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HEDGING FOREIGN CURRENCY TRANSACTION EXPOSURE: THE IMPORTANCE OF REAL RATES OF INTEREST

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Abstract

Increasingly, U.S. firms are involved in global transactions which expose them to foreign currency fluctuations and potential adverse financial effects. Hedging forward exchange rates has become commonplace, but at a cost. Thus, information is needed by managers regarding forward exchange rates. Forward exchange rates are believed to contain two expectational components which vary through time: the expected premium, and the expected future spot exchange rate. Pooled time series analysis is employed in this study to empirically test a relationship which equates the expected premium to the difference in expected real interest rates for six major European Currency Unit (ECU) countries. The empirical tests confirm that differences in the level of expected real interest rates between the U.S. and the six major ECU countries over the study period are statistically equal to the expected forward premiums. The implication of this finding is that firms should use all available information on differences between real rates of interest when making forward hedge decisions.

INTRODUCTION

Increasingly, U.S. firms are engaging in global transactions which are often denominated in a foreign currency. Statement of Financial Accounting Standards No. 52, "Foreign Currency Translation", requires that assets and liabilities resulting from these transactions be translated and reported in U.S. dollars with gains and losses due to exchange rate fluctuations impacting net income. As a result, the majority of firms engaged in foreign trade regularly hedge foreign transactions to offset potential adverse effects on net income.[1]

Of course, not all transaction exposure produces adverse effects. For example, a company holding a liability position will recognize a gain if the foreign currency weakens and thus will benefit from not hedging this transaction. Additionally, Flicker and Bline [6] emphasize that the transaction cost associated with purchasing forward contracts means that the successful manager would prefer not to hedge all transactions denominated in a foreign currency. This paper shows that differences in the expected real rates of interest between countries may help managers make decisions on which transactions to hedge.

A model is presented which indicates that the expected value of the risk premia in forward foreign exchange rates, $E(P_{t+1})$, is equal to the difference in the expected real rates of interest between the United States and six major European Currency Unit (ECU) countries. The typical textbook presentation of the international parity relationships generally states that the difference in the expected real rates of interest between two countries must be zero in equilibrium and that $E(P_{t+1}) = 0$. If this were not the case, investment funds would flow from the country with the lower expected rate to the country with the higher expected rate until the two were equal (e.g., Eiteman and Stonehill [3]). Specifically, one should not find an expected forward risk premium that can be explained as the difference between the expected real rates for two countries and that forward foreign exchange rates are an unbiased estimate of the expected future spot rate.

Considerable research, however, has rejected the hypothesis that forward foreign exchange rates are an unbiased estimate of the expected future spot rate. Cumby and Obstfeld [1] and Hodrick and Srivastava [8] present

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empirical results consistent with the existence of a risk premium (i.e., $E(P_{t+1}) \neq 0$). Fama [4] concludes that forward rates contain an expected spot rate and a premium component, both of which are time varying.

This study extends prior research on the expected premium component of foreign exchange rates by using pooled time series analysis to directly test the hypothesis of equality between the expected risk premium and the difference in expected real interest rates. It is shown in this research that if covered interest rate parity, ex ante purchasing power parity, and the Fisher equation hold, the expected forward premium is equal to the difference between the expected real rates of the two countries for forward foreign exchanges. This does not imply that the two series are exactly equal, only that the expected values are equal. The dispersion and/or distribution of each series may be different. The statistical equivalency between the expected values of the two distributions is the main focus of this research.

INTERNATIONAL PARITY RELATIONSHIPS

Unbiasedness

In a rational or efficient marketplace, under the assumption of risk neutrality, the forward exchange rate at time t for an exchange at time $t+1$ is equal to the expected future spot exchange rate:

Equation 1

$$F_t = E(S_{t+1})$$

In differenced form equation (1) can be stated as:

Equation 2

$$F_t - S_t = E(S_{t+1}) - S_t$$

In a rational or efficient marketplace, under the assumption of risk aversion, the forward exchange rate observed at time t for an exchange at time $t+1$ can be split into a term for the expected future spot rate, conditional on all information available at t, and an expected risk premium:

Equation 3

$$F_t = E(P_{t+1}) + E(S_{t+1})$$

F_t and S_{t+1}, respectively, are the natural logs of the forward rate and the future spot rate expressed in U.S. dollars per unit of foreign currency; P_{t+1} is the market's risk premium or reward from selling the foreign currency in the forward market; and E is the expectations operator. Under an assumption of risk neutrality, $E(P_{t+1})$ is zero and the forward rate is said to be an unbiased predictor of the future spot rate. In differenced form, equation (3) can be restated as:

Equation 4

$$F_t - S_t = E(P_{t+1}) + E(S_{t+1}) - S_t$$

where S_t = *current spot rate.*

Covered Interest Rate Parity (CIRP)

In order to prevent risk-free arbitrage profit, a definable relationship (ignoring transaction costs), known as covered interest rate parity, exists among the forward rate, the one-period nominal risk-free interest rates (*r*) for country *i* and the U.S., and the current spot exchange rate:

Equation 5

$$F_t = ln\left[\frac{1+r_{us,t}}{1+r_{i,t}}\right] + S_t$$

or in differenced form:

Equation 6

$$F_t - S_t = R_{US,t} - R_{i,t}$$

where $R = ln(1 + r)$.

Ex Ante Purchasing Power Parity

The rational or efficient markets version of purchasing power parity implies that the best estimate of next period's exchange rate is the current exchange rate adjusted for price level (*V*) changes, conditional on all information available at time *t*. Algebraically, this may be stated:

Equation 7

$$E(S_{t+1}) = E\left(ln\left[\frac{V_{US,t+1} / V_{US,t}}{V_{i,t+1} / V_{i,t}}\right]\right) + S_t$$

or in differenced form:

Equation 8

$$E(S_{t+1}) - S_t = E\left(\Delta_{US,t+1}\right) - E\left(\Delta_{i,t+1}\right)$$

where $\Delta_{t+1} = ln(V_{t+1} / V_t)$ is the inflation rate.

International Fisher Effect

According to the well-known Fisher equation, $(1 + r_t) = [1 + E(r_t)]\, E(V_{t+1}) / V_t$, where r_t is the real rate of interest, it follows that equation (6) may be restated as:

Equation 9

$$F_t - S_t = \left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + \left[E\left(\Delta_{US,t+1}\right) - E\left(\Delta_{i,t+1}\right)\right]$$

where $E(\Gamma)$ is the expected continuously compounded real return on nominal bonds. From equations (6), (8), and (9), it follows that if the differential in the expected real rates is zero, then:

Equation 10

$$R_{US,t} - R_{i,t} = E\left(S_{t+1}\right) - S_t$$

This relationship is known as the International Fisher Effect. The International Fisher Effect is not well supported. Previous research has shown that the level of the expected real interest rates can differ between the U.S. and other countries for extended periods of time (see Mishkin [12], Mark [9], and Merrick and Saunders [11].[2]

If equation (10) holds, it is implied that $F_t - S_t = E(S_{t+1}) - S_t$, or $E(P_{t+1})$ is zero. If equation (10) fails to hold, as previous research has shown, but equations (6) and (8) hold, which implicitly assumes the Fisher equation holds, it follows from equations (4) and (9) that:

Equation 11

$$E\left(P_{t+1}\right) = \left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] \neq 0$$

That is, the expected risk premium component of foreign exchange rates is explained by the differential in expected real rates.

Whether the two series are exactly equal or, as samples, are drawn from the same population distribution, is not predicted by the model. Only the equality between the expected values should be of concern. In the next section, the statistical methodology for testing this hypothesis is developed.

STATISTICAL METHODOLOGY

In this section, statistical models are developed for empirically testing the central hypothesis of equality between the expected premia in forward foreign exchange rates and the differences in expected real rates of interest developed in the previous section. That is, whether it can be statistically demonstrated that $E(P_{t+1}) = E(\Gamma_{US,t}) - E(\Gamma_{i,t}) \neq 0$. All of the statistical models are analyzed using pooled time series methodology which bears a direct structural relationship to the theoretical models and which can provide a pooled test of equation (11) across the major ECU currencies relative to the U.S. dollar.

Parity Relationship Regressions

If equation (9) is true, a suitable regression equation to test for the existence of a premium is:

Equation 12

$$F_t - S_t = \beta_0 + \beta_1\left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + \beta_2\left[E\left(\Delta_{US,t}\right) - E\left(\Delta_{i,t}\right)\right] + e_t$$

Failure to reject the joint hypothesis $\beta_0 = 0$, $\beta_1 = 0$, $\beta_2 = 1$, implies unbiasedness, or forward parity, $F_t = E(S_{t+1})$. On the other hand, a reliably zero β_0 and reliably non-zero β_1 and β_2 under *ex ante* PPP implies the existence of a premium. The average size of the premium is represented by the estimate of $[E(\Gamma_{US,t}) - E(\Gamma_{i,t})]$. Additionally, if equation (9) is true, the regression equation:

Equation 13

$$F_t - S_t = \gamma_0 + \gamma_1\left[E\left(\Delta_{US,t}\right) - E\left(\Delta_{i,t}\right)\right] + v_t$$

is underspecified.[3] In this case, γ_1 is biased and the variance of v_t is overestimated. Further, v_t is not i.i.d., since it contains information on the missing variable $[E(\Gamma_{US,t}) - E(\Gamma_{i,t})]$. Running the regression equation:

Equation 14

$$v_t = \Psi_0 + \Psi_1\left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + z_t$$

to confirm that v_t contains information on $[E(\Gamma_{US,t}) - E(\Gamma_{i,t})]$, and not rejecting $\psi_0 = 0$ and $\psi_1 = 1$, provides additional statistical evidence that $E(P_{t+1}) = [E(\Gamma_{US,t}) - E(\Gamma_{i,t})]$.

Pooled Time Series Analysis

Pooled time series analysis describes regression analysis for data that are a combination of cross-section and time series. Pooled time series analysis is appropriate in testing for risk premia in forward foreign exchange, since the parity conditions imply that risk premia should not be unique to any one country, but to all countries. Pooled time series analysis has the advantage of combining cross-sections (countries) and time series in order to capture variations across the different countries as well as the variations that emerge over time.[4] Misspecification in pooled time series models is well known (e.g., Johnston [10]). This misspecification is captured only in the error term and, as such, is a source of contamination of the regression estimates in a pooled time series. There are numerous ways to characterize the relationship between the right-hand side variables and the error in a pooled time series. Several models are generally used; the choice of a particular model reflects assumptions about the relationship between the right-hand side variables and the error term.

To define the models estimated, assume there are observations on $i = 1, \ldots, N$ countries for each of $t = 1, \ldots, T$ months. The dependent variable is denoted by Y_{it} and the independent variables byX_{it}. The Total Pooled Regression Model (TPRM) is:

Equation 15

$$Y_{it} = \alpha + X_{it}B + u_{it}$$

where α is the overall intercept and u_{it} is i.i.d. This model assumes a single set of slope coefficients for all the observations.

The Fixed-Effect Model assumes that there are common slopes, but that each cross-section unit (country) has its own unique intercept, which may or may not be correlated with the X's. The FEM is:

Equation 16

$$Y_{it} = \alpha_i + X_{it}B + u_{it}$$

The Random-Effects Model (REM) assumes that both the slopes and the intercepts vary across cross-section units. The REM is:

Equation 17

$$Y_{it} = \alpha_i + X_{it} B_i + u_{it}$$

The Between-the-Means Model specifies the same relationship between the individual variable means. If the variable means are assumed to be a representation of their expected values, this model then becomes a primary tool in the investigation of risk premia in forward foreign exchange rates. The BMM is:

Equation 18

$$E(Y_i) = \alpha + E(X_i) B + u_i$$

The TPRM and BMM are the primary methods used in this study to test for the existence of a premium in forward foreign exchange rates that can be explained by the difference in the expected real rates of interest between the countries involved. The TPRM method permits pooling of the data. The results will generally not be significant under TPRM unless there is a close relationship between the observed values of the dependent and independent variables in equations (12), (13), and (14). On the other hand, the BMM method permits a cross-sectional test of expected values which is central to the development of equation (11), the main hypothesis. The FEM and REM results are also presented as statistical support for the fact that 1) the risk premia in foreign forward exchange rates exist, 2) the risk premia can be explained by the differences in the expected real rates of interest between countries, and 3) the risk premia are not equal across countries.

Data

The regression equations (12), (13), and (14) are tested using 240 months of data covering the post Bretton Woods time period 1973.01 through 1992.12. Although the European Rate Mechanism (ERM) of the European Monetary System (EMS) was in effect over this period, the foreign currencies were still allowed to float against the U.S. dollar. Spot exchange rates and 30-day forward rates for six major European currency unit (ECU) countries are obtained from data provided by the Harris Bank. The rates in U.S. dollars per unit of foreign currency are Friday closing quotes sampled at four-week intervals. The six countries are Belgium (BEL), France (FR), West Germany (GER), Italy (IT), The Netherlands (NTH), and The United Kingdom (UK). The nominal interest rates for these countries and the U.S. are estimated by one-month Eurocurrency rates, on dates corresponding to the exchange rate data; these are also provided by Harris Bank.

To test the regression equations, *ex ante* inflation forecasts of the countries are required. In this study, the average value of observed inflation over the previous three-month period is used as the expected value of inflation in the coming month.[5] The inflation values are calculated from the price indices data from the Organization for Economic Cooperation and Development historical statistics.

EMPIRICAL RESULTS

In the three panels of Table 1, the TPRM regression estimates of equations (12), (13) and (14) are presented. Examination of the three panels reveals that $E(P_{t+1})$ is statistically equal to $[E(\Gamma_{US,t}) - E(\Gamma_{i,t})]$ as suggested by the international parity relationships when the expectations for future real rates of interest are not equal across countries. More specifically, evidence is provided that equation (11) holds.

Panel A in Table 1 shows that the TPRM parameter estimates for equation (12) indicate that $\beta_0 = 0$ is not rejected by a t-statistic of .47. Further, $\beta_1 = 0$ and $\beta_2 = 0$ are rejected by t-statistics of 9.67 and 10.60, respectively. The TPRM results indicate that F_t is a biased estimate of $E(S_{t+1})$ and that a risk premium exists.

When equation (13) is estimated using the TPRM method, Panel B of Table 1 shows that the results of the F-test for A, $B = A_i$, B_i are rejected with an F-statistic of 5.88 (P-value = .0000). The statistical results indicate the existence of risk premia that are consistent with the random-effects model. That is, the risk premia exist and are not constant across countries. That the risk premia are not constant is also consistent with differences in expected real rates of interest that are not constant across countries.

TABLE 1
Pooled Time Series
Total Model Estimates

Panel A: $F_t - S_t = \beta_0 + \beta_1\left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + \beta_2\left[E\left(\Delta_{US,t}\right) - E\left(\Delta_{i,t}\right)\right] + e_t$ (12)

Mean Of Dependent Variable	=	-.0006	Std. Error Of Regression	=	.0126
Std. Dev. Of Dep. Variable	=	.0131	R-Squared	=	.0731
Sum Of Squared Residuals	=	.2284	Adjusted R-Squared	=	.0719
Variance Of Residuals	=	.0002			

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Gamma_{US,t})$ - $(\Gamma_{i,t})$	.8929	.0923	9.67
$E(\Delta_{US,t})$ - $E(\Delta_{i,t})$	.9313	.0879	10.60
Constant	.0002	.0003	.47

F-stat for $A,B = A_i, B_i:\quad F(15,1422) = 0.75,\ P\text{-}value = .74$

Panel B: $F_t - S_t = \gamma_0 + \gamma_1\left[E\left(\Delta_{US,t}\right) - E\left(\Delta_{i,t}\right)\right] + v_t$ (13)

Mean Of Dependent Variable	=	-.0006	Std. Error Of Regression	=	.0130
Std. Dev. Of Dep. Variable	=	.0131	R-Squared	=	.0128
Sum Of Squared Residuals	=	.2432	Adjusted R-Squared	=	.0121
Variance Of Residuals	=	.0002			

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Delta_{US,t})$ - $E(\Delta_{i,t})$	.1971	.0456	4.32
Constant	-.0004	.0003	-1.27

F-stat for $A,B = A_i, B_i:\quad F(10,1428) = 5.88,\ P\text{-}value = .00$

Panel C: $v_t = \Psi_0 + \Psi_1\left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + z_t$ (14)

Mean Of Dependent Variable	=	.0000	Std. Error Of Regression	=	.0129
Std. Dev. Of Dep. Variable	=	.0130	R-Squared	=	.0155
Sum Of Squared Residuals	=	.2395	Adjusted R-Squared	=	.0148
Variance Of Residuals	=	.0002			

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Gamma_{US,t})$ - $E(\Gamma_{i,t})$	.2263	.0476	4.76
Constant	-.0000	.0003	-.01

F-stat for $A,B = A_i, B_i:\quad F(10,1428) = 5.01,\ P\text{-}value = .00$

In panel C of Table 1, the results of equation (14) indicate that equation (13) was in fact underspecified. Here it is shown that v_t is explained by $[E\ (\Gamma_{US,t})\ -\ E(\Gamma_{i,t})]$ over the study period. The estimated coefficient $\hat{\Psi}_1$ is .2263 and is statistically significant. That equation (13) is underspecified is consistent with the fact that the differences in the expected real rates of interest are missing from equation (13).

The BMM method estimates of equations (12), (13), and (14), shown in the three panels of Table 2, provide further strong statistical confirmation that $E(P_{t+1})$ is statistically equal to $[E(\Gamma_{US,t})\ -\ E(\Gamma_{i,t})]$. There are no F-tests in Table 2 because the results pertain to the mean estimates of the variables. Note that the estimated coefficients and their significance are consistent with the estimates in Table 1. Perhaps most important is that the hypothesis $\psi_1 = 0$ in equation (14) is rejected by a t-statistic of 2.57. The error term in equation (13) can be explained by the differences in the expected real rates of interest.

Tables 3 and 4 report the results of the fixed-effects and random-effects model estimates. In all cases, the null hypothesis of A, $B = A_i$, B is rejected. The primary importance of the null being rejected is that it confirms that the intercept terms, in this study the difference in the expected real rates of interest, is not constant between countries. Further, the Hausman test rejects the equivalency of the fixed-effects versus random-effects models.

Overall, statistical support is demonstrated for the existence of a sizable expected forward premium for many currencies that is explained by the difference in the expected real interest rates for the two countries for forward exchange. These results provide strong evidence that a difference in the expected real rates of interest can exist between two countries for a sustained period of time and can explain the size of the forward premium.

SUMMARY AND CONCLUSION

This study has provided a pooled time series empirical test for risk premia in forward foreign exchange rates. The data used were nominal Eurocurrency rates, CPI data, and exchange rates between the U.S. and six major ECU countries. It is a known fact that the European currency markets have been subject to recurring periods of turmoil over the sample time period which is covered in this research. However, the empirical methodology does generate statistically significant findings. The results strongly support 1) the existence of an expected forward premium that is statistically equal to the difference in the expected real interest rates between the two countries for forward exchange, and 2) that a difference in the expected real rates of interest can exist between pairs of countries for a sustained period of time. A practical implication of these findings for both the accounting and finance professions is that expected real rates of interest between countries should be taken into consideration when managers make hedging decisions which involve forward contracts for foreign exchange.

ENDNOTES

1. A survey by the Financial Accounting Standards Board found that 84% of company treasurers engage in hedging foreign currency exposure [5].

2. Dotsey [2] presents ex post evidence that the real rates of interest have differed between the U.S. and other countries over the time period encompassed by the present study.

3. For a discussion on underspecification, see Johnston [10].

4. Individual country regressions were run for equations (12), (13), and (14). Individual regression analysis does not offer strong statistical support for equation (11).

5. Interest rate models and univariate time series models have been shown to forecast inflation well over longer time periods and not for the short one-month time periods of this study (Mishkin [12]). Hafer and Hein [7] suggest that a moving average approach works just as well as any other method for short-term forecasting periods due to the significant amount of noise which may be present.

TABLE 2
Pooled Time Series
Between-the-Mean Estimates

Panel A: $F_t - S_t = \beta_0 + \beta_1\left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + \beta_2\left[E\left(\Delta_{US,t}\right) - E\left(\Delta_{i,t}\right)\right] + e_t$ (12)

Mean Of Dependent Variable	=	-.0006	Std. Error Of Regression	=	.0005
Std. Dev. Of Dep. Variable	=	.0031	R-Squared	=	.9834
Sum Of Squared Residuals	=	.0000	Adjusted R-Squared	=	.9724
Variance Of Residuals	=	.0000			

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Gamma_{US,t})$ - $(\Gamma_{i,t})$	2.263	.4211	5.38
$E(\Delta_{US,t})$ - $E(\Delta_{i,t})$	.9240	.1051	8.79
Constant	.0001	.0002	.61

Panel B: $F_t - S_t = \gamma_0 + \gamma_1\left[E\left(\Delta_{US,t}\right) - E\left(\Delta_{i,t}\right)\right] + v_t$ (13)

Mean Of Dependent Variable	=	-.0006	Std. Error Of Regression	=	.0015
Std. Dev. Of Dep. Variable	=	-.0031	R-Squared	=	.8240
Sum Of Squared Residuals	=	.0000	Adjusted R-Squared	=	.7800
Variance Of Residuals	=	.0000			

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Delta_{US,t})$ - $E(\Delta_{i,t})$	1.1631	.2688	4.33
Constant	.0004	.0006	.57

Panel C: $v_t = \Psi_0 + \Psi_1\left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + z_t$ (14)

Mean Of Dependent Variable	=	.0000	Std. Error Of Regression	=	.0019
Std. Dev. Of Dep. Variable	=	.0027	R-Squared	=	.6230
Sum Of Squared Residuals	=	.0000	Adjusted R-Squared	=	.5287
Variance Of Residuals	=	.0000			

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Gamma_{US,t})$ - $(\Gamma_{i,t})$	3.4970	1.3603	2.57
Constant	-.0000	.0008	-.05

TABLE 3
Pooled Time Series
Fixed-Effects Model Estimates

Panel A: $F_t - S_t = \beta_0 + \beta_1\left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + \beta_2\left[E\left(\Delta_{US,t}\right) - E\left(\Delta_{i,t}\right)\right] + e_t$ (12)

Mean Of Dependent Variable	= .0000		Std. Error Of Regression	=	.0126
Std. Dev. Of Dep. Variable	= .0128		R-Squared	=	.0321
Sum Of Squared Residuals	= .2271		Adjusted R-Squared	=	.0273
Variance Of Residuals	= .0002				

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Gamma_{US,t})$ - $(\Gamma_{i,t})$	.7631	.1172	6.51
$E(\Delta_{US,t})$ - $E(\Delta_{i,t})$	.7997	.1165	6.87

F-stat for $A_i,B = A_i,B_i$: $F(10,1422) = 0.350$, P - *value* = .97
F-stat for $A,B = A_i,B$: $F(5,1432) = 1.540$, P - *value* = .17

Panel B: $F_t - S_t = \gamma_0 + \gamma_1\left[E\left(\Delta_{US,t}\right) - E\left(\Delta_{i,t}\right)\right] + v_t$ (13)

Mean Of Dependent Variable	= .0000		Std. Error Of Regression	=	.0128
Std. Dev. Of Dep. Variable	= .0128		R-Squared	=	.0034
Sum Of Squared Residuals	= .2339		Adjusted R-Squared	=	-.0008
Variance Of Residuals	= .0002				

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Delta_{US,t})$ - $E(\Delta_{i,t})$	.1040	.0469	2.22

F-stat for $A_i,B = A_i,B_i$: $F(5,1428) = 0.3133$, P - *value* = .91
F-stat for $A,B = A_i,B$: $F(5,1433) = 11.4810$, P - *value* = .00

Panel C: $v_t = \Psi_0 + \Psi_1\left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + z_t$ (14)

Mean Of Dependent Variable	= .0000		Std. Error Of Regression	=	.0127
Std. Dev. Of Dep. Variable	= .0128		R-Squared	=	.0133
Sum Of Squared Residuals	= .2314		Adjusted R-Squared	=	.0092
Variance Of Residuals	= .0002				

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Gamma_{US,t})$ - $(\Gamma_{i,t})$	.2064	.0470	4.39

F-stat for $A_i,B = A_i,B_i$: $F(5,1428) = .0161$, P - *value* = .99
F-stat for $A,B = A_i,B$: $F(5,1433) = 10.0010$, P - *value* = .00

TABLE 4
Pooled Time Series
Random-Effects Model Estimates

Panel A: $$F_t - S_t = \beta_0 + \beta_1\left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + \beta_2\left[E\left(\Delta_{US,t}\right) - E\left(\Delta_{i,t}\right)\right] + e_t \quad (12)$$

Mean Of Dependent Variable	=	-.0005	Std. Error Of Regression	=	.0126
Std. Dev. Of Dep. Variable	=	.0130	R-Squared	=	.0606
Sum Of Squared Residuals	=	.2280	Adjusted R-Squared	=	.0560
Variance Of Residuals	=	.0002			

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Gamma_{US,t})$ - $(\Gamma_{i,t})$	.8660	.0979	8.85
$E(\Delta_{US,t})$ - $E(\Delta_{i,t})$	.9046	.0943	9.59
Constant	.0001		.34

Hausman test of FE vs. RE: *CHRISQ(2) = 4.79, P-value = .09*

Panel B: $$F_t - S_t = \gamma_0 + \gamma_1\left[E\left(\Delta_{US,t}\right) - E\left(\Delta_{i,t}\right)\right] + v_t \quad (13)$$

Mean Of Dependent Variable	=	-.0002	Std. Error Of Regression	=	.0128
Std. Dev. Of Dep. Variable	=	.0128	R-Squared	=	.0042
Sum Of Squared Residuals	=	.2349	Adjusted R-Squared	=	-.0000
Variance Of Residuals	=	.0002			

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Delta_{US,t})$ - $E(\Delta_{i,t})$	.1144	.0467	2.45
Constant	-.0005	.0011	-.48

Hausman test of FE vs. RE: *CHISQ(1) = 4.99, P-value = .03*

Panel C: $$v_t = \Psi_0 + \Psi_1\left[E\left(\Gamma_{US,t}\right) - E\left(\Gamma_{i,t}\right)\right] + z_t \quad (14)$$

Mean Of Dependent Variable	=	.0000	Std. Error Of Regression	=	.0127
Std. Dev. Of Dep. Variable	=	.0128	R-Squared	=	.0135
Sum Of Squared Residuals	=	.2323	Adjusted R-Squared	=	.0094
Variance Of Residuals	=	.0002			

Variable	Estimated Coefficient	Standard Error	t-statistic
$E(\Gamma_{US,t})$ - $(\Gamma_{i,t})$	.2082	.0470	4.44
Constant	.0000	.0010	-.0025

Hausman test of FE vs. RE: CHISQ(1) = 3.50, P-value = .06

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