

# The Optimal Interval for the Taylor rule Appliance in Romania

Daniel G. Belingher, Dumitru-Alexandru D.D. Bodislav

**Abstract**—In these days of economic uncertainty macroeconomic policies must be used to set in line the economic development with the economic deployment of the evolution of the country's government. This research paper studies the evolution in the last 9 years of the monetary policy interest rate (MPIR) and the actual development of some macroeconomic indicators of Romania compared with the Taylor rule generated interest rate. For this, the authors have chosen the original 1993 Taylor Rule, but also an interval in which the Taylor Rule varies according to different scenarios for the Romanian economic framework. The Taylor rule underlines the connection between the Central Bank of a country, through its nominal interest rate, the economic momentum-cycle, through the output gap, and other economic conditions, especially inflation. Actually, as a brief of this rule, we can say that for each 1 percent increase in inflation, the Central Bank needs to raise the nominal interest rate with more than 1 percent.

**Keywords**—Gross Domestic Product, Interest rate, Monetary policy, Taylor rule, Output gap

## I. INTRODUCTION

CENTRAL bank interdependence has become over time one of the key concepts in modern theory and policy [1]. In 1993 the U.S. economist John Taylor proposed his rule and principle as a mild mathematic overview of where should the policy of the Central Bank, especially the Federal Reserve, should act.

This rule was intended to foster the stability of prices and sustain full employment by reducing uncertainty in the system and creating confidence in the future actions taken by central banks. The rule plays a safe game when is under the pressure of time. In order to this, the macroeconomic performances, in terms of inflation and productivity gap, would be more stable and efficient if the Taylor's rule would be used by a certain central bank in fixing its main interest rate [2].

The original Taylor rule was represented through a general equation created from the nominal interest (monetary policy interest rate, in the studied case), actual and targeted inflation rates and of the actual and potential Gross Domestic Product [3].

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$$i_t = \pi_t + r_t^* + a_\pi(\pi_t - \pi_t^*) + a_y(y_t - \bar{y}_t) \quad (1)$$

where  $a_\pi$  and  $a_y$  are parameters and:

$i_t$ - targeted short term nominal interest rate (MPIR);

$\pi_t$ - inflation (measured with the GDP deflator);

$\pi_t^*$ - desired rate of inflation;

$r_t^*$ - equilibrium real interest rate;

$y_t$ - real GDP (logarithm);

$\bar{y}_t$ - potential output (logarithm).

The GDP is under a logarithm because the resulted graphs from the Taylor equation should have a linear trend.

Taylor's paper from 1993 sets  $a_\pi = a_y = 0.5$  that results in a high interest rate (tight monetary policy) when we deal with a higher than targeted actual inflation, a low interest rate (easy monetary policy) when an output stimulus is wanted. In case of stagflation, when full employment is below the target and inflation is higher than the target, the rule becomes an indicator for when to reduce inflation or increase output.

## II. THE OPTIMAL INTEREST RATE

The Taylor principle consists in the specification of  $a_\pi > 0$ , where the Taylor rule says that increasing inflation with 1 percent will pressure the central bank to raise the nominal interest rate (MPIR) with more than 1 percent. From the real interest rate formula ( $r_t^*$ ), which is equal with the difference between the monetary policy interest rate and inflation rate ( $MPIR - \pi_t$ ), this resulting in the fact that when inflation rises, the real interest rate should be increased, this fact being called the Taylor principle and has as first tier effect the cooling of the entire economy.

In 2009, Taylor sustained that in real values the situation should be observed like following: if inflation rises with 1% the central bank's reaction should be of raising the interest rate with 1.5% (the optimal is reached if the increase is bigger than 1%). If the GDP decreases by 1%, the response of the central bank is to cut the interest rate by 0.5% [4].

Establishing the measures that should be taken by a Central Bank can be easily underlined, but they are quantified at their optimal value. We take for implementation the Taylor rule and principle on Romania's Monetary Policy Interest Rate (MPIR) comparison. It is desirable that economic measure (MPIR) should be in line with the theoretical measure (the Taylor rule) to validate that the economy is heading in the right direction,

with the help of the government, and in this research paper's focus, the Central Bank.

#### A. *The Macro-framework of Romania*

The actual economic crisis brings to the table the need for using new economic policies to tune the public sector, controlled by the government and by the central bank. Globally, after the events that occurred in the '70 and the '80 the fiscal and monetary policies were in the spot light again [5].

There were done many studies on fiscal policies that should stabilize the economy, but our research paper will be based on a particular component of the other type of policies, the monetary policy, in particular the Taylor rule.

For this research paper it is wanted to calculate and demonstrate if the National Bank of Romania through the nomination of the interest rate if it was in tune, or not, with the appliance of the Taylor rule. For creating this demonstration, we have used in our research, the following variables and data for Romania:

1. The Output Gap (the output is equal with the difference between the actual GDP and the potential GDP – source: [5]);
2. The Inflation Rate (source: National Bank of Romania database);
3. The Targeted Inflation Rate (source: National Bank of Romania database);
4. The Monetary Policy Interest Rate (that is imposed by the National Bank of Romania, called **MPIR**);

The time series starts from 2002 and ends in 2010 (it contains 9 observations) and was chosen only this period, due to the data availability and because the fact that at the beginning of the year 2001 the Romanian economy started to have an established structure and didn't need any external influencers, or help to be sustainable in its development to a mature and healthy economy.

The Output Gap can be positive or negative, depending on the actual status of the economy and the forecast. When the output gap is positive we are facing the situation of an inflationary gap that has as cause an extra pressure on the aggregate demand, sometimes created by the sudden rise of government spending. The negative output gap is created by a smaller actual GDP, than the potential GDP, sometimes this situation is born from the sudden fall of the aggregate demand or a shock on the aggregate offer.

The traditional economics underlines the fact that the economy usually adjusts itself automatically and the actual and the future GDP equals the potential GDP, but the adjustments are done in time and with high social costs. That's why the government and the central bank are working together to solve any syncope in the economic environment.

In this paper the focus is on the measures taken by the central bank, in our case the National Bank of Romania, so when the economy is in the positive output situation – economic expansion, money have to be more expensive through the following measure: selling bonds through the open market, raising the minimum reserve rate and increasing the

nominal interest rate. In the actual situation of a global economy, therefore Romania's economy we are close to another dip into recession. When the economy enters a recession, bonds are bought on the open market, the minimum reserve rate is lowered and the nominal interest rate is decreased, with the purpose to stimulate the aggregate demand and to lower the unemployment rate by offering cheaper credits and facilitate the injection of money in the economy.

As a specific for Romania, its central bank and its governor have as main purpose direct targeting the inflation rate. The strategy based on targeting the inflation is in tune with the Taylor rule because it has as direct pressuring variable on the inflation the monetary policy interest rate. Direct targeting of the inflation is done through direct settlement on only one indicator and has a faster reaction on prices stability, but sometimes tends to inflationary states of the economy. What is specific for this strategy is that for a period of time the inflation rate is settled by the monetary authority and this way a strategy based on the direct targeting of the inflation rate that is created with transparency for the general public, and this way they know the direction of the Central Bank's action [6].

In the same time, to secure the fulfillment of this objective, the Central Bank must have access to more information on the stability of prices, because it needs to create realistic forecasts on the inflation rate movement.

The analysis of the factors that influence the inflation's level must include an overview on:

1. The variables that influence the labor market (including here the minimum wage and the productivity level in the economy);
2. Import prices;
3. Production prices;
4. Monetary policy and real interest rate (the components that are direct influenced by the Central Bank);
5. The real and nominal exchange rate;
6. The budgetary deficit, through which is settled the direct intervention of the government in the economy.

Even if these monetary measures are adopted, there are to be considered the pressure created by the globalization phenomena through the liberalization of the capital market or the creation of new financial innovation, like CDOs or CDSs. All these factors represent new needed information on the way monetary measures are created and implemented, and their accuracy depends on their relevance.

Direct targeting of inflation helps create a better image and increases credibility in the Central Bank and its actions.

When you submit your final version, after your paper has been accepted, prepare it in two-column format, including figures and tables.

### III. THE DEVELOPMENT OF ROMANIA'S ECONOMIC ENVIRONMENT – DIFFERENT SCENARIOS

#### A. *The 1993 Taylor rule verified in Romania*

The variables that are needed to create the overview on the monetary policy interest rate imposed by the National Bank of

Romania and the interest rate generated according to the Taylor rule, that Prof. John Taylor presented initially in 1993 [3], are presented in *Table 1*.

The model, or equation used in our analysis, is the following:

$$\text{TrIR}'93 = \text{MPIR} + 0.5 * (\pi_t - \pi_t^*) + 0.5 * \text{Output Gap} \quad (2)$$

where, the remaining MPIR is derived from the equation (1) and  $\pi_t^* = (\text{MPIR} - \pi_t)$  and  $\pi_t$  reduces with  $(-\pi_t)$ .

#### I. Development of Romania and the generated initially Taylor rule Interest Rate (TrIR'93), 2002-2010

Year	Output Gap	Inflation Rate	Targeted Inflation Rate	MPIR (year average)	TrIR'93
2002	-0.48	22.5	22	28.47	28.48
2003	-0.97	15.3	14	18.81	18.98
2004	1.04	11.9	9	20.27	22.24
2005	-1.09	9	7.5	9.59	9.8
2006	-0.81	6.56	5	8.44	8.82
2007	2.17	4.84	4	7.46	8.97
2008	6.2	7.85	3.8	9.46	14.59
2009	-2.95	5.59	3.5	9.33	8.9
2010	-3.46	6.09	3.5	7.27	6.84

Values calculated and expressed in percentages.

The used data was gathered from databases of INSSE, NBR, previous articles and was processed with Microsoft Office – Excel 2010 and STATA 10 for generating the needed data for the Monetary Policy Interest Rate and the Taylor rule Interest Rate (TrIR'93) and creating the figures that were inserted in this research paper.

According to the output gap, Romania's economy had three years of economic boom, in 2004, 2007 and 2008. If we consider the output gap as difference between the achieved GDP and the potential GDP and the economy as functioning at its full capacity when this difference equals 0, than this relationship, at Romania's level, may be expressed better in the further figure:

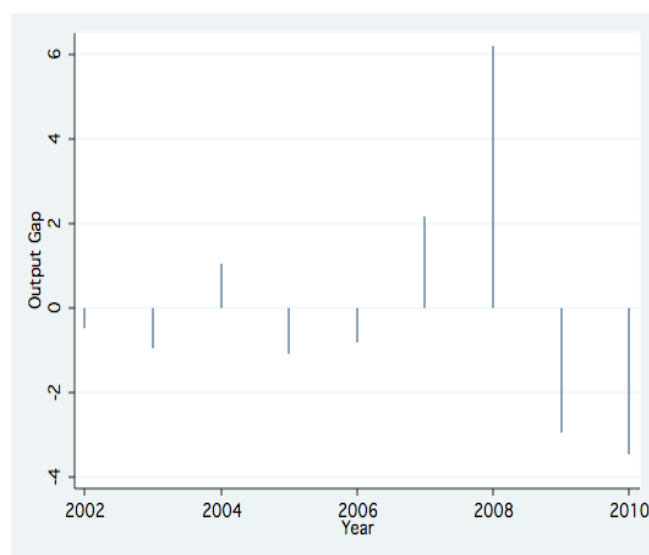


Fig. 1 Output gap in Romania between the 2002-2010 period (expressed in percentages)

The evolution of the inflation rate is positive going from 22.5% in 2002 to 6.09 in 2010, but with a minimum of 5.59 in 2009. Future calculations on the year 2011 will show an anomaly on observing the inflation rate because of government's decision to increase the Value Added Tax in July 2010 from 19% to 24%, but the Inflation will continue its descending trend after absorbing the VAT's year on year influence.

According to the equation created through the Taylor 1993 rule it results the above mentioned interest rate in *Table 1* and also that may be described visually, through the following figure:

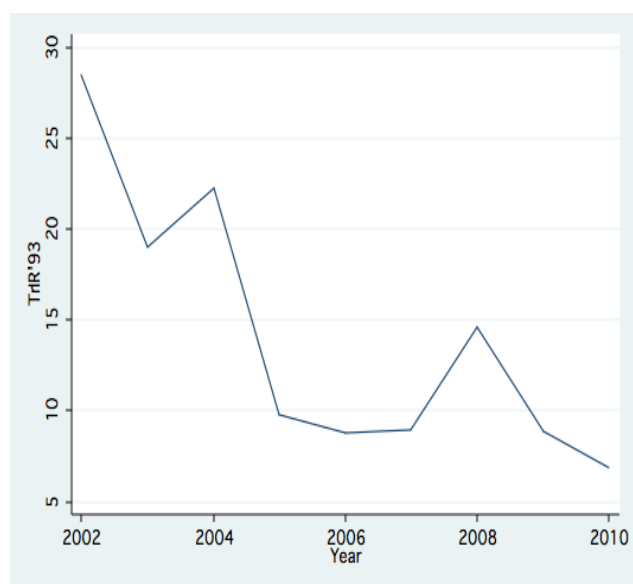


Fig. 2 Taylor rule Interest Rate (TrIR'93) (expressed in percentages)

The National Bank of Romania practiced the following Monetary Policy Interest Rates:

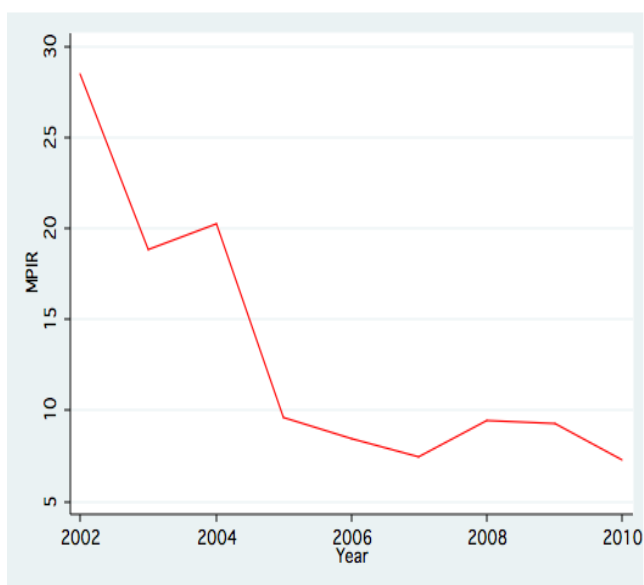


Fig. 3 Monetary Policy Interest Rate (MPIR) (expressed in percentages)

The trends of the Monetary Interest Rate (MPIR) and of the Taylor rule Interest Rate from 1993 (TrIR'93), can be expressed to the next figure:

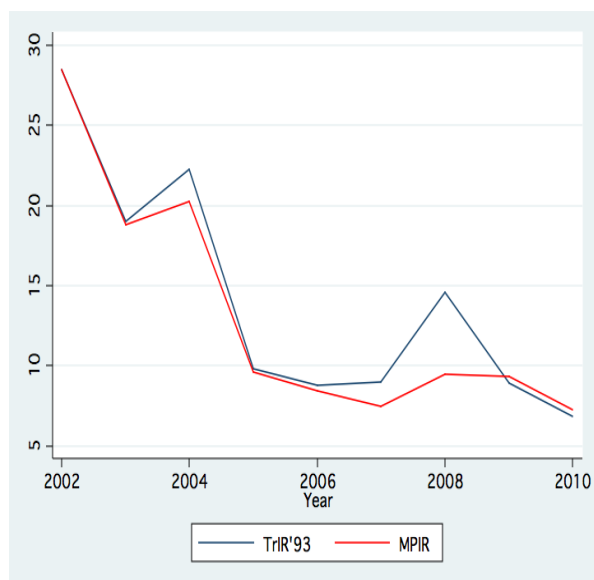


Fig. 4 Monetary Policy Interest Rate versus Taylor rule Interest Rate (expressed in percentages)

From this graph the obvious can be stated that during the last 9 years the economic development of Romania by measuring the output gap and the evolution of the inflation rate with a decreasing trend, with the monetary policy interest rate created for targeting the inflation rate it can be observed that the National Bank of Romania took the right measures, but not

at their maximum potential. In the year 2003 and 2007 the Monetary Policy Interest Rate reached the most significant differences (as you can see on gaps from the graph) than the Taylor rule generated Interest Rate. Most probably, The National Bank of Romania took the right measures in 2004, because in Romania there was needed cheap money on the market, so a lower monetary policy interest rate was welcomed during that period. According to the 1993 Taylor principle, a big mistake was made during 2006 and 2007, when the Romanian economy was over-heated also because of the global economic boom, but mainly because of the real estate bubble that was happening in Romania. In that period it was mandatory to raise the monetary policy interest rate, in order to prevent a future crisis. One of the deepest causes of the financial crisis has been the abundant liquidity created by the major central banks around the world [7].

#### B. Lower and upper limits of the Taylor rule for the Romanian economy

In order to complete this analysis, we have assumed the risk to develop some variations of the Taylor rule, in which we estimate the minimum and maximum points of the monetary policy interest rate, also using the Taylor principle.

Our research process on creating the optimal interval for the Taylor rule will start with conceiving the lower limit for the interval.

On Romania's case, we have estimated which could have been the lower limit for the monetary policy interest rate during the period 2002-2010. Our model stands on some economical theoretical premises, but the most important is the one that says that in order to have an efficient monetary policy interest rate, this, have to be at least equal with inflation [8]. As a result of this statement, we will have an equal value between *MPIR* and *Inflation Rate* ( $\pi_t$ ) in the initial, Taylor model, so the equilibrium real interest rate ( $r_t^*$ ) will disappear:

$$TrIR(\min) = \pi_t + a_\pi (\pi_t - \pi_t^*) + a_y * Output\ Gap \quad (3)$$

The results, compared with the 1993 Taylor rule, are:

II. Lower limit of the Taylor rule interval, compared with the 1993 Taylor rule Interest Rate

Year	TrIR'93	TrIR(min)
2002	28.48	22.51
2003	18.98	15.465
2004	22.24	13.87
2005	9.8	9.205
2006	8.82	6.935
2007	8.97	6.345
2008	14.59	12.975
2009	8.9	5.16
2010	6.84	5.655

Values calculated and expressed in percentages.

In the below graph, we can see how the orange line, which is the minimum of the Taylor rule interval, follows the same trend as the initial Taylor rule:

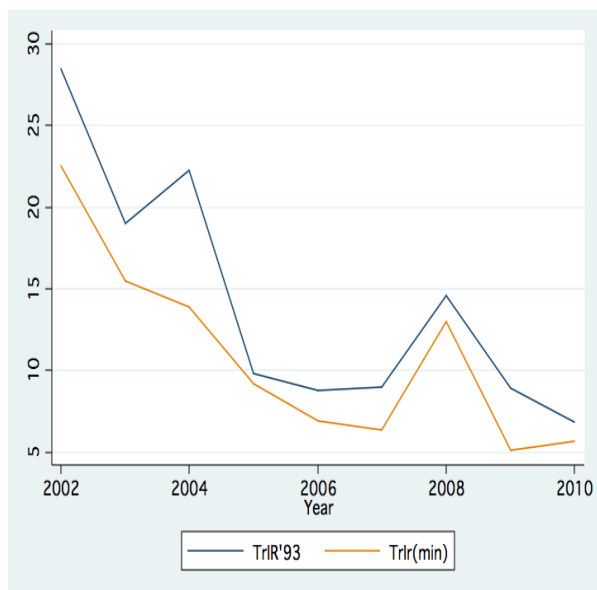


Fig. 5 Taylor rule Interest Rate (TrIR(min)) versus Taylor rule Interest Rate (TrIR'93) (expressed in percentages)

We followed the research process with the creation of the upper limit for the Taylor rule interval.

For the same period studied until now, we will determine which could have been the upper limit of the Taylor rule. For this, we will exclude from the initial model the equilibrium real interest rate ( $r_t^*$ ) and we will substitute it with the targeted inflation ( $\pi_t^*$ ):

$$TrIR(max) = \pi_t + \pi_t^* + a_\pi(\pi_t - \pi_t^*) + a_y * Output\ Gap(4)$$

The reason for which we utilized this solution is because we wanted to exclude any functional dependencies between the calculated monetary policy interest rate and the calculation model. In order, we will have the following results:

III. Upper limit of the Taylor rule interval, compared with the Taylor rule Interest Rate (TrIR'93)

Year	TrIR'93	TrIR(max)
2002	28.48	44.51
2003	18.98	29.465
2004	22.24	22.87
2005	9.8	16.705
2006	8.82	11.935
2007	8.97	10.345
2008	14.59	16.775
2009	8.9	8.66
2010	6.84	9.155

Values calculated and expressed in percentages.

These upper values are mainly for use in an economic expansion scenario, when you need to slow down the economic activity, because, an exaggerated high monetary policy interest rate will decrease the amount of money which are irrigating the economy.

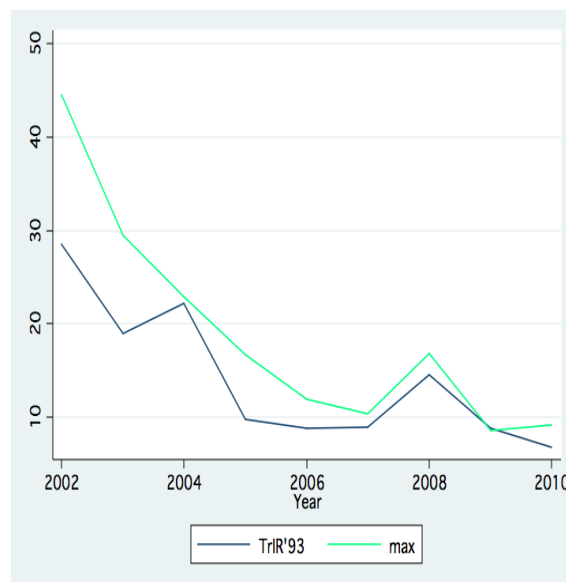


Fig. 6 Taylor rule Interest Rate (TrIR(max)) versus Taylor rule Interest Rate (TrIR'93) (expressed in percentages)

In this last graph of our study, we will see all the above lines and trends, combined in one single picture, in order to have a

general, idea of what happened in reality versus what could have happened.

The minimum and maximum calculated TrIR create a gap in which the MPIR and TrIR'93 can move without creating huge disparities and asymmetries for the internal market, because they internally overheat the system and on the long run could create a rupture from the global economic system and stop the deployment of FDI (Foreign Direct Investment) in Romania.

From the created interval between the TrIR(min) and TrIR(max) and including in it the value of TrIR'93 and the MPIR we can create a larger working value for Taylor's rule, but we can also confirm that the rule needs fundamental improvement because in times of economic distress the rule it's not available on an econometric level because the TrIR'93 value for the year 2009 will be out of the interval.

#### IV. Cumulated Research on the Taylor rule, regarding Romania's case

Year	MPIR	TRIR'93	TrIR(min)	TrIR(max)
2002	28.47	28.47	22.51	44.51
2003	18.81	18.81	15.465	29.465
2004	20.27	20.27	13.87	22.87
2005	9.59	9.59	9.205	16.705
2006	8.44	8.44	6.935	11.935
2007	7.46	7.46	6.345	10.345
2008	9.46	9.46	12.975	16.775
2009	9.33	9.33	5.16	8.66
2010	9.16	7.27	5.655	9.155

Values calculated and expressed in percentages.

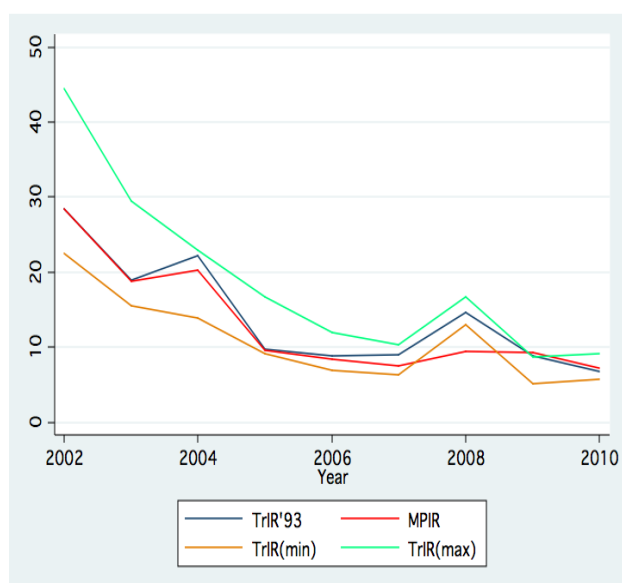


Fig. 7 The interval for the Taylor rule – Romania's study case (expressed in percentages)

#### IV. CONCLUSIONS

The actual global crisis puts a lot of challenges for the monetary policy that should remain consistent, credible and effective [9]. The last 10 years were fructuous both for the United States of America and for Romania. Despite the fact that the United States was the "crisis engine starter", because they grew the crisis through the least inspired monetary policy measures taken by Alan Greenspan by lowering the nominal interest rate from 6.5% to 1% in the 2001 – 2004 period this way he accelerated the growth of the speculative bubble that burst in 2008. Romania is delayed with one year from the U.S., that's why the year 2008 was the best year for Romania's macroeconomic evolution. Consumption was the first component that was corrected by the microeconomic adjustment from the private sector's response, a much faster reaction than the public sector (a weak government response).

The relation between the economic environment and the National Bank of Romania became chaotic for the 2009-2010 period because the Gross Domestic Product lost 21% of its value calculated regarding inflation, and that took by surprise the Government and the National Bank of Romania and created the need for new measures in using the market as a regulator.

From 2002 to 2007 Romania got the chance to grow like never before and had the chance to save some funds for the days when the economy is not working at its full potential by raising taxes through new fiscal policies, but it chose in 2004 to relax the taxation system and this way it did not retained the needed funds to pass the crisis with minimum losses.

The structure of the of Romania's economy is unhealthy because it cannot rely on steady and consistent middle class. If there are considered the yearly incomes and the assets owned by the people we can distribute the population in:

- 2% very rich;
- 8% the middle class (a well developed country has a developed middle class at around 45 to 50% of its population);
- 90% poor and under the limits of their existence.

The National Bank of Romania had to face through their policies the year 2010 that was extremely different from the year 2009. The panic was installed and created the settlement for a low consumption, but as a positive fact it created one of the highest investment rates from the public budget and the state will take a bigger part in spending for restarting the economic growth.

Considering the actual development of the world economy and regarding the evolution of some „Black Swan” phenomena that cannot be forecasted by the National Bank of Romania we can realize that governments are slow in adapting and adopting proactive measures to stop recessions or the deployment of general crisis in their countries and they can create delays and impediments in reactive measures taken by the NBR. The „early adopters” of economic measures are from the private sector and they have the tendency to pull after their model the entire economy, they are shortly followed by the monetary policy makers – the NBR and as a result the governments are

in tune with the private sector with the almost right macroeconomic complementary measures (but with a delay). The Taylor rule was created to show a general path for the adopted monetary policy by the monetary policy makers and it uses general macroeconomic indicators, so it is not always the optimal model to use, but offers general guidance. In its defense we can add the fact that the Federal Reserve under Alan Greenspan's and Paul Volcker's issued measures are in line with the Taylor rule, the same for Canada, New Zealand and Germany, countries that adopted inflation targeting rules. Under the syncope created by the housing bubble the Taylor rule is not so accurate, that's why in the generated graphs for the comparison between the two interest rates of the years 2008 and 2009 the trends were not in line, especially for the year 2009 when MPIR was higher than TrIR'93 with 0.43% so it can be underlined the fact that the National Bank of Romania took a risk measure to cut the easy money flow because that was the period when the real effect of the housing bubble reached Romania, for the period 2010 – 2011 the influence of the VAT's increase will create a large gap between the MPIR and the Taylor rule interest rate until the 5% VAT increase is absorbed. The fact that the trend of the MPIR was in then with the Taylor rule interest rate but under its absolute value underlines the fact that the NBR has the tendency to play a safe game and wants to put away the pressure, but because it nominated smaller interest rates than what it could nominate puts under the spotlight the fact that in Romania for the last 9 years credit was cheap, not only in the used measures, but in the price of money.

## APPENDIX

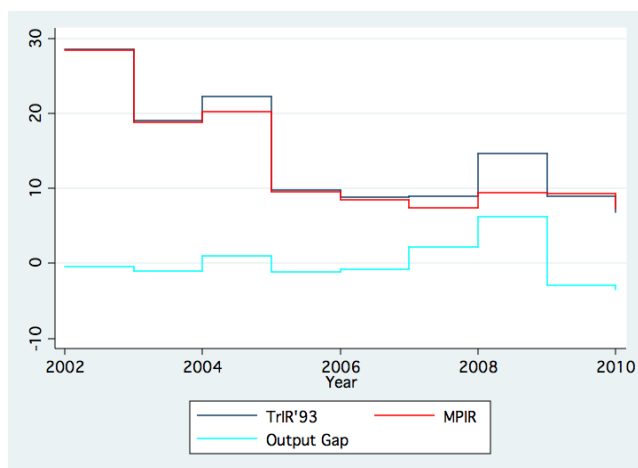


Fig. 8 The interval for the Taylor rule – Romania's study case

We chose to add as an appendix the comparison between the main influencer that creates the Taylor rule. And to underline the fact that this figure is apart from the others we have chosen a special design for it, to express in a more suggestive way the linkage between these variables.

We can see from figure 8 that we have the output gap of the Romanian Gross Domestic Product that is in direct correlation

with the Taylor rule Interest Rate (TrIR'93) resulted using the initial rule from the 1993 article of John Taylor. We can observe this, from the fact that the peaks of the output gap variable are walking in-line with the peaks of the Taylor monetary policy interest rate.

The Monetary Policy Interest Rate (MPIR) has to reach the same trend lines as the Taylor rule resulted interest rate and in the times of economic growth and without human influencers like information asymmetry, moral hazard and risk adversity. Generally speaking, the monetary policy interest rate used by any central bank, not only the one used by The National Bank of Romania and the 1993 Taylor monetary policy interest rate are created on the same wavelength, but when the trend of the output gap starts to change suddenly it creates logical ruptures in the evolution of the monetary policies that are adopted and adapted by the National Banks, so, as a direct consequence of this fact, this rule, most probably, needs stabilizers for the long term because on the long term the average disparities created can invalidate the model created on Taylor's research, for that we proposed the creation of an interval in which Central Banks can use it to stabilize the long term monetary policy interest rate, also, taking into consideration the economic cycle momentum.

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