



Jul 1st, 12:00 AM

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Systematic Risks, Speculators and the Forward Rate Puzzle

Kim Radalj

Department of Economics, University of Western Australia (radaljk@hotmail.com)

Abstract: An often-cited explanation for the forward rate puzzle is that predictions obtained under risk neutrality do not apply in a world where the typical agent is risk averse. Thus, ignoring risk premiums in empirical testing amounts to misspecification, which may unduly influence the estimated coefficients. Whether risk premiums exist in currency markets is especially important to those exposed to international commodity and financial markets, as there are implications for both hedging strategies and the expectations formation process. This paper focuses upon two possible sources of premia, namely systematic risk arising from market portfolio risk and secondly, the influence of speculative pressures upon currency markets. Perusal of the literature finds support for the importance of both these above sources, yet strangely no research seems to place them together and in the context of the forward rate puzzle. There is evidence to suggest that systematic risks do arise from currency exposure, but that the marginal speculator cannot impose a premium upon the currency market. Furthermore, we compare the results from two sets of estimators, namely OLS and IV, due to our reliance upon proxy variables. While there is little substantive difference in the two sets of results, it does improve upon historical practices, which typically ignore the problems introduced by proxy variables. Another interesting extension is to determine whether incorporation of risk premiums can improve currency forecasts. We attempt to mimic the conditions faced by those in the marketplace through implementation of recursive techniques. We find that evaluating forecasts using standard criteria suggests that using risk premiums does not assist in forecasting future spot exchange rates.

Keywords: Australian dollar; forecasting; forward exchange rates; risk premium; speculation

1. INTRODUCTION

Arbitrage arguments suggest that the forward rate reflects the market's expectation of the future spot exchange rate. This relationship is known as the 'Unbiased Forward Rate Hypothesis' (UFRH). The systematic violation of the UFRH has spawned the 'forward rate puzzle'. Many explanations have been offered to reconcile this anomaly with market efficiency. Two avenues of the risk premium hypothesis are explored to determine whether they contribute to any failure of the UFRH. The first analyses whether systematic risks are present within Australian Dollar currency markets. An international version of a Capital Asset Pricing Model is implemented to determine whether forward market participants can demand compensation for assuming forward rate risk. The second avenue extends recent studies of normal backwardation, first propounded by Keynes (1930). Although dated, the literature maintains interest in the importance of speculators (see for example, Chang (1985), Bessembinder (1992), Miffre (2000)).

This paper makes important contributions to the UFRH literature, as no papers have examined the implications speculators have for forward contracts. Forwards and futures are intimately connected but possess different properties. One important difference is that futures gains/losses are realised daily via marking-to-market effects, with forward realised only at maturity.¹

Furthermore, research has focused upon JPY/USD and USD/DEM rates. Little is published on the USD/AUD rate and none have applied the risk premium models done so here. Given its historical linkage with commodity markets, the Australian dollar is worthy of consideration. Finally, a quasi-forecast evaluation of the model is performed which thus far appears to have escaped the attention of researchers.

2. THEORETICAL DEVELOPMENT

The Unbiased Forward Rate Hypothesis (UFRH) is well known among financial economists. Simply, the UFRH states that the forward rate should provide an unbiased and efficient forecast of future spot exchange rates such that:

$$S_{t+1} = F_t^{t+1} + \epsilon_t \quad (1)$$

This led to the following specification:

$$\epsilon_t \ln S_t = \epsilon_t + \epsilon_t (\ln F_{t-1}^t - \epsilon_t \ln S_{t-1}) \quad (2)$$

where $\epsilon_t \ln S_t = \ln S_t - \ln S_{t-1}$ and F, S are the forward and spot rates (domestic units per unit of foreign exchange). The UFRH implies a joint null hypothesis of ($\epsilon_t=0$, $\epsilon_t=1$). However, the UFRH is overwhelmingly

¹ With stochastic interest rates, the marking-to-market of futures contracts may cause slight deviations between

forwards and futures of equal maturity. Researchers generally find this to be minimal (see Hull, 2000, p.62).

rejected empirically, with estimated β coefficients frequently of the wrong sign as predicted by theory.

Underlying the UFRH is a set of assumptions such as the risk-neutrality of agents. Risk neutrality is a sufficient condition to derive the UFRH. Anecdotally, it seems agents do exhibit risk aversion. However, under modern portfolio theory, whether the capital markets permit a premium to be charged is a matter for empirical investigation. If a premium exists then (1) becomes:

$$S_{t+1} = F_t^{t+1} + \beta_t + \beta_{t+1}$$

where β represents the premium. The aim of this paper is to explore factors that are believed to contribute *a priori* to this premium.

3. EMPIRICAL SPECIFICATION

We begin with a percentage change specification of (2).

$$\begin{aligned} \% \Delta S_t &= \beta + \beta(\text{spread}_{t|\Omega}) + \beta_t \\ \beta_t &\sim iid(0, \beta^2) \end{aligned} \quad (3)$$

where: $\% \Delta S_t = (S_t - S_{t-1}) / S_{t-1}$ and $\text{spread}_{t-1} = (F_{t-1} - S_{t-1}) / S_{t-1}$

Ordinary Least Squares (OLS) is first employed as a means of benchmark comparisons, along with diagnostic tests for misspecification. For example, Domowitz and Hakkio (1985) postulated that the influence of conditional variance might generate a time varying risk premium. Thus, testing for no ARCH effects will address whether (3) should be adapted to incorporate conditional variance.

A risk premium model derived from financial theory is then specified. The purpose is to determine whether an omitted variable explanation can be attributed to any anomalous results from estimating (2). A simple extension of the domestic CAPM is employed, whereby the relevant benchmark is the world market portfolio, to show that (2) can be generalised to include systematic risk. We show that if a currency is viewed as an asset, then an international CAPM can be reworked to derive a spot-forward regression with a risk premium term.

As the CAPM is specified in terms of expectations, financial researchers use *ex-post* observations on the basis of rational expectations. That is:

$$(R_{AUD} - r_{US,t}^f) = \beta_{AUD} (R_{world,t} - r_{US,t}^f) + \beta_t \quad (4)$$

where: R_{AUD} is the monthly return to holding AUD = $\% \Delta S_t + r_{AUD}^f$

$R_{world,t}$ is the monthly return on the MSCI World

index = $(\text{MSCI}_t - \text{MSCI}_{t-1}) / \text{MSCI}_{t-1}$

$r_{US,t}^f$ is the one-month USD interest rate.

Decomposing the return to holding AUD into the currency change and the AUD risk-free rate, (4) can be re-arranged to give:

$$\% \Delta S_t = (r_{US,t}^f - r_{AUD,t}^f) + \beta_{AUD} (R_{world,t} - r_{US,t}^f) + \beta_t \quad (5)$$

Under CIP, the difference between interest rates is approximately equal to the forward spread. That is:

$$(r_{US,t}^f - r_{AUD,t}^f) \approx \text{spread}_{t|\Omega}$$

Thus, (5) can be used to incorporate the presence of systematic risk within the forward rate regression. That is:

$$\% \Delta S_t = \beta(\text{spread}_{t|\Omega}) + \beta_{AUD} (R_{world,t} - r_{US,t}^f) + \beta_t \quad (6)$$

β is hypothesised to equal one, and the regression's intercept should be statistically insignificant (that is, theoretically the model is one of regression through the origin). A statistically significant $\hat{\alpha}$ is consistent with an element of systematic risk within Australian dollars.

Following Bessembinder (1992), (6) can be generalised to capture speculative pressure. After controlling for systematic risk, we can test for the presence of any residual risk that speculators are compensated with. The positions of speculators at time 't-1' are used in the model because expectations must be formed at the start of the period. Therefore:

$$\begin{aligned} \% \Delta S_t &= \beta(\text{spread}_{t|\Omega}) + \beta_{AUD} (R_{m,t}^{world} - r_{US,t}^f) \\ &+ \beta(\text{spec}_{t|\Omega}) + \beta_t \end{aligned} \quad (7)$$

4. DATA

Spot and forward exchange rate data were obtained from the Reserve Bank of Australia's web site (www.rba.gov.au) for the period September 1992 to June 2000. Thirty-day frequencies are employed mainly because sampling data at a finer frequency than the forecast horizon creates a moving-average error term.

The international CAPM requires a world market portfolio. Hence, estimation necessarily entails the use of a market proxy that overlooks some assets available to investors, which Roll (1977) argued is problematic. The Morgan Stanley Capital Index (MSCI) was chosen as the measure of a world portfolio. Being a value-weighted index of equities only, the MSCI has deficiencies. For example, the MSCI does not encompass the whole asset universe as required under basic CAPM assumptions. Despite its shortcomings, the MSCI is easily the most widely applied index in the international finance literature and given the author's resources, the MSCI was adopted as the benchmark index. Data for the London interbank money market bid rate on 30-day U.S. dollar deposits were obtained from the Federal Reserve's web site (www.federalreserve.gov) for the risk free interest rate.

To establish the importance of speculators, we follow Chang (1985), Bessembinder (1992) and Chatrath *et al.* (1997) by relying upon historical Commitments of Traders (COT) Reports, published by the Commodity Futures Trading Commission (CFTC), the regulatory body of the United States' futures and options markets. The COT report summarises the open interest in a particular commodity's contract series, in this instance the Australian dollar contract, which trades on the International Money Market division of the Chicago Mercantile Exchange.

A time series was constructed by collating freely available COT reports from the CFTC's web site (www.cftc.gov). Our curiosity as to the importance of speculators and the availability of an unbroken series determined the initial period of interest would be October 1992 to June 2000.² As speculative positions are sampled weekly, a monthly speculator series was constructed by using values at the start of the month. Following Chatrath *et al.* (1997), we consider the proportion of net non-commercial positions as a percentage of open interest. The reason is to account for any patterns in the total volume of futures traded. While the Commitment of Traders reports imperfectly capture speculative positions, they appear the best option to incorporate speculators. Problems arise because speculators may prefer over-the-counter markets to protect their privacy, so as not to provide signals to the market with their trades. Also hedging and speculation need not be independent. Commercial traders implicitly speculate when

they decide whether to hedge, and to what extent. These effects cannot be captured by net non-commercial positions. Thus, the potential for measurement error to raise econometric concerns must be considered.

5. RESULTS

5.1 Regression Findings

Recall (1) - the standard forward spread regression. We estimated this equation over the entire sample and two sub-periods, the demarcation corresponding to the Asian crisis of August 1997. Results are presented in Table 1 along with diagnostic tests. Diagnostics are important because they highlight any deficiencies in the theory's ability to explain the data, and whether the assumptions underlying our estimation techniques are empirically valid. Standard diagnostic tests did not reject the validity of the specification.

Table 1 shows that although the spread coefficient was estimated to be negative over the whole sample, contrary to theory, a null hypothesis of $\beta = 1$ was not rejected. While the negative coefficient is consistent with the forward rate anomaly literature, it seems that the forward rate anomaly was not apparent within the Australian dollar market over the 1990's. Maybe it is because a different currency was examined, in a period later than those studies. We would also be unable to reject a null of $\beta = 0$. Hence, there appears to be significant noise, even within monthly data. This is also apparent from the estimates obtained from the respective sub-samples, which differed greatly in magnitude, but were estimated with such imprecision, as to render a comparison uninformative. The \bar{R}^2 of 0.41% is of similar magnitude to previous spot/forward studies. Intuitively, what one knows today about the exchange rate in thirty days time is unlikely to differ largely from what we know about today's rate, which may explain the inability of thirty day forward spreads to explain spot rate movements. This is to be expected given that fluctuations in realised spot rates are of an order greater than the forward spread.

An international CAPM with speculative pressure was then estimated via OLS. Table 2 indicates that $\hat{\alpha}$ is negative, which is theoretically incorrect, although it is statistically insignificant. That is, speculative positioning cannot explain future exchange rate movements in excess of what the forward spread and excess returns on the market index can explain. Thus, the data do not support

² The CFTC was consulted to ascertain the cause. For positions in a contract series to be reportable in any one week, a minimum of twenty traders must hold open

not analysed, the period was prior to our data and

Table 1. Standard Forward Spread

$$\% \Delta S_t = \alpha + \beta (\text{spread}_{t-1}) + u_t$$

Period	α	S.E.(α)	β	S.E.(β)	S.C.(12)	ARCH(4)	J-B	R-bar sq
10/92 to 06/00	-0.0054	0.0040	-3.7806	3.2144	13.7273	1.6846	3.9176	0.0041
p-values	0.1817	-	0.2426	-	0.3185	0.7935	0.141	-
10/92 to 08/97	0.0019	0.0086	0.8379	5.5349	9.7376	2.9196	1.8876	-0.0170
p-values	0.8246	-	0.8802	-	0.6390	0.5714	0.3892	-
09/97 to 06/00	-0.0061	0.0053	-17.2366	20.1869	10.3512	3.6441	3.6162	-0.0083
p-values	0.2599	-	0.3995	-	0.5852	0.4563	0.1640	-

* denotes significant at the five percent significance level.

SC(12) is an LM test for 12th-order serial correlation. ARCH(4) is an LM test for 4th order ARCH effects. J-B denotes the Jarque-Bera normality test.

Table 2. Forward Spread and Risk Premia

$$\% \Delta S_t = \alpha + \beta (\text{spread}_{t-1}) + \gamma (R_m^{world} - r^f) + \delta (\text{spec}_{t-1}) + u_t$$

Period	α	β	γ	δ	S.C.(12)	ARCH(4)	J-B	R-bar sq
10/92 to 06/00	-0.0085 *	-4.2579	0.2976 **	-0.0023	7.9943	4.0031	1.2772	0.1537
S.E.	(0.0039)	(3.1409)	(0.0707)	(0.0099)	-	-	-	-
p-value	0.0333	0.1787	0.0001	0.8163	0.7856	0.4056	0.528	-
10/92 to 08/97	-0.0027	-0.8030	0.2339	-0.0008	9.2163	5.7506	1.2663	0.0776
S.E.	0.0089	5.5635	0.1135	0.0119	-	-	-	-
p-value	0.7643	0.8858	0.0442	0.9479	0.6844	0.2186	0.5309	-
09/97 to 06/00	-0.0114	-33.5738	0.3589	-0.0277	13.8339	2.7281	1.1463	0.254
S.E.	0.0052	21.0452	0.0995	0.0223	-	-	-	-
p-value	0.0368	0.1211	0.0011	0.2222	0.3114	0.6043	0.5638	-

* (***) denotes significant at the five (one) percent significance level.

SC(12) is an LM test for 12th-order serial correlation. ARCH(4) is an LM test for 4th order ARCH effects. J-B denotes the Jarque-Bera normality test.

the insurance theory of speculation.³ Perhaps marginal speculators are unable to anticipate currency movements better than the market or that contemporary market structures render the theory irrelevant.⁴ Bernstein's (1996, p.200) quote from Bachelier's 100 year-old proof seems applicable, that 'the mathematical expectation of the speculator is zero.'

The above findings too conflict with Bessembinder (1992) who reported hedging pressure to significantly influence returns on currency futures. Factors that may reconcile the results include that the Australian dollar as

perhaps futures data on speculators is less relevant to forward contracts, despite their intimate connection via arbitrage conditions. Note that our tests are uninformative about the profitability of individual speculators, so it is feasible that individual speculators are remunerated accordingly.

5.2 Forecasting Exercise

The results indicate that an international CAPM contributes towards understanding movements in the Australian Dollar. We conduct a forecasting exercise to study this proposition by comparing the forecasting performance of a naive random walk, the forward rate, and the forward rate combined with a risk premium. Since we could not reject the null hypothesis that speculative positions have an immaterial impact upon currency movements, the following analysis considers purely systematic risk. Hence, the models take the forms:

³ Regressions with net hedgers were also estimated but the results were also insignificant.

⁴ For example, not knowing the counterparty's motive or traders earning a bid-ask spread rather than a premium

$$S_{t+1} = S_t + u_{t+1}$$

$$S_{t+1} = F_t^{t+1} + v_{t+1}$$

$$S_{t+1} = \beta_1 F_t^{t+1} + \beta_2 (ER_{world} - r_t^f) + w_{t+1}$$

$$\text{where: } ER_{world,t} = \frac{E_t(MSCI_{t+1}) - MSCI_t}{MSCI_t}$$

No studies utilising an international CAPM provided any forecast evaluations, choosing instead to focus upon the model's ability to explain within-sample variation. The potential for these models to assist agents makes the lack of forecast comparisons surprising. Thus, this approach may offer insights for those wishing to improve upon how they formulate expectations and/or their risk management practices. To determine whether our results can enlighten decision-making processes, the position of an agent faced with forming expectations for period t+1, possessing information only up to period t is assumed. As $E(R_{world,t})$ is unobservable it must be generated. We tried to ensure that as best as possible that the results were not driven by information agents were not privy to.

We have already tested our general model, concluding that speculative positions are unimportant. If we use that data for forecast evaluations, then our study is subject to forward-looking bias, because our model was chosen on the basis of the entire sample. Thus, to mitigate any forward-looking bias that may contaminate our comparisons, the period July 2000 to August 2001 is examined. To mimic an *ex-ante* risk premium we need to estimate it, which is accomplished with two equations. The first requires what an agent may reasonably expect future equity returns to be. The second requires estimates of the currency premium itself.

Drawing upon research into equity and futures returns, we implement the following relationship to generate what

$$XSR_{t+1} = \alpha + \beta_1 XSR_t + \beta_2 TS_t + \beta_3 DEFAULT_t + u_{t+1}$$

an agent may expect period t+1 equity returns to be, possessing information at time t. That is:

(8)

Ferson and Harvey (1991), Harvey (1991), Bessembinder and Chan (1992) and McCurdy and Morgan (1991, 1992), are just some who use variables similar to those in (8) to predict equity returns, with time variation also being prevalent. The above studies report variables related to default premiums and the term structure has having predictive powers of future equity return. TS_t equals the spread between six-month and one-month U.S. dollar interest rates. $DEFAULT_t$ represents the difference between yields on Moody's BAA and AAA rated bonds.

Over the forecast period (8) is estimated recursively, which parallels an agent's ability to update their model. To obtain predicted excess returns we substitute in actual values. Forward speculative profit is then regressed against estimated expected returns to generate a risk

$$(S_{t+1} - F_t^{t+1}) = \beta_{AUD} (X\hat{S}R_t^e) + u_{t+1} \tag{9}$$

The coefficient of F_t^{t+1} in (9) has been restricted to unity to see how the forward rate can be improved upon by including a risk premium. Over the forecast period we update β_{AUD} as new information comes to hand to mimic how agents respond.

The forecast period is for July 2000 to July 2001. The initial estimated coefficients are determined from the period October 1992 to June 2000. Multiplying the actual values in June 2000 by the estimated coefficients gives estimated expectations for July 2001. Each coefficient is then recursively estimated to update the agent's information set as new information arrives. That is, values are added to the information set as they are observed and used to re-estimate equations 8 and 9.

There are limitations to this approach. The equation is atheoretic, obtained purely from existing studies. Econometric concerns arise from the use of generated regressors (GR), as mentioned in Pagan (1984), McAleer and McKenzie (1992) and McKenzie and McAleer (1994). Following Pagan's taxonomy, the model contains 'predictor GR' - fitted values from an auxiliary regression have been used as an explanatory variable in the second-stage regression. Generally, a two-stage estimator is consistent though inefficient, that is, the point estimate converges in probability to the population value but the standard error in finite samples is larger than need be (see McAleer and Oxley, 1993, p. 19).⁵ As we are interested in obtaining point estimates to incorporate expectations into forecasting, and not testing *per se*, consistency seems to be more relevant than efficiency in the current context. However, that consistency is a large sample property deserves mention. In small samples, measurement error from generated regressors may remain, thereby contaminating the estimates.⁶

Standard forecast evaluation criteria are calculated and then compared for the random walk, the forward rate, and the forward rate supplemented with a risk premium. As a formal analysis of various forecast criteria is beyond the scope of this paper, attention was restricted to mean-square error (MSE) and root mean-square error (RMSE).

Table 3 displays the forecast results. A risk-adjusted forward rate failed to outperform both the random walk and the forward rate. This is not surprising, given the

⁵ Furthermore, McAleer and McKenzie (1992, p.4) showed that 'parameter estimates of the structural equation are not efficient...' under recursive estimation.

⁶ Possible misspecification in the auxiliary equation is also a cause for concern (see McKenzie and McAleer

estimation issues previously discussed. The findings are broadly consistent with Wolff (2000) who could not better a random walk with a Kalman filter to estimate the forecast error's autoregressive structure. Unfortunately the forecast sample is regrettably small. Thus, further analysis of the role for risk for forecasting appears warranted given its potential importance to managers interested in mitigating fluctuations in portfolio values.

Table 3. Forecast Criteria

Measure	MSE	RMSE
Random-Walk	0.00047	0.0216
Forward Rate	0.00046	0.0215
F+ Premium	0.00049	0.0220

6. CONCLUSION

Evidence suggestive of systematic risk in currency returns, with little incremental role for speculation, was presented. A forecasting approach was then adopted to determine whether our results have economic implications. Given the limited sample, incorporating risk premiums into forecasts deserves careful future consideration. Those considering using derivatives for risk management often base their hedging decisions on exchange rate forecasts. One implication of this paper is that management may wish to redirect resources into forming expectations for world equity returns, to incorporate systematic risk into decision processes. Whether market risk can be used to diminish fluctuations in exposures relative to other strategies would be an interesting extension. Not only would managers better assess the costs of hedging, but also it would enable the efficient allocation of resources.

7. ACKNOWLEDGEMENTS

This paper was adapted from my Honours thesis at the University of Western Australia. I would like to thank Nic Groenewold and Michael McAleer, for helpful comments and suggestions. The financial support of the Hackett Postgraduate Award is gratefully acknowledged.

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