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A MULTIPLE REGRESSION MODEL OF INFLATION RATE IN ROMANIA IN THE ENLARGED EU

Key words: inflation rate, econometric model, EU integration

ABSTRACT

The main goal of Romanian monetary authorities after accession to the European Union is to maintain the inflation rate in the proposed target. In that respect, the process of slowing inflation can be maintained through considerably reduced raises in administered and volatile prices and minimizing the inflationary impact of the newly introduced indirect tax on alcohol and tobacco products. The persistence of inflationary risk associated with the current macroeconomic framework, largely as a result of the increasing of some indirect taxes and of fast expansion in domestic demand, prompted the monetary authorities to continue the gradually tighten policy.

This context makes necessary the elaboration of a model that studies the trend of inflationary process due to most significant influence factors. A very important factorial variable is the average interest rate on credit institutions with direct implications in the evolution of the domestic demand. Other variables that have influence are the net income and the unemployment rate. All these conditions are considered in the process of elaboration of the multiple regression models for Romania in the enlarged European Union.

1. INTRODUCTION

In the last decades, the main problem of the world economy was the generalized growth of the goods prices. The pressure generated by increasing prices lead to significant distortions in the monetary, economic, political and social environment. The inflation is the main factor of economic crisis, discourages the investments and determines the migration of capital to other countries or real estates. The broken equilibrium created by inflation strongly affects the decisions of private sector to invest or develop, with the final effects in decreasing of production and stagnation.

After years of high level of inflation, Romania is facing in the last couple of years with a significant disinflation process. That fact has a very strong implication in the development of Romania's economy and foreign commercial activity. In the last two

years, inflation moved almost all periods in the lower half of the target band. At the end of December 2006, the annual inflation was below the target assumed by the National Bank of Romania in 2005, at the time inflation targeting was adopted. Over that period, the main source of disinflation was the performance of volatile prices, whose annual rate of increase further slowed from modest levels in the last months. Another favorable implication was the successive decreases in fuel prices that given the weaker tensions on the international oil market.

In the econometric models, the main statistical indicator for the inflation rate is the national Consumer Price Index (CPI). The models of inflation rate from the paper are based on the evolutions of this index. Accessing of Romania to the European Union increases the importance of the Harmonized Index of Consumer Prices (HICP). The nominal convergence criterion on inflation for joining the Euro zone is given by HICP and the European Central Bank defines price stability as a annually increase in the HICP of below – but close to 2 percent.

The HICP measures changes in the level of retail prices of goods and services on the territory of Romania, with the weights for calculating the index being drawn from the structure of residents and non-residents consumption expenditure. In fact, the definition of this index requires taking into account not only the consumption by residents, but also the expenditure by foreign visitors in Romania.[1]

The status of both indices has not changed after accession of Romania to the EU, excepting the increased resort to HICP in making economic analyses, especially for comparing inflation performances with the other Member States. The HICP is not aimed at replacing the national CPI, but at ensuring comparability at European level.

2. <u>THE MAIN INFLUENCE FACTORS</u>

To elaborate a regression model of inflation rate is necessary to underline the importance of the main influence factors. Those factors are very diverse and action into the national economy and from external sources. From the large number of known inflation influence factors will be selected the factors with a significant action to inflation in Romania in the enlarged EU. It is very important to choose the factors that can be found in the national and European statistical publications.

After a preliminary analysis, resulted that the main influence factors of inflation rate in Romania which can be found in the national and European statistical publications are:
- Labor market
- Exchange rate of Romanian Leu
- Interest rates
- Production Price Index (PPI)
- Monetary Policy – Broad Money (M2)
- Non-government Credit

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[1] National Bank of Romania – *Inflation Report * February 2007*

The impact of all those factors will be studied in the first place with one-factor regression models. If they have significant influence to inflation, it will be included in the final multiple regression model or inflation rate in Romania.

First significant factor of influence for inflation in Romania is the labor market. The most important indicators of the evolution of labor market are the unemployment rate and the net income of the employees.

Unemployment rate was significantly low in the last years in Romania, with direct implications in the process of slowing inflation. In the last three years, net income of the Romanian employees was constantly increasing, with direct impact to inflation. The one-factor regression models between CPI and unemployment rate (*UnR*), respectively, between CPI and net income (*Ninc*) shows a strong linear links in the period of 2004 – 2007 years (Table 1 and Table 2).

Table 1 Regression Linear Model between *CPI* and *Unemployment Rate*

Dependent Variable: *CPI*				
Method: *Least Squares*				
Included observations: *29 monthly observations after adjusting endpoints*				
$CPI = \alpha_1 * UnR$				
Estimated Coefficient	*Value*	*Std. Error*	*t-Statistic*	*Probability*
$\hat{\alpha}_1$	0.10189237	0.01211002	8.4138886	5.02427 E-09
Multiple R	0.8508278	*Mean dependent var. CPI*		0.6167857
R-Square	0.7239080	*S.D. dependent var. CPI*		0.4029618
S.E. of regression	0.392114	*F-statistic*		70.793521
t critical	2.0518304	*F critical*		1.9048229

Table 2 Regression Linear Model between *CPI* and *Net Income*

Dependent Variable: *CPI*				
Method: *Least Squares*				
Included observations: *29 monthly observations after adjusting endpoints*				
$CPI = \alpha_2 * NInc$				
Estimated Coefficient	*Value*	*Std. Error*	*t-Statistic*	*Probability*
$\hat{\alpha}_2$	0.00080648	0.0001133	7.1152631	1.19 E-07
Multiple R	0.8075783	*Mean dependent var. CPI*		0.6167857
R-Square	0.6521827	*S.D. dependent var. CPI*		0.4029618
S.E. of regression	0.440110	*F-statistic*		50.62697
t critical	2.0518304	*F critical*		1.9048229

Source of data: National Bank of Romania – Annual and Monthly Reports 2004 – 2007

In the both tables the *Multiple R* has values relatively close to 1, which means that the connections between evolution of CPI and unemployment rate, respectively, net income in the period studied are strong. The Fisher test values *F-statistic* for those two factors of influence are greater than *F critical* that shows the same thing, a strong link between dependent variable CPI and the influence factors from the labor market.

The Student test value *t-Statistic* is greater than *t critical* that shows the models are statistically significant. The positive values of $\hat{\alpha}_1$ and $\hat{\alpha}_2$ estimated coefficients means that the evolutions of CPI, unemployment rate and net income are directly connected (if unemployment rate and net income slows, the CPI is slowing too).

Other important factors that have significant actions to inflation in Romania are the exchange rate and the interest rates. In the last years, the exchange rate of Romanian Leu (*ER*) was appreciating and the interest rates (*IR*) are slowing down, with a strong effect in process of disinflation. The one factor linear models for these two indicators in the 2004 – 2007 periods are presented in Table 3 and Table 4.

Table 3 Regression Linear Model between *CPI* and *Exchange Rate*

Dependent Variable: *CPI*				
Method: *Least Squares*				
Included observations: *29 monthly observations after adjusting endpoints*				
CPI = α₃ * ER				
Estimated Coefficient	*Value*	*Std. Error*	*t-Statistic*	*Probability*
$\hat{\alpha}_3$	0.1654676	0.0196291	8.4297087	4.84 E-09
Multiple R	0.851268	*Mean dependent var. CPI*		0.6167857
R-Square	0.724658	*S.D. dependent var. CPI*		0.4029618
S.E. of regression	0.391581	*F-statistic*		71.05998
t critical	2.0518304	*F critical*		1.9048229

Table 4 Regression Linear Model between *CPI* and *Interest Rate*

Dependent Variable: *CPI*				
Method: *Least Squares*				
Included observations: *29 monthly observations after adjusting endpoints*				
CPI = α₄ * IR				
Estimated Coefficient	*Value*	*Std. Error*	*t-Statistic*	*Probability*
$\hat{\alpha}_4$	0.0301487	0.0033677	8.9521705	1.44 E-09
Multiple R	0.864867	*Mean dependent var. CPI*		0.6167857
R-Square	0.747996	*S.D. dependent var. CPI*		0.4029618
S.E. of regression	0.374618	*F-statistic*		80.14135
t critical	2.0518304	*F critical*		1.9048229

Source of data: National Bank of Romania – Annual and Monthly Reports 2004 – 2007

In the Table 3 and the Table 4 the *Multiple R* and *R-Square* has values close to 1, which means that the connections between evolution of CPI, exchange rate and interest rate are very strong. The Fisher test values *F-statistic* for those two factors of influence are greater than *F critical* that shows the strong links between CPI, exchange rate and interest rate.

The Student test value *t-Statistic* is greater than *t critical* that shows the models are statistically significant, too. The positive values of $\hat{\alpha}_3$ and $\hat{\alpha}_4$ estimated coefficients means that the evolutions of CPI, exchange rate and interest rate are directly connected. The appreciation of the exchange rate of Romanian Leu and the decreasing interest rates in the studied periods determines an important effect to decrease the inflation.

The last set of influence variables for inflation in Romania is given by the production price index (PPI), broad money (M2) and non-government credit (NGC). The one factor linear models for these three indicators in the 2004 – 2007 periods are presented in Table 5, Table 6 and Table 7.

Table 5 Regression Linear Model between *CPI* and *Production Price Index*

Dependent Variable: *CPI*				
Method: *Least Squares*				
Included observations: *29 monthly observations after adjusting endpoints*				
CPI = α₅ * PPI				
Estimated Coefficient	*Value*	*Std. Error*	*t-Statistic*	*Probability*
$\hat{\alpha}_5$	0.4529413	0.04812868	9.41105684	5.13 E-10
Multiple R	0.875426	*Mean dependent var. CPI*		0.6167857
R-Square	0.766371	*S.D. dependent var. CPI*		0.4029618
S.E. of regression	0.360702	*F-statistic*		88.56799
t critical	2.0518304	*F critical*		1.9048229

Table 6 Regression Linear Model between *CPI* and *M2*

Dependent Variable: *CPI*				
Method: *Least Squares*				
Included observations: *29 monthly observations after adjusting endpoints*				
CPI = α₆ * M2(-1)				
Estimated Coefficient	*Value*	*Std. Error*	*t-Statistic*	*Probability*
$\hat{\alpha}_6$	0.0078342	0.0012431	6.3019569	9.58 E-07
Multiple R	0.771551	*Mean dependent var. CPI*		0.6167857
R-Square	0.595291	*S.D. dependent var. CPI*		0.4029618
S.E. of regression	0.474741	*F-statistic*		39.71466
t critical	2.0518304	*F critical*		1.9048229

Table 7 Regression Linear Model between *CPI* and *Non-Government Credit*

Dependent Variable: *CPI*				
Method: *Least Squares*				
Included observations: *29 monthly observations after adjusting endpoints*				
$CPI = \alpha_7 * NGC(-1)$				
Estimated Coefficient	*Value*	*Std. Error*	*t-Statistic*	*Probability*
$\hat{\alpha}_7$	0.0101961	0.001786	5.7062841	4.60 E-06
Multiple R	0.739383	*Mean dependent var. CPI*		0.6167857
R-Square	0.546688	*S.D. dependent var. CPI*		0.4029618
S.E. of regression	0.502439	*F-statistic*		32.56167
t critical	2.0518304	*F critical*		1.9048229

Source of data: National Bank of Romania – Annual and Monthly Reports 2004 – 2007

In the case of broad money and the non-government credit, the influence has a one-month *time lag*. Like in the case of the other variables in the Tables 5, 6 and 7 the *Multiple R* have values close enough to 1, which means that the links between evolution of CPI, PPI, money broad and non-government credit are strong. The Fisher test values *F-statistic* for those three factors of influence are much greater than *F critical* that shows the strong connections between CPI and these three influence factors.

The Student test value *t-Statistic* is much greater than *t critical* that shows the models are statistically significant. The positive values of α_5, α_6 and α_7 estimated coefficients means that the evolutions of CPI, PPI, money broad and non-government credit are directly connected. The decreasing *PPI, M2* and *NGC* in the studied periods determine a significant effect to decrease the inflation.

3. THE MULTIPLE REGRESSION MODEL

After the main influence factors are found and explained, the next step is the elaboration of the multiple regression model of inflation rate. The model is a classic linear regression function with standard parameters. The coefficients of regression are estimated with well known least square method. All the restrictions of the method are accomplished.

The results of the model are tested with statistical tests: Student, Fisher and Durbin-Watson test. In the same time are calculated and studied the Standard Errors of the model and of the coefficients estimated. The panel of data is structured on monthly data in the period of 2004 – 2007 years[2] (before and after Romania's accession to the EU). From the 38 values initially introduced in the model, a number of values were adjusted and the final number of observations is 29. The main results of the final model are given in Table 8:

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[2] The sources of data are Annual and Monthly Reports of National Bank of Romania 2004 – 2007

Table 8 Multiple Regression Model between CPI and the main influence factors

Dependent Variable: *CPI*				
Method: *Least Squares*				
Included observations: *29 monthly observations after adjusting endpoints*				
$CPI_t = \beta_1 * UnR_t + \beta_2 * NInc_t + \beta_3 * ER_t + \beta_4 * IR_t + \beta_5 * PPI_t +$ $+ \beta_6 * M2_{t-1} + \beta_7 * NGC_{t-1} + \varepsilon_t$				
Estimated Coefficients	*Value*	*Std. Error*	*t-Statistic*	*Probability*
$\hat{\beta}_1$	0.4300095	0.1250906	3.4375862	0.0024699
$\hat{\beta}_2$	-0.0065920	0.0015236	4.3266737	0.0002975
$\hat{\beta}_3$	0.3572905	0.0619004	5.7720271	9.93 E-06
$\hat{\beta}_4$	1.3657612	0.5156265	2.6487414	0.0150186
$\hat{\beta}_5$	-0.1120603	0.0526710	2.1275539	0.0453856
$\hat{\beta}_6$	-0.0369584	0.0162664	2.2720759	0.0337128
$\hat{\beta}_7$	-0.0439367	0.0135458	3.2435668	0.0038891
Multiple R	0.9577295	Mean dependent var. CPI		0.6167857
R-Square	0.9172454	S.D. dependent var. CPI		0.4029618
S.E. of regression	0.2434179	t critical		2.0518304
F-statistic	33.251995	F critical		1.9048229
Durbin-Watson	1.96964	DW critical $d_L{}^3$		1.05
		DW critical $d_U{}^4$		1.84

First observation is that the values of the *Multiple R* and *R-Square* are very close to 1. That means that the evolution of inflation rate in Romania is very strong influenced by the variations of the independent factors from the model. All the statistical tests show a very significant dependence of inflation rate by the influence factors.

The positive value of estimated coefficient β_1 means that in the studied periods, unemployment rate and CPI have similar trends. The negative value of the estimated coefficient β_2 means that the CPI and net income have different trends. These evolutions due to pressures in the labor market, causing registered unemployment rate to slow down at 5 percent. Additional signs of the constricted labor market were provided by the other elements relating to labor supply (outflows of employees had the higher annual growth rate in the last three years and the number of people subject to retire remained relatively low and was considerably smaller than the number of hiring).

The positive values of estimated coefficients β_3 and β_4 means that the CPI, exchange rate and interest rate have the same trend in the periods studied. The appreciation of the Romanian Leu against the Euro accelerated, especially in the last year. The main forces behind the appreciation of the Romanian currency were larger and more diversified capital inflows, attracted by favorable conditions on the domestic market and expectations of a decreasing trend of the exchange rate. Interest rates were less volatile

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[3, 4] Pindyck, R.S. and Rubinfeld, D.L. (1998), *Econometric Models and Economic Forecasts,* McGraw–Hill, Fourth Edition, p. 610

than previous periods while the average daily rates seriously fluctuated. Another important factor was the average spread between bid and ask rates for very short maturities which significant narrowed. All that evolutions implied important decreases of the CPI.

The negative value of estimated coefficient β_5 means that PPI was increasing in the period studied while CPI decreased. Inflationary pressures of producer prices for industrial goods remained high. The prices for non-durable goods posted also unfavorable developments. Prices for agricultural products increased significantly, in both vegetal and animal products. Trend reversals are expected in the next periods in the industrial and agricultural producer prices that slower the pressure on CPI.

Finally, the negative value of estimated coefficients β_6 and β_7 means that CPI has different trend than broad money (M2) and non-government credit. The broad money registered a decline in the increase of currency and of demand deposits. In addition, the stronger nominal appreciation of the Romanian Leu through into a relative improvement of the composition of broad money by currency slowed the trend of the M2. The dynamics of domestic currency-denominated loans posted a decline in the period studied, while foreign currency-denominated loans increasing. Influence factors of these changes, mainly included the increase in the minimum reserve requirements on RON-denominated liabilities and the nominal appreciation of the domestic currency.

Considering all the influence factors included in the multiple regression model, the evolutions of CPI and model based predicted CPI are presented in the Figure 1:

Figure 1 The evolutions of CPI and Model based predicted CPI
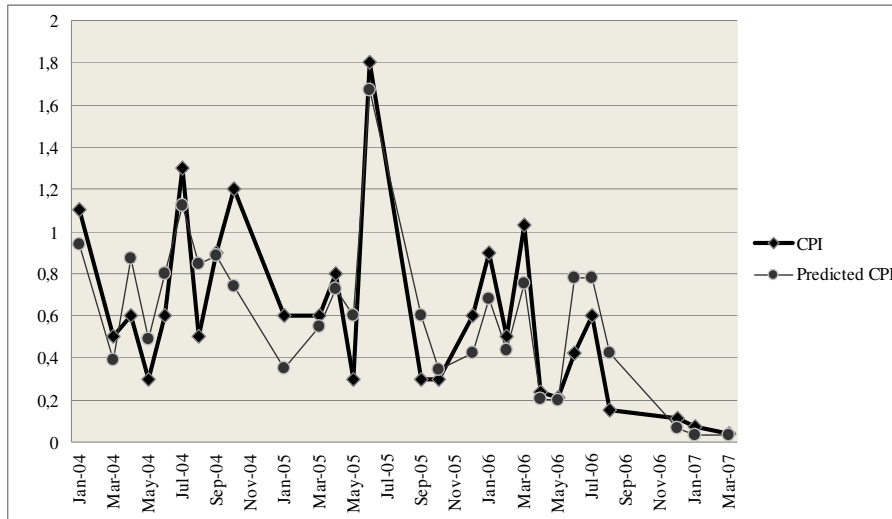
Source of CPI data: National Bank of Romania – Monthly Reports 2004 – 2007 (CPI value for March 2007 is estimated)

Like is shown in the figure 1, in the most of studied periods, predicted CPI was lower than real CPI that shows the model underline the decreasing trend of inflation rate in Romania. The model mark very good the periods with very low inflation and not prognosis the periods with a higher level of inflation. The correlation real life – model is better in the last year, 2007, than in the first year of analysis, 2004, that shows the more predictability of inflation rate in the last periods very close or after accession in the European Union.

4. <u>CONCLUSIONS</u>

According to the National Romanian Bank baseline scenario, the annual consumer price inflation is projected to stay within the target band over the entire prognosis horizon, reaching estimated levels of 4.6 percent at the end of year 2007 and 4.1 percent at the end of year 2008[5]. Assuming that, during the forecast period, agricultural outputs are considered unaffected by major shocks and the low base effect of the 2006 food prices is assumed to result in a temporary acceleration of the annual growth rate of consumer prices, which will be manifest especially in the latter half of the year in case of volatile food prices.

The reaction of National Bank of Romania to possible inflationary shocks has to be based on a credible model of monetary policy. This model must include with no doubts the previous experience of the influences suffered by inflation rate. The accurate predictions of the model are possible only if the economy will not be affected by several risks[6]:
• Increases of the wages faster than expectations, uncorrelated with productivity growths;
• Deviation of the budget execution from its projected parameters;
• Great discrepancy between saving and investment;
• Uncertainties about developments in volatile food prices, in world market prices of oil and natural gas and future exchange rate developments.

Romania's accession to the European Union could, in the short term, bring about changes in consumer prices originating in the adoption of some mechanisms and policies specific to the Community, as well as in influences resulting from the integration into a common market. According to National Romanian Bank estimates, changes in food prices determined by the adoption of the Common Agricultural Policy and Common Customs Policy as from 1 January 2007 will add about 0.3 percentage points to inflation rate. Their impact considered to become manifest only in the first half of 2007.

Accession to the European Union and integration in a common market of Romania cause to producers and consumers an increased flexibility in accessing the markets. Foreign producers interested in the Romanian market potential could choose to increase

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[5] National Bank of Romania – *Inflation Report * February 2007*
[6] Press Conference of the Governor of National Bank of Romania – *Inflation Targeting. Quarterly Inflation Report*, Bucharest, 15 February 2007

their deliveries to Romania, which might result in a substantial over supply and slow down the domestic consumer prices (as it was the case in the Czech Republic, Slovakia and Slovenia).

Once Romania has joined the European Union, it shifted to the Common Customs Policy. In that respect, customs duties relative to trade with other Member States are removed and the common customs regime is adopted. Some EU imports will become cheaper following the elimination of customs duties and a similar performance is expected for imports from non-EU members. For a limited number of goods from the countries that were parts of preferential agreements signed by Romania prior to its joining the European Union may occur the price increases. In time is expected a changing of structure by supplier of such goods and replacing with EU partners.

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