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Factors Affecting the Exchange Rate Risk Premium

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Abstract

The objective of this work is to identify and examine the risk premium of the exchange rate; then, to determine the factors that cause it, and to measure its variance by using a GARCH-M model. Some theoretical models are developed by taking the exchange rate risk premium as dependent variable and other macro-variables, political events, and market conditions as independent ones. There are three different exchange rates ($/€, $/£, and ¥/$) used, here, for the measurement of the risk premium and the empirical test of the model. The empirical results show that the variances of our macro-variables, the policy variables (interest rates and money supply), the price of oil, the war in Iraq, the European debt crisis, and other factors have a significant effect on the risk premium. Also, the conditional variances of the stock markets risk premium are having a highly significant effect on the exchange rate risk premia. The empirical results show that the foreign exchange market is not very efficient and the monetary policy not very effective.

JEL classification numbers: C13, C22, C53, F31, F41, F42, G14
Keywords: Estimation, Time-Series Models, Forecasting and Other Model Applications, Foreign Exchange Risk: Time-Varying Risk Premium, Open Economy Macroeconomics, International Policy Coordination, Information and Market Efficiency: Event Studies

1 Introduction

The exchange rates do not have a constant mean and exhibit phases of relative tranquility followed by periods of high volatility (no constant variance).[2] We want

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[2] If the variance of a stochastic variable is not constant [$E(\varepsilon_t^2) \neq \sigma^2$], it is called heteroskedastic.

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to see and examine the behavior of these time series, here, and to model the conditional heteroskedasticity (ARCH or GARCH).[3] By graphing the following three exchange rates: €/$, £/$, and ¥/$,[4] we see that these series are not stationary; their means do not appear to be constant and there is a strong heteroskedasticity. They have time-varying means (they are not stationary). These exchange rates show that they go through sustained periods of appreciation and then depreciation with no tendency to revert to a long-run mean. This type of random walk behavior is typical of nonstationary series.[5] Enormous shocks were the central banks' target rates persistence with a violently very low value (closed to zero) for seven or more years. Also, the volatility of many macro-variables was not constant over time. Globalization has made the macro-variables in the four countries and economies (U.S., Euro-zone, U.K., and Japan) to share co-movements. We want to identify and estimate the risk premia of these three exchange rates.

The objective is to model and forecast the volatility (conditional variance) of our variables. We need to analyze the risk of holding a specific currency. This can be done by determining these variables that affect the exchange rate risk premium and forecasting the variance of their errors. Then, more efficient estimates can be obtained if heteroskedasticity in the errors is handled properly. Autoregressive Conditional Heteroskedasticity (ARCH) models are specifically designed to model and forecast conditional variances. The variance of the dependent variable is modeled as a function of past values of the dependent variable [AR (p) process] and independent or exogenous variables.

In other words, we want to forecast the risk premia and their variances over time. The approach can be to explicitly introduce independent variables, based on some economic theory and to predict their volatility. Financial economists try to establish a relationship between exchange rate risk premia and the measure of risk. One popular approach is the consumption-based international

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[3] ARCH = Autoregressive Conditional Heteroskedastic model and GARCH = Gerneralized Autoregressive Conditional Heteroskedasticity. In Statistics, a collection of random variables is **heteroscedastic** [or "heteroskedastic"; from Ancient Greek ἕτερον (*hetero* = "different") and σκέδασις (*skedasis* = "dispersion")] if there are sub-populations that have different variabilities from others. Here "variability" could be quantified by the variance or any other measure of statistical dispersion. Because heteroskedasticity concerns expectations of the second moment of the errors, its presence is referred to as misspecification of the second order.

[4] Graphs, Figures, and many Tables are omitted, here, due to space constraints, but they are available from the author upon request.

[5] The test of stationary (Augmented Dickey-Fuller Unit Root Test) shows: (1) Indirect quotes for the U.S. dollar: S_1(€/$): -1.417 I(1); D($S_1$): -11.349***I(1). S_2(£/$): -2.833*I(0); D($S_2$): -16.323***I(1). S_3(¥/$): -2.647* I(0); D($S_3$): -16.440***I(1). (2) Direct quotes for the U.S. dollar: S_1' ($/€): -1.514 I(1); D($S_1'$): -11.858***I(1). S_2'($/£): -2.736*I(0); D(S_2'): -15.794***I(1). S_3'($/¥): -1.750 I(1); D($S_3'$): -16.696***I(1). [I(0) = series contain zero unit roots (stationary), I(1) = series contains one unit root (integrated order one, nonstationary), D(S) = variable in 1st differences, *significant at the 10% level, **significant at the 5% level, and ***significant at the 1% level].

Asset Pricing Model,[6] which built on the promise that the economic agent chooses an optimal time path of consumption and assets that yield uncertain returns. Some empirical results have shown that movements in the conditional risk premia of returns on the U.S. stock market are similar to those of the conditional risk premia in the forward foreign exchange markets. Attempts have been made to establish an empirical link between the exchange risk premium and these financial variables.

The historical data show that: (1) $\bar{S}_1 = 1.218$ \$/€, $\sigma^2_{S_1} = 0.032231$, the expected $s^e_{t+1} - f_t = rp^e_{t+1} = -0.002449$ and $\sigma^2_{rp^e_{t+1}} = 0.0010763$, the actual $S_t - F_{t-3} = RP_t = -0.006704$, $\sigma^2_{RP_1} = 0.00445089$, and ln of the actual $s_t - f_{t-3} = rp_t = -0.005453$, $\sigma^2_{rp_1} = 0.00245213$. (2) $\bar{S}_2 = 1.760$ \$/£, $\sigma^2_{S_2} = 0.094608$, $rp^e_{t+1} = -0.000104$, $\sigma^2_{rp^e_{t+1}} = 0.000915728$, $RP_t = -0.003693$, $\sigma^2_{RP_1} = 0.0055662$, and $rp_t = -0.002163$, $\sigma^2_{rp_1} = 0.001939698$. (3) $\bar{S}_3 = 163.874$ ¥/\$, $\sigma^2_{S_3} = 5{,}535.6814$, $rp^e_{t+1} = 0.001770$, $\sigma^2_{rp^e_{t+1}} = 0.001189836$, $RP_t = -0.226191$, $\sigma^2_{RP_1} = 32.1817$, and $rp_t = -0.001455$, $\sigma^2_{rp_1} = 0.00256948$.

2 Some Theories of Exchange Rate Risk Premium Determination

Some researchers have related the expected and realized return in the foreign exchange markets to the nominal interest rates (monetary policy target rates and IRP condition) as follows,[7]

$$s_{t+1} - s_t - (i_t - i^*_t) = \gamma_0 + \gamma_1 i_t + \gamma_2 i^*_t + \varepsilon_{t+1} \qquad (1)$$

where, $\gamma_1 < 0$, $\gamma_2 > 0$, $s_t - (i_t - i^*_t) = f_t$ is the covered interest parity condition, and if $s_{t+1} - f_t \neq 0$ this is the exchange rate risk premium (rp_{t+1}), which shows foreign exchange market inefficiency.

The forecasting of the expected spot exchange rate (s^e_{t+1}) can be done by using an ARMA (p, q) process or the following equation:

$$s_t = \xi_0 + \xi_1 s_{t-1} + \xi_2 s_{t-2} + \xi_3 f_{t-1} + \xi_4 f_{t-2} + \xi_5 i_{t-1} + \xi_6 i_{t-2} + \xi_7 i^*_{t-1} + \xi_8 i^*_{t-2} + \varepsilon_t \qquad (1')$$

[6] See, Mehra [16].
[7] See, Kallianiotis [15, 107-114]. Also, see, Giovannini and Jorion [13].

Now, we know the coefficients ($\hat{\xi}_s$) and updating one period the variables of the above eq. (1′), we receive the $E_t s_{t+1}$ conditional on the information available at period t.

Also, by decomposing the nominal interest rate (i_t) into two components, real (r_t) and expected inflation (π_t^e), eq. (1) can be written,

$$s_{t+1} - s_t - (i_t - i_t^*) = \delta_0 + \delta_1 (r_t + \pi_t^e) + \delta_2 (r_t^* + \pi_t^{*e}) + \varepsilon_{t+1} \tag{2}$$

where, $\delta_1 < 0$, $\delta_2 > 0$.

Thus, increases in foreign exchange risk premia, that is, higher values of ($s_{t+1} - f_t = rp_{t+1}$) are reliably associated with decreases in U.S. interest rates and increases in foreign interest rates.[8] Also, this holds for a decrease in the U.S. real rate of interest and the expected inflation or an increase in the foreign real rate and foreign expected inflation. We assume: $r_t = r_t^*$ and we forecast the π_t^e and the π_t^{*e}. Also, assuming that $\pi_t^e \cong \dot{m}_t^e$ and $\pi_t^{*e} \cong \dot{m}_t^{*e}$, monetary policy can affect the foreign exchange market.

In addition, we take the money demand equation and making the money demand equal to the money supply at their equilibrium point, we have the following general function in natural logarithm term:

$$m_t = f(y_t, p_t, i_t) \tag{3}$$

where, m_t = ln of money supply, y_t = ln of income, p_t = ln of the price level (CPI), and i_t = the short term interest rate.

Solving eq. (3) for i_t, we receive:

$$i_t = f(m_t, y_t, p_t) \tag{4}$$

And for the foreign country, we will have a similar relationship:

$$i_t^* = f(m_t^*, y_t^*, p_t^*) \tag{5}$$

where, an asterisk (*) denotes the foreign variables.

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[8] This holds for the UKS and the UKF: $i_t^* \Rightarrow (+) \Rightarrow s_{UK}$ and $i_t^* \Rightarrow (+) \Rightarrow f_{UK}$.

Substituting i_t and i_t^* from the above equations to eq. (1), we receive the following relationship for the risk premium:

$$s_{t+1} - s_t - (i_t - i_t^*) = \zeta_0 + \zeta_1 m_t + \zeta_2 y_t + \zeta_3 p_t + \zeta_4 m_t^* + \zeta_5 y_t^* + \zeta_6 p_t^* + \varepsilon_{t+1} \qquad (6)$$

where, $\zeta_1 > 0$, $\zeta_2 < 0$, $\zeta_3 < 0$, $\zeta_4 < 0$, $\zeta_5 > 0$, $\zeta_6 > 0$, $s_t - (i_t - i_t^*) = f_t$ is the covered interest parity condition, and $s_{t+1} - f_t = rp_{t+1}$ is the risk premium.

Further, Kallianiotis [15] is using another formula of exchange rate determination, which can be used, here, to determine the spot rate as a function of the variables,

$$s_t = f(p_{oil_t}, nd_t, td_t, p_{Gold_t}, WD, EDCD) \qquad (7)$$

where, p_{Oil_t} = ln of the price of oil, nd_t = ln of national debt, td_t = ln of trade deficit, p_{Gold_t} = ln of price of gold, WD = the Iraqi war dummy (taking values of zero before 2003:03 and one after that date), and $EDCD$ = European debt crisis dummy (taking zero before 2009:10 and one after).

By applying eq. (7) into eq. (1), for the i_t (for the U.S. i_t) plus i_t^* (for the foreign interest rate), we can write the risk premium of exchange rate as follows:

$$s_{t+1} - s_t - (i_t - i_t^*) = \theta_0 + \theta_1 p_{oil_t} + \theta_2\, nd_t + \theta_3\, td_t + \theta_4\, p_{Gold_t} + \theta_5\, WD + \theta_6\, EDCD + \theta_7 i_t^* + \varepsilon_t \qquad (8)$$

Also, Chiang [5] has developed a model to link the risk premia in foreign exchange markets to the equity risk premia in the stock markets. Returns in the foreign exchange market and the stock market move together over time. The equation can be the following:

$$s_{t+1} - s_t - (i_t - i_t^*) = \delta_0 + \delta_1 (R^e_{m,t+1} - i_t) + \delta_2 (R^{*e}_{m^*,t+1} - i_t^*) + \varepsilon_{t+1} \qquad (9)$$

where, i_t = the three-month T-Bill rate, $\delta_1 > 0$, $\delta_2 < 0$, $R^e_{m,t+1} - i_t$ = the expected equity risk premium in the domestic market, and $R^{*e}_{m^*,t+1} - i_t^*$ = the expected equity risk premium in the foreign market.

Empirical evidence supports the hypothesis that the exchange risk premia are empirically associated with the relative expected equity risks in stock markets.

3 Multivariate GARCH-in-Mean Model

In conventional econometric models, the variance of the disturbance term is assumed to be constant. Thus, a stochastic variable with a constant variance [$E(\varepsilon_t^2) = \sigma^2$] is called homoskedastic; but, if the variance is not constant [$E(\varepsilon_t^2) \neq \sigma^2$], it is called heteroskedastic. The exchange rate series show no particular tendency to increase or decrease. The U.S. dollar seems to go through sustained periods of appreciation and then depreciation, especially with respect the yen and the euro, with no tendency to revert to a long-run mean. This type of random walk behavior is typical of nonstationary series, I(1) for $/€ and $/¥ (they seem to meander). When the volatility of a series is not constant over time, we call it conditionally heteroskedastic.

We can model the distribution of the excess return (or money) in the foreign exchange market jointly with the other macroeconomic factors. Since the conditional mean of the excess return depends on time-varying second moments of the join distribution, we require an econometric specification that allows for a time-varying variance-covariance matrix. A choice can be the multivariate GARCH-in-Mean (GARCH-M) model.[9]

We begin with the simplest GARCH (1, 1) specification:

$$rp_t = X_t^{'} \theta + \varepsilon_t \tag{10}$$

$$\sigma_t^2 = \omega + \alpha\, \varepsilon_{t-1}^2 + \beta\, \sigma_{t-1}^2 \tag{11}$$

Where, the mean equation (10) is written as a function of exogenous macro-variables (X'_t) from both countries [i. e., eqs. (1) or (2) or (6) or (8) or (9)] with an error term ε_t. Since σ_t^2 is the one-period ahead forecast variance based on current information, it is the conditional variance. This conditional variance specified in eq. (11) is a function of three terms: The constant term ω; news about volatility from the previous period, measured as the squared residual from the mean equation ε_t^2 (the ARCH term); and the current period's forecast variance σ_t^2 (the GARCH term).

This specification can be interpreted as follows. A trader in foreign currency predicts this period's variance by forming a weighted average of a long term average (the constant ω), the forecasted variance from the current period (the GARCH term σ_t^2), and information about the volatility observed in the current period (the ARCH term ε_t^2). If the exchange rate volatility (rp_t) was

[9] See, Engle, Lilien, and Robins [11]. Also, Smith, Soresen, and Wickens [18].

unexpectedly large in either the upward or the downward direction; then, the trader will increase the estimate of the variance for the next period.[10]

A higher order GARCH model, GARCH (q, p), can be estimated by choosing either q or p greater than 1, where q is the order of the autoregressive GARCH terms and p is the order of the moving average ARCH terms. The GARCH (q, p) variance is:

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 \tag{12}$$

The X'_t in eq. (10) represent exogenous or pre-determined macro-variables from both countries included in the mean equation. By introducing the conditional variance into the mean equation, we get the GARCH-in Mean (GARCH-M),[11] as follows:

$$rp_t = X_t^{'}\theta + \lambda \sigma_t^2 + \varepsilon_t \tag{13}$$

Equation (12) can be extended to allow for the inclusion of exogenous or pre-determined regressors, Z'_t, in the variance equation, as follows:

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + Z_t^{'}\phi \tag{14}$$

The forecasted variance can be positive or negative. The best for us can be to introduce regressors in a form where they are always positive to minimize the possibility that a single large negative value generates a negative forecasted value.

4 Data and Estimation of the Model

The data are monthly and are coming from *Economagic.com*, *Eurostat*, and *Bloomberg*. For the euro (€) the data are from 1999:01 to 2015:12 and for the other two currencies pound (£) and yen (¥) from 1971:01 to 2015:12. Other data are the 3-month T-bill rates, the money supply (M2), the real income, the consumer price index, the price of oil, the national debt, the current account, the price of gold, the stock market indexes, and two dummies: (1) WD = the war

[10] This model specification is also consistent with the volatility clustering often seen in financial return data, where large changes in returns are likely to be followed by further large changes.

[11] The GARCH-M model is often used in financial applications where the expected return on an asset is related to the expected asset risk. The estimated coefficient on the expected risk is a measure of the risk-return tradeoff.

dummy in Iraq (with 0 before 2003:03 and 1 after 2003:04) and (2) EDCD = the European debt crisis dummy (with 0 before 2009:09 and 1 after 2009:10).

The estimation accompanies the four (4) following steps:

1st : We forecast the s_{t+1}^{e} in eq. (1) as follows:

$$s_t = \alpha_0 + \alpha_1 s_{t-1} + \alpha_2 s_{t-2} + \alpha_3 f_{t-1} + \alpha_4 f_{t-2} + \alpha_5 i_{t-1} + \alpha_6 i_{t-2} + \alpha_7 i_{t-1}^{*} + \alpha_8 i_{t-2}^{*} + \varepsilon_t \tag{1''}$$

and we receive the $s_{t+1}^{e} = SF$ (spot forecasting) from the computer forecasting it for next period (by forwarding for one period). We can use an ARMA (p, q) process or eq. (7), too.

2nd : We run eqs. (1), (2), (6), (8), and (9) and determine the error terms (ε_t) of these five different risk premium specifications.

3rd : We determine (estimate) the GARCH (p, q) equation of the above five risk premia models [eq. (11)].

4th : We incorporate the GARCH results into eqs. (1), (2), (6), (8), and (9) to see the effects of the variance of the different variables on the exchange rate risk premium (rp_t) or we can run the mean equation (upper part) and the lower part the variance equation, eq. (13), simultaneously.

The empirical results show that the sum of the ARCH and GARCH coefficients ($\alpha + \beta$) is very close to one (1), indicating that volatility shocks are quite persistent. These results are often observed in high frequency financial data.

We start forecasting the s_{t+1}^{e} by using eq. (1′), which gives some very good statistics and very small RMSEs. Table 1 presents the GARCH estimation of eq. (1), the rp_{t+1}^{e} by using eq. (13), the conditional variance of the risk premium (rp). We see that the residual (ARCH) is not highly significant, but the variance (GARCH) is highly significant at 1% level.

Then, we forecast the ln of price level (p_t^e), the expected inflation (π_t^e), and the ln of money supply (m_t^e). Tables 2, 3, and 4 show the estimation of eq. (13) for the above three groups of variables (p_t^e, π_t^e, and m_t^e) by using the GARCH-M model. The GARCH-M model shows significant effects of ARCH and GARCH on the variance of the rp_{t+1}^{e}.

Further, the estimation of eq. (6) takes place and Table 5 gives the estimation of eq. (13) by using eq. (6) to determine the rp as a function of GARCH-M, which is significant only for the dollar/pound exchange rate rp_{t+1}^{e}. Table 6 estimates eq. (7) and Table 6′ estimates the risk premium of the same eq. (7) with the use of GARCH-M. The war dummy (WD) and the European debt crisis dummy (EDCD) have the correct expected signs (+ and -) and have significant effects on spot rate ($/€) and on the rp_t; but the GARCH-M specification is not very effective. Lastly, Table 7 gives the estimation of eq. (13) by using eq. (9), the stock market risk premium. It shows significant effects (at 1% level) of the market risk premium and CARCH-M on the exchange rate risk premia, except the Euro Stoxx 600 Companies Index.

Here, the forecasted variances are all positive, except the \$/£ in eq. (1), \$/€ in eq. (9) and \$/£ in eq. (9), which is good for us because we will have a positive forecasted value.

Figures 1′and 1′′ show the static and dynamic forecasting of the rp_{t+1}^{e} (\$/€), where the variance is not constant and it is growing overtime. Also, the static and dynamic forecasting of the rp_{t+1}^{e} (\$/£), show that the variance is not constant, but it is declining overtime. Further, the static and dynamic forecasting of the rp_{t+1}^{e} (¥/\$) give that the variance is not constant and it is increasing with the passing of time.

Furthermore, the static and dynamic rp_{t+1}^{e} (\$/€) with respect the stock market risk premium (DJIA and Euro Stoxx 50 Index) display that the variance is not constant and is growing over time. The static and dynamic rp_{t+1}^{e} (\$/€) with the stock market risk premium (DJIA and Stoxx Europe 600 Index) present that the variance is falling at the beginning and stays constant after 2005.

Finally, the static and dynamic rp_{t+1}^{e} (\$/£) with respect the stock market risk premia (DJIA and FTSE 100 Index) reveal that the variance is not constant and it is declining over time. The static and dynamic forecasting of the rp_{t+1}^{e} (¥/\$) with their effects from the stock market risk premia (DJIA and Nikkei Stock Avg Index) show that the variance is not constant and is increasing overtime.

5 Conclusion

The aim of this research was to determine the factors that affect the exchange rate risk premium. From the historical data for three different exchange rates (\$/€, \$/£, and ¥/\$), we see that there are historic risk premia, which are mentioned in section I above. By graphing these three exchange rates, we observe that they do not have a constant mean and exhibit phases of relative tranquility and also of high volatility, which means that they have no constant variance. For this reason, we model the conditional heteroskedasticity (GARCH) of their risk premia. Some series share co-movements with other series even in other countries. The underlying economic forces that affect the U.S. economy affect also the economies of other countries, due to globalization (high correlation between U.S. and foreign economies; i.e., $\rho_{U.S.,EU} \cong +1$). The analysis show that pure monetary policies are not effective and cannot improve efficiency, growth, stability, confidence, and certainty in our complex interdependent economies.

The theoretical models are using as independent variables, policy variables (i_t and M_t^s), inflation, income (production), price of oil, national debt, trade deficit, stock market premium, and other events (war in Iraq and European debt crisis) to determine their effects on the exchange rate risk premium (rp_t). The multivariate GARCH-in-Mean models determine the volatility of the exchange rate and then, the foreign currency trader can increase the estimate of the variance for next period, if the volatility is unexpectedly large.

Lastly, the empirical results show a very good forecasting of the exchange rates based on our model and reveal also a significant effect of the squared residuals (ARCH) and the variance (GARCH term) on the exchange rate risk premia. The war in Iraq[12] has depreciated the U.S. dollar ($) and the European debt crisis has depreciated the euro (€) and appreciated the dollar ($). Lately, the possibility of the exit of U.K. from the EU hs affected negatively the value of the British pound and the stock markets, too.[13] The static and dynamic forecasting of the rp_{t+1}^e show that their variances are not constant and are increasing overtime, except the ($/£) exchange rate, which is falling. The stock market volatility has a high significant effect on the risk premia for the three exchange rates, which can be seen also graphically with the forecasting of its variance. The variances are not constant, too and mostly are increasing overtime, except for the ($/£) exchange rate and the stock market risk premia (DJIA and FTSE 100 Index). Foreign exchange markets are not very efficient. The next step of this research must be the use of some different diagnostic and model specification tests to improve our confidence regarding the theoretical models.

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[12] This was the beginning of the Middle East crisis (March 2003), which was spread from Iraq to Afghanistan to Syria and all over the area and in North Africa (Libya) and now, to Europe (mostly in Greece) with these millions of illegal immigrants. This suspicious crisis that was generated by the West has increased the global risk (systemic) and has a significant economic and social effect on the western economies.

[13] Labour Party lawmaker, Jo Cox, was murdered on June 15, 2016, who was in favor of "YES" in the EU referendum. See, http://www.express.co.uk/finance/city/658338/Brexit-EU-Exit-How-Affect-Pound-UK-Economy. Also, http://www.bloomberg.com/news/articles/2016-06-17/u-k-parliament-to-pay-tribute-to-murdered-cox-before-eu-vote

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Table 1: Estimation of Eq. (13) with the use of Eqs. (1) and (1′)
Risk Premium Determination ($s^e_{t+1} - f_t = rp^e_{t+1}$)

Variables	$LEUSF - LEUF$	$LUKSF - LUKF$	$LJSF - LJF$
C	0.001	-0.001	0.001
	(0.004)	(0.002)	(0.003)
$STT3M_t$	-0.003	0.001	-0.001
	(0.005)	(0.001)	(0.001)
$STT3M^*_t$	0.001	-0.001	0.001
	(0.004)	(0.001)	(0.004)
		Variance Equation	
C	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
ε^2_{t-1}	0.147	0.062***	0.031
	(0.091)	(0.022)	(0.022)
σ^2_{t-1}	0.664***	0.827***	0.921***
	(0.234)	(0.085)	(0.067)
R^2	0.012	-0.001	0.001
SSR	0.110	0.201	0.236
$D-W$	2.124	1.923	2.024
N	128	310	256
$RMSE$	0.029249	0.025416	0.030351

Note: $LEUS$ = ln of \$/€ spot rate, $LUKS$ = ln of \$/£ spot rate, LJS = ln of \$/¥ spot rate, LS_t = ln of spot exchange rate, $STT3M_t$ = short term Treasury-Bill 3-month, $STT3M^*_t$ = short term foreign Treasury-Bill 3-month, *** significant at the 1% level, ** significant at the 5% level, and * significant at the 10% level. $LEUSF - LEUF$ = risk premium ($s^e_{t+1} - f_t = rp^e_{t+1}$).

Source: *Economagic.com*, *Bloomberg*, and *Eurostat.*

Table 2: Estimation of Eq. (13) with the use of eq. (2)
Risk Premium Determination ($s^e_{t+1} - f_t = rp^e_{t+1}$) with GARCH-M

Variables	$LEUSF - LEUF$	$LUKSF - LUKF$	$LJSF - LJF$
C	-0.315	0.027	0.153
	(0.276)	(0.038)	(0.718)
p^e_t	0.470***	-0.073*	-0.003
	(0.182)	(0.041)	(0.013
p^{*e}_t	-0.473**	0.079*	-0.030
	(0.220)	(0.047)	(0.149
		Variance Equation	
C	0.001	0.001*	0.001
	(0.001)	(0.001)	(0.001)
ε^2_{t-1}	0.128	0.072***	0.036
	(0.082)	(0.025)	(0.025)
σ^2_{t-1}	0.638**	0.804***	0.915***
	(0.283)	(0.084)	(0.066)
R^2	0.060	0.004	-0.001
SSR	0.104	0.201	0.236
$D-W$	2.247	1.920	2.026
N	129	311	257
$RMSE$	0.028446	0.025410	0.030320

Note: See, Tables 1 and 4.
Source: See, Table 1.

Table 3: Estimation of Eq. (13) with the use of Eq. (2)
Risk Premium Determination ($s^e_{t+1} - f_t = rp^e_{t+1}$) with GARCH-M

Variables	$LEUSF - LEUF$	$LUKSF - LUKF$	$LJSF - LJF$
C	0.005	0.001	-0.001
	(0.007)	(0.003)	(0.002)
π^e_t	-0.001	-0.001	0.001
	(0.001)	(0.001)	(0.001)
π^{*e}_t	-0.003	-0.001	0.001
	(0.003)	(0.001)	(0.001)
	Variance Equation		
C	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
ε^2_{t-1}	0.150	0.064***	0.037
	(0.098)	(0.023)	(0.027)
σ^2_{t-1}	0.613**	0.816***	0.904***
	(0.256)	(0.087)	(0.082)
R^2	-0.001	0.001	0.003
SSR	0.111	0.026	0.235
$D-W$	2.123	1.916	2.018
N	129	311	256
$RMSE$	0.032650	0.030216	0.034131

Note: See, Tables 1 and 4.
Source: See, Table 1.

Table 4: Estimation of Eq. (13) with the use of Eq. (2)
Risk Premium Determination ($s^e_{t+1} - f_t = rp_t$) with GARCH-M

Variables	$LEUSF - LEUF$	$LUKSF - LUKF$	$LJSF - LJF$
C	-0.183	0.509	0.776
	(0.220)	(0.312)	(1.419)
m_t	0.025	0.030	0.028
	(0.050)	(0.023)	(0.056)
m_t^*	-0.005	-0.028	-0.076
	(0.067)	(0.019)	(0.142)
	Variance Equation		
C	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
ε^2_{t-1}	0.140*	0.070***	0.038
	(0.084)	(0.024)	(0.029)
σ^2_{t-1}	0.638**	0.821***	0.907***
	(0.260)	(0.080)	(0.074)
R^2	0.015	-0.001	0.001
SSR	0.109	0.201	0.236
$D-W$	2.132	1.921	2.025
N	128	310	256
$RMSE$	0.029198	0.025435	0.030351

Note: See, Tables 1 and 4.
Source: See, Table 1.

Table 5: Estimation of Eq. (13) with the use of eq. (6)
Risk Premium Determination ($s^e_{t+1} - f_t = rp_t$)

Variables	$LEUSF - LEUF$	$LUKSF - LUKF$	$LJSF - LJF$
C	34.327***	4.587***	3.485
	(5.102)	(1.196)	(2.213)
m_t	-1.083	0.036	-0.113
	(1.105)	(0.027)	(0.142)
y_t	-3.652***	0.154	0.140
	(0.511)	(0.137)	(0.103)
p_t	0.403	0.763***	0.192
	(0.495)	(0.201)	(0.186)
m^*_t	1.302***	-0.157***	-0.088
	(0.409)	(0.059)	(0.237)
y^*_t	0.632	-0.374**	-0.338**
	(0.640)	(0.178)	(0.144)
p^*_t	-1.758	-0.287***	0.169
	(1.431)	(0.100)	(0.208)
	Variance Equation		
C	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
ε^2_{t-1}	-0.246	0.071**	0.033
	(0.581)	(0.032)	(0.046)
σ^2_{t-1}	0.785	0.833***	0.730*
	(1.313)	(0.094)	(0.414)
R^2	0.409	0.054	0.032
SSR	0.006	0.182	0.224
$D-W$	1.949	1.978	2.072
N	20	298	244
$RMSE$	0.016740	0.024738	0.030308

Note: See, Tables 1, 4, and 2′′′. m_t = ln of money supply, y_t = ln of income, p_t = ln of prices (CPI), and (*) denotes the foreign variable.
Source: See, Table 1.

Table 6: Estimation of Eq. (7); Spot Exchange Rate

Variables	*LEUS*	*LUKS*	*LJS*
C	-1.322**	1.247**	7.195***
	(0.603)	(0.488)	(0.637)
p_{oil_t}	0.111***	0.068***	0.027
	(0.021)	(0.017)	(0.017)
nd_t	0.081	-0.167**	-0.289***
	(0.087)	(0.074)	(0.085)
ca_t	0.093	-0.196*	-0.339**
	(0.147)	(0.109)	(0.138)
p_{gold_t}	0.050	0.068*	-0.018
	(0.044)	(0.040)	(0.036)
WD	0.088***	0.063***	0.018
	(0.017)	(0.012)	(0.035)
$EDCD$	-0.054***	-0.058***	-0.045***
	(0.017)	(0.016)	(0.017)
ε_{t-1}	1.153***	1.199***	1.142***
	(0.074)	(0.086)	(0.076)
ε_{t-2}	0.910***	1.093***	1.061***
	(0.105)	(0.122)	(0.113)
ε_{t-3}	0.486***	0.754***	0.775***
	(0.080)	(0.116)	(0.106)
ε_{t-4}	-	0.467***	0.431***
		(0.073)	(0.078)
R^2	0.965	0.944	0.970
SSR	0.156	0.099	0.093
$D-W$	1.676	1.798	1.790
N	160	160	160
$RMSE$	0.034793	0.025977	0.024160

Note: See, Tables 1 and 3; p_{oil_t} = ln of price of oil, nd_t = ln of national debt, ca_t = ln of current account, p_{gold_t} = ln of price of gold, WD = (Iraqi) war dummy, and $EDCD$ = EU debt crisis dummy,
Source: See, Table 1.

Table 6′: Estimation of Eq. (13) with the use of Eq. (7)
Risk Premium Determination ($s^e_{t+1} - f_t = rp_t$)

Variables	$LEUSF - LEUF$	$LUKSF - LUKF$	$LJSF - LJF$
C	-1.736***	-0.976***	-0.079
	(0.497)	(0.001)	(0.239)
p_{oil_t}	0.046***	-0.001	0.018
	(0.016)	(0.014)	(0.012)
nd_t	0.242***	0.155***	0.035
	(0.063)	(0.015)	(0.038)
ca_t	-0.149*	0.017	0.084
	(0.086)	(0.055)	(0.066)
p_{gold_t}	-0.109***	-0.063**	-0.046*
	(0.033)	(0.025)	(0.028)
WD	-	-0.029***	0.006
		(0.010)	(0.013)
$EDCD$	0.004	-0.016*	0.004
	(0.011)	(0.009)	(0.010)
ε_{t-1}	-	-	0.149**
			(0.066)
ε_{t-2}	-	-	-
ε_{t-3}	-	0.260***	0.186**
		(0.077)	(0.076)
ε_{t-4}	-	-	0.152**
			(0.063)
		Variance Equation	
C	0.001	0.001***	0.001
	(0.001)	(0.001)	(0.001)
ε^2_{t-1}	0.685*	-0.099	-0.041
	(0.397)	(0.085)	(0.101)
ε^2_{t-2}	-	-	-0.164**
			(0.071)
σ^2_{t-1}	0.281	0.350**	-0.478
	(0.255)	(0.186)	(0.491)
σ^2_{t-2}	-	-	0.504

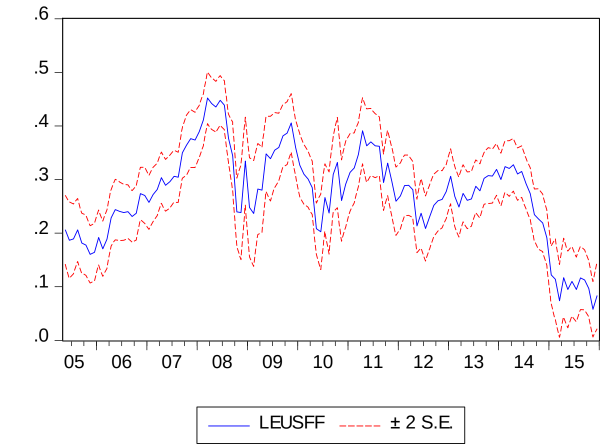
			(0.496)
R^2	0.063	0.160	0.098
SSR	0.074	0.127	0.143
$D-W$	2.118	1.713	1.915
N	86	160	160
$RMSE$	0.029310	0.028135	0.029913

Note: See, Tables 1 and 3; p_{oil_t} = ln of price of oil, nd_t = ln of national debt, ca_t = ln of current account, p_{gold_t} = ln of price of gold, WD = (Iraqi) war dummy, and $EDCD$ = EU debt crisis dummy,
Source: See, Table 1.

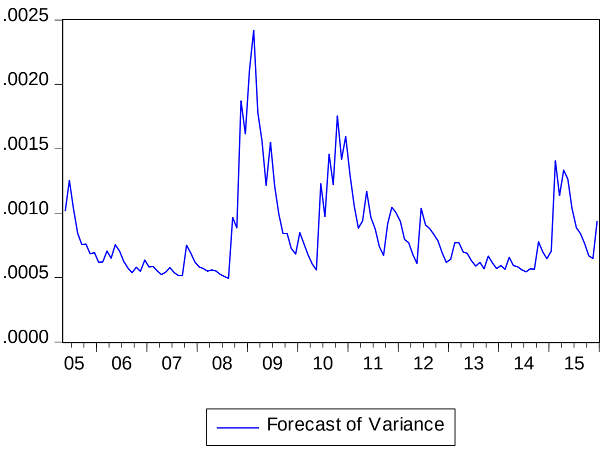
Table 7: Estimation of Eq. (13) with the use of Eq. (9)
Risk Premium Determination ($s_{t+1}^{e} - f_t = rp_t$) with GARCH-M

Variables	$LEUSF - LEUF$	$LEUSF - LEUF$	$LUKSF - LUKF$	$LJSF - LJF$
C	-0.004***	-0.004	0.001	0.002
	(0.001)	(0.003)	(0.001)	(0.002)
$R_{m,t}^{e}$	-0.001***1	0.001**	-0.001***	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
$R_{m,t}^{*e}$	0.001[2]	-0.001***3	0.001***4	-0.001***5
	(0.001)	(0.001)	(0.001)	(0.001)
		Variance Equation		
C	-0.001	0.001*	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
ε_{t-1}^{2}	-0.129*	0.347	0.056*	-0.052*
	(0.069)	(0.225)	(0.029)	(0.031)
σ_{t-1}^{2}	1.145***	-0.408	0.900***	1.056***
	(0.104)	(0.461)	(0.045)	(0.040)
R^2	0.007	0.185	0.082	0.041
SSR	0.078	0.064	0.260	0.152
$D-W$	2.048	1.849	1.667	1.559
N	86	86	312	160
$RMSE$	0.030171	0.027338	0.028862	0.030841

Note: See, Tables 1 and 4. [1] DJIA (U.S. Dow Jones Industrial Average of 30 Stocks Index), [2] SX5E_INDEX (Euro-zone Stoxx 50 Stock Index), [3] STOXX Europe 600 (Europe Stoxx 600 Companies Index), [4] FTSE 100 Index (U.K. Financial Times Stock Exchange 100 Companies Index), and [5] Nikkei Stock Avg Index (Japan; Nikkei 225 Stock Market Index for the Tokyo Stock Exchange). Source: See, Table 1.

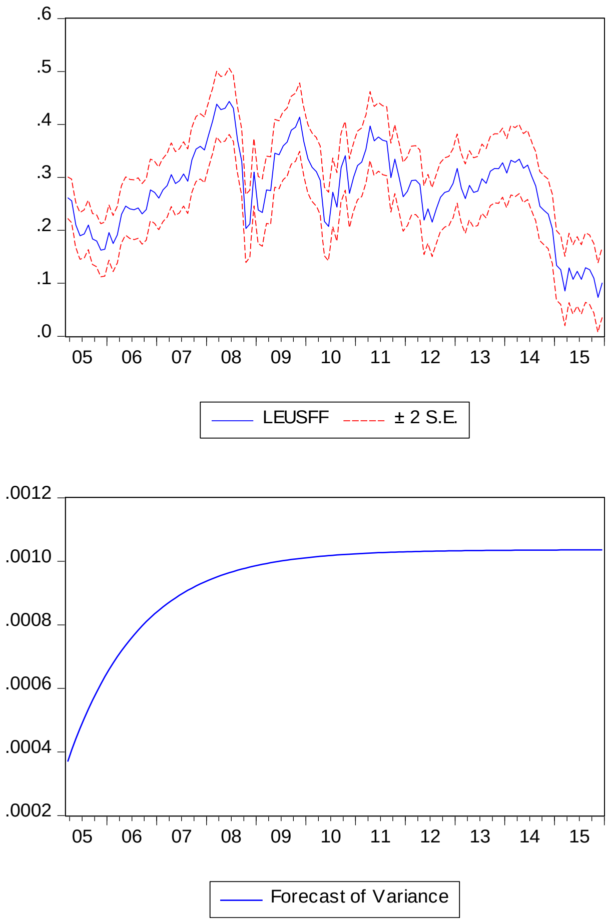


Forecast: LEUSFF	
Actual: LEUSF	
Forecast sample: 1950M01 2016M12	
Adjusted sample: 2005M05 2015M12	
Included observations: 128	
Root Mean Squared Error	0.029249
Mean Absolute Error	0.022365
Mean Abs. Percent Error	9.522784
Theil Inequality Coefficient	0.051303
Bias Proportion	0.000403
Variance Proportion	0.016721
Covariance Proportion	0.982876



Note: See, tables 1 and 1΄. LEUSFF=LEUSF-LEUF= $rp_{t+1}^{e} = s_{t+1}^{e} - f_t$ (\$/€).
Source: See, table 1.

Figure 1΄: Static Forecasting of the rp_{t+1}^{e} (\$/€): Eqs (1΄), (1), and (13)



Forecast: LEUSFF	
Actual: LEUSF	
Forecast sample: 1950M01 2016M12	
Adjusted sample: 2005M03 2015M12	
Included observations: 86	
Root Mean Squared Error	0.029697
Mean Absolute Error	0.023291
Mean Abs. Percent Error	8.269322
Theil Inequality Coefficient	0.048814
Bias Proportion	0.001157
Variance Proportion	0.042800
Covariance Proportion	0.956042

Note: See, Tables 1 and 1′ and Figure 1′.
Source: See, table 1.

Figure 1′′: Dynamic Forecast of the rp_{t+1}^{e} (\$/€): Eq. (1) and (13) (LEUSF-LEUF)