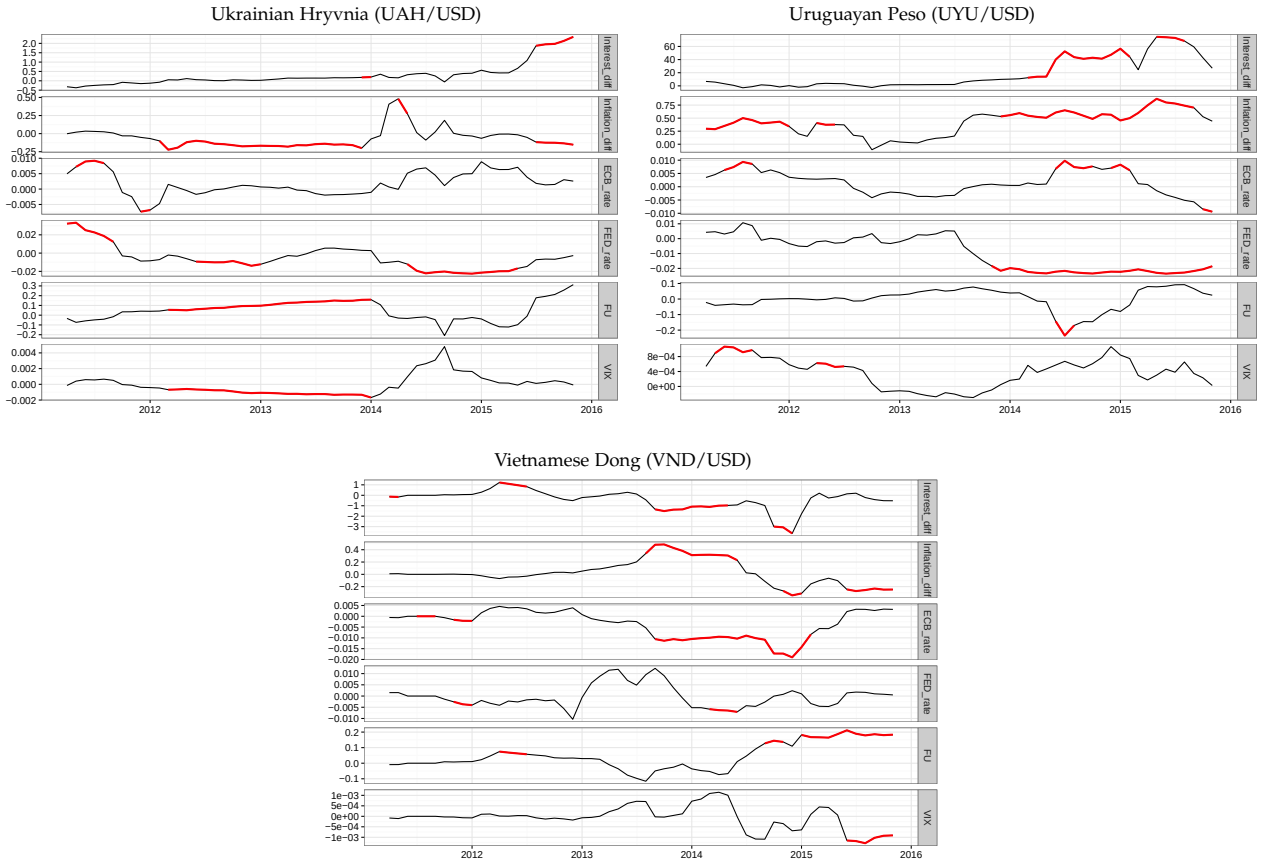
Note: The graphs show rolling window regression estimates for the sample period running from 2008/11-2015/11 based on the following regression equation (for $h = 3$): $(E_t(s_{t+h}) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 17 **Time-varying coefficients for expected exchange rate changes of minor currencies (part IV)**



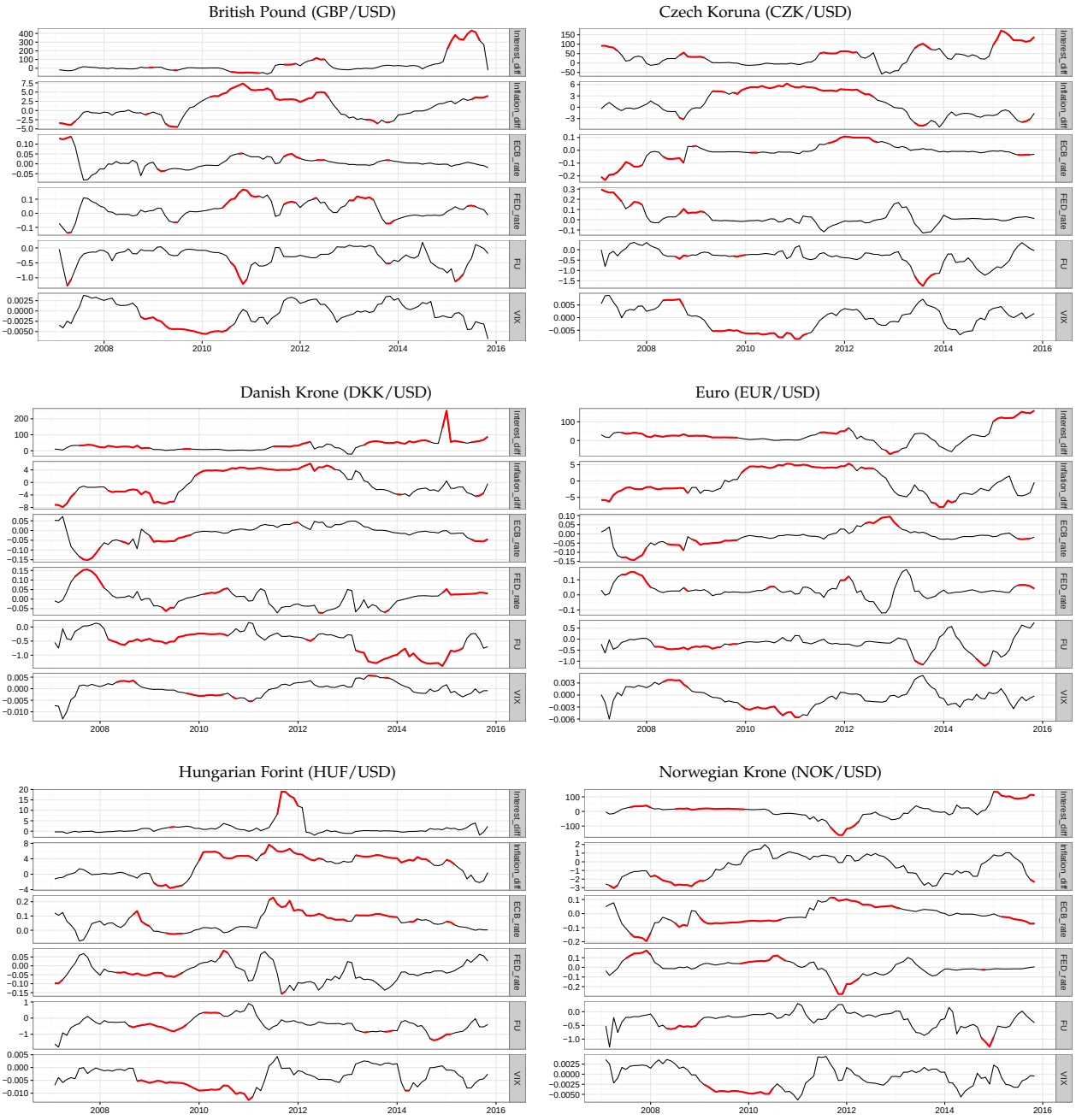
Note: The graphs show rolling window regression estimates for the sample period running from 2008/11-2015/11 based on the following regression equation (for $h = 3$): $(E_t(s_{t+h}) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 18 **Time-varying coefficients for expected exchange rate changes of minor currencies (part V)**



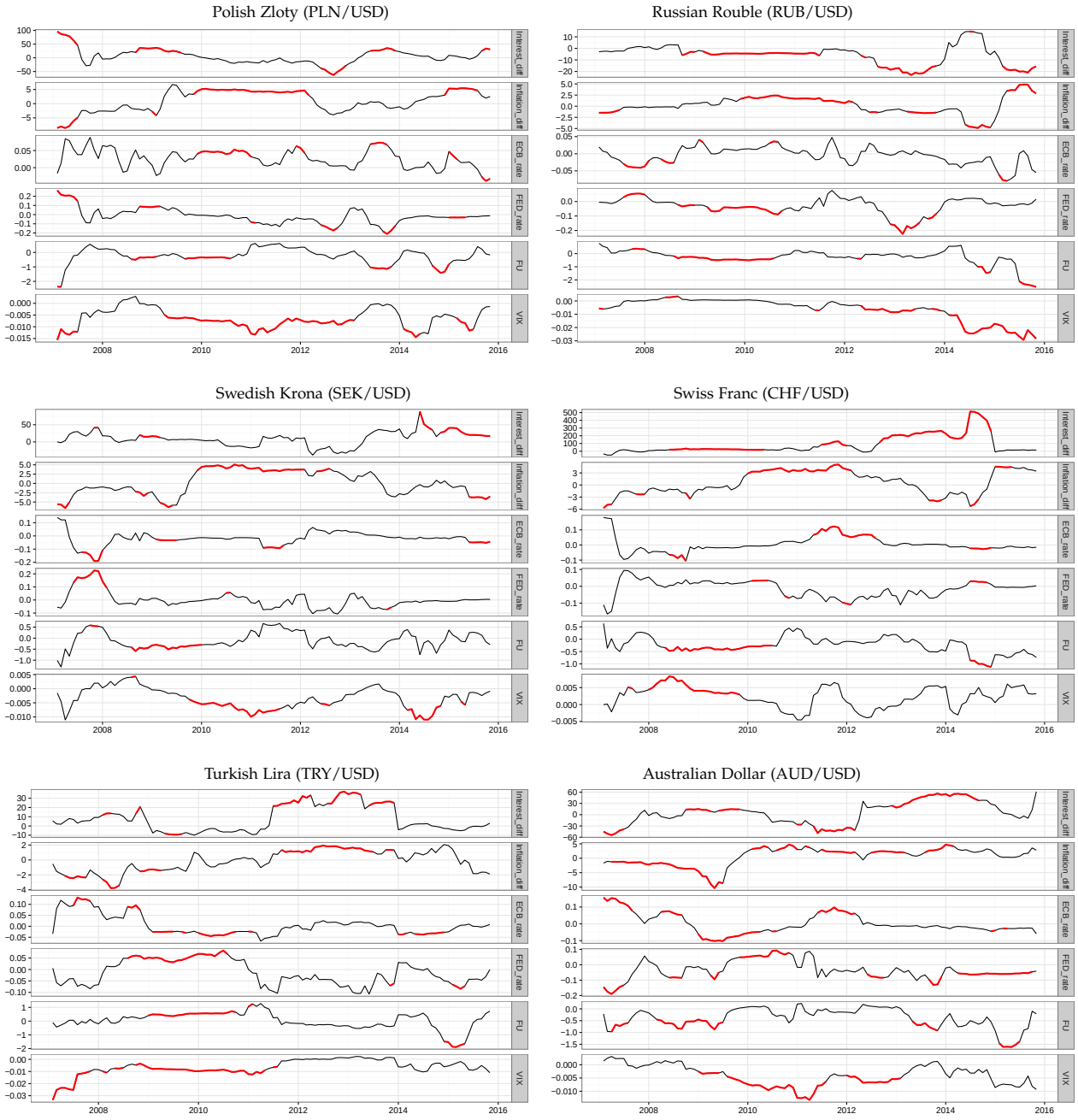
Note: The graphs show rolling window regression estimates for the sample period running from 2008/11-2015/11 based on the following regression equation (for $h = 3$): $(E_t(s_{t+h}) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the expected exchange rate change $(E_t(s_{t+h}) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 19 **Time-varying coefficients for forecast errors of major currencies (part I)**



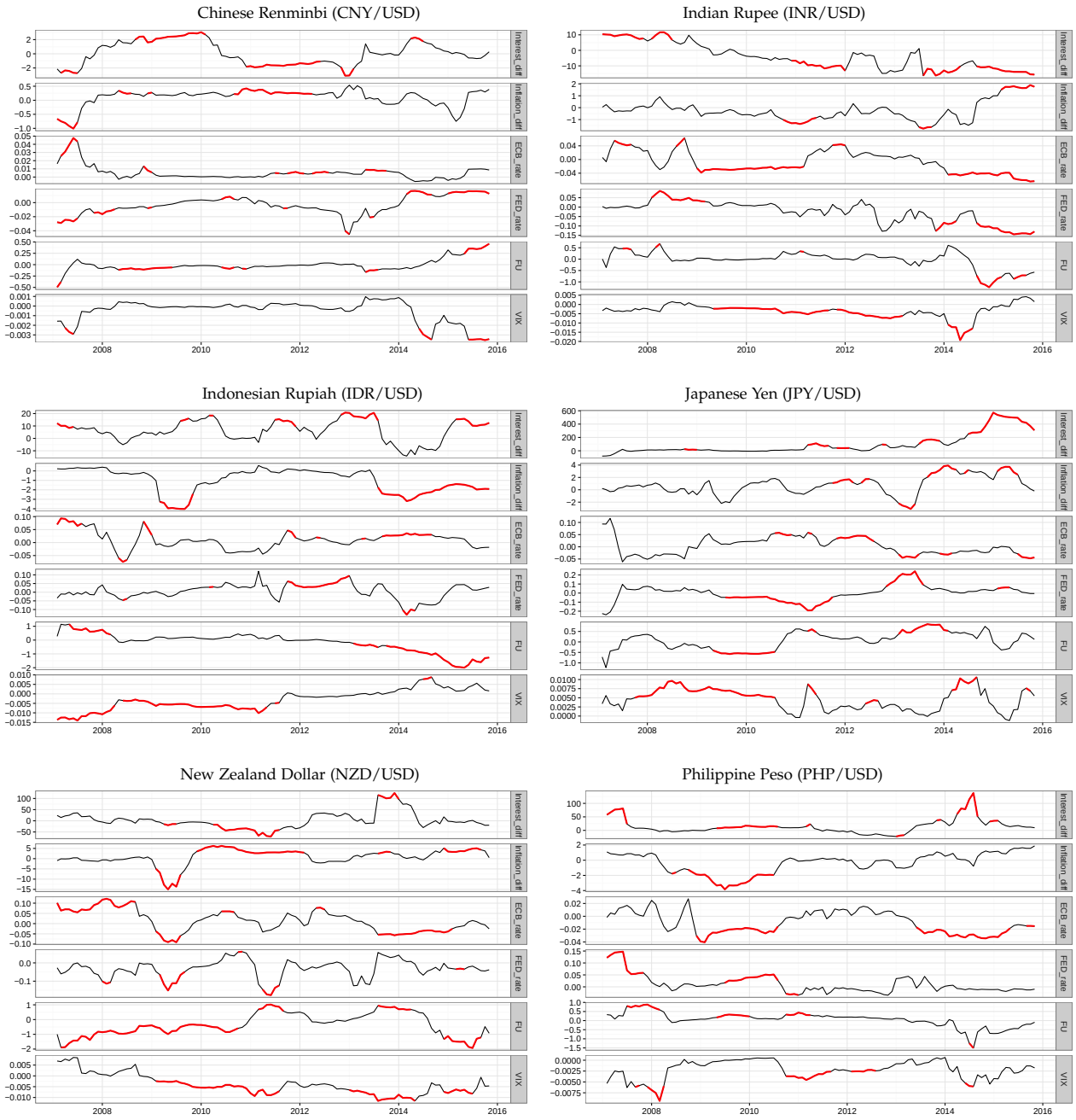
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_{t-h}(s_t) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the professionals forecast error $(E_{t-h}(s_t) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 20 **Time-varying coefficients for forecast errors of major currencies (part II)**



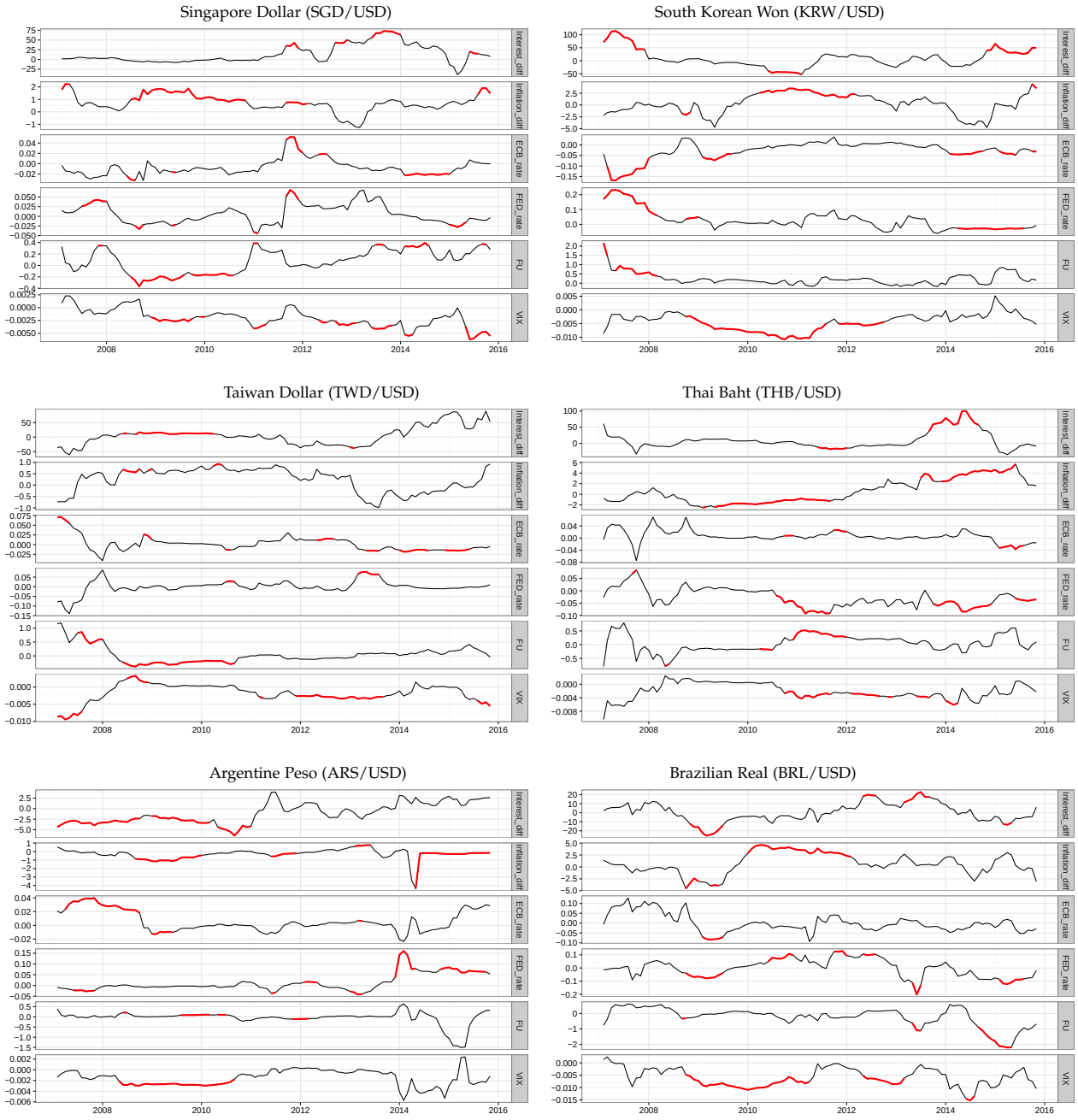
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_{t-h}(s_t) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the professionals forecast error $(E_{t-h}(s_t) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 21 **Time-varying coefficients for forecast errors of major currencies (part III)**



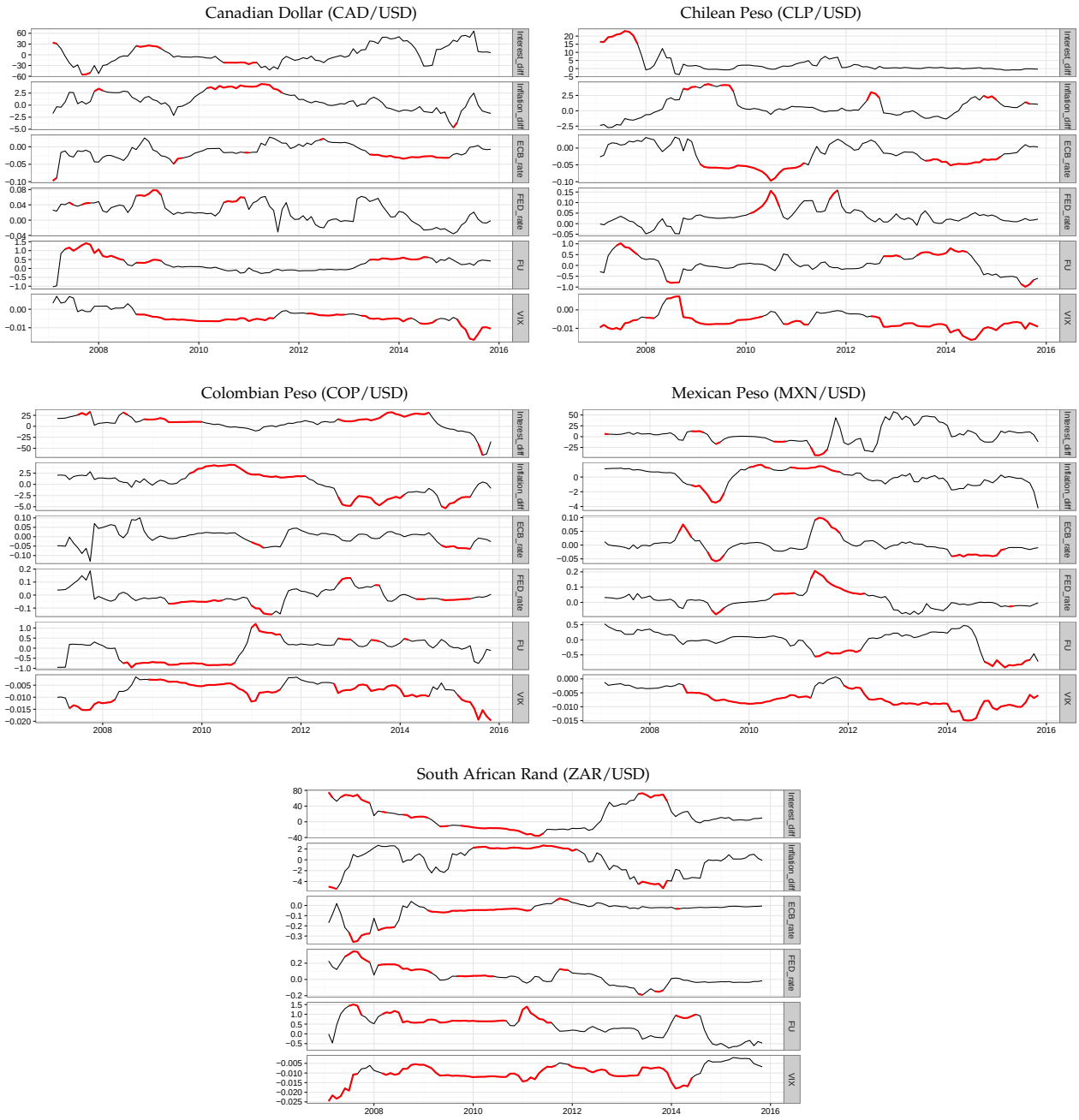
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_{t-h}(s_t) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the professionals forecast error $(E_{t-h}(s_t) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 22 **Time-varying coefficients for forecast errors of major currencies (part IV)**



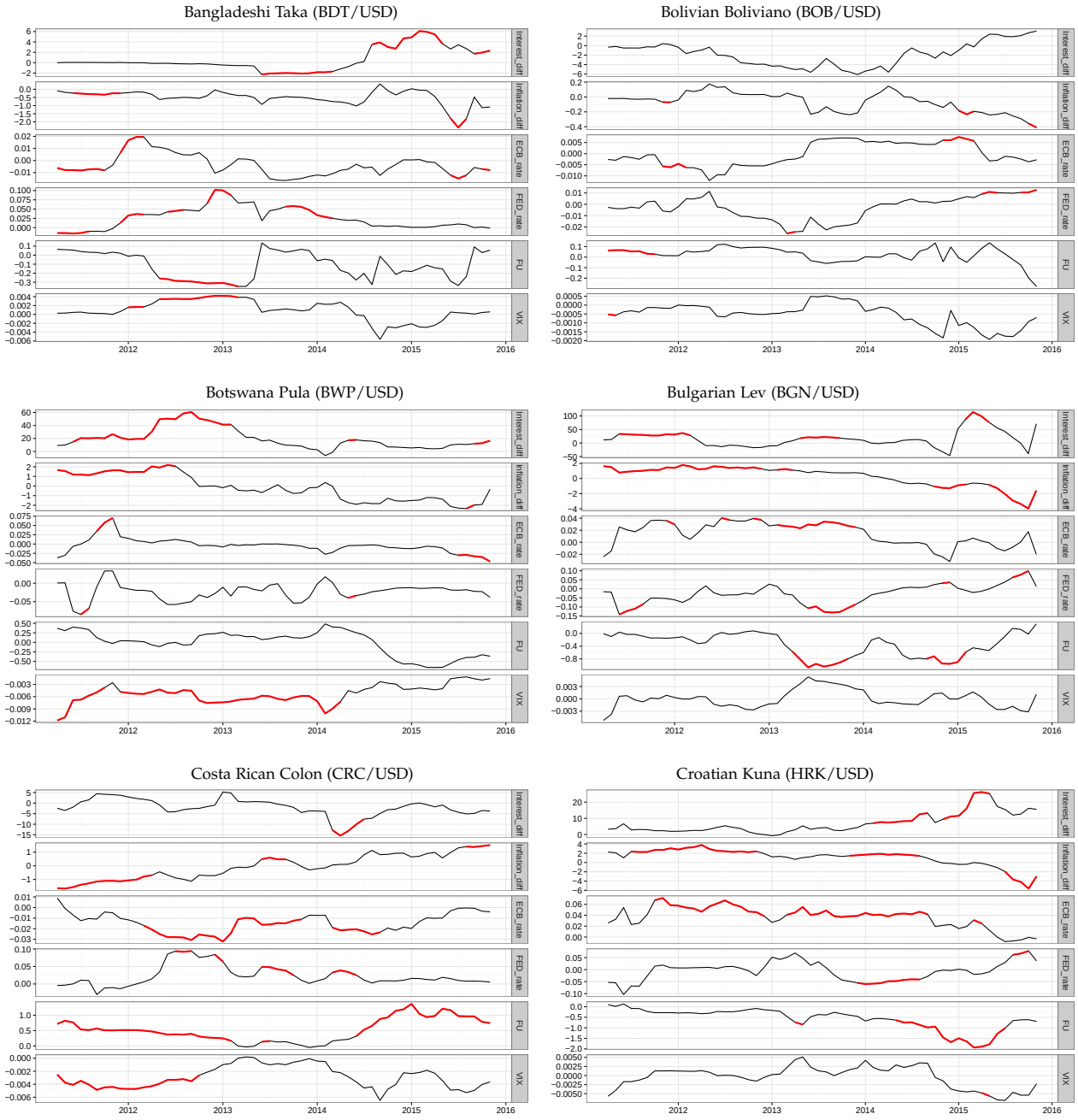
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_{t-h}(s_t) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the professionals forecast error $(E_{t-h}(s_t) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 23 **Time-varying coefficients for forecast errors of major currencies (part V)**



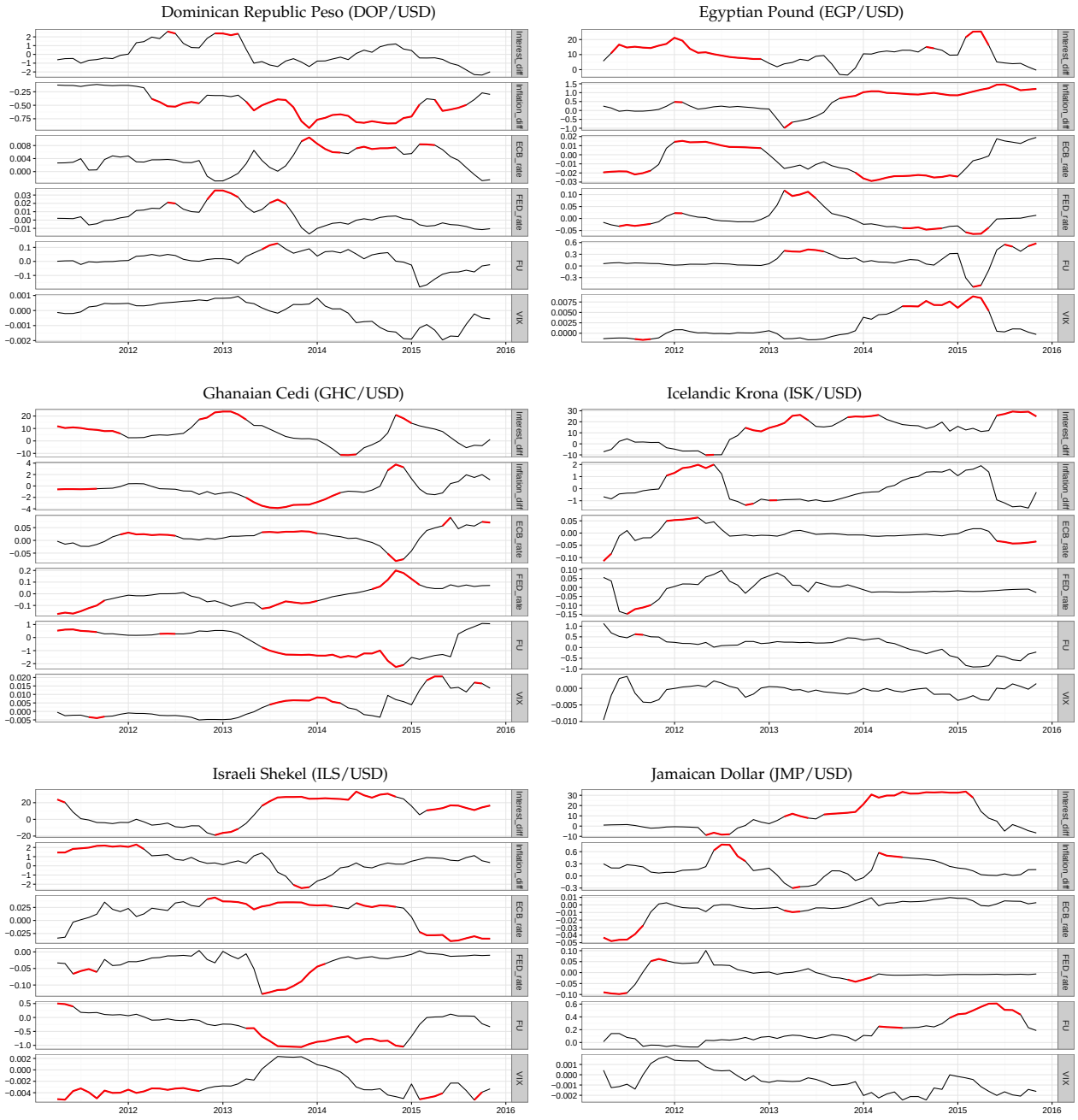
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_{t-h}(s_t) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the professionals forecast error $(E_{t-h}(s_t) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 24 **Time-varying coefficients for forecast errors of minor currencies (part I)**



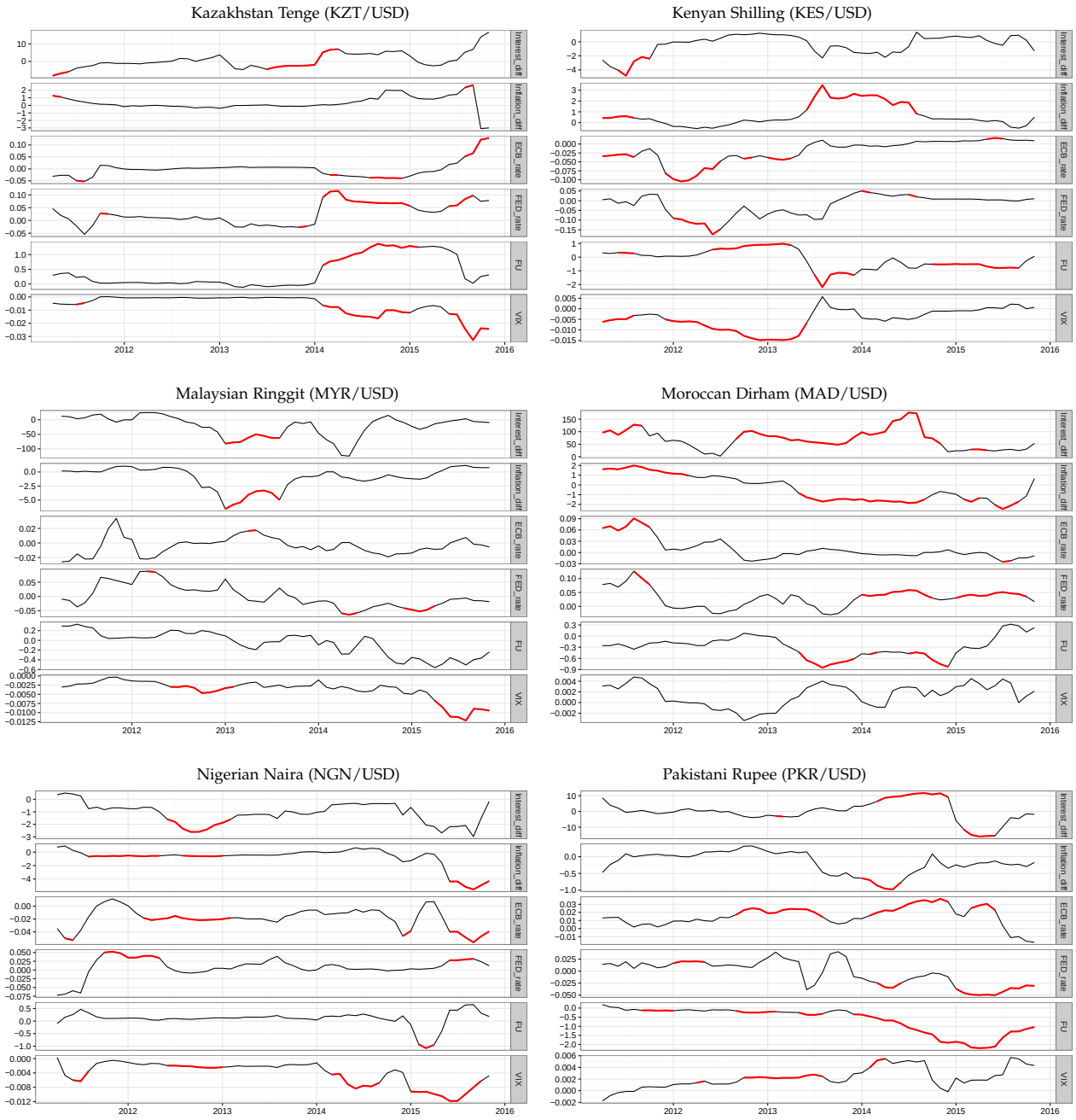
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_{t-h}(s_t) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the professionals forecast error $(E_{t-h}(s_t) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 25 **Time-varying coefficients for forecast errors of minor currencies (part II)**



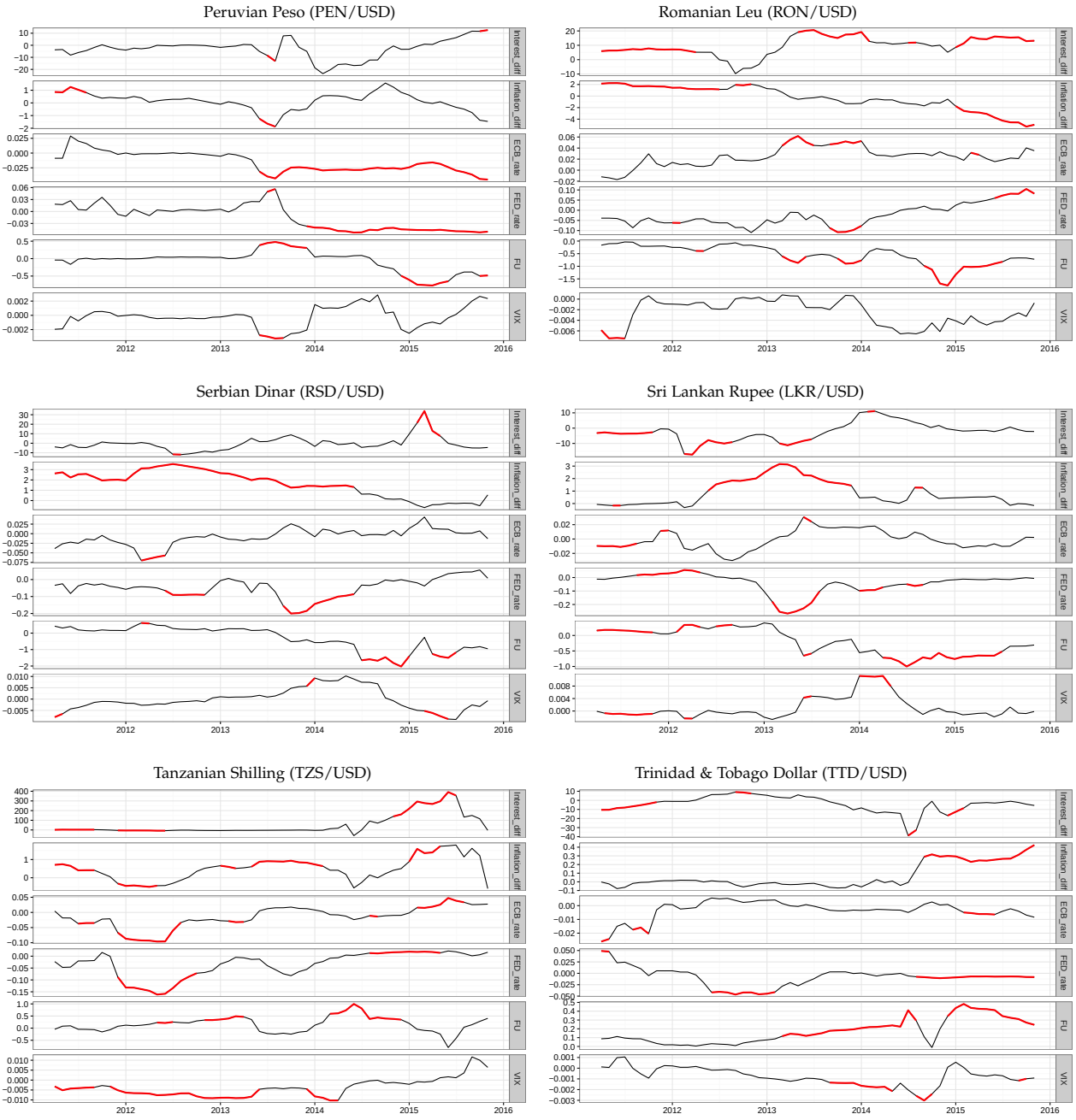
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_{t-h}(s_t) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the professionals forecast error $(E_{t-h}(s_t) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 26 **Time-varying coefficients for forecast errors of minor currencies (part III)**



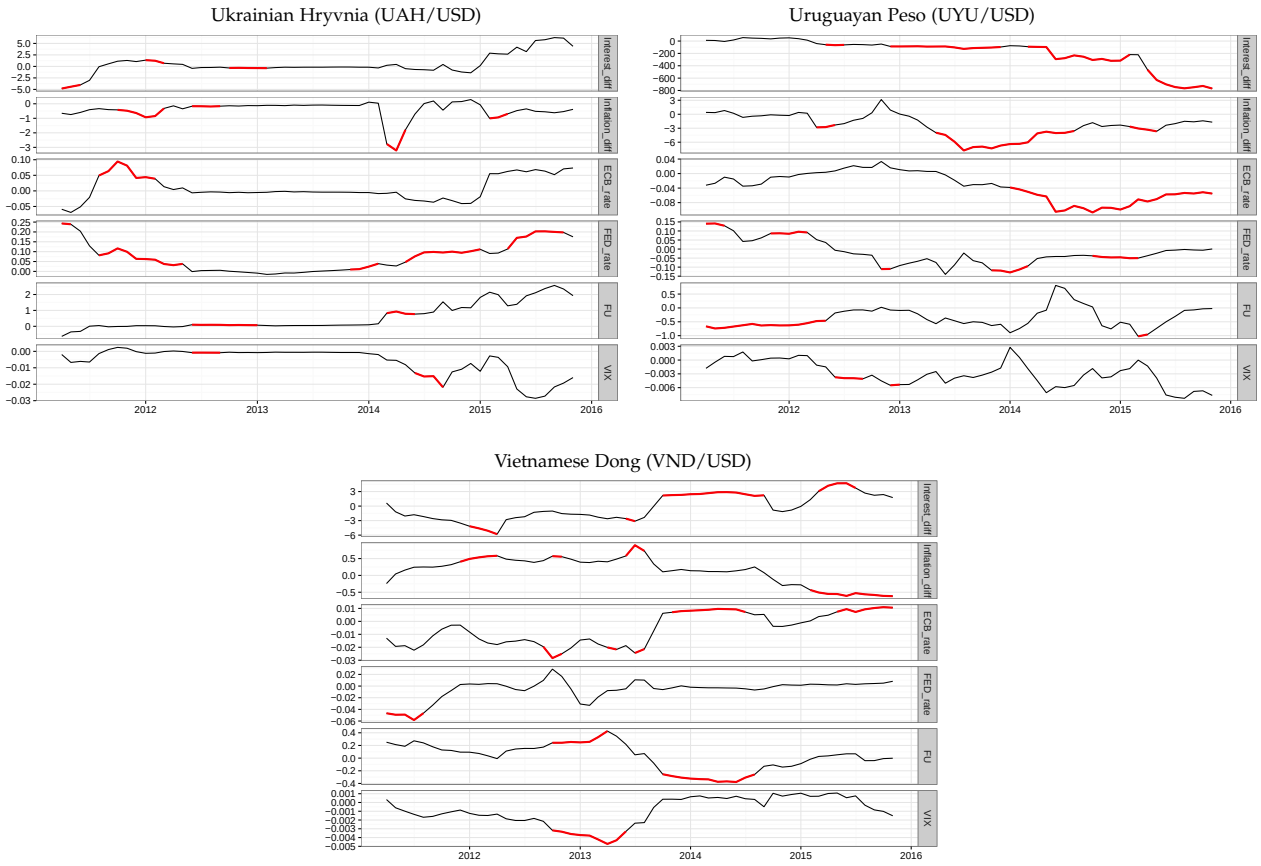
Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_{t-h}(s_t) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the professionals forecast error $(E_{t-h}(s_t) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 27 **Time-varying coefficients for forecast errors of minor currencies (part IV)**



Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_{t-h}(s_t) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the professionals forecast error $(E_{t-h}(s_t) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

FIGURE 28 **Time-varying coefficients for forecast errors of minor currencies (part V)**



Note: The graphs show rolling window regression estimates for the sample period running from 2004/09-2015/11 based on the following regression equation (for $h = 3$): $(E_{t-h}(s_t) - s_t) = \theta_{0,t:t+30} + \theta_{1,t:t+30}(r_t - r_t^*) + \theta_{2,t:t+30}(\pi_t - \pi_t^*) + \theta_{3,t:t+30}\text{pr}_t^{\text{ECB}} + \theta_{4,t:t+30}\text{pr}_t^{\text{FED}} + \theta_{5,t:t+30}\text{FU}_t + \theta_{6,t:t+30}\text{VIX}_t + \eta_t$, where the professionals forecast error $(E_{t-h}(s_t) - s_t)$ is regressed on domestic-US differentials of the three-month interest rate $(r_t - r_t^*)$ and the inflation rate $(\pi_t - \pi_t^*)$ as well as shadow rates of the ECB and the US Fed pr_t^{ECB} and pr_t^{FED} and two uncertainty measures – financial uncertainty FU_t and the CBOE volatility index VIX_t. Statistical significance at the 10% level is shown in red.

Appendix

TABLE 11 **Data set**

Time series	**Unit**	**Source**
Exchange rate expectations	Domestic currency per US dollar	FX4Casts.com
Shadow interest rates	% p.a.	Wu and Xia (2016)
Spot (end of month) exchange rates	Domestic currency per US dollar	FX4Casts.com
US money supply	M1, index	OECD
Money supply other economies	M1/M3, indices/units domestic currency	OECD/domestic central banks
US interest rate	3-month interbank rates (% p.a.)	Thompson Reuters Datastream
Interest rates other economies	3-month interbank rates/central bank deposit rates (% p.a.)	Thompson Reuters Datastream
US CPI	Index	Thompson Reuters Datastream
CPI/Inflation other economies	CPI if available, inflation rate otherwise	Thompson Reuters Datastream/domestic central banks

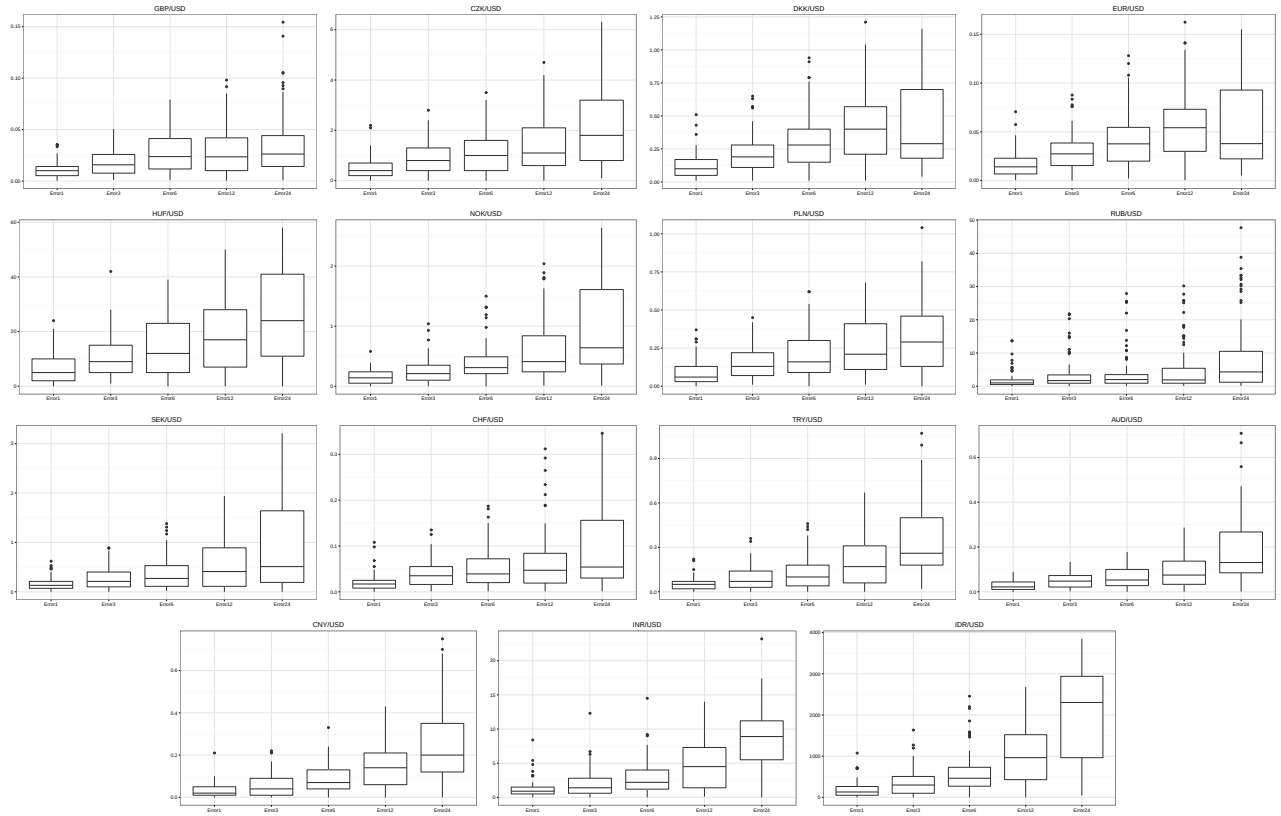
TABLE 12 **Exchange rate regimes for major currencies**

Country		Type	Arrangement 2010	Type	Arrangement 2012	Type	Arrangement 2014	Type	Arrangement 2015
UK	GBP	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework
Czech Republic	CZK	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Soft Peg	Other Managed Arrangement to Inflation-targeting framework	Soft Peg	Stabilized Arrangement to Inflation-targeting framework
Denmark	DKK	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR
Austria	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Belgium	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Cyprus	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Finland	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
France	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Germany	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Greece	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Ireland	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Italy	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Luxembourg	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Malta	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Netherlands	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Portugal	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Slovakia	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Slovenia	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Spain	EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Estonia	EUR	Hard Peg	Currency board to EUR	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to other
Latvia	EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Floating	Free-floating to other	Floating	Free-floating to other
Lithuania	EUR	Hard Peg	Currency board to EUR	Hard Peg	Currency board to EUR	Hard Peg	Currency board to EUR	Floating	Free-floating to other
Hungary	HUF	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Norway	NOK	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework
Poland	PLN	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework
Russia	RUB	Residual	Other Managed Arrangement to composite	Residual	Other Managed Arrangement to other	Residual	Other Managed Arrangement to other	Floating	Floating to Inflation-targeting framework
Sweden	SEK	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework
Switzerland	CHF	Floating	Floating to Inflation-targeting framework	Residual	Other Managed Arrangement to other	Soft Peg	Crawl-like Arrangement to EUR	Soft Peg	Crawl-like Arrangement to EUR
Turkey	TRY	Floating	Free-floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Australia	AUD	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework
China	CNY	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD
India	INR	Floating	Floating to other	Floating	Floating to other	Floating	Floating to other	Floating	Floating to Inflation-targeting framework
Indonesia	IDR	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Japan	JPY	Floating	Free-floating to other	Floating	Free-floating to other	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework
New Zealand	NZD	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Philippines	PHP	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Singapore	SGD	Residual	Other Managed Arrangement to composite	Residual	Other Managed Arrangement to composite	Soft Peg	Stabilized Arrangement to composite	Soft Peg	Stabilized Arrangement to composite
Korea	KRW	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Thailand	THB	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Argentina	ARS	Floating	Floating to monetary aggregate target	Soft Peg	Crawl-like Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD
Brazil	BRL	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Canada	CAD	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework
Chile	CLP	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework
Colombia	COP	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Mexico	MXN	Floating	Floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework
Venezuela	VEF	Soft Peg	Conventional Peg to USD	Soft Peg	Conventional Peg to USD	Soft Peg	Conventional Peg to USD	Soft Peg	Conventional Peg to USD
South Africa	ZAR	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework

TABLE 13 **Exchange rate regimes for minor currencies**

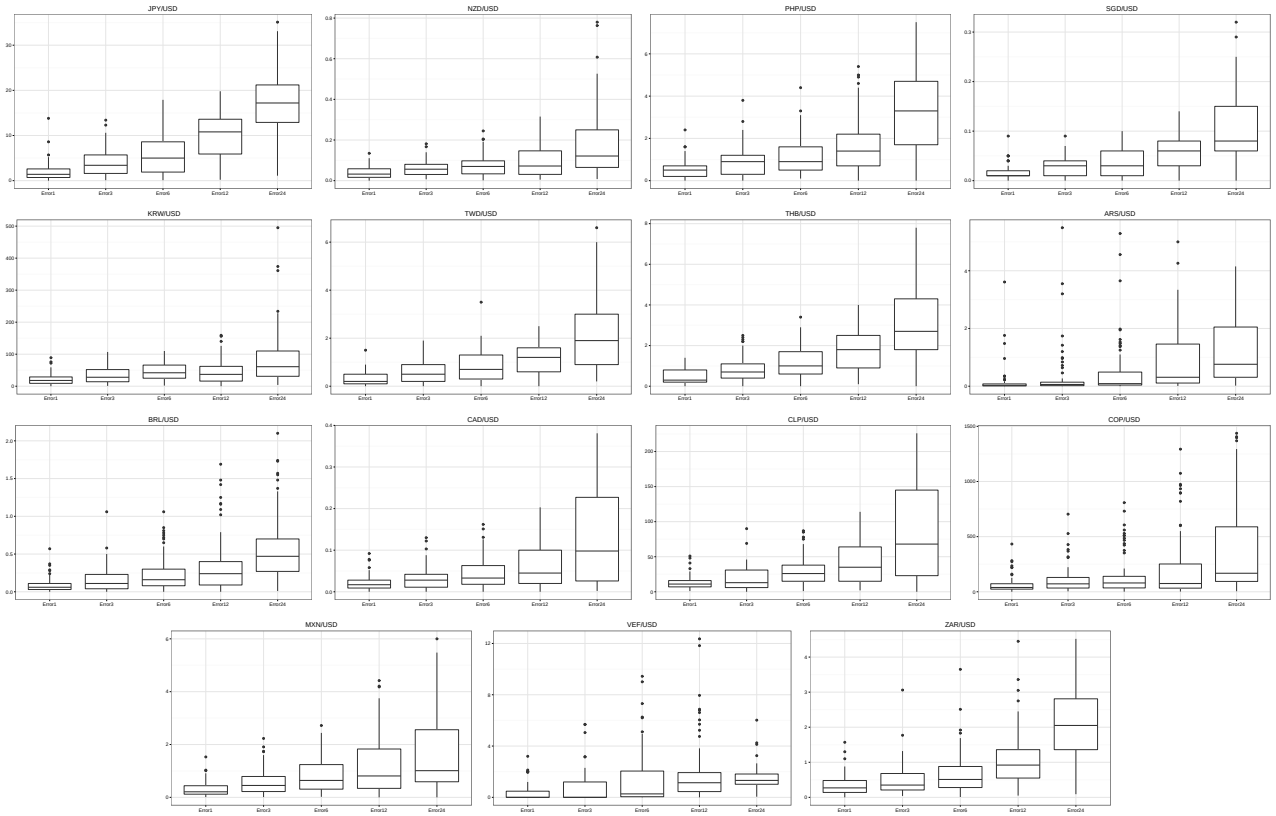
Country		Type	Arrangement 2010	Type	Arrangement 2012	Type	Arrangement 2014	Type	Arrangement 2015
Algeria	DZD	Residual	Other Managed Arrangement to composite	Residual	Other Managed Arrangement to composite	Residual	Other Managed Arrangement to composite	Residual	Other Managed Arrangement to composite
Bangladesh	BDT	Soft Peg	Stabilized Arrangement to USD	Residual	Other Managed Arrangement to monetary aggregate target	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD
Bolivia	BOB	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Crawling Peg to USD	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD
Botswana	BWP	Soft Peg	Crawling Peg to composite	Soft Peg	Crawling Peg to composite	Soft Peg	Crawling Peg to composite	Soft Peg	Crawling Peg to composite
Bulgaria	BGN	Hard Peg	Currency board to EUR	Hard Peg	Currency board to EUR	Hard Peg	Currency board to EUR	Hard Peg	Currency board to EUR
Costa Rica	CRC	Residual	Other Managed Arrangement to USD	Residual	Other Managed Arrangement to other	Residual	Other Managed Arrangement to other	Soft Peg	Stabilized Arrangement to other
Croatia	HRK	Soft Peg	Stabilized Arrangement to EUR	Soft Peg	Crawl-like Arrangement to EUR	Soft Peg	Crawl-like Arrangement to EUR	Soft Peg	Crawl-like Arrangement to EUR
Dominican Rep.	DOP	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD
Egypt	EGP	Residual	Other Managed Arrangement to other	Soft Peg	Stabilized Arrangement to composite	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to composite
Ghana	GHC	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Iceland	ISK	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Israel	ILS	Floating	Floating to Inflation-targeting framework	Floating	Free-floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Benin	XOF	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR
Burkina Faso	XOF	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR
Cote d'Ivoire	XOF	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR
Guinea-Bissau	XOF	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR
Mali	XOF	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR
Niger	XOF	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR
Senegal	XOF	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR
Togo	XOF	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR	Soft Peg	Conventional Peg to EUR
Jamaica	JMP	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD
Kazakhstan	KZT	Soft Peg	Crawl-like Arrangement to USD	Soft Peg	Crawl-like Arrangement to USD	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to other
Kenya	KES	Floating	Floating to monetary aggregate target	Floating	Floating to monetary aggregate target	Floating	Floating to monetary aggregate target	Floating	Floating to other
Kuwait	KWD	Soft Peg	Conventional Peg to composite	Soft Peg	Conventional Peg to composite	Soft Peg	Conventional Peg to composite	Soft Peg	Conventional Peg to composite
Lebanon	LBP	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD
Malaysia	MYR	Residual	Other Managed Arrangement to other	Residual	Other Managed Arrangement to other	Residual	Other Managed Arrangement to other	Residual	Other Managed Arrangement to other
Morocco	MAD	Soft Peg	Conventional Peg to composite	Soft Peg	Conventional Peg to composite	Soft Peg	Conventional Peg to composite	Soft Peg	Conventional Peg to composite
Nigeria	NGN	Residual	Other Managed Arrangement to monetary aggregate target	Residual	Other Managed Arrangement to monetary aggregate target	Residual	Other Managed Arrangement to monetary aggregate target	Residual	Other Managed Arrangement to monetary aggregate target
Pakistan	PKR	Floating	Floating to other	Floating	Floating to monetary aggregate target	Residual	Other Managed Arrangement to other	Residual	Other Managed Arrangement to other
Paraguay	PYG	Residual	Other Managed Arrangement to other	Residual	Other Managed Arrangement to monetary aggregate target	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Peru	PEN	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Romania	RON	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Serbia	RSD	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Sri Lanka	LKR	Soft Peg	Stabilized Arrangement to USD	Floating	Floating to monetary aggregate target	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD
Syria	SYP	Soft Peg	Stabilized Arrangement to composite	Residual	Other Managed Arrangement to composite	Residual	Other Managed Arrangement to composite	Residual	Other Managed Arrangement to composite
Tanzania	TZS	Floating	Floating to monetary aggregate target	Floating	Floating to monetary aggregate target	Floating	Floating to monetary aggregate target	Floating	Floating to monetary aggregate target
Trinidad/Tobago	TTD	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD
Uganda	UGX	Floating	Floating to monetary aggregate target	Floating	Floating to monetary aggregate target	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework
Ukraine	UAH	Residual	Other Managed Arrangement to monetary aggregate target	Soft Peg	Stabilized Arrangement to USD	Floating	Floating to monetary aggregate target	Floating	Floating to monetary aggregate target
Uruguay	UYU	Floating	Floating to Inflation-targeting framework	Floating	Floating to Inflation-targeting framework	Floating	Floating to monetary aggregate target	Floating	Floating to monetary aggregate target
Vietnam	VND	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD	Soft Peg	Stabilized Arrangement to USD
Zambia	ZMK	Floating	Floating to monetary aggregate target	Floating	Floating to monetary aggregate target	Floating	Floating to other	Floating	Floating to other

FIGURE 29 **Boxplots of forecast errors for major currencies (part I)**



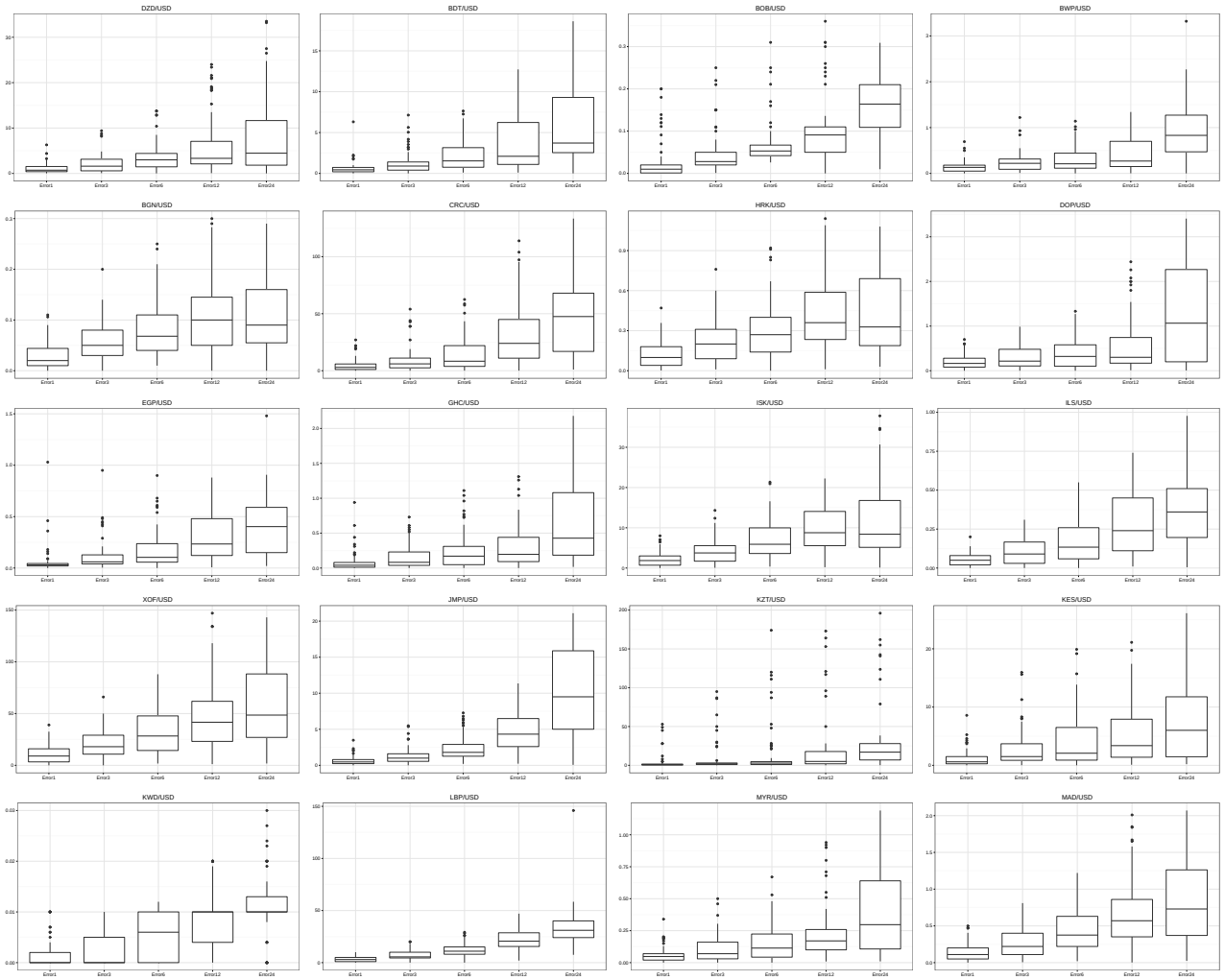
Note: The figure shows boxplot diagrams of forecast errors for expectations formed 1- (Error1), 3- (Error3), 6- (Error6), 12- (Error12) or 24-months (Error24) before for the following exchange rates (sample period 2010/07-2016/03): British Pound (GBP/USD), Czech Koruna (CZK/USD), Danish Krone (DKK/USD), Euro (EUR/USD), Hungarian Forint (HUF/USD), Norwegian Krone (NOK/USD), Polish Zloty (PLN/USD), Russian Rouble (RUB/USD), Swedish Krona (SEK/USD), Swiss Franc (CHF/USD), Turkish Lira (TRY/USD), Australian Dollar (AUD/USD), Chinese Renminbi (CNY/USD), Indian Rupee (INR/USD), and Indonesian Rupiah (IDR/USD).

FIGURE 30 **Boxplots of forecast errors for major currencies (part II)**



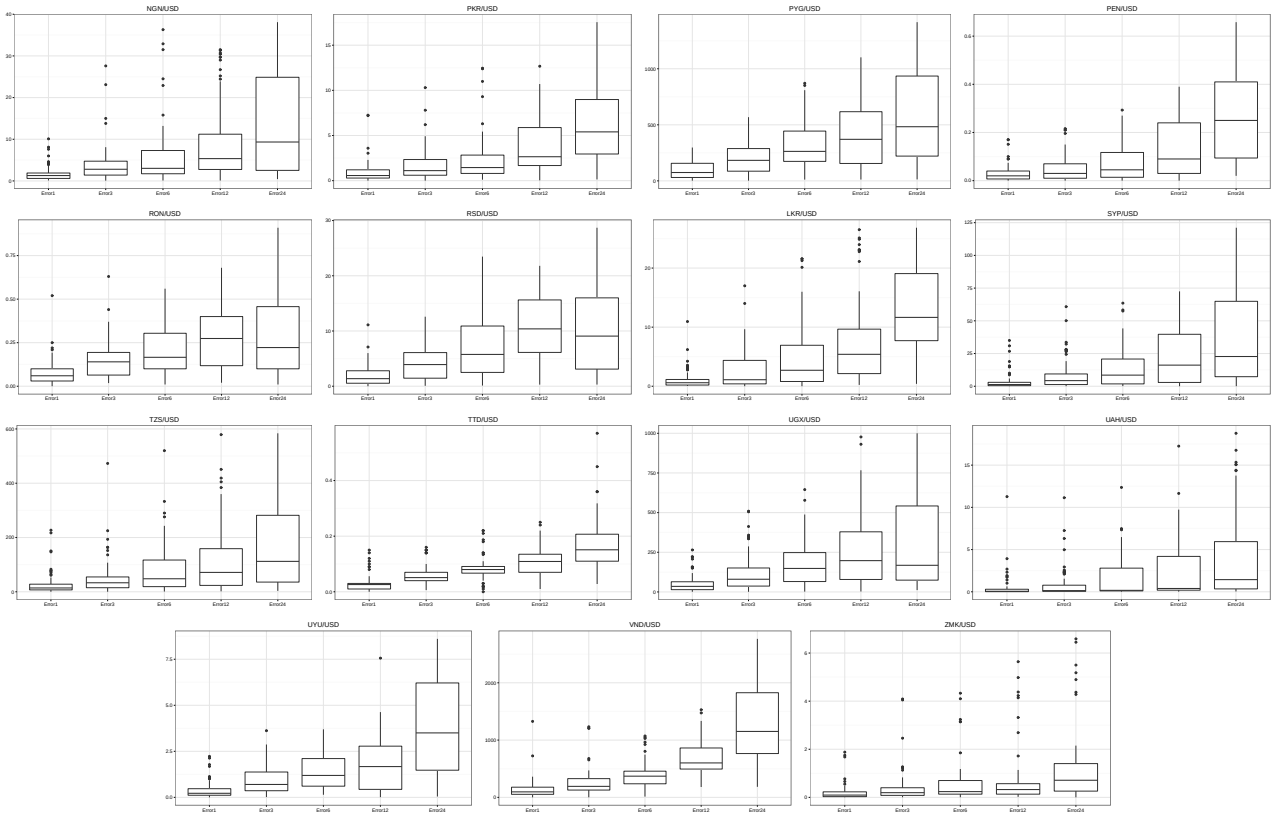
Note: The figure shows boxplot diagrams of forecast errors for expectations formed 1- (Error1), 3- (Error3), 6- (Error6), 12- (Error12) or 24-months (Error24) before for the following exchange rates (sample period 2010/07-2016/03): Japanese Yen (JPY/USD), New Zealand Dollar (NZD/USD), Philippine Peso (PHP/USD), Singapore Dollar (SGD/USD), South Korean Won (KRW/USD), Taiwan Dollar (TWD/USD), Thai Baht (THB/USD), Argentine Peso (ARS/USD), Brazilian Real (BRL/USD), Canadian Dollar (CAD/USD), Chilean Peso (CLP/USD), Colombian Peso (COP/USD), Mexican Peso (MXN/USD), Venezuelan Bolivar (VEF/USD), and South African Rand (ZAR/USD).

FIGURE 31 **Boxplots of forecast errors for minor currencies (part I)**



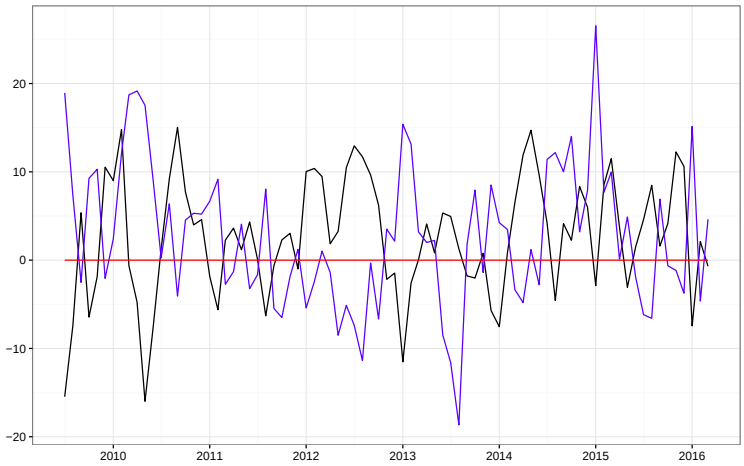
Note: The figure shows boxplot diagrams of forecast errors for expectations formed 1- (Error1), 3- (Error3), 6- (Error6), 12- (Error12) or 24-months (Error24) before for the following exchange rates (sample period 2010/07-2016/03): Algerian Dinar (DZD/USD), Bangladeshi Taka (BDT/USD), Bolivian Boliviano (BOB/USD), Botswana Pula (BWP/USD), Bulgarian Lev (BGN/USD), Costa Rican Colon (CRC/USD), Croatian Kuna (HRK/USD), Dominican Republic Peso (DOP/USD), Egyptian Pound (EGP/USD), Ghanaian Cedi (GHC/USD), Icelandic Krona (ISK/USD), Israeli Shekel (ILS/USD), Ivory Coast Franc (XOF/USD), Jamaican Dollar (JMP/USD), Kazakhstan Tenge (KZT/USD), Kenyan Shilling (KES/USD), Kuwaiti Dinar (KWD/USD), Lebanese Pound (LBP/USD), Malaysian Ringgit (MYR/USD), and Moroccan Dirham (MAD/USD).

FIGURE 32 **Boxplots of forecast errors for minor currencies (part II)**



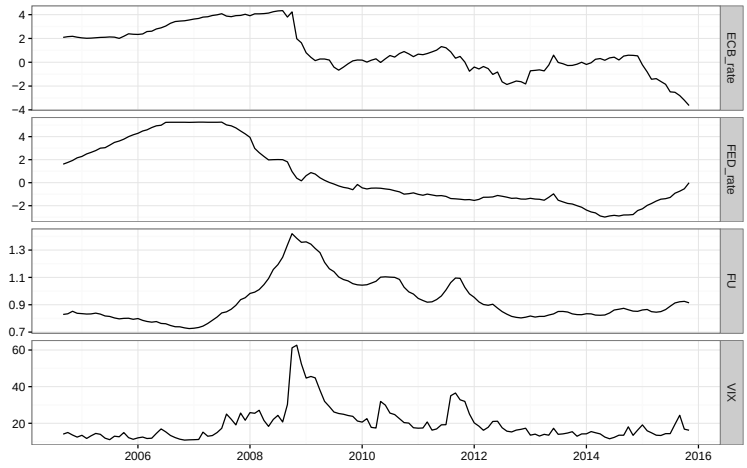
Note: The figure shows boxplot diagrams of forecast errors for expectations formed 1- (Error1), 3- (Error3), 6- (Error6), 12- (Error12) or 24-months (Error24) before for the following exchange rates (sample period 2010/07-2016/03): Nigerian Naira (NGN/USD), Pakistani Rupee (PKR/USD), Paraguayan Guarani (PYG/USD), Peruvian Peso (PEN/USD), Romanian Leu (RON/USD), Serbian Dinar (RSD/USD), Sri Lankan Rupee (LKR/USD), Syrian Pound (SYP/USD), Tanzanian Shilling (TZS/USD), Trinidad & Tobago Dollar (TTD/USD), Ugandan Shilling (UGX/USD), Ukrainian Hryvnia (UAH/USD), Uruguayan Peso (UYU/USD), Vietnamese Dong (VND/USD), and Zambian Kwacha (ZMK/USD).

FIGURE 33 **Annualized portfolio returns**



Note: The figure reports the time series pattern of portfolio returns based on professional expectations and the momentum strategy at a 3-months ($h = 3$) horizon (sample period 2009/05-2016/03). The portfolios have been constructed from the following exchange rates: British Pound (GBP/USD), Euro (EUR/USD), Norwegian Krone (NOK/USD), Swedish Krona (SEK/USD), Swiss Franc (CHF/USD), Australian Dollar (AUD/USD), Indonesian Rupiah (IDR/USD), Japanese Yen (JPY/USD), New Zealand Dollar (NZD/USD), Singapore Dollar (SGD/USD), South Korean Won (KRW/USD), Taiwan Dollar (TWD/USD), Canadian Dollar (CAD/USD), and South African Rand (ZAR/USD). For the portfolio construction currencies have been ranked based on the three strategies: (1) $E_t(s_{t+h}) - s_t - (i_t - i_t^*)$ and (2) $s_t - s_{t-1} - (i_t - i_t^*)$. For the next month the portfolio is constructed by buying the three highest ranked currencies and selling the three lowest ranked currencies. Professional expectation based returns are shown in black and momentum returns in blue.

FIGURE 34 **Shadow rates and uncertainty measures**



Note: The figure shows the time series pattern of the shadow policy rates of the ECB and the US Fed provided by Wu and Xia (2016) and the two uncertainty measures, i.e. financial uncertainty (FU) proposed by Jurado *et al.* (2015) and the conventional CBOE volatility index (VIX) which measures the volatility of the S&P500 (sample period 2004/09-2015/11).