A Test of Perfect Substitutability in the Foreign Exchange Market*

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I. Motivations for the Test

The question of whether or not domestic bonds are perfect substitutes for foreign bonds in investors' portfolios, implying that the expected rates of returns must be equalized across currencies, is an important one for two reasons. The question is crucial, first, for choosing among various asset-market models of exchange rate determination and, second, for evaluating tests of efficiency in the forward exchange market.

To illuminate the first motivation, a brief discussion of models of exchange rate determination is necessary. All "asset-market" models share the assumption that there are no significant transactions costs, capital controls, or other impediments to the international flow of capital. Thus actual portfolios adjust instantaneously to equal desired portfolios. This implies, for example, covered interest parity: the domestic interest rate should differ from the foreign interest rate by an amount exactly equal to the forward discount rate.

Perfect substitutability between domestic and foreign bonds is the stronger assumption that market participants are indifferent as to the currency composition of their portfolio. It implies uncovered interest parity: the domestic interest rate must differ from the foreign interest rate by an amount exactly equal to the expected rate of depreciation. The perfect substitutability assumption is far from standard. In fact, exchange rate models within the asset-market view can be classified into those that belong to the "monetary approach," defined by the assumption of perfect substitutability, and those that belong to the "portfolio-balance approach," defined by the assumption of imperfect substitutability.

In the portfolio-balance approach, investors hold well-defined proportions of their wealth in the form of each country's assets, with the proportions depending on the expected rates of return, as in equation (1):

$$B/W = \beta(i - i^* - \Delta s^e) \tag{1}$$

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where $B \equiv$ the supply of domestic assets, which are willingly held

$W \equiv B + SF$, total financial wealth

$S \equiv$ the spot exchange rate, the price of foreign currency in terms of domestic currency

$F \equiv$ the supply of foreign assets, which are willingly held

$\beta \equiv$ the share of the portfolio allocated to domestic assets, an increasing function of the expected relative return $i - i^* - \Delta s^e$.

$i - i^* \equiv$ the difference between the domestic and foreign short-term interest rates

$\Delta s^e \equiv (\text{Log } S_{t+1})^e - (\text{Log } S_t)$, the rate of depreciation expected by the public.

(To go from equation (1) to a complete portfolio-balance model of exchange rate determination it would be necessary to specify also the determinants of the expected rates of return.)

In the monetary approach, by contrast, the asset-demand function β is assumed to be infinitely sensitive to the expected relative return. Thus bond-market arbitrage insures that uncovered interest parity must hold:

$$i - i^* = \Delta s^e.$$

But given that it does hold, bond supplies then become irrelevant. Responsibility for determining the exchange rate is shifted onto the money markets. The exchange rate, as the relative price of foreign money, depends negatively on the relative supply of foreign money and positively on the relative demand for foreign money, where the relative demand for foreign money is in turn typically specified as a function of the income differential and the expected inflation differential.[1]

There are a number of reasons why two financial securities may be imperfect substitutes: liquidity, tax treatment, default risk, political risk, and exchange risk. Of these, exchange risk seems the most relevant for describing the securities of the major industrialized countries that are traded in world capital markets, especially if the securities are similar in respects other than currency of denomination. Under this interpretation, risk-averse investors balance their portfolios in order to diversify risk originating from uncertainty in currency values. The expected relative return, or deviation from uncovered interest parity, $i - i^* - \Delta s^e$, is an exchange risk premium which induces them to hold relatively more domestic assets. The function β depends on the variances and covariances of the values of the two currencies and on the degree of risk-aversion.

The risk premium leads us to the second motivation, in addition to the distinction between monetary models and portfolio-balance models, for examining the question of substitutability. Most empirical tests of rational expectations in the foreign exchange market use the forward discount as their measure of the expected future rate of spot

1. Examples of the portfolio-balance approach include Branson [1], Dooley and Isard [6], Girton and Henderson [15], and Kouri [18; 19]. Examples of the monetary approach include Frenkel [14] and Dornbusch [7]. Surveys of the two classes of models are offered by Dornbusch [8] and Frankel [13].

depreciation.[2] The existence of a nonzero risk premium would invalidate these tests because it would constitute a discrepancy between the forward discount and the expected rate of depreciation. Richard Levich [20] has emphasized this point, and called for modeling the risk premium as a prerequisite for testing efficiency.

Notice that the definition of the risk premium as the difference between the forward discount (call it d) and the expected rate of depreciation (Δs^e) is identical to the earlier definition as the difference between the interest differential and the expected rate of depreciation ($i - i^* - \Delta s^e$), given covered interest parity ($i - i^* = d$). Thus the absence of a risk premium in the forward exchange market ($d = \Delta s^e$) is equivalent to uncovered interest parity in the bond market ($i - i^* = \Delta s^e$), given covered interest parity.[3]

Despite the importance of the question, the existence of the risk premium is more often assumed (or assumed away), than it is demonstrated theoretically or observed empirically. On a theoretical level, it has been shown that risk aversion is not in itself sufficient to guarantee the existence of the risk premium. If every asset held is viewed as someone else's liability, in other words if they are all "inside assets", then all exchange risk might be diversifiable. Market participants who expose themselves to exchange risk by failing to use the forward market would not be compensated by a greater expected rate of return any more than (according to the capital asset pricing model) would holders of an equity the return on which is variable but uncorrelated with the market basket.[4]

On the empirical level, one could interpret tests of whether the unconditional forward rate systematically overpredicts or underpredicts the spot rate, as tests of the existence of a risk premium, under the assumptions of rational expectations and a stable risk premium. But the forward rate very rarely fails this weak test; if the risk premium exists, it would have to fluctuate between positive and negative frequently to account for this finding.[5] Furthermore, the few empirical attempts to relate the mean excess return on each country's currency to its correlation with a world portfolio, as suggested by the capital asset pricing model, have not been entirely successful.[6]

2. Examples of the large and growing literature testing efficiency in the forward market are Cornell [3], Frankel [11], and Hansen and Hodrick [16]. Kohlhagen [17] and Levich [20] contain surveys of this literature.

3. Cumby and Obstfeld [5] examine discrepancies between the interest differential and the actual rate of depreciation and statistically reject the hypothesis that they are random. They present their results as a test of uncovered interest parity. But given covered interest parity, their results might more properly be classified with the tests of the efficient market hypothesis (jointly with the zero risk premium hypothesis) cited in the last footnote.

4. See Frankel [10]. Throughout the present paper, the description of the forward rate as equal to the expected future spot rate in the absence of a risk premium is slightly loose. The precise expression for the forward rate in the absence of a risk premium is the ratio of the expected purchasing power of foreign currency to the expected purchasing power of domestic currency. This ratio is equal to the expected future spot rate only in the special case when the future purchasing power of domestic currency is known with certainty. In this case the reciprocal of the forward rate (i.e., the forward rate from the viewpoint of the foreign country) is *not* equal to the expected future reciprocal of the spot rate. This consequence of Jensens's inequality is sometimes called the Siegel paradox.

5. Stockman [23] claims some evidence for nonzero risk premia on the basis of such a test, but only after dividing the four-year sample into sub-samples and only for two countries out of six. Cornell [3] argues, "it is hard to believe that the premium could change sign over a period as short as four years" (p. 59), implying that the risk premium does not exist. If one ignores significance levels and interprets mean overpredictions as point estimates of risk premia, one would have to conclude from the results in either Stockman, Cornell, or Frankel that the dollar has been viewed as safer than all other major currencies, except for the pound, which became viewed as safer than the dollar in the period after 1974.

6. Cornell and Dietrich [4] examine changes in currency values in excess of the forward premium for a cross section of six countries. They look for a correspondence between the countries having high mean returns and the countries having high correlations (betas) with a portfolio of real assets (pp. 116-17). They do not find significant betas and conclude that high mean returns are not compensation for risk. Roll and Solnik [22] find support for a risk model in an examination of mean "extraordinary" returns on foreign currencies and correlations (betas) with the returns on other foreign currencies, for a cross section of eight countries. Their results show—from the viewpoint of a U.S. investor, for example—that the foreign currencies with the lowest mean returns (the pound and the Canadian dollar) are also those with the lowest betas and thus the lowest risk.

II. The Procedure

This paper suggests a way of testing substitutability in the foreign exchange market. The first step is to specify an asset-demand function of the portfolio-balance type, as in equation (1). That is, the demand for the domestic country's assets, as a proportion of total wealth, depends on the expected relative rate of return, or ex ante risk premium. The second step is to invert the asset demand function, giving the expected relative rate of return as a function of asset stocks:

$$i - i^* - \Delta s^e = \beta^{-1}(B/W). \tag{2}$$

The third step is to impose the assumption of rational expectations. The expected change in the spot rate is equal to the actual change plus an error term:

$$\Delta s^e = \Delta s + \epsilon \tag{3}$$

where the error term ϵ is uncorrelated with all past variables, including B, S, F and W. Substituting (3) into (2), we find:

$$i - i^* - \Delta s = \beta^{-1}(B/W) + \epsilon. \tag{4}$$

Equation (4) is a representation of Dornbusch's [8] decomposition of exchange rate changes (in excess of the interest differential) into the risk premium and the "news."

In the fourth and final step we observe that equation (4) is a perfect subject for ordinary least squares regression. The lefthand-side variable, which we could call the actual or ex post excess return on domestic assets, unlike the expected or ex ante excess return, is observable. Under the maintained hypothesis of rational expectations, ϵ is uncorrelated with the righthand-side variables. Indeed, the reason we inverted equation (1) to begin with was so that ϵ would enter the lefthand-side variable rather than the righthand-side variable, allowing us to use regression estimation.

The null hypothesis of perfect substitutability implies that uncovered interest parity holds, the dependent variable is identical to the random expectational error, and the asset supplies are irrelevant; we should get zero coefficients in the regression of equation (4). The alternative hypothesis of imperfect substitutability implies that the dependent variable differs from the expectational error by the risk premium, which is systematically related to the asset supplies by the portfolio-balance function; we should get a positive coefficient in the regression of equation (4). Intuitively, periods during which the market allocates a high proportion of wealth to domestic assets should correspond to periods when the return on domestic assets exceeds the return on foreign assets.[7]

The most obvious functional form for β is the linear one.[8] Equation (1) becomes

$$B/W = a + b(i - i^* - \Delta s^e),$$

7. The test was largely inspired by Dooley and Isard [6]. Their approach is similar, but they never explicitly test the existence of the risk premium. Rather, they take its existence for granted and use regressions like equation (4) to estimate the parameters of the portfolio-balance model. Their interest focuses primarily on the fact—which they find surprising—that the fitted values, which are estimates of the ex ante risk premium, do not predict all or most of the actual variation in the ex post excess return. The premise of the present paper is that this fact is less interesting than the claim that the fitted values predict *any* significant amount of the variation in the ex post excess return.

8. In a model in which investors maximize a function of the mean and variance of their return, it can be shown that the linear form is correct. $1/b$ is equal to the constant of relative risk aversion multiplied by the variance of the real exchange rate. See Dornbusch [9]. Frankel [12] tests the constraints implied by the hypothesis that investors are mean-variance optimizing.

and the equation to be estimated, (4) becomes

$$i - i^* - \Delta s = -(a/b) + (1/b)(B/W) + \epsilon. \tag{5}$$

The null hypothesis is $b = \infty$; both coefficients are zero. The alternative hypothesis is a positive coefficient on the domestic asset share of the portfolio.

With respect to the null hypothesis, the technique outlined above is very general, in that any model that assumes rational expectations and perfect substitutability implies zero coefficients. But with respect to the alternative hypothesis, different portfolio-balance models imply different asset-demand specifications. Thus we must consider two specification questions.

III. Two Questions of Portfolio-Balance Specification

The first question is what sorts of assets are to be included in the definitions of B and F. One could argue that exchange speculators operate by buying and selling bonds (or, equivalently, forward contracts), so that B and F are interest-paying bonds. Since only the *net* supplies of bonds to the private market matter, we look at the supplies of government bonds, as given by the accumulation of Treasury debt, corrected for Central Bank operations.[9]

Alternatively, one could argue that, to the extent that government debt implies future tax liabilities to pay it off, high-powered *money* is the only true "outside asset", and thus the only asset able to create nondiversifiable exchange risk for the private market. In any case, there is a class of portfolio-balance model, going by the name "currency substitution," that assumes that investors balance their portfolios among national moneys.[10] Under this interpretation, B and F would represent the domestic and foreign money supplies, respectively. We can allow for the likely possibility that the relative money demand depends only on the expected rate of depreciation, and not on the interest differential, by including the interest differential as an additional righthand-side variable in equation (5) and looking for a unit coefficient. We can also allow for a transactions demand for money by adding domestic and foreign income, Y and Y^*, to the asset-demand function (1):

$$B/W = a - b(\Delta s^e) + dY - d^*Y^*$$

and estimating the equation

$$i - i^* - \Delta s = -a/b + 1/b(B/W) + c(i - i^*) - d/b\ Y + d^*/bY^* + \epsilon. \tag{6}$$

Finally, one could argue with Kouri [6] that all assets whose return is nominally fixed in a given currency are the same from a risk viewpoint. Then B and F should include the total supplies of assets, bonds *as well as* money, denominated in domestic and foreign

9. Dooley and Isard [6] use this specification. Of the two conditions that could lead to perfect substitutability, namely risk-neutrality and the absence of outside assets, the latter is perhaps the more plausible. If the bond supplies calculated from government debt are indeed not true outside assets, they will not, of course, equal zero, but they should show a zero coefficient in the regression. Unless the possibility of imperfect substitutability is to be dismissed out of hand, the bond supplies must be calculated in this way.

10. An example of currency-substitution models is Calvo and Rodriguez [2].

currency respectively. Again, one could include interest rates and income levels as additional determinants of asset demands. It is worth repeating that under the joint null hypothesis of rational expectations and perfect substitutability, all regression coefficients should show up as zero no matter what righthand-side variables are included.

The most difficult question of portfolio-balance specification concerns the identity of the investors whose portfolios we are examining. If B and F are the total net supplies of domestic and foreign assets in the world (whether bonds, money or both), then equations (1) - (6) only make sense as a description of aggregate behavior of investors who are assumed to have the same portfolio preferences regardless of their country of residence. The indebtedness of one country's residents to another's has no effect because it nets out. Recently a number of finance papers have shown that portfolio preferences will be uniform throughout the world if they are based on expected utility maximization by investors who consume the same good or basket of goods throughout the world.[11]

The uniform-preference model stands in contrast to the more standard portfolio-balance model in which F represents the cumulation of the domestic country's past current accounts. In this "small-country" model, the risk premium or exchange rate is determined by the behavior of domestic residents only, because foreign residents are assumed to be uninterested in holding domestic assets. One motivation for this assumption has been to simplify the accounting; it allows the identification of a capital inflow or outflow with a decrease or increase in the supply of foreign assets in the home market, by assuming away the problem of the currency of denomination. A second motivation is that, under floating exchange rates, it leads to the realistic implication that a current account deficit causes a depreciation of the home currency, since the counterpart to the current account deficit is a capital inflow. The reduction in the supply of foreign-denominated assets in the market leads to a rise in their price in terms of domestic currency.[12]

A realistic portfolio-balance model for large countries must recognize that residents of both countries hold assets issued by both countries. The (cumulated) current account will still have the expected effect on the exchange rate, provided domestic residents wish to hold a greater proportion of their wealth as domestic assets and foreign residents wish to hold a greater proportion as foreign assets.[13]

It is a simple matter to specify separate asset-demand functions for residents of different countries. For example, (1) is replaced by

$$B_G / W_G = a_G + b(i - i^* - \Delta s^e)$$

$$B_{US} / W_{US} = a_{US} + b(i - i^* - \Delta s^e)$$

$$B_R / W_R = a_R + b(i - i^* - \Delta s^e) \tag{7}$$

where the subscripts G, US and R denote holdings by residents of Germany, the United States, and the rest of the world. In the empirical work we are going to take B, the "domestically-denominated" asset, to be marks, and F, the "foreign-denominated" asset, to be dollars. Presumably $a_G > a_R > a_{US}$. If data on B_G, B_{US}, B_R, F_G, F_{US} and F_R were

11. Examples include Frankel [10] and Dornbusch [9].

12. Branson [1] and Kouri [18], among others, assume that domestic assets are not held by foreigners.

13. Models that allow the foreign preferences for holding domestic assets to be less than the domestic preference and yet greater than zero appear for example in the appendix to Dornbusch [9], and Dooley and Isard [6].

available, each of these three equations would be inverted separately and estimated separately. Unfortunately, data on who holds how much of what asset are very difficult to construct.

Since only more aggregated data are available, the solution is to aggregate the equations in (7). We multiply them by W_G/W, W_{US}/W and W_R/W, respectively, and then add them up to get

$$B/W = a_R + (a_G - a_R)(W_G/W) + (a_{US} - a_R)(W_{US}/W) + b(i - i^* - \Delta s^e). \tag{8}$$

When wealth is redistributed to German residents (for example when Germany runs a current account surplus with the rest of the world), then the net demand for mark bonds increases, because $a_G > a_R$. When wealth is redistributed to U.S. residents (for example when the United States runs a current account surplus with the rest of the world) then the net demand for mark bonds falls, because $a_{US} < a_R$. Now (8) inverted gives us another equation to estimate:

$$\begin{aligned} i - i^* - \Delta s = -(a_R/b) + (1/b)(B/W) - [(a_G - a_R)/b](W_G/W) \\ + [(a_R - a_{US})/b](W_{US}/W) + \epsilon. \end{aligned} \tag{9}$$

The null hypothesis, again, implies that all coefficients are zero. But the alternative hypothesis now implies, in addition to the negative constant term and positive coefficient on the relative supply of mark bonds, a negative coefficient on German wealth (the increase in this variable that would otherwise raise net demand for marks must be accompanied by a lower expected relative return on marks if the same supply is to be willingly held) and a positive coefficient on U.S. wealth (the increase that would otherwise reduce net demand for marks must be accompanied by a higher expected relative return if the same supply is to be willingly held). Equation (5), the uniform-preference model, can be viewed as the special case of equation (9) in which the coefficients on German and U.S. wealth are zero because $a_G = a_R = a_{US}$.

IV. Empirical Results

The only variables to present important data problems were the asset stocks. The total net supply of assets denominated in a country's currency to the private market was calculated as the stock of federal debt outstanding (whether monetized by the Central Bank or not) plus the Central Bank's cumulative sales of assets in foreign exchange intervention (measured as its international reserve holdings corrected for valuation changes) minus a measure of the holdings by foreign central banks of the country's assets in the form of foreign exchange reserves. The net supply of bonds to the private market was calculated as the total net supply of assets minus the monetary base. The sample consisted of monthly observations from January 1974 to October 1978. The data calculations become especially difficult after October 1978 because of the issuing of mark-denominated Carter notes by the U.S. Treasury, the holding of foreign exchange reserves valued at current exchange rates by the Federal Reserve, and the turning over of reserves to the European Monetary System by the Bundesbank. For purposes of distinguishing German-held wealth and

Table I. OLS January 1974 - October 1978
Dependent Variable: Relative Return on Marks $i_G - i_{US} - \Delta s$

Preferences Assumed	*B*, *F*, and *W* Defined to Include	Coefficients				R^2	D.W.	SSR	log Likelihood
		Const.	B/W	W_G/W	W_{US}/W				
Uniform across country of residence	Total Assets	.060 (.041)	−.300 (.218)			.03	1.83	.05680	117.62
	Bonds only	.042 (.027)	−.304 (.217)			.03	1.83	.05675	117.64
	Monetary base only	.055 (.055)	−.167 (.183)			.01	1.84	.05787	117.07
Different across country of residence	Total assets	.246 (.256)	−.654 (1.122)	.138 (.731)	−.133 (.188)	.04	1.82	.05617	116.88
	Bonds only	.152 (.149)	−.774 (.909)	.152 (.346)	−.064 (.098)	.05	1.82	.05598	116.98
	Monetary base only	−.083 (.191)	.354 (.948)	−.144 (.249)	.028 (.033)	.03	1.87	.05703	116.45

(Standard errors are reported in parentheses.)

U.S.-held wealth, in each country the current account surplus and federal debt were cumulated to arrive at the private sector's total net claims on outside agents. Sources and definitions for the data are explained at some length in an appendix available on request.

Many regressions were run, representing the various possible combinations of types of assets (bonds, monetary base, or both combined), possible additional variables (the interest differential and real income levels) and possible breakdown of wealth by residence of holder. No coefficients appeared significantly different from zero. Table I reports regressions for six equations, with the interest differential and income level omitted as righthand side variables. The coefficients do not even appear with the signs hypothesized by the portfolio-balance model, with the exception of the last regression (the currency-substitution model with the wealth variables included).

The finding that emerges from these regressions is a striking failure to reject the null hypothesis. If accepted at face value, these results would suggest that mark and dollar assets are perfect substitutes, that uncovered interest parity holds, that all variation in the dependent variable is due to expectational errors, and that the exchange risk premium is a mythical construct. But before we do anything as drastic as writing off the risk premium or the entire portfolio-balance approach, we must note some important qualifications to the test.

V. Econometric Qualifications

Perhaps the most important qualification is that failure to reject a null hypothesis is not the same as acceptance. (This well-known point has been glossed over in some of the tests which fail to reject rational expectations.) One might suspect that the power of the test is particularly low due to the very high variability that the error term is known to have. Recall that the error term ϵ consists of expectational errors. All authors, regardless of their positions on rational expectations or the risk premium, agree that expectational errors have been very large since 1973.[14]

The second qualification has to do with the possible endogeneity of the right-hand side variables in the regression equation. Of course if the error term is correlated with the righthand side variables, the estimates are biased and inconsistent and the test is invalid. But we must be careful here. The existence of a simultaneous equation determining S (i.e. the remainder of a complete theory of spot rate determination) or even the existence of simultaneous equations determining B and F (e.g. Central Bank reaction functions) would not necessarily lead to biasedness and inconsistency. Due to the special nature of the rational expectations assumption, righthand side variables could be endogenous and yet, because they are known at the time expectations are formed, be independent of the error term ϵ, provided the asset demand function is specified correctly.

Trouble arises if the asset demand function is not specified correctly. This would be the case if there are omitted variables or if the function shifts during the sample period, for example because of a shift in the perceived rate-of-return covariance matrix. Further research might be able to refine the specification of the asset demand function.

Trouble could also arise if there are errors in the measurement of the righthand-side variables, particularly in the asset and wealth variables. The expectational error will be independent of the true righthand-side variables, but the regression error will consist of the expectational error *plus* the measurement error, and the latter will not be independent of the righthand-side variables *as measured.*[15] The presence of errors in variables would, of course, bias the estimates toward zero. However the fact that the coefficients in Table I generally appear incorrect in sign indicates that even if we could somehow correct for the bias toward zero, a one-tailed test against the alternative hypothesis would still fail to reject the null hypothesis that they are equal to zero.

VI. Conclusions

This paper has presented a technique for testing the hypothesis of perfect substitutability between domestic and foreign bonds. The technique began by specifying a portfolio-balance equation that gave asset demands as a function of the expected relative rate of return, and inverting the equation so that the expected relative rate of return is expressed as a function of the asset stocks. Then the ex post relative rate of return was regressed against the asset stocks, with the knowledge that they will be independent of the error term under the assumption of rational expectations. The result was a failure to reject the

14. See, for example, Mussa [21].

15. If one is willing to stretch rational expectations far enough to argue that expectational errors should be independent of true variables as well as of erroneous data being compiled at the time by statisticians and economists, then under the null hypothesis the OLS coefficients would be unbiased estimates of the true parameters (which are zero). But the coefficients still would not be unbiased under the alternative hypothesis, and thus the test would lose its interest. I am indebted for much of the discussion of the econometric effects of endogeneity under rational expectations to Mark Machina and Paul Evans.

hypothesis of zero coefficients, and thus of perfect substitutability, uncovered interest parity, and the nonexistence of a risk premium. As in any econometric test, the conclusion must be qualified by noting that a failure to reject is not the same as acceptance.

The test is predicated on the hypothesis that expectations of exchange rate changes are rational. One implication of this hypothesis, an absence of serial correlation in the prediction errors, is borne out by the Durbin-Watson statistics in Table I (and by more direct tests on this data, not reported). Thus there is nothing in this paper to change the mind of the reader who was favorably inclined toward the rational expectations hypothesis to begin with.

But many of the studies cited in footnote 5 reject the hypothesis of rational expectations, finding, for example, serial correlation in the prediction errors made by the forward rate. The results in Cumby and Obstfeld [5] show that the finding of serial correlation extends to the prediction errors made by the interest differential in their data sample. How is the reader to combine these findings with the results of the substitutability test? Previously it was possible to argue, as do Cumby and Obstfeld, that the finding of serially correlated prediction errors was due solely to a serially correlated risk premium. But if that were the case, we would have expected in Table I to reject the null hypothesis. Our failure to do so, when combined with the findings of other papers, suggests that perhaps expectational errors are in fact autocorrelated. But such a conclusion goes beyond the scope of the test presented in this paper.

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