# A Trace and Maximal Eigen Value Analysis of Spot-forward Forex Rates in OECD Countries

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## Abstract

*In the new era towards a globalised economy, countries worldwide are confronting each other in implementing an international economic policy to support each other's overall balance in their government policies through the exchange rate as one of its policies. The issues of forward premium puzzle in the foreign exchange market remains unsolved despite tremendous efforts have been made by researchers using various econometric methods for the last two and a half decades. The objective of the present study is to investigate the weak and semi-strong efficiency of the foreign exchange market in the OECD countries. The data from period 2000 to 2007 were analysed using cointegration test (Johansen, 1998) and found that the forex market in the OECD countries is inefficient.*

**Keywords:** Cointegration test, Foreign exchange market, Market efficiency, OECD countries

## *1. Introduction*

An investment in a foreign security has two components; a security gain or loss and a foreign exchange gain or loss. Investors and traders in global markets frequently hedge their currency exposures, while speculators take positions in foreign currencies based on their own expectations. For these participants, foreign exchange risk is an important component in their decision making process. Any risk reduction through the identification of inter-currency relationships would be highly beneficial (Cuthbertson and Nitzsche, 2004).

The forex market efficiency is an important consideration of all currency market participants. It is vital to have an efficient foreign exchange market so as to discourage investors or speculators in the market from taking any unnecessarily risky currency positions and hoping to gain superior profits from it, because such actions would lead to a currency crisis too. The recent currency crisis in Asia from 1997 to 1998 demonstrates how critically exchange rates impact economic developments. Stanley Fischer, First Deputy Managing Director of the IMF, noted that one of three key factors that led to the crisis was the maintenance of pegged exchange rate regimes for too long which encouraged external borrowing and led to excessive exposure to foreign exchange risk in both the financial and corporate sectors. Also contributing to the crisis were wide swings of the yen/dollar exchange rate over the past three years. Fischer explained that the crisis erupted during the summer in Thailand and the contagion to the regions' economies appeared relentless. As currencies continued to slide, debt service costs rose. This led domestic residents to hedge their external liabilities and intensified exchange rate pressure. One of the problems the IMF has faced in trying to help stem the crisis is that it took months to gauge the magnitude of the problem in the face of Asia's opaque accounting and financial secrecy.

The key to stemming the crisis remains restoring confidence in stabilizing the regions currencies because when confidence crisis happen, it always turn things upside down and is considered the wildest card when it comes to predicting an event like recession (Alias, 2007). Since the international business environment is one in which there is no universal medium of exchange, exchange rates are a matter of necessity for international trade. As a result, when transactions are denominated in foreign currencies two basic needs arise. First, there is the need for translation. That is, the transaction which is stated in terms of a foreign currency must be re-expressed or restated in terms of the local currency before it can be recorded in the local accounting records. Second, settlement of the transaction requires conversion. This means that when payment is due, a sufficient amount of the local currency must be exchanged for the stated amount of foreign currency so that payment can be made. At present, both translation and conversion of foreign currency involve the use of exchange rates. Therefore, in order to gain a more thorough understanding of foreign currency translation, it is important to examine its efficiencies. Thus, it is significant to examine the forex market efficiencies in order to determine whether the rates are predictable or not by examining its efficiencies in the market.

## *2. Background*

Rapp and Sharma (1999) used cointegration testing and common-feature testing to investigate market efficiency among daily spot and 1-month forward exchange rates with respect to the US Dollar of the G-7 from June 1, 1973 through December 31, 1996. Efficiency of the exchange rates is tested across countries and within countries. For across countries market efficiency test, the cointegration testing of Johansen (1988), Johansen and Juselius (1990) and stationarity test of Engle and Granger (1987), within the context of bivariate models were utilized for spot and for forward exchange rates to determine whether a long-run relationship between the spot exchange rates or between the forward exchange rates exists. An existence of long-run relationship would indicate a violation of the EMH as one rate could predict the other. For non-existence of the cointegrating relation, a common feature test (Engle and Kozicki, 1993) is used in order to analyse stationary co-movement between exchange rates. A common serial correlation feature would indicate market inefficiency. For within the individual countries, the same data are used but using spot and forward exchange rate of a single country to investigate co-movement between the rates. The across-country evidence supports efficiency as no co-movement is detected but the within-country test results are mixed. Market efficiency within countries is supported by the finding of co-movement between the forward rate and the corresponding spot rate, and by the finding of stationarity of the forecast errors.

However, the rate of depreciation and the forward premium are not found to exhibit the co-movement that efficiency would imply. Newbold et al. (1998) explore the two puzzles in the literature on foreign exchange market efficiency. Monthly time series of spot and one month forward exchange rates are constructed from daily data for the period May 1984 until October 1995. The data are obtained from Data Resources Incorporated and rates are calculated as the average of bid and ask quotes for Pound Sterling, Japanese Yen and German Mark against the US Dollar. First, it appears that while excess returns are stationary, the forward premium could be generated by a time series process that is integrated of orders one: that is theoretically impossible. Second, regressions of the future change in the spot rate on the forward premium very often generate negative estimated slopes.The implication that the forward rate has perverse merit in the prediction of future spot rates is paradoxical. It is shown how the first puzzle can be resolved through the properties of a simple bivariate time series model that is compatible with their data sets. The second puzzle vanishes when forecasts are corrected for autocorrelated errors. The essence of their argument is that the forward premium is only a very small component of excess returns – the standard deviation of the white noise innovation generating the former is a tine fraction of the white noise innovation generating the latter. The observations follow from both our model and direct analysis of the data sets.

The stationarity of the forward premium permits a regression of the future change in the log spot rate on the forward premium. There is long-standing evidence that such regressions can lead to estimates of the slope parameter that are negative – often significantly so, according to the standard tests. Taken at face value, such results imply the paradoxical conclusions that the forward rate has perverse value in the prediction of the future spot rate. It is seen that the paradox disappears when one allows for autocorrelation in the series of excess returns, leading to an autocorrelated errors – corrected forward rate. They do not find strong evidence against the hypothesis that this corrected forward rate is an efficient predictor of the future spot rate.Wu and Chen (1998) found that the cointegration of spot rates is neither necessary nor a sufficient condition to account for the lack of foreign exchange market efficiency. They employ daily observations on 1-month Eurocurrency spot, 1, 2, and 3-month forward rates i.e. rates quoted for currencies on deposits outside their country of origin from Canada, Germany, France, Italy, Japan, the Netherlands, Switzerland, the United States and the United Kingdom.

The empirical period begins from January 1979 and ends in December 1995 by using model without trend. The lag length is set to be 12 for monthly data, six for bi-monthly data and four for quarterly data. The objective of this study is to determine the semi-strong efficiency by analysing the long-run cointegration relationship among the variables using the Johansen test for the selected OECD countries.

## *3. Methodology*

In making inferences about the number of cointegrating relations, two statistics known as trace statistic and maximal eigenvalue statistic are used in this study. The trace statistic tests the null hypothesis that there are at most *r* cointegrating vectors against the alternative hypothesis of *r* or more cointegrating vectors. Meanwhile, in the maximal eigenvalue statistic test the null hypothesis of *r* cointegrating vectors is tested against the alternative of *r+1* cointegrating vectors. To make inferences regarding the number of cointegrating relationships, trace and maximum eigenvalue statistics are compared with the critical values tabulated in Osterwald-Lenum (1992). The Johansen cointegration results report a no-cointegration based on the 5% significance level. This study conduct Johansen (1988) cointegrating test to determine whether there exist any long-run relationship in the spot-forward forex rates in the OECD countries.

### *3.1 Data Collection*

The data was obtained from Reuters, based on live trading results thru weekly observations from 2000:W1 to 2007:W30. This covers a period of nearly 7 years and consists of a total of more than 300 observations each. All the exchange rates are transformed by taking logarithms except for AUD and NZD. Data for countries namely Belgium, Germany, Greece, Spain, France, Ireland, Italy, Luxembourg, the Netherlands, Austria, Portugal and Finland currencies will be combined and used under EUR as they are created as one single currency on 1st January 1999. EVIEWS was used to perform the cointegration test.

## *4. Result and Discussion*

Both the Maximal Eigenvalue and Trace likelihood ratio tests reject the null hypothesis of zero cointegrating factors and have at least one to two cointegrating vectors (See Table 1 and 2). However, the tests cannot reject the null hypothesis of zero cointegrating for NZD and KRW between spot against 3-month, 6-month and 1-year forward and JPY spot and 3-month forward. Thus it is implied that there is zero cointegrating vector exist among the spot and forward 3-month, spot and forward 6-month, spot and forward 1-year for the currencies. This study also found that cointegration exists for JPN between spot and 6-month and 1-year forward and consistent with Aggarwal & Mougoue (1993) and Kearney and Muckley (2005). However, the non-cointegration between the spot and 3-month forward rate could be institutively due to the usual omitted variable problem as we only deal with bivariate tests of cointegration (Maddala & Kim, 1998). For the case of NZD and KRW, they have no cointegration relation. The result for KRW is comform with Jeon and Seo (2003) that shows the foreign exchange market in Korea is efficient after the Asian currency crisis. One reason where there is no cointegration and granger causality for NZD is because New Zealand has a very strong economic relation with Australia and both are partners in *Closer Economic Relations* which allows for free trade in goods and most services. Australia is also New Zealand's largest trading partner. Exports to Australia has increased almost double from 20 years back to 21% and this has created a single market of more than 22 million people and has provided new opportunities for New Zealand exporters. NZD is very much dependent on AUD performance as it is highly related due to its goods and services balance. Therefore, the government of New Zealand must not allow its currency to fluctuate too much. If NZD were to strengthen too much compared to the AUD, it will reduce Australia's import demand from them and this will affect its balance of payments significantly.

Comparative advantage is also a factor to be considered between New Zealand and Australia to the rest of the world especially for their favourable international prices of the countries' exported mineral commodities. For instance, if NZD strengthen more compared to AUD against the USD, their commodities' prices will be more expensive than Australia thus less demand for their commodities will affect their gross national product[1]. Both AUD and NZD are moving in tandem most of the trading times. Thus, it is highly likely that the spot rate and forward rates for NZD/USD do not cointegrated and granger cause each other's but possibly to the AUD/USD performance as the trade competitiveness and interest rate differentials between the two countries factor most for their economic growth. This is shown by Li and Zhao (2006) whereby it is proved that the two currencies are more correlated during appreciations than during depreciations, which is consistent with the policy objective of Reserve Bank of New Zealand to maintain price stability as priority to export competitiveness.

[1] Bureau of East Asian and Pacific Affairs, 2007

Whilst for EUR, there is unilateral granger causality from all 3, 6 and 1- year forward rate to spot rate as shown in the result. This could be explained when the demand for spot transactions are based on the forward rates quoted. As interest rate differential between the two currencies is a factor that contributes to the forward rate, when the interest rates move to the market players' favour, the spot rate will also be highly demanded. Since there is no bi-directional relation occurs, spot rate element in the forward rate could not be the contributing factor that leads to the forward rate movement. It is the benchmark interest rate announced during the central banks i.e. European Central Bank (ECB) and Federal Open Market Committee (FOMC) monetary policy meetings that play the most important role in determining the EUR spot level. Hence, only uni-directional causality exists for EUR whereby the forward rates granger causes the spot rate. This conform with result from Fung et al. (1992) when they conducted research in the Eurodollar market, reverse causality exists in the first half, but disappears in the second half of the decade as the Euro forex market are evolving into rapid incorporation of prior interest rate information into current rates.

These results are likely to be due to reduced market regulation, expansion of futures trading, more sophisticated telecommunications and 24-hour trading practices (Fung, 1992).The spot-forward market for the forward tenor tested is efficient. The above empirical evidence also suggests that the spot rate and the forward rate pairs do not exhibit a long-run equilibrium relationship. Overall results suggest evidence for strong stationary long run relationship between the spot and forward variables of the currencies. The cointegration and Granger causality tests provide evidence against the semi-strong version of the EMH. They indicate that the movement of one or more spot and forward exchange rates can be predicted from the movements of the others. Therefore, the participants in the foreign exchange market can engage in profitable transactions both in the short and long-run. This contradicts to the findings by Jeon and Seo (2003) and Rapp and Sharma (1998) of no cointegrating vector existence but confirms to Wickremasinghe (2004), Kellard (2006) and Kasman and Ayhan (2007).

## *5. Conclusion*

This study analysed the cointegrating properties of the bivariate variables (spot-forward) in the selected OECD countries. The basis of the analysis is foreign exchange market efficiency, estimated on weekly data from 2001 to 2007. As the tests performed show inconsistent results, we can conclude that, in interpreting the tests of market efficiency, while assuming that all information are available at zero costs (a very strong assumption), in the short run, the market does not move to "efficiency" when the well informed traders make profits relative to the less well informed traders. Also, the smart money sells when actual prices are above fundamental value, and if noise traders (irrational behaviour) are present, the rational traders have to take their behavior also into account (Cuthbertson & Nitzsche, 2005). Our results could also due to the economic policies employed by the government of the OECD countries. Since some of the currencies are related regionally or due to their trade balances with each other, they are locked into following similar fiscal and monetary policies. As such, any change in one economy or country should affect the others in the region. It is possible that the long-run relationship found during all periods is primarily the result of conscious policy decisions to maintain stable exchange rates rather than inefficiencies caused by market forces as the monetary policy can be affected by the foreign exchange market when the monetary authorities may want to manipulate exchange rates by changing the money supply and interest rates (Mishkin, 2006).

## *6. Limitations and Recommendations for Future Research*

Capital controls also mean that weak efficiency tests of cointegration amongst international rates are not meaningful (also problem of excess return concept); on the other hand, using black market rates for different currencies is also suspect for typically thin markets in all but the major (usually US Dollar) currency. Tests of forward market and spot cointegration are obviously impossible where forward markets are absent or highly regulated (Aron, 1997). It would be interesting to consider employing cointegration based on the data before, during and after financial crisis, since the data covers only the observations after the European financial crisis of in 1992 to 1993 and after the Asian financial crisis of 1997-1998.

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**Table 1: Sport and cointegrating vector – Maximum Eigenvalue**

| Reject Null Hypotheses* | Spot and forward 3 month | Spot and forward 6 month | Spot and forward 1 year |
|---|---|---|---|
| Zero cointegration | AUD; DKK; EUR; GBP; HUF; MXN; SEK; SKK; TRY | AUD;CAD; CHF; DKK; EUR; GBP; HUF; ISK; JPY; MXN; PLN; SEK; SKK; TRY | AUD; CHF; DKK; EUR; GBP; JPY; MXN; SEK; SKK; TRY |
| At least 1 Cointegration | CAD; ISK; PLN; SKK | CAD; SKK | CAD; CZK; SKK |

* Rejection at the Osterwald-Lenum (1992) 95% critical value

**Table 2: Sport and cointegrating vector – Trace**

| Reject Null Hypotheses* | Spot and forward 3 month | Spot and forward 6 month | Spot and forward 1 year |
|---|---|---|---|
| Zero cointegration | AUD; CAD; CHF; CZK; DKK; EUR; GBP; HUF; ISK; MXN; PLN; SEK; SKK; TRY | AUD;CAD; CHF; CZK; DKK; EUR; GBP; HUF; ISK; JPY; MXN; PLN; SEK; SKK; TRY | AUD; CAD; CHF; CZK; DKK; EUR; GBP; HUF; ISK; JPY; MXN; PLN; SEK; SKK; TRY |
| At least 1 Cointegration | CAD; ISK; PLN; SKK | CAD; CZK; SKK | CAD; CZK; SKK |

* Rejection at the Osterwald-Lenum (1992) 95% critical value