Monetary Policy and the Uncovered Interest Rate Parity Puzzle

David K. Backus, Chris Telmer and Stanley E. Zin
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UIP Puzzle

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■ Standard regression:

$$s_{t+1} - s_t = \alpha + \beta(i_t - i_t^*) + \text{residuals}$$

Estimates of β are around -2 .

■ Equivalent regression:

$$s_{t+1} - f_t = \alpha + (\beta - 1)(f_t - s_t) + \text{residuals}$$

- ◆ LHS is payoff to “carry trade:” receive GBP, deliver USD.
- ◆ If $\beta \neq 1 \implies$ carry trade payoffs are predictable.

Carry Trade Payoffs

FIGURE 3

Cumulative Realized Nominal (USD) Returns to Currency Speculation (Nov. 1979=1)

From "The Returns to Currency Speculation," by Burnside, Eichenbaum, Kleshchelski and Rebelo, August 2006.

Question

Taylor rules:

$$\begin{aligned} \dot{i}_t &= \tau + \tau_1 \pi_t + z_t \\ i_t^* &= \tau^* + \tau_1^* \pi_t^* + z_t^* \end{aligned}$$

Is the UIP puzzle a reflection of these sorts of interest rate rules?

- Builds on McCallum (1994)
- Also Gallmeyer, Hollifield, Palomino, and Zin (2007)

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■ Taylor rule and Euler equation:

$$i_t = \tau + \tau_1 \pi_t + z_t$$

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

■ Imply difference equation for inflation:

$$\pi_t = -\frac{1}{\tau_1} (\tau + z_t + \log E_t n_{t+1} e^{\pi_{t+1}})$$

■ Exchange rate:

$$\frac{S_{t+1}}{S_t} = \frac{n_{t+1}^* e^{\pi_{t+1}^*}}{n_{t+1} e^{\pi_{t+1}}}$$

Assumption 1

■ Constant real exchange rate:

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

■ Model:

$$\begin{aligned} \dot{i}_t &= \tau + \tau_1 \pi_t + z_t \\ \dot{i}_t^* &= \tau^* + \tau_1^* \pi_t^* + z_t^* \end{aligned}$$

$$\begin{aligned} \pi_t &= -\frac{1}{\tau_1} (\tau + z_t + \log E_t e^{\pi_{t+1}}) \\ \pi_t^* &= -\frac{1}{\tau_1^*} (\tau^* + z_t^* + \log E_t e^{\pi_{t+1}^*}) \end{aligned}$$

$$\log(S_{t+1}/S_t) = \pi_{t+1} - \pi_{t+1}^*$$

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Facts About UIP Puzzle

1. *Stochastic volatility not an option.*

■ Fama's decomposition:

$$\begin{aligned} i_t - i_t^* &= (f_t - E_t s_{t+1}) + (E_t s_{t+1} - s_t) \\ &\equiv p_t + q_t \end{aligned}$$

$$p_t = 0 \implies \text{UIP}$$

■ Backus, Foresi, and Telmer (2001), with lognormality:

$$\begin{aligned} p_t &= -\frac{1}{2} (Var_t(m_{t+1}) - Var_t(m_{t+1}^*)) \\ &= -\frac{1}{2} (Var_t(\pi_{t+1}) - Var_t(\pi_{t+1}^*)) \end{aligned}$$

■ Difference equation, with lognormality:

$$\pi_t = -\frac{1}{\tau_1} \left(\tau + z_t + E_t \pi_{t+1} - \frac{1}{2} Var_t(\pi_{t+1}) \right)$$

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2. *Restrictions on conditional mean and variance.*

- Fama, mapped into (lognormal) pricing kernel language:

$$\begin{aligned}i_t - i_t^* &= p_t + q_t \\q_t &= -E_t(\log \pi_{t+1} - E_t \log \pi_{t+1}^*) \\p_t &= -\frac{1}{2}(\text{Var}_t(\pi_{t+1}) - \text{Var}_t(\pi_{t+1}^*))\end{aligned}$$

- Fama's necessary conditions for $\beta < 0$:

$$\begin{aligned}\text{Cov}(p, q) &< 0 \\ \text{Var}(p) &> \text{Var}(q)\end{aligned}$$

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- Result 2: Asymmetry
- Result 2: Interpretation

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Result 1: Symmetry

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- **Result 1: Symmetry**
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$$i_t = \tau + \tau_1 \pi_t + z_t$$

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

$$z_t = \varphi_z z_{t-1} + v_{t-1}^{1/2} \varepsilon_t$$

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

- Solution for inflation is

$$\pi_t = a + a_1 z_t + a_2 v_t$$

- Foreign equations are the same, with identical coefficients, but different shocks, ε_t^* and w_t^* .

- If $\rho_z = 0$,

$$\beta = \frac{\varphi_v}{\tau_1}$$

Result 2: Asymmetry

■ Same symmetric equations as Result 1, except ...

■ Taylor rules are:

$$\begin{aligned} \dot{i}_t &= \tau + \tau_1 \pi_t + z_t \\ \dot{i}_t^* &= \tau^* + \tau_1^* \pi_t^* + z_t^* + \tau_3^* \log(S_t/S_{t-1}) \end{aligned}$$

■ If the domestic and foreign shocks are independent, then

$$\beta < 0 \quad \text{if} \quad \tau_3^* < -\tau_1^*$$

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Result 2: Interpretation

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- If $\tau_1 = \tau_1^* = 1.1$, then, for example, $\tau_3^* = -1.2$

$$i_t^* = \tau^* + \tau_1^* \pi_t^* + z_t^* + \tau_3^* \log(S_t/S_{t-1})$$

- Since $\log(S_t/S_{t-1}) = \pi_t - \pi_t^*$,

$$i_t^* = \tau^* + (\tau_1^* - \tau_3^*) \pi_t^* + z_t^* + \tau_3^* \pi_t$$

If $\tau_1 = 1.1$, then, for example, $\tau_3^* = -1.2$ and $\tau_1^* - \tau_3^* = 2.3$

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Important Restriction

What does the Taylor rule *do*?

- Provides an *endogenous* link between the mean and variance of the pricing kernel. Consider *exogenous* inflation:

$$\pi_{t+1} = \alpha + \delta v_t + \gamma v_t^{1/2} \varepsilon_{t+1}$$

If $\delta - \gamma^2/2 < 0$, then $\beta < 0$.

- Here is what the Taylor rule implies:

$$\pi_{t+1} = a + a_2 \varphi_v v_t + a_1 v_t^{1/2} \varepsilon_{t+1} + \text{stuff}$$

For $\beta < 0$, need $\varphi_v < 0$.

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$$s_{t+1} - s_t = \alpha + \beta(i_t - i_t^*) + \text{residuals}$$

$$i_t = \tau + \tau_1 \pi_t + z_t$$

$$\implies \beta = \frac{\varphi_v}{\tau_1}$$

- If $\tau > 1$ interest rates move more than inflation.

- But the problem is more dynamic than this: φ_v matters:

$$\pi_t = C - \frac{a_1^2}{2\tau_1} E_t(v_t + v_{t+1} + v_{t+2} + \dots) - \frac{1}{\tau_1} E_t(z_t + z_{t+1} + z_{t+2} + \dots)$$

- Mean moves less than variance because mean terms get discounted twice.

Negative Correlation?

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$$\pi_t^* = C^* - E_t \left(\sum_{j=0}^{\infty} \frac{a_1^{*2}}{2} \frac{v_{t+j}}{\phi^j} + \frac{a_2^{*2}}{2} \frac{v_{t+j}^*}{\phi^j} + \frac{z_{t+j}^*}{\phi^j} + \tau_3^* \frac{\pi_{t+j}}{\phi^j} \right) / \phi$$

where $\phi \equiv \tau_1^* - \tau_3^*$.

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- Don't like the policy shocks? Consumption growth is z_t :

$$\dot{i}_t = -\log E_t n_{t+1}(z_{t+1}) e^{\pi_{t+1}}$$

$$\dot{i}_t = \tau + \tau_1 \pi_t + z_t$$

$$\implies \pi_t = a + a_1 z_t + a_2 v_t$$

- Or, output shocks:

$$\pi_t = \alpha_1 z_t + \alpha_2 E_t \pi_{t+1}$$

$$\dot{i}_t = \tau + \tau_1 \pi_t + z_t$$

$$\dot{i}_t = -\log E_t e^{-\pi_{t+1}}$$

$$\implies \pi_t = a + a_1 z_t + a_2 v_t$$

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- Different interest rate rules have different implications for currency risk premiums. Should this matter for optimal policy?
- Interest rate rules have implications for central bank balance sheets. Are central banks holding the losing side of the carry trade?
- Monetary union eliminates the carry trade. Are there welfare effects?

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References

Backus, David K., Silverio Foresi, and Christopher I. Telmer, 2001, Affine term structure models and the forward premium anomaly, *Journal of Finance* 56, 279–304.

Gallmeyer, Michael F., Burton Hollifield, Francisco Palomino, and Stanley E. Zin, 2007, Arbitrage-free bond pricing with dynamic macroeconomic models, Working paper, Carnegie Mellon University.

McCallum, Bennett T., 1994, A reconsideration of the uncovered interest rate parity relationship, *Journal of Monetary Economics* 33, 105–132.

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Structure

1. UIP puzzle is...(regression and its complement).
2. graph
3. Question: short-term interest rates, obviously, strongly influenced by policy (interest rate rules are commonplace). Given a process for S_t that's consistent with these policies, is $\beta < 0$ still a puzzle?
 - (a) Can/should the puzzle be recast from interest rate behavior to relative monetary policy behavior? Why are they doing this?
 - (b) Seems reasonable to me. What seems puzzling, to me, is that, for instance, Iceland was able to sustain a high interest policy for so long in the face of massive carry trade inflows.
 - (c) What's puzzling is that interest rate differentials remain persistently high in spite of lots of people trying to arb them.
4. Basic idea:
 - (a) Taylor rule
 - (b) Euler Eqn
 - (c) Non-linear diff equation gives solution for endogenous inflation
 - (d) Basic New-Keynesian idea: inflation (and therefore monetary policy) responds to the same underlying shocks as the real economy, consumption and the like.
 - (e) Exchange rate? Ratio of m 's.
 - (f) Question made precise: is UIP manifest in these types of rules, which imply a particular path for future inflation and, therefore, exchange rates.
 - (g) McCallum
5. Assumption 1: real exchange rates are = 1.
6. Some facts about the UIP puzzle.
 - (a) Interest rate differential can be written as $p + q$. Mention Fama. BFT show that p equals the difference in the cond. variances.
 - (b) Write the difference equation....show that what the macro guys do is set variance to zero. We can't....it's everything for us.
 - (c) What do you need? Mean and variance to move in the same direction...variance more.

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1. Result 1.
2. Result 2.
3. Interpretations:
 - (a) What does Taylor *do*?
 - i. connects the mean and the variance endogenously....basic feature of the non-linear difference equation. For example, we can arbitrarily connect them (using the exogenous inflation example). The Taylor rule gives (i) an interpretation of *why* this connection is there (the non-linear difference equation, driven by the fact that the interest rate depends on the mean AND the variance), (ii) a restriction on the coefficients.
 - ii. Gives downward bias in natural way: (i) static intuition for τ_1 , using Stan's story of "the interest rates need to move MORE than the LHS, or, FX has just the mean, but interest rates have both the mean and the variance..... (ii) dynamic for φ_v .
 - iii. Delivers Fama (2) but not (1)....for (1) we need some sort of asymmetry....Taylor gives it in a natural way for the USD-centric world in which we live.
 - iv. Makes the entire future of shocks, inflation and so on matter. ie: for short rate, with exogenous inflation, all we care about is the cond. dist. of inflation at $t + 1$. With Taylor, we care about future inflation, but since the central bank is committed to this interest rate rule, then we must care about next period's interest rate also. But next period's interest rate depends on inflation at $t + 2$and so on. So, the static intuition can't be complete (ie, $\tau_1 > 1$).
4. 2nd last slide.....can cook it many different ways....same basic message.
5. Conclusions.....can be used to evaluate different policies. Are central banks giving it up? Welfare effects of EMU?