The Performance of UIP and PPP: Emerging Markets

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January, 2008
I. Introduction

Our earlier work (Campbell, et al. 2007), which was based on data for developed countries, pointed to errors in exchange-rate expectations as the major force behind the poor performance of UIP and hence as the explanation for the UIP Puzzle. Risk premia, the competing alternative explanation in the literature, appeared to play at most a minor supporting role.

Here we revisit this question, replicating the experiment using data for a group of emerging market countries and comparing the results of that exercise with those from our earlier paper. The rationale for our doing so is straightforward: If risk premia rather than expectational errors were the major force producing deviations from UIP, the basic UIP regression results with the emerging-country data should be even worse than the results with the developed-country data used in our earlier paper since risk associated investments in developing countries is in general much greater than for investments in developed countries (see Frankel and Poonawala, 2004).

Our work in this paper, therefore, involve two steps: estimation of basic UIP and PPP regressions for the Emerging market countries and comparison of the results against each other; we then go on to estimate a latent factor model for these countries. We compare and analyze the results to determine what is driving deviations from both UIP and PPP conditions.

II. Basic empirical results

We use monthly data for the period January 1976 to December 2005 for 19 countries
relative to the United States: China, Ghana, Indonesia, Israel, jamacia, Kenya, Korea, Malawi, Malaysia, Mexico, Pakistan, Phillipines, Sierra Leone, Singapore, South Africa, Swaziland, Thailand, Trinidad and Tobago, and Tunisia. We obtain most of these data from the International Monetary Fund’s *International Financial Statistics*. Exchange rates are denominated in units of foreign currency per U.S. dollar; interest rates are short-term domestic Treasury bill or money market rates.

**II.A. UIP Regressions**

We begin by running standard UIP regressions of the following form for each country in our LDC sample individually over the full sample period: and compare those results with comparable regressions for developed countries:

\[ s_{t+1} - s_t = \alpha + \beta(i_t - i_t^*) + e_{t+1}, \]  

(1)

where \( s_{t+1} - s_t \) is the one-period change in the log spot exchange rate and \( i_t - i_t^* \) is the corresponding foreign interest differential compared to that of the U.S.

Under UIP, \( \alpha = 0 \) and \( \beta = 1 \) in (1). Thus, for example, if a return on a domestic \( n \)-period zero coupon bond is one percentage point per annum higher than the return on a comparable foreign bond, the foreign currency would appreciate on average by one percent over the next \( n \) periods.
Table 1 contains the results for the less-developed and developed countries.

*Insert Table 1*

II.B. UIP & PPP regressions using temporally averaged data

Figures 1 and 2 show plots of the UIP relation based on full-period averages of the data for our emerging markets. Table 3 presents the results of the corresponding regression. To provide a theoretical frame of reference in the charts, we also show a 45 degree line drawn through the origin.

*Insert Figure 1 & 2*

In both cases, we see a steady progression towards the relation posited by the theory as the level of temporal aggregation increases with a significant and positive relation for the Emerging market countries.
III. Modeling UIP & PPP Deviations

In order to disentangle the effects of risk premia and systematic exchange rate forecast errors on UIP, we use the framework developed in Marston (1997). We examine the deviations from UIP together with those from PPP and RIE.

III. A. The three-parity framework

We consider the expectational form of PPP in equation (2), written here in terms of expected rates of change of the variables:

\[
E_t [\pi_{t+1} - \pi_{t+1}^*] = E_t [s_{t+1} - s_t]
\]

where \( \pi_{t+1} \) and \( \pi_{t+1}^* \) are the rates of inflation in the home and foreign countries, respectively.

Deviations from PPP arise either as a result of exchange rate forecast errors, \( e_{st} \), inflation forecast errors, \( e_{pt} \), or expected changes in the real exchange rate \( \theta_t \) in Equation (3). For identification reasons we assume that PPP holds ex ante\(^1\).

\[
(\pi_{t+1} - \pi_{t+1}^*) - (s_{t+1} - s_t) = e_{st} + e_{pt} + \theta_t.
\]
When we compare equations (5) and (3), we see that risk premia do not affect deviations from PPP, but exchange rate errors affect both UIP and PPP deviations.

However, UIP, PPP, and RIE are not independent. The deviations from any one of these relations is equal to an algebraic combination of the deviations from the other two. Thus, by subtracting (3) from (2), we obtain an equation for the real-interest differential, \( r - r^* \), in the form of equation (4):

\[
(4) \quad r_t - r_t^* = \rho_t - \theta_t - \varepsilon_{pt}.
\]

When comparing (4) with (3), the risk premium is the only common component in the UIP and RIE equations. Exchange rate forecast errors do not matter for RIE.

**III. B. A dynamic factor approach to decomposing the UIP relation**

To investigate the process driving the UIP deviations, we adopt a dynamic latent factor model. Although this type of model has been extensively used in other fields, univariate models generally predominate in exchange rate studies (e.g., Wolff, 1987; and Nijman, Palm, and Wolff, 1993).

\[^1\] Dumas (1992) shows that imperfect goods arbitrage leads to a situation in which the ex ante real exchange rate can be written as a (linear) function of the ex ante real interest differential. A risk premium thus enters the PPP relation if we do not assume that PPP holds ex ante.
In equations (2), (4), and (5) we presented the deviations from UIP, PPP, and RIE, respectively, in terms of the risk premium, $\rho_t$, exchange rate forecast errors, $\varepsilon_t$, inflation forecast errors, $\varepsilon_{\mu_t}$, and expected changes in the real exchange rate, $\theta_t$. Since these last two variables never appear separately in any of the equations, we cannot disentangle their effects. Thus, we have a three-equation system with three common factors - the risk premia, exchange rate forecast errors, and a factor that combines inflation forecast errors and expected changes in the real exchange rate. Each of the three parity conditions is affected by just two of these factors, which makes it possible to distinguish between the effects of risk premia and exchange rate forecast errors in deviations away from the UIP relation.

Exchange rate risk premia affect only nominal and real interest differentials, not inflation differentials. Systematic errors in forecasting exchange rates affect only nominal, not real interest differentials. Thus, we have a system of three parity condition equations with three unknown factors. By estimating any combination of two parity conditions we are able to observe the ex post effects of risk premia and exchange rate forecast errors on deviations from UIP. Additionally, we can identify the ex post effects of risk premia and the combination of expected changes on the real exchange rate and inflation forecast errors on deviations from the RIE equation.

We model the set of joint parity conditions by estimating a dynamic latent factor model for UIP and RIE together. The common factor in these relations is the risk premium $\rho_t$.

\begin{equation}
\begin{pmatrix}
i_t - i_t^* & (s_t + 1 - s_t) \\
r_t - r_t^*
\end{pmatrix} = \begin{pmatrix}
c_{U} \\
c_{R} \end{pmatrix} + \begin{pmatrix}1 \\ 1 \end{pmatrix} \rho_t + \begin{pmatrix}v_{U}^{U} \\ v_{R}^{R} \end{pmatrix}.
\end{equation}
We assume the errors $\nu_t^{UIP}$ and $\nu_t^{RIE}$ to be iid with variances $\sigma_{UIP}^2$ and $\sigma_{RIE}^2$, respectively. We allow a covariance between the two errors. We consider the common factor for the risk premium, $\rho_t$, to be a latent factor, governed by an AR(1) process as shown in equation (7)\(^2\),

\[ \rho_t = \phi \rho_{t-1} + \eta_t, \quad \eta_t \sim N(0, \sigma^2_\rho). \]

We estimate the model parameters and the risk premium by maximum likelihood and compute the likelihood function recursively using the Kalman filter (Harvey, 1991). Once we have estimated the common factor, the risk premium, we can identify the exchange rate forecast error $\varepsilon_{st}$ from equation (2) and the joint component composed of the inflation forecast error and expected real exchange rate change, $\theta_t + \varepsilon_{pt}$, from equation (4).

In Table 2 we present the estimation results for the dynamic factor model for the Emerging market data.

Insert Table 2

The autoregressive coefficients on the latent lagged risk premium $\phi_\rho$ show that the estimated risk premium is quite persistent, with a coefficient of over 0.9 in all three cases. The

\(^2\)Alternative specifications for the risk premium do not significantly alter the results.
standard deviations of the innovation errors are much larger for the UIP equations, \( \sigma_{\text{UIP}} \), than for the RIE equations. Moreover, we find that the innovation variances of the risk premia \( \sigma_{\rho} \) are low as well, showing that most of the variability in the deviations from UIP is caused by the expectational errors instead of being caused by variability in the risk premium.

The variance of the risk premium is much lower than the variance of the exchange rate forecast errors. Froot and Frankel (1989) find estimates similar in magnitude in their survey data. Importantly, these results show that the variability of the risk premium is much lower than the variability of expected exchange rate returns. As a result the rejection of UIP and PPP cannot be attributed completely to the existence of a risk premium. Exchange rate forecast errors appear to play a much more important role in terms of variability than the risk premia.

### III. C. Expectational Errors, the UIP puzzle and PPP

The question that we now address is the relative size of the impacts of the risk premium and the exchange rate forecast error on the estimate of the beta in the original UIP regression (1). To answer this question we decompose the estimate of the slope coefficient in this regression.

To see the impact from errors made in forecasting exchange rates we first write the estimated slope coefficient for the UIP regression in terms of the standard OLS formula:

\[
\beta_{\text{OLS}} = \frac{\text{cov}(i_t - i_t^*, s_{t+1} - s_t)}{\text{var}(i_t - i_t^*)}.
\]
In Table 2 we see that some of these beta estimates are negative. From Equation (8) we see that a negative slope coefficient can only occur if the covariance between the interest differential and the exchange rate change is negative, i.e. the numerator in equation (8).

To determine the specific effects of the risk premia and exchange rate errors on the regression coefficient, we follow Engel (1996), who decomposes the beta into a beta related to the risk premium, \( \beta_{rp} \), and a beta for the expectational errors, \( \beta_{ss} \). In our case we rewrite the numerator from Equation (8) using the decomposition in Equation (2). More specifically, we find that

\[
\text{cov}(i_t - i_t^*, s_{t+1} - s_t) = \text{var}(i_t - i_t^*) - \text{cov}(\rho, i_t - i_t^*) - \text{cov}(\varepsilon, i_t - i_t^*). \tag{9}
\]

This decomposition allows us to write the OLS beta as

\[
\beta_{OLS} = 1 - \beta_{rp} - \beta_{ss}, \tag{10}
\]

with the beta for the risk premium \( \beta_{rp} \) defined by

\[
\beta_{rp} = \frac{\text{cov}(\rho, i_t - i_t^*)}{\text{var}(i_t - i_t^*)}, \tag{11}
\]

and the beta for the expectational errors as,
\[
(12) \quad \beta_{ss} = \frac{\text{cov}(\varepsilon_{ss}, i_t - i^*_t)}{\text{var}(i_t - i^*_t)}.
\]

When we replace the moments in (11) and (12) with their sample equivalents we find that the beta for the expectational error, $\beta_{ss}$, is mostly greater than that for the risk premium, $\beta_{rp}$ for almost all Emerging markets considered.

**IV. Results**

From the dynamic latent factor model we find evidence that the standard deviations of the innovation errors are much larger for the UIP equations than for the RIE equations. Innovation variances of the risk premia are low – average for the Emerging Markets of 0.8. Innovation variances of the expectational errors are much larger in magnitude – average of 18.6 for the Emerging markets. The breakdown of the betas according to equations (11) and (12) are given in the final 2 columns of Table 2 and show the relevance of risk premia and expectational errors in forecasting the exchange rate in the size of the UIP beta for the Emerging market countries.

**V. Conclusions**

We find strong evidence of a long run relation for UIP and PPP in Emerging markets. The results for PPP are highly significant in the long run. These results are much stronger than found in the
previous literature for developed countries.

Using a three parity framework we are able to assess whether risk premia or expectational errors made in forecasting exchange rates drive deviations from UIP and PPP conditions. If risk premia rather, than expectational errors were the major force producing deviations from UIP the basic UIP regression results with Emerging market data should be even worse than the results for developed countries. Results from Campbell et al (2007) provide evidence that expectational errors are driving deviations from parity conditions, and the results here provide consistent new evidence that expectational errors are driving short run deviations from both UIP and PPP conditions for Emerging market countries.

Furthermore when we analyse the size of the deviations from both UIP and PPP using a dynamic latent factor model we find strong evidence for mainly expectational errors playing the dominant role in the size of the beta in the UIP and PPP regressions. The size of the risk premia in explaining these deviations is larger (for some Emerging market countries) than may have first been thought. Although the results are preliminary, the results have significant implications for assessing the size of the risk premia for Emerging market countries.
References


Table 1
Presents the results of the corresponding UIP and PPP regressions for the LDC’s.

<table>
<thead>
<tr>
<th>Country</th>
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<th>n</th>
<th>PPP Beta</th>
<th>n</th>
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Table 2

Results of the Dynamic Latent Factor model to asset the size of the deviation attributable to the risk premium (column 6) and the exchange rate forecast error (column 7).

<table>
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<tr>
<th>Results</th>
<th>Dynamic Latent Variables Model</th>
<th>Common factor</th>
<th>Risk premium</th>
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<th>s(UIP)</th>
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<th>var(fe)</th>
<th>beta OL S</th>
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Figure 1
Full period averages of exchange rate changes against the interest differential for 19 Emerging Markets
Figure 2

Full period averages of exchange rate changes against the inflation differential for 19 Emerging Markets