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The Effect of Errors in Variables on Tests for a Risk Premium in Forward Exchange Rates

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ABSTRACT

Conventional tests for a risk premium in the price of forward exchange use the subsequently realized spot rate as a proxy for prior expectations. Use of this proxy creates a serious errors-in-variables problem which makes it difficult to reject the null hypothesis of zero risk premium. Use of a better proxy for expectations indicates the presence of a risk premium in the forward exchange rate of all countries analyzed.

IF THERE IS ZERO risk premium in the price of forward exchange, the forward rate will equal agents' expectations of the future spot rate. Since the expected future spot rate is not observed, investigators have had to construct an expectations proxy in order to test for a risk premium. The standard approach has been to use the subsequently realized spot rate as a proxy for prior expectations. This approach is justified by invoking the theory of rational expectations. If agents efficiently process all information, then the realized spot rate will differ from prior expectations by a zero mean, serially uncorrelated random variable. Given this expectations proxy, the presence of a risk premium is tested by regressing the future realized spot rate on the forward rate. Intercept and slope regression coefficients which are not significantly different from zero and unity respectively imply a zero risk premium. Such tests have generally been unable to reject the hypothesis of zero risk premium.[1]

It is the contention of this paper that the subsequently realized spot rate is a poor proxy for the prior expectations of rational agents. Use of this proxy creates a serious errors-in-variables problem in tests for a risk premium, and this makes it difficult to reject the null hypothesis. When a better proxy for expectations is employed, we find evidence of a risk premium in the price of forward exchange. As a result, the forward rate, uncorrected for the risk premium, does not provide unbiased market-implicit forecasts of the future spot rate.[2]

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[1] An interesting exception is Frenkel [4] who detects a bias in the forward rate as a prediction of the future spot rate for the German hyperinflation. This bias is attributed to transaction costs. Using different econometric techniques, both Geweke and Feige [5] and Hansen and Hodrick [7] also find evidence of a "risk premium" in forward exchange rates.

[2] This finding does not imply that the market for forward exchange is inefficient. Both Grauer, Litzenberger, and Stehle [6] and Stockman [11] derive models in which risk aversion implies that the forward rate will differ from the expected future spot rate by a risk premium. Some authors refer to the absence of a risk premium as "simple market efficiency."

I. Errors in Variables and Conventional Risk Premium Tests

Our working hypothesis is that the one period forward exchange rate F_t is determined from agents' expectations of the spot rate one period hence S_t^E according to the relationship

$$F_t = a_0 + a_1 S_t^E + e_t \tag{1}$$

where e_t is a serially uncorrelated random variable with zero mean and variance σ_e^2. If agents are risk neutral and if there are zero transaction costs, then a_0 and a_1 equal zero and unity respectively. Values of a_0 and a_1 which differ from this null hypothesis reflect a risk premium in forward rates which is similar to the risk premium which exists in the term structure of interest rates.

Equation (1) cannot be directly tested for the presence of a risk premium because S_t^E is an unobserved variable. As a result, investigators have had to construct a proxy S_t^* for S_t^E. We shall confine our attention to unbiased proxies so that

$$S_t^* = S_t^E + u_t \tag{2}$$

where u_t is a serially uncorrelated random variable with mean zero and variance σ_u^2. The key to obtaining useful empirical results is to specify an expectations proxy for which σ_u^2 is small. For completeness we also assume that forward rate data F_t^* are corrupted by observations errors so that

$$F_t^* = F_t + v_t \tag{3}$$

where v_t has mean zero and variance σ_v^2.

Regressing F_t^* on S_t^* to test the null hypothesis of zero risk premium will result in biased parameter estimates because of the errors-in-variables associated with the expectations proxy. Estimates $\hat{a}_0$ and $\hat{a}_1$ of a_0 and a_1 respectively have the properties[3]

$$\begin{aligned} Plim(\hat{a}_0) &= a_0 + \frac{a_1\sigma_u^2}{\sigma_E^2 + \sigma_u^2}\bar{S}^E \\ Plim(\hat{a}_1) &= a_1 - \frac{a_1\sigma_u^2}{\sigma_E^2 + \sigma_u^2} \end{aligned} \tag{4}$$

where $\bar{S}^E$ and σ_E^2 are the mean and variance of S_t^E. Since the model is not identified, it is not possible, without prior restrictions on the value of σ_u^2, to determine a_0 and a_1 from the estimated values $\hat{a}_0$ and $\hat{a}_1$.

Although we cannot determine unbiased estimates of a_0 and a_1, we can bound these parameters by comparing results from the regression of F_t^* on S_t^* with those obtained from the reverse regression of S_t^* on F_t^*. If we denote parameters of the reverse regression as $\hat{b}_0$ and $\hat{b}_1$, then these imply values of a_0 and a_1 given by $-\hat{b}_0/\hat{b}_1$ and $1/\hat{b}_1$ respectively. It can be shown that

$$\begin{aligned} \frac{-Plim(\hat{b}_0)}{Plim(\hat{b}_1)} &= a_0 - \frac{\sigma_e^2 + \sigma_v^2}{a_1\sigma_E^2}\bar{S}^E \\ 1/Plim(\hat{b}_1) &= a_1 + \frac{\sigma_e^2 + \sigma_v^2}{a_1\sigma_E^2} \end{aligned} \tag{5}$$

[3] The errors in variables results given below are derived in most econometric texts.

Comparing Equations (4) and (5) we see that, in the limit, the standard regression parameters and those implied by the reverse regression bound the actual model parameters. If the parameter bounds are fairly narrow, the results of Equations (4) and (5) can provide a useful test of the null hypothesis of a zero risk premium. Since σ_e^2 and σ_v^2 are probably small, the range of the parameter bound will depend critically on σ_u^2. A more accurate proxy for S_t^E, which reduces the size of σ_u^2, will shrink the parameter bounds and allow a more powerful test of the null hypothesis.

Parameter bounds determined from ordinary least squares (OLS) and reverse least squares (RLS) are strictly applicable as a test of the null hypothesis only for large samples in which the parameter estimates converge to the values given by Equations (4) and (5). For small samples, the parameter bounds are random variables which only equal the asymptotic results in expected value. If the estimated parameter bounds are to provide a test for the presence of a risk premium, they should be significantly different from the null hypothesis values. Suppose, for example, that $1 < \hat{a}_1 < 1/Plim(\hat{b}_1)$ so the estimated bounds exclude the null hypothesis value of unity. These bounds provide a useful test of the null hypothesis only if $\hat{a}_1$ is significantly different from unity. This is a more stringent test than is actually required because $\hat{a}_1$ is biased towards unity. However, it is the only test which can be implemented because the extent of the bias in $\hat{a}_1$ is unknown.

Conventional tests for a risk premium, which use S_{t+1} as a proxy for S_t^E are investigated in Table I which presents coefficients from the regression of F_t^* on S_{t+1}, coefficients implied by the reverse regression of S_{t+1} on F_t^* and coefficients from the reverse regression.[4] These regressions were run on monthly values of the spot and one month forward exchange rate, expressed as dollars per unit of foreign exchange, for a time interval covering the floating rate period of July 1973 through November 1980.[5]

[4] In an attempt to avoid the errors-in-variables problem, most investigtors have employed the reverse regression

$$S_{t+1} = b_0 + b_1 F_t^* + w_t$$

where $w_t = u_t - (v_t + e_t)/a_1$. Some authors implicitly assume that the slope coefficient is unity and test to see if the forecast error $S_{t+1} - F_t^*$ has a constant bias which is significantly different from zero. Cornell [1] extends this analysis to see if the forecasting error in the forward rate can be explained by information in past spot rates. This regression, however, suffers from an errors in variables problem for two reasons. First, the regression parameters are biased as indicated by Equation (5). It could be argued that this bias is probably small. Even though the bias may be small, there is an additional problem if S_{t+1} is a poor proxy for S_t^E. In this case, the sampling errors for the estimated coefficients may be so large as to provide a very weak test of the null hypothesis.

[5] All regressions contain a correction for residual serial correlation. This correction changes the asymptotic values of the OLS and RLS estimates but does not change the fact that these estimates bound the actual parameter values. For example, the OLS estimate of a_1 yields

$$\text{Plim}(\hat{a}_1) = a_1 - \frac{a_1\sigma_u^2(1+\rho^2)}{\sigma_E^2(1 - 2\rho r_E + \rho^2) + \sigma_u^2(1+\rho^2)}$$

where ρ is the residual correlation coefficient and r_E is the correlation between S_t^E and S_{t-1}^E. Since S_t^E and S_{t-1}^E are highly correlated, the limit is approximately equal to

$$\text{Plim}(\hat{a}_1) = a_1 - \frac{a_1\sigma_u^2(1+\rho^2)}{\sigma_E^2(1-\rho)^2 + \sigma_u^2(1+\rho^2)}$$

Table I

Regressions Using the Realized Spot Rate One Period Hence as a Proxy for the Expected Future Spot Rate (Monthly data from June 1973 through November 1980)

	$F_t^* = a_0 + a_1 S_{t+1}$					
	Direct Regression		Implied By Reverse Regression[a]		$S_{t+1} = b_0 + b_1 F_t^*$	
Country	$\hat{a}_0$	$\hat{a}_1$	$\hat{\hat{a}}_0$	$\hat{\hat{a}}_1$	$\hat{b}_0$	$\hat{b}_1$
Canada	0.028	0.972	−0.002	1.003	0.002	0.997
	(0.018)	(0.019)			(0.018)	(0.020)
France	0.016	0.926	−0.031	1.139	0.028	0.878
	(0.011)	(0.048)			(0.011)	(0.050)
Germany	0.003	0.992	−0.017	1.036	0.016	0.965
	(0.010)	(0.023)			(0.010)	(0.023)
Italy	−1.4E-6	0.999	−5.6E-5	1.041	5.4E-5	0.961
	(2.9E-5)	(0.022)			(2.8E-5)	(0.021)
Japan	8.2E-5	0.978	−1.9E-4	1.048	1.8E-4	0.954
	(1.1E-4)	(0.028)			(1.1E-4	(0.029)
Switzerland	−0.002	1.003	−0.014	1.029	0.014	0.972
	(.008)	(0.018)			(0.008)	(0.017)
England	0.046	0.975	−0.083	1.037	0.080	0.965
	(0.056)	(0.027)			(0.056)	(0.027)

[a] The parameters implied by the reverse regression are computed as $\hat{\hat{a}}_0 = -\hat{b}_0/\hat{b}_1$ and $\hat{\hat{a}}_1 = 1/\hat{b}_1$. The parameter standard errors are listed in brackets below the estimated coefficients.

These regression results provide little indication of a risk premium in forward exchange rates. For all cases except Switzerland, the parameter bounds indicated in Table I span the range of the null hypothesis of zero risk premium. For Switzerland, an F-test indicates that the lower bounds established by the regression of F^* on S_{t+1} are not significantly different from the null hypothesis values of zero and unity respectively and, therefore, do not provide reliable evidence of a risk premium. In the next section we shall examine similar regressions using a more accurate proxy for S_t^E. This proxy shrinks the parameter bounds (and coefficient standard errors) by a factor of approximately ten in most cases and indicates the presence of a risk premium for all seven countries.

The corresponding value derived from the RLS estimate is

$$1/\text{Plim}(\hat{b}_1) = a_1 + \frac{(1-\rho^2)\sigma_e^2 + \sigma_v^2(1+\rho^2)}{a_1\sigma_E^2(1-\rho)^2}$$

As with zero serial correlation, the corrected OLS and RLS estimates bound the actual parameter value. The correction for serial correlation will tend to increase the parameter bounds. However, the estimated values of ρ were usually small and the parameter bounds were not significantly different from those given by OLS and RLS regressions without a correction for serial correlation. The serial correlation correction was made to obtain a better estimate of the parameter standard errors in order to test if the bounds were significantly different from the null hypothesis.

II. An ARMA (1, 1) Proxy for Expectations

In the previous section we failed to detect a risk premium in the forward exchange rate when S_{t+1} was used as a proxy for S_t^E. It was suggested that this failure occurred because the ultimately realized spot rate is an unbiased but poor proxy for the prior expected future spot rate. An autoregressive forecasting rule, say $\hat{S}_t^E$, based on past spot rates can also provide an unbiased proxy of S_t^E. The desirability of using S_{t+1} rather than $\hat{S}_t^E$ as an estimate of the true market expectations hinges on whether the error in variables $(\hat{S}_t^E - S_t^E)^2$ due to omitting information not embodied in past spot rates exceeds on average $(S_{t+1} - S_t^E)^2$.

More specifically, consider the simple model in which S_t is jointly determined by its own history as well as an additional variable X according to

$$S_t = X_{t-1} + b_1 S_{t-1} + b_2 S_{t-2} + \cdots a_t \tag{6}$$

where a_t is a random variable and X_{t-1} is assumed orthogonal to past S. For this model the rational forecast would be

$$S_t^E = X_t + b_1 S_t + b_2 S_{t-1} + \cdots \tag{7}$$

which has a forecast error of σ_a^2. If expectations are modeled using S_{t+1} as a proxy for S_t^E, the error in variables is $u_1 = S_{t+1} - S_t^E = a_{t+1}$ so that $\mathrm{Var}(u_1) = \sigma_a^2$. No matter what the form of the model generating rational expectations, the error in variables involved in using S_{t+1} for S_t^E is always equal to the forecasting error of rational agents. If expectations are modeled by making use of only information contained in the past history of S_t we would obtain

$$\hat{S}_t^E = \bar{b}_1 S_t + \bar{b}_2 S_{t-1} + \cdots \tag{8}$$

The assumption that X and S are orthogonal means that $\bar{b} = b$ so that Equation (8) has a forecasting error of $\sigma_a^2 + \sigma_x^2$.[6] Using $\hat{S}_t^E$ as a proxy for S_t^E yields an error in variables of $u_2 = \hat{S}_t^E - S_t^E = -X_t$ so that $\mathrm{Var}(u_2) = \sigma_x^2$. Therefore, S_{t+1} is a better proxy for agents' rational expectations than the best autoregressive model if $\sigma_x^2 > \sigma_a^2$.

The condition that $\sigma_x^2 > \sigma_a^2$ is equivalent to the requirement that additional information reduce the forecast error variance of the autoregressive model by at least one half in order to justify the use of S_{t+1} rather than $\hat{S}_t^E$ as a proxy for rational expectations. Given the lack of strong relationships among economic variables found in various tests for causality (e.g., Pierce [9]), this condition is highly unlikely to be satisfied. The argument against use of S_{t+1} as a proxy for agents expectations is strengthened if expectations are economically rational in the sense of Feige and Pearce [3] who argue that agents may economize on the use of information if the value of improved prediction from sophisticated forecasting rules is outweighed by the cost of making these forecasts. Economic rationality may then take the form of efficiently utilizing only the information in past values of the series being forecast.

[6] This point is discussed in greater detail by Shiller [10]. The assumption of orthogonality between X and S is not crucial but merely serves to simplify the exposition. If X and S are not orthogonal, the b would adjust so that the specification error of Equation (8) was the variance of that part of X which was orthogonal to S.

In this section we shall use a simple ARMA(1, 1) model of the spot rate to generate the expected future spot rate $\hat{S}_t^E$. In many cases the model is sufficient to capture the important time series properties of the spot rate. The use of $\hat{S}_t^E$ as a proxy for S_t^E is investigated in the regressions presented in Table II. In all cases, the parameter bounds in Table II exclude the null hypothesis values for a zero risk premium. Also for all cases, the OLS regression of F_t^* on $\hat{S}_t^E$ gives the parameter bounds closest to the respective null hypothesis values of $a_0 = 0$ and $a_1 = 1$. An F-test to determine if the lower bound, established by the OLS regression, is significantly different from the zero risk premium values is presented in the last column of Table II. In all cases, we reject at the 1% level of significance the hypothesis that the lower bound satisfies the conditions of a zero risk premium. As a result, the bounds established by the OLS and RLS regressions indicate the presence of a risk premium in the price of one-month forward exchange.

The parameter estimates in Table II are similar to the implied parameters of Table I. This indicates that the reverse regression of S_{t+1} on F_t^*, commonly used to test for a risk premium, does not lead to seriously biased coefficients but does significantly overstate the standard errors of the parameters. As a result, these regressions provide very weak tests of the null hypothesis of zero risk premium.[7]

The OLS and RLS estimates establish bounds for the model parameters but provide no guidance in selecting the "best" estimate of these parameters. If a suitable instrument were available, the instrumental variables estimates (IV) would be consistent and unambiguously preferred for large samples. For small samples, Leamer [8] has shown that, if the OLS, RLS, and IV estimates of a_1 have the same sign, the IV estimate is the maximum likelihood estimate if and only if it satisfies the parameter bounds established by OLS and RLS. As a general rule, the maximum likelihood estimate of a_1 is the median of the OLS, RLS, and IV estimates.

The difficulty in implementing instrumental variables is finding a variable which is correlated with the expected future spot rate S_t^E but not with the error between S_t^E and the expectations proxy S_t^*. As suggested by Durbin, we have used the rank values of $\hat{S}_t^E$ as an instrumental variable. Instrumental variables estimates of a_1 using this instrument are compared with the OLS and RLS estimates in Table III. The median of the three estimates is underlined to indicate

[7] We obtained more powerful tests of the null hypothesis by employing a more accurate proxy for the expected future spot rate. Two other econometric techniques have recently been used to obtain more powerful tests for the presence of a risk premium. Geweke and Feige [5] examine the realized rate of return in forward markets, defined as $(S_{t+1} - F_{t}{}''$ $_t$ to see if it has mean zero and is serially uncorrelated. Forward rates which satisfy this criteria are called market efficient. To obtain more powerful test statistics, they simultaneously estimate the market efficiency equations for six countries. In this case they are able to reject the market efficiency hypothesis. They attribute the rejection of market efficiency to a risk premium in the price of forward exchange. Conventional tests for a risk premium have used nonoverlapping data. For example, tests using the three month forward rate would employ quarterly data even though the spot and forward rate may be available on a daily or weekly basis. The use of nonoverlapping data eliminates some complicated econometric problems but only at the sacrifice of efficiency. Hansen and Hodrick [7] develop an estimation technique for using overlapping data and reject the hypothesis of "simple market efficiency."

Table II

Regressions Using an ARMA(1,1) Forecast as a Proxy for the Expected Future Spot Rate (Monthly data from June 1973 through November 1980)

	$F_t^* = a_0 + a_1\hat{S}_t^E$						
	Direct Regression		Implied By Reverse Regression[a]		$\hat{S}_t^E = b_0 + b_1 F_t^*$		F-Test
Country	$\hat{a}_0$	$\hat{a}_1$	$\hat{\hat{a}}_0$	$\hat{\hat{a}}_1$	$\hat{b}_0$	$\hat{b}_1$	$a_0 = 0$ & $a_1 = 1$
Canada	−0.089	1.095	−0.099	1.107	0.090	0.903	33.1
	(0.012)	(0.012)			(0.010)	(0.010)	
France	−0.036	1.162	−0.037	1.166	0.032	0.858	131.1
	(0.002)	(0.007)			(0.001)	(0.006)	
Germany	−0.017	1.039	−0.017	1.040	0.163	0.961	159.3
	(0.001)	(0.003)			(0.001)	(0.003)	
Italy	−2.0E-5	1.008	−2.6E-5	1.013	2.6E-5	0.987	6.3
	(1.1E-5)	(0.007)			(1.0E-5)	(0.007)	
Japan	−1.7E-5	1.046	−5.3E-4	1.050	4.6E-4	0.879	53.8
	(2.6E-5)	(0.007)			(6.2E-5)	(0.016)	
Switzerland	−0.011	1.030	−0.011	1.030	0.011	0.971	475.2
	(.001)	(0.002)			(0.001)	(0.002)	
England	−0.019	1.005	−0.026	1.009	0.025	0.991	11.4
	(0.011)	(0.005)			(0.010)	(0.005)	

[a] The parameters implied by the reverse regression are computed as $\hat{\hat{a}}_0 = -\hat{b}_0/\hat{b}_1$ and $\hat{\hat{a}}_1 = 1/\hat{b}_1$.

Table III

Ordinary Least Squares, Reverse Least Squares, and Instrumental Variables Estimates of a_1
(Monthly data from June 1973 through November 1980)

Country	OLS	IV	RLS
Canada	<u>1.0955</u>	1.0090	1.1069
France	<u>1.1618</u>	1.1573	1.1660
Germany	1.0394	<u>1.0396</u>	1.0402
Italy	1.0085	1.0141	<u>1.0131</u>
Japan	1.0459	<u>1.0467</u>	1.0495
Switzerland	1.0295	<u>1.0297</u>	1.0297
England	1.0055	1.0119	<u>1.0089</u>

Note: The maximum likelihood estimate is underlined.

the maximum likelihood estimate. The IV estimate provides supporting evidence of a risk premium in forward exchange rates.

A number of investigators have used quarterly spot rates and the three month forward rate, rather than monthly data, in tests for a risk premium. There is a possibility that the one month risk premium depicted in Table II merely reflects the thinness of the market for one month forward exchange and would not exist in the more developed three month forward market. If this were true, regressions using quarterly data would fail to reject the null hypothesis of zero risk premium. Alternatively, since longer maturity forward contracts involve greater risk, we might expect the risk premium to increase with time to maturity. In this case, regressions using quarterly data would exhibit a larger risk premium than that obtained with monthly data.

These alternatives were investigated by running the regressions on quarterly data. As with the monthly data, the regressions using S_{t+1} as a proxy for S_t^E provide little evidence for a risk premium. The actual coefficients deviate more from the null hypothesis values of zero and unity respectively, but the reduced sample size also yields much larger standard errors. In all cases, the parameter bounds implied by the standard and reverse regression span the range of the null hypothesis.[8] The use of the ARMA model $\hat{S}_t^E$ as a proxy for S_t^E is investigated in Table IV. In all cases except Canada, the parameter bounds lie outside the range

[8] As an example of the regression results, consider the Canadian regressions

$$\underset{}{F_t^*} = \underset{(0.006)}{0.0007} + \underset{(0.062)}{0.911}S_{t+1}$$

$$S_{t+1} = \underset{(0.067)}{0.016} + \underset{(0.071)}{0.978}F_t^*$$

where the second regression implies value of a_0 and a_1 given by -0.016 and 1.022 respectively. Although the parameters of the regression of S_{t+1} on F_t give the appearance of a risk premium, the large standard errors would indicate acceptance of the null hypothesis of zero risk premium.

Table IV

Regressions Using an ARMA(1, 1) Forecast as a Proxy for the Expected Future Spot Rate (Quarterly data from 1973 to 1980)

	$F_t^* = a_0 + a_1\hat{S}_t^E$				$\hat{S}_t^E = b_0 + b_1F_t^*$		
	Direct Regression		Implied By Reverse Regression[a]				F-Test
Country	$\hat{a}_0$	$\hat{a}_1$	$\hat{\hat{a}}_0$	$\hat{\hat{a}}_1$	$\hat{b}_0$	$\hat{b}_1$	$a_0 = 0$ & $a_1 = 1$
Canada	0.005	0.994	−0.011	1.011	0.011	0.989	0.4
	(0.022)	(0.023)			(0.019)	(0.020)	
France	−0.108	1.479	−0.114	1.505	0.076	0.664	113.0
	(0.008)	(0.034)			(0.003)	(0.015)	
Germany	−0.055	1.034	−0.062	1.047	0.054	0.871	30.5
	(0.010)	(0.022)			(0.008)	(0.018)	
Italy	−1.1E-4	1.056	−1.7E-4	1.104	1.5E-4	0.906	27.6
	(4.6E-5)	(0.034)			(4.6E-5)	(0.035)	
Japan	−4.8E-4	1.118	−6.6E-4	1.165	5.7E-4	0.859	8.89
	(1.8E-4)	(0.044)			(1.3E-4)	(0.033)	
Switzerland	−0.041	1.103	−0.041	1.104	0.037	0.906	102.2
	(0.003)	(.005)			(0.002)	(0.004)	
England	−0.104	1.040	−0.119	1.047	0.114	0.955	7.6
	(0.036)	(0.017)			(0.032)	(0.016)	

[a] The parameters implied by the reverse regression are computed at $\hat{\hat{a}}_0 = -\hat{b}_0/\hat{b}_1$ and $\hat{\hat{a}}_1 = 1/\hat{b}_1$.

Table V

Ordinary Least Squares, Reverse Least Squares, and Instrumental Variables Estimates of a_1
(Quarterly data from 1973 to 1980)

Country	OLS	IV	RLS
Canada	0.994	<u>1.009</u>	1.011
France	<u>1.479</u>	1.476	1.505
Germany	1.034	<u>1.144</u>	1.147
Italy	<u>1.056</u>	1.050	1.104
Japan	1.118	<u>1.120</u>	1.165
Switzerland	1.103	<u>1.104</u>	1.104
England	<u>1.040</u>	1.030	1.047

Note: The maximum likelihood estimate is underlined.

of the null hypothesis. In addition, they indicate a significantly larger risk premium than was obtained with the monthly data. The IV estimates, compared with the OLS and RLS estimates in Table V, also provide supporting evidence of a larger risk premium for the three month forward rates. As a result, the monthly results are consistent with a risk premium which increases with time to maturity rather than special circumstances in the market for one month forward exchange.

III. Summary

Previous studies of the price of forward exchange have generally been unable to detect a significant risk premium in the price of forward exchange. As a result, the forward rate has been viewed as an unbiased measure of market expectations of the future spot rate. Since expectations are not observed, tests for a risk premium require a proxy for market expectations of the future spot rate. The standard approach has been to use the realized spot rate one period hence as a proxy for current rational expectations.

This paper demonstrates that the realized spot rate is a poor proxy for prior expectations. This does not mean that S_{t+1} is a biased measure of S_t^E. Rather, it means that the variance of $S_{t+1} - S_t^E$ is significantly greater than that for other proxies such as an autoregressive model based on past spot rates. As a result, a considerable errors-in-variables problem exists in standard tests for a risk premium which makes it difficult to reject the null hypothesis of zero risk premium. When a more accurate proxy of expectations is employed, we detect a risk premium in the price of forward exchange for seven countries during the floating rate period from 1973 through 1980. Of course, all tests for a risk premium are conditional on the expectations proxy employed. The possibility exists that our results are due to systematic differences between the ARMA model and the actual expectations of market participants.

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