Uncertainty and Deviations from Uncovered Interest Rate Parity

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Abstract: It is well-known that uncovered interest rate parity does not hold empirically. But is it really so? We conjecture that uncovered interest rate parity is more likely to hold in low uncertainty environments, relative to high uncertainty ones, since arbitrage opportunity gains become more uncertain in a highly unpredictable environment, thus blurring the relationship between exchange rates and interest rate differentials. In this paper, we first provide a new exchange rate uncertainty index, that measures how unpredictable exchange rates are relative to their historical past. Then we use the new measure of uncertainty to provide empirical evidence that uncovered interest rate parity does hold in five industrialized countries vis-a'-vis the US dollar at times when uncertainty is not exceptionally high, and breaks down during periods of high uncertainty.

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1 Introduction

A well-known empirical fact in international finance is that uncovered interest rate parity (UIRP) does not hold. UIRP states that, in the absence of arbitrage opportunities, the returns from investments in two countries should be equalized, once they are converted in the same currency; the implication is that interest rate differentials should predict bilateral nominal exchange rate appreciations or depreciations. UIRP is an important building block of most international macroeconomic models, and the lack of its validity is of such importance to deserve the term "UIRP puzzle". Another puzzling empirical fact about UIRP is that, not only the coefficients do not have the theoretical values predicted by the theory, but also that they are unstable over time. This paper tries to offer an explanation to *both* these puzzles by arguing that uncertainty is one of the reason explaining the empirical invalidity of the UIRP; that the coefficients in UIRP regressions are more likely to be close to the values predicted by UIRP at times in which uncertainty is low; and that their time variation is, at least partly, due to the fact that UIRP holds when uncertainty is low but does not when uncertainty is high.

More in detail, this paper makes two main contributions. First, it proposes a new measure of exchange rate uncertainty. The novelty is not in the methodology to construct the new index, which is based on Rossi and Sekhposyan (2015); rather, its application to measure exchange rate uncertainty. To our knowledge, this is the first paper to propose *an index of exchange rate uncertainty*. We measure uncertainty at a point in time by the likelihood of observing the realized exchange rate forecast error at that point in time relative to the historical distribution of exchange rate forecast errors. Since the uncertainty measure is based on forecast errors, it clearly depends on the model used to forecast exchange rates. To minimize the dependence on the model chosen to produce the forecasts, we use Consensus survey forecasts, which have the nice feature of being model-free and timely incorporating a large amount of information. These survey forecasts have been used recently by Ozturk and Sheng (2016) to measure macroeconomic uncertainty; instead, we use them to construct an index of exchange rate uncertainty.

The second contribution is to make a step towards understanding why UIRP does not empirically fit the data. In fact, typical estimates of the slope are either negative or zero or too large to be reconciled with the theory (Froot and Thaler, 1990); UIRP also fails to produce competitive out-of-sample forecasts relative to the random walk (Meese and Rogoff, 1983a,b; 1988; Cheung, Chinn and Pascual, 2005; Alquist and Chinn, 2008) – see Rossi (2013) for a recent survey. The possible explanations that have been put forward in the literature include, among others: the presence of time-varying risk premia (Fama, 1984; Ghoshray, Li and Morley, 2011); imprecise standard errors (Baillie and Bollerslev, 2000; Rossi, 2007); small samples (Chinn and Meredith, 2004; Chinn and Quayyum, 2013; and Chen and Tsang, 2011); and rare disasters, such as currency crashes (Brunnermeier et al., 2008).[1] In this paper we consider an alternative explanation for the UIRP puzzle, namely the fact that *the uncovered interest rate parity relationship might not hold in highly*

[1] Brunnermeier et al. (2009) look at currency crashes and carry trades, where traders borrow low-interest-rate currencies and lend high-interest currencies. One of their findings is that higher levels of the VIX and TED spread predict higher future returns on the carry trade, implying larger UIRP violations.

uncertain environments, while it is more likely to hold when uncertainty is low. In fact, when uncertainty is high, investors might postpone their investment decisions, and thus create deviations from what it is expected in the absence of arbitrage opportunities.

This paper is related to several recent strands in the literature. The first strand is the literature on the UIRP puzzle. While it is un-controversial that the UIRP does not hold at short horizons, Chinn and Meredith (2004), Lothian and Wu (2011) and Chinn and Quayyum (2013) find more empirical evidence in favor of UIRP at longer horizons.[2] In particular, Chinn and Meredith (2004) argue that the lack of empirical evidence in favor of UIRP is due to small samples, and find that UIRP holds at longer horizons (above one year) in the longer sample of data they have available. Lothian and Wu (2011) examine historical data from 1800 to 1999, and find that the UIRP regression slope is positive for the longest sample, and the strong negative relation found in the literature is a feature of the late 1970s and the 1980s. Finally, Chinn and Quayyum (2013) extend the analysis in Chinn and Meredith (2004) by a decade and find that the results in the latter are robust; however, the evidence is slightly weaker, potentially because the longer sample includes the zero-lower bound period. In this paper, differently from the contributions listed above, we focus instead on the lack of empirical validity of the UIRP in the short run, which still remain a puzzle in the literature, and argue that uncertainty plays a potentially important role in explaining the puzzle.

The second strand is the literature on uncertainty. Several recent papers have analyzed the effects of uncertainty on the macroeconomy; for example, Bloom (2009), among others, has measured uncertainty as the volatility in financial markets. In this paper, we use survey forecasts to measure uncertainty, similarly to Ozturk and Sheng (2016), who use survey forecasts to measure global and country-specific macroeconomic uncertainty, and Rossi, Sekhposyan and Soupre (2016), who use survey density forecasts to understand the sources of macroeconomic uncertainty. However, differently from Ozturk and Sheng (2016) and Rossi, Sekhposyan and Soupre (2016), we focus on exchange rate uncertainty and measure uncertainty using a methodology that has the advantage of allowing to study asymmetries in uncertainty. The literature on the relationship between exchange rates and uncertainty is, instead, more limited. Berg and Mark (2016) and Mueller, Tahbaz-Salehi and Vedolin (2016), for example, study the relationship between trading strategies in exchange rate markets and uncertainty. The former study the exposure of carry-trade currency excess returns to global fundamental macroeconomic risk. Their measure of global macroeconomic uncertainty, defined as the cross-country high-minus-low conditional skewness of the unemployment gap, is a factor priced in currency excess returns. Mueller, Tahbaz-Salehi and Vedolin (2016) instead study whether trading strategies of going short on one currency and long on other currencies exhibits significantly larger excess returns on FOMC announcement days, and find that the excess returns are higher the higher is uncertainty about monetary policy. Belke and Kronen (2015) analyze the role of uncertainty in explaining exchange rate bands of inaction and their effects on exports. Our paper also studies the effects of uncertainty in exchange rate markets, but focuses on explaining the UIRP puzzle, as opposed to explaining larger excess returns in cross section carry-trade strategies or fluctuations in exports.

[2] This finding mirrors the empirical finding that monetary models of exchange rates are more likely to hold at long horizons (Mark, 2005).

This paper is organized as follows. The next section describes the data used in this study and Section 3 discusses the exchange rate uncertainty index that we use. Section 4 revisits the empirical evidence on UIRP in our sample, while Section 5 investigates whether deviations from UIRP can be explained by uncertainty. Section 6 concludes.

2 The Data

We collect monthly data spanning 1993:M11 to 2015:M1 on exchange rates, three-month Euribor rates, and the uncertainty measure. We focus on industrialized countries, and consider five currency pairs: the Swiss franc, the Canadian dollar, the British pound, the Japanese yen, and the Euro against the US dollar. We focus on exchange rates for industrialized countries for which the survey expectations necessary to construct our uncertainty index are available. The period has been chosen based on the availability of the uncertainty index. In fact, the data on our uncertainty measure start in 1993:M11 and end in 2015:M1 for all currencies except the Euro (for the Euro it begins on 2011:M7) – see below for more details on the uncertainty measure. The data on the exchange rates for the five currency pairs are from WM/Reuters. The exchange rates are values of the national currencies relative to one US dollar. For the interest rates we collect monthly data on three-month Euribor rates for the respective five countries and the United States. The data are from the Financial Times. All data have been collected via Datastream. More details (including mnemonics) are provided in Table 1.

INSERT TABLE 1 HERE

3 The Exchange Rate Uncertainty Index

Regarding uncertainty, several methodologies and strategies to construct uncertainty indices are available. Bloom (2009) proposes to measure macroeconomic uncertainty using the volatility in stock prices, while Baker, Bloom and Davis (2016) propose a measure of macroeconomic policy uncertainty. Since we are interested in exchange rate uncertainty, we cannot use their measure. Jurado, Ludvigson and Ng (2015) propose to measure uncertainty as the time-varying volatility of forecast errors in predicting exchange rates while Scotti (2016) measures uncertainty as macroeconomic news announcements. The uncertainty series that we use are similar in spirit to Jurado, Ludvigson and Ng (2015) but they are obtained using the methodology in Rossi and Sekhposyan (2015). Rossi and Sekhposyan's (2015) uncertainty index is constructed by comparing the realized forecast error of the target variable with the unconditional forecast error distribution of the same variable. The intuition is that, if the observed realization of the forecast error is in the tails of the distribution, then the realization was very difficult to predict; thus, such an environment is deemed very uncertain. One of the advantages of the Rossi and Sekhposyan (2015) index is that it allows for asymmetry: in other words, it can separately distinguish between uncertainty due to unexpectedly high and low exchange rates – an important feature that is not shared by uncertainty indices based on the volatility of forecast errors.

We construct the exchange rate uncertainty index based on forecast errors from surveys conducted by Consensus Economics. The uncertainty index is monthly and the forecast horizon is three months; therefore, the interest rate differential is based on three-months interest rates. Let the bilateral nominal exchange rate between a country and the US at time t be denoted by S_t and let $s_t = \ln(S_t)$. Furthermore, let the $h-$step-ahead forecast error for the rate of growth of the exchange rate between time t and time $t+h$ be denoted by $e_{t+h} = (s_{t+h} - s_t) - E_t(s_{t+h} - s_t)$, and its unconditional forecast error distribution be denoted by $p(e)$. Rossi and Sekhposyan's (2016) index is based on the cumulative density of forecast errors evaluated at the realized forecast error, e_{t+h}: $U_{t+h} = \int_{-\infty}^{e_{t+h}} p(e)\, de$. A large value of the index (which takes values between zero and one) indicates a realization of the exchange rate that is very different from the expected value. In particular, a realized value much bigger than the expected value measures a positive "shock", while a value of the index close to zero indicates situations where the realized value was much smaller than the expected value, identifying a negative unexpected "shock." To convey information about the asymmetry in uncertainty, Rossi and Sekhposyan (2016) propose to construct "positive"and a "negative" uncertainty indices (relative to the average value of uncertainty) over time, as follows:

$$U_{t+h}^{+} = \frac{1}{2} + \max\left\{U_{t+h} - \frac{1}{2}, 0\right\}, \quad U_{t+h}^{-} = \frac{1}{2} + \max\left\{\frac{1}{2} - U_{t+h}, 0\right\}. \tag{1}$$

Note that U_{t+h}^{+} measures uncertainty associated with situations where the exchange rate turns out to be higher than expected, while U_{t+h}^{-} measures uncertainty associated with situations where the exchange rate turns out to be lower than expected. Note that the uncertainty is measured such that unexpectedly low exchange rate values correspond to an unexpected depreciation of the US dollar relative to the reference currency (or an unexpected appreciation of the reference currency).

We refer to U_{t+h}^{+} as a measure of upside uncertainty, and to U_{t+h}^{-} as a measure of downside uncertainty. Note that, by construction, the indices have values between 0.5 and 1. We also consider an overall uncertainty index, defined as:

$$U_{t+h}^{*} = \frac{1}{2} + \left|U_{t+h} - \frac{1}{2}\right|.$$

Figure 1 plots the overall uncertainty indices for the countries in our sample. The time series fluctuations of the uncertainty indices are consistent with several events that have affected these countries over time. For example, focusing on Europe, the two periods of high uncertainty during the latest financial crisis are clearly visible; they are related to the two recent recessions in the Euro-area: the first from 2008:Q1 to 2009:Q2 and the second from 2011:Q3 to 2013:Q1. In particular, the Euro debt crisis shows up as an upward trend in uncertainty in Europe since mid-2011. A similar pattern affects the UK during the same period. Note also the upward trend in uncertainty is visible in Canada during the recent US financial crisis starting in 2007. Finally, another notable event taking place in 2006 is Bank of Japan raising interest rates for the first time in several years, which might have caused the drastic increase in uncertainty around mid-2006.

INSERT FIGURE 1 HERE

4 Revisiting Uncovered Interest Rate Parity

Uncovered interest rate parity (UIRP) states that, in a world of perfect foresight and a nominal bilateral exchange rate S_t, investors can buy $1/S_t$ units of foreign bonds using one unit of the home currency, where S_t denotes the price of foreign currency in terms of home currency. Suppose the foreign bond pays one unit plus the foreign interest rate between time t and $(t+h)$, i^*_{t+h}, where h is the horizon of the investment. At the end of the period, the foreign return can be converted back in the home currency with a value of $S_{t+h}\left[\left(1+i^*_{t+h}\right)/S_t\right]$ in expectation. In the absence of transaction costs, by arbitrage this return must be in expectation equal to the return of the home bond, $(1+i_{t+h})$. Therefore, $\left(1+i^*_{t+h}\right)E_t\left(S_{t+h}/S_t\right)=(1+i_{t+h})$, where $E_t\left(.\right)$ denotes the expectation at time t. By taking logarithms and ignoring Jensen's inequality, the uncovered interest rate parity equation follows directly:

$$E_t\left(s_{t+h}-s_t\right)=\alpha+\beta\left(i_{t+h}-i^*_{t+h}\right), \quad (2)$$

where the UIRP parameters α and β have the theoretical values: $\alpha=0$ and $\beta=1$.

Overall, the empirical evidence is not favorable to UIRP – see Rossi (2013) for a recent survey. It is well-known that the constant, α, is different from zero, and the slope, β, is either negative or close to zero, or sometimes positive and very large in magnitude. Similarly, the empirical evidence is equally not supportive of the UIRP in out-of-sample forecast evaluations; in fact, it is also well-known, since the early work by Meese and Rogoff (1983a,b; 1988), that eq. (2) does not forecast exchange rates out-of-sample better than the random walk. The same result was reinforced by Cheung, Chinn and Pascual (2005) and Alquist and Chinn (2008). Slightly more positive findings have been reported by Clark and West (2006) at short-horizons; however, as Rossi (2013) pointed out, the reason for the positive findings in Clark and West (2006) are mainly due to the use of new and different test of predictive ability.

We start by confirming the existing findings in the literature, namely that UIRP does not hold in the data. Panel A in Table 2 estimates regression (2) in our sample, and shows that, for several countries, β is very small, and in the case of Switzerland, Canada and Japan, it is negative and statistically significantly different from one. Only for Europe and the UK the slope is positive and statistically indistinguishable from its theoretical value under the UIRP. The constant instead is small and insignificantly different from zero for most countries.[3]

Our results are similar to those in the literature, except that our estimates are slightly smaller than those reported in the earlier literature. For instance, Chinn and Quayyum (2013) use quarterly data spanning the period of 1975:Q1-2011:Q4 for the same set of currency pairs, and they find slope estimates ranging from -1.85 to -2.25 with the exception of the Canadian dollar, whose slope is -0.17. However, a detailed analysis reveals that the large

[3]The confidence intervals are constructed based on a Newey and West (1987) HAC estimator for the covariance matrix, using a truncation lag equal to two.

negative values are driven by sample selection. Firstly, the rolling-window estimates which we report later in the paper show that the slope coefficients have been increasing over time: our sample is shorter than, e.g., Chinn and Quayyum (2013), and in particular it omits the Seventies and the Eighties; the latter are decades with large deviations from UIRP according to Lothian and Wu (2011).[4] Secondly, if we consider the sample up to 2011:M10, that is, omitting the last 4 years to better match the sample used in Chinn and Quayyum (2013), the estimates become negative for four countries out of five and the negative coefficients are larger in magnitude. The results are reported in Table 2, Panel B.

INSERT TABLE 2 HERE

A comparison of the results in the two panels in Table 2 also points out another important empirical feature of UIRP: the well-known fact that the UIRP parameters are unstable over time. In fact, note how, for example, the slope coefficient for the Euro data turns from positive to negative depending on the sample, and how its magnitude varies in Japanese data. Rossi (2006) investigates the instability in the parameters in exchange rate monetary models (that is, models that explain exchange rate fluctuations using output, money and interest rate differentials) and finds ample evidence of instabilities based on conventional tests of parameter instability. Furthermore, she argues that the empirical rejections of the monetary exchange rate model can be due to parameter instabilities; in fact, by using alternative and more powerful tests that evaluate Granger-causality robust to instabilities, she finds that monetary models' predictors helped forecasting exchange rates *at some point in time*.

We investigate the stability of the UIRP parameters over time by plotting their estimates in rolling windows over ten years of data in the top panel in Figures 2(a-e). The figures confirm the presence of instabilities throughout the sample that we consider. For Canada, the value of the constant is small throughout the sample, but the slope value changes significantly from negative to positive. The slope changes drastically for Europe as well, ranging from values close to zero at the beginning of the sample to almost four towards the end of the sample. In the case of Japan, the coefficient is close to zero for almost all the sample except the beginning and the end. Switzerland and the UK are two other countries where the slope changes drastically from negative values to large and positive values. For the latter country, the constant also is very unstable, taking both positive and negative values depending on the sample period.

INSERT FIGURE 2 HERE

We investigate more formally whether instabilities affect UIRP in Table 3(a-c). We consider the following regression:

$$E_t\left(s_{t+h} - s_t\right) = \alpha_t + \beta_t\left(i_{t+h} - i^*_{t+h}\right), \tag{3}$$

[4] Our sample is shorter since it is determined by the availability of the uncertainty index.

where the constant, or the slope parameter, or potentially both, might be time-varying. Absence of time variation manifests itself in constant parameters, that is: $\alpha_t = \alpha$ and/or $\beta_t = \beta$. We test parameter stability using a battery of tests, including Andrews' (1993) Quandt Likelihood Ratio test (QLR), Andrews and Ploberger's (1993) Exponential-Wald (Exp-W) and Mean-Wald (Mean-W) tests, as well as Nyblom's (1989) test. The tests differ depending on the type of instability they allow for; in particular, Andrews (1993) and Andrews and Ploberger (1993) allow for one-time structural changes while Nyblom (1989) considers smoother and more frequent changes.

Table 3(a) reports results for testing the joint instability in both the constant and the slope parameters. It is clear that the stability is overwhelmingly rejected, with p-values that are zero in all cases. We then investigate whether the instability is more pronounced in the constant or in the slope. Table 3(b) reports tests of stability on the constant. The table shows that the constant is unstable for most countries except the UK. A time-varying α may be evidence of a time-varying risk premium. Table 3(c) reports tests of stability on the slope; the table shows that the slope is unstable for all countries, including the UK.

INSERT TABLE 3 HERE

Since the parameters are time-varying, the UIRP tests presented in Table 2 are invalid, as they assume stability in the parameters. Therefore, we complement the analysis with tests that are robust to parameter instabilities. In particular, we implement the Exp-W*, Mean-W*, Nyblom* and QLR* tests proposed by Rossi (2005), which are valid to test the UIRP conditions that $\alpha_t = 0$ and $\beta_t = 1$ even in the presence of time-variation in the parameters.[5] Tables 4(a-c) show that the results in Table 2 are robust. In particular, Table 4(a) shows that the both parameters are significantly different from the values predicted by the UIRP; Tables 4(b-c) report results for the constant and the slope separately, and show that the rejections are mostly due to the fact that the slope is different from unity, especially for Canada, the UK and Japan.[6]

INSERT TABLE 4 HERE

The analysis in this section shows that UIRP does not hold in the data, and that the coefficients estimated in UIRP regressions are very unstable over time. However, the analysis does not shed light on why there are deviations from UIRP. The next section will tackle this important question.

[5] The difference among the Exp-W*, Mean-W*, QLR* and Nyblom* tests is, again, that they focus on different types of instabilities. In particular, the first three focus on the case of a one-time structural change while Nyblom* allows smoother and more frequent changes.

[6] Note that, in Table 4(b), the Exp-W* test does not reject for some countries while the Mean-W*, Nyblom* and QLR* tests reject. The reason why the tests disagree is because they consider different types of instabilities: the Nyblom* test, for example, has more power when parameters are smoothly time-varying.

5 Can Uncertainty Explain Deviations from Uncovered Interest Rate Parity?

The previous section has confirmed the existence of two important puzzles in the empirical literature in international finance: *UIRP coefficients are both different from their theoretical values and unstable over time*. This paper tries to offer an explanation to *both* these puzzles by arguing that uncertainty is one of the reason explaining the empirical invalidity of the UIRP; that the coefficients in UIRP regressions are more likely to be close to the values predicted by UIRP in times when uncertainty is low; and that their time variation is, at least partly, due to the fact that UIRP holds when uncertainty is low but does not when uncertainty is high.

We start our analysis by depicting our uncertainty index for each country together with the rolling estimates of the UIRP parameters. The bottom panels in Figure 2-4 show the uncertainty index for each country. We consider the three measures of uncertainty discussed in the previous section: the bottom panels in Figures 2(a-e) plot the overall uncertainty index, U^*_{t+h}, while those in Figures 3(a-e) and 4(a-e) depict upside and downside uncertainty, U^+_{t+h} and U^-_{t+h}, respectively. Figure 1 shows that there is correlation between uncertainty and UIRP coefficients for most countries: when uncertainty is substantially high, there are more deviations from UIRP, both in terms of deviations of α from zero as well as deviations of β from unity. For example, the case of Switzerland (depicted in Figure 2d) is emblematic: the negative values of the slope and the constant are clearly visible at the beginning of the sample, and that is also when the uncertainty is the highest. Similarly, in the case of UK and Canada (depicted in Figures 2e and 2a, respectively), the slope is closest to unity around 2005-2008, which is exactly when uncertainty is the lowest, and very different from unity both at the beginning (when the slope is negative) and towards the end of the sample (when the slope is positive and large), when uncertainty is the highest. For Europe, depicted in Figure 2(b), uncertainty is high for most of the sample we consider. Finally, in the case of Japan (depicted in Figure 2c) too, both the slope and the intercept are negative at the beginning of the sample, when the uncertainty is often at high levels.

To investigate more formally whether uncertainty can explain the UIRP puzzle, we estimate the following regression:

$$E_t\left(s_{t+h}-s_t\right)=\alpha_1\cdot(1-d_t)+\beta_1\cdot(1-d_t)\cdot\left(i_{t+h}-i^*_{t+h}\right)+\alpha_2\cdot d_t+\beta_2\cdot d_t\cdot\left(i_{t+h}-i^*_{t+h}\right), \quad (4)$$

where d_t is a dummy variable which equals one if the uncertainty is exceptionally high. Since the uncertainty indices are quite volatile, we smooth them out using the same rolling window that we used to estimate the parameters in the UIRP regression, equal to ten years of data. Time periods of high uncertainty are identified by situations in which uncertainty is in the upper quartile of its distribution, i.e. we identify high uncertainty periods with sub-samples with the 25% highest values of uncertainty.

INSERT TABLE 5 HERE

Table 5 reports the estimates of eq. (4) when uncertainty is measured by the overall uncertainty index. The table shows that the empirical evidence in favor of UIRP is weakest in periods where uncertainty is exceptionally high, and substantially stronger in periods where uncertainty is around normal values. More in detail, we note that, in the case of Switzerland, both values of α_2 and β_2 are negative and large in absolute value; since α_2 and β_2 are the constant and slope of the UIRP in periods of high uncertainty, the regression results confirm the existence of large deviations from UIRP when uncertainty is exceptionally high. However, in periods of low uncertainty, both α_1 and β_1 are closer to their theoretical values, and insignificantly different from them. Japan is another case where the slope switches from negative values (and significantly different from unity) during periods of high uncertainty, to positive values close to unity (and statistically insignificantly different from unity). In Canada and the UK, again, the slope is negative and close to zero for the former and large and positive for the latter in periods of high uncertainty, while it becomes positive and closer to unity in periods of low uncertainty; the constant also gets closer to its theoretical value of zero in periods of low uncertainty. In the case of Europe, the uncertainty state also drives the slope coefficient closer to its theoretical value; in all cases, the point estimates are more precisely estimated in periods of low uncertainty.

Table 6 and Figures 3-4 investigate whether the type of uncertainty matters, namely whether it is upside or downside uncertainty that is most important in resolving the UIRP puzzle. As Table 6 shows, except for countries such as Switzerland and Europe, for which the downside uncertainty seems the most important one that affects the slope parameters, the type of uncertainty does not matter much. Periods of downside uncertainty are typically associated with a more positive slope coefficient than periods of upside uncertainty in high uncertainty periods, although in both cases the slope coefficients gets closer to its theoretical value under the UIRP during low uncertainty times.

INSERT TABLE 6 AND FIGURES 3-4 HERE

Finally, we investigate whether uncertainty can help explaining UIRP deviations directly by estimating the following regression:

$$E_t\left(s_{t+h} - s_t\right) = \alpha + \beta\left(i_{t+h} - i^*_{t+h}\right) + \gamma U^*_{t+h}, \tag{5}$$

where U^*_{t+h} is the measure of uncertainty, and testing whether γ is significantly different from zero using the tests robust to instabilities. The results are reported in Table 7. Indeed the table shows that uncertainty does significantly help in explaining deviations from UIRP for all countries.

INSERT TABLE 7 HERE

6 Conclusions

This paper has investigated whether uncertainty can explain the short-run deviations from UIRP that we empirically observe in the data. We have found that deviations from UIRP are stronger in periods of high uncertainty, while UIRP tends to hold in periods of low uncertainty. While it is well-known that deviations from UIRP are large and time-varying, this is the first paper that provides an economic rationale for both the UIRP puzzle and the presence of time variation in UIRP coefficient estimates by linking UIRP deviations to uncertainty.

Additional analyses that could be carried out in the future include analyzing whether other uncertainty indices may also explain UIRP deviations, e.g. the macroeconomic uncertainty indices available in the literature. However, given the well-known exchange rate disconnect puzzle, we do not expect that to be the case. Also, one might investigate whether similar results hold at long horizons; however, the UIRP puzzle is really a puzzle at short horizons, which is what we focused on in this paper.

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Tables

Table 1. Data Description

Currency	Period	Code	Full Name
		Exchange rates:	
Swiss franc	1994M1:2015M1	SWISSF$	SWISS FRANC TO US $ (WMR) - EXCH. RATE
Canadian dollar	1994M1:2015M1	CNDOLL$	CANADIAN $ TO US $ (WMR) - EXCH. RATE
British pound	1993M11:2015M1	UKDOLLR	UK £ TO US $ (WMR) - EXCH. RATE
Japanese yen	1993M11:2015M1	JPXRUSD	JP JAPANESE YEN TO US $ - EXCH. RATE
Euro	1993M11:2015M1	EUDOLLR	EURO TO US $ (WMR&DS) - EXCH. RATE
		Interest rates:	
Switzerland	1993M11:2015M1	ECSWF3M	SWISS FRANC 3M DEPOSIT (FT/TR)
Canada	1993M11:2015M1	ECCAD3M	CANADIAN DOLLAR 3M DEPOSIT (FT/TR)
United Kingdom	1993M11:2015M1	ECUKP3M	UK STERLING 3M DEPOSIT (FT/TR)
Japan	1993M11:2015M1	ECJAP3M	JAPANESE YEN 3M DEPOSIT (FT/TR)
Europe	1999M2:2015M1	ECEUR3M	EURO 3M DEPOSIT (FT/TR)
United States	1993M11:2015M1	ECUSD3M	US DOLLAR 3M DEPOSIT (FT/TR)

Note to Table 1. The table reports mnemonics and descriptions for our data. All interest rates are "middle rates".

Table 2. Traditional UIRP Regressions

	Panel A. Full Sample		Panel B. Sub-sample ending in 2011	
Country:	α	β	α	β
Switzerland	-0.01	-0.59	-0.023	-0.817
	(-0.028;-0.002)	(-1.09;-0.100)	(-0.039;-0.007)	(-1.382;-0.252)
Europe	-0.007	0.391	-0.004	-0.351
	(-0.016;0.002)	(-0.576;1.358)	(-0.016;0.007)	(-1.178;0.476)
Canada	-0.001	-0.196	-0.003	-0.383
	(-0.007;0.004)	(-0.706;0.312)	(-0.010;0.003)	(-0.906;0.140)
UK	-0.004	0.378	-0.005	0.410
	(-0.012;0.004)	(-0.513;1.271)	(-0.014;0.004)	(-0.502;1.324)
Japan	-0.002	-0.118	-0.023	-0.585
	(-0.015;0.011)	(-0.533;0.296)	(-0.036;-0.010)	(-0.988;-0.181)

Note to the table. The table reports estimates of UIRP regressions in the full sample as well as a sub-sample ending in 2011.

Table 3(a). Instability Tests: Joint Test on α and β

Country:		QLR	Exp-W	Nyblom
Switzerland	Test statistic	39.08	15.11	3.55
	P-value	0	0	0
Europe	Test statistic	35.69	13.98	3.27
	P-value	0	0	0
Canada	Test statistic	24.54	9.44	2.44
	P-value	0	0	0
UK	Test statistic	50.09	19.9	1.98
	P-value	0	0	0
Japan	Test statistic	44.52	18.1	4.50
	P-value	0	0	0

Note to the table. The table reports joint tests of parameter instabilities on the two UIRP regression coefficients.

Table 3(b). Instability Tests: Test on the Constant (α)

Country:		QLR	Exp-W	Nyblom
Switzerland	Test statistic	23.73	7.377	0.671
	P-value	0	0	0.151
Europe	Test statistic	34.06	13.52	1.978
	P-value	0	0	0
Canada	Test statistic	16.40	4.763	0.862
	P-value	0	0	0.076
UK	Test statistic	3.150	0.544	0.171
	P-value	0.809	0.828	0.847
Japan	Test statistic	51.40	21.00	1.577
	P-value	0	0	0

Note to the table. The table reports tests of parameter instabilities on the constant coefficient in the UIRP regressions.

Table 3(c). Instability Tests: Test on the Slope (β)

Country:		QLR	Exp-W	Nyblom
Switzerland	Test statistic	26.81	8.74	1.746
	P-value	0	0	0
Europe	Test statistic	45.34	18.88	3.459
	P-value	0	0	0
Canada	Test statistic	27.28	10.68	2.416
	P-value	0	0	0
UK	Test statistic	26.44	8.54	1.06
	P-value	0	0	0.036
Japan	Test statistic	26.66	8.92	1.176
	P-value	0	0	0.023

Note to the table. The table reports tests of parameter instabilities on the slope coefficient in the UIRP regressions.

Table 4(a). Granger-causality Tests: Joint Test on α and β

Country:		Exp-W*	Mean-W*	Nyblom*	QLR*
Switzerland	Test statistic	68.91	121.76	31.93	146.45
	P-value	0	0	0	0
Europe	Test statistic	23.09	26.052	6.023	54.09
	P-value	0	0	0	0
Canada	Test statistic	57.23	89.393	16.28	120.36
	P-value	0	0	0	0
UK	Test statistic	44.90	48.059	8.28	98.60
	P-value	0	0	0	0
Japan	Test statistic	77.34	129.908	31.9604	163.7371
	P-value	0	0	0	0

Note to the table. The table reports tests of UIRP robust to parameter instabilities. The tests are performed jointly on both the constant and the slope in the UIRP regressions.

Table 4(b). Granger-causality Tests: Test on the Constant (α)

Country:		Exp-W*	Mean-W*	Nyblom*	QLR*
Switzerland	Test statistic	11.19	16.55	3.52	29.48
	P-value	0	0	0.021	0
Europe	Test statistic	11.32	13.16	3.02	29.36
	P-value	0	0	0.034	0
Canada	Test statistic	3.948	4.095	0.677	14.143
	P-value	0.123	0.404	0.550	0.051
UK	Test statistic	1.117	1.810	0.938	4.437
	P-value	0.822	0.847	0.404	0.820
Japan	Test statistic	17.31	6.837	1.749	43.652
	P-value	0	0.121	0.153	0

Note to the table. The table reports tests of UIRP robust to parameter instabilities. The tests are performed on the constant coefficient in the UIRP regressions.

Table 4(c). Granger-causality Tests: Test on the Slope (β)

Country:		Exp-W*	Mean-W*	Nyblom*	QLR*
Switzerland	Test statistic	9.363	26.81	8.74	1.746
	P-value	0.002	0	0	0
Europe	Test statistic	1.081	45.34	18.88	3.459
	P-value	0.298	0	0	0
Canada	Test statistic	0.946	27.28	10.68	2.416
	P-value	0.330	0	0	0
UK	Test statistic	1.216	26.44	8.54	1.0642
	P-value	0.270	0	0	0.036
Japan	Test statistic	0.559	26.66	8.926	1.176
	P-value	0.454	0	0	0.023

Note to the table. The table reports tests of UIRP robust to parameter instabilities. The tests are performed on the slope coefficient in the UIRP regressions.

Table 5: UIRP and Overall Uncertainty

Country	Low Uncertainty		High Uncertainty	
	α_1	β_1	α_2	β_2
Switzerland	0.001	0.469	-0.034	-9.389
	(-0.017;0.019)	(-0.274;1.213)	(-0.074;0.006)	(-19.342;0.564)
Europe	-0.001	1.918	-0.012	3.445
	(-0.015;0.013)	(0.188;3.649)	(-0.081;0.056)	(-3.518;10.407)
Canada	-0.005	1.632	-0.009	-0.114
	(-0.015;0.005)	(0.525;2.738)	(-0.041;0.024)	(-4.606;4.379)
UK	-0.007	0.332	-0.033	6.951
	(-0.017;0.003)	(-0.485;1.150)	(-0.067;0.000)	(4.754;9.147)
Japan	0.009	0.739	-0.002	-0.331
	(-0.007;0.025)	(0.089;1.390)	(-0.030;0.026)	(-1.186;0.523)

Note to the table. The table reports parameter estimates in eq. (4), where the measure of uncertainty is overall uncertainty.

Table 6: UIRP and Upside/Downside Uncertainty

Country		Low Uncertainty α_1	β_1	High Uncertainty α_2	β_2
Switzerland	Upside Unc.	0.000	0.926	-0.005	-0.149
		(-0.018;0.017)	(-0.011;1.863)	(-0.046;0.037)	(-1.599;1.301)
	Downside Unc.	0.000	0.419	-0.034	-9.340
		(-0.018;0.018)	(-0.324;1.162)	(-0.083;0.014)	(-20.664;1.983)
Europe	Upside Unc.	-0.007	1.946	0.016	1.500
		(-0.021;0.007)	(0.349;3.543)	(-0.007;0.039)	(-1.062;4.061)
	Downside Unc.	-0.004	3.059	-0.029	-0.380
		(-0.021;0.013)	(0.375;5.742)	(-0.046;-0.013)	(–1.498;0.738)
Canada	Upside Unc.	-0.007	1.347	-0.001	1.697
		(-0.019;0.005)	(-0.023;2.717)	(-0.016;0.013)	(0.450;2.945)
	Downside Unc.	-0.004	1.741	-0.010	0.751
		(-0.017;0.009)	(0.553;2.928)	(-0.034;0.015)	(-2.929;4.430)
UK	Upside Unc.	-0.010	0.312	-0.007	3.533
		(-0.019;-0.001)	(-0.557;1.181)	(-0.047;0.033)	(0.288;6.778)
	Downside Unc.	-0.011	1.356	-0.011	2.782
		(-0.025;0.002)	(-0.051;2.762)	(-0.050;0.029)	(-4.765;10.330)
Japan	Upside Unc.	0.009	0.739	-0.002	-0.331
		(-0.007;0.025)	(0.089;1.390)	(-0.030;0.026)	(-1.186;0.523)
	Downside Unc.	0.015	0.271	-0.008	1.153
		(-0.002;0.033)	(-0.249;0.791)	(-0.029;0.012)	(0.306;2.000)

Note to the table. The table reports parameter estimates in eq. (4), where the measure of uncertainty is either upside or downside uncertainty.

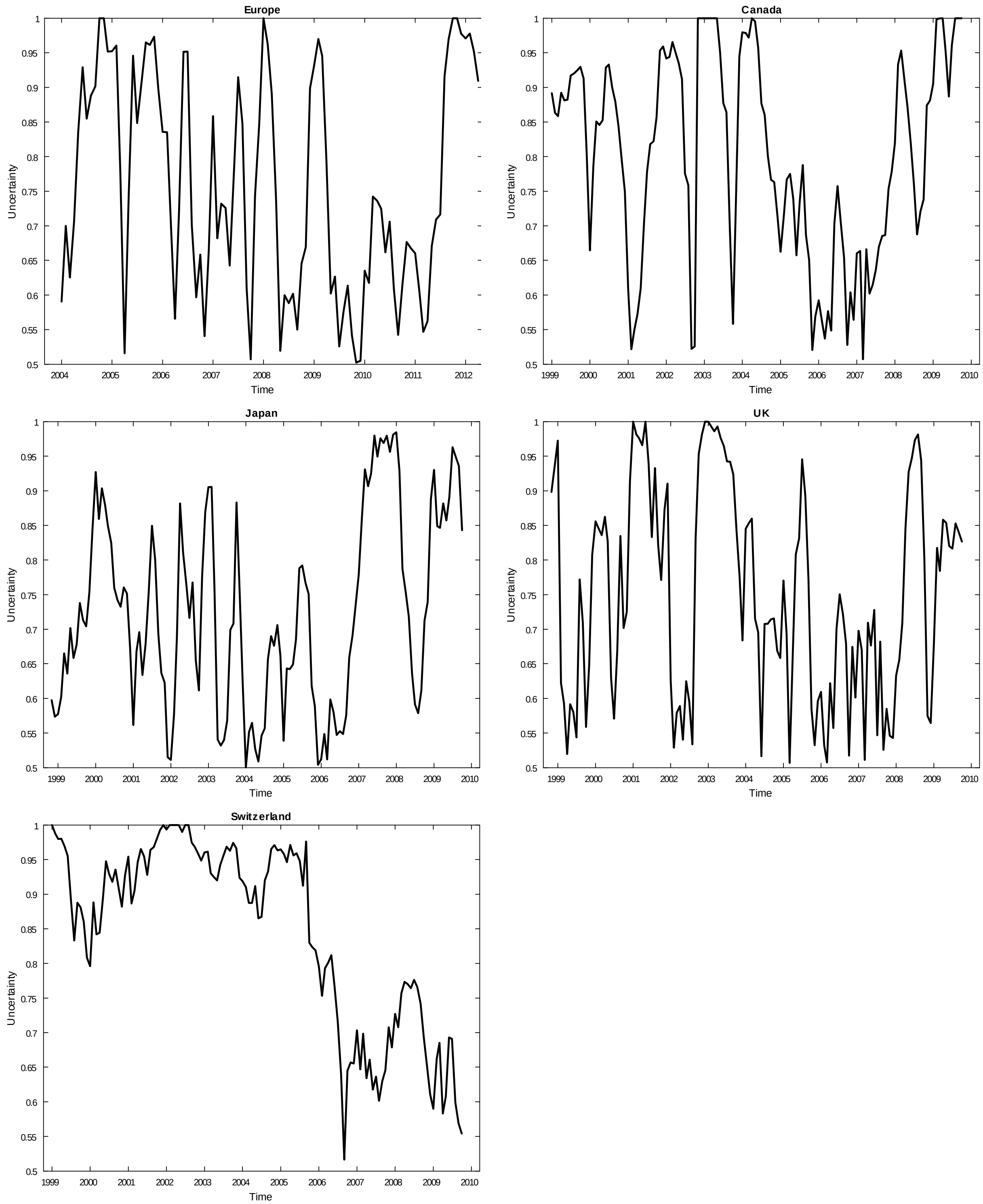
Table 7: Does Uncertainty Granger-cause Exchange Rates?

Country:		Exp-W*	Mean-W*	Nyblom*	QLR*
Switzerland	Test statistic	68.91	121.7	31.93	146.4
	P-value	0	0	0	0
Europe	Test statistic	23.09	26.05	6.02	54.09
	P-value	0	0	0	0
Canada	Test statistic	57.23	89.39	16.28	120.3
	P-value	0	0	0	0
UK	Test statistic	44.90	48.05	8.28	98.60
	P-value	0	0	0	0
Japan	Test statistic	77.34	129.9	31.96	163.7
	P-value	0	0	0	0

Note to the table. The table reports tests robust to parameter instabilities of whether uncertainty is a significant predictor in UIRP regressions.

Figures

Figure 1. Uncertainty Indices



Notes to the figure. The figure plots the overall uncertainty index for the countries in our sample.

Figure 2(a)

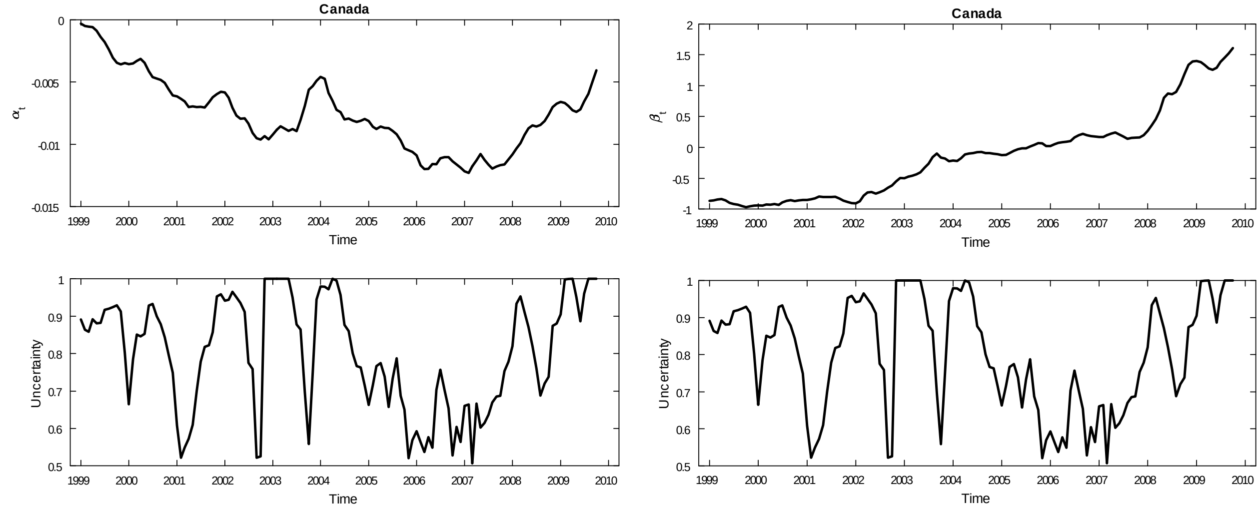


Figure 2(b)

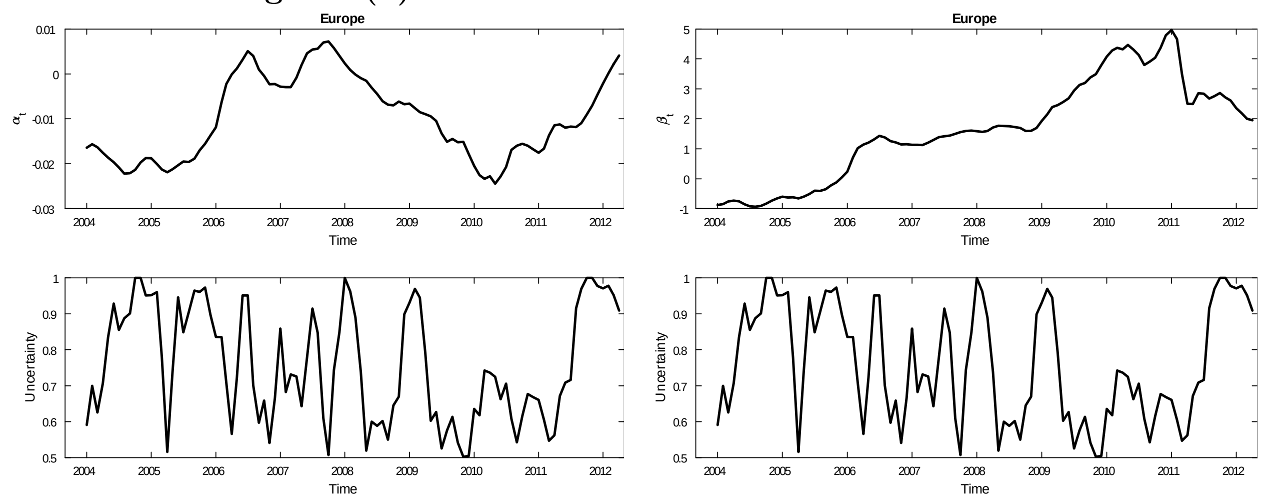


Figure 2(c)

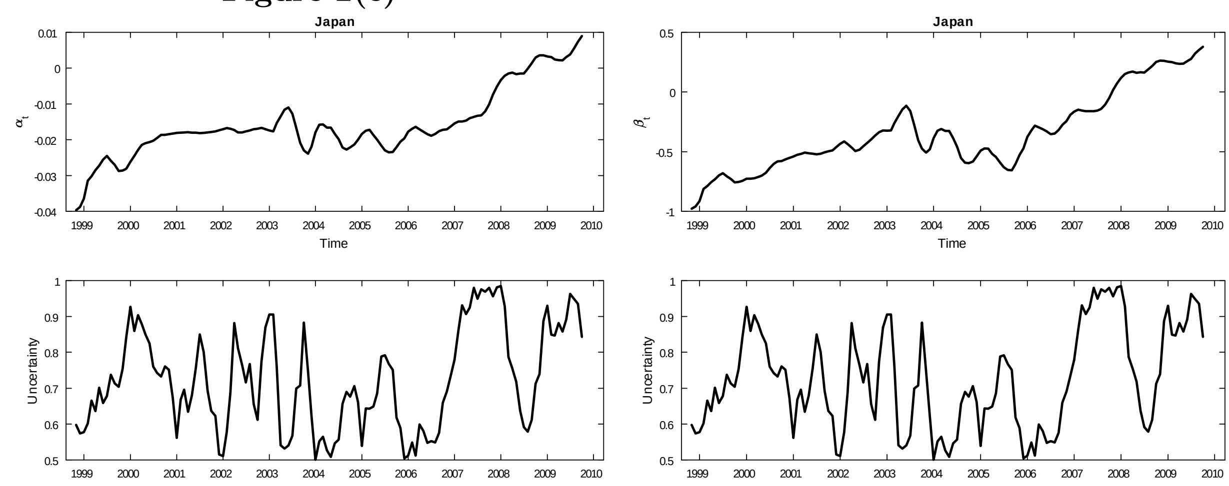


Figure 2(d)

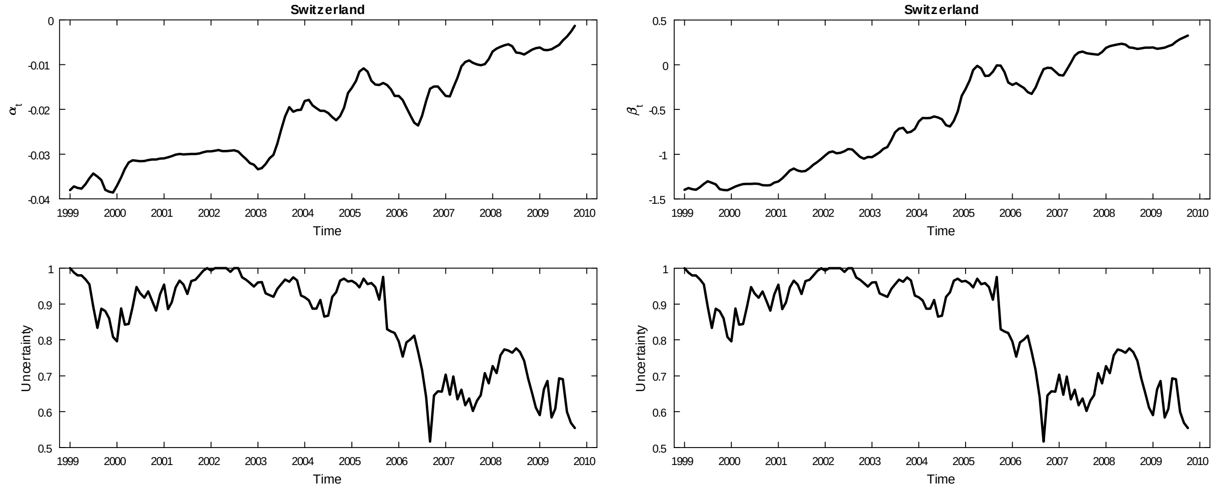


Figure 2(e)

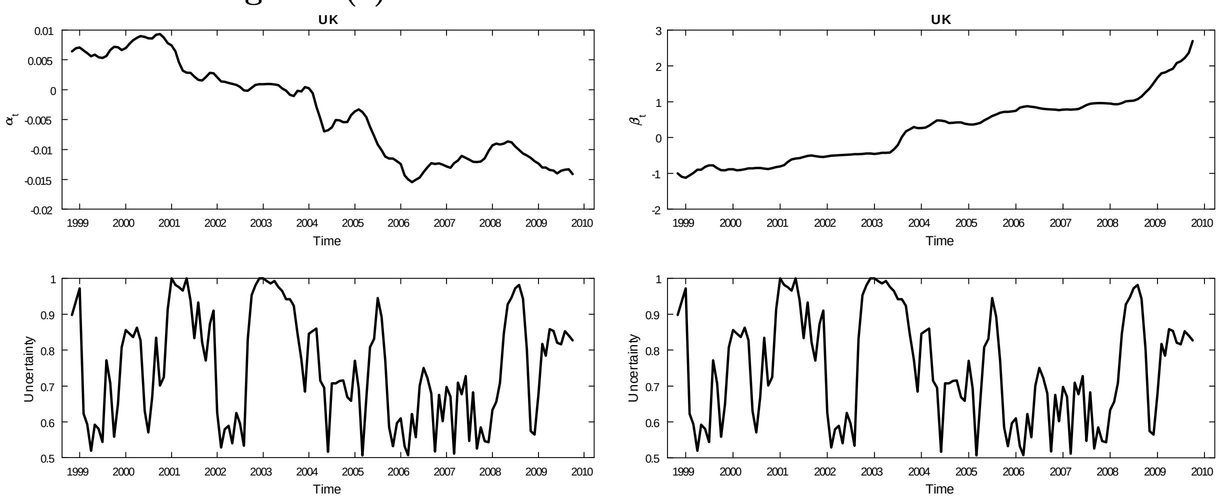


Figure 3(a)

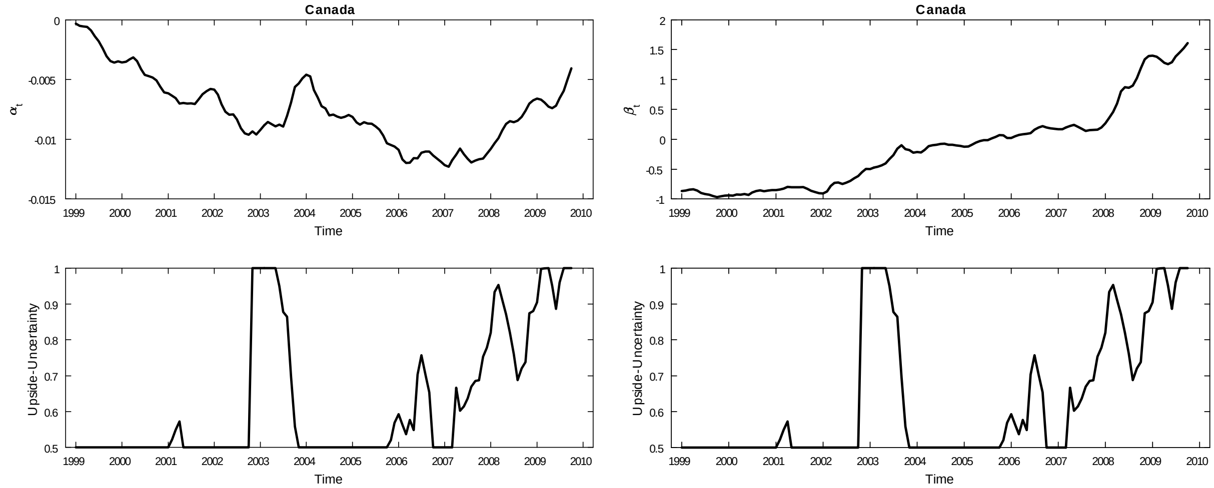
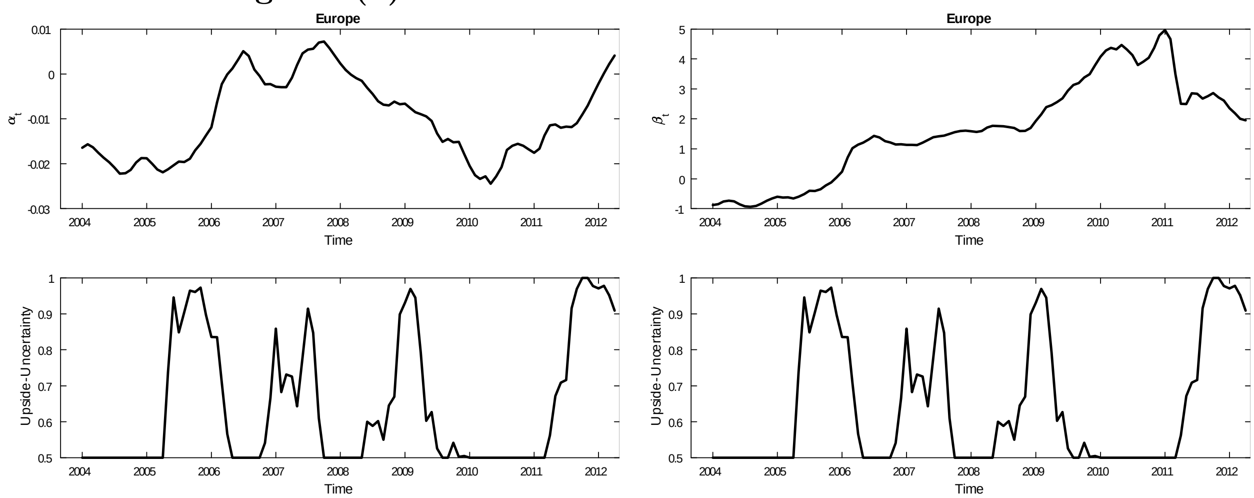


Figure 3(b)



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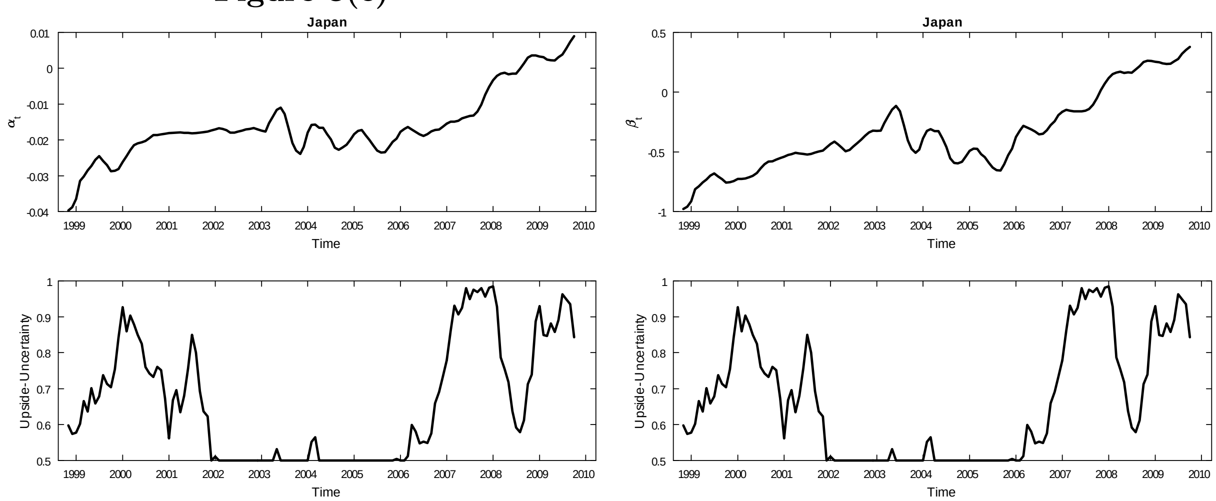

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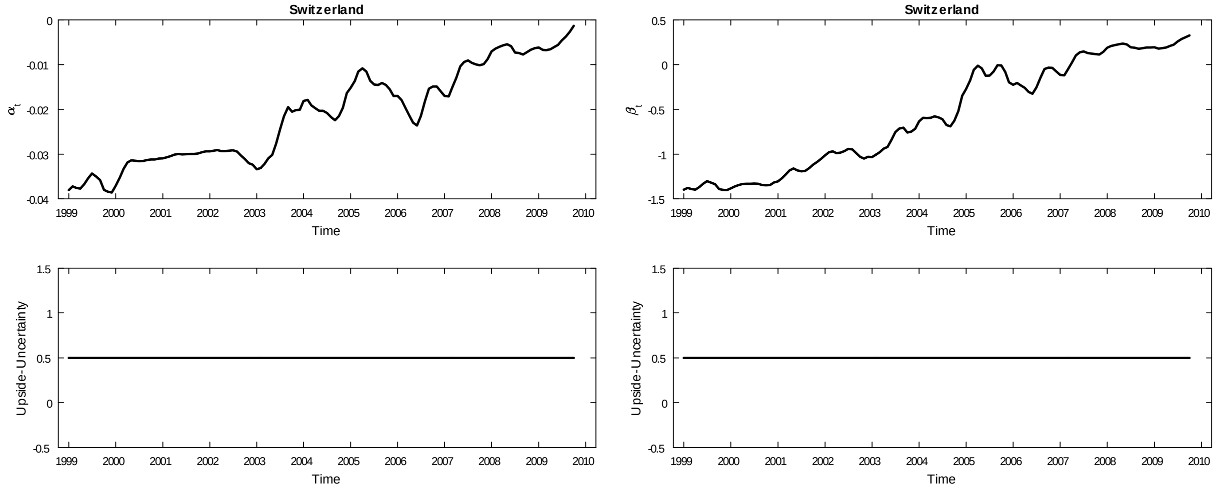

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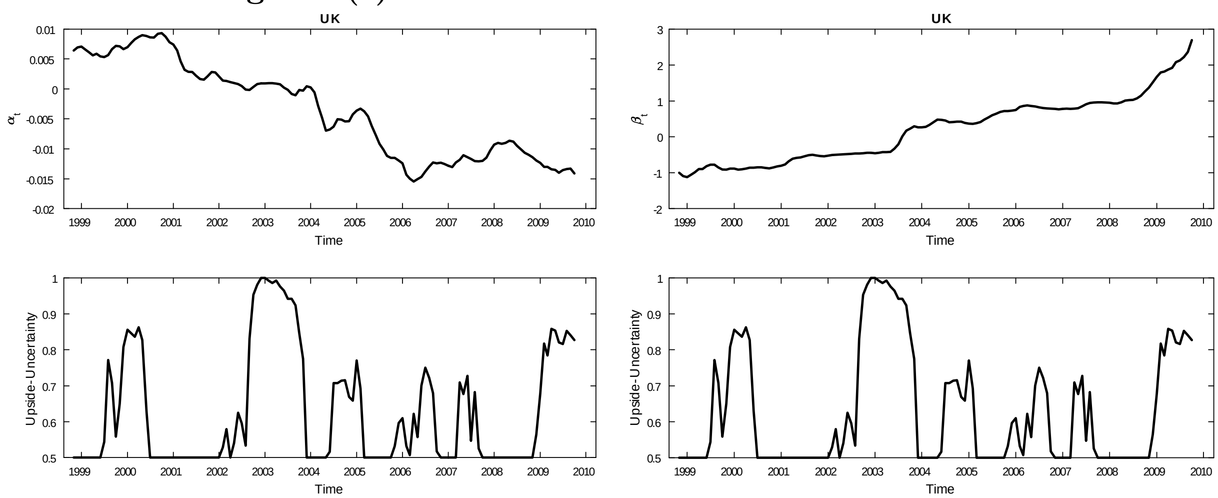


Figure 4(a)

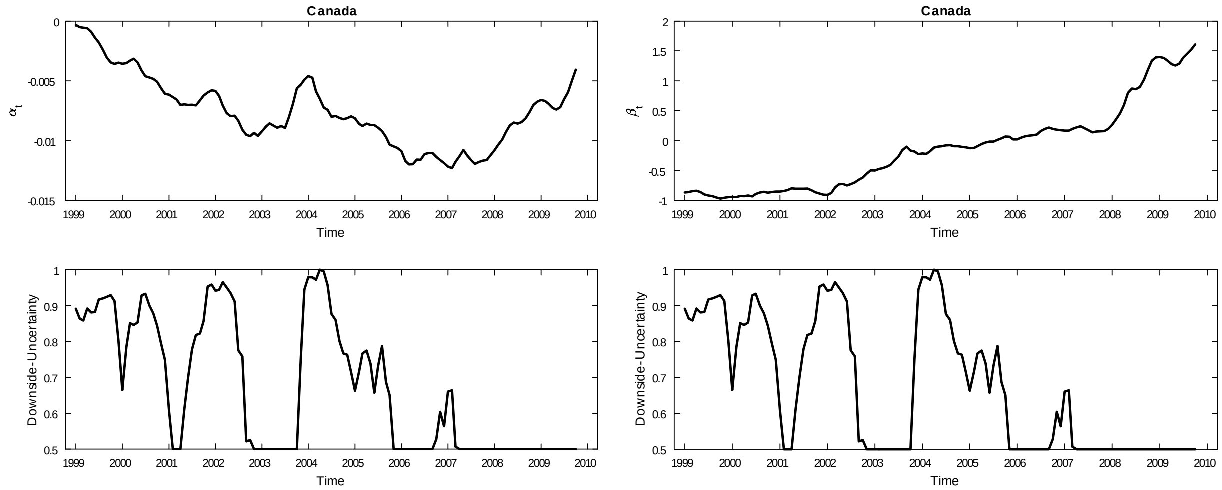


Figure 4(b)

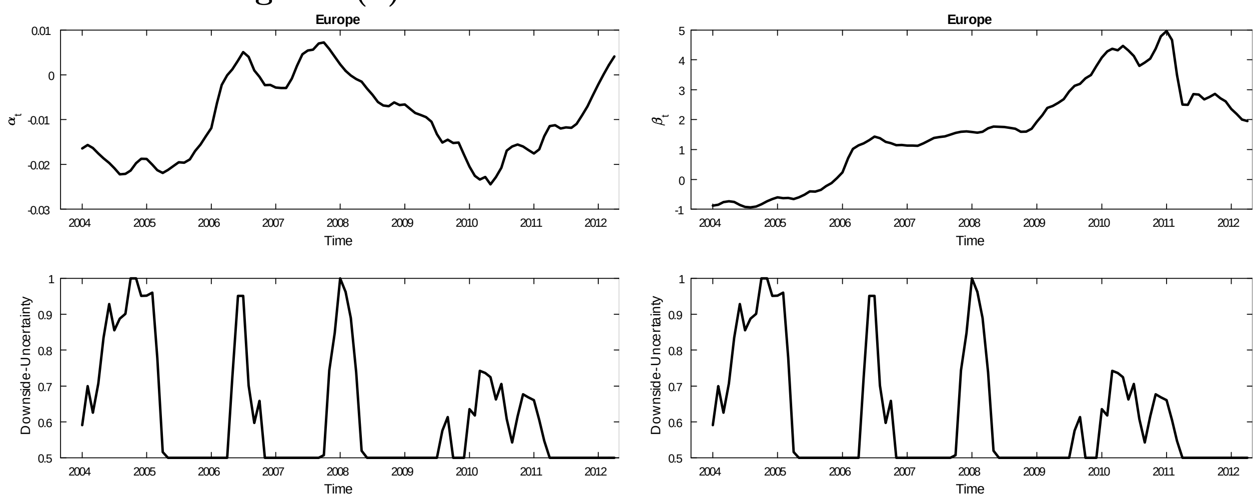


Figure 4(c)

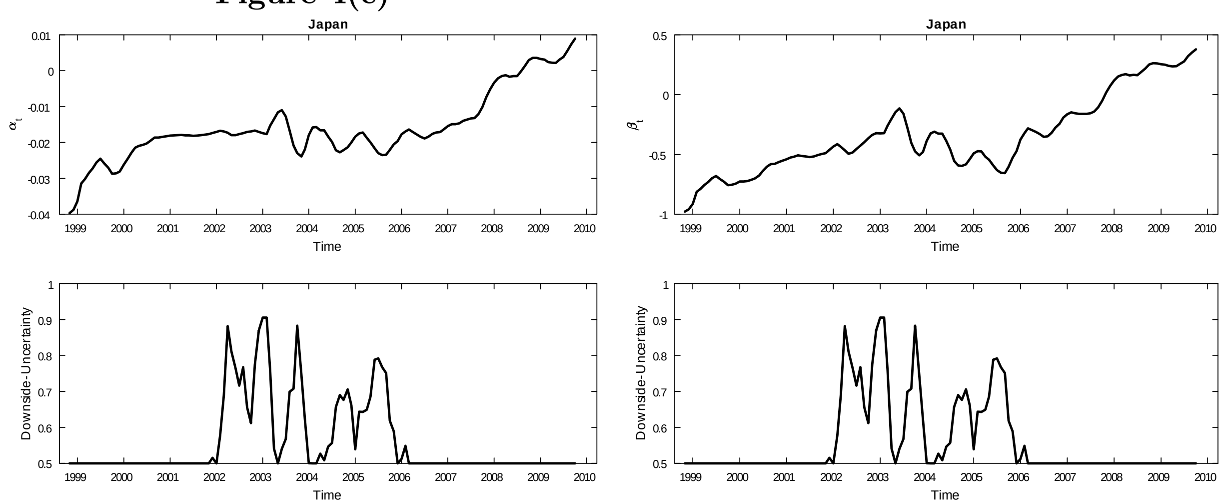


Figure 4(d)

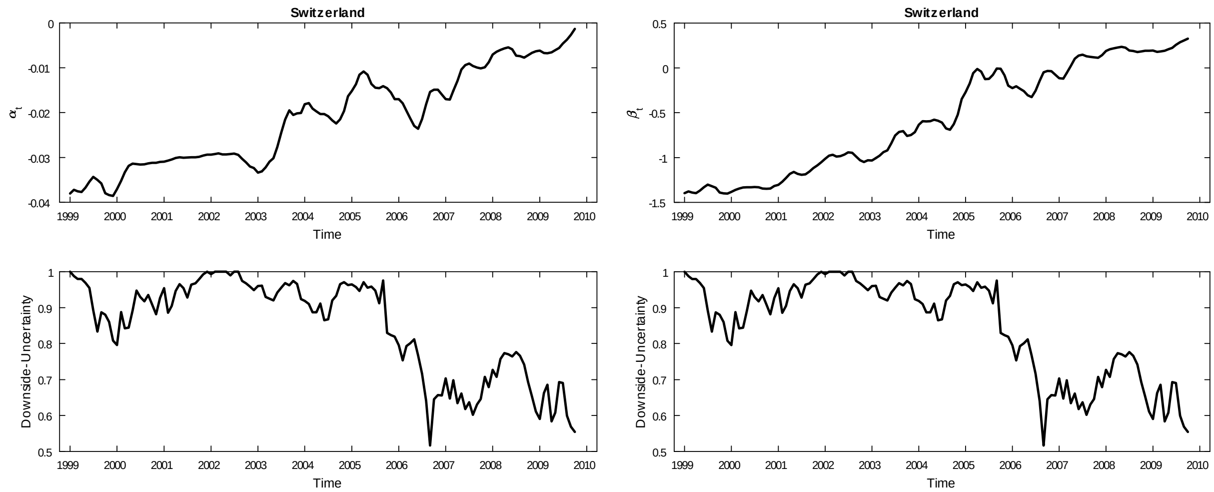
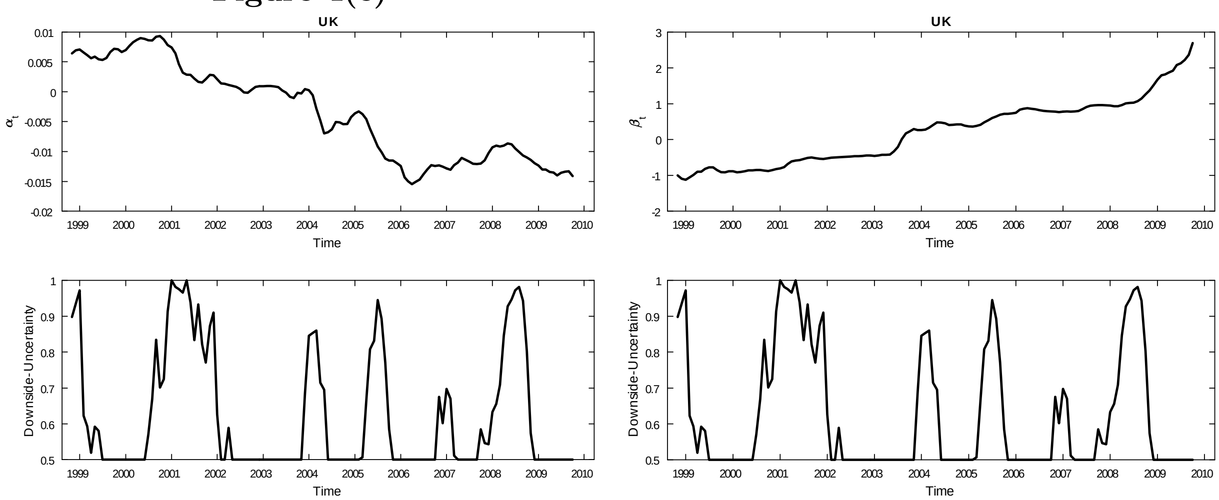


Figure 4(e)



Notes to Figure 2-4. The top panels in the figure plot the UIRP coefficients estimated in rolling windows (the constant is depicted on the left and the slope on the right). The bottom panels in the figures plot the corresponding uncertainty index, either overall uncertainty (Figure 2), upside uncertainty (Figure 3) or downside uncertainty (Figure 4).