Uncertainty and the Uncovered Interest Parity Condition: How Are They Related?

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A brief overview

The standard uncovered interest rate parity (UIP), after taking logarithms and ignoring Jensen's inequality, is given by

$$E_t s_{t+h} - s_t = i_{h,t} - i^*_{h,t}, \tag{1}$$

where

- E_t denotes the expectation conditional in time $1 \leq t \leq T$;
- s_t is the exchange rate (in logs);
- $i_{h,t}$ denotes the domestic interest rates that matures in period h;
- $i^*_{h,t}$ denotes the foreign interest rates that matures in period h.

A brief overview

Empirically this condition has been examined by regressing the (expected) change in the bilateral exchange rate on short-term deposit interest rate differential –the so-called Fama regression.

$$\widehat{s}_{t+h} - s_t = \alpha + \beta(i_{h,t} - i^*_{h,t}) + e_{t+h}, \tag{2}$$

where $\widehat{s}_{t+h}$ is an approximation of the expected value.

In this regression, the intercept and slope coefficients implied by the UIP condition are equal to zero and one.

There is a well-established literature that documents the failure of the uncovered interest parity (UIP) condition.

A brief overview

Most empirical studies, however, report that the estimated slope coefficient is either negative or smaller than one (Froot and Thaler, 1990, Bansal and Dahlquist, 2000, Burnside et al., 2006, among others).

This finding has been labeled the UIP puzzle. Several avenues have been explored as possible explanations for this puzzle.

First, most empirical studies have examined the joint hypothesis of UIP and rational expectations (Isard, 1996, Chinn and Meredith, 2004, Bussiere, et al. 2018).

In this line, other studies have examined whether exchange rate expectations are rational.

A brief overview

There is ample evidence that suggests the failure of the unbiasedness hypothesis (whether exchange rate forecasts are unbiased)-as prediction errors are often negatively related to the interest differential so that estimated slopes are negative (Meese and Rogoff, 1983, Froot and Thaler, 1990, Flood and Rose, 2002, among others).

Second, some studies have noted that the Fama regression equation could be omitting one or more explanatory variables.

If economic agents are risk-averse, then the Fama regression equation needs to include a time-varying risk premia term (non-standard preferences, Verdelhan, 2010, Lustig, et al. 2011; or introducing disaster risk, Farhi and Gabaix, 2008). The exclusion of such a variable might bias the slope coefficient downward.

A brief overview

Other variables that could affect the time-varying risk premia term are capital controls, exchange rate regime, inflation rate, and terms of trade (Farhi and Werning, 2014). Nevertheless, these same studies are unable to match other essential characteristics of the data -such as the evolution of the real exchange rate (Engel, 2015).

Third, other studies have explored the presence of non-linearities in the Fama regression equation.

The presence of non-linearities was initially justified as the result of transactions costs (Hollifield and Upal, 1997) or limits to speculation (Sarno et al. 2006).

Contribution

On the other hand, uncertainty can affect this equation because of its influence on:

- Aggregate investment and saving (Bloom, 2009, Bloom, et al., 2012).
- Financial market liquidity, as portfolio rebalances and funds move internationally (Rehse et al., 2019).
- Credit market conditions; since uncertainty hurts credit growth (Bordo et al., 2018).
- Currency risk. Higher excess returns in currency carry trade operations (Husted, Rogers, and Sun, 2017 and Berg and Mark, 2018).

All these suggest that uncertainty is an important omitted variable that could affect the Fama regression equation; thus, this paper examines how they are related in non-linear ways.

Methodology

Equation (2) is a time series model, it can be extended to a panel data model, that is

$$\widehat{s}_{it+h} - s_{it} = \mu_i + \alpha + \beta(i_{h,it} - i^{*}_{h,it}) + e_{it+h}, \tag{3}$$

where μ_i is an unobserved country-specific effect and is assumed to be fixed, and $1 \leq i \leq n$ indexes countries. Equation (3) is a panel model which allow us

- a more accurate inference of model parameters (more sample variability), since UIP time series estimations are unstable;
- to capture common parameters and to control for omitted variables and country-unobservable characteristics persistent over time;
- to reduce the correlation between current variable and its lags, since macroeconomic models are inherently dynamic.

Methodology

In order to test if uncertainty matters for the UIP equation, we estimate the following variation of the UIP

$$\widehat{s}_{it+h} - s_{it} = \begin{cases} \mu_i + \alpha_1 + \beta_1(i_{h,it} - i^*_{h,it}) + e_{it+h} & \text{if} \quad q_{it} \leq \gamma \\ \\ \mu_i + \alpha_2 + \beta_2(i_{h,it} - i^*_{h,it}) + e_{it+h} & \text{if} \quad q_{it} > \gamma, \end{cases} \tag{4}$$

where q_{it} stands for the uncertainty (threshold variable), γ is the threshold parameter and needs to me estimated. As in Ismailov and Rossi (2016) we are interested in testing if the UIP is more likely to hold under the low uncertainty regime.

Data

We collect monthly data for 14 countries or regions (Australia, Canada, Chile, China, Colombia, European Union, Hong Kong, India, Japan, Korea, Mexico, Singapore, Sweden and United Kingdom).

The period spans from January 2003 to December 2018, since uncertainty data for some countries are not available before 2003.

The exchange rates and the three-month deposit interest rates were obtained from Bloomberg, exchange rate forecasts from the Consensus Forecast, and the domestic and foreign uncertainties from the Economic Policy Uncertainty website.

The analysis for each country is respect to the currency who is anchored, all the cases respect to the U.S. Dollar, except Sweden, who is anchored to the Euro.

Data

We focus on the ex-ante approach by dropping the assumption of rational expectations, and we rely upon survey-based expectations of future exchange rates (Frankel and Chinn, 1993; Chinn and Frankel, 1994; Chinn and Frankel, 2019).

We use data from the Consensus forecast, which has been widely used in many empirical studies; this survey data is found to be more precise than the random walk forecast, the forecast implied by the forward rate, and forecast made by the OECD and IMF (Novotný and Raková, 2011; Batchelor, 2001).

Results: Test for threshold effects

Table 1: Tests for threshold effects

	Threshold estimate	Test F	Bootstrap p-value	Critical values
Country uncertainty as a threshold variable	115.930	93.595	0.005	41.612[1/] 51.488[2/] 83.160[3/]
Anchored uncertainty as a threshold variable	84.549	81.900	0.059	66.877[1/] 85.630[2/] 139.543[3/]
Weighted 1 uncertainty as a threshold variable	114.316	107.603	0.005	44.846[1/] 55.869[2/] 89.473[3/]
Weighted 2 uncertainty as a threshold variable	114.676	117.249	0.004	44.604[1/] 57.902[2/] 97.645[3/]

Note: 1/, 2/ and 3/ critical values at 10%, 5% and 1%, respectively. We used 1000 bootstrap replications for the test.

Results: Confidence interval of the threshold estimate

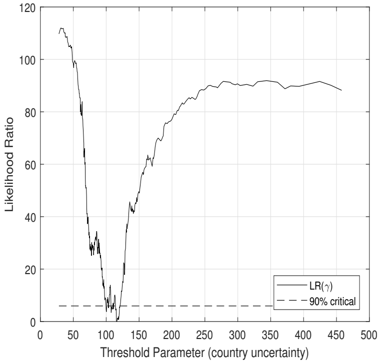
Table 2: Asymptotic confidence interval in threshold model

Threshold variable	Threshold estimate	90% confidence interval	99% confidence interval
Country uncertainty	115.930	[99.657 ; 120.577]	[97.584 ; 122.661]
Anchored uncertainty	84.549	[82.686 ; 89.915]	[78.506 ; 91.438]
Weighted 1 uncertainty	114.316	[75.486 ; 129.419]	[75.184 ; 129.938]
Weighted 2 uncertainty	114.676	[114.676 ; 128.112]	[113.014 ; 128.563]

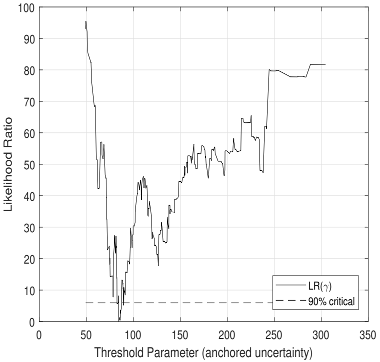
Results: Confidence interval of the threshold estimate

Figure 1: Confidence interval construction for threshold

(a) With country uncertainty



(b) with anchored uncertainty



Results: Slope estimation results

Table 3: Panel data estimation with an estimated threshold

	Linear estimation	Threshold estimation			
		Country EPU	Anchored EPU	Weighted 1 EPU	Weighted 2 EPU
$\widehat{\beta}$	0.473**	-	-	-	-
	(0.166)				
$\widehat{\alpha}_1 - \widehat{\alpha}_2$	-	-0.021**	-0.023**	-0.018**	-0.016**
		(0.005)	(0.005)	(0.004)	(0.004)
Low uncertainty					
$\widehat{\beta}_1$	-	1.031	1.501*	1.128	1.134
		(0.175)	(0.267)	(0.177)	(0.174)
High uncertainty					
$\widehat{\beta}_2$	-	-0.390**	0.009**	-0.297**	-0.337**
		(0.185)	(0.178)	(0.184)	(0.182)
Threshold estimate	-	115.930	84.549	114.316	114.676
99% confidence interval	-	[97.6 , 122.7]	[78.5 , 91.4]	[75.2 , 129.9]	[113.0 , 128.6]
Test for threshold effects	-	0.005	0.059	0.005	0.004
Observations	2674	2674	2674	2674	2674
Countries	14	14	14	14	14
Period	03m01-18m12	03m01-18m12	03m01-18m12	03m01-18m12	03m01-18m12

Notes: Heteroscedasticity and autocorrelation consistent (HAC) standard errors are in parentheses, lag length is set to $T^{\frac{1}{4}}$. The test for threshold effects shows the probability value for the null hypothesis of $\widehat{\alpha}_1 = \widehat{\alpha}_2$ and $\widehat{\beta}_1 = \widehat{\beta}_2$; we used 1000 bootstrap replications for the test. * and ** denote statistical significance at the 10 and 1 percent level, respectively, for the individual null hypotheses of an intercept equal to zero and a slope equal to 1.

Results: Observations in each regime across countries

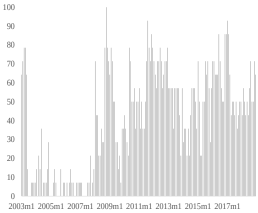
Table 4: Percentage of observations in each regime by country

Variable	*Country uncertainty*		*Anchored uncertainty*		*Weighted 1 uncertainty*		*Weighted 2 uncertainty*	
	Low	High	Low	High	Low	High	Low	High
Australia	70.8	29.2	20.3	79.7	54.2	45.8	64.6	35.4
Canada	37.0	63.0	20.3	79.7	43.8	56.3	42.2	57.8
Chile	72.4	27.6	20.3	79.7	69.3	30.7	70.8	29.2
China	46.4	53.6	20.3	79.7	45.8	54.2	45.8	54.2
Colombia	72.9	27.1	20.3	79.7	62.0	38.0	53.1	46.9
European Union	32.3	67.7	20.3	79.7	30.7	69.3	37.0	63.0
Hong Kong	44.8	55.2	20.3	79.7	44.8	55.2	45.8	54.2
India	72.9	27.1	20.3	79.7	71.4	28.6	71.9	28.1
Japan	68.8	31.3	20.3	79.7	62.0	38.0	57.3	42.7
Korea	45.3	54.7	20.3	79.7	43.8	56.3	44.8	55.2
Mexico	91.7	8.3	20.3	79.7	59.4	40.6	67.7	32.3
Singapore	54.2	45.8	20.3	79.7	53.1	46.9	53.1	46.9
Sweden	90.6	9.4	15.6	84.4	30.7	69.3	30.7	69.3
United Kingdom	29.2	70.8	20.3	79.7	28.6	71.4	53.1	46.9
Full sample	59.2	40.8	20.0	80.0	50.0	50.0	52.7	47.3

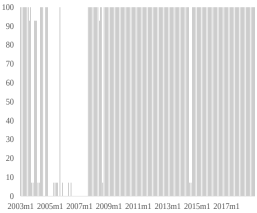
Results: Observations in each regime over time

Figure 2: Percentage of contries in a high uncertainty regime over time

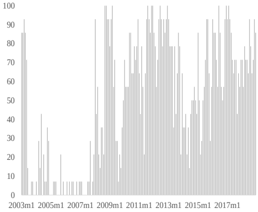
(a) Country uncertainty



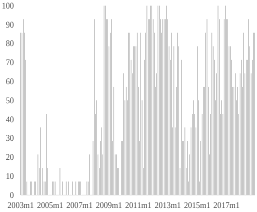
(b) Anchored uncertainty



(a) Weighted 1 uncertainty



(b) Weighted 1 uncertainty



Robustness: Adding control variables

Table 5: Panel data estimation with other controls as regressors

	Linear estimation	Threshold estimation			
		Country EPU	Anchored EPU	Weighted 1 EPU	Weighted 2 EPU
Capital controls	-0.100**	-0.112**	-0.107**	-0.112**	-0.108**
	(0.028)	(0.028)	(0.028)	(0.029)	(0.029)
Uncertainty	0.045*	0.047*	-0.149*	0.065*	0.012
	(0.024)	(0.026)	(0.056)	(0.031)	(0.044)
Terms of trade	-0.295**	-0.279**	-0.274**	-0.274**	-0.283**
	(0.060)	(0.058)	(0.059)	(0.058)	(0.058)
Inflation differentials	-0.002	-0.002*	-0.003**	-0.002*	-0.002*
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Exchange rate flexibility	0.001	0.001	0.002	0.001	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$\widehat{\beta}$	0.523**	-	-	-	-
	(0.166)	-	-	-	-
$\widehat{\alpha}_1 - \widehat{\alpha}_2$	-	-0.016**	-0.035**	-0.010*	-0.015*
		(0.006)	(0.006)	(0.005)	(0.006)
Low uncertainty					
$\widehat{\beta}_1$	-	1.089	1.528*	1.112	1.205
		(0.179)	(0.252)	(0.177)	(0.180)
High uncertainty					
$\widehat{\beta}_2$	-	-0.325**	0.091**	-0.330**	-0.275**
		(0.180)	(0.172)	(0.187)	(0.179)
Threshold estimate	-	115.930	85.969	127.938	114.676
99% confidence interval	-	[107.5 , 121.8]	[84.5 , 96.4]	[114.3 , 129.9]	[113.0 , 129.9]
Test for threshold effects	-	0.000	0.021	0.001	0.001
Observations	2674	2674	2674	2674	2674
Countries	14	14	14	14	14

Robustness: Adding time fixed variables

Table 6: Panel data estimation with time fixed effects

	Linear estimation	Threshold estimation			
		Country EPU	Anchored EPU	Weighted 1 EPU	Weighted 2 EPU
$\widehat{\beta}$	0.579*	-	-	-	-
	(0.202)				
$\widehat{\alpha_1} - \widehat{\alpha_2}$	-	-0.028**	-0.032**	-0.021**	-0.023**
		(0.005)	(0.011)	(0.005)	(0.005)
Low uncertainty					
$\widehat{\beta}_1$	-	1.341	2.153**	1.392*	1.251
		(0.214)	(0.288)	(0.216)	(0.206)
Low uncertainty					
$\widehat{\beta}_2$	-	-0.174**	0.273**	-0.140**	-0.299**
		(0.197)	(0.192)	(0.201)	(0.207)
Time dummies	Yes	Yes	Yes	Yes	Yes
Threshold estimate	-	118.667	84.549	120.337	128.112
99% confidence interval	-	[97.6 , 123.1]	[84.5 , 87.4]	[114.3 , 128.5]	[113.9 , 129.0]
Test for threshold effects	-	0.000	0.003	0.000	0.000
Observations	2674	2674	2674	2674	2674
Countries	14	14	14	14	14
Period	03m01-18m12	03m01-18m12	03m01-18m12	03m01-18m12	03m01-18m12

Notes: Heteroscedasticity and autocorrelation consistent (HAC) standard errors are in parentheses, lag length is set to $T^{\frac{1}{4}}$. The test for threshold effects shows the probability value for the null hypothesis of $\widehat{\alpha}_1 = \widehat{\alpha}_2$ and $\widehat{\beta}_1 = \widehat{\beta}_2$; we used 1000 bootstrap replications for the test. * and ** denote statistical significance at the 10 and 1 percent level, respectively, for the individual null hypotheses of an intercept equal to zero and a slope equal to 1. The linear estimation includes the own country uncertainty; the others uncertainty measures give pretty similar results.

Robustness: One-year forecast horizon

Table 7: Panel data estimation with one-year forecast horizon

	Linear estimation	Threshold estimation			
		Country EPU	Anchored EPU	Weighted 1 EPU	Weighted 2 EPU
$\widehat{\beta}$	0.338**	-	-	-	-
	(0.089)				
$\widehat{\alpha}_1 - \widehat{\alpha}_2$	-	-0.004*	-0.003	-0.002	-0.002
		(0.002)	(0.002)	(0.002)	(0.002)
Low uncertainty					
$\widehat{\beta}_1$	-	0.614**	0.737**	0.642**	0.635**
		(0.096)	(0.094)	(0.095)	(0.093)
High uncertainty					
$\widehat{\beta}_2$	-	-0.004**	0.123**	-0.021**	-0.073**
		(0.091)	(0.091)	(0.087)	(0.085)
Threshold estimate	-	117.796	91.438	127.938	128.563
99% confidence interval	-	[115.5 , 128.3]	[84.6 , 91.4]	[117.6 , 129.9]	[126.6 , 129.9]
Test for threshold effects	-	0.009	0.031	0.007	0.005
Observations	2674	2674	2674	2674	2674
Countries	14	14	14	14	14
Period	03m01-18m12	03m01-18m12	03m01-18m12	03m01-18m12	03m01-18m12

Heteroscedasticity and autocorrelation consistent (HAC) standard errors are in parentheses, lag length is set to $T^{\frac{1}{4}}$. The test for threshold effects shows the probability value for the null hypothesis of $\widehat{\alpha}_1 = \widehat{\alpha}_2$ and $\widehat{\beta}_1 = \widehat{\beta}_2$; we used 1000 bootstrap replications for the test. * and ** denote statistical significance at the 10 and 1 percent level, respectively, for the individual null hypotheses of an intercept equal to zero and a slope equal to 1.

Robustness: Maximum likelihood estimation

Table 8: Maximum likelihood panel data estimation

	Linear estimation	Threshold estimation			
		Country EPU	Anchored EPU	Weighted 1 EPU	Weighted 2 EPU
$\widehat{\beta}$	0.488**	-	-	-	-
	(0.032)				
$\widehat{\alpha}_1 - \widehat{\alpha}_2$	-	-0.020**	-0.022**	-0.016**	-0.015**
		(0.004)	(0.002)	(0.003)	(0.004)
Low uncertainty					
$\widehat{\beta}_1$	-	1.048	1.517**	1.093	1.148*
		(0.074)	(0.140)	(0.080)	(0.075)
High uncertainty					
$\widehat{\beta}_2$	-	-0.357**	0.037**	-0.368**	-0.305**
		(0.101)	(0.062)	(0.095)	(0.104)
Threshold estimate	-	115.930	84.475	127.938	114.676
99% confidence interval	-	[100.0 , 122.7]	[75.1 , 91.4]	[75.5 , 129.6]	[113.0 , 130.0]
Test for threshold effects	-	0.000	0.002	0.001	0.000
Observations	2674	2674	2674	2674	2674
Countries	14	14	14	14	14
Period	03m01-18m12	03m01-18m12	03m01-18m12	03m01-18m12	03m01-18m12

Notes: Standard errors are in parentheses. The test for threshold effects shows the probability value for the null hypothesis of $\widehat{\alpha}_1 = \widehat{\alpha}_2$ and $\widehat{\beta}_1 = \widehat{\beta}_2$; we used 1000 bootstrap replications for the test. * and ** denote statistical significance at the 10 and 1 percent level, respectively, for the individual null hypotheses of an intercept equal to zero and a slope equal to 1.

Conclusion

In this paper, we study whether uncertainty can help to explain the uncovered interest parity puzzle.

Using survey-based exchange rate expectations, we find that for a different measure of uncertainty, there exists a statistically significant uncertainty threshold that splits the sample into two regimes.

More importantly, our analysis finds that the UIP condition holds in the low-uncertainty regime but fails in the high-uncertainty one.

Why does UIP holds in a low-uncertainty regime but fails in a high-uncertainty one?