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Analysis of the Dynamics of Inflation in Serbia

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Abstract
Inflation is one of the phenomena that attract the attention of many researchers. Inflation is not a phenomenon that has appeared in recent years, from the time of creation of money and the development of the first economies. Today, although there are a large number of papers on this topic, we still do not know enough about all the factors that affect the formation and evolution of inflation and inflation dynamics. Regression analysis is a powerful statistical tool that can help you gain a large amount of existing data on inflation analysis and thus to partial answers to the questions that are all factors that affect inflation and in what way. In this paper, the use of multiple regression analysis was performed to analyze the influence of factors that contribute to the emergence of inflation, such as monetary aggregates, discount rate and the level of gross domestic product, the discount rate of the Central Bank of Serbia. It is also an analysis of the coefficients of price elasticity of money in the long run, the coefficient of price elasticity of production in the long term and elasticity of demand for money in Serbia.

Keywords
CPI, Serbia, monetary aggregates, multiple regression analysis, long-run price elasticity of money, long-run price elasticity of output, income elasticity of money demand.

Introduction

Since the creation of money people have constantly been investigating its origin, character and essence. These studies continue today, and will continue as long as there is money. From the moment when money is inserted into the process of exchange of goods, it constantly occupied professional public. It is especially important how and to what extent money affects key macroeconomic variables such as inflation, exchange rates, interest rates, growth rates of gross domestic product, unemployment, etc.

In terms of the impact of money on these variables, there are conflicting opinions in theory. Some highlight the role of money and emphasize that it is very important. Others argue that money has a neutral role and only affects nominal variables, while in the long term it has no influence on real variables. Third point out that one could live and work without money, because money has intermediary role. However, the fact is that when the central bank loses compass in the conduct of monetary policy, it results in high inflation, which often ends in hyperinflation episode, which destroys the financial and economic system, and seriously undermines the functioning of the social system. It is therefore very important to correctly measure the timely acceleration of money supply by the central bank, because the fact is that the existence of a stable economy is possible only if there is a required amount of money in circulation.

The aim of this paper is to use regression analysis and multiple regression analysis to determine the impact of parameters such as the amount gross domestic product, the M3 monetary aggregate, discount rate of the Central Bank of

Serbia on the level of inflation in Serbia in the period from 2007 to 2015 on a quarterly level.

1. The concept of inflation

Inflation can be defined as the continuous growth of the general level of prices or continuous absolute decline in the value of money. Many authors are trying to define inflation in different ways so that they can explain its consequences in detail. The best definition of inflation was given by Professor Hamid Filipović (1960, p. 69) as follows: "Inflation is an economic and financial phenomenon, caused by disturbance of the balance in the factors of production, and as a consequence it results in increase of money circulation by issuing banknotes and credit money without proper cover in metal or production, which results in loss of purchasing power of money and the price rise, which is reflected in the redistribution of national income at the expense of poorer, and in favour of wealthier social classes".

Inflation is not an economic phenomenon of recent date. The first signs of inflation date back to ancient times when precious metals played the role of money. For example, when gold was used as money, rulers collected coins, melted and mixed them with other metals, copper or lead, and put it back on the market, with the nominal value of these coins remaining the same, but with changed real value. In this way, the authorities issued a greater amount of money than they possessed gold for making it, and thus made a profit by reducing the cost of minting new coins. This lead to an increase in money supply in circulation with an unchanged demand for it, which lead to a reduction in the value of money. This still means that the purchase for the same quantity of certain goods citizens had to provide greater amount of money, which lead to an increase in the price of goods and services due to the fall in the value of money. There are numerous examples of rulers who have used this technique.

The consequences of inflation are numerous, and can be positive and negative. Some authors identify inflation with alcoholism and drunkenness (Đurović-Todorović, 2014, p. 353). Initially, inflation is low and has a positive effect, because it leads to the expansion in production and employment, increases in the prices of goods and an increase in wages. Later economic agents recognize that the changes are only apparent, that real wages have not increased, but only nominally, and economic agents try to predict future inflation trends, and to engage in increasing their earnings. If policymakers do not react on time with appropriate instruments and measures, and do not maintain the confidence of other undertakings, it can lead to hyperinflation, the rejection of the national currency due to loss of confidence in it and the collapse of the economy.

What now interested many researchers is to identify signs of inflation to be used by policy makers as a signal that there is a certain change in the dynamics of inflation. So today, a number of central banks' main objective includes maintaining price levels and implementing the strategy of inflation targeting.

2. Theories and measurement of inflation

Inflation has many causes and is rarely caused by only one factor. Usually the initial impulse is given by one factor, but it soon adds new impulses caused by other factors. Depending on whether the initial causes of inflation are on the demand side or on the cost side, we can talk about inflation, demand inflation and costs inflation. In addition to these theories of inflation in the literature there is theory of structural inflation, which sees causes of inflation in structural disturbances in the economy.

The theory of inflation demand occurs in two main variants: Classical and Keynesian. According to the classical approach, inflation is a monetary phenomenon. Since it is expressed in monetary prices of goods, there must be a definite relationship between the money supply and price level. Basically the classical explanation of inflation is a quantitative theory of money. The inflation rate will depend on whether the economy is in a state of full employment and whether there are inflationary expectations.

Chicago School monetarists do not consider the speed of circulation of money a constant, as it is considered by the quantitative theory of money, but more stable and predictable function of a number of variables. In the long run, velocity of money is very stable, with a slight downward trend. Therefore, inflation in the long term is impossible without an increase in the money supply. In the short term, monetary changes will mainly operate on output growth in the long run will act solely on price.

Keynesian theory rejected the assumption of the functional interdependence of money and aggregate spending. Prices may rise when the money supply is not growing, but can also remain unchanged when the money supply grows faster

than production. In a state of full employment, increasing effective demand can affect the increase in production and employment, but only on the growth of the general price level. The growth of nominal wages in a state of full employment, with unchanged propensity to save, encourages imbalance between aggregate demand and aggregate supply and leads to price increases. The price increase will continue until the state reduces the level of disposable income. Keynes sees an important role for fiscal policy.

Keynes essentially denied Say's Law of the market, arguing that the balance of savings and investments is not as easy as classicists thought. His criticism was directed towards the flexible prices and wages, considering that various monopolies and trade unions impede the movement of prices and wages down, which would lead to the establishment of a new full employment. Keynes' measures proved to be successful to pull the economy out of a deep depression (Živkov, 2008, p. 21).

According to the theory of cost inflation, inflation is caused by growth of costs in the production of goods and services, with unchanged demand. The increase in any category of costs that are not compensated by a corresponding reduction of some other categories of costs, pushed up prices, and hence the term cost-push inflation. Rising costs put pressure on prices, thus moving upward the spiral of costs and prices.

According to the theory of structural inflation insufficient sectoral coordination of supply and demand is the cause of inflation. The backwardness of entire branches of industry increased prices of their products and services, even if the economy does not have an excess of aggregate demand. If it is an important economic sector such as construction and agriculture, the increase in prices in these sectors is transmitted to all branches and causing inflation. If there is excess aggregate demand, structural inflation may become very strong.

Inflation is usually determined by the rate of inflation. The inflation rate is calculated as a percentage share of the price difference from the current period with the price from the previous period in price from the previous period.

$$\%\, inflation = \frac{price\ level(t) - price\ level\ (t-1)}{price\ level\ (t-1)} \cdot 100\%$$

Inflation can be measured by different price indices: The producer price index, consumer price index and GDP deflator (Kitanović & Golubović, 2006, p. 485).

In practice, the most widely used measure is the Consumer Price Index (CPI). Consumer Price Index is a measure of the price level selected group of goods that the average consumer uses. It is calculated as:

$$CPI = \frac{current\ price\ level}{price\ level\ in\ base\ period} \cdot 100$$

When calculating the overall consumer price index to each of the price of goods that have been acquired by the list allocates the appropriate weight and is calculated as a weighted average of prices of goods.

$$CPI = \sum_{i=1}^{n} CPI_i \cdot w_i$$

Producer Price Index (PPI) is the average change in prices of the products produced by local manufacturers.

In addition to these indicators more indicators are used such as cost of living index, consumer price index, GDP deflator and core inflation. Cost of living index measures the change in the average level of the cost of living. The retail price index measures the change in the average level of retail prices. GDP deflator is a measure of the price level of new final products and services produced in the country and core inflation. It is calculated as the ratio between the nominal GDP and real GDP and the resultant value is multiplied by a hundred. Core inflation is a measure of inflation that has been in use the past few decades. It is calculated on the basis of changes in retail non-seasonal goods and services which are formed according to market conditions. It does not include the price rove in some of the regimes of regulation (energy, utilities and other services, medicines, etc.).

European Central Bank is using in the harmonized consumer price index - HICP to determine the inflation and price stability. This index is the consumer price index, which is compiled according to the methodology that is harmonized in the countries of the European Union. In the euro area HICP is a weighted average price index of the Member States that have adopted the euro. The primary objective of the ECB is to maintain price stability, defined as the maintenance of HICP growth from one year to not more than 2% over the medium term.

3. Measuring inflation dynamics through regression analysis

In today's inflation, great attention is dedicated to the research of the dynamics of inflation and its relation to other macroeconomic indicators, such as unemployment, income and money supply. Some of the works dealing with this issue are Hess and Schweitzer (2009) and Bjornstad and Nymoen (2008). Rudd and Whelan (2005) study inflation in their work in terms of rational expectations of economic agents and the inflation trends. Flanita and Sipos (2007) dealt with the analysis of inflation and the impact of macroeconomic indicators such as unemployment rate, foreign exchange rate, interest rate, PPI, monetary aggregates and loans issued on the case of Romania and determine the existence of a significant relationship and impact of these indicators on inflation.

One of the things that also attracted the attention of researchers has studied the dynamics of inflation, or in terms of physics. Lewis (2010) applied Newton's law of cooling to describe the trend of inflation in the case of the United States over the long term and showed that this law, which is used in physics in the field of thermodynamics, can describe the trend of inflation in the long run. Also Tomić (2011) in his master thesis has shown that the same law can be applied to describe the dynamics of the value of monetary aggregates in the long term.

Today, many studies conducted in order to determine the importance of the use of monetary aggregates to maintain the stability of the price level. Ndjokou (2011) has shown that it is important to define the monetary aggregates well in order to maintain a stable price level in the BEAC zone. In his work on the case of Nigeria, Adedoyin (2006) found that there is a relationship between monetary aggregates and inflation. Frederic (2000) studied what the best strategy is to maintain price stability in the case of industrialized countries. In the case of Germany and Switzerland it has been shown that targeting monetary aggregates gives the best results, while the case of other countries, inflation targeting is the best strategy. Bennett and Edward (2010) demonstrated relationship between monetary aggregates and inflation by the quantity theory in their work.

In this paper we analyze the dynamics of inflation in the Republic of Serbia in the period from January 2007 to the end of the third quarter of 2015. Data on dynamics in the price level were obtained from the website of the Statistical Office of the Republic of Serbia in which was used as an indicator of inflation CPI with base value in 2006. Graph made using the program Origin 9.

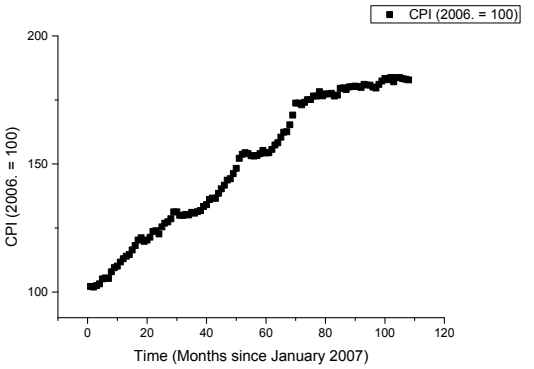

Figure 1 Graph of CPI dynamics
Source: Authors

On the basis of the graphic we can see that in the period from January 2007 until the first 70 months there is a strong trend of price growth in Serbia, while from the 70 month onwards a decline in the growth rate of the price level and come up with a period of stabilization of the price level in Serbia.

To perform the analysis of the dynamics of inflation in Serbia we used the data for CPI, GDP, CBS discount rate and the M3 monetary aggregate on a quarterly basis in the period from the first quarter of 2007 to the third quarter of 2015. At the beginning regression analysis was performed for each of the observed elements of simple linear regression, while after this analysis, we used the model presented by dr Rangarajana (2012) which performs analysis of inflation trends based on multiple regression analysis and to:

$$P_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 M_t + \alpha_3 E_t + \alpha_4 P_{t-1} + \varepsilon_t$$

where:

Y_t - logarithmic value of GDP per time unit *t*
M_t - logarithmic value of the M3 monetary aggregate per unit time *t*
E_t - logarithmic value discount rate NBS unit time *t*
P_t - logarithmic value of the CPI index in a unit of time *t*
$\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4$ - coefficients
ε_t - error

Based on the obtained values of coefficients we can see the degree of influence of some of the

observed indicators of the movement of the price level in the reporting period *t*. Rangarajan also proposed to use additional indicators that will talk about the elasticity of money and elasticity of output in the long term, as well as the income elasticity of demand for money. These indicators are obtained by applying the following formula:

$$El_n = \frac{\alpha_2}{1-\alpha_4}$$

$$El_o = \frac{\alpha_1}{1-\alpha_4}$$

$$El_t = \left|\frac{\alpha_1}{\alpha_2}\right|$$

Further work will be performed linear regression of each of the parameters that are taken into consideration and presented free linear regression models. Durbin-Watson test will be taken as a test of autocorrelation.

4. Results

Based on the model presented in this paper an analysis of data is collected using the multiple linear regression. Data processing is performed in the Gretl program.

Table 1 Values for multiple linear regression

	Coefficient	*Standard error*	*t-ratio*	*p-value*	
const	0,609212	0,274505	2,2193	0,0344	**
logGDP	−0,136214	0,0437054	−3,1166	0,0041	***
logM3	0,0883919	0,0425057	2,0795	0,0465	**
loges	0,0245395	0,0109992	2,2310	0,0336	**
logCPI1	0,831558	0,063285	13,1399	<0,0001	***

Source: Authors

Mean dependent var	2,172962	S.D. dependent var	0,076238
Sum squared resid	0,000751	S.E. of regression	0,005090
R-squared	0,996083	Adjusted R-squared	0,995542
F(4, 29)	1843,474	P-value(F)	1,94e-34
Log-likelihood	133,9955	Akaike criterion	−257,9910
Schwarz criterion	−250,3592	Hannan-Quinn	−255,3883
rho	0,208825	Durbin-Watson	1,570188

Source: Authors

Based on an analysis using the multiple linear regression we can see that the model describes well the impact of the observed indicators on inflation. The obtained data shows that if there is growth of logarithmic value of GDP by 1% it would have a negative impact on the amount of inflation which will decrease for 0.14%. The logarithmic value of the M3 monetary aggregate has a positive impact on the trends in inflation and if there is an increase in the value of 1% there will be an increase in the amount of inflation of 0.09%. The discount rate also has a positive impact on inflation so that in case of growth of logarithmic discount rate by 1% will be an increase in inflation of 0.02%. The model was also observed and influenced the amount of CPI index, or inflation in the previous quarter so that the impact is positive. Parameter values are statistically significant at the 5% level of significance, while the logarithmic value of GDP and CPI in the previous period, the level of significance of 1%. The value of the coefficient of determination was 0.99 which indicates that this model can describe 99% of the variation in values. Also Durbin-Watson test shows no statistical evidence that errors are negatively autocorrelated, while statistically not determined whether or not there is a positive autocorrelated in residuals.

The following graph shows the values obtained on the basis of data from the model and statistical data from the 95% significance.

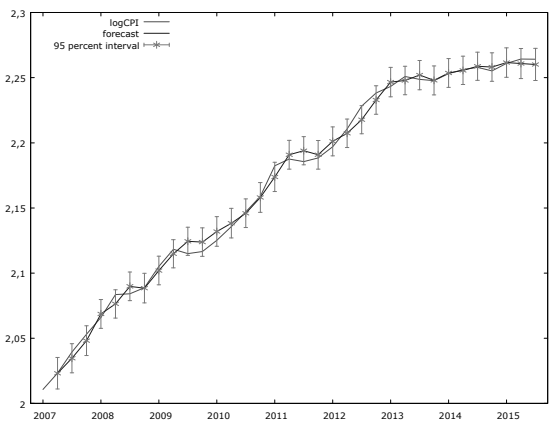

Figure 2 CPI index values (model / statistical data)
Source: Authors

Based on the obtained values of coefficients the following values for the elasticity of money, the elasticity of output and income elasticity of demand for money were obtained:

$$El_n = 0{,}52476$$

$$El_o = -0{,}80867$$

$$El_t = 1{,}5410$$

Conclusion

One of the problems with which every economy in the world meets is inflation. It is a monetary phenomenon, which leads to the continuous growth of the general level of the absolute price or a continuous decline in the value of money. This phenomenon attracted the attention of economists. Also there are many studies that will address the causes, and consequences of this phenomenon. Among many factors inflation affects the amount of money in circulation whose value is in charge of the Central Bank. It is determined through the conduct of monetary policy by the application of its instruments and measures controlling the money supply, while monetary aggregates are used as indicators and benchmark for the control and strategy of monetary policy. Using the multiple regression analysis, the impact of monetary aggregate M3, GDP and the discount rate at the level of inflation in Serbia in the period 2007 – 2015 was tested in this paper, on a quarterly basis using the model proposed by Rangarajan. The value of the coefficient of determination was 0.99 which indicates that this model can describe 99% of the variation in values. Also, the values obtained for the long-term elasticity of money: 0.52; the long-term elasticity of output -0.81 and long-term income elasticity of demand for money of 1.54. The value of t-statistic for the observed parameters indicates that the values obtained are statistically significant and confirms the influence of these parameters on the level of the CPI index in the reporting period.

In further research, model can be extended to observation and other economic factors and how they affect the dynamics of the level of inflation in Serbia, as well as the observation of individual components of the goods and services and which of them has the most influence on the overall level of CPI index. Also in future work should address and analyze perceptions of inflation of economic agents, population, economy and financial sector and how it affects the level of inflation. SM

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