Expected Currency Returns

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Introduction: uncovered interest parity

- **Uncovered interest parity** (UIP) dictates that expected exchange rate returns should *equalize* cross-country interest rate differentials

$$\mathbb{E}_t^*\left[\frac{e_T}{e_t}\right] = \frac{R_{f,t}}{R_{f,t}^i}$$

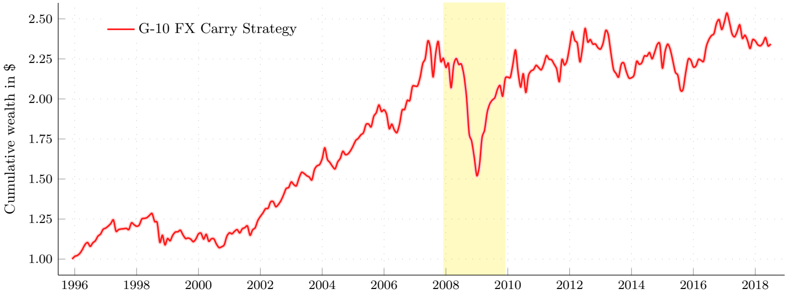
  - UIP builds on *rational expectations* and *risk-neutrality*, and is a key building block for a vast literature in international macro-finance.

- In the data, *UIP fails* to predict exchange rate returns

$$\mathbb{E}_t\left[\frac{e_T}{e_t}\right] \neq \frac{R_{f,t}}{R_{f,t}^i}$$

  - Why? A growing literature finds evidence of a **time-varying risk-premium** (e.g., Bilson, 1981; Fama 1984; Lustig *et al.*, 2011).

Introduction: uncovered interest parity



- A **currency excess return** can be made by simply selling *low-yielding* currencies and buying *high-yielding* currencies.

Introduction: risk-neutral vs physical measures

- This benchmark would fails as it requires that

$$\mathbb{E}_t\left[\frac{e_T}{e_t}\right] = \mathbb{E}_t^*\left[\frac{e_T}{e_t}\right].$$

- Measuring the changes of (ex-ante) risk-premiums could tell us
  - Changes in (representative) agent's risk preference, ambiguity aversion in international financial market (narrative of this talk)
  - Changes in the market conditions, financial constraints the intermediaries might face, changes in subjective beliefs of agents.

What we do...

- Theoretically, we provide a **flexible framework** that incorporate time-varying risk aversion (or ambiguity aversion/constraints) which can generate time varying *ex-ante* risk premia.
- Empirically, we measure expectation of currency returns from options on equity market index and exchange rates against US dollar.
  - ...and compare it to consensus forecasts (survey of professionals) on the G30 to pin down the risk preferences of the representative agent
  - ...both measurements of expected returns are forward looking, available in real time.

Theory: Our Setting

- We assume **no-arbitrage** through out this talk

$$\mathbb{E}_t\left[M_T R_{e,T}\right] = \mathbb{E}_t\left[M_T R^i_{f,t}\frac{e_T}{e_t}\right] = 1, \tag{1}$$

  - M_T is the *domestic* SDF between times t and T,
  - $R_{e,T}$ is the gross currency return from t to T,
  - e_t is the price of one unit of foreign currency at time t,
  - $R^i_{f,t}$ is the foreign gross riskless rate from t to T.

- Our work *does not* require the following assumptions:
  - Market completeness, log-normal DGP, all agents are rational, ...

Theory: settings

- We can expand the expectation and obtain

$$\mathbb{E}_t\left[\frac{e_T}{e_t}\right]\underbrace{\mathbb{E}_t[M_T]}_{1/R_{f,t}} + \mathrm{cov}_t\left(M_T, \frac{e_T}{e_t}\right) = \frac{1}{R^i_{f,t}}$$

which could be rewritten as

$$\mathbb{E}_t\left[\frac{e_T}{e_t}\right] - \frac{R_{f,t}}{R^i_{f,t}} = \mathrm{cov}_t\left(\frac{-M_T}{\mathbb{E}_t[M_T]}, \frac{e_T}{e_t}\right).$$

- Under risk-neutral expectations, the covariance term disappears and we would recover the UIP condition.

Theory: growth optimal return

- A *less well-known* result from the no-arbitrage theory is the existence of a *growth optimal return* that satisfies

$$M_T R_{g,T} \equiv 1.$$

- The *growth optimal return* is a portfolio which has a maximal expected growth rate over any time horizon.

Theory: a *risk-neutral* decomposition

- We can alternatively decompose the expected currency return as

$$\mathbb{E}_t[R_{e,T}] = \mathbb{E}_t[\overbrace{M_T R_{g,T}}^{=1} R_{e,T}] = R_{f,T}^{-1}\mathbb{E}_t^*\left[R_{g,T}R_{e,T}\right]$$
$$= R_{f,t} + R_{f,t}^{-1}\operatorname{cov}_t^*\left(R_{g,T}, R_{f,t}^{i}\frac{e_T}{e_t}\right).$$

- Dividing both sides by $R_{f,t}^{i}$ and rearranging terms, we have

$$\mathbb{E}_t\left[\frac{e_T}{e_t}\right] - \frac{R_{f,t}}{R_{f,t}^{i}} = \operatorname{cov}_t^*\left(\frac{R_{g,T}}{\mathbb{E}_t^*[R_{g,T}]}, \frac{e_T}{e_t}\right).$$

What is the advantage of the risk-neutral view?

- Two ways to decompose the expected return of exchange rate
  - under physical measure

$$\mathbb{E}_t\left[\frac{e_T}{e_t}\right] - \frac{R_{f,t}}{R^i_{f,t}} = \operatorname{cov}_t\left(\frac{-M_T}{\mathbb{E}_t[M_T]}, \frac{e_T}{e_t}\right),$$

  - under risk-neutral measure

$$\mathbb{E}_t\left[\frac{e_T}{e_t}\right] - \frac{R_{f,t}}{R^i_{f,t}} = \operatorname{cov}^*_t\left(\frac{R_{g,T}}{\mathbb{E}^*_t[R_{g,T}]}, \frac{e_T}{e_t}\right).$$

- The *risk-neutral view* has some advantages
  - It is (*at least partially*) observable from option prices
  - It is (*almost*) model free

Option implied expected returns

- A popular choice is setting

$$R_{g,T} = R^{\phi}_{mkt,T},$$

- We can then imply

$$\mathbb{E}_t\left[\frac{e_T}{e_t}\right] - \frac{R_{f,t}}{R^i_{f,t}} = \underbrace{\mathrm{cov}^*_t\left(\frac{R^{\phi}_{mkt,T}}{\mathbb{E}^*_t[R^{\phi}_{mkt,T}]}, \frac{e_T}{e_t}\right)}_{:=\,\mathrm{ERP}_{\phi,t}}. \tag{2}$$

  - ϕ could be time varying (here for rotational convenience it is written as a constant).

The Quanto theory of FX returns

- The Quanto theory of Kremens & Martin (AER, 2019) corresponds

$$R_{g,T} = R_{mkt,T}.$$

- Under the above assumption, our key equation simplifies to

$$\mathbb{E}_t\left[\frac{e_T}{e_t}\right] - \frac{R_{f,t}}{R^i_{f,t}} = R_{f,t}^{-1}\,\mathrm{cov}_t^*\left(R_{mkt,T}, \frac{e_T}{e_t}\right).$$

- There are some *advantages* of such a choice
  - The predictor is observable from *Quanto* forwards.
- There are also some *disadvantages* of such a choice
  - *Quanto* are observed monthly, limited cross section and maturity,
  - The log agent might not be the most accurate (at least) *conditionally*

What do we gain by allowing $\phi \neq 1$?

- Take a simple example of $\phi = 2$, we then have

$$\mathrm{ERP}_{2,t} = 2\mathrm{ERP}_{1,t} + \frac{1}{\mathbb{E}_t^*[R_{mkt,T}^2]} \operatorname{cov}_t^* \left((R_{mkt,T} - \mathbb{E}_t^*[R_{mkt,T}])^2, \frac{e_T}{e_t} \right).$$

  - The second term could be seen as the 'risk-neutral' co-skewness between exchange rate returns and market volatility
  - Quanto contract only captures the co-movement between exchange rate and market's level,
  - $\mathrm{ERP}_{\phi,t}$ captures FX rates' co-movement with the higher order risks (when $\phi > 2$).

Computing option implied expected returns

- The ERP consists of three pieces

$$\mathrm{cov}_t^*\left(\frac{R^{\phi}_{mkt,T}}{\mathbb{E}_t^*[R^{\phi}_{mkt,T}]}, \frac{e_T}{e_t}\right) = \rho^*_{\phi,t}\sqrt{\mathrm{var}_t^*\left(\frac{R^{\phi}_{mkt,T}}{\mathbb{E}_t^*[R^{\phi}_{mkt,T}]}\right)}\sqrt{\mathrm{var}_t^*\left(\frac{e_T}{e_t}\right)}.$$

  - The first $\mathrm{var}_t^*(\cdot)$ term is *observable* from index option.
  - The last $\mathrm{var}_t^*(\cdot)$ term is *observable* from FX options.

- The risk-neutral correlation $\rho^*_{\phi,t}$ is not directly observable:
  - Can check if the above naive methods are good when $\phi = 1$

Realized vs implied correlation when $\phi = 1$

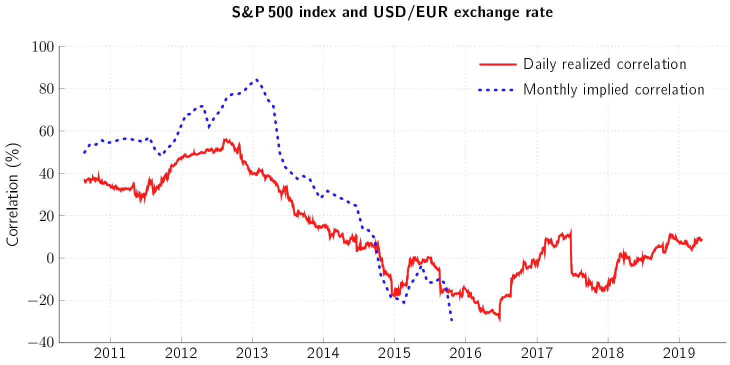


Figure: Empirical v.s. risk-neutral correlation

- Implied correlation is computed using Quanto price, options on S&P 500 index and options on USD/EUR.
- Realized correlation is computed in a rolling window fashion.

Option data

- Daily spot and forward exchange rates via DataStream.
- Daily data on S&P 500 index options (European style) obtained from OptionMetrics.
- Daily data on FX options (US dollar/foreign currency) between obtained from JP Morgan and Bloomberg (30 currencies)
  - AUD, BRL, CAD, CHF, CLP, CNY, CZK, DKK, EUR, GBP, HKD, HUF, IDR, ILS, INR, JPY, KRW, MXN, MYR, NOK, NZD, SEK, PHP, PLN, RUB, SGD, THB, TRY, TWD, ZAR.
- Maturities of 1 to 24 months, from 1996-2019 when available.

Survey data

- Monthly observations of consensus FX forecasts (30 foreign currencies in our sample) from Consensus Economics
  - AUD, BRL, CAD, CHF, CLP, CNY, CZK, DKK, EUR, GBP, HKD, HUF, IDR, ILS, INR, JPY, KRW, MXN, MYR, NOK, NZD, SEK, PHP, PLN, RUB, SGD, THB, TRY, TWD, ZAR.
- It covers all major market participants in FX market (banks, financial institutes) and some policy institutions,
- Forecast horizons up to 24 months

Unconditional analysis

- We estimate the unconditional level of ϕ by running panel regressions at the daily frequency as

$$\mathrm{ERX}_{i,t,T} = \alpha_i + \alpha_t + \beta_\phi \, \mathrm{ERP}^{(\phi)}_{i,t,T} + \varepsilon_{\phi,i,t,T},$$

  - α_i is currency fixed effect
  - α_t is time fixed effect
  - We also add a variety of controls

- We estimate the above equation for
  - Different forecast horizons and different values of ϕ,
  - Theory indicates the right choice of ϕ should give $\beta_\phi = 1$.

Full-sample with expected excess returns

Panel A: 1-month Maturity							
ϕ	1	2	3	4	5	6	7
ERP	5.085***	2.386***	1.473***	1.010***	0.730**	0.543**	0.409*
	(1.223)	(0.641)	(0.445)	(0.346)	(0.286)	(0.245)	(0.215)
R^2	0.330	0.330	0.329	0.329	0.329	0.328	0.328
N	152,627	152,627	152,627	152,627	152,627	152,627	152,627
Panel B: 3-month Maturity							
ERP	4.948***	2.463***	1.621***	1.196***	0.940***	0.770***	0.648***
	(0.941)	(0.505)	(0.358)	(0.283)	(0.237)	(0.205)	(0.182)
R^2	0.335	0.334	0.332	0.331	0.331	0.330	0.329
N	153,827	153,827	153,827	153,827	153,827	153,827	153,827
Panel C: 1-year Maturity							
ERP	2.235***	1.216***	0.872***	0.694***	0.584**	0.506**	0.448**
	(0.698)	(0.400)	(0.301)	(0.249)	(0.217)	(0.194)	(0.178)
R^2	0.455	0.455	0.454	0.454	0.454	0.453	0.453
N	153,740	153,740	153,740	153,740	153,740	153,740	153,740
Panel D: 2-year Maturity							
ERP	2.371***	1.358***	1.016***	0.837***	0.727***	0.654***	0.601***
	(0.690)	(0.404)	(0.309)	(0.259)	(0.227)	(0.206)	(0.192)
R^2	0.551	0.551	0.551	0.551	0.551	0.551	0.551
N	140,570	140,570	140,570	140,570	140,570	140,570	140,570
controls	✓	✓	✓	✓	✓	✓	✓
currency fe	✓	✓	✓	✓	✓	✓	✓
time fe	✓	✓	✓	✓	✓	✓	✓

Full-sample with expected exchange rate returns

Panel A: 1-month Maturity							
ϕ	1	2	3	4	5	6	7
ERP	4.605***	2.346***	1.589***	1.208***	0.976***	0.820***	0.707***
	(0.862)	(0.453)	(0.317)	(0.248)	(0.207)	(0.179)	(0.159)
R^2	0.334	0.334	0.333	0.333	0.332	0.332	0.332
N	154,876	154,876	154,876	154,876	154,876	154,876	154,876
Panel B: 3-month Maturity							
ERP	1.715***	0.880***	0.599***	0.458**	0.372**	0.315**	0.273**
	(0.565)	(0.301)	(0.213)	(0.169)	(0.142)	(0.124)	(0.111)
R^2	0.329	0.329	0.328	0.328	0.328	0.328	0.327
N	156,635	156,635	156,635	156,635	156,635	156,635	
Panel C: 1-year Maturity							
ERP	1.516***	0.834***	0.606***	0.491***	0.420***	0.372***	0.336***
	(0.456)	(0.256)	(0.191)	(0.157)	(0.137)	(0.123)	(0.113)
R^2	0.368	0.368	0.368	0.367	0.367	0.367	0.367
N	156,548	156,548	156,548	156,548	156,548	156,548	
Panel D: 2-year Maturity							
ERP	1.451***	0.829***	0.622***	0.516***	0.451***	0.408***	0.377***
	(0.512)	(0.294)	(0.222)	(0.185)	(0.162)	(0.146)	(0.136)
R^2	0.351	0.351	0.350	0.350	0.350	0.350	0.350
N	140,704	140,704	140,704	140,704	140,704	140,704	140,704
IRD	✓	✓	✓	✓	✓	✓	✓
currency fe	✓	✓	✓	✓	✓	✓	✓
time fe	✓	✓	✓	✓	✓	✓	✓

A linear truncation of $\text{ERP}_{\phi,t}$

- Recall the example we just discussed when $\phi = 2$, it looks like

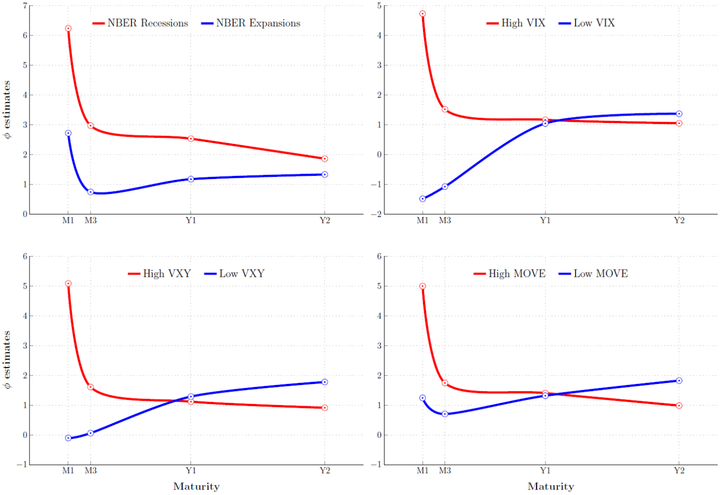
$$\text{ERP}_{2,t} = 2\text{ERP}_{1,t} + \text{residual}$$

A general decomposition is possible,

$$\text{ERP}_{\phi,t} = \phi\text{ERP}_{1,t} + \text{residual} \tag{3}$$

- We have claimed that the residual term might be important. The linear truncation in (3) makes it possible to verify this view empirically by comparing the regression coefficient of $\text{ERP}_{1,t}$ to the value of ϕ that returns coefficient 1.

Conditional term structure of slope coefficients



Summary

- *Theoretically*, we show how to extract a (almost) utility-free measure of risk preferences for FX market participants.
- *Empirically*, we show how to estimate this measure by comparing expected FX returns from professional forecasters and options.
- Unconditionally, the term structure of risk preferences is downward-sloping, i.e., FX risk premia provide a greater compensation for high-order risk as the forecast horizon decreases.
- Conditionally, this negative term structure slope strengthens in bad times, but becomes upward-sloping in good times.