
Dependencies Occurring Between the Basic Macroeconomic Indicators in Eurozone

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Abstract

The article is of a theoretical and empirical nature. The main purpose of the article was to verify the existence of dependencies between selected basic macroeconomic indicators. The following were adopted for the study: unemployment rate, inflation rate, Gross Domestic Product, interest rate, exchange rate, value of exports and imports. An attempt was made to obtain an answer to the question whether there is a causal relationship between macroeconomic indicators characterizing the economic situation. The hypothesis was adopted that the interest rate is the strongest determinant of basic macroeconomic values. Pearson's linear correlation coefficient was used to determine the direction and strength of interdependencies between the analysed categories. Using the auto regression vector model, the apparent correlation was eliminated and the influence of delays of explanatory (exogenous) variables on the explained (endogenous) was presented. The final stage of the analysis was the Granger causality test showing cause-and-effect dependencies occurring between the examined indicators. The empirical part uses the World Bank resources on the basic annual average macroeconomic measures characterizing the euro area from 1999-2016.

The most important sources of information in the theoretical part were economic literature, supplementary use of normative documents, publications in serial publications and magazines as well as Internet resources.

Keywords: Causation, connections, GDP, Granger test, macroeconomic indicators

Introduction

The economy is a system built of households, enterprises and all state or private institutions to ensure the needs of a given population [1]. They create markets for particular goods and services that add up to the national market (national economy), the regional market (regional economy) or the international market (international economy) [2]. The economy is constantly subjected to regulation by the state (command economy), self-regulation through the market (market economy) or regulation in an integrated manner (market economy with a country having tools and opportunities to intervene in the economic system-mixed economy) [3]. The economy is an extremely dynamic organism that changes its internal structure through complex long-term processes as well as one-time phenomena-crises, shocks, conflicts and wars, or natural disasters [4].

Each individual country strives to build the strongest economy, because it will ensure the growth of the well-being, security and quality of life of its community, and thus the main purpose of the

existence of state institutions will be met [5]. The situation is similar in the case of currency-economic unions, which consist of different countries, and thus economies forming one in common. It is true that there are specific differences between particular countries, but all of them work together jointly for joint economic success. An example of this is the euro zone, which has been operating successfully since 1999.

The economy, through its characteristics and complexity, is in constant motion. Therefore, it must be under constant control, or surely economic phenomena are what governments would like.

Any deviations from the assumptions can be adjusted, among others thanks to state interference, it is extremely important to diagnose problems and deviations at the earliest possible stage in order to use tools to counteract or repair an undesirable condition in a timely manner. Each and every component of macro-environment influences the economy, as well as the relations that take place between them. The current state of each macroeconomic indicator characterizing the given economic phenomenon affects the economy in the same way. Thus, the question arises whether relations and causal relationships exist between the basic macroeconomic measures. In the light of the question posed in this article, an attempt was made to verify whether dependencies exist between selected macroeconomic indicators and what their nature is. There are many measures of economic condition, which, depending on the needs, show its selected fragments. The following average yearly data were used for the analysis:

- GDP (in current USD) – GDP at purchaser’s prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources;
- Unemployment rate (% of total labour force, modelled ILO estimate) – unemployment refers to the share of the labor force that is without work but available for and seeking employment;
- Inflation rate (consumer prices %) – inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly;
- Interest rate (%) – the main tool of central banks to stabilize prices in the economy;
- Exchange rate (EUR/USD) – the price of the currency expressed in another currency, that is the exchange ratio of one currency to another. The place of transaction is the currency market;
- Export value (in current USD) – exports of goods and services represent the value of all goods and other market services provided to the rest of the world;
- Import value (in current USD) – imports of goods and services.

The article verifies the hypothesis that interest rate is the strongest determinant of basic macroeconomic values. In order to determine the direction and strength of the correlation occurring between the studied categories, Pearson’s linear correlation coefficient was used [6]. A more detailed analysis of the connections between macroeconomic factors was based on the analysis of the VAR model according to the equation [7]:

$$x_t = \alpha_1 + \alpha_{1.1}x_{t-1} + \dots + \alpha_{1.k}x_{t-k} + \beta_{1.1}y_{t-1} + \dots + \beta_{1.k}y_{t-k} \quad (1)$$

$$y_t = \alpha_2 + \alpha_{2.1}x_{t-1} + \dots + \alpha_{2.k}x_{t-k} + \beta_{2.1}y_{t-1} + \dots + \beta_{2.k}y_{t-k} \quad (2)$$

The model, according to the criteria of Akaike [8], Schwarz-Beusian [9] and Hannah-Quinn [10], was created with one delay. Both the residual autocorrelation test [11] and the normality test of the distribution of residues [12] confirmed the correctness of the selection of delays. The VAR model was also used to perform the Granger causality test [13]. His results showed whether any of the analyzed macroeconomic factors was the cause of another in the Granger sense. The subject of the study was the euro area, while information about its macroeconomic factors came from the World Bank's online resources.

The Eurozone 1999-2016

The eurozone (euro area) is a monetary union, which involves coordinating a common fiscal, economic and monetary policy and the use of the single currency – the euro (€). It was introduced on January 1, 1999 in non-cash form, whereas in cash form it exists from January 1, 2002.

Currently, around 340 million citizens of 19 countries live in the zone. The central bank of the zone is the European Central Bank (ECB), which is responsible for setting and implementing the economic and monetary policy framework. The ECB's main priorities are to maintain price stability and to support economic growth, and hence employment growth [14], [15]. The euro is the second most important currency in the FOREX market after the US dollar, which indicates the relatively high stability and significance of the zone on the international market [16]. It is worth noting that the euro area has changed over the period considered due to the accession of new countries to it.

However, due to the requirement to meet the convergence and fiscal unification criteria, it is assumed that each successive country did not negatively affect the macroeconomic indicators of the euro area (did not create disturbances in the economic situation).

In the analyzed time series, a positive trend of GDP and the unemployment rate was observed (Fig. 1). The GDP grew the most dynamically in 2001-2008. The global crisis caused a drop in the index by less than USD 2 trillion in 2010 compared to 2008. In 2011, the euro area economy recorded the first post-crisis GDP growth, however it did not meet the challenges and by 2016 it was negative trend of the indicator. The unemployment rate reached minimum values in 2007-2008. The outbreak of the crisis triggered a strong rise in unemployment, which reacted much stronger than GDP to the recession. Since 2013, the unemployment rate has a relatively strong negative trend. It is worth noting that until 2008 there was a negative correlation between GDP and the unemployment rate. This fact is a natural phenomenon, because the consequence of economic growth is the decline in unemployment. The situation changed after the outbreak of the crisis, because despite maintaining GDP at a relatively similar level, there was a significant increase in the unemployment rate. This is related to the problems of countries such as Spain and Portugal, which are unable to cope with the consequences of the recession.

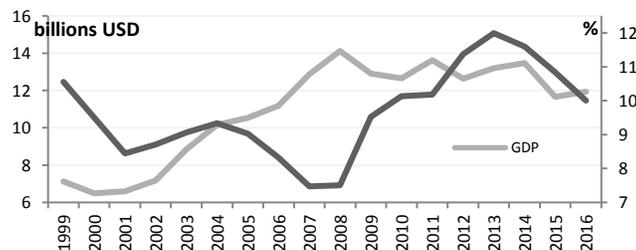


Fig. 1. GDP and unemployment rate in euro area in 1999-2016 (World Bank's online resources)

The global crisis 2008-2009 significantly affected the euro area. Its effect was also a relatively strong reduction in imports and exports (Fig. 2). However, in the entire analyzed period there was a significant positive trend of both measures. It is worth noting that since 2011 the trade surplus started to increase significantly, to exceed 10% y/y in 2015-2016. When analyzing the EUR/USD exchange rate, particular attention should be paid to the year 2012, in which the EUR/USD rate exceeded 1. Since 2009, there has been a negative relation between import and export and the exchange rate. It is assumed that the determinant of this phenomenon was the export causing an increase in foreign currency transfer to the market.

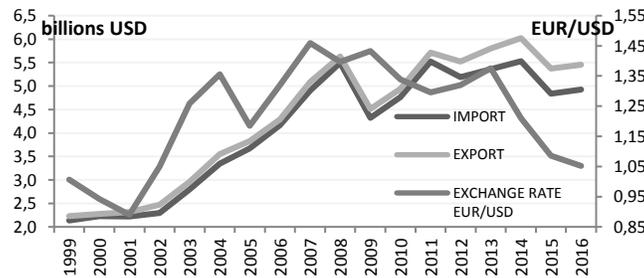


Fig. 2. Imports, exports and exchange rate in euro area in 1999-2016 (World Bank’s online resources)

One of the ECB’s basic missions is to maintain a stable price level, because deflation or excessive inflation causes many adverse consequences, which include a drop in the purchasing power of money. The central bank’s influence on this phenomenon is the interest rate, whose growth is caused by a drop-in demand in the economy, which results in a fall in prices. In the analyzed period, one can notice a correlation between the inflation rate and interest rates (Fig. 3).

There is a noticeable attempt to lower the inflation rate by the ECB in 2000, 2005-2007 and 2011. In the first case, the increase in interest rates was in almost perfect correlation with the increase in the rate of inflation. In the second situation, we can see a slightly belated reaction of the ECB, which until 2007 significantly increased the level of interest rates and it is assumed that the inflation growth trend was stopped. In order to minimize the effects of the economic crisis, it was decided to drastically reduce interest rates. There was only one correction in 2011, which effectively stopped the increase in the level of prices. The years 2014-2016 were, thanks to the minimum inflation and at record low interest rates, an ideal environment for the economic growth of the euro area.

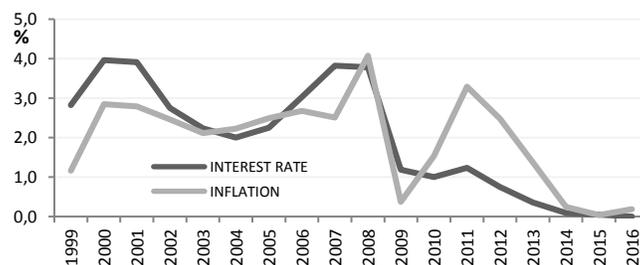


Fig. 3. Interest rate and inflation in euro area in 1999-2016 (World Bank’s online resources)

The analysis of the basic indicators of the euro area in the examined period of time showed some negative and positive relations, which can be expected in the further part. According to the theory

of economics there are relations between the indicators that were not observed using charts. The rest of the analysis should display any doubts.

Analysis of Dependencies Between Basic Macroeconomic Indicators in Eurozone

In the first stage of the analysis, the correlation between the examined categories was examined (Tab. 1). Pearson's linear correlation coefficient showed positive relations (highlighted): export values with the value of import, exchange rate with the value of import and the value of exports, interest rate inflation rate, GDP with import value, export value and exchange rate.

Table 1. Correlation relationships between the analyzed basic macro indicators in euro area

	Imports	Exports	Exchange rate	Interest rate	Unemployment rate	Inflation rate	GDP
Imports	1						
Exports	0,9958	1					
Exchange rate	0,6446	0,6032	1				
Interest rate	-0,5775	-0,6324	-0,1744	1			
Unemployment rate	0,3051	0,3568	-0,0764	-0,8029	1		
Inflation rate	-0,1586	-0,2263	0,1186	0,7238	-0,5982	1	
GDP	0,9738	0,9592	0,7747	-0,5313	0,2167	-0,1431	1

Source: own calculations based on World Bank data

The vector auto regression model with one delay was used for further analysis. This allowed to create equations describing each macroeconomic factor using the remaining ones (Tab. 2). As a result, the apparent correlation was eliminated and the impact of delays of the tested categories on endogenous variables was estimated. The VAR model also allowed to examine the significance of equations as well as exogenous variables. Based on the study, the apparent correlation was rejected and significant causal relationships between variables (highlighted) were estimated. An influence on the export value (Y explained by X in 98%) was found: positive – EUR/USD exchange rate; negative – GDP, unemployment and interest rates. The change in the interest rate by unit caused the reverse of the export value by 16 units (the strongest relation). The import value was influenced by (Y explained by X in 97%): positive – EUR/USD exchange rate; negative – GDP, unemployment rate and interest rate. The direction of dependence and their strength were at a similar level as in the case of explaining the value of exports. In this case, a change in the interest rate per unit resulted in a negative change in the value of exports by almost 16 units. The reverse effect of the unemployment rate on the EUR/USD exchange rate (Y explained by X in 84%) was observed. The change in the unemployment rate by unit affected the reduction of the exchange rate by less than 10 units. The analysis showed the impact on GDP (Y explained by X in 98%): positive-exchange rate y/y; negative – GDP lag 1, unemployment rate and interest rate. A change in the interest rate per unit resulted in a GDP decrease by over 12 units (the strongest ratio). The unemployment rate was determined positively (Y explained by X in 83%) by: the inflation rate and the interest rate. In both cases, the change of exogenous factors by unit did not cause a change in the unemployment rate exceeding the unit. It is worth noting the fact that the equation describing a given Y did not contain significant explanatory variables in two cases: while explaining the inflation rate and the interest rate. In the first situation, no macroeconomic indicator was statistically significant, but also the entire equation was devoid of significance (the equation described Y in only 62%). In turn, in the second case, the situation is all the more interesting because despite the lack of significance of

individual explanatory variables, the equation itself is important, so you can use it to describe the interest rate in 81%. In the last step of the research, the Granger causality test was carried out (Tab. 3). The following dependences were distinguished in color in the Granger sense: the value of exports is the cause of the inflation rate; the value of imports is the cause of export value and inflation rate; the inflation rate is the cause of the unemployment rate; the EUR/USD exchange rate is the reason for the value of exports, imports and GDP; GDP is the cause of the value of exports and imports; the unemployment rate is the cause of the value of exports, imports, EUR/USD and GDP; the interest rate is the cause of the value of exports, imports and GDP.

It is worth nothing that the test results of the Granger Causality test were not completely in line with the results of the VAR model analysis.

Table 2. Causal relationships in the Granger sense between the analyzed basic macro indicators in euro area

	Exports	Imports	Inflation	Exchange rate	GDP	Unemployment rate	Interest rate
Exports		0,1582	0,0312	0,8811	0,6681	0,6384	0,2441
Imports	0,0324		0,0394	0,8862	0,1825	0,4839	0,2869
Inflation rate	0,2331	0,2169		0,6063	0,9448	0,0215	0,1464
Exchange rate	0,0005	0,0011	0,1648		0,0042	0,4821	0,4224
GDP	0,0023	0,0094	0,2153	0,8724		0,2711	0,5706
Unemployment rate	0,0019	0,0051	0,2721	0,0223	0,0147		0,9706
Interest rate	0,0008	0,0032	0,3079	0,0677	0,0004	0,6831	

Source: own calculations based on World Bank data

Conclusion

The studies carried out clearly indicate the existence of dependencies between the basic macroeconomic indicators, and thus between the phenomena characterizing the economic situation in eurozone in years 1999-2016. The VAR model presented that the increase in the inflation rate caused a relatively weak increase in the unemployment rate. The phenomenon is in line with the theory of economics, because an unfavorable level of inflation can affect the reduction of employment. VAR showed a small positive relation between the EUR/USD exchange rate and the value of imports, exports and GDP. The increase in the exchange rate in accordance with the theory of economics stimulates imports and increases GDP, while it inhibits exports – in this case the study indicated the opposite. In addition, the exchange rate was related to the future exchange rate in the negative relationship, which is difficult to explain. VAR pointed out that GDP growth affected the decline in the value of exports, imports and the future GDP. This is an interesting situation, because according to the theory of economics, increased income (production) affects: the increase in imports through initiated demand for production factors and foreign consumer goods; increase in exports through the increased value of exported goods and services; increasing future GDP. The VAR model pointed out that the growing unemployment rate had a significant impact on reducing the value of imports, exports, the exchange rate and GDP. This phenomenon is strongly felt in the euro area, as countries such as Spain and Portugal are struggling with rising unemployment and declining imports, exports and GDP. In the case of these countries, the exchange rate is somehow stabilized by other countries in the euro area, but if they had their own currency, one can assume that its exchange rate would decrease as strongly as other measures.

VAR also presented a significant impact of the interest rate increase on the reduction in the value of exports, imports, GDP and an increase in the unemployment rate. The theory of economics

confirms these phenomena, because the increase in interest rates causes an increase in interest rates on the money and credit-deposit market. This means that enterprises and households decide to save money at a higher interest rate, instead of taking out unattractive consumer or investment loans.

The increase in interest rates simultaneously reduces the supply of bank loans due to the increased risk of the problem with repayment of liabilities, more expensive obtaining of external financing by banks, but also by transferring bank funds into, for example, more attractive state bonds. The reduction of investment and consumption reduces demand within the economy in relation to supply. This, in turn, may be the reason for the price pressure. As a consequence of the increase in interest rates, the unemployment rate will increase, export and import decrease, as well as GDP. The Granger causality test did not confirm all the dependencies of the VAR model, but additionally indicated those which the model considered irrelevant. The differences indicated by the test include the causality in the Granger sense of the value of exports on the inflation rate and the value of imports on the value of exports and the inflation rate. In turn, the lack of causality in the Granger sense occurred in the case of the impact of the interest rate on the unemployment rate.

The analysis made it possible to recognize the validity of the hypothesis that the interest rate has the strongest impact on basic macroeconomic values. Its increase is assumed to be responsible for the reduction of the inflation rate (which the study did not confirm), but it carries very unfavorable results for other macroeconomic indicators, and thus for the whole economy. It is also worth noting that the strong negative impact on the basic measures was caused by increases in the unemployment rate. This fact is easily linked to the policy of governments that strive for the lowest unemployment rate, while remembering that its level should not threaten economic growth.

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Table 3. Relations between basic macro indicators using the VAR model in euro area

	X							P value		
	α	β_1	β_2	β_3	β_4	β_5	β_6		β_7	R^2
Y = exports	$\alpha = 41,7287$ p = 0,0032	imports lag1	exports lag1	inflation lag1	EUR/USD lag1	GDP lag1	unemployment lag1	interest rate	0,9761	0,0475
		$\beta_1 = -3,5276$ p = 0,0611	$\beta_2 = -1,4746$ p = 0,3128	$\beta_3 = -3,2862$ p = 0,2636	$\beta_4 = -1,0709$ p = 0,0069	$\beta_5 = -2,4002$ p = 0,0138	$\beta_6 = -10,4145$ p = 0,0128	$\beta_7 = -16,0749$ p = 0,0085		
Y = imports	$\alpha = 41,1318$ p = 0,0063	exports lag1	imports lag1	inflation lag1	EUR/USD lag1	GDP lag1	unemployment lag1	interest rate	0,9695	0,0024
		$\beta_1 = -2,1585$ p = 0,1917	$\beta_2 = -4,0877$ p = 0,0522	$\beta_3 = -3,7723$ p = 0,2482	$\beta_4 = -1,1116$ p = 0,0098	$\beta_5 = -2,2628$ p = 0,0290	$\beta_6 = -10,4414$ p = 0,0207	$\beta_7 = -15,6600$ p = 0,0164		
Y = inflation	$\alpha = 2,3705$ p = 0,1364	exports lag1	inflation lag1	imports lag1	EUR/USD lag1	GDP lag1	unemployment lag1	interest rate	0,6193	0,1497
		$\beta_1 = -0,4106$ p = 0,0596	$\beta_2 = -0,2657$ p = 0,5031	$\beta_3 = -0,4695$ p = 0,0695	$\beta_4 = 0,0589$ p = 0,1982	$\beta_5 = -0,1347$ p = 0,2466	$\beta_6 = -5,104$ p = 0,3005	$\beta_7 = -0,6761$ p = 0,3345		
Y = Exchange rate	$\alpha = 5,50443$ p = 0,6954	exports lag1	EUR/USD lag1	imports lag1	inflation lag1	GDP lag1	unemployment lag1	interest rate	0,8432	0,0049
		$\beta_1 = -0,2677$ p = 0,8844	$\beta_2 = 0,6132$ p = 0,1585	$\beta_3 = -0,30097$ p = 0,8913	$\beta_4 = 6,71398$ p = 0,0933	$\beta_5 = -0,16396$ p = 0,8760	$\beta_6 = -9,9716$ p = 0,0482	$\beta_7 = -11,3814$ p = 0,1009		
Y = GDP	$\alpha = 38,0678$ p = 0,0009	exports lag1	GDP lag1	imports lag1	inflation lag1	EUR/USD lag1	unemployment lag1	interest rate	0,9765	0,0311
		$\beta_1 = -0,443$ p = 0,6781	$\beta_2 = -1,4266$ p = 0,0385	$\beta_3 = 1,6469$ p = 0,2152	$\beta_4 = -0,1428$ p = 0,9463	$\beta_5 = 0,9468$ p = 0,0026	$\beta_6 = -10,6991$ p = 0,0021	$\beta_7 = -12,6829$ p = 0,0064		
Y = unemployment rate	$\alpha = -1,1602$ p = 0,3201	exports lag1	unemployment lag1	imports lag1	inflation lag1	EUR/USD lag1	GDP lag1	interest rate	0,8279	0,0072
		$\beta_1 = 0,0682$ p = 0,6492	$\beta_2 = 0,8591$ p = 0,6926	$\beta_3 = -0,1214$ p = 0,5016	$\beta_4 = 0,6663$ p = 0,0470	$\beta_5 = -0,0227$ p = 0,4999	$\beta_6 = 0,091$ p = 0,2997	$\beta_7 = -0,8591$ p = 0,0380		
Y = interest rate	$\alpha = 1,0614$ p = 0,4169	exports lag1	interest rate	imports lag1	inflation lag1	EUR/USD lag1	GDP lag1	unemployment lag1	0,8127	0,0102
		$\beta_1 = -0,1911$ p = 0,2741	$\beta_2 = 0,7019$ p = 0,2499	$\beta_3 = 0,2019$ p = 0,3146	$\beta_4 = -0,4761$ p = 0,1804	$\beta_5 = -0,0293$ p = 0,4430	$\beta_6 = -0,0531$ p = 0,5845	$\beta_7 = -0,0147$ p = 0,9714		

Source: own calculations based on World Bank data