The Impact of Uncertainty on Professional Exchange Rate Forecasts

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Abstract

This paper analyzes the role of uncertainty on both exchange rate expectations and forecast errors of professionals for four major currencies since 1986. Based on survey data of FX forecasts, we consider macroeconomic uncertainty, financial uncertainty, economic policy uncertainty and disagreement among CPI forecasters to account for different dimensions of uncertainty. Based on a Bayesian VAR approach, we find that increasing uncertainty increases the forecast error and results in an expected appreciation of the US dollar and the Japanese yen. Effects on forecast errors of professionals turn out to be more significant compared to the adjustment of exchange rate expectations. Our findings are robust to different forecasting horizons and point to an unpredictable link between exchange rates and fundamentals. Furthermore, we illustrate the importance of considering common unpredictable components for a large number of US variables.

Keywords: Bayesian VAR, Exchange rates, Expectations, Forecast, Uncertainty

JEL classification: F31, F37

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1 Introduction

Forecasting exchange rate is notoriously difficult. The path-breaking paper by Meese and Rogoff (1983) has highlighted that fundamental exchange rate models are unable to beat a simple random walk benchmark. This finding continues to hold more than 30 years later with exchange rate predictability depending on the choice of the sample period, the currency and the forecasting horizon (Rossi, 2013). It is notable that professional forecasters are also unable to provide adequate exchange rate forecasts. Contrary to theoretical suggestions related to market efficiency, expected and actual exchange rate diverge significantly in terms of point forecasts. Although this does not per se imply that professional forecasts are not useful from an investor's perspective, the finding that even professionals fail to outperform a simple random walk benchmark is still surprising. Against this background, it is surprising that potential reasons for the weak performance of professional forecasters have hardly been explicitly addressed despite the rich literature on exchange rates. While several studies have focused on explaining the dispersion of forecasts across professionals based on theoretical models which for example include contagion or asymmetric information, less is known about the empirical determinants of forecast errors by professionals despite the general evidence that predictability and forecast errors on financial markets are related.

We contribute to the literature by analyzing the role of uncertainty for both professional exchange rate expectations and the resulting forecast error. From a theoretical perspective, unexpected exchange rate changes are a result of unexpected news or unexpected changes in fundamentals. Recent findings by Dick, MacDonald and Menkhoff (2015) also suggest that adequate exchange rate forecasts requires an understanding of fundamentals. The degree of uncertainty therefore has a potential impact on both expectations and forecast errors. Bacchetta and Wincoop (2006) argue that dispersed information about fundamentals leads to persistence of non-fundamental exchange rates and confusion about the source of exchange rate fluctuations. The underlying questions we examine are twofold: (1) Do exchange rate forecasters revise their expectations in case of uncertainty? (2) Are professional forecasters performing worse in case of higher uncertainty? By putting both questions under closer scrutiny, the core issue we tackle is the role of unpredictable changes in macroeconomic and financial variables for exchange rate predictability. Taking into account that a unique definition of uncertainty does not exist, we distinguish between four different kinds of uncertainty: economic policy uncertainty, macroeconomic uncertainty, financial uncertainty and disagreement among CPI forecasters. We incorporate short-term interest rates, industrial production and money supply as current fundamentals which provide useful control variables when analyzing effects resulting from uncertainty. Based on a Bayesian vector autoregressive (BVAR) framework, we also consider different forecasting horizons to analyze whether effects resulting from uncertainty are short-lived or also materialize over longer horizons.

We adopt survey data of FX forecasts as a measure of professional exchange rate expectations. Studies by Fratzscher, Rime, Sarno and Zinna (2015), Bacchetta, Mertens and van Wincoop (2009) and Cavusoglu and Neveu (2015) rely on a related dataset. Using aggregated data implies the shortcoming that the full distribution of expectation is not considered. On the opposite, using disagreement among forecasters might indeed be useful to provide insights and improve the forecasting power (Cavusoglu and Neveu, 2015). However, those measures are not available over the full sample period under observation and we are interested in explaining the overall behavior of professionals rather than improving forecasts based on expectations or analyzing disaggregated expectations for a specific currency.

The remainder of this paper is organized as follows. Section 2 summarizes both theoretical considerations regarding a link between uncertainty and exchange rate expectations and previous literature while Section 3 provides our data and our empirical approach. Section 4 presents our empirical results and Section 5 concludes.

2 Theoretical background and literature review

Although survey data potentially incorporate useful information for forecasting, subjective survey-based forecasts are frequently found to be biased (So, 2013). In this spirit, survey data of exchange rate expectations has been adopted in a large number of studies without convincingly approximating future exchange rates. Among others, Blake, Beenstock and Brasse (1986), Chinn and Frankel (1994) and Verschoor and Wolff (2002) reject the hypothesis of unbiased exchange rate expectations based on the following simple regression

$$s_{t+h} - s_t = a_1 + a_2(E_t(s_{t+h}) - s_t) + \varepsilon_{t+h}, \tag{1}$$

where $E_t(s_{t+h})$ denotes the expected exchange rate at t for $t+h$ (Jongen, Verschoor and Wolff, 2008) The implied rejection of the rational expectation or perfect foresight hypothesis has been attributed to different factors such as time-varying risk premia or irrational expectations (Jongen *et al.*, 2008). As will be illustrated below, our findings also suggest significant forecast errors of professional forecasts. Taking this pattern as given, the question we address is whether the forecast error in the above equation, ε_{t+h}, which occurs if $E_t(s_{t+h}) \neq s_{t+h}$, is affected by different dimensions of uncertainty.

The expected value approach of Engel and West (2005) provides a good theoretical starting point for analyzing the potential impact of uncertainty on expected exchange rates. According to their framework, the exchange rate is driven by current and expected fundamentals. One implication is that expected fundamentals are potentially more important than current fundamentals (Dick *et al.*, 2015). Hence, uncertainty regarding fundamentals should also affect exchange rates and exchange rate expectations. Adopting their framework provides

$$s_t = (1-b)\sum_{j=0}^{\infty} b^j E_t(f_{1,t+j} + u_{1,t+j}) + b\sum_{j=0}^{\infty} b^j E_t(f_{2,t+j} + u_{2,t+j}), \tag{2}$$

where b denotes a discount factor with $0 < b < 1$. In this representation, the exchange rate s_t defined as the natural logarithm of the home currency price of foreign currency (i.e., US dollar per unit of foreign currency) consist of a systematic and an unsystematic component. The systematic components $f_{1,t+j}$ and $f_{2,t+j}$ are given by the current path of realized fundamentals such as money supply, interest rates and industrial production which we consider in our empirical setup. The larger the value of the discount factor b, the greater the importance of expected future fundamentals relative to the current value. The unsystematic components $u_{1,t+j}$ and $u_{2,t+j}$ denote unobservable fundamentals, which might for example mirror revisions in expectations or risk premia and are usually considered to be unobservable to the econometrician (Engel and West, 2005). Among others, order flow data is considered as an approximation to such factors (Rime, Sarno and Sojli, 2010). However, it can easily be argued that the degree of uncertainty affects those unobservable components so that exchange rate expectations are affected by uncertainty.

The same logic can be applied to forecast errors defined as the difference between expected and actual exchange rate. Also relying on survey data, Bacchetta and Wincoop (2006) identify a strong relationship between predictability of returns on financial markets and expectational errors of professionals. In this regard the news approach to exchange rate argues that unanticipated exchange rate movements are due to unexpected news (Hakkio and Pearce, 1985). Such news are usually approximated by forecast errors that is unexpected changes in fundamentals. However, we argue that the cross-section unforeseeable component of macroeconomic and financial variables provided by Jurado, Ludvigson and Ng (2015) gives a much better approximation of unexpected changes in the underlying drivers of exchange rates. Their measure focuses on predictability of the state of the economy rather than on dispersion or volatility and controls for a predictable component in forecast errors. More precisely, uncertainty for a specific variable y_t is given by

$$E_t(\mathrm{UN}_t) = (y_{t+h} - E_t(y_{t+h}))|I_t, \tag{3}$$

where I_t denotes the information set of economic agents. The underlying idea of the measure provided by Jurado *et al.* (2015) is to control for the systematic component $y_{t+h}|I_t$ to dissect forecastable variations and the unpredictable component. The aggregated uncertainty measure displays the common variation of uncertainty across many series but is independent of uncertainty on any particular series (Jurado *et al.*, 2015). Starting with the assumption that the expected exchange rate is based on the state of the economy, such an uncertainty measure should capture unexpected changes in the stochastic components $u_{1,t+j}$ and $u_{2,t+j}$ and might therefore result in $E_t(s_{t+h}) \neq s_{t+h}$. Relying on a broad set of fundamentals as a starting point for uncertainty is also in line with the finding that factor models provide improved exchange rate forecasts (Engel, Mark and West, 2015).

The findings of Jurado *et al.* (2015) based on a VAR including 12 variables suggest that their uncertainty measures have significant effects on forecast errors of standard macroeconomic variables such as GDP. The disagreement among inflation forecasters represents an alternative measure of the unsystematic component. The intuitive idea is related in the sense that disagreement among inflation forecasters should affect exchange rate expectations if the latter incorporates expectations about future fundamentals. Finally, the consideration of economic policy uncertainty enables us to detect a possible impact of uncertainty about the future policy path on expected exchange rates and the resulting forecast errors.

In the context of exchange rates we are analyzing, it is important to consider the effects over different horizons. Theoretical considerations suggest that exchange rates are easier to predict over longer horizons due to their volatility over short horizons and potential mean reversion to fundamental values. Mark (1995) indeed concludes that predictability increases over longer horizons while a recent survey by Rossi (2013) concludes that the degree of exchange rate predictability depends on horizon, country and model and that no clear pattern emerges.[1] We therefore try to answer the question

[1]The fact that an in-sample relationship does not necessarily translates into out-of-sample predictability might be due to the occurrence of structural breaks. The results provided by Sarno and Valente (2009) suggest that identifying

whether the effect of uncertainty on professional market expectations and the resulting forecast errors differ across horizons.

Overall, we distinguish between expected and unexpected effects on exchange rate stemming from uncertainty by considering both exchange rate expectations and the forecast error that is the difference between realized exchange rates and exchange rates expectations. To control for the systematic components $f_{1,t+j}$ and $f_{2,t+j}$, we adopt money supply, interest rates and industrial production as a standard set of fundamentals within our framework. Adopting a BVAR methodology assures that all variables are considered to be endogenous and also accounts for serial correlation across errors.

3 Data and empirical framework

3.1 Data

We use data from 1986:08 until 2014:12 on a monthly frequency. Survey data on exchange rate expectations are obtained from FX4casts formerly known as the Financial Times Currency Forecaster.[2] Forecasts are provided for 3, 6 and 12 months horizons.[3] The consensus is based on 48 individual responses and is calculated as the geometric mean in order to reduce distortion due to extremes outliers. Table I provides the participating institutions. Bacchetta *et al.* (2009) and Cavusoglu and Neveu (2015) rely on the same dataset as an approximation of expectations. In our study we examine the exchange rates of the major currencies against the US dollar, i.e. the Euro, the Japanese yen, the Canadian dollar, and the British pound sterling.

*** Insert Table I about here ***

We adopt the proxy proposed by Jurado *et al.* (2015) as a measure for macroeconomic and financial uncertainty. Macroeconomic uncertainty is measured by the common volatility in the unforecastable component of 132 macroeconomic time series while financial uncertainty is measured in a similar fashion using a broad number 147 monthly financial series which for example include equity valuation

an adequate model in real-time represents a major caveat even if relevant information are embedded in fundamentals. The scapegoat approach suggested by Bacchetta *et al.* (2009) also argues that different fundamentals matter at different points in time.

[2]See `http://www.fx4casts.com/` for details.

[3]We are grateful to Alan Teck and FX4casts for providing the data.

ratios, dividend growth rates or risk factors according to (Fama and French, 1993).[4] Compared to conventional uncertainty measures such as the VIX, the advantage of the Jurado *et al.* (2015) approach is that it relies on conditional expectations. This allows to disentangle uncertainty from forecastable components which potentially also drive stochastic volatility and error terms of forecasts.

The economic policy uncertainty index (EPUI) we consider is obtained from Baker, Bloom and Davis (2013). We adopt two different measures of uncertainty: US newspaper based economic policy uncertainty and disagreement among CPI forecasters. The main index on economic policy uncertainty is based on text-searching in articles published in the 10 largest US newspapers: the USA Today, Miami Herald, Chicago Tribune, Washington Post, Los Angeles Times, Boston Globe, San Francisco Chronicle, Dallas Morning News, New York Times, and the Wall Street Journal. The index is obtained based on articles containing the triple of: 'uncertainty' or 'uncertain'; 'economic' or 'economy'; and one of the following six policy terms: 'congress', 'deficit', 'Federal Reserve', 'legislation', 'regulation' or 'white house' (Baker *et al.*, 2013). Hence, this measure summarizes different aspects of uncertainty which is directly related to the political situation without explicitly referring to macroeconomic fundamentals. Our final uncertainty measure is the disagreement among CPI forecasters according to the Federal Reserve Bank of Philadelphia's Survey of Professional Forecasters. The underlying question is whether uncertainty regarding future fundamentals is transmitted into exchange rate expectations and forecast errors.

We also consider interest rates, industrial production and money supply as a standard set of fundamentals within our framework to control for systematic factors. The choice of current fundamentals is driven by standard exchange rate models such as the monetary approach or a Taylor rule model (Taylor and Sarno, 2004; Rossi, 2013).

3.2 Empirical framework

For each exchange rate under consideration we estimate a Bayesian vector autoregression (BVAR) for

$$x_t = [\mathrm{UN}_t, \varepsilon_{t+h}, \tilde{r}_t, \tilde{m}_t, \tilde{y}_t]' \tag{4}$$

with UN_t as the uncertainty index (i.e. the US news-based economic policy uncertainty index (Baker *et al.*, 2013), the US CPI disagreement index, the US macroeconomic uncertainty index and the US

[4] The fact that the exchange rate is one of the macroeconomic series used for construction is not an issue since the derived measure is independent of any specific series (Jurado *et al.*, 2015).

financial uncertainty index (Jurado *et al.*, 2015), respectively), ε_{t+h} as the forecast error computed as the difference between the actual and the expected exchange rate ($\varepsilon_{t+h} = s_{t+h} - E_t(s_{t+h})$) for $h = 3, 6, 12$ (following Bacchetta *et al.* (2009)). In order to examine the role of uncertainty on expectations, we also use the change in exchange rate expectations $\Delta E_t(s_{t+h})$ instead. In addition, we also include fundamentals into x_t as follows: the interest rate differential $\tilde{r}_t = r_t - r_t^*$, where r_t is the h-month money market rate of the domestic economy and r_t^* its US counterpart (for $h = 3, 6, 12$), the money supply differential $\tilde{m}_t = \log m_t - \log m_t^*$, where m denotes money supply, and the output differential $\tilde{y}_t = \log y_t - \log y_t^*$, where y denotes industrial production.

The BVAR model has the following form

$$x_t = a_0 + a_1 x_{t-1} + \ldots + a_p x_{t-p} + \eta_t, \quad t = 1, \ldots, T, \tag{5}$$

where η_t is i.i.d. $N(0, \Sigma)$. The lag length p has been set to be equal to 2 for all models in order to achieve comparability.[5] Eq. (5) can be stacked in two different ways as follows

$$X = AZ + E \tag{6}$$

or

$$x = (I_5 \otimes Z)\alpha + \eta, \quad \eta \sim N(0, \Sigma \otimes I_5), \tag{7}$$

where x is defined as a vector of dimension $5T$ stacking all T observations of each variable below each other and X is defined as a matrix of order $T \times 5$ stacking these observations in columns side by side. η and E are defined analogously stacking the corresponding error terms. Z is a $T \times (1 + 5p)$ matrix of regressors, $A = (a_0, a_1, \ldots, a_p)'$ and $\alpha = vec(A)$ stacks all coefficients in one vector.

The BVAR model given above has been estimated using the Gibbs sampler with a Minnesota prior (sometimes also called Litterman prior) which basically means that Σ is estimated to be diagonal. The elements on the diagonal of $\hat{\Sigma}$ are the simple OLS estimates of the error variance from equation-by-equation estimation of AR(2) models for each variable in the system. Since Σ has been replaced by an estimate, we only require a prior for α as follows

$$\alpha \sim N(\alpha_0, V_0), \tag{8}$$

[5] This choice is supported by several information criteria in most of the cases.

where α_0 is a vector of zeros ensuring shrinkage of the BVAR coefficients towards zero and lessening the risk of over-fitting (Koop and Korobilis, 2009). The prior variance-covariance matrix V_0 is defined as follows (Koop and Korobilis, 2009)

$$V_{0_{i,j}} = \begin{cases} \frac{0.5}{p^2}, & \text{for coefficients on own lags,} \\ \frac{0.5\sigma_i^2}{p^2\sigma_j^2}, & \text{for coefficients on lags of variable } j \neq i, \\ \sigma_i^2, & \text{for coefficients on exogenous variables (i.e. the constant).} \end{cases} \tag{9}$$

Then, the posterior distribution has the following form

$$p(\alpha|\Sigma, X) = N(\alpha_1, V_1) \tag{10}$$

with

$$V_1 = \left[V_0^{-1} + \left(\hat{\Sigma}^{-1} \otimes (Z'Z)\right)\right]^{-1} \tag{11}$$

and

$$\alpha_1 = V_1 \left[V_0^{-1}\alpha_0 + \left(\hat{\Sigma}^{-1} \otimes Z\right)' x\right]. \tag{12}$$

The BVAR estimates based on a Gibbs sampler with 10.000 iterations after discarding the burn-in period of 5.000 have been used to compute the impulse responses of the forecast error and the change in exchange rate expectations, respectively, to a shock on the different uncertainty measures. The corresponding results will be discussed in Section 4.2.

4 Empirical results

4.1 Overview

We start this section with descriptive statistics for the four uncertainty measures considered in our study provided in Table II. Due to the construction based on removing systematic components, macroeconomic and financial uncertainty display a much lower standard deviation relative to conventional volatility or uncertainty measures. Disagreement among inflation forecasters displays a much higher standard deviation. Table III provides the correlation across the different uncertainty indices. Unsurprisingly, macroeconomic and financial uncertainty display a significant correlation of around 65%, still leaving the consideration of both indices as a useful distinction. On the opposite, the correlation of economic policy uncertainty with financial and macroeconomic uncertainty is only around 40 and 30%, respectively. The correlation of disagreement among CPI forecasters with all other alternative uncertainty measures is below 40%.

*** Insert Tables II and III about here ***

Figure I shows the pattern of the different uncertainty measures. In line with our descriptive results, the economic policy uncertainty measures display a different pattern compared to financial and macroeconomic uncertainty. Nevertheless, uncertainty significantly increases around the occurrence of the Subprime crisis. The overall findings suggest that the consideration of all four uncertainty measures potentially exhibit different information. As a next step, we consider the link between current exchange rates and exchange rate forecasts provided in Figure II. While short-run forecasts (3 month) are closely related to the actual exchange rates we find that medium- (6 month) and long-run forecasts (12 month) deviate significantly from the current exchange rates. Hence, expectations incorporate additional factors besides the current exchange rate if the forecasting horizon increases. How well do professional forecasters perform? In line with previous studies outlined in Section 2, Figure III illustrates significant forecast errors for all horizons, illustrating that $E_t(s_{t+h}) \neq s_{t+h}$ in most cases. All forecast errors display significant spikes during specific periods. Taking uncertainty into account, an interesting pattern is that the forecast error increases significantly around 2009 for the British pound and the Canadian dollar while this is not the case for the Euro and the Japanese yen. Comparing the forecast error of the expected exchange rate with a simple random walk benchmark shows that professionals fail to beat the current exchange rates as a simple predictor.[6]

*** Insert Figures I to III about here ***

[6]This holds for both the mean squared error and the root mean squared error as a benchmark with the results available upon request.

4.2 Impulse response analysis

In the following we explicitly analyze the effect of uncertainty on both expected exchange rates and the resulting forecast errors. Figures IV to XI provide impulse response functions of expectations and the corresponding errors to a shock on uncertainty for each currency under investigation. In each case, we analyze four different kinds of uncertainty for three horizons: 3, 6 and 12 months. We take both 68% and 95% confidence bands into account. Keeping in mind that an increase denotes an expected appreciation of the US dollar, we start with the impact on expected exchange rates to examine whether exchange rate expectations adjust to an increase in uncertainty.

Shocks on economic policy uncertainty are considered as a first step. While the effects for the Japanese yen are not significant over the 3-month horizon, increasing economic policy uncertainty in the United States results in expected US dollar appreciation over the next three months against the British pound, the euro and the Canadian dollar at the 68% confidence level. Similar effects are observed for all currencies over higher horizons. The overall direction of economic policy shocks is unambiguous but the effects of increasing CPI disagreement among forecasters differs across currencies. While an expected appreciation of the US dollar against the euro is observed over six months and against the Canadian dollar at all horizons, both the yen and the pound are expected to appreciate against the US dollar over each horizon.

*** Insert Figures IV to XI about here ***

Turning to the effects of macroeconomic and financial uncertainty, we mostly observe more persistent effects compared to the first two measures. The results for the yen display a quite remarkable pattern. In five out of six cases, the yen is expected to appreciate against the US dollar if financial or macroeconomic uncertainty increases. The only exception is the effect of macroeconomic uncertainty for the 3-month forecast. The effects of financial uncertainty are stronger relative to macroeconomic uncertainty with significance also indicated at the 95% confidence interval for forecasts over 6- and 12-month horizons. The effects of macroeconomic uncertainty on all other expectations displays the opposite pattern with the US dollar expected to appreciate against the euro, the Canadian dollar and the pound across all horizons, even at the 95% confidence interval. The impact of financial uncertainty displays the same pattern but is slightly less significant for each currency.

The next question is whether the resulting forecast errors of professionals are also affected by uncertainty. A general observation is that the response of forecast errors is more frequently significant compared to the adjustment of expectations. The effect for economic policy uncertainty suggests that professionals do a slightly better job in forecasting the yen over 6- and 12-months. The effects for the euro and the Canadian dollar again suggest a reversed pattern with the forecast error increasing over each horizon. The strongest effects are observed for the Canadian dollar. Increasing uncertainty regarding future inflation results in lower forecast errors for the JPY/USD and the GBP/USD exchange rate while the forecast error for the CAD/USD increases. In line with the findings for expectations, the impact of macroeconomic and financial uncertainty on forecast errors is even stronger with the accuracy of forecasts decreasing for the Canadian dollar, the euro and the pound while a significant positive effect on the forecast error of the yen cannot be observed. The effects on the forecast errors of the euro and the Canadian dollar are relatively persistent and significantly increasing even at the 95% confidence interval. The effect of forecast errors on the pound is slightly more pronounced and persistent over longer horizons.

While macroeconomic and financial uncertainty is based on a cross-section perspective, we have also considered interest rates, money supply and industrial production relative to the US as a benchmark shock. The impulse response analysis for shocks on those fundamentals is available upon request but hardly provides significant effects compared to the different uncertainty shocks considered so far. In line with previous findings, this suggests that cross-county factors are more important determinants of exchange rates than country specific fundamentals. The result that exchange rate expectations react less to uncertainty might for example be driven by either sluggish adjustment of expectations or relying on the current exchange rate for predicting the exchange rate in the next period. Taking this pattern as given, the result that forecast errors are affected by uncertainty even if expectations are adjusted potentially reflects an unpredictable effect of fundamentals on exchange rates. Several studies have illustrated the time-varying and unstable relationship between exchange and fundamentals which is referred to as the exchange rate disconnect puzzle. Our findings clearly point to an existing but complex link since part of exchange rate movements which are unpredictable by professionals is directly related to the common unpredictable component of financial and macroeconomic series. These findings are also in line with recent results provided by Dick *et al.* (2015) who find that the forecast adequacy of fundamentals affects the performance of exchange rate forecasts. In this spirit, we find that the unpredictable common component of financial and macroeconomic aggregates affects the forecast errors of professionals. The fact that newspaper based economic policy uncertainty also has an impact on expectations and forecasts errors suggests that expected policy decisions also play an important role for exchange rates and the related expectations. Finally, the link between disagreement about CPI forecasters and exchange rate expectations confirms that the expected path of fundamentals affects future and expected exchange rates.

Forecast errors of professionals can reflect a scenario where the exchange rate overshoots an expected value while they might also move into the opposite direction as expected. Our results therefore beg the question whether the effects of uncertainty on future exchange rates occur randomly or whether any systematic influence can be identified and adopted for forecasting exchange rates. This could for example be analyzed in the context of averaging across models which includes uncertainty measures when forecasting exchange rates. Such a proceeding has for example been adopted by Wright (2008) and Beckmann and Schüssler (2016). While the success of factor models for exchange rate forecasting suggests that this is a promising approach, one needs to take into account that some of the uncertainty measures we consider might not be available to a forecaster in real-time. The economic policy uncertainty is standardized over the entire sample period while the dispersion across CPI forecasts is potentially also difficult to obtain in real-time. Our findings indicate that it might be difficult to utilize the degree of uncertainty in a forecasting exercise since the underlying effects occur in a non-systematic fashion.

5 Conclusion

This paper has examined the role of uncertainty on both exchange rate expectations and forecast errors of professionals for four major currencies since 1986. We consider macroeconomic uncertainty, and financial uncertainty, economic policy uncertainty and disagreement among forecasters to account for different dimensions of uncertainty. While the first two measures are calculated based on the unpredictable component of a large set of macroeconomic and financial series, the economic policy index is based on newspaper coverage and CPI disagreement is based on the inflation predictions of professionals. In line with previous results, we find that professional have a hard time predicting exchange rates. We observe that the change of the forecast errors of professionals to uncertainty is more significant compared to the effect on exchange rate expectations. The fact that professional expectations fail to incorporate uncertainty in an effective way can be interpreted as an artefact of the unpredictable link between exchange rates and fundamentals and the unpredictability of exchange rates per se. Our finding that different dimensions of uncertainty translate into uncertainty about expected exchange rates mirrors the findings of Bacchetta and Wincoop (2006) who find that expectation errors are unpredictable in markets where this is also the case for excess returns.

Although the considered uncertainty measures differ by construction, the directional effects mostly point to higher forecast errors and an expected appreciation of the US dollar if uncertainty increases. The only exception is increasing disagreement among CPI forecasters where significant effects differ across currencies. Macroeconomic and financial uncertainty overall have the strongest effects, in particular on forecast errors. A notable exception is the Japanese yen. On the one hand, professionals seem to expect an appreciation against the US dollar in case of higher uncertainty which points to safe haven consideration of investors. Interestingly, professionals also do a better job on forecasting the yen in case of uncertainty with the forecast error reacting negatively to uncertainty. This is also in line with the descriptive evidence that the forecast error for the JPY/USD exchange rate has not increased significantly after the crisis. An interesting question is whether expected or actual interventions by the Bank of Japan are important in this context. The overall finding points to a safe haven role of both the yen and the dollar which are expected to appreciate against other currencies if uncertainty increases. Although, the directional effect of macroeconomic and financial uncertainty are mostly equivalent, their impact differs across currencies. Macroeconomic uncertainty has a higher impact on forecasts and forecast errors of the pound while the yen is more affected by financial uncertainty. Our findings are also robust across different forecasting horizons with shocks to financial and macroeconomic uncertainty partly displaying more persistence for longer termed predictions. This suggests a mostly similar behavior of forecasters across different forecasting horizon, at least from an aggregated perspective. Overall, the findings for macroeconomic and financial uncertainty illustrate the importance of the cross-section when analyzing exchange rates. While previous research of Engel *et al.* (2015) and others has focused on the cross-section of fundamentals across countries based factor models, we illustrate the importance of considering common unpredictable components for a large number of US variables.

While we have focused on changes in expectations and the resulting forecast errors, a related question is whether the performance of forecasters from an investor's perspective is affected by uncertainty when considering a portfolio of currencies. We have not explicitly addressed this question due to a lack of data availability since expectations for a full set of currencies are not available from 1986. Another possible extension could consider factors such as order flow data or expected fundamentals as a potential starting point for understanding the transmission channels for an impact of uncertainty on exchange rates and forecast errors. Considering that individual forecasters might be successful even if aggregated predictions display high forecast errors, the dispersion of forecasts among professionals and the resulting heterogeneity constitutes another open research topic. While a lack of data availability prevents us from analyzing this topic, disagreement measures across exchange rate forecasters are provided for a large number of economies from 2001. The response of individual forecasters to increasing uncertainty potentially depends on established determinants such as asymmetric information or herding behavior. A final extension of our study could conduct country specific uncertainty indices. While our focus on uncertainty based on US variables is justified against the background that we consider US dollar exchange rates, relying on a broad set of variables and using comparable uncertainty indices for other economies would also be an interesting extension. The latter would enable analyzing the impact of relative uncertainty between two countries on expectations and should be able to improve the understanding of forecasting behavior on foreign exchange markets.

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Tables

Table I **Contributors to FX4casts Consensus Forecasts**

Allied Irish Bank, ANZ Bank, Bank of America/Merrill Lynch, Bank of New York Mellon, Barclays Capital, Bayerische Landesbank, BNP Paribas, Canadian Imperial Bank of Commerce, Credit-Agricola, Citigroup, Commerzbank, Credit Suisse - First Boston, Danske Bank, Deka, Deutsche Bank, DnBNOR, Economist Intelligence Unit, Goldman Sachs, Handels Banken, HSBC, IHS Global Insight, ING Bank, Intesa Sanpaolo, JP Morgan Chase, Julius Baer, Lloyds TSB, Macquarie Capital Securities, Moody's Economy.com, Morgan Stanley, National Australia Bank, Nomura, Nordea, Rabobank, Royal Bank of Canada, Royal Bank of Scotland, Scotia Bank, SEB, Societe Generale, Standard Chartered, Suntrust, Swedbank, Tokyo-Mitsubishi UFJ, Toronto Dominion, UBS Warburg, UniCreditHVB, Vontobel, Wachovia, Westpac

Table II **Descriptive statistics of the uncertainty measures**

	EPU	**CPI Dis**	**MU**	**FU**
Min	44.782753	4.080673e+01	5.523089e-01	0.63364515
Max	283.665588	1.904314e+02	1.080325e+00	1.54640293
Median	97.512993	9.378748e+01	6.372402e-01	0.86308807
Mean	107.922091	9.676209e+01	6.519263e-01	0.90057007
Std.dev	40.354659	2.734938e+01	8.423063e-02	0.18768427

Note: This table reports descriptive statistics of five uncertainty measures, i.e. US economic policy uncertainty (EPU), US CPI disagreement (CPI Dis), US macroeconomic uncertainty (MU), and US financial uncertainty (FU).

Table III **Correlation matrix of the uncertainty measures**

	EPU	**CPI Dis**	**MU**	**FU**
EPU	1.0000000	0.1540828	0.3233375	0.4185804
CPI Dis	0.1540828	1.0000000	0.3084234	0.2612989
MU	0.3233375	0.3084234	1.0000000	0.6580316
FU	0.4185804	0.2612989	0.6580316	1.0000000

Note: This table reports the correlation matrix of five uncertainty measures, i.e. US economic policy uncertainty (EPU), US CPI disagreement (CPI Dis), US macroeconomic uncertainty (MU), and US financial uncertainty (FU).

Figures

Figure I **Uncertainty measures**

The plot shows four measures of uncertainty over a sample period running from 1986:08 until 2014:12 on a monthly frequency: US economic policy uncertainty (EPU), US CPI disagreement (CPI Dis), US macroeconomic uncertainty (MU), and US financial uncertainty (FU).

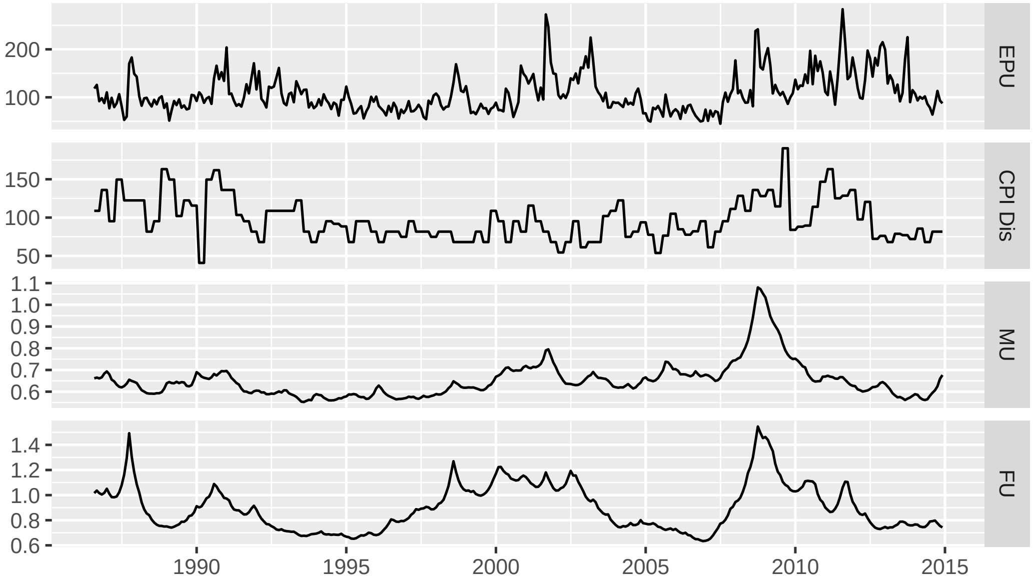
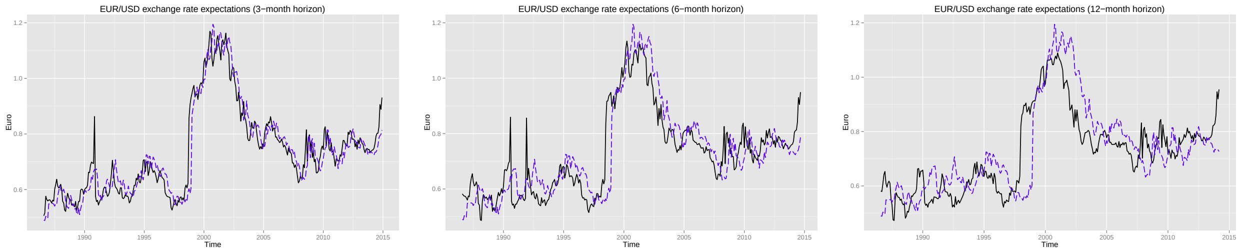


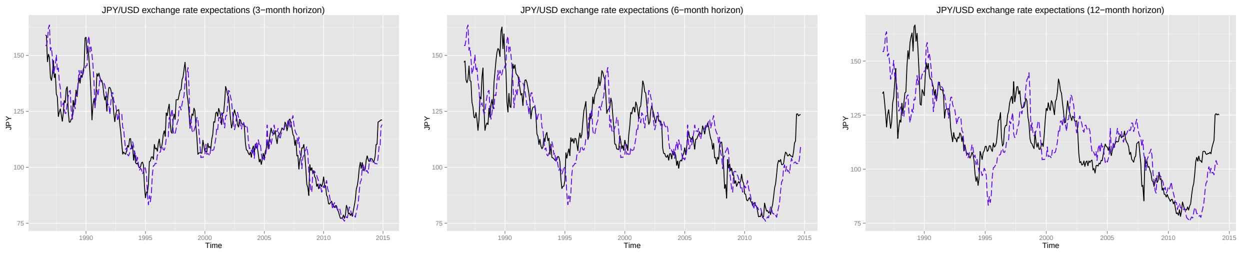
Figure II **Exchange rate expectations**

The plots show the exchange rate expectations (black line) compared to the actual exchange rates (blue line) for all currencies (EUR/USD, JPY/USD, CAD/USD, GBP/USD) and all horizons ($h = 3, 6, 12$).

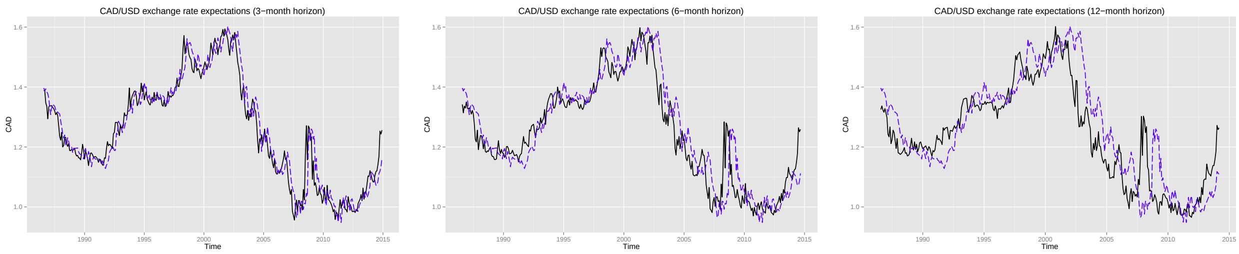
EUR/USD



JPY/USD



CAD/USD



GBP/USD

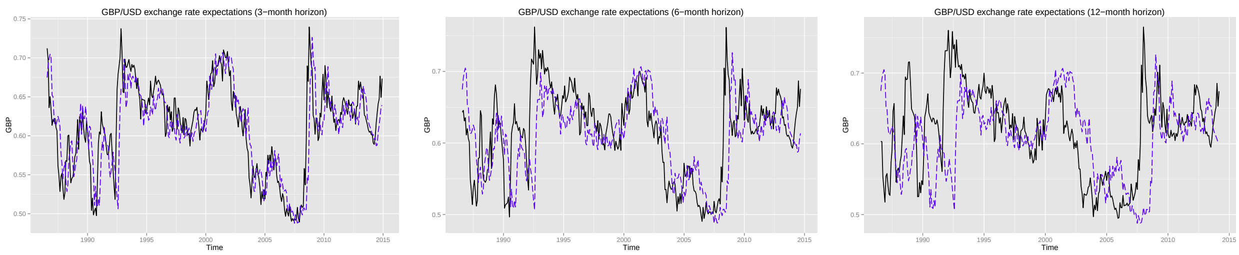
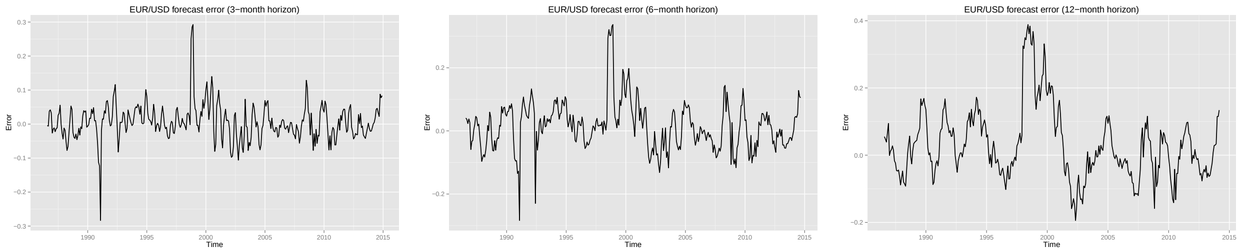


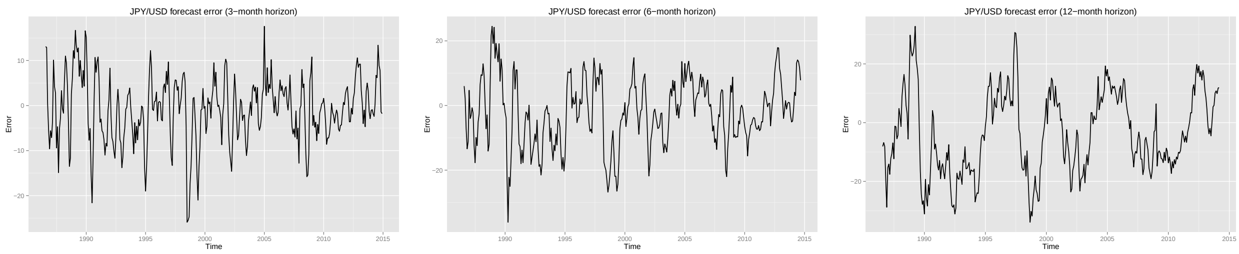
Figure III **Forecast errors**

The plots show the exchange rate forecast errors computed as the difference between the actual and the expected exchange rate for all currencies (EUR/USD, JPY/USD, CAD/USD, GBP/USD) and all horizons ($h = 3, 6, 12$).

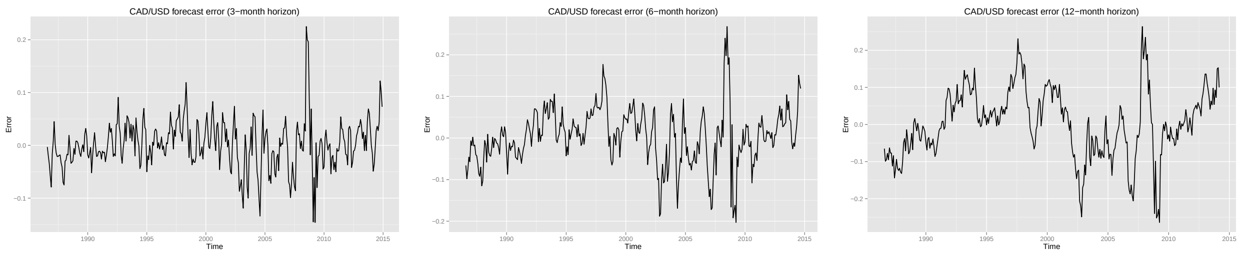
EUR/USD



JPY/USD



CAD/USD



GBP/USD

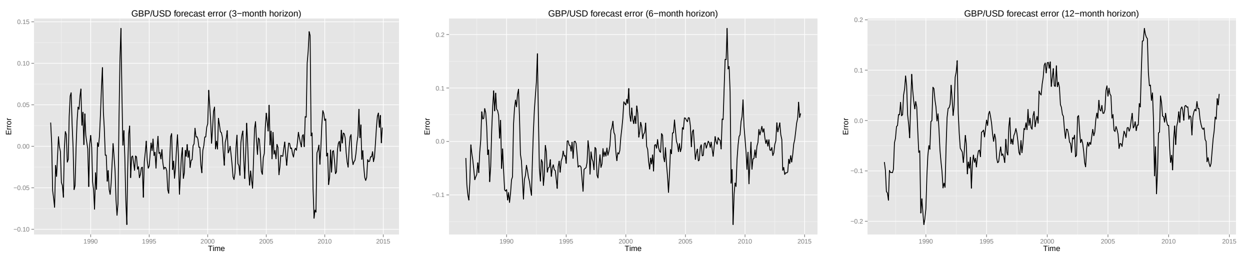


FIGURE IV **Response of the change in EUR/USD forecast to a shock on uncertainty**

The plots show the reaction of the change of the EUR/USD forecast ($\Delta E_t(s_{t+h})$ for $h = 3, 6, 12$) to a shock of the US news-based economic policy uncertainty index, the US CPI disagreement index, the US macroeconomic uncertainty index and the US financial uncertainty index. The first column gives the response of the forecast at a three month horizon, the second at a six month horizon, and the third at a twelve month horizon. The first row gives the reaction to a shock of US economic policy uncertainty, the second to US CPI disagreement, the third to US macroeconomic uncertainty, and the last to US financial uncertainty. The reaction is represented by the solid red line and the corresponding confidence bands by blue shadings (the 95% level in light blue and the 68% in grey blue). The dashed black line displays the zero line.

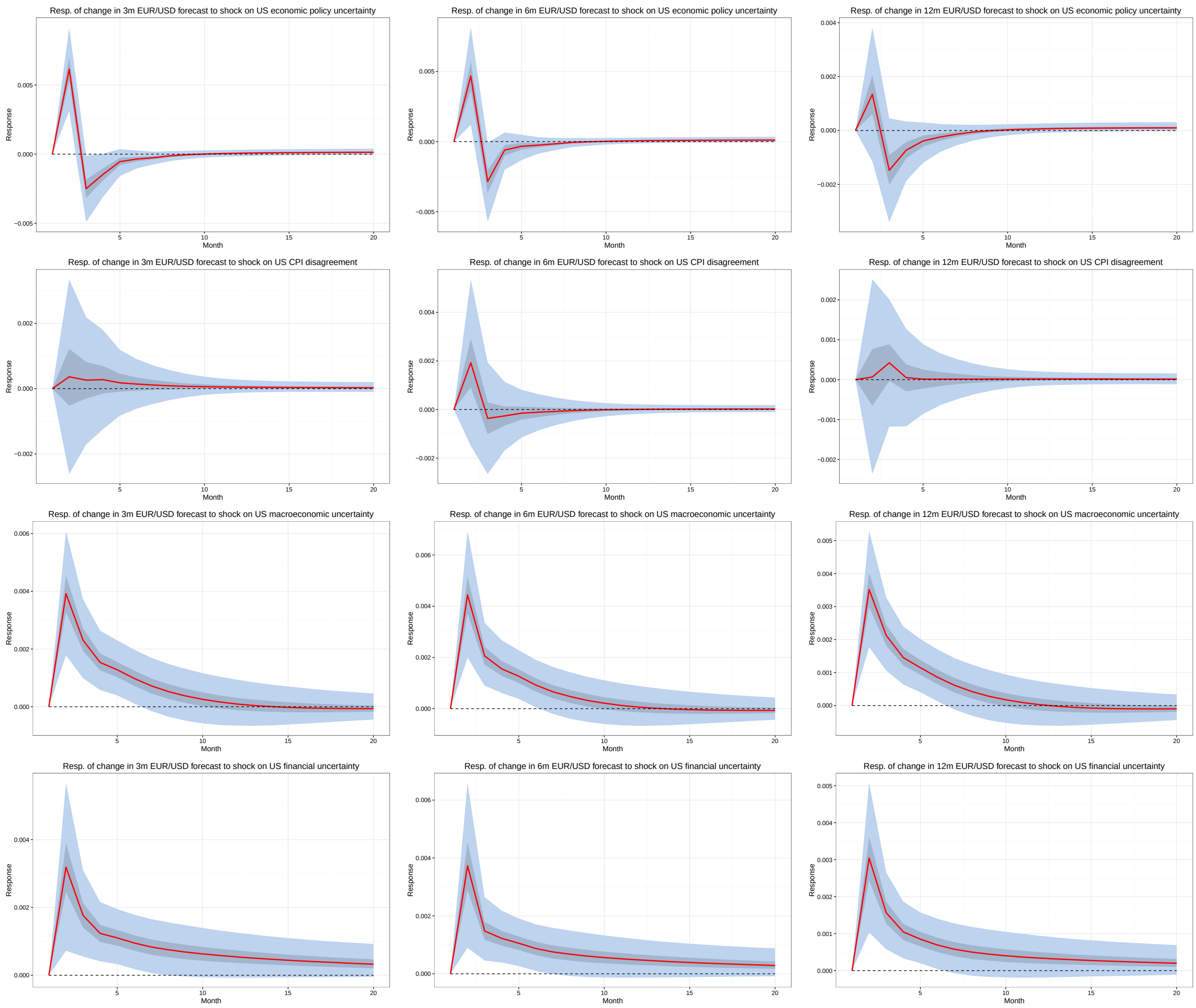


Figure V **Response of the change in JPY/USD forecast to a shock on uncertainty**

The plots show the reaction of the change of the JPY/USD forecast ($\Delta E_t(s_{t+h})$ for $h = 3, 6, 12$) to a shock of the US news-based economic policy uncertainty index, the US CPI disagreement index, the US macroeconomic uncertainty index and the US financial uncertainty index. The first column gives the response of the forecast at a three month horizon, the second at a six month horizon, and the third at a twelve month horizon. The first row gives the reaction to a shock of US economic policy uncertainty, the second to US CPI disagreement, the third to US macroeconomic uncertainty, and the last to US financial uncertainty. The reaction is represented by the solid red line and the corresponding confidence bands by blue shadings (the 95% level in light blue and the 68% in grey blue). The dashed black line displays the zero line.

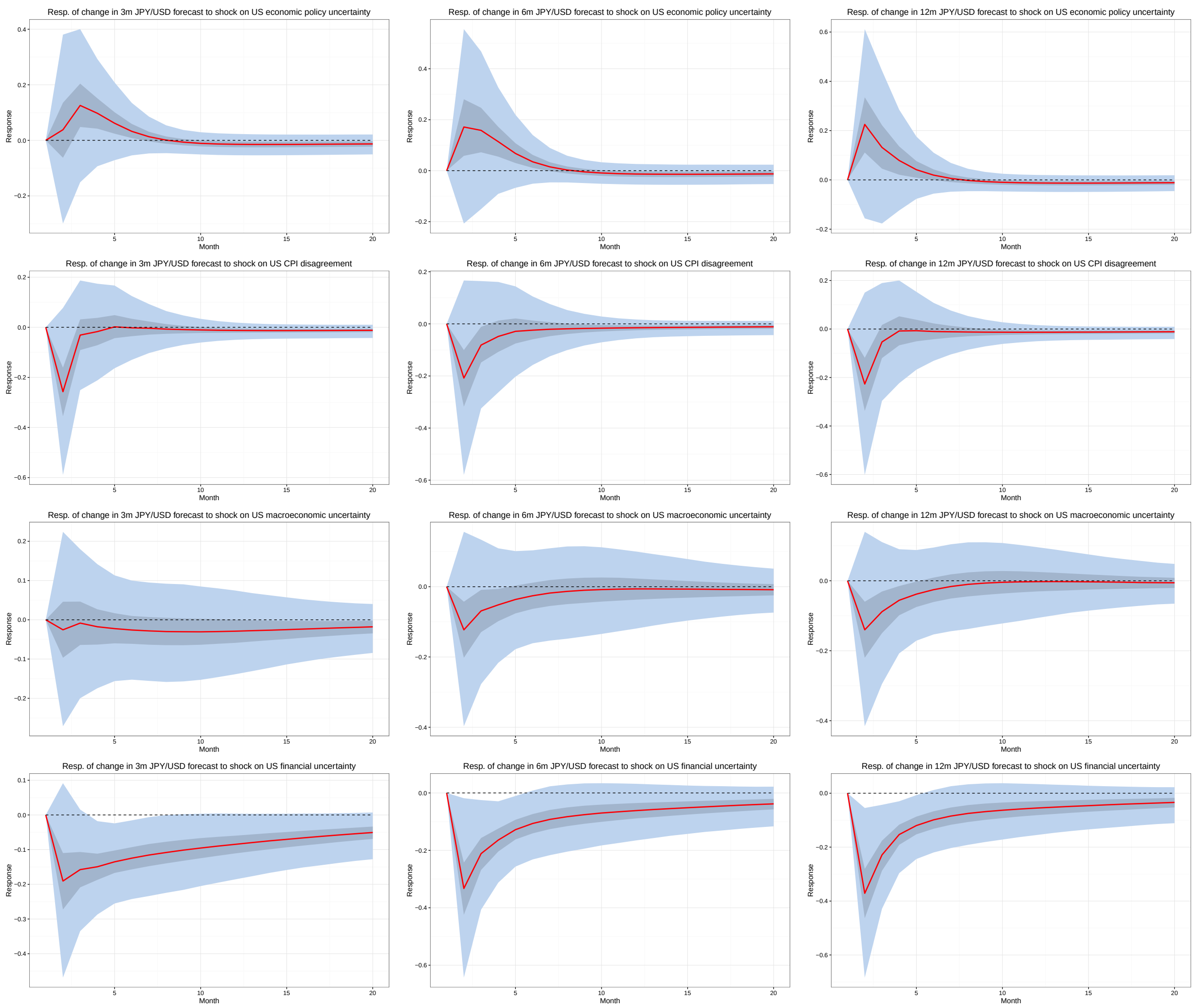


Figure VI **Response of the change in CAD/USD forecast to a shock on uncertainty**

The plots show the reaction of the change of the CAD/USD forecast ($\Delta E_t(s_{t+h})$ for $h = 3, 6, 12$) to a shock of the US news-based economic policy uncertainty index, the US CPI disagreement index, the US macroeconomic uncertainty index and the US financial uncertainty index. The first column gives the response of the forecast at a three month horizon, the second at a six month horizon, and the third at a twelve month horizon. The first row gives the reaction to a shock of US economic policy uncertainty, the second to US CPI disagreement, the third to US macroeconomic uncertainty, and the last to US financial uncertainty. The reaction is represented by the solid red line and the corresponding confidence bands by blue shadings (the 95% level in light blue and the 68% in grey blue). The dashed black line displays the zero line.

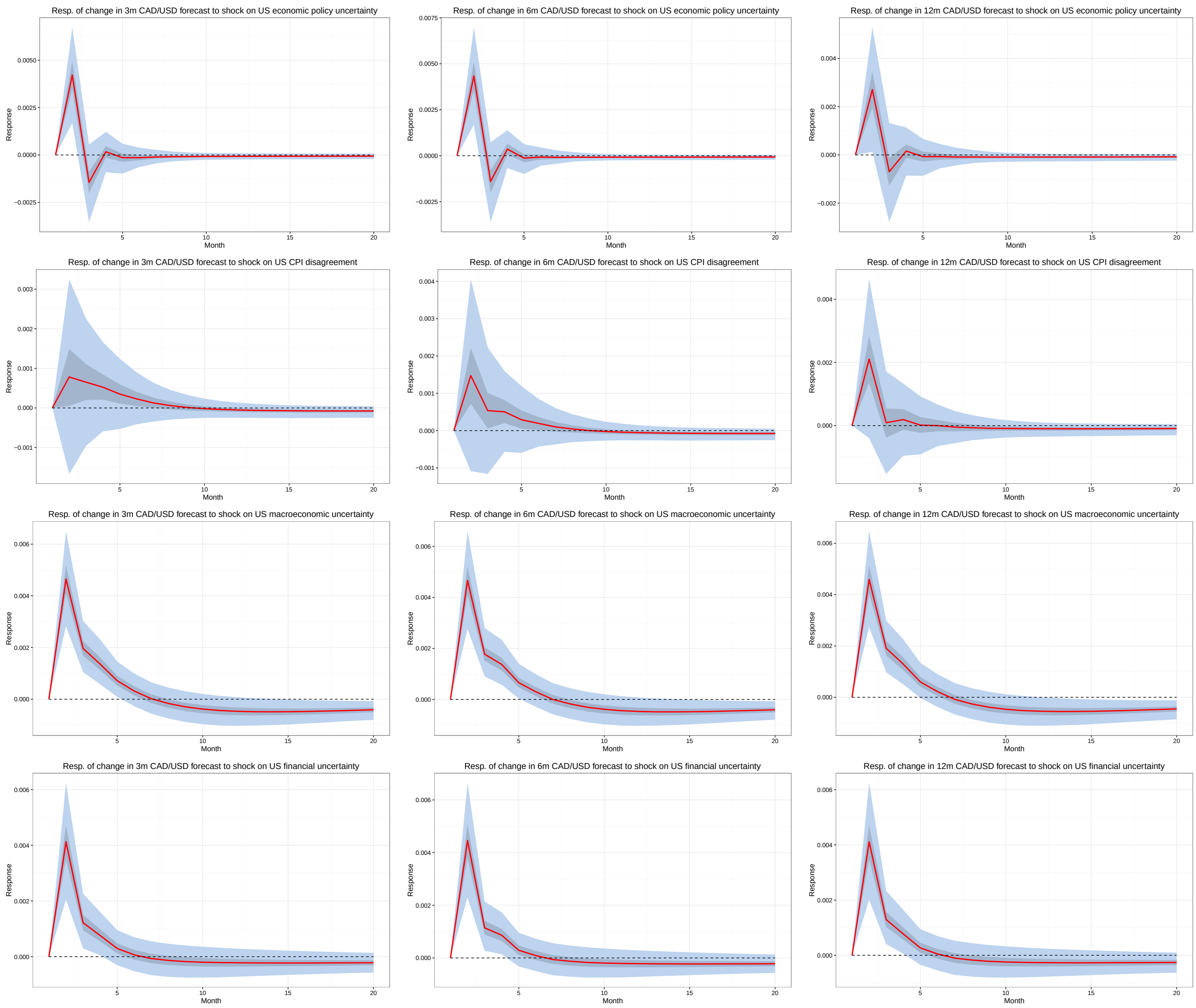


FIGURE VII **Response of the change in GBP/USD forecast to a shock on uncertainty**

The plots show the reaction of the change of the GBP/USD forecast ($\Delta E_t(s_{t+h})$ for $h = 3, 6, 12$) to a shock of the US news-based economic policy uncertainty index, the US CPI disagreement index, the US macroeconomic uncertainty index and the US financial uncertainty index. The first column gives the response of the forecast at a three month horizon, the second at a six month horizon, and the third at a twelve month horizon. The first row gives the reaction to a shock of US economic policy uncertainty, the second to US CPI disagreement, the third to US macroeconomic uncertainty, and the last to US financial uncertainty. The reaction is represented by the solid red line and the corresponding confidence bands by blue shadings (the 95% level in light blue and the 68% in grey blue). The dashed black line displays the zero line.

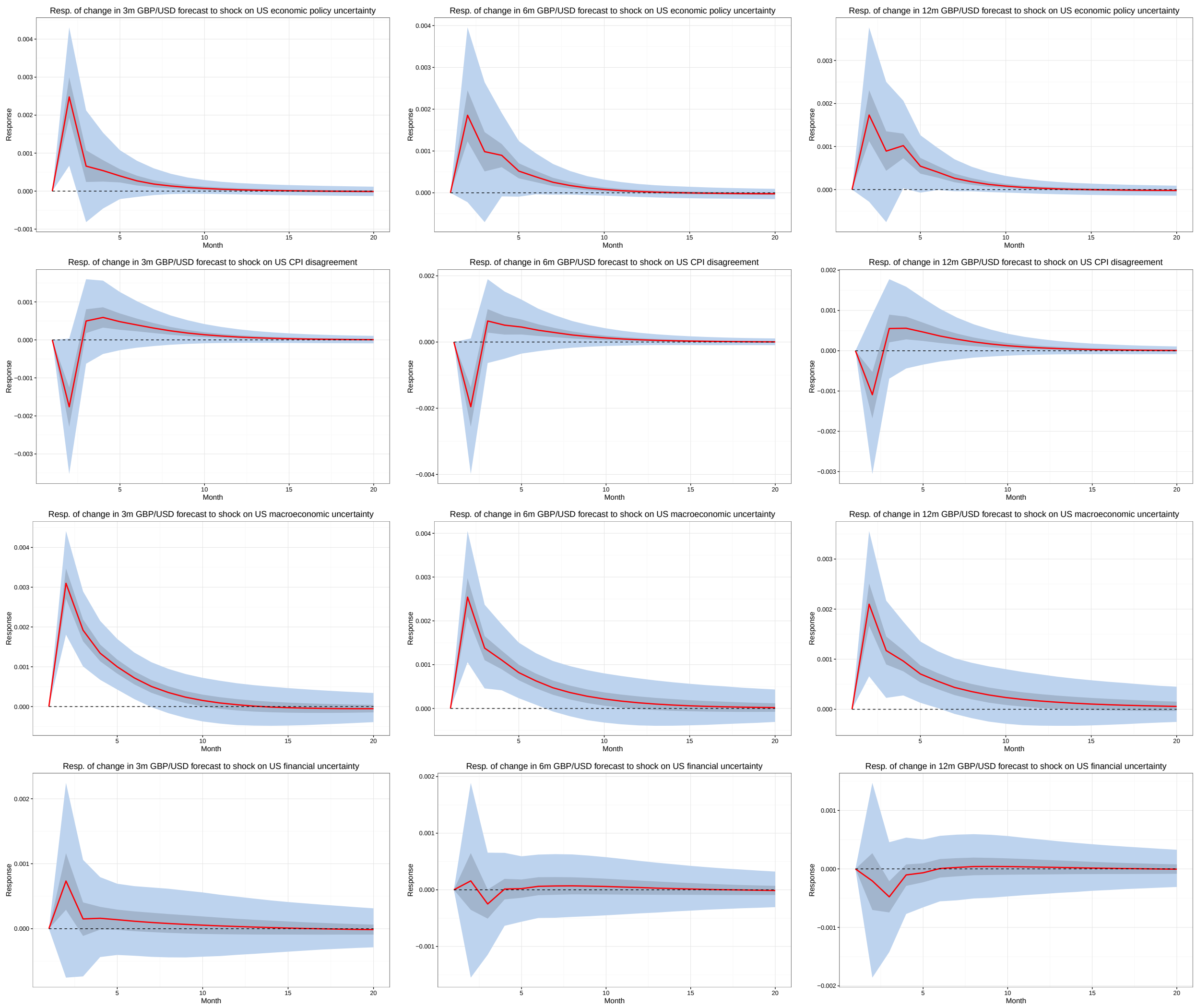


FIGURE VIII **Response of the EUR/USD forecast error to a shock on uncertainty**

The plots show the reaction of the EUR/USD forecast error ($\varepsilon_{t+h} = s_{t+h} - E_t(s_{t+h})$ for $h = 3, 6, 12$) to a shock of the US news-based economic policy uncertainty index, the US CPI disagreement index, the US macroeconomic uncertainty index and the US financial uncertainty index. The first column gives the response of the forecast error at a three month horizon, the second at a six month horizon, and the third at a twelve month horizon. The first row gives the reaction to a shock of US economic policy uncertainty, the second to US CPI disagreement, the third to US macroeconomic uncertainty, and the last to US financial uncertainty. The reaction is represented by the solid red line and the corresponding confidence bands by blue shadings (the 95% level in light blue and the 68% in grey blue). The dashed black line displays the zero line.

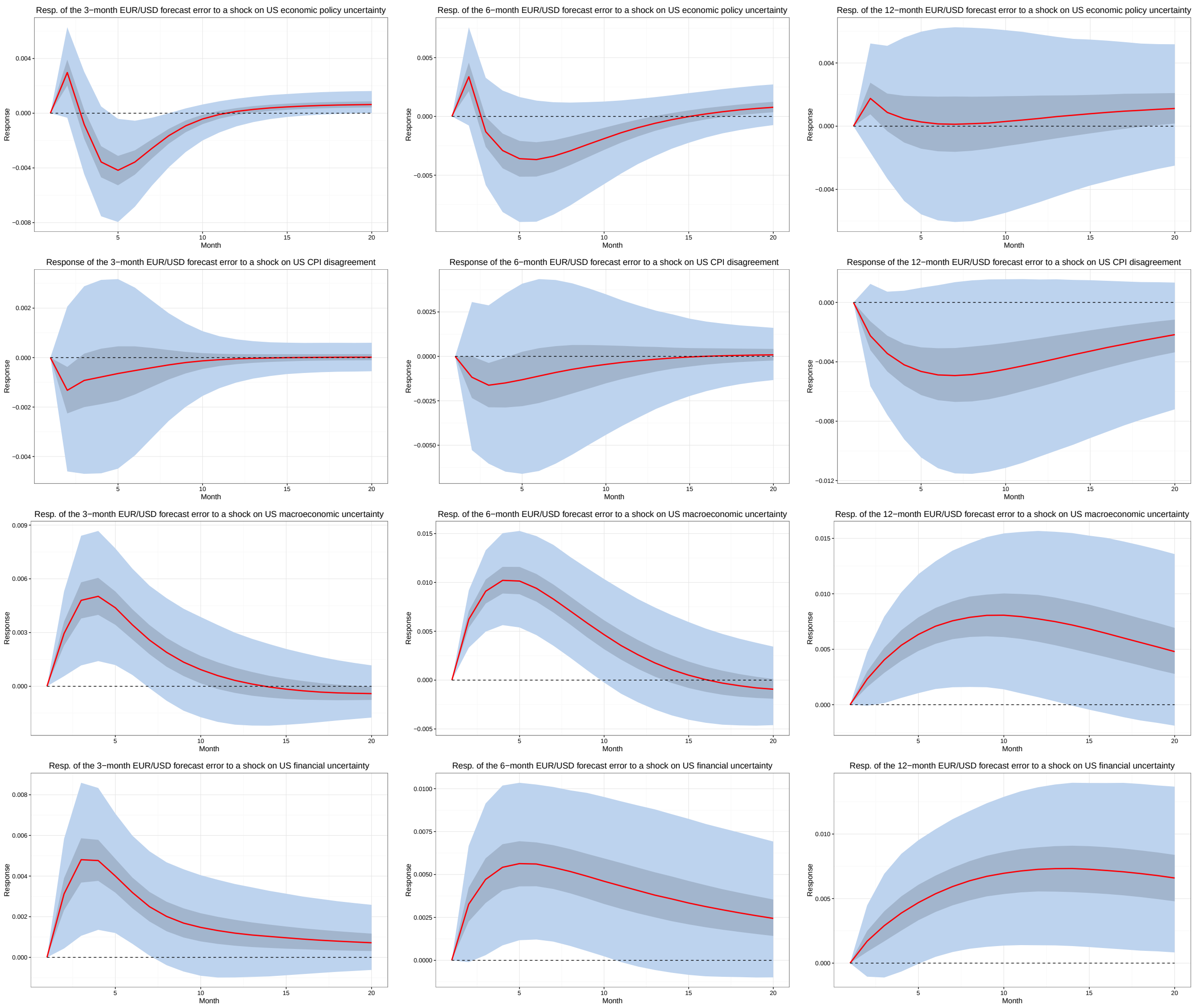


Figure IX **Response of the JPY/USD forecast error to a shock on uncertainty**

The plots show the reaction of the JPY/USD forecast error ($\varepsilon_{t+h} = s_{t+h} - E_t(s_{t+h})$ for $h = 3, 6, 12$) to a shock of the US news-based economic policy uncertainty index, the US CPI disagreement index, the US macroeconomic uncertainty index and the US financial uncertainty index. The first column gives the response of the forecast error at a three month horizon, the second at a six month horizon, and the third at a twelve month horizon. The first row gives the reaction to a shock of US economic policy uncertainty, the second to US CPI disagreement, the third to US macroeconomic uncertainty, and the last to US financial uncertainty. The reaction is represented by the solid red line and the corresponding confidence bands by blue shadings (the 95% level in light blue and the 68% in grey blue). The dashed black line displays the zero line.

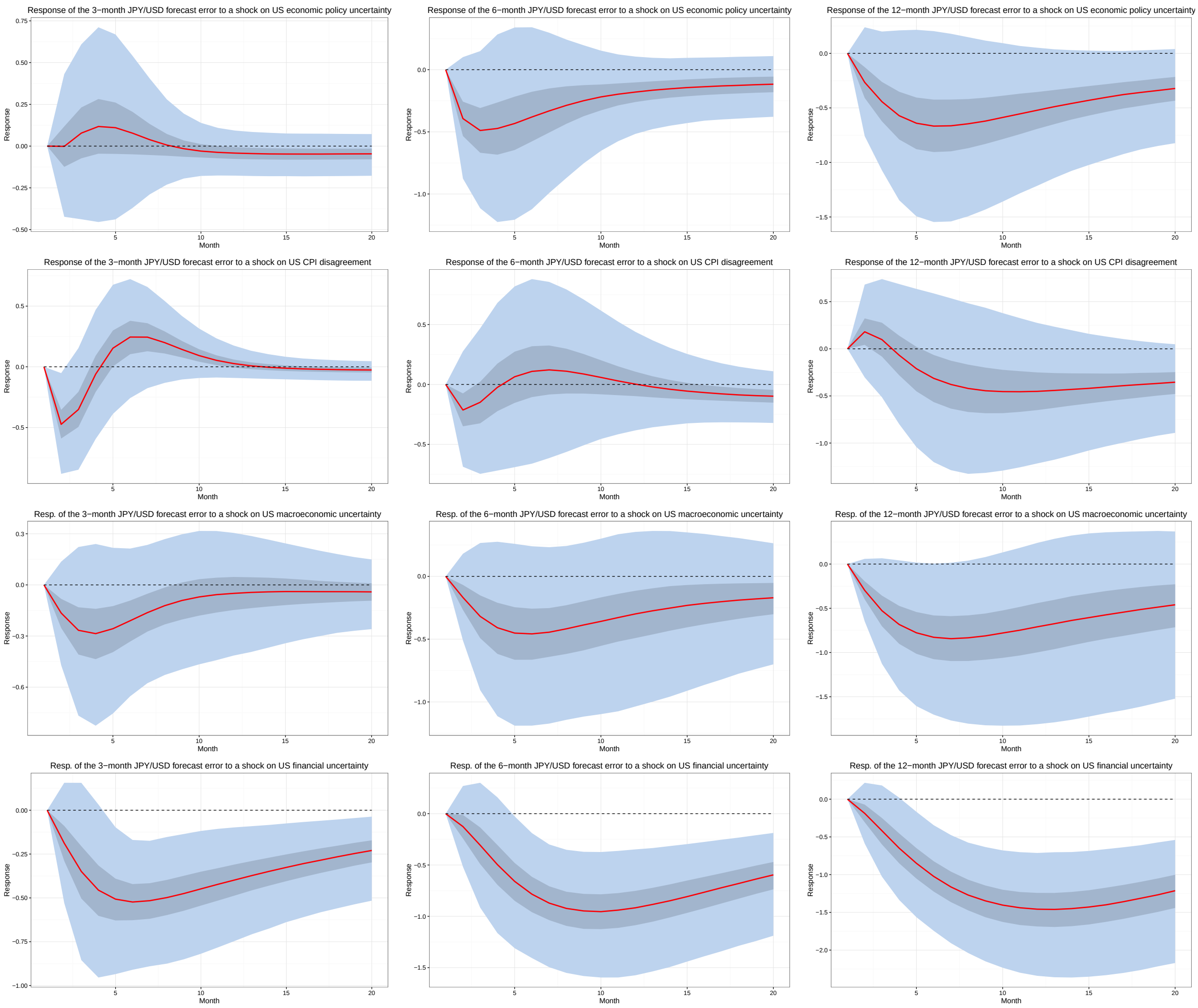


FIGURE X **Response of the CAD/USD forecast error to a shock on uncertainty**

The plots show the reaction of the CAD/USD forecast error ($\varepsilon_{t+h} = s_{t+h} - E_t(s_{t+h})$ for $h = 3, 6, 12$) to a shock of the US news-based economic policy uncertainty index, the US CPI disagreement index, the US macroeconomic uncertainty index and the US financial uncertainty index. The first column gives the response of the forecast error at a three month horizon, the second at a six month horizon, and the third at a twelve month horizon. The first row gives the reaction to a shock of US economic policy uncertainty, the second to US CPI disagreement, the third to US macroeconomic uncertainty, and the last to US financial uncertainty. The reaction is represented by the solid red line and the corresponding confidence bands by blue shadings (the 95% level in light blue and the 68% in grey blue). The dashed black line displays the zero line.

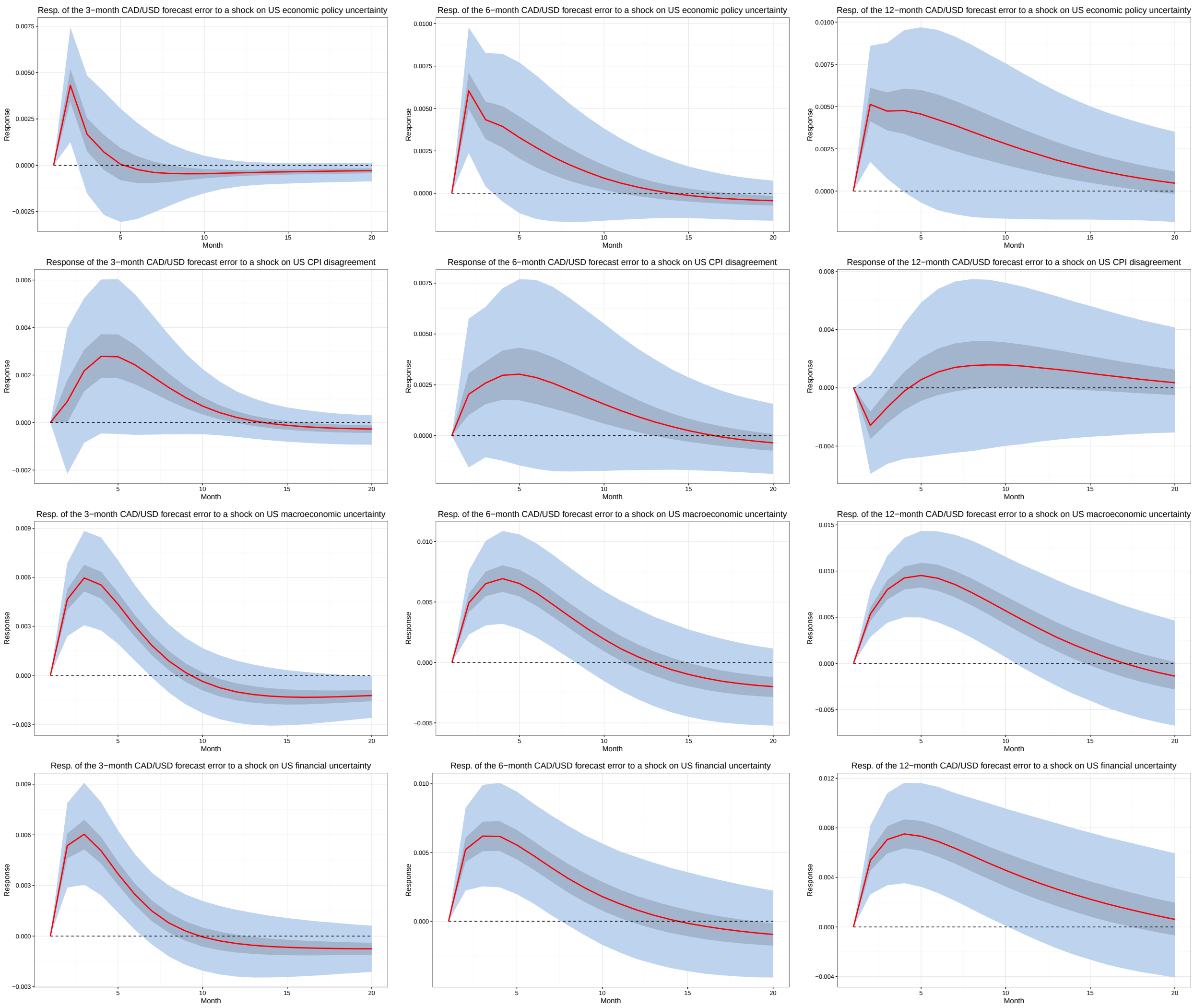


Figure XI **Response of the GBP/USD forecast error to a shock on uncertainty**

The plots show the reaction of the GBP/USD forecast error ($\varepsilon_{t+h} = s_{t+h} - E_t(s_{t+h})$ for $h = 3, 6, 12$) to a shock of the US news-based economic policy uncertainty index, the US CPI disagreement index, the US macroeconomic uncertainty index and the US financial uncertainty index. The first column gives the response of the forecast error at a three month horizon, the second at a six month horizon, and the third at a twelve month horizon. The first row gives the reaction to a shock of US economic policy uncertainty, the second to US CPI disagreement, the third to US macroeconomic uncertainty, and the last to US financial uncertainty. The reaction is represented by the solid red line and the corresponding confidence bands by blue shadings (the 95% level in light blue and the 68% in grey blue). The dashed black line displays the zero line.