RISK PREMIUMS IN THE FOREIGN EXCHANGE MARKET

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CONTENTS

I. Introduction

Since the era of flexible foreign exchange rates, there has been considerable poltical, commercial and academic interest in the efficiency of the forward foreign exchange markets. Policy makers are concerned that excessive speculation in the forward exchange market results in unwarranted volatility in the spot exchange market, and the predictability of forward exchange rates in forecasting the future spot exchange rates is used in arguments against intervention by central banks.

Early studies by Frenkel (1977) and Levich (1979) supported the proposition that the forward rate was an unbiased predictor of the future spot rate which was taken as an indication of the efficiency of the market. There is growing literature showing that forward exchange rates are systematically biased predictors of future spot exchange rates when expectations are posited to be rational. The unbiasedness hypothesis is rejected in many empirical studies (Dooley and Shafter (1983), Cumby and Obstfeld (1981), Bilson (1981), and Fama (1984)). Theoretically, numerous international asset pricing models demonstrate that the bias is their risk premium, possibly time varying, risk-averse investors receive as compensation for the risk inherent in forward exchange rate speculation. Unfortunately, despite the general agreement over the significance of the risk premiums, few of these theoretical specifications are empirically tractable and the rejection of unbiasedness hypothesis has not been considered as an acceptance of a particular risk premium model. In an important contribution to the literature, Fama (1984) showed that the nature of the risk premiums can be further understood without the need to utilize a particular model. Specifically, Fama decomposed the forward premium into two unobservable components: the expected spot exchange rate and the risk premium. He not only found the risk premium to be time-varying

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but that its variations rather than movements in expected spot exchange rates account for most of the volatility in one-month forward premiums. The results are further supported by Hodrick and Srivastava (1986) employing different methodologies. However, these studies examined just one-month maturity forward contract. In contrast, the foreign exchange markets are characterized by trading in forward contracts of numerous maturities.

The purpose of this papaer is to determine if the nature of time variation in risk premiums is invariant with respect to the maturity of the forward contracts. This is accomplished by studying the relative variation in the risk premium and the expected future spot components of forward rates and the covariation between the two for forward contracts of various maturities. This has numerous implications for the foreign exchange markets. To the extent that maturity-specific risk premiums are identified, the analysis can uncover the presence of market segmentation. In short, it may very well be that the observed volatility in the risk premiums occurs only in the one-month forward rates. Furthermore, most of the fluctuations in the foreign exchange markets can be attributed to the arrival of new maturity-specific information and the nature of the information can have differential impacts on forward contracts of different maturities. For example, unexpected changes in short-term interest rates will likely affect only short term forward contracts.

An obvious problem in using contracts of longer maturities is the corresponding decline in the number of observations with nonoverlapping forecast errors. For example, with twelve-month forward contracts, less than 15 observations are available for the current floating exchange rate period.[1] On the other hand, the standard generalized least squares cannot be used to adjust for the serial correlation in the residuals induced by the overlapping data. This is because when the regressors are predetermined but are not strictly exogenous, generalized least squares produces inconsistent estimates.

In this paper, we capitalize on the availability of weekly data and scrutinize the testable restrictions by using the Generalized Method of Moments (GMM) procedure suggested by Hansen (1982) that yields consistent and relatively efficient asymptotic estimates. The present paper therefore extends prior analysis of one-month contracts using weekly data. Since previous tests rely on the asymptotic distribution theory, with the four-fold increase in sample size the adequacy of the previous data can be addressed. In addition, a number of studies have found that conditional heteroskedasticity is present in foreign exchange rates data. The GMM is also appropriate in that it yields estimates that are robust with respect to conditional heteroskedasticity. Since the various forward exchange markets do not operate in isolation, it is important to allow for the interactions between them. Accordingly the estimations are performed simultaneously for various forward maturities for each exchange rate as well as different exchange rates for each

1. All previous findings are subject to the question of the statistical validity of the test since they were based on asymptotic distribution theory. This limitation on the number of observations induced Hodrick and Srivastava (1985) to study the nature of risk premiums in the foreign exchange futures market.

maturity. This is achieved by extending the GMM to the case of joint estimation.

II. Hypotheses, Data, and Econometric Issues

1. Hypotheses

The forward exchange rate F_t observed at time t for an exchange at t+k is the market determined certainty equivalent of the future spot exchange rate S_{t+k}. The forward rate can be decomposed into two part: expected future spot exchange rate and a risk premium.

$$(1)\ f_t = E(s_{t+k}) + p_t,$$

where $f_t = \log(F_t)$, $s_{t+k} = \log(S_{t+k})$, p_t is the risk premiums, and the expected future spot rate, $E(s_{t+k})$, is the rational forecast, conditional on all information available at t.[2] Using (1) the forward premium is

$$(2)\ f_t - s_t = E\ (s_{t+k} - s_t) + p_t.$$

From the following two regression equations Fama (1984) drew testable restrictions to assess the role of forward premiums in the determination of forward rates.

$$(3)\ f_t - s_{t+k} = a_1 + b_1 (f_t - s_t) + e_{1,\ t+k},$$

$$(4)\ s_{t+k} - s_t = a_2 + b_2 (f_t - s_t) + e_{2,\ t+k}.$$

Since the sum of dependent variables of (3) and (4) is the common independent variable, the sum of the intercepts in (3) and (4) is zero and the sum of the slope coefficients is one. In other words, the two equations contain identical information about two components in the forward premium: variation in the risk premium and the expected future spot exchange rate. Dependent variable in (3), f_t-s_{t+k}, is the premium, p_t, plus random forecaset errors, $E(s_{t+k}) - s_{t+k}$. Evidence that b_1 is significantly different from zero or equivalently that b_2 is significantly different from one implies the existence of time-varying risk premiums. Then the null hypothesis for the existence of time-varying risk premium is

$$(5)\ H_0:\ b_1 \doteq 0 \text{ or } b_2 = 1.$$

It is also shown in Fama (1984) that the relative magnitude of variations of premium and expected change in spot exchange rate can be expressed as the difference between two slope coefficients,

2. Natural logs are used in (1) to make the analysis independent of whether exchange rates are expressed as units of domestic currency per unit of foreign currency or vice versa. Logarithm also transforms the foreign exchange rate series to more stationary series.

$$(6)\ b_1 - b_2 = \frac{\mathrm{var}(p_t) - \mathrm{var}(E(s_{t+k} - s_t))}{\mathrm{var}(f_t - s_t)}$$

Evidence that $b_1 - b_2$ is significantly greater than zero means that variation of risk premium is larger than that of the expected rate of change of the future spot exchange rate. Then the null hypothesis for the test of relative magnitude of the variation of risk premiums and the variation of expected future spot rate changes is

$$(7)\ H_0:\ b_1 - b_2 = 1\text{-}2b_2 \leqslant 0.$$

2. Data

Weekly data for the 9 spot and forward foreign exchange rates come from the Weekly Review of the Harris Trust and Savings Banks. Friday close exchange rates of U.S. dollar per foreign currency are used. The sample period begins August 31, 1973, which coincides with Fama's (1984) study and ends May 9, 1986. Four maturities for forward contracts are available. For the nonoverlapping sample, one-, three-, six-, and twelve-month forward rates are sampled at 4, 13, 26, and 52 weeks interval, respectively. Data availability for the twelve-month contracts limits its starting date to September 6, 1974.

3. Econometric Issues

To conserve notation, let us define the following variables.

$y_{t+k} = s_{t+k} - s_t =$ the vector of change in spot exchange rates from t to t+k,
$x_t = f_t - s_t =$ the vector of m forward premiums observed at time t,
$e_{t+k} =$ the vector of innovation in y_{t+k},
$I_t =$ the information set available at time t,
$b =$ an m-dimensional column vector of parameters.

Consider the problem of estimating the parameters of a k-period ahead forecasting equation,

$$(8)\ E(y_{t+k} \mid I_t) = x_t b, \text{ or equivalently}$$
$$y_{t+k} = x_t b + e_{t+k}.$$

Under the rational expectations, y_{t+k} can be written as its conditional expectation $(E(y_{t+k} \mid I_t))$ plus a mean zero forecast error (e_{t+k}) uncorrelated with any variable in the information set I_t. It can be shown that $E(e_{t+k}\, e_{s+k})$ is zero for all $\mid t\text{-}s \mid \geqslant k$. Only in the case when the sampling interval is the same as the forecasting interval, that is, k=1, will forecast errors be serially uncorrelated.

Under the presence of serial correlation, the Ordinary Least Squares (OLS) estimators are consistent, but asymptotic variance-covariance matrix is inconsistent. Consequently, in testing hypothesis concerning forecasting equations, one alternative is to define the sampling interval to be equal to the forecast interval. This alternative clearly does not use all available data.

A standard econometric technique for estimation in the presence of serial correlation is the Generalized Least Squares (GLS). The GLS in the time series data requires the strict econometric exogeneity of x_t process. This means that $E(e_{t+k} \mid x_t, x_{t-1}, x_{t+1}, ...) = 0$. This strict assumption means that knowledge of future x_t's would be useless in determining the optimal forecast for y_{t+k}. In the study of the exchange market the assumption of strict exogeneity is clearly inappropriate since knowledge of future values of these variables would provide useful information in forecasting future spot exchange rates. If the x_t vector contains variables which are predetermined but not strictly exogenous, the GLS adjustment for the serial correlation produces inconsistent estimator.

The estimation strategy in this chapter is to obtain consistent estimators using all available sample or data sampled more finely than the forecast errors. To handle the serial correlation problem of multi-period ahead forecast equation the Generalized Method of Moments (GMM) of Hansen (1979) is required. By making the appropriate adjustment in the estimation of the asymptotic covariance matrix, we can increase dramatically the sample size of the data used and hence increase the asymptotic power of the tests.

III. Empirical Procedures and Results

As pointed out earlier, the results on the long-maturity forward rates are subject to the statistical validity due to the small sample size. Furthermore, cross-maturity study is infeasible since only a few observations are available for the joint estimation. To compromise the sample size and the statistical problems caused by overlapping sample, the GMM procedure is used. The GMM procedure produces consistent estimates from serial correlation and conditional heteroscedasticity. Standard econometric technique implicitly assumes that the disturbance $\{e_t\}$ is homoscedastic with respect to the instruments, so that

(9) $E(e_t^2 \mid X_t) = \sigma_e^2$, for all t.

Condition (9), however, will hold, for example, when the disturbance and instruments are jointly normally distributed. An advantage of the GMM is that it avoids some restrictive assumptions concerning the covariance matrices of residuals.

As has been the case of the SUR estimation of nonoverlapping sample, joint estimation of overlapping sample produces more efficient estimates and allows cross-currency and cross-maturity joint tests. Table 1 reports correlation coefficients of residuals from single equation GMM estimation of each currency for different maturities. Except for the Canadian dollar, all 8 currencies are highly correlated even after adjustment of serial correlation and conditional heteroscedasticity. Furthermore, the nature of cross-currency correlation is invariant with respect to maturity. Evidence from Table 1 warrants the necessity of the cross-currency joint GMM estimation. Simultaneous estimation of 9 currencies for each maturity can be accomplished by extending single equation GMM estimation into the SUR framework.

Using previously defined notations, define the vector function $h(y_{t+k}, x_t, b^*) = e_{t+k}$

$$(10)\quad h(y_{t+k}, x_t, b^*) = y_{t+k} - a - bx_t,$$

where b^* is the 18 element vector of parameters (a_1 b_1 ... a_9 b_9). The model provides orthogonality conditions that can be used for estimation of b in (10).

Let $z_t' = (1\ x_{1t} \cdots x_{9t})$ be the 10 elements vector of instruments, and define the function f by

$$(11)\quad f(y_{t+k}, x_t, b^*) = h(y_{t+k}, x_t, b^*) \otimes z_t,$$

where $\otimes$ is the Kronecker product of matrix.

The model implies

$$(12)\quad E[f(y_{t+k}, x_t, b^*)] = 0$$

when f is evaluated at the true parameter vector b^*. This is a vector of 90 orthogonality conditions formed from the unobservable error terms. The GMM estimator exploits the sample moment of (12) defined by

$$(13)\quad g_T(b) = (1/T) \sum_{t=1}^{T} f(y_{t+k}, x_t, b)$$

for a sample of size T.

The parameters are chosen to minimize the criterion function,

$$(14)\quad J_T(b) = g_T(b)' W_T g_T(b)$$

for an appropriately chosen 90 x 90 symmetric weighting matrix W_T. The optimal choice of W_T is described in Hansen (1982). The optimal W_T is chosen in a way to minimize the asymptotic covariance matrix of the parameters for the class of estimators that exploit the same orthogonality conditions.

$$(15)\quad W_T = [(1/T) \sum_{t=1}^{T} f(y_{t+k}, x_t, b)\, f(y_{t+k}, x_t, b)']^{-1}$$

In the context of the SUR procedure, the model can be written as

$$(16)\quad Y = Xb^* + e,$$

where Y is the 9T-dimensional column vector of y_{it} (i = 1, ... 9, and t = 1, ..., T), e is the 9T-dimensional column vector of e_{it}, and X is the 5Tx18 block diagonal matrix which has X_i as its i-th diagonal matrix and X_i is itself the Tx2 matrix of $(1, X_{it})$. Define the instrument matrix Z as the 5Tx90 block diagonal matrix which has Z_i (i = 1, ..., 9) as its diagonal matrix and Z_i itself is the Tx10 matrix of $(1, x_{1t}, ..., x_{9t})$.

Then the orthogonality conditions are

(17) $g_T(b^*) = Z'(Y-Xb^*)/T,$

and the GMM estimates, b_T, can be obtained by minimizing the criterion function

(18) $J_T(b^*) = (1/T)^2 (Y-Xb^*)'ZW_TZ'(Y-Xb^*),$

where the weighting matrix W_T ix

(19) $$W_T = [\sum_{K=-L+1}^{L-1} (1/T) \sum_{t=1}^{T-K} (\hat{e}_t \otimes z_t)(\hat{e}_{t-k} \otimes z_{t+k})']^{-1}$$

where $\hat{e}_t$ is a consistent estimates of e.[3]

Then the GMM estimates are

(20) $b_T = (X'ZW_TZ'X)^{-1}X'ZW_TZ'Y,$

and the asymptotic covariance matrix for $/T(b_T-b^*)$ is

(21) $V(b_T) = (D_T'W_TD_T)^{-1}$, where $D_T = Z'X/T$.

However, when the number of lag, L, is positive, there is no guarantee that the computed variance-covariance matrix will be positive definite. This can happen when autocovariance dominate own variances. A positive definite matrix can be obtained by multiplying weighting matrix by modified Bartlett lag window, w (P),

(22) $$w(P) = \left|\frac{L+1-|K|}{L+1}\right|^P \qquad K = -L, -L+1, ..., L-1, L$$

to give less weight to the higher-order autocovariances of estimated residuals.[4] After a lag window adjustment weighting matrix becomes

3. The OLS residuals are used to estimate the weighting matrix. Another alternative is to use the residuals from the SUR. Also, in actual estimation of weighting matrix, we only need to calculate the matrix sum for K=0, ..., L-1 since the matrix sum over K=1, ..., L-1 is a transpose of the matrix sum over K=-L+1, ..., -1.

4. When P = 0, there is no lag window adjustment. When P = 1, w(P) is called a triangular or a tent lag window. When P is infinity, the weight matrix is a null matrix and no serial correlation is adjusted.

$$(23)\ W_T = [\sum_{K=-L+1}^{L-1} w(P)\ (1/T) \sum_{t=1}^{T-K} (\hat{e}_t \otimes z_t)\ (\hat{e}_{t-k} \otimes z_{t+k})']^{-1}$$

It also needs to be noted that consistency is preserved through the lag window transformation.

Test of joint hypothesis can be accomplished by imposing cross-equation linear restrictions such as $Rb_T = r$ and utilizing the Wald test. R is a qXm restriction matrix with q restrictions and r is a q-dimensional column vector. Then the test statistic has the chi-square distribution with degrees of freedom equal to the number of restrictions (q) or the row dimension of matrix R.

$$(24)\ (Rb_T - r)'\ [RV(b_T)R'/T]^{-1}\ (Rb_T - r)$$

The estimated variance-covariance matrices are not positive definite for L=12 and the triangular lag window (P=1.0) is used. Table 2 reports the joint estimation of 9 currencies for each maturity. For the one-month forward contract, 8 exchange rates are negative and significant, 7 currencies at 5% significance level and 1 currency at the 10% level. Due to the sample size, the more reliable comparisons between overlapping and nonoverlapping estimations can be performed for the one-month forward rates. For the one-month rate data, overall results are very similar to each other. The French franc, which has insignificant positive slope coefficient in the SUR estimation, has negative but insignificiant slope coefficient. The Japanese yen's slope coefficient, which is insignificant in the SUR estimation, is negatively significant only at 10% level. As to the magnitude of slope coefficients, all significant GMM estimates are larger than all significant SUR estimates. The one-month estimation result shows that the GMM and the SUR produce almost identical result and we can draw reliable inferences from overlapping data for long-term maturity forward rates.

Contrary to the SUR estimation of three-month forward rates, all slope coefficients are negative and significant for the three-month GMM estimation. For the six- and twelve-month forward rates data, all exchange rates except for the Canadian dollar have negative and significant slope coefficients. The sign of intercept terms are identical for two estimation methods regardless of the mturity. Significantly negative slope coefficients in Table 2 implies that the covariation between forward premiums and expected spot rate changes is negative and the magnitude of covariation is greater than the variation of expected spot rate changes for all maturities.

Table 3 reports chi-square tests on various joint hypotheses on the slope coefficients. The hypothesis that all the slope coefficients are equal is rejected for all maturities. The hypothesis that all the slope coefficients are equal to one is also rejected for all maturities. Table 2 indicates that the nature of risk premiums in the foreign exchange forward rates is the same across currencies in the sense that they all have the time-varying components in them. However, the quantitative effects of forward premiums on the future spot exchange rates differ among currencies.

To see the relative magnitude of the variation of risk premiums and the variation of expected future spot rate changes, the hypothesis

(25) $H_0: \text{var}(p_t) < \text{var}(E(s_{t+k} - s_t))$

is tested and reported in Table 4. The hypothesis is equivalent to the one that b_1-$2b_2$ is negative and the test is implemented by estimating the one-tailed t-value of b_1-$2b_2$. The test in the SUR estimtion of the one-month nonoverlapping sample shows that except the French franc the null hypothesis is rejected for all other exchange rates. As we move to long-term maturity forward rates, the null hypothesis is not rejected for more exchange rates. The test in the GMM estimation of overlapping sample shows that the null hypothesis is rejected only for the six and twelve-month forward rates. Along with Table 3, Table 4 reveals that both the premium, p_t, and the expected changes in the spot rate, $E(f_{t+k} - s_t)$, in forward premium, $f_t - s_t$, vary through time, and var (p_t) is large relative to var $(E(s_{t+k} - s_t))$.

The cross-maturity joint estimation allows us to incorporate any contemporaneous correlation of maturity-specific information. As pointed out before, the biggest disadvantage of nonoverlapping sample is the lack of enough observations for various tests. Particularly, for the cross-maturity tests, only 11 observations are available for our sample period. Hence, the GMM is essential for the cross-maturity tests. Table 5 reports cross correlation coefficients of residuals from single equation GMM estimation of each maturity for 9 currencies. As has been the case of the cross-currency estimation, the residuals are highly correlated. Residuals from adjacent forward premiums (diagonal terms in the correlation matrices) are more highly correlated than those from distant forward premiums (off-diagonal terms in the correlation matrices). Furthermore, the nature of cross-maturity correlation is invariant with respect to currency. Evidence from Table 5 warrants the necessity of the cross-maturity joint GMM estimation. Simultaneous estimation of 4 maturities for each currency can be accomplished by extending single equation GMM estimation into the SUR framework. Since the forecasting horizons increase for the long maturity forward contracts the maximum lags of 52 (L=52) are used for the estimation of single equation residuals and the variance-covariance matrix.[5] So, the estimates of standard errors are conservative measures. Table 6 reports the cross-maturity estimation of the GMM for each exchange rate. Except for the Canadian dollar all slope coefficients are negative but are less significant than cross-currency estimation.

Various joint hypothesis on the slope coefficients are tested and reported in Table 7. The hypothesis that the slope coefficients are equal across maturity for each currency is rejected for the 4 maturities. The rejection of this hypothesis implies that the resolution of uncertainty in the forward exchange market is not uniform across maturity for some currencies. It can happen only if there exists maturity-specific information and the market has ability to differentiate it from one another with respect to maturity. The hypothesis that all slope coefficients are equal

5. Frequency domain approach can be used to obtain the weighting matrix. Spectrum and cross-spectrum of e'Z series at frequency zero is the estimates of covariance matrix in the frequency domain. This method, however, is not approrpriate for our purpose since we have to estimate (90) (91)/2 number of spectral density functions.

to one across maturity is rejected for all exchange rates. So the existence of time-varying risk premiums is confirmed and the nature of risk premiums in the foreign exchange market remains the same whether we incorporate the cross-currency correlation or the cross-maturity correlation.

Table 8 reports the test of the hypothesis in (25). Except for the Canadian dollar and the French franc, the hypothesis that the variation of risk premiums is smaller than the variation of expected changes in spot rates is rejected. Except for the longer term forward rates of the Canadian dollar and the French franc, the variation in the risk premiums dominates the variation in the expected spot rate changes. Together with Table 4 and Table 8, we can conclude that var (p_t) is reliably greater than var $(E(s_{t+k} - s_t))$.

IV. Conclusions

This study documents a rejection of the hypothesis that forward foreign exchange rates are unbiased predictors of future spot rates. The cross-maturity tests and the cross-currency tests for longer term maturities are possible by exploiting nonoverlapping weekly data using the GMM procedure. The rejection of unbiasedness hypothesis is consistent with various maturities and exchange rates. Joint tests across currency and across maturity also confirm not only the existence of time-varying risk premiums in the forward foreign exchange market but that the variations in the forward premiums rather than movements in expected spot exchange rate changes account for most of the volatility in forward exchange rates. We also found that the resolution of uncertainty in the foreign exchange market is not uniform across maturity and there is maturity-specific information across maturity and there is maturity-specific information investors can use in their investment decisions.

The existence of time-varying risk premiums in the forward foreign exhcnage market can be extended into the framework of the single latent variable model to test whether the risk premiums in the forward exchange markets move in proportion to a single latent variable. The single latent variable can be interpreted as a constant beta on a single, unobservable benchmark portfolio in the context of the Intertemporal Capital Asset Princing Model (ICAPM).

Table 1. GMM Single Equation Residuals' Correlation Coefficients (Cross-Currency Correlation).

Panel A: Lower triangular matrix is for the 1 month forward rate
Upper triangular matrix is for the 3 month forward rate

	CD	BP	BF	FF	DM	IL	DG	SF	JY
CD		0.093	0.101	0.012	0.115	0.002	0.127	0.202	-0.034
BP	0.293		0.594	0.580	0.625	0.627	0.647	0.620	0.446
BF	0.241	0.629		0.863	0.944	0.778	0.923	0.825	0.585
FF	0.237	0.607	0.888		0.852	0.845	0.847	0.752	0.582
DM	0.230	0.622	0.943	0.876		0.782	0.970	0.868	0.585
IL	0.188	0.617	0.801	0.843	0.802		0.812	0.700	0.560
DG	0.244	0.653	0.936	0.883	0.968	0.812		0.861	0.588
SF	0.234	0.616	0.841	0.796	0.884	0.742	0.874		0.627
JY	0.106	0.450	0.602	0.615	0.598	0.570	0.595	0.624	

Panel B: Lower triangular matrix is for the 6 month forward rate
Upper triangular matrix is for the 12 month forward rate

	CD	BP	BF	FF	DM	IL	DG	SF	JY
CD		-0.193	-0.085	-0.162	-0.008	-0.198	-0.004	0.013	-0.195
BP	-0.040		0.709	0.790	0.740	0.855	0.729	0.732	0.586
BF	0.017	0.608		0.929	0.947	0.859	0.912	0.813	0.543
FF	-0.079	0.649	0.891		0.900	0.933	0.875	0.800	0.545
DM	0.021	0.637	0.953	0.870		0.883	0.982	0.885	0.554
IL	-0.138	0.679	0.824	0.876	0.829		0.886	0.789	0.567
DG	0.077	0.614	0.893	0.832	0.939	0.830		0.865	0.578
SF	0.174	0.649	0.801	0.764	0.840	0.706	0.863		0.647
JY	-0.093	0.428	0.546	0.543	0.558	0.548	0.543	0.607	

Notes:
CD = Canadian dollar
BP = British pound
BF = Belgian franc
FF = French franc
DM = Deutsche mark
IL = Italian lira
DG = Dutch guilder
SF = Swiss franc
JY = Japanese yen.

Table 2. Cross-Currency Estimation: GMM

	Maturity							
	1 month N = 659		3 month N = 650		6 month N = 637		12 month N = 558	
	a	b	a	b	a	b	a	b
CD	-0.003 (0.001)	-1.841 (0.306)	-0.007 (0.001)	-0.176 (0.097)	-0.012 (0.000)	0.485 (0.037)	-0.023 (0.000)	0.981 (0.012)
BP	-0.006 (0.001)	-1.400 (0.233)	-0.019 (0.001)	-1.670 (0.089)	-0.034 (0.001)	-1.466 (0.028)	-0.058 (0.001)	-0.811 (0.012)
BF	-0.002 (0.001)	-0.915 (0.103)	-0.007 (0.001)	-0.817 (0.045)	-0.010 (0.001)	-0.253 (0.016)	-0.036 (0.001)	-0.164 (0.011)
FF	-0.002 (0.001)	-0.155 (0.100)	-0.014 (0.001)	-0.601 (0.044)	-0.253 (0.001)	-0.698 (0.022)	-0.056 (0.001)	-0.014 (0.001)
DM	0.006 (0.001)	-1.703 (0.159)	0.018 (0.001)	-1.813 (0.069)	0.006 (0.001)	-0.127 (0.001)	0.031 (0.001)	-1.000 (0.008)
IL	-0.007 (0.001)	-0.333 (0.120)	-0.029 (0.001)	-0.434 (0.040)	-0.049 (0.001)	-0.232 (0.014)	-0.108 (0.001)	-0.229 (0.005)
DG	0.005 (0.001)	-1.965 (0.114)	0.015 (0.001)	-2.321 (0.070)	0.031 (0.001)	-2.389 (0.051)	0.022 (0.001)	-1.407 (0.009)
SF	0.013 (0.002)	-2.095 (0.232)	0.043 (0.002)	-2.449 (0.084)	0.084 (0.001)	-2.422 (0.034)	0.139 (0.001)	-2.138 (0.018)
JY	0.004 (0.001)	-0.197 (0.104)	0.011 (0.001)	-0.615 (0.449)	0.026 (0.001)	-0.733 (0.029)	0.094 (0.001)	-1.892 (0.013)

Notes: Number in parentheses are standard errors
N = Number of observations
CD = Canadian dollar
BP = British pound
BF = Belgian franc
FF = French franc
DM = Deutsche mark
IL = Italian lira
DG = Dutch guilder
SF = Swiss franc
JY = Japanese yen.

Table 3. Cross-Currency Tests: GMM Estimation

	Null Hypothesis		
Maturity	$b_i = b_j$ $X^2(8)$	$b_i=1.0$ $X^2(9)$	$b_i=0.0$ $X^2(9)$
1 month N=659	336 (0.00)	1192 (0.00)	473 (0.00)
3 month N=650	1881 (0.00)	10609 (0.00)	3586 (0.00)
6 month N=637	8781 (0.00)	656101 (0.00)	13991 (0.00)
12 month N=558	52730 (0.00)	23825809 (0.00)	77304 (0.00)

Notes: Numbers in parentheses are marginal significance levels
N = number of observation.

Table 4. Test of H_0: $b_1 - b_2 = 1 - 2b_2 \leqslant 0$ (Cross-Currency Estimation).

Panel A: SUR Estimation

	Maturity			
	1 month N=165	3 month N=50	6 month N=25	12 month N=11
CD	3.53 (0.00)	0.33 (0.37)	0.13 (0.45)	-0.19 (0.57)
BP	2.98 (0.00)	3.41 (0.00)	2.65 (0.01)	0.93 (0.19)
BF	5.54 (0.00)	2.41 (0.01)	0.89 (0.19)	5.06 (0.00)
FF	0.97 (0.16)	-0.48 (0.68)	0.60 (0.28)	5.27 (0.00)
DM	4.96 (0.00)	1.78 (0.04)	1.34 (0.09)	7.33 (0.00)
IL	4.04 (0.00)	2.07 (0.02)	0.44 (0.33)	1.66 (0.06)
DG	6.12 (0.00)	5.06 (0.00)	3.42 (0.00)	5.62 (0.00)
SF	3.70 (0.00)	3.02 (0.00)	3.13 (0.01)	6.34 (0.00)
JY	2.43 (0.01)	2.12 (0.02)	1.14 (0.13)	4.41 (0.00)

Panel B: GMM Estimation

	Maturity			
	1 month N=659	3 month N=650	6 month N=637	12 month N=558
CD	7.66 (0.00)	6.97 (0.00)	0.42 (0.34)	-41.20 (1.00)
BP	8.17 (0.00)	24.36 (0.00)	70.89 (0.00)	106.70 (0.00)
BF	13.74 (0.00)	29.20 (0.00)	46.99 (0.00)	62.73 (0.00)
FF	6.67 (0.00)	25.21 (0.00)	53.41 (0.00)	2046.24 (0.00)
DM	13.82 (0.00)	33.32 (0.00)	426.16 (0.00)	182.31 (0.00)
IL	6.97 (0.00)	23.14 (0.00)	54.21 (0.00)	158.96 (0.00)
DG	21.53 (0.00)	40.20 (0.00)	56.18 (0.00)	224.09 (0.00)
SF	11.20 (0.00)	35.13 (0.00)	85.77 (0.00)	143.63 (0.00)
JY	6.70 (0.00)	22.95 (0.00)	43.18 (0.00)	180.60 (0.00)

Notes: Test statistics are t-statistics
Numbers in parentheses are marginal significance levels
N = Number of observations
CD = Canadian dollar
BP = British pound
BF = Belgian franc
FF = French franc
DM = Deutsche mark
IL = Italian lira
DG = Dutch guilder
SF = Swiss franc
JY = Japanese yen.

Table 5. GMM Single Equation Residuals' Correlation Coefficients (Cross-Maturity).

Canadian dollar

	3-month	6-month	12-month
1-month	0.484	0.407	0.353
3-month		0.703	0.533
6-month			0.689

British pound

	3-month	6-month	12-month
1-month	0.580	0.425	0.304
3-month		0.742	0.538
6-month			0.766

Belgian franc

	3-month	6-month	12-month
1-month	0.581	0.428	0.301
3-month		0.761	0.542
6-month			0.758

French franc

	3-month	6-month	12-month
1-month	0.571	0.439	0.288
3-month		0.770	0.544
6-month			0.769

Deutsche mark

	3-month	6-month	12-month
1-month	0.577	0.395	0.247
3-month		0.722	0.487
6-month			0.721

Italian lira

	3-month	6-month	12-month
1-month	0.577	0.407	0.262
3-month		0.730	0.510
6-month			0.744

Dutch guilder

	3-month	6-month	12-month
1-month	0.569	0.377	0.205
3-month		0.718	0.438
6-month			0.698

Swiss franc

	3-month	6-month	12-month
1-month	0.583	0.392	0.204
3-month		0.723	0.422
6-month			0.676

Japanese yen

	3-month	6-month	12-month
1-month	0.523	0.413	0.177
3-month		0.722	0.366
6-month			0.636

Table 6. Cross-Maturity Estimation: GMM (N = 558)

	Maturity							
	1 month		3 month		6 month		12 month	
	a	b	a	b	a	b	a	b
CD	-0.004	-1.368	-0.008	-0.364	-0.014	0.103	-0.022	0.809
	(0.001)	(0.357)	(0.001)	(0.480)	(0.003)	(0.441)	(0.005)	(0.294)
BP	-0.006	-1.473	-0.018	-1.380	-0.036	-1.238	-0.059	-0.451
	(0.002)	(0.413)	(0.007)	(0.404)	(0.013)	(0.427)	(0.025)	(0.497)
BF	-0.003	-0.848	-0.007	-0.316	-0.009	0.200	-0.010	0.154
	(0.002)	(0.279)	(0.006)	(0.394)	(0.011)	(0.538)	(0.020)	(0.585)
FF	-0.004	-0.027	-0.013	-0.333	-0.025	-0.321	-0.044	-0.020
	(0.002)	(0.101)	(0.007)	(0.170)	(0.013)	(0.239)	(0.024)	(0.014)
DM	0.004	-1.787	0.008	-1.174	-0.003	-0.095	0.031	-0.909
	(0.001)	(0.404)	(0.003)	(0.300)	(0.005)	(0.008)	(0.018)	(0.417)
IL	-0.011	-0.444	-0.033	-0.447	-0.058	-0.310	-0.109	-0.2892
	(0.002)	(0.207)	(0.007)	(0.228)	(0.013)	(0.199)	(0.021)	(0.184)
DG	0.003	-2.530	0.009	-2.427	0.017	-2.333	0.026	-1.815
	(0.001)	(0.474)	(0.004)	(0.520)	(0.001)	(0.536)	(0.017)	(0.399)
SF	0.012	-2.214	0.026	-1.662	0.043	-1.494	0.096	-1.717
	(0.004)	(0.554)	(0.014)	(0.630)	(0.031)	(0.728)	(0.065)	(0.805)
JY	0.005	-1.097	0.017	-1.379	0.037	-1.434	0.082	-1.509
	(0.002)	(0.364)	(0.006)	(0.389)	(0.012)	(0.430)	(0.028)	(0.571)

Notes: Numbers in parentheses are standard errors
N = Number of observations
CD = Canadian dollar
BP = British pound
BF = Belgian franc
FF = French franc
DM = Deutsche mark
IL = Italian lira
DG = Dutch guilder
SF = Swiss franc
JY = Japanese yen.

Table 7. Cross-Maturity Tests: GMM Estimation (N=558).

	Null Hypothesis		
	$b_i = b_j$ X^2 (3)	$b_i = 1.0$ X^2 (4)	$b_i = 0.0$ X^2 (4)
CD	70.53 (0.00)	90.72 (0.00)	70.87 (0.00)
BP	5.69 (0.13)	40.50 (0.00)	14.63 (0.01)
BF	7.89 (0.05)	95.01 (0.00)	33.00 (0.00)
FF	8.91 (0.023)	5625.20 (0.00)	10.21 (0.04)
DM	42.56 (0.00)	22243.70 (0.00)	193.58 (0.00)
IL	2.65 (0.45)	127.89 (0.00)	11.43 (0.02)
DG	1.94 (0.59)	108.18 (0.00)	49.41 (0.00)
SF	3.16 (0.37)	52.70 (0.00)	27.56 (0.00)
JY	2.05 (0.56)	38.69 (0.00)	12.63 (0.01)

Notes: Test statistics are chi-square-statistics
Numbers in parentheses are marginal significance levels
Number of observations = 558
CD = Canadian dollar
BP = British pound
BF = Belgian franc
FF = French franc
DM = Deutsche mark
IL = Italian lira
DG = Dutch guilder
SF = Swiss franc
JY = Japanese yen.

Table 8. Test of H_0: $b_1 - b_2 = 1 - 2b_2 \leqslant 0$ (Cross-Maturity Estimation).

	Maturity			
	1 month	3 month	6 month	12 month
CD	5.23 (0.00)	1.80 (0.04)	0.90 (0.18)	-1.05 (0.84)
BP	4.78 (0.00)	4.66 (0.00)	4.07 (0.00)	1.91 (0.03)
BF	4.84 (0.00)	2.07 (0.02)	0.56 (0.39)	0.59 (0.38)
FF	5.21 (0.00)	4.89 (0.00)	3.34 (0.00)	36.64 (0.00)
DM	5.67 (0.00)	5.62 (0.00)	74.40 (0.00)	3.38 (0.00)
IL	4.56 (0.00)	4.14 (0.00)	4.07 (0.00)	4.28 (0.00)
DG	6.39 (0.00)	5.63 (0.00)	5.28 (0.00)	5.81 (0.00)
SF	4.90 (0.00)	3.43 (0.00)	2.74 (0.00)	2.75 (0.01)
JY	4.39 (0.00)	4.83 (0.00)	4.50 (0.00)	3.52 (0.01)

Notes: Test statistics are t-statistics
Numbers in parentheses are marginal significance levels
Number of observations = 558
CD = Canadian dollar
BP = British pound
BF = Belgian franc
FF = French franc
DM = Deutsche mark
IL = Italian lira
DG = Dutch guilder
SF = Swiss franc
JY = Japanese yen.

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RISK PREMIUMS IN THE FOREIGN EXCHANGE MARKET.

〈國文要約〉

외환 시장에서의 위험 Premium

林 錫 弼

外國換은 現物市場(spot market), 先物市場(futures market), 先渡市場(forward market)에서 거래가 되는데 變動換率制度(floating exchange rate system) 실시 이후 특히 선도환율의 움직임은 많은 관심을 모으고 있다.

현물환율(spot exchange rate)과 선도환율(forward exchange rate)과의 관계는 선도환율은 미래에 실현될 현물환율에 대한 不偏豫想値(unbiased predictor)라는 不偏期待假說(unbiased expectation hypothesis)과 불편예상치이외에 선도거래에 수반되는 위험에 대한 보상이 포함되어있다는 危險補償假說(risk premium hypothesis)이 있다. 근래에는 위험보상가설을 지지하는 많은 연구가 발표되었다.

본 논문은 이러한 선도환율에 존재하는 위험보상이 각 외국환마다 또 각 선도거래의 滿期(maturity)에 따라 다른 특징을 갖는가를 새로운 실증분석 방법을 이용하여 연구한 것이다. 이 연구에 이용된 GMM (Generalized Method of Moment)는 時系列資料(time series data)가 흔히 가질 수 있는 문제들 특히 자료의 重疊性(overlapping data)에서 비롯되는 문제들을 해결하면서도 바람직한 推定値(desirable estimates)를 얻을 수 있는 방법으로 최근 많이 이용되고 있다.

본 논문의 결과를 요약하면 다음과 같다.

첫째, 외환에 관한 불편기대가설을 棄却하고

둘째, 선도외환에 존재하는 위험보상은 일정한 것이 아니고 시간에 따라 변한다(time-varying risk premium).

셋째, 선도환율변동(volatility)의 대부분은 미래현물환율 기대치의 변동보다는 위험보상의 변동에 의한 것이다.

넷째, 외환의 선도거래에 따르는 위험은 선도거래의 만기에 따라 다르다.

위의 이론적인 결론들로부터 파생되는 실질적인 결론은 외환거래에 참여하는 경제주체는 직접 선도거래에 참여하지 않는다하더라도 만기에 따른 특이한 정보(maturity-specific information)을 자기의 거래 목적에 맞게 이용할 수 있다는 것이다.