American Journal of Applied Science 2 (2): 504-507, 2005
ISSN 1546-9239

A Causal Relationship and Macroeconomic Activity: Empirical Results From European Union

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Abstract: This study investigates the relationship among macroeconomic variables using quarterly data for European Union covering the period from 1970 I to 2000 IV. The purpose of this study is to estimate the dynamic interrelation among macroeconomic variables such as money, gross domestic product, interest rates, level of price and exchange rates. For the empirical analysis of this investigation, we employ the Johansen multivariate cointegration technique as well as Granger causality tests. The empirical results provide evidence for the existence of important causality relations between variables that describe macroeconomic activity.

Key words: Causal Relationship, Macroeconomic Activity, European Union

INTRODUCTION

In the study of empirical macroeconomics the dynamic interrelation among economic variables is crucial and controversial. The central question has been the study of the causal relationship among output and other macroeconomic variables such as money supply, interests, inflation and exchange rates. Different schools of thought, such as the Classicals, the Keynesians, the Monetarists, the New Classicals, the New Keynesians, the New Growth Theorists have provided different explanations for the relationship among variables.

The emphasis of the Keynesian theory was that the effective demand determines output. Even if output eventually returns to its natural level in the long run, this process is very slow. In the 60s debates between Keynesians and Monetarists, dealt with three issues: the effectiveness of monetary versus fiscal policy, the Phillips curve and the role of policy. The Keynesian school of thought emphasized fiscal rather than monetary policy as more important to the economy.

Friedman and Schwarz [1] studied the evidence on monetary policy and the relationship between money supply and output in the U.S.A over a century. Their conclusion was that the monetary policy was very powerful and could explain most of the fluctuations in output. Monetarists agreed with the Classicals about the long-run neutrality of money supply and that in the long run there was no trade-off between inflation and unemployment. An important development during the 80s was the emergence of the Real Business Cycle Theory. As opposed to Keynesians and Monetarists who concluded that business cycles result in changes in Aggregate Demand (AD), RBC theorists ruled out any demand changes as a likely cause of long-lasting changes in real output. Some new classical economists assumed that business cycles are caused by factors that disturb the long-run growth trend of aggregate supply. According to this view, real factors as technology, resource availability and productivity are the main causes of business cycles.

Since the mid-1980s the New Growth Theorists have been discussing the determinants of technological progress and the role of the increasing returns to scale in explaining economic growth. A vast empirical literature has studied the predictions on the theories. Kamas and Joyce [2] investigated the impact of changes in monetary variables in domestic and foreign sections for Mexico and India under fixed exchange rates in two economies. The results of their investigation proved that the domestic monetary policy didn't affect output in the two economies. Bryant [3] contrasted and compared simulations by more than 10 empirical macroeconomic models. Karras [4, 5] using a simple model studied the ability of monetary policy to affect output for a panel of 38 countries and concluded that money supply affects output, while increases its influence on inflation.

In the same framework Gordon and King [6], Masih and Masih [7, 8], Hondroyannis [9] have examined the causal relationships among money supply and other variables of macroeconomic activity for various countries and time periods. The different results of all these studies make it difficult for policymakers to draw firm conclusions on the relationship among macroeconomic variables. Furthermore, the new advances in the time series models help to shed light on the question of the interrelations among the macroeconomic variables.

The purpose of this study is to evaluate empirically the dynamic interaction among macroeconomic variables for European Union such as output, money supply,

Table 1: DF/ADF for a Unit Root Test

Variable	In levels			1st differences		
	Lag	Test statistic (DF/ADF)*	LM(4)**	Lag	Test statistic (DF/ADF)*	LM(4)**
LM	2	-1.4704	15.0362[.005]	1	-4.7254	3.0362[.055]
LGDP	1	-1.2515	7.8905[.096]	0	-4.7202	3.8905[.096]
LPRICE	4	-2.3987	64.7029[.000]	0	-9.7632	2.1539[.164]
LINTER	1	-0.2837	13.2958[.010]	0	-7.9049	3.2958[.110]
LEXCH	0	-2.1629	106.322[.000]	0	-8.3140	3.8567[.098]

* Critical value: -2.8859

** The numbers in parentheses show the levels significance

Table 2: Johansen and Juselious Cointegration Tests
Variables LM, LGDP, LPRICE, LINTER, LEXCH

Eigenvalues			Critical Values	
Null	Alternative	Eigen value	95%	90%
r = 0	r = 1	64.250	29.9500	27.5700
r<= 1	r = 2	23.8181	23.9200	21.5800
r<= 2	r = 3	17.9623	17.6800	15.5700
r<= 3	r = 4	3.1086	11.0300	9.2800
r<= 4	r = 5	0.6309	4.1600	3.0400
Trace statistic			Critical Values	
Null	Alternative	Trace	95%	90%
r = 0	r>= 1	109.7705	59.3300	55.4200
r<= 1	r>= 2	45.5200	39.8100	36.6900
r<= 2	r>= 3	21.7019	24.0500	21.4600
r<= 3	r>= 4	3.7395	12.3600	10.2500
r<= 4	r = 5	0.6309	4.1600	3.0400

inflation, interests and exchange rates. The testing for the existence of statistical relationship among 5 variables carries out as follows: Initially we confirm the integration order of related variables. Then we proceed with cointegration test using the Johansen maximum likelihood approach and finally Granger causality test deploys, since firstly the vector error correction model has preceded.

Unit root tests: The ADF tests are presented in Table 1 for the 5 variables that have been used in this study. The tests for the existence of unit root are based on Dickey-Fuller studies [10, 11] and used to measure the integration order of the examined variables in this empirical analysis. For the best structure of ADF equations we used the Akaike [12] and Schwarz [13] information criteria, while the Lagrange Multiplier LM(4) test has been used for the autocorrelation test of disturbance terms.

The results of Table 1 indicate that the variables in their first differences become stationary, therefore they can be characterized as integrated order 1, I(1). Moreover, for all variables LM(4) test first differences shows that there is no serial correlation in the disturbance terms.

Since it has been determined that the variables under examination are integrated order 1 I(1), we proceed by defining the number of cointegrating vectors among variables, using the Johansen [14] maximum likelihood procedure approach, Johansen and Juselious [15, 16]. This approach tests the number of cointegrating vectors among all variables. It also treats all variables as endogenous, thus avoiding the arbitrary choice of a dependent variable.

Given the fact that in order to apply the Johansen technique a sufficient number of time lags is required, we have followed the relative procedure which is based on the calculation LR (Likelihood Ratio) test statistic [17]. The results showed that the value $\rho = 3$ is the appropriate specification for the above mentioned relationship. Further on we determine the cointegration vectors among all variables. The procedure of calculating order r is related to the estimation of the characteristic roots (Eigenvalues), which are the following:

$\hat{\lambda}_1 = 0.41198$ $\hat{\lambda}_3 = 0.13796$ $\hat{\lambda}_5 = 0.005200$

$\hat{\lambda}_2 = 0.17868$ $\hat{\lambda}_4 = 0.025364$

The results that appear in Table 2 suggest that the number of statistically significant cointegration vectors

Table 3: Estimation of Error Correction Model Coefficients

Endogenous variables	Estimates of EC Coefficient terms	t-statistic	P-value
DLGDP	- 0,6278E-3	- 4,9631	0,000
DLM	- 0,7516E-3	- 9,1183	0,000
DLPRICE	- 0,2443E-3	- 1,2425	0,217
DLINTER	0,0013132	1,6480	0,102
DLEXCH	0,6045E-3	1,0039	0,318

Table 4: Granger Causality Tests

Dependent variable	Hypothesis tested	F1	F2
DLM	DLGDP there is a unidirectional relationship (DLM ⇒ DLGDP)	0,304	5,316
	DLPRICE there is a unidirectional relationship (DLM ⇒ DLPRICE)	1,302	3,495
	DLINTER there is a unidirectional relationship (DLM ⇐ DLINTER)	3,243	1,435
	DLEXCH there is a unidirectional relationship (DLM ⇐ DLEXCH)	3,922	0,360
DLGDP	DLPRICE there is a unidirectional relationship (DLGDP ⇐ DLPRICE)	3,106	0,304
	DLINTER there is a unidirectional relationship (DLGDP ⇐DLINTER)	4,066	1,603
	DLEXCH there is a unidirectional relationship (DLGDP ⇐DLEXCH)	4,485	0,431
DLPRICE	DLPRICE there is a unidirectional relationship (DLPRICE ⇒ DLINTER)	1,157	5,164
	DLPRICE there is a unidirectional relationship (DLPRICE⇐ DLEXCH)	3,824	0,524
DLINTER	DLINTER there is a unidirectional relationship (DLINTER ⇒ DLEXCH)	0,432	3,840

Critical value: 3,07

is equal to three. The results are the following:

LGDP= 14,8253LM –12,2490LPRICE -,9162LINTER –18,1903LEXCH (1)
LGDP= 7,5918LM –11,3461LPRICE + 5,8001LINTER + 9,0590LEXCH (2)
LGDP= 7,2475LM –11,6723LPRICE + 2,0322LINTER – 28,4300LEXCH (3)

According to the signs of the vector cointegration components and based on the basis of economic theory, relationship (1) can be used as an error correction mechanism in the VAR model.

The VAR Model with an Error Correction Model: After determining that the logarithms of the model's variables are cointegrated, we must estimate a VAR model with an error-correction model (EC).
Table 3 presents the estimations of error correction terms for all variables. The negative signs of the coefficients of the EC are consistent to the hypothesis that this term corrects the deviations from the long-term equilibrium relationship. Also, in Table 3 we can see that there is significance of the coefficients of error correction model in all variables.
From Table 3 it can be inferred that the coefficients of the error correction model are statistically significant in the functions of output and money supply, while are not statistically significant in the functions of price level, interest rates, exchange rate. Also, we don't have the expected signs in the functions of interest rates and exchange rate.

Granger Causality Tests: The model that was estimated in the previous part was used in order to examine the Granger [18] causal relationships among the variables under examination. As a testing criterion the F statistic was used. With the F statistic the hypothesis of statistic significance of specific groups of explanatory variables was tested for each separate function. The results relating to the existence of Granger causal relationships among the variables appear in Table 4.
The results of Table 4 suggest the following for money supply: There is a unidirectional causal relationship between money supply and output with direction from money supply to output.
There is a unidirectional causal relationship between money supply and price level with direction from money supply to price level.
There is a unidirectional causal relationship between money supply and interest rates with direction from interest rates to money supply.
There is a unidirectional causal relationship between money supply and exchange rate with direction from exchange rate to money supply.
For output we can infer that: There is a unidirectional causal relationship between output and price level with direction from price level to output.
There is a unidirectional causal relationship between output and interest rates with direction from interest rates to output.
There is a unidirectional causal relationship between output and exchange rate with direction from exchange rate to output. For the price level we can infer that: There is a unidirectional causal relationship between

price level and interest rates with direction from price level to interest rates. There is a unidirectional causal relationship between price level and exchange rate with direction from exchange rate to price level.
Finally, for the interest rates we infer that: There is a unidirectional causal relationship between interest rates and exchange rate with direction from interest rates to exchange rate.

CONCLUSION

The main purpose of this study was to examine the dynamic interrelations among money supply, output, price level, interest rates, exchange rate using quarterly data for the European Union. In the framework of this empirical analysis, we applied the cointegration technique then we specified an error correction model and specified an error correction model and finally investigated the existence of causal relationships of the variables in use. The evidence of cointegration existence among these variables suggest that there is a long-term equilibrium relationship. This implies that although these variables may have occasional short-term or transiently deviations from their long-term equilibrium, at the end they are directed to equilibrium due to pressure. Moreover, the cointegration excludes the possibility that the estimated relationship is spurious. This means that there must be Granger causal relationship among variables. The results showed that money supply directs output (is more consistent with Keynesian and monetaristic theory) and price level, while interest rates and exchange rates are in reverse direction relatively with money supply. Moreover, the results suggest that price level, interest rates and exchange rate direct output. Finally, interest rates are directed by price level, while exchange rate directs price level and is directed by interest rates.

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