Monetary Policy and the Uncovered Interest Rate Parity Puzzle

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The Global Economy

Exchange Rates

NYU STERN

The idea

- Exchange rates…

The idea

- Exchange rates…

… where economic theory goes to die!!!

UIP 101

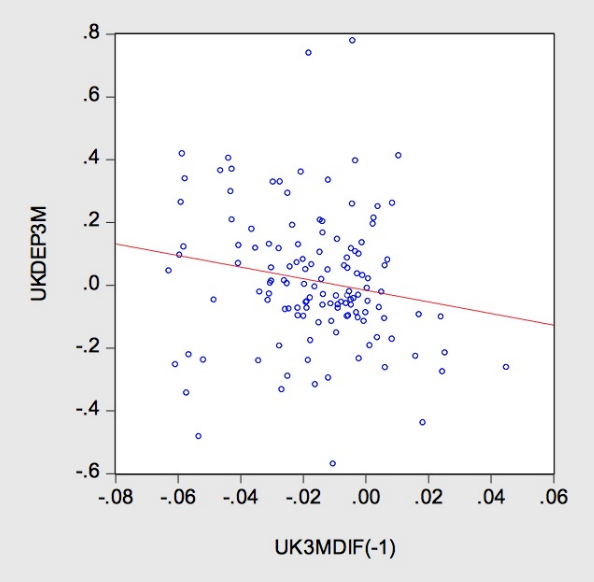
Simplest version of UIP

- cross-country nominal interest rates differences are compensation for expected currency depreciation

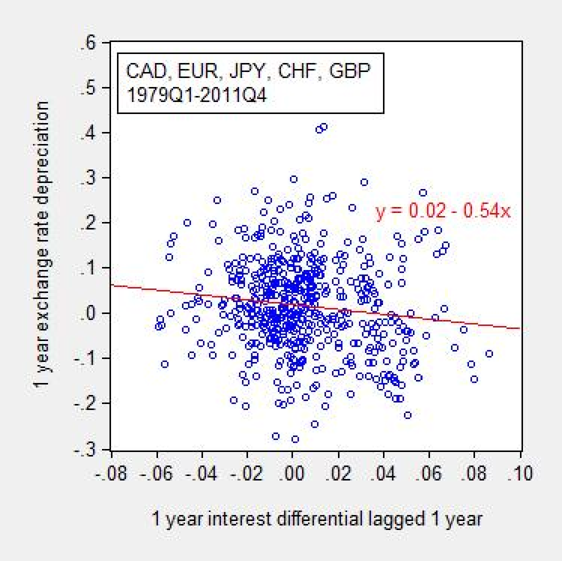
$$i_t - i_t^* \approx (s_{t+1} - s_t) + \text{noise}$$

- unfortunately, most of our models make this prediction... but the data look nothing like this

US-UK 3-months



US-World 1-year



CIP 101

What's missing from the simple UIP story? Risk!

$$\begin{aligned} i_t - i_t^* &= f_t - s_t \\ &= \underbrace{f_t - E_t s_{t+1}}_{\text{risk prem}} + \underbrace{E_t s_{t+1} - s_t}_{\text{exp depr}} \end{aligned}$$

- Now all we need to match the data is a sensible model of the risk premium
- How easy is that? See Backus's MBA slides.

Negative correlation?

Exchange rate movements driven by nominal pricing kernels

$$s_{t+1} - s_t = m^*_{t+1} - m_{t+1}$$

Negative correlation between interest rate spreads and currency depreciation requires

$$\text{Cov}(\underbrace{V_t m^*_{t+1} - V_t m_{t+1}}_{\text{risk prem}}, \underbrace{E_t m^*_{t+1} - E_t m_{t+1}}_{\text{exp depr}}) < 0$$

and

$$\text{Var}(V_t m^*_{t+1} - V_t m_{t+1}) > \text{Var}(E_t m^*_{t+1} - E_t m_{t+1})$$

That's really hard to get out of a structural model!

Question?

Does this have anything to do with monetary policy?

The model

- exchange economy with exogenous endowments
- persistent stochastic volatility of endowment growth rates
- recursive utility $\Rightarrow$ sensible asset pricing
- Taylor rule $\Rightarrow$ endogenous inflation
- 2 countries with different monetary policies

Real economy

- Preferences

$$U_t = [(1-\beta)c_t^\rho + \beta\mu_t(U_{t+1})^\rho]^{1/\rho}$$

$$\mu_t(U_{t+1})^\alpha = E_t U_{t+1}^\alpha$$

- marginal rate of intertemporal substitution

$$n_{t+1} = \log\beta + (\rho-1)\log(c_{t+1}/c_t) + (\alpha-\rho)[\log U_{t+1} - \log\mu_t(U_{t+1})]$$

- Endowment growth with stochastic volatility

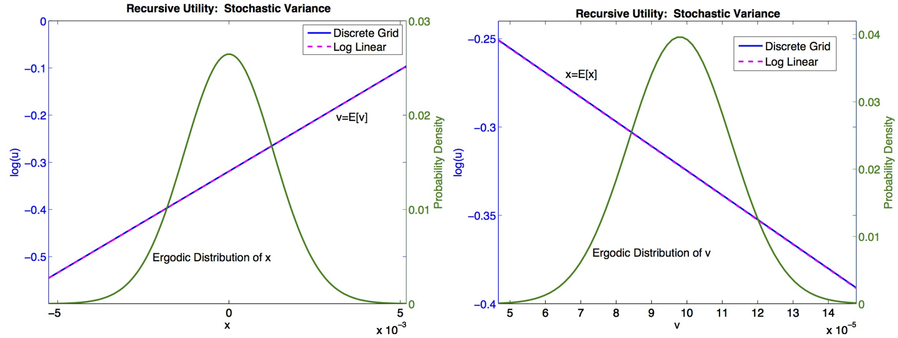
$$x_{t+1} = (1-\varphi_x)\theta_x + \varphi_x x_t + v_t^{1/2}\varepsilon_{t+1}^x$$

$$v_{t+1} = (1-\varphi_v)\theta_v + \varphi_v v_t + \sigma_v \varepsilon_{t+1}^v$$

Log-linear approximation

$$u_t \equiv \frac{U_t}{c_t} = \left[(1-\beta) + \beta \mu_t \left(\frac{U_{t+1}}{c_{t+1}} \frac{c_{t+1}}{c_t} \right) \right]^{1/\rho}$$

$$\log(u_t) \approx b_0 + b_1 \log \mu_t$$



Solution: Real pricing kernel

$$-n_{t+1} = \delta + \gamma_x x_t + \gamma_v v_t + \lambda_x v_t^{1/2} \varepsilon_{t+1}^x + \lambda_v \sigma_v \varepsilon_{t+1}^v$$

$$\gamma_x = (1-\rho)\varphi_x \qquad \gamma_v = \alpha(\alpha-\rho)(\omega_x+1)^2/2$$

$$\lambda_x = (1-\alpha) - (\alpha-\rho)\omega_x \qquad \lambda_v = -(\alpha-\rho)\omega_v$$

Inflation

- simple Taylor rule

$$i_t = \bar{\tau} + \tau_\pi \pi_t + \tau_x x_t$$

- could add a shock to this equation... later
- frictionless complete-markets model... TR just sets the value of the numeraire
- bond market must clear

$$i_t = -\log E_t e^{n_{t+1} - \pi_{t+1}}$$

Equilibrium inflation

- equilibrium inflation solves

$$\bar{\tau} + \tau_\pi \pi_t + \tau_x x_t = -\log E_t e^{\log n_{t+1} - \pi_{t+1}}$$

$$\Rightarrow \pi_t = \frac{1}{\tau_\pi}\left[-\bar{\tau} - \tau_x x_t - \log E_t e^{\log n_{t+1} - \pi_{t+1}}\right]$$

- note the role played by the Taylor principle: $\tau_\pi > 1$
- guess solution

$$\pi_t = a + a_x x_t + a_v v_t$$

Endogenous inflation

$$\pi_t = a + a_x x_t + a_v v_t$$

$$a_x = \frac{\gamma_x - \tau_x}{\tau_\pi - \varphi_x} \qquad a_v = \frac{\gamma_v - (\lambda_x + a_x)^2/2}{\tau_\pi - \varphi_v}$$

Nominal pricing kernel

$$\begin{aligned} -m_{t+1} &= -n_{t+1} + \pi_{t+1} \\ &= \delta^{\$} + \gamma_x^{\$} x_t + \gamma_v^{\$} v_t + \lambda_x^{\$} v_t^{1/2} \varepsilon_{t+1}^x + \lambda_v^{\$} \sigma_v \varepsilon_{t+1}^v \end{aligned}$$

$$\gamma_x^{\$} = \gamma_x + a_x \varphi_x \qquad \gamma_v^{\$} = \gamma_v + a_v \varphi_v$$

$$\lambda_x^{\$} = \lambda_x + a_x \qquad \lambda_v^{\$} = \lambda_v + a_v$$

Foreign inflation

- foreign economy has its own monetary policy summarized by a different Taylor rule

$$i_t^* = \bar{\tau}^* + \tau_\pi^* \pi_t^* + \tau_x^* x_t$$

- all other parameters of the model common across the two countries (complete markets)
- solve for foreign inflation and the foreign nominal pricing kernel
- given both pricing kernels we can now talk about exchange rates

Results: theory

Risk premium on foreign currency is increasing in $\tau_x^* - \tau_x$ and decreasing in $\tau_\pi^* - \tau_\pi$

- a relatively pro-cyclical monetary policy creates a relatively risky currency
- a relatively stronger anti-inflationary monetary policy creates a relatively safer currency

Note: TR parameters also affect expected depreciation rates

Simpler example

- turn off x_t: $\varphi_x = 0$, $\tau_x = \tau_x^* = 0$

$$\Rightarrow a_x = a_x^* = 0 \qquad a_v = \frac{\gamma_v}{\tau_\pi - \varphi_v} \qquad a_v^* = \frac{\gamma_v}{\tau_\pi^* - \varphi_v}$$

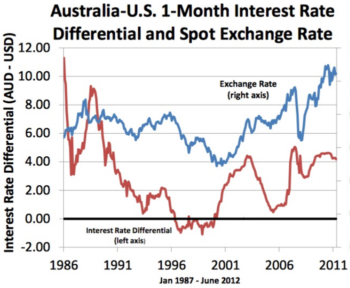
- expected depreciation rate

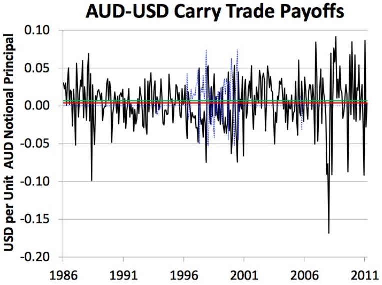
$$\begin{aligned} E_t m_{t+1}^* - E_t m_{t+1} &\approx \gamma_v^{\$} - \gamma_v^{*\$} \\ &= (\gamma_v + a_v) - (\gamma_v + a_v^*) \\ &= a_v - a_v^* \end{aligned}$$

- risk premium

$$\begin{aligned} V_t m_{t+1}^* - V_t m_{t+1} &\approx (\lambda_v^{\$*})^2 - (\lambda_v^{\$})^2 \\ &= (\lambda_v + a_v^*)^2 - (\lambda_v + a_v)^2 \end{aligned}$$

Results: quantitative (US v. Australia)





Quantitative limitations of complete markets

- under the assumption of complete markets the real exchange rate is exactly 1 and doesn't change
- differences in the nominal pricing kernels are driven entirely by differences in the inflation processes
- choose TR parameters to match inflation moments $\Rightarrow$ exchange rate properties unrealistic
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- Solutions? Add more shocks? Relax complete markets?

Aside: monetary policy shocks

- Add unobservable shocks to each country's Taylor rule

$$
\begin{aligned}
i_t &= \bar{\tau} + \tau_\pi \pi_t + \tau_x x_t + z_t \\
i_t^* &= \bar{\tau}^* + \tau_\pi^* \pi_t^* + \tau_x x_t + z_t^*
\end{aligned}
$$

- Even if policies are perfectly symmetric, these shocks will drive differences in the pricing kernels:

$$m_{t+1}^* - m_{t+1} \approx z_{t+1}^* - z_{t+1}$$

$\Rightarrow$ potential for reverse engineering

- What about the nominal term structures in each country?

Calibration

Description	Parameter		Value	
Panel A: The Real Economy				
Discount factor	β		0.993	
Relative risk aversion	$1-\alpha$		90.408	
Elasticity of intertemporal substitution	$(1-\rho)^{-1}$		1.5	
Mean of consumption growth	θ_x		0.0015	
Autocorrelation of consumption growth	φ_x		0	
Cross-Country correlation in consumption innovations	η_{x,x^*}		0.999	
Mean volatility level	θ_u		$6.165e^{-5}$	
Autocorrelation of volatility	φ_u		0.987	
Volatility of volatility	σ_u		$6.000e^{-6}$	
Cross-Country correlation in volatility innovations	η_{u,u^*}		0.999	
Panel B: The Nominal Economy		*Model I*	*Model II*	*Model III*
Constant in the domestic interest rate rule	$\bar{\tau}$	-0.002	-0.002	-0.008
Constant in the foreign interest rate rule	$\bar{\tau}^*$	-0.002	-0.002	0.002
Domestic response to consumption growth	τ_x	0.198	0.194	0.200
Foreign response to consumption growth	τ_x^*	0.205	0.304	0.866
Domestic response to inflation	τ_π	1.968	1.965	4.423
Foreign response to inflation	τ_π^*	1.884	1.874	1.264

Nominal 1

		Model I	Model II	Model III
Inflation (π_t, π_t^*)				
Domestic, U.S.				
Mean	2.833	2.833	2.834	2.833
Standard Deviation	0.911	0.911	0.914	0.294
Autocorrelation	0.428	0.898	0.902	0.814
Correlation(x_t, π_t)	-0.300	-0.300	-0.294	-0.418
Foreign, Australia				
Mean	3.199	3.199	3.199	3.199
Standard Deviation	0.985	0.985	0.985	1.964
Autocorrelation	0.429	0.898	0.788	0.098
Correlation(x_t^*, π_t^*)	-0.300	-0.300	-0.449	-0.949
Nominal Interest Rate (i_t, i_t^*)				
Domestic, U.S.				
Mean	4.304	3.786	3.773	3.820
Standard Deviation	2.584	1.711	1.717	1.181
Autocorrelation	0.992	0.987	0.987	0.987
Foreign, Australia				
Mean	7.076	4.159	4.559	8.213
Standard Deviation	3.558	1.771	1.648	0.784
Autocorrelation	0.994	0.987	0.987	0.987

Nominal 2

Nominal Depreciation Rate ($log(m_t^*/m_t)$)				
Mean	1.675	0.342	0.357	0.274
Standard Deviation	11.398	11.398	11.396	11.505
Autocorrelation	0.052	0.000	0.001	0.000
Nominal Currency Risk Variables				
Nominal UIP Coefficient	-1.019	-0.127	-1.019	-0.894
Uncond. Risk Premium on AUD, $-E(p_t)$	4.459	0.007	0.421	4.028
Unconditional Sharpe Ratio	0.389	0.001	0.039	0.361
Conditional Risk Premium on AUD	7.933	0.982	1.080	4.326
Conditional Sharpe Ratio	0.709	0.084	0.091	0.365

What's next?

- Phillips curve $\Rightarrow$ endogenous consumption growth
- add policy shocks disciplines by properties of nominal term structures
- more countries
- more convincing calibration/estimation