(entry written for *the Princeton Encyclopedia of the World Economy*)

Forward Premium Puzzle

Definitions and Related Concepts

The forward premium puzzle is closely related to the failure of uncovered interest parity to hold, and the phenomenon of forward rate bias. The puzzle is the finding that the forward premium usually points in the wrong direction for the ex post movement in the spot exchange rate. Uncovered interest parity states that, if covered interest parity holds, then the forward discount and hence the interest differential, should be an unbiased predictor of the ex post change in the spot rate, assuming rational expectations. The forward rate bias puzzle is given by the fact that the forward rate does not provide an unbiased forecast of the future spot rate.

To fix concepts and terms, define the forward rate at time t for a trade to occur at time k as F_t^k and the spot rate at time t as S_t. Further, let the subjective expectation of the spot rate at time t+k, based upon time t information, be defined as $\varepsilon_t(S_{t+k})$. Assume for the moment rational expectations, viz., $E_t(S_{t+k})$. Then one should expect:

$$S_{t+k} = F_t^k + u_{t+k} \tag{1}$$

Where the error term is an expectational error.

In reality, regression estimates do not find a regression coefficient of unity, although the point estimate is often not statistically significantly far from the posited value. A more problematic aspect of such regressions is that the estimated regression error term often exhibits serial correlation, violating the rational expectations hypothesis.

The forward premium puzzle can be identified by assuming that the error term is log normally distributed, so that (1) can be rewritten as:

$$s_{t+k} = \beta_0 + \beta_1 f_t^k + \tilde{u}_{t+k} \tag{2}$$

Where under the null hypothesis, $\beta_1 = 1$, and β_0 is allowed to equal some constant impounding some Jensens Inequality terms.

Notice that one can subtract the current log spot rate s_t from both sides, since under the null $\beta_1 = 1$. This yields:

$$s_{t+k} - s_t = \beta_0 + \beta_1 (f_t^k - s_t) + \tilde{u}_{t+k} \tag{3}$$

The left hand side of equation (3) is ex post depreciation, while the term in the parentheses is the forward discount (or inverse of the forward premium).

The puzzle is that estimates of β_1 are not only different from the value of unity, and statistically significantly so, but also that the coefficient estimates are typically *negative*.

This issue is linked up to uncovered interest parity in the following sense. If covered interest parity holds, then:

$$(f_t^k - s_t) = (i_t^k - i_t^{k*}) \tag{4}$$

Substituting this no arbitrage profits condition into (3), one finds that (3) can be re-written as:

$$s_{t+k} - s_t = \beta_0 + \beta_1 (i_t^k - i_t^{k*}) + \tilde{u}_{t+k} \tag{5}$$

Which is the regression equation used to test the joint null hypothesis of uncovered interest parity and rational expectations. The finding of a negative slope coefficient in equation (5) is equivalent to the finding of a negative slope coefficient in (3), for instances where covered interest parity holds.

There are several reasons why the forward premium puzzle might exist, even when capital is perfectly mobile according to the covered interest parity criterion: (1) the invalidity of the rational expectations hypothesis; (2) issues of econometric implementation; and (3) the existence of an exchange risk premium.

As discussed at greater length in the entry on Interest Rate Parity, estimates of equation (5) using values for k that range up to one year typically reject the unbiasedness restriction on the slope parameter. For instance, the survey by Froot and Thaler (1990), for instance, finds an average estimate for β of -0.88. Chinn and Meredith (2004) document that this result holds for more recent periods extending up to 2000. They also show that the bias tends to decrease at longer horizons.

The Validity of the Rational Expectations Hypothesis

It is important to recall that, in fact, uncovered interest parity properly defined as relating to expected depreciation, is untestable. Estimation of the standard UIP regression equation relies upon the rational expectations methodology embodied in equation (1). Of course, reliance upon the assumption of mean zero expectational errors is by no means uncontroversial. In a number of papers, Froot and Frankel (1989) demonstrate that the standard tests for UIP yield radically different results when one uses survey-based measures of exchange rate depreciation. They find that most of the variation of the forward discount appears to be related to expected depreciation, rather than a time varying risk premium, thereby lending credence to UIP.

Chinn and Frankel (1994, 2002) document the fact that it is difficult to reject UIP for a broader set of currencies, when using forecasts provided by the *Currency Forecasters' Digest* (*CFD*), although there is some evidence of a risk premium at the 12 month horizon. Chinn and Frankel interpret the differing results as arising from a wider set of currencies – they examine 17 currencies as opposed to the 5 or so examined by Frankel and Froot (1987) – where the assumption of perfect substitutability of debt instruments is less likely to hold.

As these authors have stressed, rejection of the rational expectations hypothesis does not necessarily mean one accepts the proposition that agents are irrational. It may be that agents are constantly learning about the economic environment such that their forecasts are biased for long stretches of time. Models incorporating Bayesian learning includes Lewis (1989). More recently, Bacchetta and van Wincoop (2006) have introduced incomplete information processing – essentially a transactions costs rationale for infrequent portfolio rebalancing – as a reason for why the forward premium puzzle exists. (Lyons' (2001) appeal to institutional and microstructural factors to explain the presence of excess returns is a related, but distinct, approach.)

Econometric Issues

Chinn and Meredith (2004) explain the divergence in short and long-horizon results by McCallum (1994) appealed to a monetary reaction function that responds to exchange rate changes, thereby making interest rates endogenous in an economic sense. This argument can be reinterpreted in an econometric framework following Moore (1994) and Villanueva (2005). However, it is unclear whether such approaches can explain the negative coefficients obtained.

A wide variety of different econometric issues have also been investigated. Baillie and Bollerslev (2000) argue that there is a nonlinearity in the relationship between the spot rate and the forward discount. When the forward discount is large in absolute value, then the forward discount is likely to point in the right direction. When the forward discount is small, it is likely to point in the wrong direction, perhaps because transactions costs are large relative to potential gains.

Maynard and Phillips (2001) argue that imposing a unit coefficient on the relationship by subtracting the spot rate from both sides of equation (2) can induce distortions into the distribution for the slope parameter when the regressor and regressand are both highly persistent. However, follow-up work by Maynard (2003) indicates that the negative slope coefficient cannot be entirely explained by the time series characteristics of the variables.

A Risk Premium Interpretation

Perhaps the most natural explanation for why the forward premium predicts the wrong direction of exchange rate movements is that a risk premium drives a wedge between expected changes and actual changes. How to model the risk premium is the challenge; Engel (1996) provides a survey. The portfolio balance approach, which focuses on stocks of outside assets, was the framework first adopted in the modeling of the risk premium. However, the widespread failure to find any link between stocks of outside assets (such as government bonds) and the ex post risk premium (Frankel and Engel, 1984) ended this avenue of research.

Other risk-based explanations have been forwarded. One set of explanations rely upon the presence of sticky prices in general equilibrium models. Engel (1999) discusses the risk that arises due to the covariation of consumption and exchange rates in such models with nominal rigidities. Other rigidities have been introduced in order to induce risk premia. One such set of models incorporates "limited participation" on the part of agents. Households only enter into arbitrage when the benefits exceed the costs sufficiently. See for instance Alvarez, et al. (2002).

The consumption based risk premium approach has also been resurrected by appealing to more exotic preferences. Bekaert, Hodrick and Marshall (1997) conclude that while introducing first order risk aversion can produce negative slope coefficients, the relative magnitudes of exchange rate changes and risk premia cannot be matched. More recently, Verdelhan (2006) has forwarded a model wherein ad hoc external habit preferences, combined with trade costs, which can lead to quantitatively large risk premia. At the same time, he is able to match the variance of real exchange changes. Moore and Roche (2006) also relies upon external habit preferences, but imbeds these into a monetary model. The combination of multiple costs or rigidities appears to be a fruitful approach for explaining why the forward discount typically points in the wrong direction for the ex post exchange rate change.

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