Exchange Rates and Interest Parity

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Discussion

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Introduction

- This is an outstanding survey of a vast theoretical and empirical literature on the exchange rate (ER) and uncovered interest rate parity (UIP).

- With only 15 minutes, there is no short summary I could do that would do justice to the paper, and there is no way I can discuss how Charles treats all the literature branches it reviews.

- Therefore, I will focus on the part of the literature I am most familiar with—trying to offer suggestions on how its most significant contributions can perhaps be made more transparent—and I will highlight a potential issue that arises when one tries to reconcile this part of the literature with Charles' own work with Kenneth West.

- Since I will have nothing to say about the excess return term λ_t that Charles introduces in the UIP equation, I will eliminate that term altogether from my discussion.
  - Note: This does not mean that I believe λ_t is not important.

New Keynesian ER Models

- The paper "identifies" the New Keynesian literature on the ER with the literature that models monetary policy as endogenous interest rate setting in response to economic conditions—product price inflation in the paper's examples—plus exogenous interest rate shocks.

- That is different from how I (and perhaps others) think of the New Keynesian literature on the ER.

- Obstfeld and Rogoff (*JPE* 95—OR below) was the first New Keynesian paper on ER dynamics—the defining New Keynesian features being price setting power based on monopolistic competition and price rigidity.

- Betts and Devereux (*JIE* 00—BD below) and Corsetti and Pesenti (*QJE* 01—CP below) are other New Keynesian papers on ER dynamics.

New Keynesian ER Models, Continued

- In all these papers, monetary policy is modeled as exogenous money shocks, and all these papers perform the classic Dornbusch (*JPE* 76) exercise in the context of the respective models:
  - Does a permanent money increase cause ER overshooting?
  - Yes if the consumption elasticity of money demand is below 1 and there are deviations from purchasing power parity (PPP)—non-traded goods in OR, local currency pricing (LCP) in BD.
- The key contribution of these papers to the ER literature was to provide a rigorous microfoundation to Dornbusch's exercise, shedding light on the structural features of the economy that are important for ER overshooting when households and firms behave optimally.

New Keynesian ER Models, Continued

- In all these exercises, money demand is the centerpiece of ER determination, with the ER (ε_t) determined (under assumption of separable, power utility from consumption and real money balances) by an equation of the form:

$$\varepsilon_t (1 - \kappa) = \mathsf{M}_t - \mathsf{M}_t^* - \frac{1}{\varphi} (\mathsf{C}_t - \mathsf{C}_t^*) + \frac{1}{\varphi\delta} E_t (\varepsilon_{t+1} - \varepsilon_t), \tag{1}$$

  where:

  - $\kappa \equiv$ fraction of firms that engage in LCP,
    - $\kappa = 0$ in OR and CP (who assume full producer currency pricing—PCP) and $0 \leq \kappa \leq 1$ in BD,
  - $\mathsf{M}_t - \mathsf{M}_t^* \equiv$ relative money supply,
  - $1/\varphi \equiv$ consumption elasticity of money demand,
  - $\mathsf{C}_t - \mathsf{C}_t^* \equiv$ relative consumption,
  - and $\delta \equiv$ households' discount rate.

- Equation (1) is combined with UIP and the other model ingredients to determine the ER in the general equilibrium (GE) of these New Keynesian models.

Endogenous Interest Rate Setting

- Taylor (*CR* 93) changed the way we think about monetary policy by showing the ability of a simple interest rate rule to track Federal Reserve behavior closely (under normal circumstances).
  - Woodford (*Book* 03) provides the most complete treatment of so-called Taylor rules in closed economies and clarifies formally the importance of (appropriate) interest rate responses to *endogenous* variables for equilibrium uniqueness, solving the indeterminacy found by Sargent and Wallace (*JPE* 75) under exogenous interest rate setting.

- Over time, many in the open economy New Keynesian camp incorporated Taylor's and Woodford's insights in thinking about ER dynamics.
  - To the best of my knowledge, Benigno and Benigno (*JIMF* 08—BB below) and Cavallo and Ghironi (*JME* 02—CG below) were the first to do it in two-country, GE models.

Endogenous Interest Rate Setting, Continued

- From my perspective, a first-order insight from the literature on ER dynamics with endogenous interest rate setting is that, under assumption of separability, the models completely de-emphasize the role of money demand in ER determination (in fact, the models are often “cashless”).

- It seems to me that this is an important change in how we think about ER determination that ought to be emphasized more in the paper.

Endogenous Interest Rate Setting, Continued

- Consider the following simple example.
- UIP holds:

$$\mathsf{i}_t - \mathsf{i}_t^* = E_t \varepsilon_{t+1} - \varepsilon_t, \quad \text{where } \mathsf{i}_t - \mathsf{i}_t^* \text{ is the interest rate differential.}$$

- Policy is described by:

$$\mathsf{i}_t = \alpha \pi_t^{CPI} + \xi_t, \quad \mathsf{i}_t^* = \alpha \pi_t^{CPI*} + \xi_t^*, \quad \alpha > 0,$$

  where:

  - π_t^{CPI} and $\pi_t^{CPI*} \equiv$ domestic and foreign CPI inflation rates,
  - and ξ_t and $\xi_t^* \equiv$ exogenous policy shocks (assume they follow independent $AR(1)$ processes with persistence $\mu \in [0,1)$ and i.i.d., normal innovations with zero mean and equal variance).
    - I assume responses to CPI inflation rather than product price inflation because it simplifies the example (and, on positive grounds, it is quite accurate, as several central banks respond to CPI inflation).

- PPP holds:

$$\pi_t^{CPI} - \pi_t^{CPI*} = \varepsilon_t - \varepsilon_{t-1}.$$

Endogenous Interest Rate Setting, Continued

- Straightforward algebra implies that, in this setup, the ER is determined by the following difference equation:

$$E_t \varepsilon_{t+1} - (1+\alpha)\,\varepsilon_t + \alpha \varepsilon_{t-1} = \xi_t^D, \quad \text{where } \xi_t^D \equiv \xi_t - \xi_t^*.$$

- The condition $\alpha > 1$ (the Taylor Principle of a more-than-proportional response of the interest rate to inflation) is necessary and sufficient for a unique solution, which can be written in terms of the state vector as:

$$\varepsilon_t = \varepsilon_{t-1} - \frac{1}{\alpha - \mu} \xi_t^D. \tag{2}$$

Endogenous Interest Rate Setting, Continued

$$\varepsilon_t = \varepsilon_{t-1} - \frac{1}{\alpha - \mu}\xi_t^D.$$

- **Observation 1:** We completely determined the ER without any reference to money demand.

- **Observation 2:** There is a unit root in the ER.
  - This is a standard implication of interest rate setting in response to inflation rates rather than price levels.
  - It is robust to a variety of alternative specifications (for instance, it arises also in BB, where policy responds to product price inflation, and also if policy responds to different measures of output in addition to inflation).

- **Observation 3:** If $\mu = 0$ (no persistence in exogenous interest rate shocks), the term $-\xi_t^D/(\alpha - \mu)$ reduces to a normally distributed innovation with zero mean, and (2) produces random walk (RW) behavior for the exchange rate.

Endogenous Interest Rate Setting, Continued

$$\varepsilon_t = \varepsilon_{t-1} - \frac{1}{\alpha - \mu}\xi_t^D.$$

- **Note:** A unit root in the ER and RW behavior without any assumption about any discount factor a la Engel and West (*JPE* 05—EW below).
  - Obviously, this does not mean that I believe this example as the theory that explains ER dynamics in reality, but it highlights certain (to me) important consequences of endogenous interest rate setting that are not as transparent in Charles' paper.

Endogenous Interest Rate Setting, Continued

- In a more fleshed out, New Keynesian model (with PCP and Calvo *JME* 83 rigidity), BB consider policy rules of the form:

$$\mathsf{i}_t = \alpha_1 \mathsf{y}_t^H + \alpha_2 \pi_t^p, \quad \mathsf{i}_t^* = \alpha_1 \mathsf{y}_t^F + \alpha_2 \pi_t^{p*}, \quad \alpha_1 \geq 0, \alpha_2 \geq 0,$$

  where y_t^H and y_t^F $\equiv$ domestic and foreign output gaps (relative to the flexible-price equilibrium), and the superscript p denotes inflation in product prices.

- Assuming the conditions for determinacy are satisfied, there is a unique solution for the ER described (under standard $AR(1)$ assumptions for exogenous shocks) by:

$$\varepsilon_t = \varepsilon_{t-1} - \mathsf{TOT}_{t-1} + \eta \tilde{\mathsf{TOT}}_t,$$

  where TOT_{t-1} is last period's terms of trade, $\tilde{\mathsf{TOT}}_t$ is the flexible-price terms of trade (a linear function of exogenous shocks), and η is an elasticity that depends on structural parameters.

  – Footnote: Given BB's definition of the terms of trade, an increase in TOT_t denotes a deterioration.

- The unit root in the ER implies that the response to shocks is non-stationary as long as the policy rules are such that the equilibrium does not replicate the flexible-price allocation (this requires both α_1 and α_2 to be finite).

Endogenous Interest Rate Setting and Net Foreign Assets

- CG observed that net foreign asset dynamics where part of ER determination in the OR model, but they disappeared from subsequent literature that “finessed the current account issue” (indeterminacy of the steady state and non-stationarity of net foreign assets) in the OR model by doing away with a role for the current account altogether (for instance, there is no role for the current account in BB).
  - Those were the years when the consensus was that current account and net foreign asset dynamics “did not matter.”

- At the same time, we were observing the United States running current account deficits in the 1990s and the dollar appreciating.
  - In the figure, an upward movement of the exchange rate indicates appreciation.

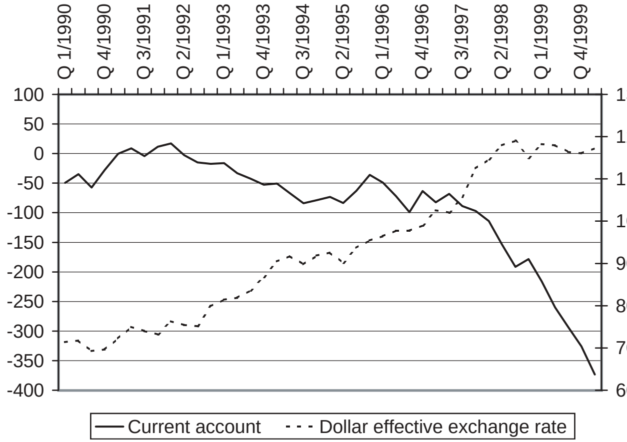

Fig. 1. The dollar and the U.S. current account.

Endogenous Interest Rate Setting and Net Foreign Assets, Continued

- CG brought net foreign assets back into the ER picture with a mechanism for steady-state determinacy and model stationarity (overlapping generations—but the same results can be obtained with other mechanisms) and endogenous interest rate setting.

- The role of net foreign assets is most easily understood under flexible prices.

Endogenous Interest Rate Setting and Net Foreign Assets, Continued

- UIP:

$$\mathsf{i}_t - \mathsf{i}_t^* = E_t \varepsilon_{t+1} - \varepsilon_t.$$

- Policy rules:

$$\mathsf{i}_t = \alpha_1 \mathsf{y}_t + \alpha_2 \pi_t^{CPI} + \xi_t, \quad \mathsf{i}_t^* = \alpha_1 \mathsf{y}_t^* + \alpha_2 \pi_t^{CPI*} + \xi_t^*, \quad \alpha_1 \geq 0, \alpha_2 \geq 0.$$

  – where y_t and $\mathsf{y}_t^* =$ home and foreign GDP (in units of consumption).

  – Then:

$$\mathsf{i}_t^D = \alpha_1 \mathsf{y}_t^D + \alpha_2 \pi_t^{CPI^D} + \xi_t^D,$$

  where the superscript D denotes a cross-country differential.

- PPP:

$$\pi_t^{CPI^D} = \varepsilon_t - \varepsilon_{t-1}.$$

Endogenous Interest Rate Setting and Net Foreign Assets, Continued

- With flexible prices, the solutions for net foreign assets and GDP can be written as:

$$\mathsf{B}_{t+1} = \eta_{BB}\mathsf{B}_t + \eta_{BZ^D}\mathsf{Z}_t^D, \tag{3}$$

$$\mathsf{y}_t^D = \eta_{y^D B}\mathsf{B}_t + \eta_{y^D Z^D}\mathsf{Z}_t^D, \tag{4}$$

  where B_t denotes net foreign assets entering period t, Z_t^D is exogenous relative productivity (assumed $AR(1)$), the elasticities η are functions of structural parameters, and, $0 < \eta_{BB} < 1$.

- Given the condition $\alpha_2 > 1$ for determinacy, this setup yields the following unique solution for the ER:

$$\varepsilon_t = \varepsilon_{t-1} + \eta_{\varepsilon B}\mathsf{B}_t + \eta_{\varepsilon Z^D}\mathsf{Z}_t^D + \eta_{\varepsilon \xi^D}\xi_t^D. \tag{5}$$

Endogenous Interest Rate Setting and Net Foreign Assets, Continued

$$\varepsilon_t = \varepsilon_{t-1} + \eta_{\varepsilon B}\mathsf{B}_t + \eta_{\varepsilon Z^D}\mathsf{Z}_t^D + \eta_{\varepsilon \xi^D}\xi_t^D.$$

- Here,

$$\eta_{\varepsilon B} \equiv -\frac{\alpha_1 \eta_{y^D B}}{\alpha_2 - \eta_{BB}}.$$

- $\eta_{y^D B} < 0$:
  - Accumulation of net foreign assets causes home agents to supply less labor than foreign, home's terms of trade improve, and home GDP falls relative to foreign.

- $\alpha_2 - \eta_{BB} > 0$ because $\alpha_2 > 1$ and $0 < \eta_{BB} < 1$.

- Therefore, $\eta_{\varepsilon B} > 0$ (as long as $\alpha_1 > 0$), and a current account deficit in period $t-1$, resulting in $\mathsf{B}_t < 0$, appreciates the ER.

- **Intuition:** Accumulation of net foreign debt causes home GDP to rise relative to foreign; home policy responds by increasing the interest rate (as long as $\alpha_1 > 0$), and the currency appreciates.

Endogenous Interest Rate Setting and Net Foreign Assets, Continued

- Under sticky prices:

$$\varepsilon_t = \varepsilon_{t-1} + \eta_{\varepsilon B}\mathsf{B}_t + \eta_{\varepsilon y^D}\mathsf{y}_{t-1}^D + \eta_{\varepsilon Z^D}\mathsf{Z}_t^D + \eta_{\varepsilon \xi^D}\xi_t^D. \tag{6}$$

  - This can be rewritten replacing y_{t-1}^D with the past terms of trade to yield an ER solution similar to that in BB, with net foreign assets as the additional endogenous state.

- CG show that, in this case, a permanent relative productivity shock will cause external borrowing (because sticky prices cause relative GDP to rise gradually to its new long-run level) and ER appreciation.

- Obviously, not a quantitative theory of what happened to the U.S. current account and ER in the 1990s (no capital, thus borrowing only if productivity shock is permanent under sticky prices), but we viewed this as a starting point to go back to having net foreign assets in the ER picture along with endogenous monetary policy.

Endogenous Interest Rate Setting and Net Foreign Assets, Continued

- CG also show how (5) or (6) can result in hump-shaped responses of the ER to shocks (or responses that are very similar to a RW, depending on scenarios).
  - Endogenous interest rate setting has implications for Eichenbaum and Evans (*QJE* 95) and the literature that followed—as noted first by McCallum (*JME* 94).

- The fact that endogenous interest rate setting introduces a unit root in the exchange rate and can produce simulated ER paths that display RW behavior or humps (depending on assumptions on shocks, policy, and parameter values) is, to me, another important contribution of this literature that perhaps deserves more explicit emphasis in the paper.
  - I view the insights from this theoretical literature (BB, CG, and others) as the starting point for understanding the empirical results in Molodtsova, Nikolsko-Rzhevskyy, and Papell (*JME* 08, *JMCB* 11) and Molodtsova and Papell (*JIE* 09).

The Engel-West Theorem with Endogenous Interest Rate Setting

- Return to the ER equation from the OR-CP-BD framework:

$$\varepsilon_t (1-\kappa) = \mathsf{M}_t - \mathsf{M}_t^* - \frac{1}{\varphi}\left(\mathsf{C}_t - \mathsf{C}_t^*\right) + \frac{1}{\varphi\delta} E_t \left(\varepsilon_{t+1} - \varepsilon_t\right).$$

- Define:

$$\mathsf{f}_t \equiv \mathsf{M}_t - \mathsf{M}_t^* - \frac{1}{\varphi}\left(\mathsf{C}_t - \mathsf{C}_t^*\right), \quad \beta^e \equiv \frac{1}{1+\varphi\delta\,(1-\kappa)}, \quad \text{and } \mathsf{f}_t^e \equiv \frac{\mathsf{f}_t}{1-\kappa}.$$

- Then:

$$\varepsilon_t = \beta^e E_t \varepsilon_{t+1} + (1-\beta^e)\,\mathsf{f}_t^e. \tag{7}$$

- This is the ER equation at the center of EW.

The Engel-West Theorem with Endogenous Interest Rate Setting, Continued

- When $\varphi = 1$ (log utility from money) and $\kappa = 0$ (no LCP firms, PPP holds), equation (7) reduces to

$$\varepsilon_t = \beta E_t \varepsilon_{t+1} + (1 - \beta)\, \mathsf{f}_t,$$

  where β is the household's discount factor:

$$\beta \equiv \frac{1}{1+\delta}.$$

- This is the OR case.

- In this case, the discount factor that approaches 1 in the EW theorem (β^e) has the "natural" interpretation of household discount factor.
  - $\beta \to 1$ poses its own problems for the solution of intertemporal utility maximization, but it is reasonable to think that β is very close to 1.

- Charles argues that equation (7) can be obtained also when we consider monetary policy through interest rate setting.

- But there is a subtle issue that perhaps deserves some attention in that case.

The Engel-West Theorem with Endogenous Interest Rate Setting, Continued

- Consider the following example.
- UIP:

$$\mathsf{i}_t^D = E_t \varepsilon_{t+1} - \varepsilon_t.$$

- Policy rules:

$$\mathsf{i}_t = \alpha_1 \mathsf{y}_t + \alpha_2 \pi_t^{CPI}, \quad \mathsf{i}_t^* = \alpha_1 \mathsf{y}_t^* + \alpha_2 \pi_t^{CPI*}, \quad \alpha_1 \geq 0, \alpha_2 \geq 0.$$

  – Then:

$$\mathsf{i}_t^D = \alpha_1 \mathsf{y}_t^D + \alpha_2 \pi_t^{CPI^D}.$$

- PPP:

$$\pi_t^{CPI^D} = \varepsilon_t - \varepsilon_{t-1}.$$

- Define:

$$\beta^e \equiv \frac{1}{1+\alpha_2}, \quad \text{and } \mathsf{f}_t \equiv \varepsilon_{t-1} - \frac{\alpha_1}{\alpha_2} \mathsf{y}_t^D.$$

- Then:

$$\varepsilon_t = \beta^e E_t \varepsilon_{t+1} + (1 - \beta^e)\, \mathsf{f}_t.$$

- This indeed has the same form as (7).

The Engel-West Theorem with Endogenous Interest Rate Setting, Continued

$$\varepsilon_t = \beta^e E_t \varepsilon_{t+1} + (1 - \beta^e)\,\mathsf{f}_t.$$

- Should the fact that f_t includes the past ER be a concern when I think in terms of the EW approach and theorem?

- More importantly, consider what it means for $\beta^e \rightarrow 1$:

- $\beta^e \equiv 1/(1+\alpha_2) \rightarrow 1$ if and only if $\alpha_2 \rightarrow 0$.

- But α_2 is the response coefficient to inflation in the policy rules, and the Taylor Principle requires $\alpha_2 > 1$.
  - If prices are sticky, $\alpha_2 > 1$ is necessary and sufficient for determinacy in this setup when $\alpha_1 = 0$.
  - Conditions for determinacy are marginally more complicated when $\alpha_1 > 0$, but $\alpha_2 > 1$ has become a “consensus” ingredient of monetary policy.

The Engel-West Theorem with Endogenous Interest Rate Setting, Continued

- Moreover, we saw before that we do not need $\beta^e \to 1$ for the ER to feature a unit root (and behavior potentially very close to a RW) with endogenous interest rate setting.
  - In fact, in the simplest example above, we needed $\alpha_2 > 1$ to ensure that (2) was the unique solution for the ER.

The Engel-West Theorem with Endogenous Interest Rate Setting, Continued

- Where does this leave us when considering the EW theorem in relation to ER determination under endogenous interest rate setting?

- Can the EW theorem really be reconciled with endogenous interest rate setting?

- Footnote: I could make the same argument above in an example without PPP.

Conclusion

- Outstanding survey, and I learned much from reading it.
- I hope these comments will be useful to accomplish a perhaps more effective treatment of the New Keynesian literature (without and with endogenous interest rate setting).