Published in Slovak Republic
European Journal of Economic Studies
Has been issued since 2012.
ISSN: 2304-9669
E-ISSN: 2305-6282
2017, 6(2): 124-143

DOI: 10.13187/es.2017.6.124
www.ejournal2.com

The Relationship between Short-Run Interest Rate and its Economic Determinants: Consumer Price Index, Industrial Production Index, Household Consumption and Exchange Rate. An Empirical Research for the Four Most Developed Countries

John Rigas [a] , George Theodosiou [b , *] , George Rigas [b], Apostolos Goulas [c]

[a] J.P. Morgan Chase Bank, UK
[b] Technological Educational Institution of Thessaly, Greece
[c] University of Thessaly, Greece

Abstract

This study investigate the relationship between the real money market rate (RMMR) and its economic determinants (Consumer price index (CPI), industrial production index (IPI), household consumption expenditure (HCE) and exchange rate (EXRAT) by using a multivariate VAR model, and examine the existence of a causal relationships between the model variables based on a vector error correction model (VECM) in the four developed countries. The results suggest the existence of a long-run relationship between the real money market rate (RMMR) and its determinants for the four developed countries, in which none of the four determinants have a significant effect on RMMR. The results of causality analysis showed that there exists a bidirectional causality: 1. between change of RMMR and rate of change of CPI for four countries, 2. between rate of change of CPI and rate of change of IPI for one country, 3. between rate of change of IPI and change of EXRAT for one country, and 4. between rate of change of CPI and change of the ratio real HCE/real GDP (gross domestic product) for two countries. Moreover, there is unidirectional causality from the changes of RMMR determinants to the change of RMMR for many countries.

Keywords: real money market rate, consumer price index, industrial production index, household consumption expenditure, exchange rate, VAR model, VEC model, cointegration, causality.

1. Introduction

The interest rate is distinguished in nominal and real. Nominal interest rate is the unadjusted interest rate for inflation. The real interest rate is given by the Fisher equation:

$r = ((1+i)/(1+p)) – 1$

Where r is the real interest rate, i the nominal one and p is the inflation rate over the year (Interest rate, Wikipedia, n.d.). However for low levels of inflation the linear approximation $r \approx i – p$ is widely used to calculate the real interest rate.

The economic theory states and the monetary authorities of countries (e.g. central banks) confirm that the control of money supply in an economy is achieved with the management of

[*] Corresponding author
E-mail addresses: geortheo@teilar.gr (G. Theodosiou),
ioannis.rigas@windowslive.com (J. Rigas), g.rigas@teilar.gr (G. Rigas), goulasap@yahoo.com (A. Goulas)

interest rates (Monetary policy, Wikipedia, n.d.). The key interest rates are those at which central banks lend money to commercial banks.

The monetary policy by the central banks through changes in interest rates and the fiscal policy by the governments affect the money supply and the decisions of households and companies for spending, investing and saving (Keynesian economics, Wikipedia, n.d.). It is important for the researchers to analyze and interpret the path movements of interest rates and their determinants as interest rates paths influence the whole economy.

Recent studies refer extensively to the relationship between interest rate (IR) and separately with each one of its key determinants: consumer price index (CPI), industrial production index (IPI), household consumption expenditure (HCE) and exchange rate (EXRAT). The basic difference between these studies and this one lies in the fact that these investigated the existence of a long-run equilibrium among two or three or four variables, while this study is expanded to include all five variables for a number of countries. Moreover, it is investigated the causal relationship among the model variables for each one of the selected developed countries.

In this research, the real money market rate is employed as a proxy of the short-run interest rates because it gives a general depiction of each country's economy and provides liquidity funding for the global financial system. The data that are used are extracted from the four developed countries across the globe. To begin with, the inflation in these countries is more controlled as these countries have good monetary policies and political stability. They are also highly industrialized which means that the industrial production index will have a crucial role. Moreover, the economic safety that is offered, results in exchange rates with no big fluctuations and it makes the trading and investments with other countries to flourish. The 4 developed countries that were selected for our research are: France, Germany, Japan and USA.

The purpose of the study is to examine the relationship between the real money market rate (RMMR) and its economic determinants (CPI, IPI, HCE and EXRAT), and additionally, to analyze the causal relationships between the model variables by using a multivariate autoregressive VAR model for each one of the four developed countries which were chosen for the research.

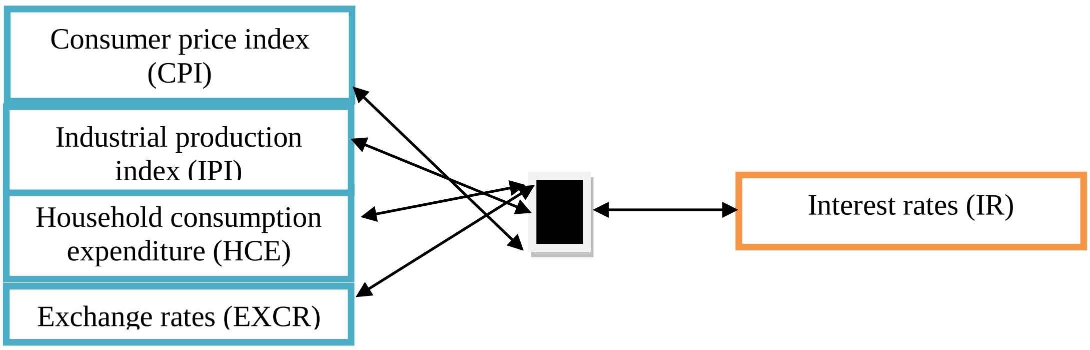

Fig. 1. Model Specification

Three econometric techniques were used to analyze the time series data on real money market rate (RMMR) and its economic determinants, namely:

1. the Augmented Dickey–Fuller (ADF) unit root tests, for the existence of unit root (stationarity tests)
2. the Johansen cointegration test for the existence of a long-run cointegrating relationship among the model variables, and the determination of an error correction model (ECM), and
3. the Granger causality tests, that determine whether one variable is useful in predicting another.

2. Literature review on the relationship among interest rates and its determinants

The effect of consumer price index (CPI) on Short-run Real Interest Rate (SRIR) and the existence of casual relationship between them are examined in this study, in order to shed more light on the empirical knowledge derived from the findings of various research works in the last decades. As stated by Kane and Rosenthal (1982) the short term interest rates are important determinants of inflation rate, which is defined as the percentage change of CPI from period to period. Namely, short term interest rates are efficient in predicting inflation, and that has implications in monetary policy. Diba and Oh (1991) found a very high negative relationship of inflation and real interest rate, while the nominal interest rate is weakly correlated with inflation.

A later study conducted by Booth and Ciner (2001) contradicts the findings of Diba and Oh (1991) regarding the correlation of inflation and nominal interest rate. Kandil (2005), in his study of fifteen developed countries with strong industry, concluded that both interest rate and money supply are underlying factors for the formation of price levels and they are strong correlated with each other. On the other hand, Cologni and Manera (2008) took into account the significant effect of the large rises in oil prices the recent years to the business cycle and assessed the performance of the G-7 countries' economies. Al-Khazali (1999) examined the relationship between interest rates and inflation in nine countries of the Pacific-Basin. His results did not give any evidence of a relationship between the variables. Nagayasu (2002) found that the impact of interest rates in the inflation evolution in Japan for the period 1980 to 2000 is very strong, especially when using short term interest rates.

Allen and Mapfumba (2006) concluded that the gap of the neutral and real interest rate is the major determinant of the inflation growth. Some years earlier, Gjerde and Saettem (1999) employed VAR model methodology for Norway with model variables interest rate, inflation, industrial production index, exchange rate and oil prices with purpose to examine how each variable affects and in what degree the rest variables. The most crucial conclusion was that interest rate affects significantly the inflation. It was also showed that there is no direct relation between interest rate and industrial production.

The joint effect of industrial production index IPI on SRIR and the existence of causality between IPI and SRIR are also examined in this study. The empirical research findings about the link between IPI and SRIR are mainly referred to the effect of interest rates on IPI. Wei (2008) examined the interest rates' impact on the industrial production and the stock market in China. He concluded that the interest rates policies affect IPI and have a short-run effect in the industrial production which is not persistent in the long-run. Tunali (2010) found out that IPI is negatively related with interest rate. Bianchi et al. (2010) found that the long - short term interest rate spread and the long term real interest rate are marginally significant for industrial output only for Italy.

Papapetrou (2001) found that interest rate is negatively related with industrial production output in Greece. Later, Gogas & Pragidis (2010) analysed the forecasting power of the yield curve and argued that the yield curve in combination with stock index has significant predicting power on the Greek Industrial Production Index (IPI).

Household consumption is closely linked to savings and to disposable income. Carlino (1982) argues that a survey on the findings of various studies revealed inconsistencies as to the significance and the sign of the estimated intertemporal relationship between consumption and interest rate. Baum (1988) derived a relationship among real rate of interest, consumption, and the personal wealth and he showed that the real interest rate has a small and not statistically significant effect on consumption-savings decisions. One year later, Campbell and Mankiw (1989) estimated the relation between consumption, income and interest-rates. They considered that the data are generated by two types of consumers, one consuming their permanent income (expected long term income) and the other their current income.

Sullivan and Lombra (1992) examined analytically and empirically the role of interest rates and of non-interest terms on loan using yearly US data. The main results of this work were that non-interest terms on loan were a determinant of household spending on housing and durables goods and become less important as deregulation and innovation have proceeded. In contrast to the previous researchers, Hahm (1998) argued that there is a significant positive relationship between consumption growth and changes in expected real interest rates. He argued that the failure of previous studies to find a significant link between consumption and real interest rates can be attributed either to the use of inappropriate instruments or using an inadequate measure of consumption (e.g. including the problematic housing services). Nakagawa and Oshima (2000) reported that for the treatment of the low consumption problem that the Japanese economy faced, Krugman (1998) suggested that a decrease in real interest rates caused by inflation expectations could increase household consumption. The question for them was whether the decline in real interest rates will lead to stimulating household consumption in Japan. To answer this question and to verify the assertion of Professor Krugman (1998), they analyzed the relationship between real interest rates and household consumption using data from Japan, U.S.A., Britain and France. They found that the relationship real interest rate – household consumption is supported for the USA and UK, where consumers are more willing to borrow, but it does not work in Japan, since Japanese like to save and are unwilling to use consumer credit even if real interest rates decline.

Zhang and Wan (2002) examined the effect of interest rate changes on household consumption in China and ascertained that nominal interest rates are less relevant to household consumption decisions than inflation rates do. Cromb and Corugedo (2004) investigated the sensitivity of consumption level to interest rates in a simple model of consumption under conditions of certainty. For most examined parameter values, they found that higher interest rates are linked with lower level of consumption. Finally, Neumeyer and Perri (2005) studied the relationship between real interest rates and business cycles for five small open developing economies and for five small open developed economies. They found that real interest rates are countercyclical and lead the cycle and the consumption. Consumption is procyclical and present higher volatility than output. Moreover, they documented that developing countries business cycles are more volatile than in developed ones.

The relationship between interest rate and its fourth determinant, the exchange rate, was investigated by many researchers, which led to interesting conclusions. Edison and Path (1993) assessed the relationship between real interest rates differentials and real exchange rates, using the exchange rates of the U.S. dollar against the other G-10 currencies. Their results indicated the no-existence of a long-run relationship between real exchange rates and real interest rates differentials. Baxter (1993) re-examined the relation real exchange rates - real interest differentials using the same data. She found that there exists a relationship between the two variables with the strongest link at trend and business-cycle frequencies and that there is no relationship between them at high frequencies. This explains why prior studies, focused on high-frequency components of the data, found no statistical relationship.

Ogaki and Santaellar (2000) studied the relationship between exchange rate and interest rate for Mexico, and found that one-month and three-month interest rate differentials have opposite results on the exchange rate. Namely, increases in the one-month interest rate differential, all other things constant, tend to appreciate the exchange rate, while increases in the three-months interest rate differential tends to depreciate the exchange rate.

Nakagawa (2002) tried to presents evidence in the relationship between real exchange rates and real interest rates differentials for the U.S. dollar against British pound, German mark, Canadian dollar and Japanese yen. He concluded that the confusion between theory, that supports a relationship between these variables, and the empirical findings, that are not clear, is due to the fact that the nonlinearity is not recognized in adjustment of real exchange rate. When threshold nonlinearity was introduced into a traditional model he had results that supported the link real exchange rates – real interest rate differentials. Zettelmeyer (2004) studied the impact of monetary policy on the exchange rates in Australia, Canada, and New Zealand using 3-month market interest rates. The main finding is that 2-3 percent appreciation of the exchange rate would require an interest rate change of about 100 basis point. This is consistent with the prevailing view about the impact of interest rates on exchange rates. Kanas (2005) findings support the existence of a relation between the US/UK real exchange rate and the real interest differential, which is justified by the theoretical knowledge about the real exchange rate determination.

Gochoco-Bautista and Bautista (2005) found that contracting domestic credit expansion and increasing the interest rate differential, they both contribute to reduce the exchange market pressure. Afterwards, Bautista (2006) examined the relationship between the real exchange rate and the real interest differential in six East Asian economies and showed that the relation changes with the nominal regime. During fixed exchange rate regimes the relation were characterized by positive time-varying correlations, while during free fall regimes correlations were negative. Chen (2006) using weekly data from six developing countries tried to answer the question of whether a higher interest rate steadies exchange rates. The empirical results indicated that higher nominal interest rates leads to increased probability of switching to a crisis regime, and that a high interest rate policy cannot defend the exchange rate. The empirical results of Choi and Park (2008) showed that the tight monetary policy and the consequent rise in interest rates were not effective in stabilizing the exchange rate during the Asian currency crisis and after the end of it.

In conclusion, interest rates have been widely investigated for their relationship with the key macroeconomic variables of inflation, industrial production, household consumption and exchange rate. As discussed above, it has high importance in knowing the path movements of interest rates as they are used for the form of government policies. What is important to mention here is that there has been discussion within the literature about the unidirectional relation of interest rate to these four variables, but as mentioned above, most of the studies do not discuss the opposite direction of the relationship. Moreover, none of the above researches had as an objective the evaluation of the joint effect of the four macroeconomic variables in the interest rate and therefore a different approach like this is required. Something else that is important to mention here is that, most of the researches that have been mentioned in the literature review have used more or less the same methodological tools which are employed in the current study. Finally, a wide range of countries have been used in the literature review, but they gave different results for the same relationships. This is probably due to the special characteristics of each country. For that reason, the current study employs a sample of the eighteen most developed countries which is anticipated to give a robust answer in the problem.

3. Research hypotheses

The objective of the study is to investigate the effect of various key economic indicators (variables) on short-run real interest rate in the case of developed countries. Namely, it is investigated the joint effect of some key economic indicators on short-run real interest rate for a number of the most developed countries.

In recent decades the relationship between interest rate and various key economic indicators has become a subject of extensive research. The research hypothesis was created after the literature survey took place and was found that each of the four economic indicators consumer price index (CPI), industrial production index (IPI), household consumption expenditure (HCE) and exchange rate (EXRAT) affects individually either with its current values or its lags the interest rates or they are affected by changes in the interest rates. These indicators indicate how well an economy is and how well it will be in the future. After the ascertainment that there exist a link between the interest-rate and the four selected indicators in some countries, we formulated the research hypothesis.

The research hypotheses of the study is to investigate the existence of a long run relationship between the real money market rate (RMMR) and its economic determinants (CPI, IPI, HCE and EXRAT), and to examine the causal relationships between the model variables for each one of the 4 developed countries which are chosen for this study.

The data used in the study are quarterly and are obtained from International Financial Statistics (International Monetary Fund, IMF, 2010). The range periods of the time series data for the 4 developed countries are appeared in Table 1 (Appendix).

The methodology of VAR models is used for this empirical research and it is based on the following reasons. The economic analysis suggests that there are long-run relationships between various economic variables included in the explanation of relevant economic phenomena (Brooks, 2008: 336). The estimation of these relations with the classical OLS method assumes that the variables are stationary, otherwise it raises the problem of "spurious regression" (Brooks, 2008: 319). The problem is treated by the stationarity and cointegration tests of variables (Cointegration, Wikipedia, n.d.). The cointegration analysis is used to estimate the long-run parameters and for its application, when there are more than two variables, VAR models are required. The usefulness of the VAR model can also be seen in the estimation of short-run parameters or imbalanced parameters. The estimation of these parameters makes use of long-run parameters estimated with the integration method. These procedures are performed with the vectors error correction models (VECM) and are based on VAR models technique. Moreover, VAR models are used to capture the evolution of multiple time series, and the interdependencies between them (Brooks, 2008: 291). From an economic point of view the joint dynamics of the VAR model variables are a depiction of the underlying economic relationships among the model variables (Vector autoregression, Wikipedia, n.d.).

The study is limited to the developed countries on the grounds that they have specific common characteristics (Developed country, Wikipedia, n.d.) and meet certain standards, as they are appeared in Table 2 (Appendix), which guarantee the reliability of data used and enhance the results of the statistical tests. Developed countries, however, differ among themselves on the temporal evolution of economic indicators (First World, Wikipedia, n.d.), which is mainly related to:

1. the production's structure of each country;
2. the contribution of each sector in the GDP formulation;
3. the propensity to consumption that the people of each country show;
4. the economic robustness of each country;
5. the degree of new technologies implementation;
6. the degree of industrial development;
7. the innovative activity and entrepreneurship;
8. the competitiveness of products and services;
9. the competitive advantages of each country;
10. the maturity of the society;
11. the scientific and professional training of citizens;
12. the applied social policy;
13. the applied fiscal and monetary policy;
14. the joining of a country in a union of countries like the European Union and the euro-area;
15. the climatic conditions, the historical evolution of the country, the mentality of population, the geographical position and a lot of other factors of smaller importance.

This differentiation is the one that can justify different values in the estimated coefficients of the variables in long-term equilibrium relationship. The estimated coefficients essentially are the long-run estimated elasticities of the short-run real interest rate as for the other four variables: consumer price index (CPI), industrial production index (IPI), household consumption expenditure (HCE) and exchange rate (EXRAT).

In this research, a total number 4 from the developed countries (see Table in introduction), as the most developed and for which data were available, was selected across the globe, most of them from the European Union which has the largest number of developed countries. A considerable number from these countries comes from euro-area. Except from the fact that the economies of developed countries meet certain standards, they also implement effective economic policies and provide reliable data and information to various organizations and databases.

4. Methodology

4.1. Model structure

A fifthvariate VAR model was used in order to test the existence of long-run relationships, to determine the interest rate function and to analyse the causal relationship. The expected long-run equilibrium relationship (cointegration equation) is specified as follows:

$$RMMR_t = b_o + b_1LNCPI_t + b_2LNIPI_t + b_3RRHCGD_t + b_4EXRAT_t + e_t \quad (1)$$

where:

$RMMR_t$ = Real money market rate = Money market rate (MMR_t) - Inflation (INF_t) $= MMR_t - INF_t$

$INF_t = (LNCPI_t - LNCPI_{t-1})*100*4 = INF_t(Q)*4$

INF_t = Annual inflation corresponding to quarter t

$INF_t(Q) = (LNCPI_t - LNCPI_{t-1})*100$ = The quarterly inflation

$LNCPI_t$ = The natural logarithm of CPI_t

$LNIPI_t$ = The natural logarithm of IPI_t

$RRHCGD_t$ = Real household consumption expenditures ($RHCE_t$)/ Real gross domestic product ($RGDP_t$) = $RHCE_t$ / $RGDP_t$

$RHCE_t$ = Household consumption expenditures / GDP_t Deflator (2005=100)

$RGDP_t$= Real GDP_t = GDP_t / GDP_t Deflator (2005=100)

$EXRAT_t$ = The current exchange rate.

The time series data of CPI and IPI are expressed in natural logarithms in order to obtain stationarity in their variance and also to capture multiplicative time series effects (Granger, Newbold, 1986), cited by Dritsakis & Adamopoulos (2004). The ratio RRHCGD = RHCE/RGDP is defined to show the real size of the household consumption.

In modelling the real money market rate equation, the methodology of unit root (Augmented Dickey-Fuller (ADF) unit root test) was used to determine whether each time series entering the model is stationary and moreover its order of integration. The long-run cointegrating relationship among the variables was examined by using the Johansen co-integrating test. The vector error correction model (VECM) was employed to determine the short-run dynamics of the variables in the model. Finally, Granger causality tests based on VECM were applied to explore the directions of causality between the model variables.

4.2. Augmented Dickey–Fuller (ADF) Test

In the first part of our analysis, we have to check for the existence of unit root test or otherwise if each one of our variables is stationary. According to Brooks (2008, p. 319), two main problems may arise from the use of non-stationary data. The first is that in case of an unpredicted change in a specific moment, the effect of this change will exist to the infinite and in the same degree of significance. The other is that the regressions will not be true as it results in high R^2 even if the variables show no sign of correlation to each other. After checking that the time span of the variables is big enough, we made sure that ADF tests can be performed for the existence of unit root of model variables. The Augmented Dickey–Fuller (ADF) (Dickey, Fuller, 1979) regression tests refer to the t-statistic of δ_2 coefficient on the following three regression equations:

$$\Delta X_t = \delta_2 X_{t-1} + \sum_{i=1}^{k} \beta_i \Delta X_{t-i} + e_t \qquad (2)$$

$$\Delta X_t = \delta_0 + \delta_2 X_{t-1} + \sum_{i=1}^{k} \beta_i \Delta X_{t-i} + e_t \qquad (3)$$

$$\Delta X_t = \delta_0 + \delta_{1t} + \delta_2 X_{t-1} + \sum_{i=1}^{k} \beta_i \Delta X_{t-i} + e_t \qquad (4)$$

Where:

$i = 1,2,3,\ldots,k$ the number of time lags

δ_0, δ_1, δ_2 and β_i $i=1,2,3,\ldots k$ are the parameters and

t is the time trend.

The null and the alternative hypothesis that are testing in the three models (2, 3 and 4) for the existence of unit root in variable X_t are as follows:

H_0 : $\delta_2=0$ (The series X_t contains a unit-root, hence it is non-stationary).

H_a : $\delta_2 < 0$ (the H_0 is not valid).

The hypotheses were tested by t-statistic of δ_2 using the critical values of MacKinnon (1991). The econometric package EViews 5.1 (2005), that was used for the ADF tests, gave the critical values of MacKinnon at 1 %, 5 % and 10 % level. Dickey-Fuller (1979) showed that the asymptotic distribution of t-statistic is independent of the number of lags of the dependent variable's first differences. What affects the values of t-distribution is the presence or absence of deterministic terms such as the intercept and time trend. The minimum values of Akaike criterion (AIC) and of Schwartz criterion (SCH) determined the optimal specification of ADF equations and the appropriate number of lags. Regarding the test of autocorrelation in disturbance terms (residuals) the Breusch-Godfrey test or otherwise the Lagrange Multiplier (LM) statistical criterion was used. The number of time-lags should be such that there are no auto-correlated residuals.

4.3. Cointegration Test

Before the explanation of the Johansen cointegration methodology that it is based on the VAR models, a presentation of the reasons that drove to the specific choice is made. The VAR models make possible to examine whether fork variables that are not stationary in levels there exists a long-run relationship, and how these k variables relate to each other. Moreover, a Vector Error Correction Model is defined that links the short-run dynamics with the long-run relationship. Apart from that, Brooks (2008, p. 291) states that a VAR model offers the flexibility to each variable to be depended not only in its own lags but to the lags of the other variables, and that the VAR forecasts are much better than those of the traditional models.

The Augmented Dickey-Fuller (ADF) unit root tests determine whether each series entering the VAR model is stationary and also its order of integration. Given the results of unit root tests, the Johansen cointegrating test examines whether there is a long-run cointegrating relationship among the model variables. These variables can be cointegrated if there is one or more linear combinations among the variables that are stationary (I(0) integrated). If the variables are cointegrated, then there is a stable long-run linear relationship between them. In the case of k variables can be up to k-1 linearly independent cointegrating vectors (cointegrating equations). The number of linearly independent cointegrated vectors is called "order of cointegration" and may range from 1 to k-1.

The Johansen cointegration tests are based on the methodology of VAR models which enable the researcher to determine the maximum number of cointegrated vectors (cointegrating equations The VAR models constitute a system of equations where all variables are endogenous and each one is determined as a function of the past values (lags) of all variables of the model. The selection criteria of likelihood ratio (LR), of Akaike, of Schwartz and of HQ are used to determine the VAR lag order and the number of lags required in the cointegration test. For testing the number of cointegrated vectors in the VAR model are used the trace (Tr) test and the maximum eigenvalue (max-eigen) test, proposed by Johansen & Juselius (1990).

The null hypothesis in the trace test is that there are at most k cointegrated vectors or there are at most k linear combinations among the model variables that are stationary. Namely, the number of cointegrating equations r is less than or equal to k, where k=0,1, 2…,m-1, and m the number of model variables. The hypotheses that are sequentially tested by trace test are:

H_o : $r \leq k$ against the alternative H_a : $r \geq k+1$, k=0,1, 2…,m-1.

In the max-eigen test the null hypothesis that there are at most k cointegrated vectors (H_o : $r \leq k$) is tested against the alternative hypothesis of k+1 cointegrated vectors (H_a : $r = k+1$), k=0,1, 2…,m-1. Thus, the hypotheses that are sequentially tested by max-eigen test are:

H_o : $r \leq k$ against the alternative H_a : $r = k+1$, k=0,1, 2…,m-1.

Based on the two criteria, the number of the cointegrated vectors is determined at 5 % and 1 % levels for each one of the 18 developed countries. Johansen and Juselius (1990) suggest the use of trace test when there are different results from the two tests.

4.4. The Error Correction Model (ECM)

The error correction model that is defined from the long-run cointegration relationship for the equation of RMMR can be expressed as follows:

$\Delta RMMR_t = Lagged(\Delta LNCPI_t, \Delta LNIPI_t, \Delta RRHCGD_t, \Delta EXRAT_t) + \lambda u_{t-1} + V_t$ (5)

where:

Δ refers to first differences of the variables,

u_{t-1} are the estimated residuals from the long-run relationship (cointegrating equation) and represents the deviation from it in time t,

$-1 < \lambda < 0$ is the short-run adjustment coefficient,

V_t is the white noise error term.

The error correction model analyses the short-run dynamics and links the short-run and the long-term behaviour of the model variables. The selection criteria of Akaike and of Schwartz are used to determine the number of lags required in the VECM.

4.5. Granger causality tests

The Granger causality tests, like the Johansen cointegration tests, are based on the methodology of VAR models. The Granger causality test determines whether one variable is useful in predicting another. Namely, for each pair of model variables X and Y it is said X Granger cause Y if and only if the prediction of Y is better by using the lag values of X together with the lag values of all other model variables (Y including). The VEC Granger Causality/Block Exogeneity Wald tests and the χ^2 (Wald) statistics are used to examine the Granger causality among the model variables. Granger causality is distinguished in unidirectional and bidirectional. Unidirectional causality exists from X to Y if X Granger causes Y but Y does not Granger causes X, and bidirectional if X Granger causes Y and Y Granger causes X. The reliability of this test depends on the order of the VAR model and on the stationarity of the variables. The reliability of this test is reduced if the variables are not stationary. For each one of the18 developed countries, the estimated vector error correction model (VECM) was used to test the existence of causal relationships among the model variables.

5. Data

The data that are used in this study were obtained from International Financial Statistics, (International Monetary Fund, IMF, 2010). The time series data are quarterly covering for each one of the 4 developed countries the range period appeared in Table 1 (Appendix).

Household consumption expenditures and Gross domestic product GDP time series data are converted from nominal to real values in national currency. The national GDP Deflator (2005=100) for each country was used to adjust nominal values to real values (base year 2005). The base year for calculation of the Indices CPI and IPI is 2005 (Index Numbers (2005=100): Period Averages, IMF (2010)). The endogenous variables of VAR model include the real money market rate (RMMR), the natural logarithm of consumer price index (LNCPI), the natural logarithm of industrial production index (LNIPI), the ratio (RRHCGD) of real household consumption expenditures (RHCE) to real gross domestic product (RGDP) and the exchange rate (EXRAT) that refers to the current exchange rate. Afterwards, some explanations for the economic indicators, by which are defined the model variables, are given below:

Money market rate (MMR) is short-term interest rate such as the three-month EURIBOR rate (Euro area countries), the rate on three-month commercial paper (USA) and the interbank offer rate for overnight deposits (UK). Analytic presentation of MMR for each one of the 4 developed countries is given in Table 3 (Appendix). Real money market rate (RMMR) is the nominal interest rate adjusted for inflation and measures the purchasing power of interest income. The linear approximation $r \approx i - p$ is used to this study to calculate the real interest rate, where r is the real, i is the nominal interest rate and p is the inflation rate over the year.

The consumer price index (CPI) is today in UK the official measure of inflation (Consumer Price Index (UK), Wikipedia, n.d.). An increasing trend in CPI can raise interest rates and bond yields and cause a fall to bond prices. Likewise, a decreasing trend in CPI can cause a fall to interest rates and bond yields . The inflation rate (INF) is the percentage change in CPI from period to period, and can be defined as: $INF_t = ((CPI_t - CPI_{t-1})/ CPI_{t-1})*100 \approx (LNCPI_t - LNCPI_{t-1})*100)$ (Sweidan, 2004; Katos, 2004: 992).

The Industrial Production Index (IPI) moves at the same time as economic activity (business cycle) and can be considered an accurate measure of industrial production and of manufacturing employment. High levels of industrial production can lead to high levels of consumption, to rapid rise of inflation and increase of interest rates. As such, IPI becomes a leading indicator of interest rates.

Household consumption expenditure (HCE) covers all domestic expenditures (from residents and non-residents) for individual needs. This includes expenditure on goods and services, rent for owner-occupied residences and the consumption of garden produce.

Gross domestic product (GDP) is a very important economic indicator measuring the economic activity of countries and is defined as the monetary value of all goods and services produced within a country in a specific time period.

The exchange rate of each one of the 4 developed countries is determined by national currency units per US Dollar, except from USA that is determined by US Dollar per Special Drawing Rights (SDR). The Euro Area member countries exchange rates, until the participation of national currencies within the Eurosystem, are expressed as national currency units per US Dollar. After the participation of national currencies within the Eurosystem the countries exchange rates are presented as Euros per US Dollar. The exchange rates of the Euro Area member countries were converted from national currency exchange rates into Euro exchange rates at official conversion rates (Euros per national currency).

6. Estimation Results

The results of the Augmented Dickey-Fuller (ADF) tests are presented in Table 4 (Appendix). The Akaike information criterion (AIC) and the Schwartz criterion (SC) determined the best specification of ADF equations and the corresponding number of lags. Regarding the autocorrelation test in error terms, the Lagrange Multiplier (LM (1)) test was applied.

The two statistical test trace test and Max-eigen test showed that there exists one cointegrating equation for each one of the 18 country. A unique long run relationship between real money market rate (RMMR) and its determinants (LNCPI, LNIPI, RRHCGD and EXRAT) is accepted for each country, which includes all five variables. The Johansen maximum likelihood cointegration test results are appeared in Table 5 (Appendix) and the normalized cointegrating coefficients of cointegrating equation for each country in Table 6 (Appendix).

Deviations from long-run equilibrium relationship could happen in the short-run due to profound changes to one or more variables of the model. The short-run dynamics were analysed by applying an error correction model (ECM). The estimated long run relationship for each country was used to include an error correction mechanism in a VAR model. The derived error-correction model has then the following form:

$$\Delta RMMR_t = Lagged(\Delta LNCPI_t, \Delta LNIPI_t, \Delta RRHCGD_t, \Delta EXCR_t) + \lambda u_{t-1} + V_t \quad (6)$$

The results of Granger causality tests are appeared in Table 6. Since the reliability of Granger causality tests depends on the order (k) of the VAR model and on the stationarity of the variables, the Granger tests were applied using the VEC model, which uses the first differences (stationary variables). That enables us to see and the economic meaning of the Granger causality relations. The selection criteria of Akaike and Schwartz were used to select the order of the VEC model for each country (Table 7 (Appendix)).

The detailed results of statistical tests for each one of the four developed countries are presented below:

1. France. The ADF tests showed that LNCPI and LNIPI are stationary at levels, while RMMR, RRHCGD and EXRAT are stationary at first differences. The results of cointegration tests suggest that there exist a long-run relationship that presents the following form:

$$RMMR = 378.534LNCPI + 234.101LNIPI + 4745.830RRHCGD - 223.851EXRAT - 5145.047 \quad (17)$$

s.e.	(132.291)	(535.384)	(1781.650)	(116.214)
t	[2.861]	[0.437]	[2.664]	[1.926]

In the long-run, LNCPI and RRHCGD have a significant positive effect on RMMR. LNIPI affects positive RMMR and EXRAT negative but both not significantly.

The error-correction models present the following form:

$$D(RMMR_t) = Lagged(D(LNCPI_t), D(LNIPI_t), D(RRHCGD_t), D(EXRAT_t)) - 0.005u_{t-1} + V_t \quad (18)$$

s.e. (0.001)

t [-3.260]

Adj. $R^2 = 0.440$, ECM Lags (in first differences) = 4

The Adj. $R^2 = 0.440$ is quite large and the coefficient of u_{t-1}= -0,005 has a negative sign and is statistically significant (t=-3.260).

The results of Granger causality tests denote that there exists a unidirectional causality from D(LNCPI) to D(LNIPI), from D(LNIPI) to D(RMMR) and from D(EXRAT) to D(LNCPI), and a bidirectional causality between D(RMMR) and D(LNCPI) at the 5% level.

2. Germany. The ADF tests showed that RMMR, RRHCGD and EXRAT are stationary at levels, while LNCPI and LNIPI are stationary at first differences. The results of cointegration tests suggest that there exist a long-run relationship that presents the following form:

$$RMMR = 71.864LNCPI - 57.320LNIPI - 115.723RRHCGD + 25.178EXRAT - 14.919 \quad (19)$$

s.e.	(16.110)	(16.419)	(134.863)	(8.343)
t	[4.461]	[-3.491]	[-0.858]	[3.018]

In the long-run, LNCPI and EXRAT have a significant positive while LNIPI has a significant negative effect on RMMR. RRHCGD affects negative RMMR but not significantly.

The error-correction model presents the following form:

$$D(RMMR_t) = Lagged(D(LNCPI_t), D(LNIPI_t), D(RRHCGD_t), D(EXRAT_t)) - 0.083u_{t-1} + V_t \quad (20)$$

s.e. (0.026)

t [-3.153]

Adj. $R^2 = 0.471$, ECM Lags (in first differences) = 5

The Adj. $R^2 = 0.471$ is quite large and the coefficient of u_{t-1}= -0,083 has a negative sign and is statistically significant (t=-3.153).

The results of Granger causality tests denote that there exists a unidirectional causality from D(LNCPI) to D(LNIPI), from D(LNIPI) to D(RMMR) and to D(RRHCGD) and from D(EXRAT) to D(RMMR) and to D(LNCPI), and a bidirectional causality between D(RMMR) and D(LNCPI) at the 5 % level.

3. Japan. The ADF tests showed that RMMR and LNIPI are stationary at levels, while LNCPI, RRHCGD and EXRAT are stationary at first differences. The results of cointegration tests suggest that there exist a long-run relationship that presents the following form:

RMMR= 9.739LNCPI – 9.920LNIPI – 83.726RRHCGD + 0.024EXRAT + 43.185 (23)
s.e. (1.886) (1.815) (14.318) (0.006)
t [5.163] [-5.466] [-5.847] [3.860]

In the long-run, LNCPI and EXRAT have a significant positive while LNIPI and RRHCGD have a significant negative effect on RMMR.

The error-correction model presents the following form:

$D(RMMR_t)$=Lagged($D(LNCPI_t)$, $D(LNIPI_t)$, $D(RRHCGD_t)$, $D(EXRAT_t)$)-0.420u_{t-1}+V_t (24)
s.e. (0.187)
t [-2.247]

Adj. R^2 = 0.458, ECM Lags (in first differences) = 2

The Adj. R^2 = 0.458 is quite large and the coefficient of u_{t-1}= -0,420 has a negative sign and is statistically significant (t=-2.247).

The results of Granger causality tests denote that there exists a unidirectional causality from D(RMMR) to D(LNCPI) and from D(LNIPI) to D(LNCPI) and to D(RRHCGD), and a bidirectional causality between D(RMMR) and D(LNIPI) at the 5% level.

4. USA. The ADF tests showed that RMMR, LNCPI and RRHCGD are stationary at levels, while LNIPI and EXRAT are stationary at first differences. The results of cointegration tests suggest that there exist a long-run relationship that presents the following form:

RMMR=5.972LNCPI + 3.675LNIPI – 224.306RRHCGD – 6.379EXRAT + 122.872 (33)
s.e. (1.649) (3.900) (42.830) (3.063)
t [3.622] [0.942] [-5.237] [-2.083]

In the long-run, LNCPI has a significant positive effect on RMMR while RRHCGD and EXRAT have a significant negative effect on RMMR. LNIPI affects positive RMMR but not significantly.

The error-correction model present the following form:

$D(RMMR_t)$=Lagged($D(LNCPI_t)$, $D(LNIPI_t)$, $D(RRHCGD_t)$, $D(EXRAT_t)$)–0.137u_{t-1}+V_t (34)
s.e. (0.052)
t [-2.659]

Adj. R^2 = 0.377, ECM Lags (in first differences) = 5

The Adj. R^2 = 0.377 is quite large and the coefficient of u_{t-1}= -0,137 has a negative sign and is statistically significant (t=-2.659).

The results of Granger causality tests denote that there exists a unidirectional causality from D(RMMR) to D(EXRAT) and from D(LNIPI) to D(RRHCGD), and a bidirectional causality between D(RMMR) and D(LNCPI) at the 5 % level.

7. Conclusions

In this study we investigate the relationship between the real money market rate (RMMR) and its economic determinants (LNCPI, LNIPI, RRHCGD and EXRAT), and additionally, examine the causal relationships between the model variables for each one of the four selected developed countries based on VECM. The results support the existence of a long-run relationship between the real money market rate (RMMR) and its determinants for the four developed countries. Specifically, the results indicated that:

1. LNCPI has a significant positive effect on RMMR for France, Germany, Japan, and USA;
2. LNIPI has a significant positive effect on RMMR for UK, while LNIPI has a significant negative effect on RMMR for, Germany and Japan;
3. RRHCGD has a significant positive effect on RMMR for, France, Japan and a significant negative effect on RMMR for the USA;
4. EXRAT has a significant positive effect on RMMR for, Germany, and a significant negative effect on RMMR for, Japan, and the USA.

The causality analysis results showed that there exists:

1. A bidirectional causal relationship between change of RMMR ($D(RMMR_t)$) and rate of change of CPI_t ($D(LNCPI_t)$=quarterly inflation /100) for France, Germany, and the USA;

2. A unidirectional causality from rate of change of IPI to change of RMMR for France and Germany;

3. A unidirectional causality from change of exchange rate to change of RMMR for Germany;

4. A unidirectional causality from D(RMMR$_t$): 1. to rate of change of CPI for Japan and 4. to change of exchange rate for the USA.

References

Al-Khazali, 1999 – *Al-Khazali, O.* (1999). Nominal interest rates and inflation in the Pacific-Basin countries. *Management Decision*, 37(6), pp. 491-498.

Allen, Mapfumba, 2006 – *Allen, D.E., Mapfumba, T.* (2006). Real Interest Rates and Inflation in Norway. School of Accounting, Finance and Economics & FIMARC Working Paper Series, Edith Cowan University, Working Paper 06.02. Jun 2006 00:00 No. 06.02 – Real Interest Rates and Inflation in Norway archived 01 Jun 2006 00:00.

Baum, 1988 – *Baum, D.* (1988). Consumption, Wealth, and the Real Rate of Interest. *A Reexamination Journal of Macroeconomics*, Winter 1988, 10(1), pp. 83-102. [Electronic resource]. URL: https://docslide.com.br/documents/consumption-wealth-and-the-real-rate-of-interest-a-reexamination.html

Bautista, 2006 – *Bautista, C.C.* (2006). The exchange rate–interest differential relationship in six East Asian countries. *Economics Letters*, 92. https://doi.org/10.1016/j.econlet.2006.01.016 pp. 137–142. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S016 517 65 06000395

Baxter, 1993 – *Baxter, M.* (1994). Real exchange rates and real interest differentials. *Journal of Monetary Economics*, 33(1), pp. 5-37.

Bianchi et al., 2010 – *Bianchi, C., Carta, A., Fantazzini, D., De Giuli. M.E., Maggi, M.* (2010). ACopula-VAR-X approach for Industrial Production Modelling. *Applied Economics*, 42(25), pp. 3267-3277.

Booth, Ciner, 2001 – *Booth, G.G., Ciner, C.* (2001). The relationship between nominal interest rates and inflation: international evidence. *Journal of Multinational Financial Management*, 11, pp. 269–280. [Electronic resource]. URL: https://www.researchgate.net/publication/222297529_The_relationship_between_nominal_interest_rates_and_inflation_International_evidence

Brooks, 2008 – *Brooks, Ch.* (2008). Introductory Econometrics for Finance, Cambridge University Press, p. 336, 2008. [Electronic resource]. URL: https://books.google.gr/books?id=CrPRZexTZLkC&printsec=frontcover&hl=el&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

Brooks, 2008 – *Brooks, Ch.* (2008). Introductory Econometrics for Finance, Cambridge University Press, p 319, 2008. [Electronic resource]. URL: https://books.google.gr/books?id=CrPRZexTZLkC&printsec=frontcover&hl=el&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

Brooks, 2008 – *Brooks, Ch.* (2008). Introductory Econometrics for Finance, Cambridge University Press, p 291, 2008. [Electronic resource]. URL: https://books.google.gr/books?id=CrPRZexTZLkC&printsec=frontcover&hl=el&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

Campbell, Mankiw, 1989 – Campbell, J. Y., Mankiw, N. G. (1989). Consumption, Income and Interest Rates: Reinterpreting the Time Series Evidence, NBER Macroeconomics Annual 4, pp.185-216. www.nber.org/chapters/c10965.pdf

Carlino, 1982 – *Carlino, G.* (1982). Interest rate effects and intertemporal consumption, Journal of Monetary Economics, 9, pp. 223-234. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/0304393282900435

Chen, 2006 – Chen, S.S. (2006). Revisiting the interest rate–exchange rate nexus: a Markov-switching approach. *Journal of Development Economics*, 79, pp. 208– 224. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S0304-3878(05)00003-9

Choi, Park, 2008 – *Choi, I., Park, D.* (2008). Causal relation between interest and exchange rates in the Asian currency crisis. Japan and the World Economy, https://doi.org/10.1016/j.japwor.2007.01.003 20, pp. 435–452. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S0922142507000114

Cologni, Manera, 2008 – *Cologni, A., Manera, M.* (2008). Oil prices, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries. *Energy Economics*, 30, pp. 856–888. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S0140988306001393

Cromb, Corugedo, 2004 – *Cromb, R., Corugedo, E. F.* (2004). Long-term interest rates, wealth and consumption, Publications Group, Bank of England, Working Paper no. 243.

Diba, Oh, 1991 – *Diba, B.T., Oh, S.* (1991). Bounds for the correlations of expected inflation with real and nominal interest rates. *Economics Letters*, 36(4), pp. 385-389. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/016517659190203W

Dickey, Fuller, 1979 – *Dickey, D., Fuller, W.* (1979). Distributions of the estimators for autoregressive time series with a unit root, Journal of American Statistical Association, http://dx.doi.org/10.1080/01621459.1979.10482531 74, pp. 427–431 [Electronic resource]. URL: http://www.tandfonline.com/doi/abs/10.1080/01621459.1979.10482531

Dritsakis, Adamopoulos, 2004 – *Dritsakis, N., Adamopoulos, A.* (2004). Financial Development and Economic Growth in Greece: An Empirical Investigation with Granger Causality Analysis. *International Economic Journal*, http://dx.doi.org/10.1080/1016873042000299981 18(4), pp. 547–559. [Electronic resource]. URL: http://www.tandfonline.com/doi/abs/10.1080/1016873042000299981.

Econometric package EViews 5.1, 2005 – Econometric package EViews 5.1 (2005).

Edison, Path, 1993 – *Edison, H.J., Path, B.D.* (1993). A re-assessment of the relationship between real exchange rates and real interest rates:1974-1990. *Journal of Monetary Economics*, 31, pp. 165-187. [Electronic resource]. URL: https://docslide.net/documents/a-re-assessment-of-the-relationship-between-real-exchange-rates-and-real-interest.html

Gjerde, Saettem, 1999 – *Gjerde, O., Saettem, F.* (1999). Causal relations among stock returns and macroeconomic variables in a small, open economy. *Journal of International Financial Markets, Institutions and Money*, 9, pp. 61–74 [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S1042443198000365

Gochoco-Bautista, Bautista, 2005 – *Gochoco-Bautista, M.S., Bautista, C.C.* (2005). Monetary policy and exchange market pressure: The case of the Philippines, *Journal of Macroeconomics*, 27, pp. 153–168. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/ pii/S0164070404000771

Gogas, Pragidis, 2010 – *Gogas, P., Pragidis, I.* (2010). The interest rate spread as a forecasting tool of Greek industrial production. *International Journal of Business and Economics*, 3(1), pp. 37-46.

Granger, Newbold, 1986 – *Granger, C., Newbold P.* (1986). Forecasting Economic Time Series, New York: Academic Press. [Electronic resource]. URL: https://books.google.gr/books?hl=el&lr=&id=oDWjBQAAQBAJ&oi=fnd&pg=PP1&dq=GRANGER,+C.+%26+NEWBOLD,+P.,+1986.+Forecasting+Economic+Time+Series,+New+York:+Academic+Press.&ots=jZ8y6Knqmx&sig=YGPerzJVE4i_S4QUFLgxIPFYWZ8&redir_esc=y#v=onepage&q&f=false

Hahm, 1998 – *Hahm, J.H.* (1998). Consumption adjustment to real interest rates: Intertemporal substitution revisited, *Journal of Economic Dynamics and Control*, 22, pp. 293-320. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S0165-1889(97)00053-5

International Monetary Fund, IMF, 2010 – International Monetary Fund, IMF 2010. International Financial Statistics Yearbook, 2010, Washington DC.

Johansen, Juselius, 1990 – *Johansen, S., Juselius, K.* (1992). Testing Structural Hypotheses in a Multivariate Cointegration Analysis at the Purchasing Power Parity and the Uncovered Interest Parity for the UK. *Journal of Econometrics*, 53, pp. 211-244.

Kanas, 2005 – *Kanas, A.* (2005). Regime linkages in the US/UK real exchange rate–real interest differential relation, *Journal of International Money and Finance*, 24, pp. 257-274

Kandil, 2005 – *Kandil M.* (2005). Money, interest, and prices: Some international evidence. *International Review of Economics and Finance*, 14, pp. 129–147. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S1059056004000176 .

Kane, Rosenthal, 1982 – *Kane A., Rosenthal, L.* (1982). International interest rates and inflationary expectations, *Journal of international money and finance*, 1, pp. 97-110. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/0261560682900079

Katos, 2004 – *Katos, A.* (2004). Econometrics: Theory and Practice, 1st Edn., Zygos, Thessaloniki, Greece.

Krugman, 1998 – *Krugman. P.* (1998). Japan's Trap. [Electronic resource]. URL: http://web.mit.edu/krugman/www/japtrap.html [Accessed 26 January 2011].

MacKinnon, 2010 – *James G. MacKinnon* (2010). Critical Values for Cointegration Queen's Economics Department Working Paper No. 1227 Department of Economics Queen's University 94 University Avenue Kingston, Ontario, Canada K7L3N6 1-2010Tests qed_wp_1227.pdf 02-Jan-2010 14:27 191K

Nagayasu, 2002 – *Nagayasu, J.* (2002). On the term structure of interest rates and inflation in Japan. *Journal of Economics and Business*, 54, pp. 505–523 [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S0148619502001042.

Nakagawa, 2002 – *Nakagawa, H.* (2002). Real exchange rates and real interest differentials: implications of nonlinear adjustment in real exchange rates. *Journal of Monetary Economics*, 49, pp. 629–649.

Nakagawa, Oshima, 2000 – *Nakagawa, S., Oshima, K.* (2000). Does a Decrease in the Real Interest Rate Actually Stimulate Personal Consumption? An Empirical Study, Research and Statistics Department, Bank of Japan, Working Paper Series, Working Paper 00-2.

Neumeyer, Perri, 2005 – *Neumeyer, P.A., Perri F.* (2005). Business cycles in emerging economies: the role of interest rates, *Journal of Monetary Economics*, 52, pp. 345–380. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S0304-3932(05)00003-6

Ogaki, Santaellar, 2000 – *Ogaki M., Santaellar, J.A.* (2000). The exchange rate and the term structure of interest rates in Mexico. *Journal of Development Economics*, 63, pp. 135–155. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S0304 387800001036

Papapetrou, 2001 – *Papapetrou, E.* (2001). Oil price shocks, stock market, economic activity and employment in Greece, *Energy Economics*, 23(5), pp. 511-532. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S0140-9883(01)00078-0

Sullivan, Lombra, 1992 – *Sullivan, E., Lombra, R.* (1992). Interest Rate Effects on Intertemporal Consumption: Do Financial Regulation and Deregulation Matter? *Journal of Economics and Business*, 44, pp. 115-125. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/0148-6195(92)90010-8

Sweidan, 2004 – *Sweidan, O.* (2004). Does inflation harm economic growth in Jordan? An econometric analysis for the period 1970-2000. *International Journal of Applied Econometrics and Quantitative Studies*, 1-2, pp. 41-66. [Electronic resource]. URL: http://www.usc.es/economet /reviews/ijaeqs123.pdf

Tunali, 2010 – *Tunali, H.* (2010). The Analysis of Relationships between Macroeconomic Factors and Stock Returns: Evidence from Turkey Using VAR Model. International Research *Journal of Finance and Economics*, Issue 57. [Electronic resource]. URL: http://www.internationalresearchjournaloffinanceandeconomics.com/ISSUES/IRJFE%20issue%2057.htm [Accessed 19 January 2011].

Wei, 2008 – *Wei, C.-C.* (2008). An Empirical Analysis of the Effect of China Interest Rate to Industrial Production and Stock Markets Index by Using the DCC-MEGARCH Model. *International Research Journal of Finance and Economics*, Issue 18. Available from: [Electronic resource]. URL: http://www.eurojournals.com/irjfe_18_01_Ching.pdf [Accessed 18 January 2011].

Wikipedia Interest rate, n.d. – Wikipedia, n.d. Interest rate. In: Wikipedia: the free encyclopaedia [online]. St Petersburg, Florida: Wikimedia Foundation. [Electronic resource]. URL: http://en.wikipedia.org/wiki/Interest_rate [Accessed 11 March 2011].

Wikipedia n.d. Consumer Price Index (UK)) – Wikipedia, n.d. Consumer Price Index (UK). In: Wikipedia: the free encyclopaedia [online]. St Petersburg, Florida: Wikimedia Foundation. [Electronic resource]. URL: http://en.wikipedia.org/wiki/Consumer_Price_Index [Accessed 4 March 2011].

Wikipedia, n.d cointegration – Wikipedia, n.d. Cointegration. In: Wikipedia: the free encyclopaedia [online]. St Petersburg, Florida: Wikimedia Foundation. [Electronic resource]. URL: http://en.wikipedia.org/wiki/Consumer_Price_Index [Accessed 11 March 2011].

Wikipedia, n.d Developed country – Wikipedia, n.d. Developed country. In: Wikipedia: the free encyclopaedia [online]. St Petersburg, Florida: Wikimedia Foundation. [Electronic resource]. URL: http://en.wikipedia.org/wiki/Developed_country [Accessed 2 March 2011].

Wikipedia, n.d. First World – Wikipedia, n.d. First world. In: Wikipedia: the free encyclopaedia [online]. St Petersburg, Florida: Wikimedia Foundation. [Electronic resource]. URL: http://en.wikipedia.org/wiki/First_World [Accessed 4 March 2011].

Wikipedia, n.d. Keynesian economics – Wikipedia, n.d. Keynesian economics. In: Wikipedia: the free encyclopaedia [online]. St Petersburg, Florida: Wikimedia Foundation. [Electronic resource]. URL: http://en.wikipedia.org/wiki/Keynesian_economics [Accessed 11 March 2011].

Wikipedia, n.d. monetary policy – Wikipedia, n.d. Monetary policy. In: Wikipedia: the free encyclopaedia [online]. St Petersburg, Florida: Wikimedia Foundation. [Electronic resource]. URL: http://en.wikipedia.org/wiki/Monetary_policy [Accessed 11 March 2011].

Wikipedia, n.d. Vector autoregression – Wikipedia, n.d. Vector autoregression. In: Wikipedia: the free encyclopaedia [online]. St Petersburg, Florida: Wikimedia Foundation. [Electronic resource]. URL: http://en.wikipedia.org/wiki/Vector_autoregression [Accessed 2 March 2011].

Zettelmeyer, 2004 – *Zettelmeyer, J.* (2004). The impact of monetary policy on the exchange rate: evidence from three small open economies. *Journal of Monetary Economics*, 51, pp. 635–652. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S0304-3932(04)00019-4

Zhang, Wan, 2002 – *Zhang, Y., Wan, G.H.* (2002). Household consumption and monetary policy in China. *China Economic Review*, 13, pp. 27–52. [Electronic resource]. URL: http://www.sciencedirect.com/science/article/pii/S1043951X01000554

Appendix

Table 1. Data time period for the 18 developed countries

Data time range for the 18 developed countries*		
Countries	Starting date	Ending Date
France	1970Q1	2009Q4
Germany	1960Q1**	2009Q4
Japan	1960Q1	2009Q4
USA	1971Q1	2009Q4

* The data starting point of the data range differs from country to country according the available time series data for each country

** The data before 1990Q4 refer to Western Germany, as it was impossible to extract data for the eastern part of the country

Table 2. The common characteristics of developed countries*

The common features and standards of developed countries refer to: 1. the real per capita GDP which is greater than a certain threshold 2. the real per capita income which is higher than the minimum allowable subsistence level 3. the policies for the reallocation of country wealth 4. the policies for the education and health of the population 5. the social policy 6. the human Development Index that includes: 6.1. life expectancy at birth 6.2. mean years of schooling 6.3. expected years of schooling and 6.4. gross national income (GNI) per capita 7. the reliability of the provided and published statistical data 8. the democratic governing for decades 9. the acceptance of economic development as a combination of economic growth and human development, and many other common features and standard of smaller importance.

*Sources:
1. First World, wikipedia, n.d.
2. Human Development Index, wikipedia, n.d

Table 3. Money market rates (MMR) for the 4 developed countries

Countries	Money market rates (MMR)*
France	The three-month EURIBOR rate, which is a three-month interbank rate
Germany	Period averages of ten daily average quotations for overnight credit.
Japan	The lending rate for overnight loans
USA	The rate on three-month commercial paper

* Source: International Monetary Fund, IMF, 2010. International Financial Statistics, Country Notes 2010

Table 4. Augmented Dickey–Fuller (ADF) unit root tests for the 4 countries

Country	Variable	At levels				At first differences				Order of Integr.
		OSRE*	Lag	Test statistic (DF/ADF)	LM(1)**	OSRE	Lag	Test statistic (DF/ADF)	LM(1)	
France	RMMR	1	5	-1.239	0.000 [1.000]	1	4	-7.869	0.065 [0.799]	I(1)
	LNCPI	2	10	-3.732	0.296 [0.587]	-	-	-	-	I(0)
	LNIPI	2	1	-3.000	0.052 [0.819]	-	-	-	-	I(0)
	RRHCGD	2	4	-2.443	2.064 [0.151]	1	3	-5.300	0.740 [0.390]	I(1)
	EXCR	2	1	-2.163	0.113 [0.737]	1	0	-8.566	0.000 [1.000]	I(1)
	The critical values for OSRE=1 at 1%, 5% and 10% are -2.580, -1.943 and -1.615 resp/ly The critical values for OSRE=2 at 1%, 5% and 10% are -3.473, -2.880 and -2.577 resp/ly The critical values for OSRE=3 at 1%, 5% and 10% are -4.019, -3.439 and -3.144 resp/ly									
	RMMR	2	3	-3.987	0.000	-	-	-	-	I(0)

Germany					[1.000]					
	LNCPI	1	3	-0.871	2.515 [0.113]	2	2	-4.505	2.467 [0.116]	I(1)
	LNIPI	3	10	-2.615	0.315 [0.574]	3	9	-5.605	0.013 [0.908]	I(1)
	RRHCGD	3	1	-3.879	0.000 [0.999]	-	-	-	-	I(0)
	EXCR	1	1	-2.001	0.514 [0.473]	-	-	-	-	I(0)
	The critical values for OSRE=1 at 1%, 5% and 10% are -2.577, -1.943 and -1.616 resp/ly The critical values for OSRE=2 at 1%, 5% and 10% are -3.465, -2.877 and -2.575 resp/ly The critical values for OSRE=3 at 1%, 5% and 10% are -4.008, -3.434 and -3.141 resp/ly									
Japan	RMMR	1	7	-2.367	2.727 [0.099]	-	-	-	-	I(0)
	LNCPI	2	4	-2.809	1.144 [0.285]	1	3	2.113	0.000 [1.000]	I(1)
	LNIPI	2	5	-4.725	0.520 [0.471]	-	-	-	-	I(0)
	RRHCGD	2	2	-2.352	1.421 [0.233]	1	1	-9.185	2,142 [0.143]	I(1)
	EXCR	1	1	-1.913	1.260 [0.261]	1	0	-9.495	0.000 [1.000]	I(1)
	The critical values for OSRE=1 at 1%, 5% and 10% are -2.577, -1.942 and -1.616 resp/ly The critical values for OSRE=2 at 1%, 5% and 10% are -3.464, -2.876 and -2.575 resp/ly The critical values for OSRE=3 at 1%, 5% and 10% are -4.041, -3.450 and -3.150 resp/ly									
	RMMR	3	5	-4.233	0.713 [0.398]	-	-	-	-	I(0)
	LNCPI	2	4	-3.460	1.191 [0.275]	-	-	-	-	I(0)
US	LNIPI	1	1	2.208	0.244 [0.621]	1	0	-6.627	0.00 0 [1.00 0]	I(1)
	RRHCGD	3	1	-3962	0.034 [0.854]	-	-	-	-	I(0)
A	EXCR	3	3	-2.849	1.531 [0.216]	1	2	-5.741	0.00 0 [1.00 0]	I(1)
	The critical values for OSRE=1 at 1%, 5% and 10% are -2.580, -1.943 and -1.615 resp/ly The critical values for OSRE=2 at 1%, 5% and 10% are -3.474, -2.881 and -2.577 resp/ly The critical values for OSRE=3 at 1%, 5% and 10% are -4.022, -3.441 and -3.145 resp/ly									

* OSRE = optimal specification of regression equation
OSRE= 1. No intersept no trend, =2. Intersept no trend, =3. Intersept and trend
** LM(1)= Lagrange multiplier for first order autocorrelation test
*** I(0)= Integrated zero order, I(1)= Integrated first order

Table 5. Johansen cointegration tests

Country	Hypothesized No. of CE(s)	Eigenvalue	Trace test			Max-Eigenvalue test		
			Trace Statistic	0.05 Critical Value	0.01 Critical Value	Max-Eigen Statistic	0.05 Critical Value	0.01 Critical Value
France	None	0.1876	77.80	69.82*	77.82	32.00	33.88	39.37
	At most 1	0.1230	45.80	47.86	54.68	20.21	27.58	32.72
	At most 2	0.0747	25.59	29.80	35.46	11.96	21.13	25.86
	At most 3	0.0618	13.63	15.49	19.94	9.82	14.26	18.52
	At most 4	0.0244	3.81	3.84	6.63	3.81	3.84	6.63
	Trend assumption: Linear deterministic trend in data and intercept in CE Trace test indicates 1 cointegrating equations at the 5% level and 0 at the 1%. Max-Eigenvalue test indicates 0 cointegrating equations at the 5% level and 0 at the 1%. VAR Lags (in first differences) = 4							
Germany	None	0.1246	71.00	69.82*	77.82	25.68	33.88	39.37
	At most 1	0.0980	45.32	47.86	54.68	19.92	27.59	32.72
	At most 2	0.0632	25.40	29.79	35.46	12.60	21.13	25.86
	At most 3	0.0404	12.81	15.49	19.94	7.95	14.27	18.52
	At most 4	0.0249	4.86	3.84	6.64	4.86	3.84	6.63
	Trend assumption: Linear deterministic trend in data and intercept in CE Trace test indicates 1 cointegrating equations at the 5% level and 0 at the 1%. Max-Eigenvalue test indicates 0 cointegrating equations at the 5% level and 0 at the 1%. VAR Lags (in first differences) = 5							
USA	None	0.2188	90.41	69.82*	77.82*	37.05	33.88*	39.37
	At most 1	0.1363	53.37	47.86*	54.68	21.99	27.58	32.72
	At most 2	0.1183	31.38	29.80*	35.46	18.89	21.13	25.86
	At most 3	0.0442	12.49	15.49	19.94	6.78	14.26	18.52
	At most 4	0.0373	5.71	3.84	6.63	5.71	3.84	6.62
	Trend assumption: Linear deterministic trend in data and intercept in CE Trace test indicates 3 cointegrating equations at the 5% level and 1 at the 1%. Max-Eigenvalue test indicates 1 cointegrating equations at the 5% level and 0 at the 1%. VAR Lags (in first differences) = 5							

* OSRE= Optimal specification of regression equation
** CE= cointegration equation

Table 6. Normalized cointegrating coefficients of cointegrating equations

Country	Variables					
France	RMMR	LNCPI	LNIPI	RRHCGD	EXRAT	C
	1.000000	-378.5341	-234.1014	-4745.830	223.8514	5145.047
		(132.291)	(535.384)	(1781.65)	(116.214)	
	* Standard error in parentheses					
Germany	RMMR	LNCPI	LNIPI	RRHCGD	EXRAT	C
	1.000000	-71.86437	57.31992	115.7227	-25.17812	14.91902
		(16.1101)	(16.4194)	(134.863)	(8.34343)	
	* Standard error in parentheses					
Japan	RMMR	LNCPI	LNIPI	RRHCGD	EXRAT	C
	1.000000	-9.739248	9.920346	83.72603	-0.024418	-43.18530
		(1.88635)	(1.81482)	(14.3185)	(0.00633)	
	* Standard error in parentheses					
USA	RMMR	LNCPI	LNIPI	RRHCGD	EXRAT	C
	1.000000	-5.972046	-3.675459	224.3058	6.379426	-122.8722
		(1.64870)	(3.90011)	(42.8303)	(3.06310)	
	* Standard error in parentheses					

Table 7. Granger causality test results

Country	**Dependent Variable**	**X^2 Wald statistic – significance level**				
		Excluded Variable				
France		D(RMMR)	D(LNCPI)	D(LNIPI)	D(RRHCGD)	D(EXRAT)
	D(RMMR)	-	12.807* (0.012)	19.733* (0.001)	7.175 (0.127)	6.512 (0.164)
	D(LNCPI)	11.734* (0.019)	-	3.653 (0.455)	2.891 (0.576)	11.753* (0.019)
	D(LNIPI)	1.637 (0.802)	10.585* (0.032)	-	4.883 (0.300)	2.837 (0.586)
	D(RRHCGD)	2.277 (0.685)	4.158 (0.385)	8.932 (0.063)	-	3.214 (0.523)
	D(EXRAT)	5.115 (0.276)	5.725 (0.221)	1.732 (0.785)	1.613 (0.806)	-
	Lag lengths = 4, df = 4					
Germany		D(RMMR)	D(LNCPI)	D(LNIPI)	D(RRHCGD)	D(EXRAT)
	D(RMMR)	-	24.123* (0.000)	18.381* (0.003)	3.717 (0.591)	22.850* (0.000)
	D(LNCPI)	17.407* (0.004)	-	0.826 (0.975)	3.836 (0.573)	19.328* (0.019)
	D(LNIPI)	7.907 (0.161)	16.443* (0.006)	-	7.956 (0.159)	3.529 (0.619)
	D(RRHCGD)	6.562	4.001	13.229*	-	7.938

		(0.255)	(0.549)	(0.021)		(0.160)
	D(EXRAT)	4.370 (0.498)	3.719 (0.591)	5.662 (0.341)	3.106 (0.681)	-
	Lag lengths = 5, df = 5					
	Lag lengths = , df = 4					
Japan		D(RMMR)	D(LNCPI)	D(LNIPI)	D(RRHCGD)	D(EXRAT)
	D(RMMR)	-	4.523 (0.104)	11.587* (0.003)	5.163 (0.076)	1.845 (0.398)
	D(LNCPI)	6.792* (0.034)	-	9.310* (0.001)	2.755 (0.252)	2.364 (0.307)
	D(LNIPI)	13.479* (0.001)	5.629 (0.060)	-	0.538 (0.764)	4.561 (0.102)
	D(RRHCGD)	3.583 (0.167)	4.216 (0.122)	22.987* (0.000)	-	2.488 (0.288)
	D(EXRAT)	0.694 (0.707)	1.055 (0.590)	1.075 (0.584)	4.258 (0.119)	-
	Lag lengths = 2, df = 2					
USA		D(RMMR)	D(LNCPI)	D(LNIPI)	D(RRHCGD)	D(EXRAT)
	D(RMMR)	-	3.045* (0.693)	7.311 (0.319)	7.099 (0.213)	7.802 (0.168)
	D(LNCPI)	20.138* (0.001)	-	2.145 (0.829)	10.120 (0.072)	4.855 (0.4.34)
	D(LNIPI)	9.875 (0.079)	8.041 (0.154)	-	6.143 (0.293)	0.482 (0.993)
	D(RRHCGD)	3.661 (0.599)	3.799 (0.579)	12.760* (0.026)	-	3.795 (0.579)
	D(EXRAT)	13.732* (0.017)	8.842 (0.116)	6.647 (0.248)	6.674 (0.246)	-
	Lag lengths =7, df = 7					

* Indicate significance at the 5 % level