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INTERACTION BETWEEN MONETARY POLICY AND EXCHANGE RATE IN THE EUROZONE: PANEL VAR APPROACH

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Abstract

This paper examines the interaction between real exchange rate, inflation (CPL), money supply and output gap index using a Panel VAR approach to establish the relationship between real exchange rate and the macroeconomic variables consisting of 15 countries. The time component of our dataset is 1990-2016. In the empirical part, we show mixed results about the interrelationship between real exchange rate and the other macro variables. Our study shows that the relationship between monetary policy and the exchange rate is better verified at long term. However, in the short term, this correlation in developed countries is not stable, and rather has an opposite sign on average. This short-term gap may be due to the existence of monetary shocks.

Keywords: Real exchange rate, monetary policy, Eurozone, Panel VAR

INTRODUCTION

A good understanding of the relationship between interest rates and exchange rate movements in emerging economies is very important for a better understanding of the transmission mechanisms of monetary policy. In addition, the importance of this analysis is enhanced given that the relationship varies with time. In addition, the group of emerging countries is heterogeneous, and major economies are the subject of separate research (Mallick and Sousa 2012, Minella et al., 2003).

Among the emerging market economies, this interest is further reinforced by the fact that many of them have recently introduced changes in their monetary and exchange rate policies, moving to inflation targeting frameworks formally operating under flexible exchange rate regimes (Sánchez, 2008). Other reviews of empirical literature (Calvo, 2001, Calvo and Reinhart, 2002, 2005, Cespedes et al, 2004, Eichengreen, 2006) have highlighted important differences between advanced economies and emerging economies. These specificities of emerging economies are responsible for a relatively low degree of exchange rate flexibility (Calvo and Reinhart, 2002). Hnatkovska et al. (2013) find that the relationship between interest rates and the exchange rate is not monotonic. In particular, they observe that the response to the exchange rate depends on the size of the interest rate increase and its initial level. For example, Chinn and Meredith (2004, 2005) find a positive relationship between the exchange rate and the interest rate differential using data on short-term bonds and data on long-term bonds. In addition, Hnatkovska et al. (2013) find that the relationship between interest rates and the exchange rate is not monotonic. In particular, they observe that the exchange rate response depends on the size of the interest rate increase and the initial level of the interest rate.

The paper is organized as follows: after introduction which is provided in Section 1 above, brief literature review is carried out in Section 2. Section 3 present the empirical methodology. Data and results are discussed in Section 4. Final section concludes the study and gives some policy implications.

OVERVIEW OF RELATED LITERATURE

This section will be devoted to review the findings of all those studies on exchange rate and monetary policy. There are a number of empirical studies that have tried to determine the direct impact of the exchange rate on monetary policy. A first attempt to examine the exchange rate and price dynamics by Franck and Young (1972) showed that there is no significant interaction between the variables. Soenen and Hennigar (1988) showed a negative and significant relationship between stock prices and exchange rates. In addition, there is strong disagreement not only for the direction of the relationship between stock prices and rates, but

also for the existence or otherwise of this relationship. Indeed, there is a first correlation index between exchange rates and prices proposed by Aggarwal (1981). He explains the correlation based on a good market hypothesis, but he did not find in which direction the movement of this correlation. Solnik (1987) conducted a slightly different study and tried to detect the impact of several economic variables, including exchange rates on stock prices. He concluded that changes in exchange rates do not have a significant impact on stock prices. Jorion (1990) did a similar study to show the relationship between US multinational equity returns and the US dollar effective exchange rate and found a moderate relationship between variables.

Bahmani Oskooee and Sohrabian (1992) were the first to use Cointegration analysis to test the direction of the correlation between prices and exchange rates. They concluded that there was no long-term relationship between the two markets but revealed a two-way causality. The non-significance of long-term relationships between the two markets is confirmed by other studies (Granger and al. 2000, Nieh and Lee, 2001, Smyth and Nandha, 2003, Kollias et al. Cointegration.

In the same vein, the first studies related to the question of statistical techniques used as regression and correlation to discover the relationship between stock prices and exchange rates. Bahmani-Oskooee and Sohrabian (1992) used monthly values, the US dollar and effective exchange rate for the period from 1973 to 1988 and Granger's causality test to detect the relationship between variables. They found two-way causality in the short term, whereas they found no long-term relationship between the variables. In addition, Edwards (1994) developed a model on a panel of 12 developing countries and showed how nominal and real factors play an important role in determining the real exchange rate in the short term. He confirmed that inconsistent macroeconomic policies lead to overvaluation of the real exchange rate. Ajayi and Mougoue (1996) have shown the long-term negative impact of stock prices on the value of the national currency. On the other hand, Chow et al. (1997) examined the same markets, but found no relationship between stock returns and real exchange rate returns.

Chow and al. (1997) using monthly data found no relationship between stock returns and real exchange rate returns. Basurto and Ghosh (2001), using a standard monetary model of exchange rate determination, show that a tighter monetary policy was actually associated with exchange rate appreciation during currency crises. Nieh and Li (2001) found that there was no significant long-term relationship between exchange rates and stock prices for the G7 countries. In addition, Caporale and Pittis (2001) were unable to find a stable relationship based on a monetary model of the exchange rate. Chinn and Moore (2011) also failed to find a long-term relationship between the exchange rate and its monetary fundamentals (money, industrial production, and interest rate spreads). In addition, Nieh and Lee (2002) have shown that there

is no long-term relationship between stock prices and exchange rates, but in the short run, stock prices depreciation of the currency. In another study, Bhattacharya and Mukherjee (2003) studied Indian markets using equity price data and economic aggregates in the foreign sector, including the exchange rate and concluded the lack of a significant relationship between stock prices and exchange rates. In the same vein, Muhammad and Rasheed (2003) examined the relationship between stock prices and exchange rates of South Asian countries named as Bangladesh, India, and India. Pakistan, they found that there is no significant relationship between either short-term or long-term variables in Pakistan and India.

Bautista (2003) examines the interaction of interest rates using a dynamic conditional correlation analysis, a multivariate GARCH method with weekly data from the Philippines from 1988 to 2000. The results show that the correlation between these variables is far from constant.

Another study by Todani and Munyama (2005) used the ARDL on quarterly data for the period 1984: Q1 2004: Q3 to examine the impact of exchange rate variability on aggregate exports of South Africa to the rest of the world and the export of goods and services. The results show that, depending on the measure of variability employed, there is no statistically significant relationship between South African exports and exchange rate volatility. Choi and Park (2008), who study the relationship between interest rates and exchange rates during the Asian crisis period using a VAR model, reject the use of a restrictive monetary policy (high interest rates) to stabilize exchange rates. Sek (2008) applies a GMM and structural VAR (SVAR) to study the relationship between exchange rates and monetary policy. They find only a strong reaction from Thai politics to exchange rate fluctuations in the pre-crisis period. The empirical results are in agreement with the results in Ball (1999) and Taylor (2001).

Zhao (2010) also finds the effects of bidirectional volatility between two markets in China using the GARCH method. On the other hand, in developed countries, the relationship between exchange rates and share prices is still ambiguous. Indeed, there are other studies that find no long-term relationship between the exchange rate and the stock price. Lean et al. (2011) examine the relationship between nominal exchange rates in relation to US dollar exchange rates and stock market indices in Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore and Thailand. Using the Lagrange multiplier Cointegration tests of Gregory and Hansen and Westerlund. Data are from January 1991 to June 30, 2005. The result for each country suggests that Korea is the only country whose exchange rate and share prices are cointegrated over the entire period and long-term unidirectional causality of Granger is the exchange rate at the stock market.

For the analysis of the panel data, exchange rates and share prices are not cointegrated. Overall, the results suggest little evidence of a long-term relationship between the exchange rate and the stock price for each country and no evidence of Cointegration for countries as a panel. The study concludes that the change in the exchange rate and share price is generally a contemporaneous effect of each other in the short term. Liang and al. (2013) reviewed the monthly analysis of panel data for the period August 2008 to June 2011. The study concludes that the portfolio's balance sheet approach, which stipulates this exchange rate, has a negative impact on actions by the mobility of capital.

Chile and Nguyen (2014) found that stock markets have more influence on exchange rates during periods of turbulence. On the contrary, other economists such as Aggarwal (1981) who conducted a study to find the relationship between the exchange rate of the US dollar and changes in US equity price indices and found a positive correlation. Similarly, Roll (1992) also studied US stock prices and exchange rates and found a positive relationship between the two markets. In some empirical literature, the relationship between the interest rate and the exchange rate is considered a lagged relationship, as is the case with Granger causality models.

Ajayi and al. (1998) studied the markets of some advanced countries such as the United States. They discovered that there is a one-way causality of stock prices on the foreign exchange markets. Thus, the Cointegration test Abdalla and Murinde (1997) is used to examine the relationship between stock prices and exchange rates for the four named Asian countries such as India, Pakistan, South Korea and the Philippines for a period from 1985 to 1994. They detected unidirectional exchange-rate causality at the stock price for India, South Korea, and Pakistan and found causality in the direction opposite for Philippines.

Devereux and Yetman (2002) have argued that the frequency of price changes depends on the monetary policy regime. A credible monetary policy reduces the frequency of price changes. Empirical evidence of the relationship between the exchange rate and stock prices is mixed (Lin, 2012: 161, Tsai, 2012). There are studies that find the significant relationship between the exchange rate and the stock price. Pan et al. (2007) study the relationship between exchange rates and stock prices in Hong Kong, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand using daily data from January 1988 to October 1998. Indeed, Granger's causality results show a significant causal relationship of exchange rate to stock market prices for Hong Kong, Japan, Malaysia and Thailand before the Asian financial crisis.

In addition, a causal relationship exists between the stock market and the exchange rate market for Hong Kong, Korea and Singapore. The authors conclude that relationships differ across economies because of the exchange rate regime and the size of the stock market. Choi and Park (2008), studied the relationship between interest rates and exchange rates during the

Asian crisis period using a VAR model, reject the use of a restrictive monetary policy to stabilize exchange rates.

Similarly, Sánchez (2008) assesses the link between interest rates and exchange rates in small open economies using flexible exchange rates, using a simple model that incorporates the role of the exchange rate move to domestic prices and distinguishes cases of expansionary depreciation. It notes that, in the context of an adverse risk premium shock, interest rates are increased to avoid the contraction effect of depreciation, whether the latter effect is strong or weak. Al-Mashat and Billmeier (2008) used a SVAR model to examine the effectiveness of monetary policy. They found that the exchange rate channel plays an important role in the spread of monetary production shocks and prices.

Vithessonthi (2014) studies the relationship between the exchange rate and the interest rate in Thailand over the period 2003-2011 and shows that, during periods of high interest rates, an unexpected increase in the policy rates a substantial depreciation of the US Dollar and the British Pound. Inci and Lee (2014) show that exchange rates have a significant impact on stock market returns. More recently, Coudert and al. (2015) use data for 68 commodity exporters from 1980 to 2012 and nonlinear econometric methods to study the relationship between real exchange rates and terms of trade. They find that terms-of-trade volatility is the key transition variable for understanding this relationship as periods of high volatility are associated with increased uncertainty in commodity markets. Their empirical evidence shows that increased volatility increases transmission of terms-of-trade movements at the exchange rate.

EMPIRICAL METHODOLOGY

Econometric Modelling

The purpose of this article is to use the PVAR approach to explain the interrelationship between the real exchange rate and macroeconomic variables. The dependent variable here is the exchange rate, and the independent variables are the real interest rate, output gap, inflation and money supply. Indeed, the econometric study concerns 15 Eurozone country consists of: Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Luxembourg, Malta, the Netherlands and Portugal. The time component of our data set is 1990-2016 inclusive.

Estimation Technique

We follow the Panel VAR approach which combines the classical VAR approach and the Panel data approach. The model to be estimated is the following:

$$\ln RER_{i,t} = \alpha_0 + \alpha_1 \ln(RER)_{i,t-1} + \alpha_2 output_{i,t-1} + \alpha_3 \ln(CPI)_{i,t-1} + \alpha_4 IR_{i,t-1} + \alpha_5 \ln(M3)_{i,t-1} + \varepsilon_{it}$$

Table 1: Definition and measurements of variables

Type	Variable	Variable Transformation and Measure
Dependent variable	Real exchange rate	Ln (RER)
Independent variables	Interest Rate	IR
	Inflation	Ln (CPI)
	Money supply	Ln (M3)
	Output gap	Output

We transformed some variable in (Ln) if series are I (1) or not stationary.

The econometric method followed for the estimation of all the equations presented is the Generalized Method of Moment (GMM) method in dynamic panel. The estimation in GMM makes it possible to provide solutions to the problems of simultaneity bias, inverse causality and omitted variables. In particular, it makes it possible to deal with the problem of the endogeneity of the variables. In addition, there are two variants of dynamic panel GMM estimators: the GMM first difference estimator and the GMM system estimator.

The GMM first difference estimator of M. Arellano and S. Bond (1991) consists in taking for each period the first difference of the equation to be estimated in order to eliminate the specific effects of the countries, and then to instrument the explanatory variables of the first difference equation by their level values delayed by one or more periods. As for the GMM estimator in R. Blundell and S. Bond (1998), he combines the first difference equations with the level equations in which the variables are instrumented by their first differences. R. Blundell and S. Bond (1998) have shown, using Monte Carlo simulations, that the GMM estimator in the system is more efficient than the first difference one. The latter gives biased results in finished samples when the instruments are weak.

EMPIRICAL RESULTS

Descriptive Statistic

The purpose of the panel VAR approach is to study the relationship between the real exchange rate and macroeconomic variables. The dependent variable here is the real exchange rate (RER). The independent variables are: Interest Rate, Inflation (CPI), monetary supply and Output gap are downloaded from World Development Indicators, international monetary fund (IMF) and from the International Financial Statistics (IFS). Data is for the period 1990–2016. The specific countries selected for the study and the time frame was dictated by data availability. These include 15 Eurozone country consists of: Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, and Portugal.

Main Results and Discussions

The Panel VAR model estimations are done with STATA 12 software because of its performance in Panel data based studies. Empirical model estimation results are represented by the equation and reported in the tables below. The objective of this analysis is consists in determine the optimum number of lags in the model in level. For the dependent variable, the optimal lag choice needs an identification model. Brooks (2002) suggests the existence of two ways to select the optimal lag.

The first way, is based on the data frequency here the optimal lag choice is not evident. The second way applies the information criteria. In fact, there exist three criteria such as the AIC (1974), the SBIC and the HQIC (1978) criteria. We start the results by performing the panel unit root test proposed by I'm and al. (2003). After checking the form in which variables would enter the empirical modeling, we used the Arellano and Bond (1991) GMM estimator to find the linkage between exchange rate and the other macro-economic variables

Table 2: Unit root tests

Variables	Fisher-Type Tests								IPS Test			
	Fisher ADF Statistic				Fisher PP Statistic				t-bar	t-tilde-bar	Z-t-tilde-bar	W-t-bar
	P	Z	L*	Pm	P	Z	L*	Pm				
Ln RER (p-value)	54.5016 (0.0040)**	-1.4574 (0.0725)*	-2.0193 (0.023)**	3.1631 (0.000)***	54.5016 (0.0040)	-1.4574 (0.0725)*	-2.0193 (0.0234)*	3.1631 (0.0008)***	-1.8633 (0.1013)	-1.7178 (0.1013)	-1.2742 (0.1013)	-0.3023 (0.3812)
IR (p-value)	126.339 (0.0000)***	-6.2730 (0.000) ***	-7.9484 (0.000) ***	12.4374 (0.000) ***	126.339 (0.000)***	-6.2730 (0.000) ***	-7.9484 (0.0000) ***	12.4374 (0.0000) ***	-3.6265 (0.000)***	-2.7948 (0.000)***	-6.0332 (0.000)***	-11.3160 (0.000)***
Ln (CPI) (p-value)	84.8454 (0.0000) ***	-5.3209 (0.000) ***	-5.6220 (0.000) ***	7.0805 (0.000) ***	84.8454 (0.000) ***	-5.3209 (0.000) ***	-5.6220 (0.0000) ***	7.0805 (0.0000) ***	-3.4319 (0.000)***	-2.7750 (0.000)***	-5.9457 (0.000)***	-2.1058 (0.000)***
Ln(M3) (p-value)	71.9539 (0.0000) ***	-4.9319 (0.0000)	-4.8291 (0.000) ***	5.4162 (0.000)***	13.0769 (0.9969)	2.5875 (0.9952)	2.5244 (0.9932)	-2.1848 (0.9855)	-2.2375 (0.0291)**	-1.8581 (0.0291)**	-1.8942 (0.0291)**	-2.1830 (0.0176)**
Output (p-value)	123.36 (0.0000)***	-7.8071 (0.000) ***	-8.6962 (0.000) ***	12.0533 (0.000) ***	40.5041 (0.0955)*	-0.6213 (0.2672)	-0.7642 (0.2235)	1.3561 (0.0875)	-3.5484 (0.000) ***	-2.9101 (0.000)***	-3.5484 (0.000)***	-4.1425 (0.000)***

Source: Author's own calculation using E-VIEWS

Note: RER= real exchange rate; IR= real Interest rate; INF=inflation (CPI); output=output gap; M3= money supply. ***: Significant at the 1% level; **: Significant at the 5% level; *: Significant at the 10% level.

We start the results by performing the panel unit root test. Our objective about this test is to decide which variables should enter the models in their level form. Based on to the statistics recorded in Table 2, it is clear that the result of the estimation show that for real exchange rate,

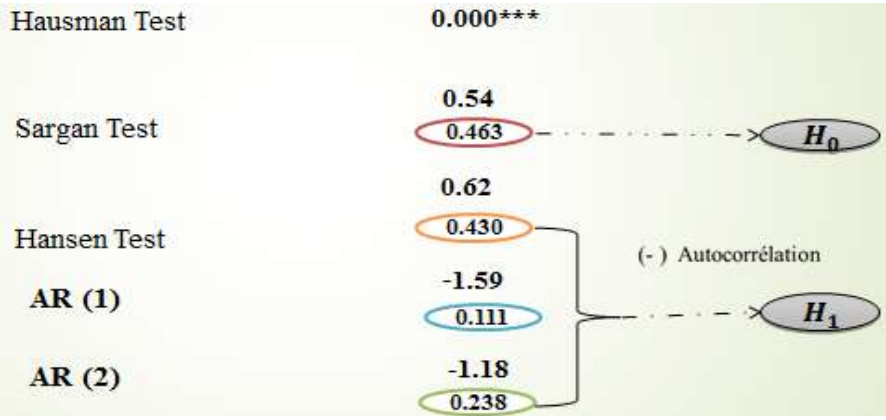
real Interest rate, inflation (CPI), output gap and money supply, the unit root null is rejected. This means that these variables are stationary. After checking the form in which variables would enter the empirical modeling, we used the Arellano and Bond (1998) GMM estimator to find the linkages between our variables.

Table 3: Optimal lag

Lag	*LL*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	-3385.070	-	235.8503	19.65258	19.70829	19.67477
1	-1886.087	2945.828	0.045885	11.10775	11.44197*	11.24086
2	-1839.972	89.28921	0.040602	10.98535	11.59809	11.22937*
3	-1811.939	53.46652	0.039904	10.96776	11.85902	11.32270
4	-1782.969	54.41395*	0.039012*	10.94475*	12.11452	11.41060
Source: Author's own calculation using STATA * indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz Criterion ,HQIC: information Hannan Quinn information criterion.						

According to Svestre (2002) that indicates that standard econometric techniques such as OLS do not provide efficient parameters estimations in a dynamic model which proposes the lagged dependent variable as explicative variable. Furthermore, the estimation of model with random effects using OLS is not efficient because there is a correlation between individual effects and estimators (Biondi and Toneto, 2008). For this, we propose to estimate with GMM method in system because this method provides solutions to different problems such as simultaneity bias and reverse causality bias. GMM estimator on system is proposed by Arellano and Bover (1995) and Blundel and Bond (1998). This empirical method assumes that equations in difference are used as variables in level tools. Monte Carlo simulations realized Blundel and Bond (1998) proved that the GMM estimator in system is more efficient than the one in first difference.

Figure 1: GMM estimation

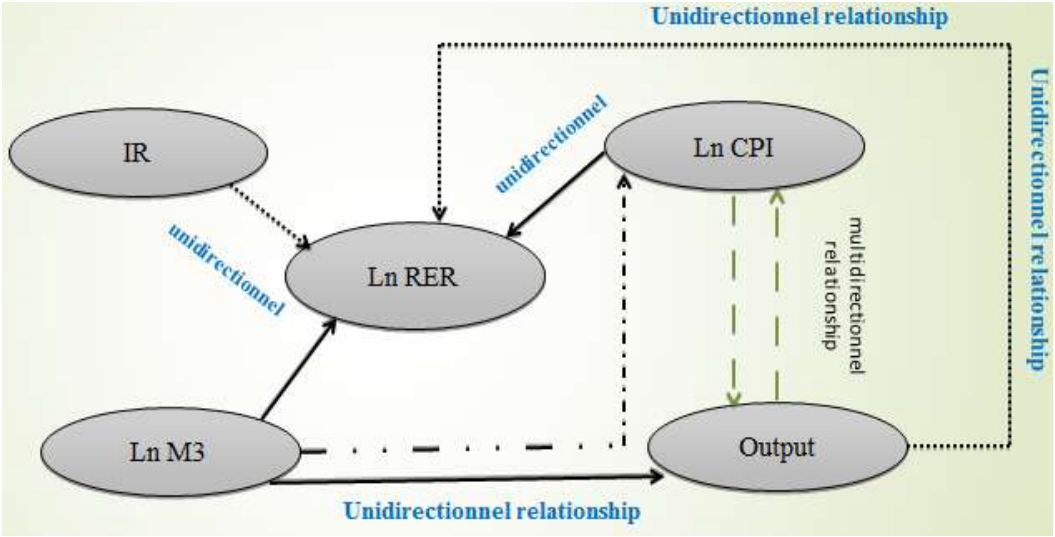


Source: Author's own calculation using STATA 12

The result of the GMM estimation show that at the level of Sargan test of over identifying restrictions, the null hypothesis: over identifying restrictions are valid. The null hypothesis of the test implies all instruments are valid. The p-value greater than 5% (0.05) implies, we accept the H_0, that is all instruments are valid (see Fig. 1).

Furthermore, there are empirical studies showing that the relationship between monetary policy and the exchange rate is best verified at LT. In the short term, however, this correlation in developed countries is not stable, and rather on average opposite in sign to what is expected by the uncovered parity relationship of interest rates. This short-term gap may be due to the existence of monetary shocks.

Figure 2: Causality Test



Source: By the author's using Eviews

For the case of our model, we found that the variables relating to Interest Rate (IR), Inflation (CPI), monetary supply (M3) and Output gap (Output) have a circular causal relationship with the dependent variable: the real exchange rate (RER). In addition, the findings reveal that there is bidirectional causal relationship between inflation (CPL) and Output, and monetary supply and output gap; there is also unidirectional causal relationship from (see Fig. 2):

- Unidirectional causality going from Output variable to RER,
- Unidirectional causality going from IR to RER,
- Unidirectional causality going from M3 to RER,
- Unidirectional causality going from M3 to Output,

Table 3 : Vector Autoregression Estimates

Response of	Response to Ln RER (t- 1)	Output (t-1)	Ln CPI (t-1)	Ln M3 (t-1)	IR (t-1)
Ln RER (t)	1.001173	-0.296185	-0.092032	-0.018481	0.000889
	(0.00664)	(0.28875)	(0.09741)	(0.04026)	(0.98654)***
Output (t)	0.002246	0.824476	0.035642	-0.005572	0.142361
	(0.00076)	(0.03318)	(0.01119)	(0.00463)	(0.11337)
Ln CPI (t)	0.003435	-0.508382	0.612376	0.018825	0.297819
	(0.00314)	(0.13658)	(0.04608)	(0.01904)	(0.46663)
Ln M3 (t)	0.003367	0.192081	0.069539	0.963329	-0.050012
	(0.00201)	(0.08755)	(0.02954)	(0.01221)	(0.29912)
IR (t)	2.84E-06	-0.009918	0.004824	-0.000303	0.435865
	(0.00032)**	(0.01396)	(0.00471)	(0.00195)	(0.04768)

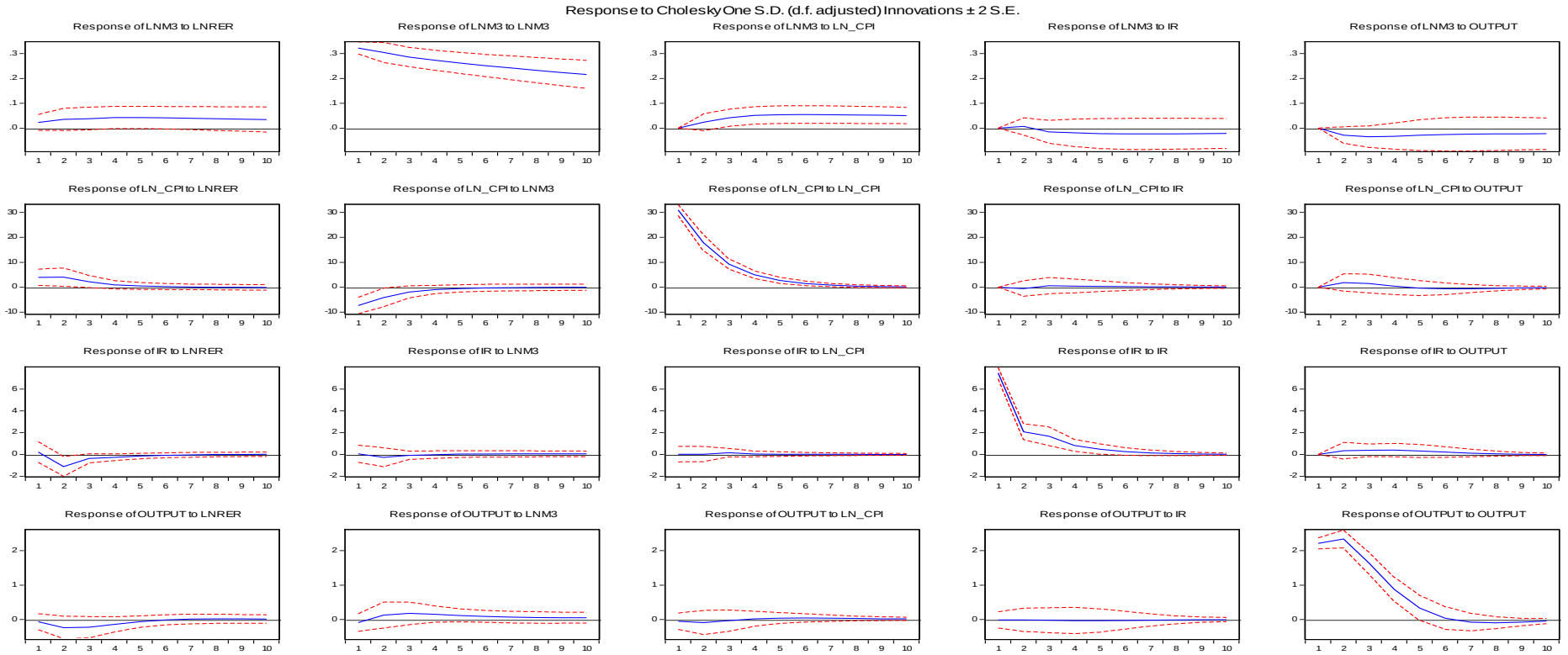
Source: Author's own calculation using STATA 12

Our main findings are as follows: Economically, the exchange rate directly impacts a country's economic growth. It is an element closely monitored by the different political and monetary authorities. On a smaller scale, the exchange rate also affects investors who hold assets in a foreign currency. The theoretical approaches to the exchange rate determination help to clarify the link between the exchange rate and macroeconomic variables. According to the monetary approach of the exchange rate, the determination of the exchange rate is dictated by the confrontation between supply and demand for real cash. Any imbalance in the particular foreign exchange market has an effect on the exchange rate.

Contrarily, the results of GMM show that the policy reaction functions react weakly to the exchange rate movements. Furthermore, excluding the exchange rate term in the policy reaction function does not generate large changes in the policy reaction function. This is because the policy function does not show a significant response to the exchange rate movement directly. However, this does not mean that the exchange rate does not play a role in the monetary policy in these countries. The exchange rate may influence the movements of policy reaction function indirectly through its effects on the domestic variables such as the inflation and output gap. On the other hand, the central bank may react to the exchange rate movements through intervention in the foreign exchange market as argued in many studies (taking the study of Osawa (2006), Disyatat and Galati (2005)).

Impulse Reponse Analysis

Figure 3: Impulse Reponse Function: Eurozone country



Errors are 5% on each side generated by Monte-Carlo with 1000 reps

Source: By the author's using Eviews

CONCLUSION AND DISCUSSION

Economists and researchers have different opinions on the relationship between exchange rate and the monetary policy. In addition, real interest rates are linked to public debt stocks, asset stocks and monetary policy. Indeed, there is a strong correlation between the following three macroeconomic variables; interest rate, inflation rate and the exchange rate. However, this relationship is often complicated by different additional factors such as public debt in% GDP, political stability and also economic performance. In the same vein, economists believe that the determination of the real exchange rate is done by the forces of supply and demand of the corresponding currencies. Nevertheless, the studies have given opposite results with respect to exchange rate fluctuations in relation to interest rate developments.

The purpose of this article was to highlight the effect of monetary policy on the exchange rate using the VAR method in panel. This paper investigated this relationship between these variables in the light of the simultaneity problem between the financial variables. 15 countries from the Eurozone: Germany, Austria, Belgium, Cyprus, Spain, Latvia, Finland, France, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands and Portugal.

Economically, the exchange rate directly impacts a country's economic growth. It is an element closely monitored by the different political and monetary authorities.

The theoretical approaches to exchange rate determination help to clarify the link between the exchange rate and macroeconomic variables. According to the monetary approach of the exchange rate, the determination of the exchange rate is dictated by the confrontation between supply and demand for real cash. Any imbalance in the foreign exchange market has an effect on the exchange rate.

We limit the sign of the response of all variables to a real exchange rate shock; in particular, the interest rate cannot fall due to a shock of depreciation of the real exchange rate. The large number of sets of impulse response functions required for the signaling restriction method is generated by the procedure recently proposed by Ouliaris and Pagan (2016). This generation method, like all other methods of generating impulse responses in sign restrictions, will influence the distribution of accepted impulse responses and the statistics (for example, the median response) that summarize them (see Fig. 3).

The relationship between the exchange rate and the interest rate has been investigated in various theoretical models of international economics, with such models frequently including other fundamental-variable determinants of the exchange rate such as relative money supplies and domestic and foreign outputs (Bilson, 1978; Dornbusch, 1976; Engel and West (2005); Fränkel, 1976, 1979; among others). The theoretical relationship between the two concepts in

the short-run negative relationship arises from the intuition that, all else equal, an increase in the home-country interest rate relative to the foreign one will induce financial capital flows to the home country, which creates pressure for the home country's currency to appreciate.

The long-term positive relationship may be due to the increase in the home country's interest rate relative to the foreign rate frequently reflecting an increase in higher inflation conditions in the home country relative to the foreign rate, which also creates pressure for the home country's currency to depreciate. A positive relationship can also be associated with a fall in the value of the home country's currency leading to an increase in the home country's trade balance on the one hand and a decrease in the external trade balance on the other hand. , which induces a rise in the domestic interest rate and a fall in the foreign interest rate (Bilson, 1978; Dornbusch, 1976; Engel and West (2005); Fränkel, 1976, 1979).

Dornbusch (1976), find that the uncovered interest rate parity condition provides a basis for the interest rate and the exchange rate being negatively related as a result of monetary shocks, both during a time period when the aggregate price level is held constant and during the period in which the aggregate price level is moving slowly toward its new long-run equilibrium.

Our main findings are as follows. First, the findings reveal that there is bidirectional causal relationship between inflation (CPL) and Output, and monetary supply and output gap; there is also unidirectional causal relationship. Second, our study shows that the relationship between monetary policy and the exchange rate is better verified at long term. However, in the short term, this correlation in developed countries is not stable, and rather has an opposite sign on average. This short-term gap may be due to the existence of monetary shocks.

Finally, exchange rates have played a necessary role in decision-making regarding monetary policy in the euro area. This reflected not only developments during the financial crisis, but also features of the current conjuncture, including the effect on exchange rates of volatility in capital flows and also low global interest rates.

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