The Forward Premium Puzzle: Before the Euro

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Abstract

Fama (1984) argues 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)). Nevertheless, the existence of a bias leads to the conclusion that the evolution of the future spot exchange rate is predictable. If this is true, speculators taking long or short uncovered positions in the forward market can make a profit. The current research's goal is to study the ex-post profits and to explore whether a Vector Error Correction Model that includes various economic indicators is able to predict the ex-ante profits and thus the future spot rate. The research shows that the profits from the uncovered forward position against the US dollar for five industrialized countries can be predicted. In addition the long term cointegration relationship reveals that Fama (1984) correctly indicated not only that the forward rate is a biased predictor of the future spot rate but also that the bias is always in the wrong direction.

Keywords: forward premium puzzle, risk premium, uncovered forward speculation, future spot exchange rate prediction, profit from uncovered forward speculation
JEL Classification: F31, F47, G14**,** G15, G17

1. Introduction

The forward exchange rate bias is now a well documented fact. Fama(1984), Frankel and Froot(1987), and since then many others[2] provided clear direct and indirect evidence of the fact that the forward premium is a biased predictor of the future change in the spot rate. The unexplained bias contradicts two important hypotheses in economics and finance: rational expectations and efficient markets. In both instances the attack has seriously damaging effects. Efforts to salvage these tenets of modern economics and finance models have taken two directions: to defend the economist point of view, research has underscored the importance of the "peso problem" in forming ex-ante rational expectations that may look biased ex-post and, to defend the financial economist point of view research has focused on the importance and

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[2] For an interesting review of literature see Wang and Jones (2002)

behavior of the 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.

The forward exchange rate bias is 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.

At a theoretical level Solnik(1974) has developed an International Capital Market (ICM) model and as a byproduct shows (under the restrictions imposed by his model) that the forward exchange rate has to be a biased estimator of the future spot exchange rate due to a risk premium dependent on the "hedging pressure" derived from international transactions. Fama (1984) assumes rational expectations in the exchange market and establishes two important results: the risk premium is time varying and changes signs (risk premia are negatively correlated with expected future changes). In an attempt to explain this behavior, theoretical models have been developed and the time series properties of both forward and spot rates have been examined. 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) identify 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) assumes again rational expectations and finds non-linear time-varying premia. Peel and Pope(1995) dispose of the rational expectation hypothesis and as a result of find statistical support for time varying risk premia.

Miles(1993) developed a theoretical model based on "hedging pressure" which can account for time varying risk premia proxied by the current balance account. The model exhibits all the empirically documented properties of the bias: time variation, sign changes and strong autocorrelation. His empirical results however cannot "salvage foreign exchange market efficiency". The proxy he chooses for the risk premium, the current balance, leaves Fama-type regressions practically unchanged.

Engle (1996) does 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 more recent review of the issue, Frankel and Poonawala (2009) reaffirm the bias for currencies of developed countries but find 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 conclude that the bias cannot be entirely attributed to risk premia as the emerging markets are riskier than the developed markets. Burnside et. all (2007) state 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."

Research done in the past 25 years could not reach a definite conclusion about this puzzling behavior. However, none could forcefully eliminate the risk premium explanation. Therefore, this paper is an attempt to continue the investigation of the possibility to tie the forward premium

to meaningful measures of risk using and a number of variables that were shown in previous literature to influence the exchange rate volatility. The paper would use some unique currency data, partially hand collected, from Europe, North America and Asia from the period before the introduction of the EURO. The introduction of the EURO made such investigation impossible. As such the paper presents a historical perspective on an important foreign exchange issue.

2. Data

The data consists of spot and forward exchanges rates against the US dollar, for five countries with high volume forward trading: Britain (GBP), Canada (CND), France (FFR), Germany (DEM), Japan (JY). All rates, spot and forward, are collected from the Wall Street Journal at the end of each month[3]. The period under consideration is October 1985 - December 1994. This period was selected for two reasons: it was following immediately after Fama's (1984) influential paper on the topic and thus one can verify if that paper had any effect on the elimination of the puzzle and 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. To eliminate any further bias introduced by the announcement of the EURO introduction the data covers a period that ends an year before the EURO announcement.

A set of variables, documented on theoretical or empirical grounds to be connected with the forward rate is used to construct a system suitable for analysis. These variables defined later in the paper 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.

Various sources in the theoretical literature, see for example Solnik(1974) and Adler and Dumas(1983), 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: a 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-a proxy for interest rate differential cum risk premium.

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

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, at expiration borrowing in the "home" currency, converting at the spot rate in the "foreign currency" and then closing the forward position at a profit in the "home" currency. The opportunity cost of the home currency is ignored as the "borrowing" period is small. 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 exchange in FFR at the spot rate and close at a profit forward position. 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 a country stock market index, SMFC were created by taking the natural logarithm of each value.

Previous research showed quite convincingly that the spot and the forward rate as well as the risk premium is non-stationary. Corbae et all. (1992) exploited the properties of I(1) by constructing systems with the forward rate of all countries investigated in an attempt to see if the future spot rate can be predicted.

Unlike them this research constructs 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 only variables that are not particular to a country are the economic time series related to the U.S.

As the in the previous research all are found to be non-stationary using the standard ADF and PP tests. The five systems are each analyzed using the well known Johansen methodology for cointegration of multiple series. The methodology would indicate is the series are cointegrated or not. 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 but 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 99 points to construct the models and a hold out sample to assess the predictive ability of each model.

4. Results

The results of the cointegration tests are presented in Table 1. An inspection of the results shows that all countries exhibit at least one cointegrating vector. According to the critical values for the maximum eigenvalue and the trace tests, UK can have between one and three cointegrating vectors, Canada and Germany between one and two, France one and Japan three cointegrating 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 cointegrating 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 cointegrating 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 cointegrating vector for each system. The Johansen procedure treats all the variables as endogenous, therefore the relation is unique.

Table 2: The long term cointegrating 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 cointegrating relationship show that RETURN and therefore, implicitly the future spot rate is related to the series selected in a meaningful long term equilibrium. 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, for this to happen the currency sold at a premium forward would need to appreciate. This confirms the initial result of Fama (1994) where the forward rate not only was a biased but was biased in the wrong direction.

RETURN is also positively related to the industrial production of UK and 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 it is to be noted that the relationship between RETURN and FORPREM is the same. This indicates that the forward premium puzzle can be confirmed for all the countries under investigation.

The next goal of this research is to examine if the RETURN can be predicted in the short term. 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 was found the most satisfying. 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 immediately: 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.

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 cointegration 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. This result can be interpreted in two ways. On the one hand, the profit is in a long-term equilibrium relationship with the exchange rate determinates. Short-term deviations from this relationship are corrected in the next period towards the equilibrium and this results in 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 all the available information in a timely manner. Available information about inflation, industrial production, stock market, and froward premium does not enter into price formation resulting in irrational expectations.

5. Conclusion

This study concludes that the question of foreign exchange premium puzzle remained a puzzle after Fama's 1984 paper was published for the currencies of six of the G-7 countires. The conclusion is drawn by investigating the long term cointegration relationship among the return from forward speculation and a number of relavant variable as well by investigating the ability to predict such return with VAR and VEC models. 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 premia is predictable. Due to the nature of the models it cannot be clarified 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 to the existence of risk premia. While the study does not solve the forward premium puzzle it adds to the literature a number of determinants that might be responsible for the bias and profitable strategies.

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