Exchange Rate is Disconnected after All

Yu-Chin Chen[1], Ippei Fujiwara[2] and Yasuo Hirose[3]

[1]University of Washington

[2]Keio University, ANU and ABFER

[3]Keio University

December 14, 2018

RBNZ Conference on Macro-Finance

Confession

- This project is still at a very preliminary stage.
  - Estimation results are tentative.
  - Even the title of the paper is tentative.
- Many more (time-consuming) experiments must be conducted.
  - It takes about 45 days to estimate parameters using a machine equipped with 36 core CPU and 128GB DRAM.

Exchange Rate Disconnect

- Nominal exchange rate is an important driver of aggregate fluctuations as well as a key link between international goods and asset markets.
- However, endogenizing realistic exchange rate dynamics as observed in the data is a task that has alluded international macroeconomists for decades.
  - Estimation efforts of such general equilibrium models typically find fluctuations in nominal exchange rates to be unrelated to macroeconomic forces as shown in Lubik and Schorfheide (2006).
  - UIP is usually not empirically supported.
- Consequently, empirical evidence for the various transmission mechanisms of international policies and shocks through the exchange rate channel remains thin to non-existent, a pattern commonly referred to in the literature as the “exchange rate disconnect.”

What We Do

- This paper evaluates two recent alternative approaches by empirically estimating a full-fledged DSGE model that encompasses both sources of fluctuations: 1) direct shocks to exchange rates or the international arbitrage condition; and 2) macroeconomic volatility shocks that induce time-varying risks in the exchange rates.
  1. Financial frictions of the wedge in the international risk sharing condition hinder international arbitrage through the exchange rates.
  2. The empirical failure of UIP may be the result of linear or first-order approximation, as endogenous risk premium may arise from covariance between the stochastic discount factor and returns to international financial investments.
     - We may find a shock which increases domestic interest rates and, at the same time, makes the foreign assets riskier.

Related Literature

- Financial frictions or the wedge in the international arbitrage condition
  - (Lubik and Schorfheide (2006);) Alvarez et al. (2009); Gabaix and Maggiori (2015); Itskhoki and Mukhin (2017)
- Endogenous risks in open economies
  - Duarte and Stockman (2005); Brunnermeier et al. (2009); Alvarez et al. (2009); Backus et al. (2010); Verdelhan (2010); Benigno et al. (2011); Bansal and Shaliastovich (2012); Chen and Tsang (2013); Colacito and Croce (2013); Farhi and Gabaix (2015); Engel (2016)

Benigno et al. (2011)

- examine the role of nominal and real stochastic volatilities in explaining exchange rate behavior by simulating a two-country NOEM model with recursive preferences.
- A negative correlation emerges between expected changes in nominal exchange rates and nominal interest rate differentials in response to nominal volatility shocks.
  - A rise in the volatility of nominal shocks in the home country enhance the hedging properties of its currency relative to those of the foreign, thereby inducing endogenously a risk premium for foreign currency-holding.
  - A rise in home nominal volatility tends to reduce domestic output and increase domestic producer inflation, while the domestic nominal interest rate declines proportionately more than the foreign one.

Need for Estimation

- Our paper moves the evaluations of these mechanisms to an estimation framework and consider the fit to the data, instead of relying only on simulations with calibrated parameters as in Benigno et al. (2011).
  - Benigno et al. (2011): "the estimation of the model is really needed to evaluate its fit. To this purpose, an appropriate methodology should be elaborated to handle the features of our general second-order approximated solutions. We leave this research for future work."
  - Uribe (2011): "I would like to [suggest] an alternative identification approach. It consists of a direct estimation of a DSGE model. ... Admittedly, estimating DSGE models driven by time-varying volatility shocks is not a simple task."

- We first solve the two-country NOEM model using perturbation methods up to the third-order approximation.
  - Benigno et al. (2011) employ the analytical method with the second order approximation, which requires structural shocks to be conditionally normal.
- We then estimate the model with a full information Bayesian approach.
  - We approximate the likelihood function using the central difference Kalman filter proposed by Andreasen (2013).

Key Takeaways

- The time-varying volatilities in monetary policy shocks can replicate the negative coefficient in the Fama regression.
  - Higher nominal uncertainty makes the home currency less risky, appreciating it, and at the same time, raises relative nominal interest rates domestically.
- The various uncertainty shocks that induce time-varying exchange rate risk premium, cannot account for the exchange rate volatility observed in the data.
  - Currency fluctuations are mostly explained by the shock to the international risk sharing condition.
  - Exchange rates appear to remain disconnected from macroeconomic fundamentals, supporting the views offered by Itskhoki and Mukhin (2017).

Structure of Presentation

- Introduction
- Model
- Estimation Strategy
- Results
- Conclusion

Model

- The model is basically the same as the one in Benigno et al. (2011).
    - The non-recursive preference *a la* Epstein and Zin (1989) is introduced together with stochastic volatilities in the otherwise standard NOEM model.
    - There are three types of agents in each country: households, firms and the central bank.

Household

- A representative household in the domestic country maximizes welfare:

$$V_t = u\left(C_t, N_t\right) + \beta\left(\mathbb{E}_t V_{t+1}^{1-\varepsilon}\right)^{\frac{1}{1-\varepsilon}},$$

subject to the budget constraint:

$$P_t C_t + B_t + \mathbb{E}_t[m_{t,t+1}\frac{D_{t+1}}{\pi_{t+1}}] = R_{t-1}B_{t-1} + D_t + W_t N_t + T_t,$$

and aggregators:

$$C_t := \left[(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}},$$

$$C_{H,t} := \left[\int_0^1 C_{H,t}\left(j\right)^{1-\frac{1}{\mu}} \mathrm{d}j\right]^{\frac{\mu}{\mu-1}},$$

$$C_{F,t} := \left[\int_0^1 C_{F,t}\left(j^*\right)^{1-\frac{1}{\mu}} \mathrm{d}j^*\right]^{\frac{\mu}{\mu-1}}.$$

Firms

Firm j in the home country sets prices in a monopolistically competitive market to maximize the present discounted value of profits Π_t:

$$\mathbb{E}_t \sum_{n=0}^{\infty} \theta^n m_{t,t+n} \frac{\Pi_{t+n}(j)}{P_{t+n}},$$

where

$$n\Pi_{t+n}(j) = nP_{H,t}(j)\, C_{H,t}(j) + (1-n)\, e_t P^*_{H,t}(j)\, C^*_{H,t}(j) - W_t N_t(j),$$

subject to the production function:

$$Y_t(j) = A_{W,t} A_t N_t(j),$$

the law of one price:

$$P_{H,t}(j) = e_t P^*_{H,t}(j),$$

the firm-level resource constraint:

$$nY_t(j) = n\left[C_{H,t}(j) + G_{H,t}(j)\right] + (1-n)\, C^*_{H,t}(j),$$

the downward sloping demand curve which is obtained from households' problem:

$$C_{H,t}(j) = \left[\frac{P_{H,t}(j)}{P_{H,t}}\right]^{-\mu}(C_{H,t} + G_t),$$
$$C^*_{H,t}(j) = \left[\frac{P^*_{H,t}(j)}{P^*_{H,t}}\right]^{-\mu} C^*_{H,t} = \left[\frac{P_{H,t}(j)}{P_{H,t}}\right]^{-\mu} C^*_{H,t},$$

and the indexation rule when price is not reoptimized:

$$P_{H,t+n}(j) = \tilde{P}_{H,t}\prod_{i=1}^{n}\bar{\pi}^{1-\iota}\pi^{\iota}_{H,t+i-1}.$$

Aggregate Conditions

- The world technological progress is assumed to be nonstationary:

$$\frac{A_{W,t}}{A_{W,t-1}} = \gamma.$$

- Monetary policy is determined by following a rule:

$$\log\left(\frac{R_t}{R}\right) = \phi_r \log\left(\frac{R_{t-1}}{R}\right) + (1-\phi_r)\left[\phi_\pi \log\left(\frac{\pi_t}{\bar{\pi}}\right) + \phi_y \log\left(\frac{Y_t}{\gamma Y_{t-1}}\right)\right] + \log(\varepsilon_{R,t}).$$

- Aggregating the firm-level resource constraint leads to

$$nY_t = \Delta_t \left[n\left(C_{H,t} + G_t\right) + (1-n)\, C^*_{H,t}\right],$$

  where the price dispersion Δ_t is given by

$$\Delta_t := \int_0^1 \left[\frac{P_{H,t}(j)}{P_{H,t}}\right]^{-\mu} dj.$$

International Risk Sharing

- International risk sharing condition is given by

$$s_t \frac{\partial V_t}{\partial C_t} = \Omega_t \frac{\partial V_t^*}{\partial C_t^*},$$

where Ω_t is a shock to the international risk sharing condition, which works as the time varying exogenous financial frictions considered in Itskhoki and Mukhin (2017).

Shocks

- Shocks: (1) the domestic technology shock, (2) the foreign technology shocks, (3) the domestic monetary policy shock, (4) the foreign monetary policy shock, (5) the domestic government expenditure shock, (6) the foreign government expenditure shock, and (7) the shock to the international risk sharing conditions.
- Since shocks are given to both level and volatility, there are 14 structural shocks:

$$\begin{aligned}
\log\left(A_t\right) &= \rho_A \log\left(A_{t-1}\right) + \sigma_{A,t} u_{A,t}, \\
\log\left(A_t^*\right) &= \rho_A^* \log\left(A_{t-1}^*\right) + \sigma_{A,t}^* u_{A,t}^*, \\
\log(\varepsilon_{R,t}) &= \rho_\varepsilon \log(\varepsilon_{R,t-1}) + \sigma_{\varepsilon,t} u_{\varepsilon,t}, \\
\log(\varepsilon_{R,t}^*) &= \rho_\varepsilon^* \log(\varepsilon_{R,t-1}^*) + \sigma_{\varepsilon,t}^* u_{\varepsilon,t}^*, \\
\log\left(g_t\right) &= \left(1-\rho_g\right) \log \bar{g} + \rho_g \log\left(g_{t-1}\right) + \sigma_{g,t} u_{g,t}, \\
\log\left(g_t^*\right) &= \left(1-\rho_g^*\right) \log \bar{g} + \rho_g^* \log\left(g_{t-1}^*\right) + \sigma_{g,t}^* u_{g,t}^*, \\
\log\left(\Omega_t\right) &= \rho_\Omega \log\left(\Omega_{t-1}\right) + \sigma_{\Omega,t} u_{\Omega,t},
\end{aligned}$$

and

$$\sigma_{A,t} = (1-\rho_{\sigma_A})\,\sigma_A + \rho_{\sigma_A}\sigma_{A,t-1} + \sigma_A z_{\sigma_A,t},$$
$$\sigma^*_{A,t} = \left(1-\rho^*_{\sigma_A}\right)\sigma^*_A + \rho^*_{\sigma_A}\sigma^*_{A,t-1} + \sigma^*_A z^*_{\sigma_A,t},$$
$$\sigma_{\varepsilon,t} = (1-\rho_{\sigma_\varepsilon})\,\sigma_\varepsilon + \rho_{\sigma_\varepsilon}\sigma_{\varepsilon,t-1} + \sigma_\varepsilon z_{\sigma_\varepsilon,t},$$
$$\sigma^*_{\varepsilon,t} = \left(1-\rho^*_{\sigma_\varepsilon}\right)\sigma^*_\varepsilon + \rho^*_{\sigma_\varepsilon}\sigma^*_{\varepsilon,t-1} + \sigma^*_\varepsilon z^*_{\sigma_\varepsilon,t},$$
$$\sigma_{g,t} = (1-\rho_g)\,\sigma_g + \rho_g\sigma_{g,t-1} + \sigma_g z_{\sigma_g,t},$$
$$\sigma^*_{g,t} = \left(1-\rho^*_g\right)\sigma^*_g + \rho^*_g\sigma^*_{g,t-1} + \sigma^*_g z^*_{\sigma_g,t},$$
$$\sigma_{\Omega,t} = (1-\rho_\Omega)\,\sigma_\Omega + \rho_\Omega\sigma_{\Omega,t-1} + \sigma_\Omega z_{\sigma_\Omega,t}.$$

Estimation Strategy

Estimation Strategy

- Solve the model using a third-order approximation.
  - Andreasen et al. (2018): Higher-order perturbation method with pruning
- Estimate the model with a full-information Bayesian approach.
  - Standard Kalman filter is not applicable to evaluate likelihood.
  - Approximate the likelihood function using the Central Difference Kalman Filter proposed by Andreasen (2013).
    - Much faster than a particle filter
    - A quasi-maximum likelihood estimator can be consistent and asymptotically normal for DSGE models solved up to the third order
- Adopt the SMC algorithm developed by Herbst and Schorfheide (2014, 2015) to approximate posterior distributions.

Data

- Data: real GDP growth rate; inflation rate of the GDP deflator; three-month TB/Euribor rate for the US and the Euro area; and the depreciation of USD/Euro exchange rate
- Sample period: 1987Q1–2008Q4
  - Inflation was relatively stable
  - Not constrained by the ZLB

Priors

Parameter	Distribution	Mean	St. dev.
ψ	Beta	0.333	0.050
θ	Beta	0.667	0.050
ι	Beta	0.500	0.150
θ^*	Beta	0.667	0.050
ι^*	Beta	0.500	0.150
ϕ_r	Beta	0.750	0.100
ϕ_π	Gamma	1.500	0.150
ϕ_y	Gamma	0.125	0.050
ϕ_r^*	Beta	0.750	0.100
ϕ_π^*	Gamma	1.500	0.150
ϕ_y^*	Gamma	0.125	0.050
ρ_A	Beta	0.500	0.150
ρ_g	Beta	0.500	0.150
ρ_A^*	Beta	0.500	0.150
ρ_g^*	Beta	0.500	0.150
ρ_Ω	Beta	0.500	0.150

Priors (cont.)

Parameter	Distribution	Mean	St. dev.
$100\sigma_A$	Inverse Gamma	2.500	1.330
$100\sigma_g$	Inverse Gamma	2.500	1.330
$100\sigma_{\epsilon_R}$	Inverse Gamma	0.500	0.270
$100\sigma_A^*$	Inverse Gamma	2.500	1.330
$100\sigma_g^*$	Inverse Gamma	2.500	1.330
$100\sigma_{\epsilon_R}^*$	Inverse Gamma	0.500	0.270
$100\sigma_\Omega$	Inverse Gamma	2.500	1.330
τ_A	Inverse Gamma	1.250	0.640
τ_g	Inverse Gamma	1.250	0.640
τ_{ϵ_R}	Inverse Gamma	1.250	0.640
τ_A^*	Inverse Gamma	1.250	0.640
τ_g^*	Inverse Gamma	1.250	0.640
$\tau_{\epsilon_R}^*$	Inverse Gamma	1.250	0.640
τ_Ω	Inverse Gamma	1.250	0.640

Posterior Estimates

	Linear		3rd order		3rd order with S.V.	
	Mean	90% interval	Mean	90% interval	Mean	90% interval
ψ	0.354	[0.323, 0.390]	0.116	[0.083, 0.167]	0.227	[0.186, 0.276]
θ	0.320	[0.262, 0.374]	0.640	[0.621, 0.658]	0.566	[0.525, 0.606]
ι	0.135	[0.086, 0.217]	0.290	[0.201, 0.429]	0.406	[0.227, 0.563]
θ^*	0.353	[0.320, 0.392]	0.558	[0.520, 0.594]	0.547	[0.495, 0.588]
ι^*	0.097	[0.045, 0.147]	0.155	[0.094, 0.231]	0.475	[0.360, 0.599]
ϕ_r	0.565	[0.504, 0.610]	0.800	[0.775, 0.829]	0.775	[0.724, 0.822]
ϕ_π	1.919	[1.796, 2.066]	2.179	[1.756, 2.455]	1.384	[1.283, 1.473]
ϕ_y	0.157	[0.104, 0.211]	0.182	[0.131, 0.279]	0.084	[0.058, 0.111]
ϕ_r^*	0.668	[0.615, 0.731]	0.777	[0.731, 0.803]	0.673	[0.598, 0.751]
ϕ_π^*	2.270	[2.142, 2.411]	1.628	[1.531, 1.714]	1.497	[1.354, 1.652]
ϕ_y^*	0.382	[0.327, 0.426]	0.175	[0.091, 0.226]	0.143	[0.091, 0.201]
ρ_A	0.737	[0.651, 0.808]	0.425	[0.308, 0.642]	0.561	[0.479, 0.651]
ρ_g	0.881	[0.837, 0.922]	0.765	[0.687, 0.805]	0.489	[0.343, 0.630]
ρ_A^*	0.758	[0.700, 0.813]	0.656	[0.618, 0.753]	0.399	[0.295, 0.505]
ρ_g^*	0.870	[0.831, 0.902]	0.933	[0.909, 0.952]	0.746	[0.565, 0.913]
ρ_Ω	0.987	[0.982, 0.993]	0.993	[0.990, 0.996]	0.997	[0.994, 1.000]

Posterior Estimates (cont.)

	Linear		3rd order		3rd order with S.V.	
	Mean	90% interval	Mean	90% interval	Mean	90% interval
$100\sigma_A$	1.625	[1.256, 1.901]	4.919	[4.164, 5.260]	0.387	[0.269, 0.522]
$100\sigma_g$	11.43	[10.55, 12.54]	10.80	[10.13, 11.93]	0.299	[0.171, 0.399]
$100\sigma_{\epsilon_R}$	0.247	[0.215, 0.276]	0.162	[0.133, 0.176]	0.487	[0.307, 0.629]
$100\sigma_A^*$	2.228	[1.999, 2.471]	3.718	[3.256, 4.381]	0.520	[0.360, 0.617]
$100\sigma_g^*$	14.35	[13.14, 15.99]	9.123	[7.910, 9.896]	0.422	[0.300, 0.528]
$100\sigma_{\epsilon_R}^*$	0.242	[0.198, 0.283]	0.158	[0.141, 0.177]	0.240	[0.126, 0.343]
$100\sigma_\Omega$	5.643	[4.863, 6.322]	5.356	[4.844, 5.798]	0.287	[0.185, 0.404]
τ_A	-	-	-	-	2.447	[1.880, 2.994]
τ_g	-	-	-	-	5.260	[4.074, 6.275]
τ_{ϵ_R}	-	-	-	-	0.133	[0.107, 0.155]
τ_A^*	-	-	-	-	4.092	[2.882, 5.151]
τ_g^*	-	-	-	-	9.576	[8.134, 11.03]
$\tau_{\epsilon_R}^*$	-	-	-	-	0.176	[0.133, 0.208]
τ_Ω	-	-	-	-	5.442	[4.958, 5.882]
$\log p(\mathcal{Y}^T)$	-866.889		-885.051		-833.890	

Comparison to Benigno et al. (2011)

Parameter	Our Estimate	Calibration by BBN
ψ	0.227	0.333
θ	0.566	0.66
ι	0.406	-
θ^*	0.547	0.75
ι^*	0.475	-
ϕ_r	0.775	0.76
ϕ_π	1.384	1.41
ϕ_y	0.084	0.66
ϕ_{r^*}	0.673	0.84
ϕ_{π^*}	1.497	1.37
ϕ_{y^*}	0.143	1.27
ρ_A	0.561	0.71
ρ_g	0.489	0.53
ρ_A^*	0.399	0.71
ρ_g^*	0.746	0.53
ρ_Ω	0.997	-

Accounting for Exchange Rate Dynamics

- The log-linear approximation of the equilibrium conditions leads to the UIP condition:

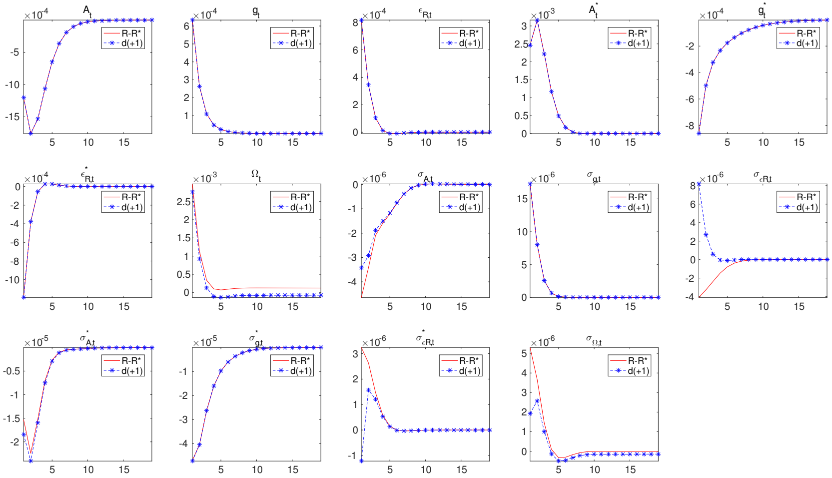
$$\hat{R}_t - \hat{R}_t^* = \mathbf{E}_t \hat{d}_{t+1} + \hat{\Omega}_t - \mathbf{E}_t \hat{\Omega}_{t+1},$$

- On the other hand, with the higher order approximation, the covariances between the stochastic discount factor and the payoff from the bond investment in the international arbitrage condition needs to be taken into account:

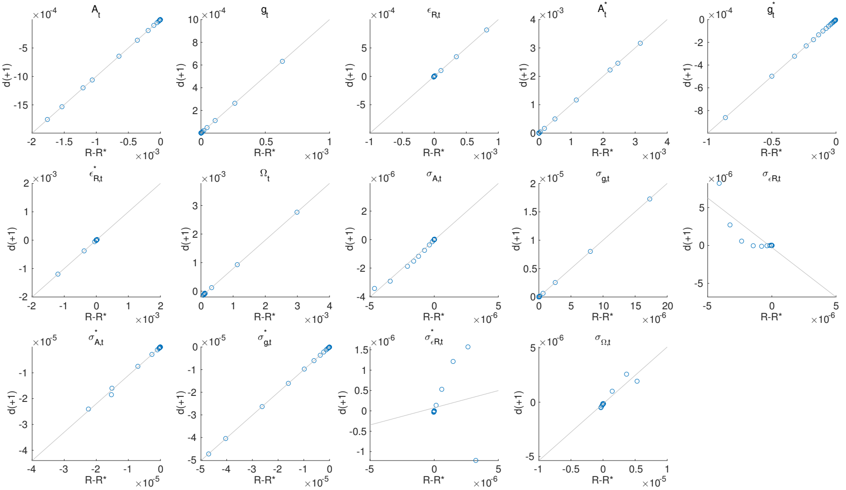
$$\mathbf{E}_t [m_{t,t+1} \frac{R_t}{\pi_{t+1}}] = \mathbf{E}_t [m_{t,t+1}^* \frac{R_t^*}{\pi_{t+1}^*}],$$

- The deviation from the UIP as observed in the data may emerge in the model, since the endogenous risk premium must be added to the UIP condition.

Responses of Interest Parity Condition



UIP Correlation



Nominal Uncertainty and Deviation from UIP

- More uncertainty in nominal shocks makes the home currency a good hedge and at the same time, leads to higher nominal interest rates, *i.e.* more demand for money, in the domestic country.
- The carry trade may yield positive excess returns.
  - The gains from the carry trade compensate for the risk of holding foreign currency to the uncertainty regarding monetary policy in the domestic country.
- These are obtained by Benigno et al. (2011) with a calibrated model.
  - They point out that interest rate smoothing and the price stickiness are key parameters to determine the size of the deviation from the UIP.

Risk Sharing Shock and Deviation from UIP

- The risk sharing shock leads to the movements consistent with UIP, which is counterfactual.
  - In Itskhoki and Mukhin (2017), the financial shock ($\approx$ the risk sharing shock) can replicate the negative coefficient in the Fama regression.
- This is because the risk sharing shock is estimated to be very persistent:

$$\hat{R}_t - \hat{R}^*_t = \mathbf{E}_t \hat{d}_{t+1} + \hat{\Omega}_t - \mathbf{E}_t \hat{\Omega}_{t+1}.$$

  - If it is not very persistent, the risk sharing shock can lead to the significant deviation from UIP.
  - This also tells the importance of the system estimation.

Relative Variance Excluding Each Shock

		$\Delta \log Y_t$	$\log \pi_t$	$\log R_t$	$\Delta \log Y_t^*$	$\log \pi_t^*$	$\log R_t^*$	d_t
Linear								
w/o:	u_A	0.592	0.434	0.226	1.000	0.994	0.981	0.986
	u_g	0.518	0.963	0.980	0.999	1.000	0.999	0.999
	u_{ϵ_R}	0.996	0.718	0.984	1.000	0.999	1.000	0.993
	u_A^*	0.999	0.981	0.966	0.537	0.339	0.293	0.984
	u_g^*	0.999	0.998	1.000	0.526	0.885	0.861	0.995
	$u_{\epsilon_R}^*$	1.000	0.999	0.999	0.998	0.818	0.986	0.995
	u_Ω	0.892	0.913	0.867	0.936	0.956	0.877	0.043
3rd order								
w/o:	u_A	0.596	0.351	0.322	0.998	0.980	0.977	0.979
	u_g	0.482	0.996	0.981	1.000	1.000	1.000	0.999
	u_{ϵ_R}	0.978	0.931	0.963	1.000	0.997	1.000	0.985
	u_A^*	0.999	0.957	0.941	0.475	0.175	0.122	0.980
	u_g^*	1.000	1.000	1.000	0.659	0.993	0.981	0.999
	$u_{\epsilon_R}^*$	1.000	0.996	0.999	0.984	0.929	0.979	0.987
	u_Ω	0.926	0.776	0.819	0.882	0.917	0.938	0.068
3rd order with SV								
w/o:	u_A	0.892	0.438	0.279	0.999	0.990	0.979	0.993
	u_g	0.140	0.996	0.966	0.999	1.000	1.000	0.999
	u_{ϵ_R}	0.986	0.746	0.904	1.000	0.993	0.995	0.946
	u_A^*	1.000	0.970	0.982	0.612	0.288	0.243	0.986
	u_g^*	1.000	0.999	1.000	0.532	0.991	0.963	0.998
	$u_{\epsilon_R}^*$	1.000	0.995	0.998	0.979	0.837	0.928	0.974
	u_Ω	0.973	0.836	0.903	0.903	0.881	0.880	0.106
	$z_{\sigma A}$	0.922	0.587	0.473	0.999	0.991	0.987	0.995
	$z_{\sigma g}$	0.159	0.996	0.967	0.999	1.000	1.000	0.999
	$z_{\sigma \epsilon_R}$	0.988	0.780	0.916	1.000	0.994	0.996	0.954
	$z_{\sigma A}^*$	1.000	0.988	0.994	0.821	0.670	0.659	0.993
	$z_{\sigma g}^*$	1.000	1.000	1.000	0.633	0.994	0.974	0.999
	$z_{\sigma \epsilon_R}^*$	1.000	0.996	0.999	0.981	0.867	0.939	0.978
	$z_{\sigma \Omega}$	0.990	0.936	0.958	0.962	0.952	0.952	0.631

- Regarding the changes in nominal exchange rates, other shocks than the international risk sharing shock can explain only about 5% of fluctuation with the first order approximation as well as the third order approximation without stochastic volatilities.
- Even if innovations to the volatilities of all structural shocks are added, the model can explain only around 10% of exchange rate fluctuations if the shock to the international risk sharing condition is excluded.
- Even the uncertainty shocks cannot explain the exchange rate dynamics as observed in the data.

Main Findings

- The time-varying volatilities in monetary policy shocks can replicate the negative coefficient in the Fama regression.
    - Higher nominal uncertainty makes the home currency less risky, appreciating it, and at the same time, raises relative nominal interest rates domestically.
- The various uncertainty shocks that induce time-varying exchange rate risk premium, cannot account for the exchange rate volatility observed in the data.
    - Currency fluctuations are mostly explained by the shock to the international risk sharing condition.
    - Exchange rates appear to remain disconnected from macroeconomic fundamentals, supporting the views offered by Itskhoki and Mukhin (2017).
    - This is because any proposed solutions for puzzles in international finance must also account for the high volatilities present in the exchange rates, but absent in other macroeconomic variables.

Future Extensions

- Future extensions include
  - long-run risks
  - trend inflation shocks
  - disaster shocks
  - news shocks
  - sunspot shocks