Exchange Rate Movement: Efficiency in the Foreign Exchange Market

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Abstract
The objective of this paper is to test the efficiency in the foreign exchange market by using three exchange rates ($/€, $/£, and ¥/$). Different theoretical models are applied, like the random walk hypothesis, the unbiased forward rate hypothesis, the composite efficiency hypothesis, and the exchange rate expectations based on anticipated and unanticipated events ("News"). The empirical results for these three major exchange rates (four currencies) show that relative efficiency exists. The most efficient market is the dollar/euro one; the other two markets (dollar/pound and yen/dollar) are not efficient. Also, statistical tests of economic fundamentals and expected change in the exchange rate are used to capture the future spot rate's volatility and predictability by using the current spot (random walk) for the variables of the four economies. The adequacy of the specification of the different models is performed to determine the exchange rate movement.
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I. Introduction

The international monetary system had to accommodate extraordinary large oil-related shocks, trade deficits, privatizations (sell-offs of SOEs), FDI, capital controls, central banks' interventions, and public and private debts that affected capital flows among nations, and a variety of risks. Surpluses had to be recycled (invested) by buying financial assets from the deficit countries. The latest global financial crisis has increased uncertainty and the deregulation of our financial institutions has increased the gap ("brain spread") between the market and politicians and deteriorated the agency problem between people (the principals) and government-market (the agents). Labor has lost completely its rights and it is exploited undefended by the inhumane capital[1] and globalization that requires wages equalization between developing and developed nations. The global terrorism, which has its root from 17th century (British, French, American, and Russian Revolutions), is completely out of control.[2] The increased interdependence among nations and the realization that economic policies by strong nations exert pressure on other weaker economies have to induce legal responses and cooperation among all nations. But, what international organization can force objectively international justice? None!

An understanding of efficiency, expectations, and risk in the foreign exchange market is important to government[3] and central bank policymakers, international financial managers,

[1] From permanent full-time jobs with healthcare coverage, they became half-time ones without healthcare benefits and now, pert-time with minimum wages without any benefits. And they have the impudence to call this employment and give an official unemployment rate of 4.8% (with January 2017). See, http://data.bls.gov/timeseries/LNS14000000 . But, the unofficial unemployment rate is 23.0% (August 2016). See, http://www.shadowstats.com/alternate_data/unemployment-charts . See also, Noam Chomsky, "The Death of the American University", *Vox Populi*, February 2014, pp. 1-4. https://voxpopulisphere.com/2014/08/10/noam-chomsky-the-death-of-the-american-university/
[2] See, Kallianiotis (2017).
[3] We are talking about democratic governments, here. But, "To suppose that any form of government will secure liberty or happiness without any virtue in the people, is a chimerical idea." [James Madison (1788)]. Today's complexity, corruption, liberalism, and foreign controls have destroyed democracies.

and of course, to investors and students of international finance. The government policymakers need to design macro-policies for achieving the goal of maximization of their social welfare through efficient resource allocation. Central banks have to be public and responsible for the wellbeing of the citizens of their own country. International investors and financial managers need to assess foreign asset returns and risks in order to make optimal portfolio decisions. The foreign exchange market efficiency hypothesis is the proposition that prices (exchange rate movements) fully reflect information available to market participants. There are no opportunities for the hedgers or the speculators to make super-normal profits; thus, both speculative efficiency and arbitraging efficiency exist. Numerous studies have been tested for speculative efficiency and arbitraging efficiency by testing the following two hypotheses respectively: (1) the forward discount is a good predictor of the change in the future spot rate, implying covered interest parity (CIP), uncovered interest parity (UIP), and rational expectations to hold and (2) the forward discount tends to be equal to the interest differential, implying that CIP holds.

Exchange rates are viewed as relative prices of two assets (actually, two central banks' liabilities,[4] their currencies) that are traded in organized markets (the foreign exchange market) and are influenced by many different domestic factors (fundamentals; production is the most important one) and of course, by expectations about the future international events ("news"). Therefore, unanticipated events will influence the exchange rates, too, as it happens with other assets. So far, the flexible exchange rate system has been successful in providing national economies with an added degree of insulation from foreign shocks and it provides policymakers with an added instrument for the conduct of trade policy.[5] Unfortunately, the Euro-zone member-nations (due to their acceptance and imperative ever since euro) have lost this valuable macroeconomic policy tool.[6] This is a criminal act of the controlled European politicians against their own citizens.

II. The Foreign Exchange Market Efficiency

The efficient market hypothesis (EMH) has been developed in the domestic finance by Eugene Fama since early 1970.[7] In finance, the EMH asserts that financial markets are "informationally efficient." In consequence of this, one cannot consistently achieve returns in excess of average market returns on a risk-adjusted basis, given the information available at the time the investment is made. In this efficient market, all new information is quickly understood by market participants and are immediately discounted into market prices. Thus, prices of financial assets and their correlation provide signals for optimal portfolio allocation. Market efficiency is associated with the rationality of market expectations.

Samuelson and Nordhaus (1985) defined an efficient market as one, where all new information is quickly understood by market participants and becomes immediately incorporated into market prices. This efficient markets hypothesis has been extensively developed and applied in the domestic and international finance literature. Its importance is due to the fact that, if the market is efficient, the current price of an asset will fully reflect available information with regard to its valuation. The prices of financial assets thus, provide signals for portfolio allocation. But, is this "available information", from our controlled

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[4] Which are backed by their governments' debt; then:
$liability_G \ x \, liability_{CB} = liability^2 \equiv fiat \ money\,(currency)$.

[5] See, Kallianiotis (2013a).

[6] See, Kallianiotis (2012).

[7] See, Fama (1970).

media and corrupted markets, the full information that human beings must have? Are the economic data correct or adjusted to satisfy political expediency? In practice, we are seeing a lot of manipulation in asset prices and macro data statistics.

To examine market efficiency, we must determine whether market participants could systematically earn an excess profit. If we designate R_{t+1} as series of asset returns next period and R^e_{t+1} as market expectations of these returns and that there are no systematic unexploited profits over time, we can write,

$$E[R_{t+1} - R^e_{t+1} \mid \Pi_t] = 0 \tag{1}$$

where, $R_{t+1} =$ the actual return next period, $R^e_{t+1} =$ the expected return derived from forecasting it one period ahead, $E =$ is the expectations operator conditioned on the information set Π_t ($\Pi =$ πληροφορίαι, very broad and completely full information)[8] available at the end of period t.

In case, that there are systematic forecast errors in R^e_{t+1}, the information would be incorporated into the forecast process. Investors inspect the forecast errors ($R_{t+1} - R^e_{t+1} = \varepsilon_{t+1}$) to see whether there are unexploited patters that may be used to improve their investment strategy. Thus, the systematic information will be exploited and the resulting error becomes

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[8] Unfortunately, this is almost impossible because the public is deliberately misinformed. Of course, there are very few people that they have full information, they know the TRUTH. We live in *the Age of Deception* [Davidson (2015)] and our information is from the controlled media. The controlled and subjective mass media have contributed to these problems, the "big lies." John Swinton, the former Chief of Staff at the *New York Times* was asked to give a toast before the prestigious New York Press Club in 1953. He made this candid confession that there is no independent press. [It's worth noting that Swinton was called "The Dean of His Profession" by other newsmen, who admired him greatly]. He said, "There is no such thing, at this date of the world's history, in America, as an independent press. You know it and I know it. There is not one of you who dares to write your honest opinions, and if you did, you know beforehand that it would never appear in print. I am paid weekly for keeping my honest opinion out of the paper I am connected with. Others of you are paid similar salaries for similar things, and any of you who would be so foolish as to write honest opinions would be out on the streets looking for another job. If I allowed my honest opinions to appear in one issue of my paper, before twenty-four hours my occupation would be gone. The business of the journalists is to destroy the truth, to lie outright, to pervert, to vilify, to fawn at the feet of mammon, and to sell his country and his race for his daily bread. You know it and I know it, and what folly is this toasting an independent press? We are the tools and vassals of rich men [dark powers] behind the scenes. We are the jumping jacks, they pull the strings and we dance. Our talents, our possibilities and our lives are all the property of other men. We are intellectual prostitutes." (John Swinton, as "the former Chief of Staff at the *New York Times,*" before the New York Press Club in 1953). Also, a politician said, "Once a nation parts with the control of its currency and credit, it matters not who makes the nations laws. Usury, once in control, will wreck any nation. Until the control of the issue of currency and credit is restored to government and recognized as its most sacred responsibility, all talk of the sovereignty of parliament and of democracy is idle and futile." [William Lyon Mackenzie King, Canadian Prime Minister (1874-1950)]. See, http://quotes.liberty-tree.ca/quote_blog/William.Lyon.Mackenzie.King.Quote.F607. Furthermore, the other side ("the rulers") said, "We are grateful to the Washington Post, the New York Times, Time Magazine and other great publications whose directors have attended our meetings and respected their promises of discretion for almost 40 years......It would have been impossible for us to develop our plan for the world if we had been subjected to the lights of publicity during those years. But, the world is more sophisticated and prepared to march towards a world government. The super-national sovereignty of an intellectual elite and world bankers is surely preferable to the national auto-determination practiced in past centuries." (This frightful quote is from David Rockefeller).
See, http://www.goodreads.com/author/quotes/9951.David_Rockefeller . Ὁ Θεός νά μᾶς λυπηθῆ καί νά μᾶς ἐλεήσῃ.

"white noise."[9] To satisfy the efficiency condition [eq. (1)], an optimal forecast of asset prices is consistent with rational expectations behavior.

In the foreign exchange markets, the efficient markets hypothesis has been applied to the spot market and to the forward market. Equation (1) can be used to express the spot exchange rate as follows,

$$E\,[s_{t+1} - s^e_{t+1} \,|\, \Pi_t\,] = 0 \tag{2}$$

where, $s_{t+1}=$ the ln (natural logarithm) of the spot exchange rate and $s^e_{t+1}=$ the ln of the expected spot rate based on information available at time t.

The above equation [eq. (2)] states that the expectations errors will be zero on average so that, no excess profits can be exploited in the foreign exchange markets. The difficulty is how to form the optimal forecast value that results in residuals displaying no informational content. We can use $AR(p)$ or $MA(q)$ processes or a multi-variable one based on economic theory (fundamentals) or a transfer function (combination of fundamentals and time series).

II.1 The Random Walk Hypothesis
Let the current value of s_t be equal to last period's value (s_{t-1}) plus a white-noise term (ε_t),

$$s_t = s_{t-1} + \varepsilon_t \tag{3}$$

or

$$s_t - s_{t-1} = \varepsilon_t \tag{4}$$

The random walk model[10] is clearly a special case of the AR(1) process: $s_t = \alpha_0 + \alpha_1\, s_{t-1} + \varepsilon_t$, when $\alpha_0 = 0$ and $\alpha_1 = 1$. In practice, the investor does not need all the information in Π_t that are based on experience, empirical knowledge, market conditions, history, politics, round knowledge, and true wisdom, because they have very high information costs. Then, a rational investor may use a smaller set of information I_t to form exchange rate expectations.[11] Economists have observed that the exchange rate follows a random walk process, which means that the expected exchange rate next period s^e_{t+1} is equal to the current spot rate s_t. Thus,

$$s^e_{t+1} = s_t \tag{5}$$

Now, substituting eq. (5) into eq. (2) and using information I_t, we get,

$$E\,[s_{t+1} - s_t \,|\, I_t\,] = 0 \tag{6}$$

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[9] White noise process is a sequence $\{\varepsilon_t\}$ if each value in the sequence has a mean value of zero, a constant variance, and is serially uncorrelated. If the notation $E\,(R)$ denotes the theoretical mean value of R, the sequence $\{\varepsilon_t\}$ is a white-noise process for each time period t, $E\,(\varepsilon_t) = 0$, $E\,(\varepsilon_t^2) = \sigma^2$, and $E\,(\varepsilon_t, \varepsilon_{t-1}) = 0$.

[10] See, Enders (1995, pp. 166-169).

[11] The information set I_t is a subset of Π_t ($I_t \subset \Pi_t$) because our (for the majority of the people) information is partial, sectoral, local, and secular information (incomplete knowledge and "fake" news) and not broader, complete, complex, historical, and correct global information (true wisdom).

This equation (6) suggests that if the foreign exchange market is efficient, the current exchange rate will reflect all the available information and the unexpected change in the spot rate ($s_{t+1} - s_t$), is essentially caused by the random shock ε_{t+1}, which hits the market between time t and time $t+1$. Market rationality suggests that the investor finds no particular pattern from the history of ε_{t+1}. This random walk (market efficiency) can be tested as follows:

$$s_t = \alpha_0 + \alpha_1 s_{t-1} + \varepsilon_t \tag{7}$$

If $\alpha_0 \cong 0$ and $\alpha_1 \cong 1$, the foreign exchange market is efficient. This random walk hypothesis explains the erratic behavior of exchange rate movements. Exchange rates respond to "news" (surprises), which are unpredictable.[12] Thus, exchange rates move randomly because they respond sensitively to the unexpected events that randomly hit the markets.

II.2 The Unbiased Forward Rate Hypothesis

Another way to measure the expected exchange rate is to use the forward exchange rate (f_t). The forward rate has been viewed as an unbiased predictor of the future spot rate ("The Unbiased Forward Rate Hypothesis"). The validity of this UFRH implies that the investor is risk-neutral, transaction costs are insignificant, and the arrival of important informational events is random. This hypothesis is derived from an efficient arbitrage activity by investors and it is expressed as,

$$s_{t+1}^e = f_t \tag{8}$$

Substituting s_{t+1}^e in eq. (2) with f_t and smaller information set I_t (due to lack of complete information because of its enormous cost), we have,

$$E[s_{t+1} - f_t | I_t] = 0 \tag{9}$$

Equation (9) states that the forecast errors resulting from using forward rates to predict the future spot rates will be zero on average. A nonzero value, $E[s_{t+1} - f_t | I_t] \neq 0$, suggests the rejection of the unbiased forward rate hypothesis, due to high transaction costs associated with arbitrage; a risk premium (rp_t) if investors are no risk-neutral; and a specification error if the model is not well specified. This UFRH (market efficiency) can be tested as follows:

$$s_t = \alpha_0 + \alpha_1 f_{t-1} + \varepsilon_t \tag{10}$$

If $\alpha_0 \cong 0$ and $\alpha_1 \cong 1$, the foreign exchange market is efficient; last period's forward rate predicts the current spot rate. Prices reflect all relevant available information; thus, the residuals in eq. (10) should contain no information and, therefore, should be serially uncorrelated [$E(\varepsilon_t, \varepsilon_{t-1}) = 0$]. Further, under the assumption of risk neutrality, if the forward exchange rate is an unbiased predictor of the future spot exchange rate [$f_t = s_{t+1}$]; then, the constant term should be closed to zero [$\alpha_0 \cong 0$] and the slope coefficient (actually, elasticity) should be closed to unity [$\alpha_1 \cong 1$].

[12] For example, we saw what happened with the British pound (£), when British voted to a referendum on June 23, 2016 to leave the EU. (http://www.bbc.com/news/uk-politics-32810887). The pound depreciated by 9% with respect the U.S. dollar. (http://money.cnn.com/2016/06/24/investing/pound-crash-eu-referendum/).

In addition, if forward exchange rates prevailing at period $t-1$ summarize all relevant information available at that period, these exchange rates should also contain the information that is summarized in data corresponding to period $t-2$ and so on. It follows that including additional lagged values of the forward rates in eq. (10) should not greatly affect the coefficients of determination and the sum of these coefficients must not differ significantly from unity (the inclusion of additional lagged variables does not improve the fit).[13]

$$s_t = \alpha_0 + \alpha_1 f_{t-1} + \alpha_2 f_{t-2} + \varepsilon_t \qquad (11)$$

Hence, if $\alpha_0 \cong 0$ and $\alpha_1 + \alpha_2 \cong 1$ the foreign exchange market is efficient; last periods' forward rates predict the current spot rate.

II.3 The Composite Efficiency Hypothesis

The composite efficiency hypothesis combines the previous two hypotheses (the random walk and the unbiased forward rate hypotheses). It suggests that the expected future spot exchange rate is a weighted average of the current spot rate and the forward rate, as follows,

$$s_{t+1}^e = w\, s_t + (1-w)\, f_t \qquad (12)$$

where, w = the weight of the spot rate

Equation (12) is based on the information contained in the spot and forward rates. We assume rational expectations, here, too. The information contained in the spot rate (s_t) reflects current market conditions and summarizes all historical information that affects exchange rates. The forward rate (f_t) reflects all the information concerning factors that are expected to determine future exchange rates. Therefore, the Composite Efficiency Hypothesis contains two sets of information affecting the future spot exchange rate; first, past historical information and second, rational expectations of the market participants. One problem might still exist: what will be the value of each one of the weights on the spot and forward rates?

The composite efficiency can be tested as follows:

$$s_t = \beta_0 + \beta_1 s_{t-1} + \beta_2 f_{t-1} + \varepsilon_t \qquad (13)$$

Then, if $\beta_0 \cong 0$, $\beta_1 = w$, $\beta_2 = (1-w)$, and $\beta_1 + \beta_2 = w + (1-w) \cong 1$, which means that the foreign exchange market is efficient.

III. Exchange Rates Volatility and Predictability

The exchange rates have been very volatile since the 1970s, when the exchange rates became flexible.[14] As an example, the standard deviation of the spot exchange rate between the U.S. dollar and the euro has been, $\sigma_s = \pm 0.18\%$ per month, as Graph 1 shows; between U.S. dollar and British pound, $\sigma_s = \pm 0.17\%$ (Graph 2); and between Japanese yen and U.S. dollar, $\sigma_s = \pm 14.16\%$ (Graph 3). Thus, the predictability of the exchange rate has become very difficult. These two characteristics of exchange rates (volatility and unpredictability) are

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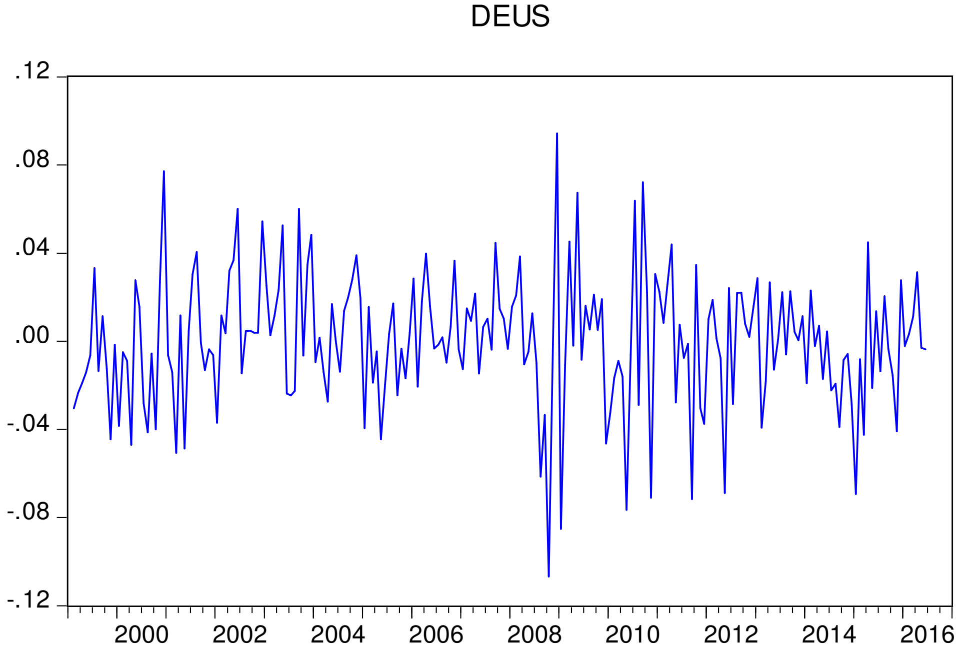
[13] We can test this eq. (11) by using more lagged values than two and to see its efficiency, if $\alpha_1 + \alpha_2 + \alpha_3 + \ldots \cong 1$.

[14] See, Kallianiotis (2016b).

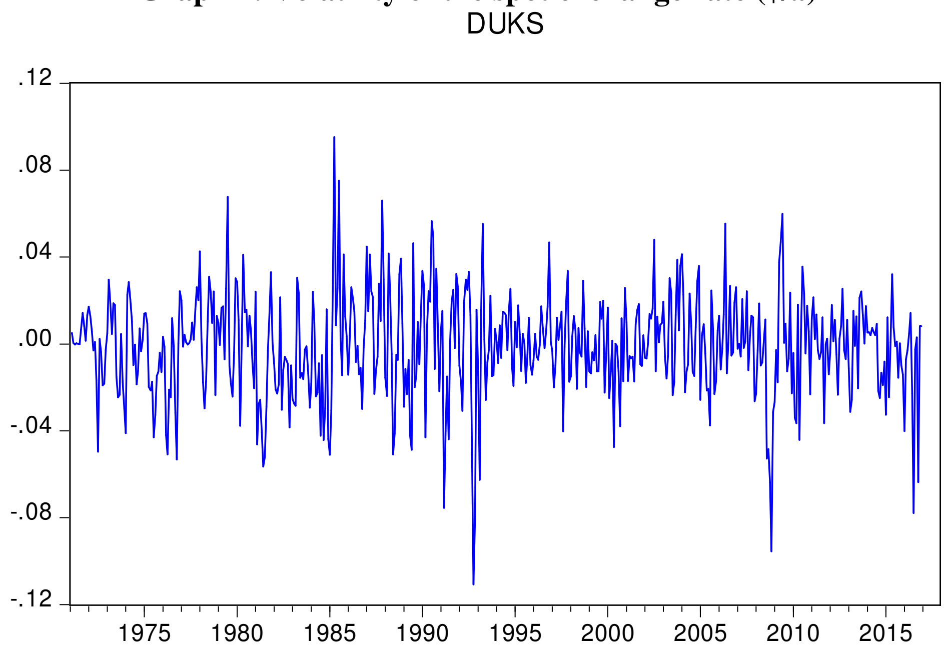
typical of auction asset markets and have worsened after 2008 with the global financial crisis and the new systemic risk that the world economies are facing. In our foreign currency markets, current spot exchange rates reflect expectations concerning the future course of events (market, political, economic, international) and new information (global news are instantaneously known to everyone), which induces changes in expectations and are immediately reflected in corresponding changes in exchange rates (and all asset prices); thus, reducing unexploited profit opportunities from arbitrage. However, speculators, insiders, and market-makers are thriving and proving at the same time that inefficiency exists in all the assets and exchange rates markets.

Graph 1: Volatility of the spot exchange rate ($/€)



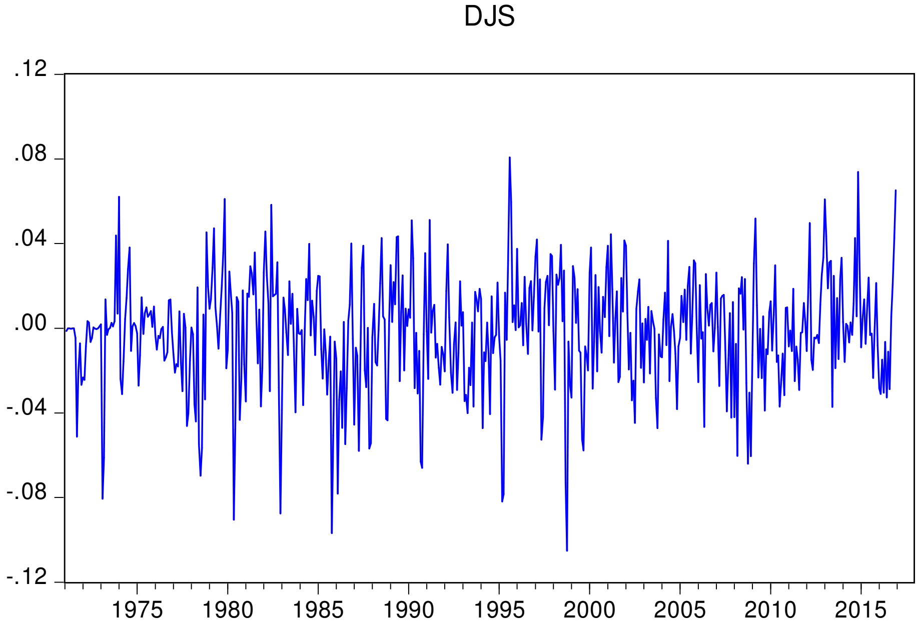
Note: $DEUS = \Delta s_t = s_t - s_{t-1}$, data from 1999:01 to 2016:06. *Source: Economagic.com*

Graph 2: Volatility of the spot exchange rate ($/£)



Note: $DUKS = \Delta s_t = s_t - s_{t-1}$, data from 1971:01 to 2016:06. Source: *Economagic.com*

Graph 3: Volatility of the spot exchange rate (¥/$)



Note: $DJS = \Delta s_t = s_t - s_{t-1}$, data from 1971:01 to 2016:06. Source: Economagic.com

The strong dependence of current prices (spot exchange rates) on expectations about the future is unique to the determination of asset prices. This strong dependence causes many problems in our economy and our social welfare; especially in periods that are dominated by uncertainties, new information, rumors (propagandas), announcements and "news" (the controlled media play a major role in today's social welfare).[15] All these, mostly negative "news" change our expectations (make us, mostly, pessimistic) and are the prime cause of fluctuations in asset prices. Consequently, since the information, which alters expectations are new ("news"), the resulting fluctuations in price (exchange rate) cannot be predicted by lagged forward exchange rates, which are based on past information. During these uncertain periods, we should expect exchange rates (and all other asset prices) to exhibit large fluctuations. Thus, past prices, which are based on past information, might be imprecise to forecast future prices. The new information cannot be anticipated and these "surprises" are affecting the spot exchange rates.

This view on exchange rate movements can be exploited with the following model:

$$s_t = E_t \Phi_{t+1} + \delta E_t (s_{t+1} - s_t) \tag{14}$$

where, Φ_t represents only the economic fundamentals, which affect the exchange rate in period t [i.e., eq. (15)] and $E_t(s_{t+1} - s_t)$ captures the expected percentage change in the exchange rate between the current period (t) and the next period ($t+1$), based on the information available today (t).

The economic fundamentals are the well-known factors presenting below by eq. (15):

$$\Phi_t \equiv s_t = (m_t - m_t^*) - \beta(y_t - y_t^*) + \gamma(i_t - i_t^*) + \varepsilon_t \tag{15}$$

[15] All the media are completely controlled and they provide to the public what the dark powers instruct them to report. We need to do some diversification of the different sources of news (domestic and foreign) and to derive our own conclusion and inferences. We live in the century of misinformation and of political correctness ("the big lie").

Equation (14) represents a more general exchange rate determination formula, which may be viewed as a *reduced form* that can be derived not only from eq. (15), but from a variety of other models of exchange rate determination (like, the transfer function).[16] Assuming that expectations are rational in eq. (14), the current exchange rate and current expectations of future exchange rates are linked and both depend on expectations concerning the future fundamentals ($E_t\Phi_{t+1}$). Thus, the spot exchange rate depends on the current exchange rate and on the expected percentage change in the future. Due to profit opportunities from arbitrage this link [eq. (14)] must be strong, at least, for the exchange rates expected in the near future. Based on the above argument, we expect a high correlation between movements of spot and forward rates. The correlation coefficient between the spot and forward rate ($/€) is so far: ($\rho_{s,f} = +0.98$), for ($/£) is $\rho_{s,f} = +0.99$, and for (¥/$) is $\rho_{s,f} = +0.99$, because both rates respond at the same time to the same flow of new information (permanent or transitory). Also, the contemporaneous spot and forward exchange rates are approximately equal, showing that the market's best forecast of the future spot rate is the current spot rate. This phenomenon reveals that exchange rates follow a random walk process.

IV. Exchange Rate Expectations and Unanticipated Events ("News")

An important characteristic of the rational expectations hypothesis is that unanticipated events, surprises, and "news" are affecting assets' returns, prices, and real variables in our economies, which are sensitive to information.[17] The recognition, the last half of the century, that expectations are extremely important to the economic decision-making process has led to a major revolution in macroeconomic and financial analysis, but at the same time has increased instability and uncertainty. The rational expectations hypothesis developed initially by Muth (1961) has played a critical role in our market-oriented system and it states that expectations reflected in market behavior will be optimal forecasts using all available information. In the context of exchange rate determination, it is emphasized that the predominant cause of exchange rate movements are the unanticipated "news" (surprises).[18] Thus,

or
$$s_t = s_t^e + s_t^u \tag{16}$$

where, s_t^e = the expected exchange rate and s_t^u = the unexpected part of the exchange rate.

As it was mentioned above, the forward exchange rate summarizes the information that is available to the market when this forward rate is being set [$f_t = E(s_{t+1} | I_t)$]. Therefore, the spot rate can be expressed as a function of factors, which have been known in advance and are summarized by the lagged forward rate plus a function of the "news" and a serially uncorrelated error term, as follows:

$$s_t = \alpha_0 + \alpha_1 f_{t-1} + \alpha_2 \, "News"_t + \varepsilon_t \tag{17}$$

where, $"News"_t$ = macro-variables used in measuring the "news."

[16] For other models, see Kallianiotis (2013a, p. 88).
[17] See, Mishkin (1983).
[18] See, Dornbusch (1978), Bilson (1978), Frenkel and Mussa (1980), Isard (1980), and Frenkel (1984).

Equation (17) can be applied to an empirical analysis of the role of unanticipated events "news" as a determinant of the spot exchange rate. The difficulty is in identifying the macro-variables, which can be used in measuring the "news". Important variables that are affecting the exchange rate can be the interest rates (the relationship of the IRP or IRA) in the two countries because they are market determined and "news" are affecting them promptly. Then, by making the assumption that the (financial) asset market clears fast and that the "news" are immediately reflected in unexpected changes in the interest rates, eq. (17) can be rewritten with an extra term, which represents the surprise between the interest differential and the expected interest differential between the two countries.

$$s_t = \alpha_0 + \alpha_1 f_{t-1} + \alpha_2 [(i_t - i_t^*) - E_{t-1}(i_t - i_t^*)] + \varepsilon_t \tag{18}$$

where, $\alpha_0 + \alpha_1 f_{t-1} =$ the expected exchange rate, $\alpha_2 [(i_t - i_t^*) - E_{t-1}(i_t - i_t^*)] =$ the unexpected (the innovation) part of the exchange rate ("news"), $(i_t - i_t^*) =$ the actual interest differential in the two countries, and $E_{t-1}(i_t - i_t^*) =$ the expected interest differential based on information available in period $t-1$.

By taking into consideration the most important relationship in international finance, the interest rate parity (IRP), the expected interest differential can be computed from a regression by using lagged values of the spot and forward rates and lagged values of the interest differential, as follows,

$$E_{t-1}(i_t - i_t^*) \equiv (i_t - i_t^*) = \beta_0 + \beta_1 s_{t-1} + \beta_2 s_{t-2} + \beta_3 f_{t-2} + \beta_4 f_{t-3} + \beta_5 (i_{t-1} - i_{t-1}^*) + \beta_6 (i_{t-2} - i_{t-2}^*) + \varepsilon_t \tag{19}$$

Now, we take the difference between the actual interest differential $[(i_t - i_t^*) \equiv ID_t]$ minus the computed expected interest differential $[E_{t-1}(i_t - i_t^*) \equiv IDF_t]$, which represents the "news". These two values are used in eq. (18); and by running this regression, the computer will give its coefficients. If $\alpha_0 \cong \alpha_2 \cong 0$ and $\alpha_1 \cong 1$, the foreign exchange market is efficient. In the case that $\alpha_2 \neq 0$, this means that the current exchange rate is affected by expectations concerning the future course of events and that the unanticipated changes in the exchange rate are primarily due to innovations. Most of the actual changes in exchange rates are unanticipated, which means that most of the actual changes in exchange rates are due to "news."

V. Empirical Results

An empirical test of efficiency is a joint test of efficiency (full information) and the equilibrium (harmony) model. By "equilibrium," we mean an internal, external, eternal, and global balance that must exist in markets and societies because we (every individual) must be in balance and live in harmony with ourselves, the others, and the entire socio-economic environment;[19] otherwise, how can there be an equilibrium? Recent tests conducted by Kallianiotis (2016b) show that the evidence supporting the unbiased forward rate hypothesis is quite weak. He found that a non-consistent risk premium is present in several major foreign exchange markets ($/€, $/£, and ¥/$). The implication of these empirical findings is that one cannot use the forward rate directly as a measure for the future spot rate because there are many interventions in the foreign exchange market.

[19] See, Kallianiotis (2017 and 2016a).

The objective, here, is to provide some evidence concerning the theories of exchange rate movement and market efficiency. Least squares regression analyses are used, which provides a method for fitting the mathematical functions discussed in theory above to observed data. The data are coming from *Economagic*, *Eurostat*, and *Bloomberg* and they are monthly. Also, testing of the above hypotheses, and presenting here can help the readers understand the theories and be able to do empirical research by using the existing data in different economies and currencies.

We start with the random walk (market efficiency), which is presented in Table 1. Between the U.S. dollar and euro ($/€), the results show, $\alpha_0 \cong 0$ (statistically insignificant) and $\alpha_1 = 0.986 \cong 1$ (statistically significant at the 1% level); then, the market for this s_t is efficient.

Table 1: Testing for Random Walk, Eq. (7)

$$s_t = \alpha_0 + \alpha_1 s_{t-1} + \varepsilon_t \qquad \text{if } \alpha_0 \cong 0 \text{ and } \alpha_1 \cong 1$$

	α_0	α_1	R^2	SSR	F	$D-W$	N
$/€	0.002 (0.003)	0.986*** (0.012)	0.972	0.140	7,230.74	1.598	213
$/£	0.006* (0.003)	0.987*** (0.006)	0.980	0.299	26,299.58	1.294	545
¥/$	0.025* (0.014)	0.995*** (0.003)	0.996	0.383	135,085.0	1.361	545

Note: R^2 = R-squared, SSR = sum of squared residuals, F = F-Statistic, $D-W$ = Durbin-Watson Statistic, N = number of observations, *** = significant at the 1% level, ** = significant at the 5% level, and * = significant at the 10% level.
Source: *Economagic.com*, *Bloomberg*, and *Eurostat*.

Then, between the U.S. dollar and British pound ($/£) the results are, $\alpha_0 \neq 0$ (statistically significant at the 10% level) and $\alpha_1 = 0.987 \cong 1$ (statistically significant at the 1% level); thus, the market for this s_t is not very efficient for this long period (from 1971:02 to 2016:06). But, it is efficient if we use data from 1999:01 to 2016:06. Lastly, the market efficiency between the Japanese yen and the U.S. dollar (¥/$) is tested and gives, $\alpha_0 \neq 0$ (statistically significant at the 10% level) and $\alpha_1 = 0.995 \cong 1$ (statistically significant at the 1% level); consequently, the market for this s_t is not very efficient. It is also efficient, if the data are from 1999:01 to 2016:06.

Then, the UFRH is tested with eq. (10) and is presented in Table 2a. For the U.S. dollar and euro, the results are as follows, $\alpha_0 \cong 0$ (statistically insignificant) and $\alpha_1 = 0.965 \cong 1$ (statistically significant at the 1% level); then, the foreign exchange market for ($/€) exchange rate is efficient and the forward rate is an unbiased predictor of the future spot rate. Also, the UFRH for the U.S. dollar and British pound, gives $\alpha_0 \cong 0.012$ (statistically significant at the 5% level) and $\alpha_1 = 0.972 \cong 1$ (statistically significant at the 1% level), which shows that the foreign exchange market for ($/£) exchange rate is relatively efficient.

Further, the UFRH for the Japanese yen and the U.S. dollar, is as follows: The $\alpha_0 \cong 0.099$ (statistically significant at the 1% level) and $\alpha_1 = 0.979 \cong 1$ (statistically significant at the 1% level); thus, the foreign exchange market for (¥/$) exchange rate is inefficient.

Table 2a: Testing for the Unbiased Forward Rate Hypothesis (UFRH), Eq. (10)

$$s_t = \alpha_0 + \alpha_1 f_{t-1} + \varepsilon_t \qquad \text{if } \alpha_0 \cong 0 \text{ and } \alpha_1 \cong 1$$

	α_0	α_1	R^2	SSR	F	$D-W$	N
$/€	0.007 (0.006)	0.965*** (0.021)	0.937	0.072	2,026.84	1.677	139
$/£	0.012** (0.005)	0.972*** (0.010)	0.968	0.083	9,445.43	1.758	315
¥/$	0.099*** (0.033)	0.979*** (0.007)	0.984	0.019	19,529.22	1.795	315

Note: See, Table 1.
Source: See, Table 1.

Now, the UFRH is tested with eq. (11) and the results are given in Table 2b. For the exchange rate between the U.S. dollar and the euro, it is as follows, $\alpha_0 \cong 0$ (statistically insignificant) and $\alpha_1 + \alpha_2 = 1.004 - 0.042 = 0.962 \cong 1$ (with α_1 statistically significant at the 1% level); then, this foreign exchange market is efficient. For the U.S. dollar and the British pound, the results are $\alpha_0 \cong 0.014$ (statistically significant at the 1% level) and $\alpha_1 + \alpha_2 = 1.054 - 0.085 = 0.969 \cong 1$ (with α_1 statistically significant at the 1% level and α_2 at the 5% level); then, this foreign exchange market is relatively efficient. Finally, the UFRH is tested for the Japanese yen and the U.S. dollar, which gives, $\alpha_0 \cong 0.106$ (statistically significant at the 1% level) and $\alpha_1 + \alpha_2 = 1.045 - 0.067 = 0.978 \cong 1$ (with α_1 statistically significant at the 1% level and α_2 at the 10% level); then, this foreign exchange market is relatively efficient.

Table 2b: Testing for the Unbiased Forward Rate Hypothesis (UFRH), Eq. (11)

$$s_t = \alpha_0 + \alpha_1 f_{t-1} + \alpha_2 f_{t-2} + \varepsilon_t \qquad \text{if } \alpha_0 \cong 0 \text{ and } \alpha_1 + \alpha_2 \cong 1$$

	α_0	α_1	α_2	R^2	SSR	F	$D-W$	N
$/€	0.008 (0.006)	1.004*** (0.066)	-0.042 (0.066)	0.937	0.072	1,002.25	1.728	138
$/£	0.014*** (0.005)	1.054*** (0.034)	-0.085** (0.035)	0.969	0.016	4,795.29	1.974	314
¥/$	0.106*** (0.033)	1.045*** (0.035)	-0.067* (0.035)	0.984	0.111	9,725.57	2.001	314

Note: See, Table 1.
Source: See, table 1.

Further, the composite efficiency, eq. (13), is presented in Table 3. For the U.S. dollar and euro the results are, $\beta_0 \cong 0$ (statistically insignificant) and $\beta_1 + \beta_2 = 0.199 + 0.772 = 0.971 \cong 1$ (with β_2 statistically significant at the 1% level); then, the composite efficiency holds, but only the forward rate contributes to the future spot rate. Then, the composite efficiency for the U.S. dollar and British pound gives the results: $\beta_0 \cong 0.014$ (statistically significant at the 1% level) and $\beta_1 + \beta_2 = -0.133 + 1.101 = 0.968 \cong 1$ (with β_1 statistically significant at the 5% level and β_2 statistically significant at the 1% level); consequently, the composite efficiency relatively holds and both spot and forward rates contribute to the future spot rate. Lastly, the composite efficiency for the Japanese yen and the U.S. dollar is tested and the results are: The $\beta_0 = 0.105$ (statistically significant at the 1% level) and $\beta_1 + \beta_2 = -0.099 + 1.076 = 0.977 \cong 1$ (with β_1 statistically insignificant and β_2 statistically significant at the 1% level); thus, the composite efficiency relatively holds, but only the forward rate contributes to the future spot rate.

Table 3: The Composite Efficiency, Eq. (13)

$s_t = \beta_0 + \beta_1 s_{t-1} + \beta_2 f_{t-1} + \varepsilon_t$ if $\beta_0 \cong 0$, $\beta_1 = w$, $\beta_2 = (1-w)$, and $\beta_1 + \beta_2 = w + (1-w) \cong 1$

	β_0	β_1	β_2	R^2	SSR	F	$D-W$	N
\$/€	0.006 (0.006)	0.199 (0.124)	0.772*** (0.122)	0.938	0.071	1,026.33	1.671	139
\$/£	0.014*** (0.005)	-0.133** (0.065)	1.101*** (0.064)	0.968	0.082	4,773.36	1.869	315
¥/\$	0.105*** (0.033)	-0.099 (0.065)	1.076*** (0.064)	0.984	0.112	9,807.26	1.885	315

Note: See, Table 1.
Source: See, Table 1.

In addition, testing eq. (14), we want to see if the current exchange rate and the current expectations of future exchange rates are linked and if both depend on expectations concerning the future fundamentals ($E_t \Phi_{t+1}$). By using $(s_t - s_{t-1})$ for the term $E_t(s_{t+1} - s_t)$, we have the following results presented in Table 4, for the \$/€, \$/£, and ¥/\$ exchange rates. Also, the table shows and a second column with the correction of the serial correlation of the error term. The results reveal that the expected future spot rate is significant, as well as the future fundamentals, which means that the market best forecast of the future spot rate is the current spot rate. The current exchange rate and the current expectations of the future exchange rate are linked on expectations regarding the future fundamentals. This indicates that exchange rates follow a random walk.

Lastly, Table 5 tests the exchange rate expectations and the "news". We start, first, running eq. (19) between U.S. and EMU (\$/€) to forecast the $E_{t-1}(i_t - i_t^*)$. We generate, $ID_t = (i_t - i_t^*)$ and the results of this regression are presented in footnote 21. The computer is giving to us the $IDF_t \equiv E_{t-1} ID_t = E_{t-1}(i_t - i_t^*)$ from the above equation. With this forecasting interest differential IDF_t, we run eq. (18) and the results shows that $\alpha_0 \cong \alpha_2 \cong 0$ (statistically insignificant both coefficients) and $\alpha_1 = 0.965 \cong 1$ (statistically significant at the 1% level). Thus, the exchange rate market for ($/€) is efficient and the unanticipated events ("news") have no effect on spot exchange rate (they are anticipated). We continue with U.S. and U.K. ($/£), running eq. (19) to forecast the $E_{t-1}(i_t - i_t^*)$ and the results of this regression are given in footnote 22. The computer is giving to us the $IDF_t \equiv E_{t-1}ID_t = E_{t-1}(i_t - i_t^*)$ from the above equation. With this forecasting interest differential IDF_t, we run eq. (18) and the results shows that $\alpha_0 \neq \alpha_2 \neq 0$ (statistically significant at 5% and 1%

Table 4: Exchange Rate Predictability, Eq. (14)

$$s_t = \alpha + (m_t - m_t^*) - \beta(y_t - y_t^*) + \gamma(i_t - i_t^*) + \delta E_t(s_{t+1} - s_t) + \varepsilon_t$$

Variables	s_t ($/€)	s_t ($/€)	s_t ($/£)	s_t ($/£)	s_t (¥/$)	s_t (¥/$)
c	0.973***	0.229***	1.939***	0.762*** -	2.906***	3.865***
	(0.061)	(0.017)	(0.140)	(0.198)	(0.915)	(0.222)
$m_t - m_t^*$	-1.491***	-0.023	-0.669***	-0.072	-1.294***	-0.166***
	(0.159)	(0.020)	(0.055)	(0.071)	(0.150)	(0.044)
$y_t - y_t^*$	-0.334***	-0.023***	-0.095***	-0.114	1.508***	0.025
	(0.036)	(0.003)	(0.033)	(0.087)	(0.214)	(0.029)
$i_t - i_t^*$	0.047**	0.002***	-0.043**	-0.006***	-0.001	0.001*
	(0.020)	(0.001)	(0.020)	(0.002)	(0.001)	(0.001)
$s_t - s_{t-1}$	0.721	0.492***	0.452***	0.500***	0.850***	0.495***
	(0.272)	(0.003)	(0.163)	(0.024)	(0.284)	(0.009)
s_{t-1}	-	-	-	1.582***	-	-
				(0.038)		
s_{t-2}	-	-	-	-0.618** *	-	-
				(0.038)		
ε_{t-1}	-	2.705***	-	-	-	2.268***
		(0.198)				(0.056)
ε_{t-2}	-	3.565***	-	-	-	2.724***
		(0.282)				(0.130)
ε_{t-3}	-	3.536***	-	-	-	2.751***
		(0.249)				(0.172)
R^2	0.577	0.989	0.478	0.976	0.314	0.988
SSR	2.087	0.052	1.316	0.061	3.562	0.064
F	70.644	1,693.521	70.234	1,750.391	28.973	1,779.548
$D-W$	0.077	1.736	0.081	1.618	0.058	1.526
N	212	212	312	312	258	258

Note: See, Table 1; m_t = ln of money supply, y_t = ln of income, i_t = short-term interest rate, and an asterisk (*) on a variable denotes the foreign variable.
Source: See, Table 1.

level); then, different than zero both coefficients and $\alpha_1 = 0.972 \cong 1$ (statistically significant at the 1% level). Thus, the exchange rate market for ($/£) is inefficient and the changes in this exchange rate are unanticipated (depend on "news"). Now, we continue with U.S. and Japan (¥/$), running eq. (19) to forecast the $E_{t-1}(i_t - i_t^*)$. We generate, $ID_t = (i_t - i_t^*)$ and the results of this regression are presented in footnote 23. The computer is giving to us the $IDF_t \equiv E_{t-1}ID_t = E_{t-1}(i_t - i_t^*)$ from the above equation. With this forecasting interest differential IDF_t, we run eq. (18) and the results shows that $\alpha_0 \neq 0$, $\alpha_2 \cong 0$ (the constant term is statistically significant at 1% level, then, different than zero; the α_2 is statistically insignificant, then zero) and $\alpha_1 = 0.979 \cong 1$ (statistically significant at the 1% level). Thus, the exchange rate market for (¥/$) is not very efficient, but the "news" do not affect it, they are anticipated.

Table 5: Exchange Rate Expectations and "News", Eq. (18)

$$s_t = \alpha_0 + \alpha_1 f_{t-1} + \alpha_2 [(i_t - i_t^*) - E_{t-1}(i_t - i_t^*)] + \varepsilon_t \quad \text{if } \alpha_0 \cong \alpha_2 \cong 0 \text{ and } \alpha_1 \cong 1$$

	α_0	α_1	α_2	R^2	SSR	F	$D-W$	N
$/€	0.007 (0.007)	0.965*** (0.023)	0.011[20] (0.011)	0.932	0.066	867.69	1.705	130
$/£	0.012** (0.005)	0.972*** (0.010)	-0.016***[21] (0.003)	0.970	0.077	5,026.74	1.854	312
¥/$	0.097*** (0.039)	0.979*** (0.008)	0.001[22] (0.001)	0.982	0.095	6,890.10	1.799	259

Note: See, Table 1.
Source: See, Table 1.

VI. Diagnostic Tests and Policy Implications

The exchange rates do not have a constant mean and exhibit phases of relative tranquility followed by periods of high volatility (no constant variance).[23] We want to see and examine

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$$ID_t = \underset{(0.069)}{0.165^{**}} + \underset{(0.850)}{0.353}\, s_{t-1} + \underset{(1.703)}{1.177}\, s_{t-2} - \underset{(1.405)}{0.703}\, f_{t-2} - \underset{(0.902)}{1.628^{*}}\, f_{t-3} + \underset{(0.090)}{0.914^{***}}\, ID_{t-1} - \underset{(0.089)}{0.066}\, ID_{t-2}$$

$$R^2 = 0.845, \quad SSR = 5.737, \quad F = 112.122, \quad D-W = 1.963, \quad N = 130, \quad RMSE = 0.210067$$

21

$$ID_t = \underset{(0.086)}{0.003} - \underset{(0.942)}{2.533^{***}}\, s_{t-1} + \underset{(1.929)}{1.833}\, s_{t-2} + \underset{(1.532)}{1.178}\, f_{t-2} - \underset{(1.039)}{0.538}\, f_{t-3} + \underset{(0.059)}{1.149^{***}}\, ID_{t-1} - \underset{(0.058)}{0.175^{***}}\, ID_{t-2}$$

$$R^2 = 0.977, \quad SSR = 20.226, \quad F = 2{,}185.208, \quad D-W = 1.990, \quad N = 312, \quad RMSE = 0.254614$$

22

$$ID_t = \underset{(13.727)}{-9.390} + \underset{(21.540)}{12.475}\, s_{t-1} + \underset{(45.929)}{14.526}\, s_{t-2} - \underset{(35.892)}{27.005}\, f_{t-2} + \underset{(24.643)}{2.350}\, f_{t-3} + \underset{(0.063)}{0.094}\, ID_{t-1} + \underset{(0.063)}{0.092}\, ID_{t-2}$$

$$R^2 = 0.026, \quad SSR = 10{,}916.91, \quad F = 1.106, \quad D-W = 2.026, \quad N = 259, \quad RMSE = 6.492321$$

the behavior of these time series, here, and to model the conditional heteroskedasticity (ARCH or GARCH).[24] By graphing the following three exchange rates: €/$, £/$, and ¥/$,[25] we see that these series are not stationary; their means do not appear to be constant and there is a strong heteroskedasticity. They have time-varying means (they are not stationary). These exchange rates show that they go through sustained periods of appreciation and then depreciation with no tendency to revert to a long-run mean. This type of random walk behavior is typical of nonstationary series.[26] Enormous shocks were the central banks' target rates persistence with a violently very low value (closed to zero) for seven or more years. Also, the volatility of many macro-variables was not constant over time. Globalization has made the macro-variables in the four countries and economies (U.S., Euro-zone, U.K., and Japan) to share co-movements ($\rho_{m,m^*} > 0$).

The historical data[27] 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 $rp_t = -0.001455$, $\sigma^2_{rp_1} = 0.00256948$. These existing risk premia show that the foreign exchange market is not very efficient.

We are in an informational disequilibrium or an informational discord that has created enormous social cost and distress in modern times. Actually, a distribution of wealth from one normal investor to the other investor (speculator) and transferring of risk from the speculator to the hard working saver. The public forms its expectations by using I_t instead of Π_t and damages the economy. The role of academics is to teach the public, but politically correctness and liberalism do not allow it to take place; the role of public policy is to set and achieve social objectives through regulations and a fair tax system. The ideal situation for the Fed would be to have complete knowledge of the economy's structure and of all the random events that might impact it. If the Fed had an attainable objective, it could set its policies

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

[24] 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.

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

[26] 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].

[27] See, Kallianiotis (2016b).

accordingly and achieve that goal. Some people believe that Federal Reserve officials have a sort of second sight that they use to foretell the future. But the truth is that the best economic forecasting is second rate when compared to the public's expectation. No one understands the economy's structure with enough precision to keep it perpetually humming along in balance and at top speed. Unfortunately, policymakers necessarily rely on second-best solutions.[28] During the latest global financial crisis, the monetary policy (Quantitative Easing) with zero interest rate from December 2008 to December 2015 was completely ineffective and efficiency has disappeared from the markets because people stopped to trust the corrupted financial market anymore.

Furthermore, exchange rates respond to surprises, to news, and to human actions due to ignorance of Π_t and knowledge of I_t only. But these surprises are unpredictable. Because exchange rates respond sensitively to the unexpected events that randomly hit markets, exchange rates themselves also move randomly. This is the nature of market efficiency and has unfortunately become our second nature, too. Investors have no other choice except to accept the market efficiency because the spot markets are following the futures markets without any questions and if someone ignores the futures market, he will have enormous losses and will go bankrupt. We are enslaved to the futures markets and for this reason, we have to regulate these markets.[29]

VII. Conclusions

In these specification models, we tested the hypothesis that the foreign exchange market is efficient and we argued that the forward rate fully reflects the limited available information (due to the lack of complete and correct global knowledge) about the exchange rate expectations and the forward rate. Thus, the forward rate is usually viewed by the market participants as an unbiased predictor of the future spot rate. The conventional test of the unbiasedness hypothesis that we used was a regression estimation by fitting the current spot on the one-period lagged spot rate, on the one-period lagged forward rate, on the one-period lagged spot and forward rate, the exchange rate predictability, and on the one-period lagged forward rate and the "news". These tests involve the joint hypothesis that the constant terms do not differ from zero, that the coefficients on the one-period lagged spot and forward rates do not significantly differ from one, that the sum of the coefficients of the one period lagged spot and forward rates do not significantly differ from one, that the coefficient of the "news" is not different from zero, and that the error terms pass some statistical tests (serial correlation, normality, homoscedasticity, ARCH, etc.).

The empirical results show that we cannot reject the unbiased hypothesis for U.S.A. and Euro-zone, but for the U.K. and Japan it is rejected. The results imply that we can use the forward rate as a proxy for the prediction of the spot rate next period between dollar and euro ($/€). There is some instability in the parameters of almost all the equations of the model, but, from a forecasting point of view, this is consistent with the least cost approach to the economic agents, although it may not yield the minimum forecast error due to interventions,

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[28] See, *Economic Trends*, Federal Reserve Bank of Cleveland, August 1994, p. 1.

[29] The Commodity Futures Trading Commission (CFTC) has jurisdiction to regulate the futures markets with oversight over the entire industry. Each U.S. futures exchange operates as a self-regulatory organization governing its floor brokers, traders and member firms. National Futures Association regulates every firm or individual that conducts futures trading business with the investing public. See, https://www.nfa.futures.org/NFA-faqs/investor_information_faqs/trading-futures-options-on-futures-and-forex/how-are-the-futures-markets-regulated.HTML . Also, for trading foreign currency, see, https://www.nfa.futures.org/NFA-investor-information/publication-library/forex.HTML

incomplete and partial knowledge (incorrect information), and simplicity in modeling. The overall results show that the foreign exchange markets for both the U.S. and Euro-zone are pretty efficient. Britain's and Japan's market efficiencies are questionable. Further diagnostic tests, like heteroskedasticity, residual, specification, and stability tests are useful to be applied for the above models.

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