European Journal of Science and Theology, June 2013, Vol.9, Supplement 2, 289-298

A REGRESSION MODEL FOR INFLATION AND MONETARY POLICY INTEREST RATE

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(Received 11 May 2013)

Abstract

An attentive basic theoretical and statistical analysis of inflation and monetary policy interest rate of Romania is conveyed. In the end, we estimate a regression model between these two variables. The resulting conclusion is that the influence of inflation over the monetary policy interest rate in Romania between 2003 and 2012 could be expressed through a cubic regression model that underlines the strong correlation between these two variables.

Keywords: monetary policy, inflation, interest rate

1. Introduction

As a key component of economic policy, monetary policy cannot act contrary to it; any monetary policy measure impacts an economic policy decision. Therefore, when talking about monetary policy objectives we need to develop an extensive analysis, beginning with the economic policy goals. Among these objectives, we identify general objectives that are common to other parts of the whole called economic policy and specific or intermediate objectives through which, the monetary authority acts to achieve objectives.

Concerning the monetary policy objectives, Romanian theoreticians [1] reveals that there may be two types of intervention of the monetary authority: interventions at the strategic level (macro), which aims to reach the final objectives of macroeconomic policy and tactical interventions, through which are highlighted operational procedures applied by the central bank to achieve its objectives. Therefore, the four general objectives of monetary policy are the following [2]: price stability; economic growth; employment rate and balance of payments equilibrium and the rise of reserves and means of international payments.

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2. The impact of monetary policy objectives over the real economy

2.1. General monetary policy objectives

Undoubtedly, as Stoica and Deaconu [2] states, the main component of this 'Magic Quadrangle' is *price stability* or, in other words, *fighting inflation*, knowing that an increasing amount of money in the economy has an inflationary impact. The importance of this objective is explained by its inclusion in the bylaw of most central banks in the world.

What are the effects [3] of price stability as the main objective of the monetary policy on the real economy?

- Helps producers and consumers to base their consumption decisions on an informed basis, eliminating any unknown variable, while resources allocation decisions will be more effective and aimed to increase productivity and consequently to achieve economic growth;
- Emboldens public to use the resources, not to store the assets in order to protect from a potential inflationary process; in this way resources are being used for an effective purpose, maximizing their effectiveness;
- Decreases the risk premium that lenders require borrowers to protect themselves from the risk of instability. In this sense, the real interest rate decreases, stimulating investment, lending and, hence, bringing economic development;
- Has no effect on wealth or income of different category of population (e.g. in the circumstance of higher inflation, borrowers have an advantage over creditors; if prices are stable, this scenario can not be possible).

When we mention the employment rate it is necessary to tackle the unemployment rate also. In other words, a general objective of the monetary policy is the increase of the employment rate or the reduction of the unemployment rate. *Balance of payments equilibrium* depends on exchange rate policy of the national currency. As part of the balance of trade, the latter influences in a decisive way the steady or imbalanced state of the balance of payments. As stated Daniela Zăpodeanu [4] in her book *Monetary Policy*, "monetary policy is twofold: monetary, aimed by the central bank by modifying the amount of money supply and credit program, targeted by the commercial banks by modifying the volume of loans to economic agents".

2.2. Intermediate and operational monetary policy objectives

Manolescu [5] identifies a number of operational objectives, in addition to the intermediary and final ones. What are these operational objectives? If we assume that a process contains several steps, the operational objectives are a step in this long process where final objectives are to be accomplished. Showing that the followed procedure is the right one, the operational objectives can be represented as monetary variables (growth rate in the quantity of money) and credit variables (short-term interest rate, the refinancing rate of the central bank). Credit ceiling (for Japan) and setting borrowed reserves (for U.S.) are other

examples of operational objectives. In addition to the general objectives of monetary policy, the monetary authorities (central banks) must establish a set of specific (intermediate) objectives. What is the purpose of these objectives? The answer is quite simple: through the general objectives, the monetary policy cannot greatly affect the size and changes in aggregate demand in the economy. Therefore, several indicators are assigned as intermediate objectives that are not directly controlled by the central bank (they rather belong to the banking system), but have direct impact on the aggregate demand. Since these monetary variables that serve as specific objectives provide long term effects, central banks use the operational objectives because it is much easier to influence them.

There are several conditions [5, p. 376] that an intermediate objective must have in order to be labeled as such: the knowledge of its evolution in a given period, the existence of a link between its evolution and that of the final objective, the effective control that the central bank could exercise upon it. There are known several classifications of intermediate objectives of monetary policy. Manolescu considers three types, while Zăpodeanu identifies four types [4, p. 138–142]: *the quantity of money in the economy (money supply), a certain level of nominal interest rates*, *financial resources allocation, a certain exchange rate of national currency*. A stable velocity of money is a condition for considering the *money supply as an intermediate objective*. It is known the inversely proportional relationship between the velocity and the demand for money or the interest rates of assets, but it is also known the directly proportional relationship between the velocity of money and the income. The demand for money depending on the interest rate is more elastic as we have a weak relationship between the money supply, on the one hand and the national income and the aggregate demand, on the other hand [2, p. 524 – 525]. Therefore, a central bank should consider two aspects: to calculate the adjustment of the demand for money or of the velocity, which should be as stable as possible and to observe how permanent or temporary is a change of the demand for money.

The stability of the velocity of money is not sufficiently enough in order that money supply can be considered an intermediate objective of the monetary policy. In addition, it also needs: *firstly*, the choice of that monetary aggregate, which will be the goal of the monetary policy (the choice depends on the ability to control the monetary aggregate also on the impact on total costs), *secondly*, setting a fixed level of the money supply fluctuations in order to reduce uncertainty or, setting a range that increases uncertainties and *thirdly*, establishing by the monetary authority of the degree of transparency of money supply policy depending on the public trust in the monetary authority.

Money supply objective is analyzed in a more detailed manner by Manolescu that names them quantitative objectives (monetary or credit aggregates) with the following form [5, p. 376]: *monetary aggregates, central bank's monetary aggregates* and *financial aggregates or credit aggregates*. All the important economists studied the interest rate, some of them appreciating the importance of it, others not granting it too much interest (see monetarists).

However, the difficulties in calculating the aggregate demand depending on the interest rate did not prevent using interest rate as a specific objective of monetary policy. It is known that the profit rate is closely related to the interest rate and that it expresses the attractiveness of an investment. Therefore, it is recommended to maintain a positive real interest rate as long as possible, that will stimulate investments and money supply growth. Domestically, *the nominal interest rate* has an impact on the volume of investments, while externally it affects the short-term capital movements. Although it can be seen as an intermediate objective, the interest rate can lead to an inflationary or deflationary monetary policy. Thus, if the central bank decides to raise the refinancing rate, the commercial banks will increase the interest rate on loans and this will reduce lending, money demand and will decrease inflation rate, too [5, p. 376].

Financial resources allocation takes into account the rentability of each use of those resources, aiming the highest profitability. In case of an estimated investment, it is difficult to calculate the profitability and this is the one of the limits of this intermediate objective of monetary policy. Stoica and Deaconu do not consider financial resources allocation as an intermediate objective, but regard credit as having a crucial role in determining the aggregate demand [2]. Being very essential for business development, the bank loan amount influences the money supply. *The exchange rate of a national currency* reflects mostly the confidence that people have in the currency and in the economy too. A strong currency is the attribute of a strong economy in which people have confidence. Being an intermediate objective of monetary policy, the fixing of exchange rate as anti-inflationary monetary anchor means that the national currency has to be reported to a strong, foreign currency. In time, there are all chances to occur the effect of *crawling pag* or *crawling pag band* through which the intern inflation rate begins to tend towards the inflation rate from the foreign country. How is that possible? Through a gradual devaluation of the nominal exchange rate of the national currency, so that the level reached is below the difference between the inflation rates of the two countries. Using this approach, it could be obtained a stabilization of the exchange rate of the national currency, at the same time increasing the credibility of monetary policy [1].

The importance of the exchange rate as intermediate objective results from the fact that it affects the country exports and domestic inflation. What is the optimal exchange rate of the national currency? A devalued currency, meaning a low exchange rate, stimulates inflation and creates a false profitability in companies. We speak of a "policy of short-term facilities, long-term paid by reducing production capacity and decreasing the standard of living" [4, p. 141]. On the other hand, a valued currency creates an inflationary pressure that will cause the bankruptcy of every company that cannot adapt to this change and it will also lead to a reduction of the economic growth.

The optimal exchange rate is that where the average level of domestic price is approximately equal to the average level of external products prices. At the same time, the level of exchange rate is optimal if individuals and firms are able to save enough to increase the investments. The practice shows the

difficulty to do such measurements because of the lack of comparable indicators. Central bank's intervention in the forex market influences the exchange rate. The intervention in the exchange market depends on external financing level and on how the business environment perceives the increase of the internal interest rate. In conclusion, through this objective is aimed the equilibrium of the balance of payments, which occurs either by controlling currency exchanges, either by modifying it on short term through capital inflows or outflows, or either by using both ways [6]. Some of the most used operational objectives of monetary policy are [1]: credit control (especially in the transition and centrally planned economies), short term interest rate control (used in developed economies in order to maintain the external balance) and monetary base control (used by the central bank in order to diminish the bank liquidity)**.**

2.3. Contradictions and complementarities between monetary policy objectives

There are a lot of contradictions between the monetary policy objectives, which means that some positive effects of achieving one objective may adversely affect other goals. And this indicates a dependency relationship between the objectives established by the monetary authorities. But, it is also important to note that their existence is limited in time.

Some of the contradictions and complementarities between general monetary policy objectives are listed below [2, p. 523–524]:

1. Complementarity between a high employment rate and the economic growth objective. These two general objectives are interdependent.
2. Complementarity between economic growth and moderate inflation that allows achieving both general objectives (economic growth and price stability);
3. An expansionary policy can lead to inflation by reducing the companies' investment capacity or by increasing the employment or decreasing the short term inflation. Thus, there may be a contradiction between economic growth – that would create an expansionary policy – and price stability – which would lead to inflation.
4. A depreciated currency reduce unemployment, otherwise it will reduce inflation. In other words, an exchange rate that would prevent both unemployment and inflation is needed. It therefore requires a solution so that the contradiction between the exchange rate on the one hand and the employment rate and price stability, on the other hand will not maintain on long term.
5. The contradiction between the employment rate and price stability: a depreciated currency increases exports and employment. In the end, it emphasizes the inflation phenomenon, too.

There are some contradictions that may occur between the intermediate objectives of monetary policy [4, p. 143–145]. Although it is not a contradiction in the literary sense of the word, such situation can appear between money supply and interest rates, especially when between these two objectives there is

no agreement. By changing these two goals, either individually or jointly, this contradiction will be solved. In the short term, an increase in the interest rate leads to an appreciation of the money supply due to a high speculative demand for money. This effect will maintain until expectations and the speculative demand for money remain constant and the interest rate is balanced. In the long-term, a growth in the interest rate will slow down any increase of the money supply, therefore, the transactional demand for money is affected and the interest rate effect is permanent. To balance money supply and the interest rate is necessary to balance the demand and the supply of money. The monetary authority can only influence the money supply by changing (increasing or decreasing) the commercial bank reserves. Thus, an increase in the supply of money increases the amount of money in circulation and reduces the interest rate, while a decrease in the money supply will increase the interest rate, reducing, the amount of money, too.

Regarding the contradictions between the objective of increasing money supply and the exchange rate objective, we start from the idea that the two objectives are coherently established on a medium term, which would mean no contradiction between these two. Any incorrect prediction may lead to short-term contradictions. For example, it can be illustrated the situation in France during 1971-1972, which promoted a restrictive monetary policy regarding the bank liquidity, reducing the volume of loans granted by banks and increasing the interest rate. Simultaneously, a weaker dollar was threatening more and more French that decided to convert their wealth in a foreign currency, other than the French franc, increasing bank liquidity and decreasing the interest rate.

The contradictions between the objective of financial resources allocation and the monetary policy follows from the fact that financial resource allocation by profitability criteria will have a negative impact over investments, and credit too. Thus, some economic agents will isolate in the market and will not answer any other changes, such as the interest rate changes. To eliminate this inconvenience, the monetary authorities try to limit as much as possible the selective credit granting policy.

3. An empirical study regarding the impact of inflation over the monetary policy interest rate in Romania between 2003 and 2012

As we stated before, price stability is one of the most important goal of monetary policy, through which central banks all around the world are trying to fight against inflation.

As a consequence of this, in this paper we were focused on knowing if there is a strong and significant relation between the inflation rate (Ri) and the monetary policy interest rate (Rdpm). In the end, we estimated a regression model between these two variables.

We started our analysis by searching monthly data regarding Ri and Rdpm for ten years (2003–2012). Both variables are measured as percentage, as seen in Table 1.

Table 1. Values of Rdpm and Ri between 2003 and 2012.

Month/ year	Rdpm (%)	Ri (%)	Month/ year	Rdpm (%)	Ri (%)	Month/ year	Rdpm (%)	Ri (%)	Month/ year	Rdpm (%)	Ri (%)
Jan-03	19.25	16.60	Jul-05	12.50	9.30	Jan-08	8.00	7.26	Jul-10	6.25	7.14
Feb-03	19.00	16.30	Aug-05	8.50	8.90	Feb-08	9.00	7.97	Aug-10	6.25	7.58
Mar-03	18.50	17.10	Sep-05	7.50	8.50	Mar-08	9.50	8.63	Sep-10	6.25	7.77
Apr-03	18.50	16.00	Oct-05	7.50	8.10	Apr-08	9.50	8.62	Oct-10	6.25	7.88
May-03	18.25	14.40	Nov-05	7.50	8.70	May-08	9.75	8.46	Nov-10	6.25	7.73
Jun-03	18.25	14.00	Dec-05	7.50	8.60	Jun-08	10.00	8.61	Dec-10	6.25	7.96
Jul-03	18.25	14.80	Jan-06	7.50	8.89	Jul-08	10.00	9.04	Jan-11	6.25	6.99
Aug-03	19.25	14.20	Feb-06	8.50	8.49	Aug-08	10.25	8.02	Feb-11	6.25	7.60
Sep-03	19.25	15.90	Mar-06	8.50	8.41	Sep-08	10.25	7.30	Mar-11	6.25	8.01
Oct-03	20.25	15.80	Apr-06	8.50	6.92	Oct-08	10.25	7.39	Apr-11	6.25	8.34
Nov-03	21.25	14.50	May-06	8.50	7.26	Nov-08	10.25	6.74	May-11	6.25	8.41
Dec-03	21.25	14.10	Jun-06	8.75	7.11	Dec-08	10.25	6.30	Jun-11	6.25	7.93
Jan-04	21.25	13.90	Jul-06	8.75	6.21	Jan-09	10.25	6.71	Jul-11	6.25	4.85
Feb-04	21.25	13.70	Aug-06	8.75	6.02	Feb-09	10.00	6.89	Aug-11	6.25	4.25
Mar-04	21.25	13.10	Sep-06	8.75	5.48	Mar-09	10.00	6.71	Sep-11	6.25	3.45
Apr-04	21.25	12.50	Oct-06	8.75	4.80	Apr-09	10.00	6.45	Oct-11	6.25	3.55
May-04	21.25	12.30	Nov-06	8.75	4.67	May-09	9.50	5.95	Nov-11	6.00	3.44
Jun-04	20.75	12.00	Dec-06	8.75	4.87	Jun-09	9.50	5.86	Dec-11	6.00	3.14
Jul-04	20.00	12.10	Jan-07	8.75	4.01	Jul-09	9.00	5.06	Jan-12	5.75	2.72
Aug-04	18.75	12.40	Feb-07	8.00	3.81	Aug-09	8.50	4.96	Feb-12	5.50	2.59
Sep-04	18.75	11.10	Mar-07	7.50	3.66	Sep-09	8.00	4.94	Mar-12	5.25	2.40
Oct-04	18.75	10.80	Apr-07	7.50	3.77	Oct-09	8.00	4.30	Apr-12	5.25	1.80
Nov-04	17.75	9.90	May-07	7.25	3.81	Nov-09	8.00	4.65	May-12	5.25	1.79
Dec-04	17.00	9.30	Jun-07	7.00	3.80	Dec-09	8.00	4.74	Jun-12	5.25	2.04
Jan-05	16.50	8.90	Jul-07	7.00	3.99	Jan-10	7.50	5.20	Jul-12	5.25	3.00
Feb-05	15.75	8.90	Aug-07	7.00	4.96	Feb-10	7.00	4.49	Aug-12	5.25	3.88
Mar-05	14.50	8.70	Sep-07	7.00	6.03	Mar-10	6.50	4.20	Sep-12	5.25	5.33
Apr-05	12.50	10.00	Oct-07	7.00	6.84	Apr-10	6.50	4.28	Oct-12	5.25	4.96
May-05	12.50	10.00	Nov-07	7.50	6.67	May-10	6.25	4.42	Nov-12	5.25	4.56
Jun-05	12.50	9.70	Dec-07	7.50	6.57	Jun-10	6.25	4.38	Dec-12	5.25	4.95

Source: Data from www.bnr.ro and www.ins.ro

For our analysis, we will consider that the monetary policy interest rate is influenced by the evolution of inflation, and so, Rdpm will be the resultative variable – noted with Y – and Ri will be the predictor or independent variable,

noted with X. Skewness coefficients for Rdpm and Ri series show that the distribution is not so much deviated from a normal distribution, having extreme values to the right (1.097 and 0.79 respectively). Moreover, Kurtosis coefficients values reveal a normal distribution, having small values, around zero (-0.268 for Rdpm and 0.001 for Ri). For our data, the P-P plot emphasize that the distribution is normal and that values are not so much deviated from the theoretical distribution line (Figure 1).

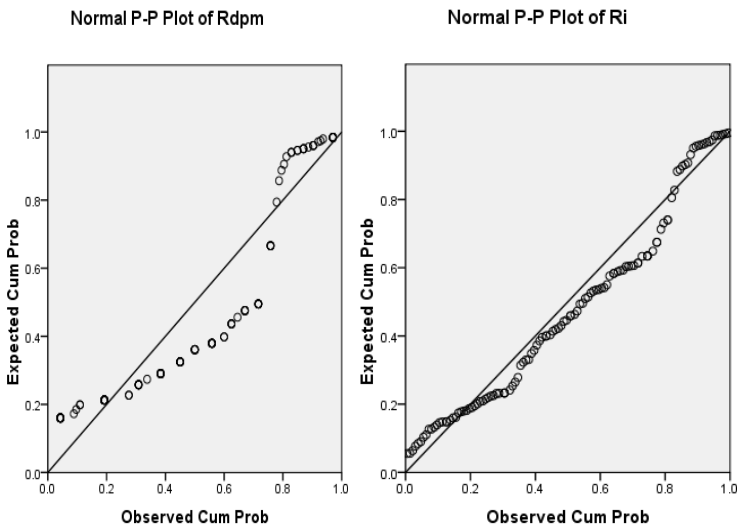

Figure 1. P-P plot for Rdpm and Ri.

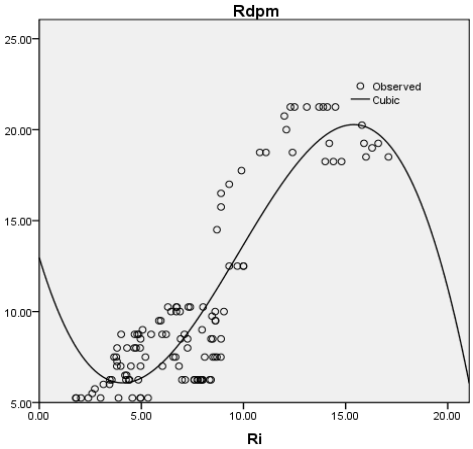

Figure 2. Scatter plot for cubic regression model between Rdpm and Ri.

In conclusion, the distribution is normal, so, using SPSS 17.0 we estimated that the correlation between Rdpm and Ri in Romania from 2003 to 2012 is approximated through a cubic regression model, that has the following equation:

$$Y = a + b_1X + b_2X^2 + b_3X^3 \quad (1)$$

where a, b_1, b_2 and b_3 are the regression coefficients.

The Pearson coefficient (r) for this cubic regression model si 0.901, revealing a very strong and significant correlation between Rdpm and Ri in Romania for the last ten years (Figure 2). At a significance level of 1%, we can assume with less than 1% of mistake that the correlation is significant.

Using Student's t test we will investigate the significance of the Pearson coefficient.

$$t_{value} = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}} \quad (2)$$

where: n – sample size and r – Pearson coefficient.

Because t_{value} (22.5609) is greater than the Student t-value for 118 degrees of freedom and a probability level of 1% (2.3583), we consider that the Pearson coefficient is statistically significant [http://www.danielsoper.com/statcalc3/calc.aspx?id=61, http://www.danielsoper.com/statcalc3/calc.aspx?id=10].

The coefficient of determination, R^2, is used in order to interpretate the model. Its high value (0.811, very close to one) points to a direct and close relation between these two indicators and shows that only 81.1% of the variation of Ri explains the variation of Rdpm. 18.9% depends on other factors.

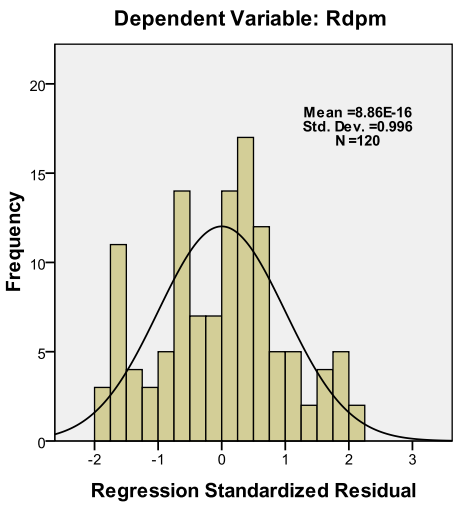

Figure 3. Histogram – linearity of the cubic regression model.

The regression model will be tested with the *F test*. In our case, a high *F test* value 165.848 and a sig. value of 0.000 (smaller than 0.05) indicate a very strong correlation that appears between Rdpm and Ri.

Calculating the regression coefficients, the equation of the cubic regression model is:

$$Y = 12.965 - 3.699*X + 0.573*X^2 - 0.02*X^3 \quad (3)$$

Test t will be used to test the regression coefficients. So, if Sig. value is 0.000 (less than 0.05), the relationship between Rdpm and Ri is significant and the cubic regression model is valid.

Finally, we will test the model errors. Because the mean of errors is 0.000 and the Sig. value according to Kolmogorov – Smirnov test is higher than 0.05 (in our case 0.746), we say that the distribution is normal.

The linearity of the cubic model is also demonstrated through the histogram in Figure 3, where we can see a normal distribution of the residuals around the mean.

4. Conclusions

Price stability is the part of the famous 'Magic Quadrangle' that has a great importance for the central banks all around the world. Low inflation is the goal of all world economies, that's why national banks focus intensively on achieving it. In this article we searched for a direct and significant correlation between the monetary policy interest rate and inflation in Romania in the past ten years. Being an instrument exclusively used by the National Bank of Romania, the monetary policy interest rate is established taking into account the evolution of the inflation in the economy.

The influence of inflation over the monetary policy interest rate in Romania between 2003 and 2012 was expressed through a cubic regression model that underlined the strong correlation between these two variables. The two analyzed variables have a significant relationship (sig. value is 0.000) that validated our model.

In this paper, we also emphasized the importance of price stability in the overall monetary policy objectives and its implications in the decisions made by the National Bank of Romania.

Acknowledgement

This work was supported by the European Social Fund in Romania, under the responsibility of the Managing Authority for the Sectorial Operational Programme for Human Resources Development 2007-2013 (grant POSDRU/107/1.5/S/78342).

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