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The Forward Premium Puzzle: Before the Euro

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Extant literature confirms that the forward premium is a biased predictor of the future change in the spot rate. The existence of a bias is an indication of the possibility to predict the evolution of the future spot exchange rate. Drawing on about 25 years of research on the issue this paper makes two contributions. First it augments the standard models with several economic variables to examine if the forward exchange bias is maintained over the long run. Second, it uses the model to examine the predictability of the ex-post profits from uncovered interest parity (UPI) speculation. The paper finds that long term co-integrating relationships confirm that the forward rate is a biased predictor of the future spot rate in the long run. In addition, predictive models for the profit generated by the UPI speculation are successful for the majority of industrialized countries included in the analysis.

Field of Research: forward premium puzzle, future spot exchange rate prediction

1. Introduction

Since Fama (1984) the forward exchange rate bias has become a quite well documented puzzle in economics and finance. Fama (1984), Frankel and Froot (1987), and since then many others (see Wang and Jones (2002) for a more extensive literature review) have provided clear direct and indirect evidence that the forward premium is a biased predictor of the future change in the spot rate. However, the extant literature has no clear cut answer as to what determines the forward rate bias: irrational expectations and/or risk premia (see for example Frankel and Froot (1987), or Cavaglia et al. (1994)). Efforts to explain the puzzle have taken several directions. Some research has underscored the importance of the "peso problem" in forming ex-ante rational expectations that may look biased ex-post while others have concentrated on the behavior and statistical properties of the proposed risk premium embedded in the forward rate. More recently Burnside et. all (2007) propose an explanation that is based on behavioral traits such as adverse selection while Obstfeld and Rogoff (2000) observed in a larger economic picture that the exchange rates seem disconnected from economic fundamentals.

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The forward exchange rate bias is a contradiction of the uncovered interest parity (UIP) condition. The UIP states that currencies in countries with a lower interest rate should appreciate relative to currencies in counties with higher interest rates. However, systematically it was noted that in fact currencies that are sold forward at a premium tend to appreciate. Models proposed in the literature to explain the bias provide the background for the current paper.

At a theoretical level Solnik (1974) developed an International Capital Market (ICM) model and as a byproduct showed (under the restrictions imposed by his model) that the forward exchange rate must be a biased estimator of the future spot exchange rate due to a risk premium dependent on the "hedging pressure" derived from international transactions. Since Fama (1984) found the negative correlation between risk premium and the expected future changes of the exchange rate several papers have attempted to explain this behavior.

Some of the models have concentrated on the time series properties of both forward and spot exchange rates. Boyer and Adams (1988) developed a simple theoretical model that exhibits the risk premium characteristics suggested by Fama's (1984) work. Using multivariate tests for unit roots Baillie and Bollerslev (1989) identified a long-run relationship among seven exchange rates and a disequilibrium error which is "an important component in next period's change in the exchange rate", thus providing more evidence for a time varying risk-premium in the maintained hypothesis of efficient markets. Peel (1993) assumed rational expectations and found evidence for a non-linear time-varying premium. Peel and Pope (1995) disposed of the rational expectation hypothesis and as a result found statistical support for time varying risk premium.

Engle (1996) did a thorough review of the literature on forward premium and the associated risk premium question. He concluded that none of the models could explain satisfactorily the issues raised by the forward premium puzzle. In a more recent review of the issue, Frankel and Poonawala (2009) reaffirmed the bias for currencies of developed countries but found less bias in the currencies of emerging markets. Even more interesting is that the bias in the emerging markets points to the right direction. They concluded that the bias cannot be entirely attributed to risk premium as the emerging markets are riskier than the developed markets. Burnside et. all (2007) stated that "While risk must surely play a role in exchange rate markets, it has been extremely difficult to tie deviations from uncovered interest parity to economically meaningful measures of risk."

Thus, research done in the past 25 years has not reached a definite conclusion about this puzzling relationship between the forward premium and the future change in the exchange rate. However, no paper forcefully eliminated the risk premium explanation and most concluded that the behavior of the risk premium is non stationary.

This paper is an attempt to tie the forward premium to meaningful measures of economic risk using and a number of variables that were shown in previous literature to influence the exchange rate determination. In addition the model explored in the paper uses the long term statistical properties suggested by previous research for the variables involved. Finally, to make the findings comparable to other research the paper uses almost the same currencies as most previous literature. Since for some European countries such an analysis is impossible after the introduction of the Euro the paper uses a suitable time frame as explained below in the data section. The data section is followed by the methodology section. Next two sections, one discussing the results and one offering concluding remarks, make up the reminder of the paper.

2. Data

The data consists of spot and forward exchanges rates against the US dollar, for five countries with high volume of forward trading: Britain (GBP), Canada (CND), France (FFR), Germany (DEM), Japan (JY). All the rates, spot and forward, are collected from the Wall Street Journal at the end of each month. The period under consideration is September 1985 - December 1995. This period was selected for two reasons. First, it starts about a year after Fama's 1984 influential paper on the topic was published and thus one can verify if that paper had any effect on the elimination of the puzzle. Second, it permits the analysis of a number of important currencies that disappeared with the advent of the Euro. While the Euro was introduced as an accounting currency in January 1999 the official name was adopted in December 1995 and thus its introduction was communicated to markets long before it was effective.

A set of variables, documented on theoretical or empirical grounds to be connected with the exchange rate is used to construct a system suitable for analysis as explained in the methodology section. These variables are taken from The Bureau of Economic Analysis which publishes the Business Cycles Indicators, a comprehensive set of data from which time series of interest to the present investigation were selected.

The study is limited to the following six industrialized countries: US, UK, France, Japan, Germany and Canada, because their macro series were found linked in much previous research and the six countries accounted for the majority of: international trade, foreign exchange market, world industrial production, world consumption and world wealth for the period under consideration.

3. Methodology

Following a decomposition of the forward rate proposed by Fama (1984), the forward rate and the expected future spot rate are linked by the following relationship:

$$f_t=E_t(s_{t+1})+rp_t \qquad (1)$$

where f_t is the natural logarithm of the forward exchange rate, $E_t(s_{t+1})$ is the expectation taken at time t of the logarithm of time t+1 spot rate, and rp_t is the risk premium perceived in the market at time t. If the realized t+1 spot rate is expressed in terms of expectation and a white noise term, equation (1) can be written as:

$$f_t-s_{t+1}=rp_t+u_t \qquad (2)$$

where u_t is the white noise term. The left hand side term of equation (2) represents the profit from the uncovered forward speculation. In the case of a stationary rp_t it is obvious that the profit must also be stationary and therefore it is unpredictable. However, if the profit is non-stationary it is important to recognize that risk premium is also non-stationary. It is then possible to construct a system of non-stationary variables that contain stationary common trends. The very existence of common trends allows for the prediction of some of the time series included in the system.

Maynard (2006) explores a model where the rp variable is the forward premium. Chinn and Meredith (2004) work on a similar relationship where they include inflation and output. Finally, Harvey (2004) proposed a post Keynesian model where a vector representing government restrictions on capital flows, monetary policies, transaction costs and other market imperfection are included along to explain UPI.

The current research draws on the idea that *rp* can be a vector representing more than the forward premium. Various sources in the theoretical literature, for example Solnik (1974), Adler and Dumas(1983), and Sarno (2005) in his review of the literature, suggest that the risk premium might depend on national wealth, forward premium, investment opportunities and deviations from purchasing power parity (PPP).

For this reason we choose the following variables for our analysis: stock market index - a proxy for national wealth, CPI -a proxy for deviations from purchasing power parity (PPP) and national identity, industrial production - a proxy for investment opportunities, and the forward premium-both a proxy for interest rate differential and representing a risk premium as seen in the literature review section. Such a combination of variables was not considered by the extant literature to this author knowledge and thus represents an addition to the research of the forward premium puzzle.

Using the US dollar as the currency of reference in the denominator (direct quotes for USD as home currency) two time series were created: a series of the return from forward speculation, RETURN = $\ln(f_{t+30} / s_{t+30})$ and a series of forward premiums FWDPREM. = $\ln(f_{t+30} / s_t)$.

The subscript t+30 indicates the 30 day forward rate or the spot rate after 30 days. From the above constructs one can observe that RETURN represents the profit or loss obtained by going “long” in a forward contract and at expiration borrowing in the “home” currency, converting at the spot rate in the “foreign currency” and then closing the forward position. To exemplify: if a party would be “long” in a forward contract to buy 1 USD for 5 FFR but at the end of the period the rate is 5.5 for 1 USD one could borrow USD for a short time, exchange in FFR at the spot rate and close at a profit forward position. The profit is represented by the difference between the amount borrowed and the amount obtained at the closing of the forward position. The borrowing cost is economically insignificant as all the transactions would be almost instantaneous. If instead the rate would have been 4.5 FFR for 1 USD the position would be closed at a loss.

In addition for each country time series for industrial production, IPFC, consumer price index, CPIFC, and country stock market index, SMFC were created by taking the natural logarithm of each value.

The first step is to find out employing the standard ADF and PP test that all the variables considered are non-stationary. Consistent with previous earlier literature, (see Corbae et all. (1992) for example) this is confirmed. This allows one to construct for each country except for US, since the USD is the reference currency, a system of time series RETURN, FORWARD, IPFC, CPIFC, SMFC, IPUS, CPIUS, SMUS.

The five systems are each analyzed using the well known Johansen methodology for co-integration of multiple series. The next step is to construct a Vector Autoregressive Model (VAR) and to augment it with the error correction term in the systems where that exists by constructing a Vector Error Correction Model (VECM.) Once this is done, the VECM and the VAR equations are used to assess the predictive ability of each model. The study uses a sample of 111 points to construct the models and a hold out sample of 12 to assess the predictive ability of each model.

4. Results

The results of the co-integration tests are presented in Table 1. An inspection of the results shows that all countries exhibit at least one co-integrating vector. According to the critical values for the maximum eigenvalue and the trace tests, UK can have between one and three co-integrating vectors, Canada and Germany between one and two, France one and Japan three co-integrating vectors, but as reported by Johansen and Juselius (1990) only the first one associated with the largest eigenvalue is of importance. In the construction of the models only the first co-integrating vector is therefore used.

Table 1: Maximum eigenvalues and trace values

The critical values are from Osterwald - Lenum, (1992), table 1.1. An * indicates the number of co-integrating vectors for each system.

99% CRITICAL VALUES			UK		CANADA	
r	λ-max	trace	λ-max	Trace	λ-max	trace
7	11.65	11.65	.333	.333	.946	.946
6	19.19	23.52	6.106	6.44	6.496	7.44
5	25.75	37.22	13.341	19.78	8.377	15.81
4	32.14	55.43	22.347	42.127	11.63	27.45
3	38.78	78.87	30.066	72.194*	35.587	63.037
2	44.59	104.20	37.496	109.69	38.809	101.846*
1	51.30	136.06	45.079*	154.769	48.911*	150.757
0	57.07	168.92	63.945	218.714	70.424	221.181

FRANCE			GERMANY		JAPAN	
r	λ-max	trace	λ-max	Trace	λ-max	trace
7	.516	.516	1.263	1.263	.0089	.009
6	4.435	4.951	5.975	7.238	14.160	14.169
5	9.267	14.2148	14.3	21.538	19.138	33.307
4	17.797	32.015	18.853	40.39	21.458	54.765
3	21.125	53.141	22.51	62.901	23.021*	77.786*
2	29.916	83.057	33.565	96.466*	45.835	123.621
1	49.142*	132.199*	44.1*	140.565	77.68	201.301
0	67.633	199.832	66.268	206.833	87.209	288.51

Table 2 exhibits the first co-integrating vector for each system. The Johansen procedure treats all the variables as endogenous, therefore the relation is unique.

Table 2: The long term co-integrating relationship for each country

	COUNTRY				
VARIABLE	UK	CAN	FR	GER	JAP
RETURN	-32.53	-105.44	-11.54	21.86	30.66
FWDPREM	909.52	133.39	217.44	-31.35	-40.98
IPFC	26.98	-3.11	6.58	7.43	12.37
IPUS	-30.87	-7.13	-.2996	-3.61	10.75
CPIFC	-4.23	-49.81	26.43	38.21	37.60
CPIUS	1.704	54.59	-29.32	-28.23	-41.61
SMFC	-24.56	.688	-3.81	.982	-2.62
SMUS	28.73	.525	8.97	-1.11	4.36

The co-integrating relationship show that RETURN and therefore, implicitly the future spot rate is related to the economic variables selected in a meaningful long term equilibrium. This contrasts with the previous research (see Obstfeld and Rogoff (2000)) that could not find such a relationship in the short run. Since this study looks at the long run the result is novel and different from the previous research. It appears that in the long run the exchange rate is connected to some fundamentals as economic theory would predict. The long-term link among the time series can be established by choosing a variable for the left hand side and by normalizing the equation with its coefficient.

To exemplify, for UK the long term relationship after moving RETURN on the left side and normalizing with its coefficient the relationship is as follows:

RETURN=27.95FWDPREM+.83IPUK-.95IPUS-.13CPIUK+.052CPIUS-755SMUK+.88SMUS

The interpretation is that the RETURN would increase when the forward premium is positive. However, in order to obtain this result the currency sold at a premium forward would need to appreciate. This confirms the initial result of Fama (1984) where the forward rate not only was biased but was biased in the wrong direction. Thus, the forward premium puzzle can be confirmed as a long term relationship and not only as a short term one as in previous literature. This result is new to our knowledge.

Continuing with the UK relationship as an example, RETURN is also positively related to the industrial production but negatively related to the UK CPI and the UK stock market index. However, RETURN is positively related to the US inflation and stock market index. Similar relationship could be constructed for all the countries. While the signs for the other countries might differ from those of UK for some of the variables it is to be noted that the relationship between RETURN and FORPREM is consistently showing a negative relationship between the forward premium and the future exchange rate. This indicates that the forward premium puzzle can be confirmed for all the countries under investigation as a long term phenomenon. Nevertheless for the countries and the period under study the exchange rate is in a long-term relationship with the economic fundamentals proposed by this study.

The next goal of this research is to examine if the RETURN can be predicted in the short term using the long term equilibrium relationship. For this step we construct VAR and VECM models for all the countries. This implies taking the first difference therefore, the predicted variable is not the return on forward market speculation but the rate of change of this return. Tables III and IV show the calibrated VAR and VECM models with one lag. Various numbers of lags have been tried using the standard ACI and Schwartz criterion, but one lag was found to provide the best fit. In order to avoid the problems introduced by autocorrelation and heteroskedasticity, a Newey -West correction with 10 lags was used.

Table 3: The results of VAR models for each system

The independent variable is $\Delta_t RETURN = \ln(f_{t+30} / s_{t+30}) - \ln(f_{t-1+30} / s_{t-1+30})$, the monthly change in the profit of an open forward position. The regression includes a constant, not shown. For the DW critical values k=8 and n=97.

		COUNTRY			
VARIABLE	UK	CAN	FR	GER	JAP
Δ_{t-1}**RETURN**	-.3494	-.334	-.478	-1.25	-.232
	[.000]	[.023]	[.000]	[.035]	[.052]
Δ_{t-1}**FWDPREM**	4.49	.868	-.03823	.726	.8835
	[.203]	[.000]	[.826]	[.2]	[.000]
Δ_{t-1}**IPFC**	.436	-.124	.707	.686	-.389
	[.212]	[.412]	[.001]	[.232]	[.268]
Δ_{t-1}**IPUS**	-.004	-.289	-.15601	-4.172	-1.370
	[.03]	[.903]	[.007]	[.115]	[.066]
Δ_{t-1}**CPIFC**	-.2064	-.94	-.4695	6.85	-.8742
	[.805]	[.028]	[.886]	[.166]	[.196]
Δ_{t-1}**CPIUS**	.0489	1.029	-1.8151	8.359	.837
	[.978]	[.037]	[.384]	[.296]	[.435]
Δ_{t-1}**SMFC**	-.1471 .	5723	-.0709	-.647	.272
	[.243]	[.154]	[.489]	[.085]	[.000]
Δ_{t-1}**SMUS**	-.018	.283	.099	.984	-.308
	[.942]	[.942]	[.438]	[.126]	[.057]
ADJ R2	.1296 .	5694	2735	.3722	.7492
D-W	2.2529	2.700	2.3758	2.2613	2.6921

Table 4: The results of VECM models for each system

The independent variable is $\Delta_t RETURN = \ln(f_{t+30} / s_{t+30}) - \ln(f_{t-1+30} / s_{t-1+30})$, the change of the profit of an open forward position. The regression includes a constant not shown. For the DW critical values k=9 and n=97.

	COUNTRY				
VARIABLE	UK	CAN	FR	GER	JAP
Δ_{t-1}**RETURN**	-.78602	-1.1072	-.50732	-.5091	-.9767
	[.000]	[.000]	[.000]	[.075]	[.000]
Δ_{t-1}**FWDPREM**	10.316	1.1493	.3516	-.33154	1.082
	[.018]	[.000]	[.438]	[.099]	[.000]
Δ_{t-1}**IPHC**	.83457	-.13856	.702	.9746	-.457
	[.007]	[.298]	[.001]	[.065]	[.063]
Δ_{t-1}**IPUS**	-2.2297	.09759	-1.5357	-5.968	-.569
	[.005]	[.646]	[.006]	[.026]	[.318]
Δ_{t-1}**CPIHC**	.4762	-.8162	-.44894	4.359	-.594
	[.530]	[.000]	[.892]	[.242]	[.422]
Δ_{t-1}**CPIUS**	2.8492	1.5839	-2.2294	9.947	-.4298
	[.009]	[.001]	[.311]	[.304]	[.753]
Δ_{t-1}**SMHC**	-.3858	.019058	-.0617	-.7448	.160
	[.000]	[.309]	[.545]	[.035]	[.006]
Δ_{t-1}**SMUS**	.39125	-.00116	.1319	.497	-.0526
	[.018]	[.97]	[.288]	[.157]	[.771]
ECM_{t-2}	.024187	.0099	.00394	.06507	-.02745
	[.000]	[.000]	[.268]	[.025]	[.000]
ADJ R2	.3936	.7494	.2726	.518	.847
D-W	2.0216	2.049	2.3402	2.2327	2.0614

In a comparison of the results shown in Tables 3 and 4, at least three distinctions can be made: 1) the VCEM adjusted R2 is always better or as good as the VAR one, 2) the DW is always better in the VECM case and 3) more variables are significant when the error correction is used. All the above observations lead to the conclusion that the VECM is a better model when it comes to fit historical data.

In order to assess the forecasting capabilities of the two models 12 observations were used as a hold out sample. Table 5 shows the predictive ability of both models. The following statistics: R2 between observed and predicted, Theil inequality coefficient U, and the sum of absolute errors are used to assess the predictive power of each model.

Table 5: Tests of predictive power for the VAR and VEC models

	UK		CANADA		FRANCE		GERMANY		JAPAN	
Criterion	VECM	VAR	VECM	VAR	VECM	VAR	VECM	VAR	VECM	VAR
Theil Inequality Coefficient U	.638	.505	1.507	.787	.546	.557	.908	1.052	.435	.479
R^2 between obs.&predicted	.2935	.294	.2207	.0269	.1994	.1677	.1895	.2486	.5334	.3303
Sum of abs. Errors	.33737	.2477	.1754	.14018	.23028	.23020	.51652	.6283	.32861	.3393

The results are mixed. In the case of UK and Canada the VAR model appears a better predictor. France displays little difference between models. This can be explained by the lack of significance of the error correction term in France regression (see Table 4). For Germany and Japan the VECM model is a better predictor. Therefore, considering that the theory of co-integration maintains that series can drift apart for short periods but deviations are corrected in the long-run one cannot argue that the correction is all the time more accurate.

Regardless of the better model issue, this research demonstrates that the change in profit from uncovered forward speculation can be predicted in a satisfactorily manner once economic variables are introduced along with the forward premium. This result can be interpreted in two ways. On the one hand, the profit is in a long-term equilibrium relationship with the economic fundamentals chosen by this study. Short-term deviations from this relationship are corrected in the next period towards the equilibrium which leads to the prediction capabilities of the model. However, the unexplained part of the short-term deviations will make any gain a compensation for bearing the risk of speculation. On the other hand, one can view the prediction possibility as the inability of the market to incorporate in a timely manner all the available information represented by the economic variables in the model. Available information about inflation, industrial production, stock market, and forward premium does not enter into the short term price formation resulting in pricing that short term is disconnected from fundamentals.

5. Conclusion

This study makes two important contributions to the literature regarding the forward premium puzzle. First it shows that there is a long term relationship between the exchange rate and several economic variables that are supposed to matter to the exchange rate determination. Second it confirms in a novel model that the question of foreign exchange premium puzzle remained a puzzle after Fama's 1984 paper was published. Moreover, the puzzle is present as a long term relationship as well as a short term one. The conclusion is drawn by investigating the long term co-integration relationship among the return from forward speculation and a number of relevant variables.

Second the study shows that the change in monthly profits from forward speculation one year ahead, using readily available data such as industrial production, consumer price indices, stock market indices and forward premium is predictable. The results are in line with those surveyed by Della Corte et. all (2007) based on different models.

Due to the empirical nature of the model used in this study it is difficult to determine if the source of prediction is due to the fact that all “available information” is not incorporated into the market decision of what the exchange rate should be or that it is due to the existence of a risk premium proxied by several variables that should be incorporated in the exchange rate determination and its risk. While the study does not solve the forward premium puzzle it adds to the literature in a meaningful way by uncovering the long-term properties of the puzzle.

References

Burnside C., M. Eichembaum and S. Rebelo, 2007, “Understanding the Forward Premium Puzzle: A Microstructure Approach” *NBER working paper 13278.*

Boyer, Russel S., and Charles Adams F., 1988, "Forward Premia and Risk Premia in a Simple Model of Exchange Rate Determination." *Journal of Money, Credit, and Banking* 20, 633-44.

Baillie, Richard T., and Tim Bollerslev, 1989, "Common Trends in a System of Exchange Rates." *Journal of Finance* 44, 167-181

Cavaglia, S.M.F.G., W.F.C. Verschoor and C.C.P. Wolff, 1994, On the biasedness of forward foreign exchange rates: Irrationality or risk premia?, *Journal of Business* 67, 321-343.

Chinn, M and G. Meredith**,** 2004**,** Monetary Policy and Long-Horizon Uncovered Interest Parity, IMF Staff Papers, Vol. 51, No. 3

Corbae,D, K. Lim and S. Ouliaris, 1992, “On Cointegration and Tests of Forward Market Unbiasedness.” *The Review of Economics and Statistics,* Vol. 74, No. 4, pp. 728-732

Della Corte, P, L. Sarno and I.Tsiakas, 2007, “An Economic Evaluation of Empirical Exchange Rate Models.” *Centre for Economic Policy Research,* Discussion Paper no. 6598

Engel, Charles, 1996, “The forward discount anomaly and the risk premium: A survey of recent evidence.” *Journal of Empirical Finance* 3 (1996) 123-192

Fama, Eugene F., 1984, "Forward and Spot Exchange Rates." *Journal of Monetary Economics* 14, 319-38.

Frankel, Jeffrey A., and Kenneth Froot, 1987, "Using Survey Data to Test Some Standard Propositions Regarding Exchange Rate Expectations." *American Economic Review* 77, 133-53.

Frankel, Jeffrey A. and Jumana Poonawala, 2009, “The Forward Market in Emerging Currencies: Less Biased than in Major Currencies.” *Harvard Kennedy School, Working Paper No. RWP09-023.*

Harvey, John, 2004, “Deviations from uncovered interest rate parity: a Post Keynesian explanation” *Journal of Post Keynesian Economics* 27, 19-35

Johansen S. and K. Juselius, 1990, “Maximum Likelihood Estimation And Inference An Cointegration -- With Applications To The Demand For Money,” *Oxford Bulletin of Economics and Statistics*, pp. 169-210.

Levy, Haim ,and Kok Chew Lim, 1994, "Forward Exchange Bias , Hedging and the Gains from International Diversification of Investment Portfolios." *Journal of International Money and Finance* 13, 159-70.

Maynard, A. (2006), The forward premium anomaly: statistical artifact or economic puzzle? New evidence from robust tests. *Canadian Journal of Economics/Revue canadienne d'économique*, 39: 1244–1281.

Miles, David K, 1993, "Time-Varying Risk Premia and Bias in the Foreign Exchange Market." *Applied Financial Economics* 3, 217-30.

Obstfeld, M., and Rogoff, K. (2000) 'The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?', in Bernanke, B. and Rogoff, K. (eds.) *NBER Macroeconomics Annual*, Cambridge: MIT Press, 339-390.

Osterwald-Lenum M., 1992, "A Note With Quantiles Of The Asymptotic Distribution Of The Maximum Likelihood Cointegration Rank Statistics," *Oxford Bulletin of Economics and Statistics*, pp. 461-480.

Peel, D.A.,and P.F. Pope, 1995, "Time-Varying Risk Premia and the Term Structure of Forward Exchange Rates." *The Manchaster School of Economic and Social Studies* 63, 69-81.

Peel, D.A., 1993, "Non-Linear Risk Premia." *Applied Financial Economics* 3, 201-4.

Pope , Peter F., 1991, "Forward Foreign Exchange Rates and Risk Premia." *Journal of International Money & Finance* 10, 443-56.

Sarno, L. (2005), Viewpoint: Towards a solution to the puzzles in exchange rate economics: where do we stand*?. Canadian Journal of Economics/Revue canadienne d'économique*, 38: 673–708.

Solnik, Bruno H., 1974, "An Equilibrium Model of the International Capital Market."*Journal of Economic Theory* 5, 500-524.

Wang, Peijie and T. Jones, 2002, "Testing for efficiency and rationality in foreign exchange markets-a review of the literature on foreign exchange market efficiency and rationality with comments" *Journal of International Money and Finance* 21, 223-239