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BUDGET DEFICIT AND INFLATION

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1. INTRODUCTION

The main objective of the central bank is to control the price level. This goal derives from the monetarist theory which can be summerized by Milton Friedman dictum that “inflation is always and everywhere a monetary phenomenon”.

Starting with Sargent and Wallace paper – “Some Unpleasant Monetarist Arithmetic”(1981) – the fiscal policy role in explaining inflation has grown considerably.

The influence of fiscal policy on price determination can be better observed in fiscal dominance regimes, like the case of Romania. These are regimes in which central bank objectives are subordinated to the fiscal authority’s decisions. The monetarist theory states that in this kind of regimes, the fiscal deficits cause inflation because it affects the policy rule of the central bank. Instead, the fiscal theory of the price level says the fiscal authority influence inflation through the effects of fiscal disturbances upon private sector budget constraint and hence upon aggregate demand.

High and persistent inflation is one of the salient features of developing countries. This phenomenon has been called chronic inflation. Different from hyperinflation which only lasts a few months, chronic inflation may spread on decades. In the same time, countries are adapting to inflation making indexation mecanisms which fuel further inflation.

Eliminating large budget deficits is, no doubt, a necesary condition to definitely reduce inflation. In this view, it is relevant the fact that macroeconomic stabilization programs which lacked fiscal adjustments or they were short lived, failed in reducing inflation. And, as Calvo and Vegh (1999) argue, the success programs included very important fiscal adjustments (for exemple the case in Israel 1985).

Regarding Romania, according to Budina and Van Wijnbergen (2000), the main cause of chronic inflation and frequent currency crises after 1991 were unsustainable budget deficits.

The goal of this paper is to find an econometric relation between budget deficit and inflation and to assess the impact of a given deficit on annual inflation. We want to show that the persistent inflation in Romania has fiscal roots and any attempt of stopping inflation should imply fiscal adjustments.

This paper uses an econometric specification derived from a macroeconomic model that relates the inflation rate and the budget deficit scaled by narrow money. This specfication was first used by Catao and Terrones (2001) in analysing the effects of budget deficit upon inflation in emerging markets economies.

For the econometric estimation we will use an error corection model due to the fact that the macroeconomic instability which caracterized Romania's economy cause very large fluctuations in the time series.

The paper is organized as follows. Section 2 presents the model used to analyse the link between inflation and fiscal deficit and the way fiscal deficit affects inflation according to the monetarist theory and the fiscal theory of the price level. In section 3 are presented the econometric results and section 4 concludes.

2. THE MODEL

To analyse the link between budget deficit and the price level we use a simplified version of the model presented by Woodford (2001).

The household seeks to maximize the following utility function:

$$\sum_{t=0}^{\infty} \beta^t u(c_t + g_t, \frac{M_t}{P_t}) \qquad (2.1)$$

where U(·) is increasing and concave in both arguments and the subjective discount factor satisfies $0<\beta<1$. We assume that real gouvernment expenditures (g_t) are perfect substitutes for real private consumption expenditure (c_t). This simplification allows us to focus solely upon the effects of the fiscal policy on private budget constraint. Gouvenment expenditure have exactly the same effect on economy as transfers to households of funds sufficient to finance private

consumption of exactly the same amount. For the same reason we assume that taxes are lump-sum and a tax increase has the same effect as a reduction of transfers that reduces the household budget. The second argument indicates the liquidity services provided by end-of-period money balances M_t. These depend upon the real purchasing power of those balances, so M_t is deflated by the price level P_t.

The representative household has each period the following budget constraint:

$$M_t + \frac{B_t}{R_t} + P_t c_t = M_{t-1} + P_t y_t - P_t \tau_t + B_{t-1} \qquad (2.2)$$

stating that end-of-period financial wealth (money balances M_t plus bonds) and consumption in period t must equal the financial wealth at the beginning of the period, plus income from the sale of period t production (y_t) net of tax payments τ_t. B_t is the nominal value of discount gouvernment bonds issued at the end of period t with the maturity in period t+1. We assume y_t, g_t, τ_t to be exogenous. R_t is gross nominal interest rate at wihch the bonds are discounted.

The goods market equilibrium condition is:

$$c_t + g_t = y_t \qquad (2.3)$$

We maximize (2.1) with respect to private constraint (2.2) and take the first order conditions with respect to c_t, m_t, b_t[1] and we impose the market clearing condition to be satisfied:

$$\frac{M_t}{P_t} = L(y_t, R_t) \qquad (2.4)$$

$$\frac{B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \frac{1}{r^j} (\tau_{t+j} - g_{t+j} + \frac{M_{t+j} - M_{t-1+j}}{P_{t+j}}) \qquad (2.5)$$

[1] $m_t = \frac{M_t}{P_t} \quad b_t = \frac{B_t}{P_{t+1}}$

$$R_t = r\frac{P_{t+1}}{P_t} \qquad (2.6)$$

The first equation defines the money demand function and is increasing with income (y) and decreasing with gross nominal interest rate (R). The left term is the real money supply.

Relation (2.5) states that real public debt must equal the present value of future fiscal surpluses (taxes τ minus gouvernment expenditures *g*).

We assume as Cochrane (2001) that the gross real interest rate (r) is constant in order to ease the calculation and without a great loss of generality. This determines that the gross nominal interest rate to depend only on expected inflation and relation (2.6) became a common Fisher equation, where r is the gross real interest rate. We can introduce (2.6) in the money demand equation and the model reduces at two equilibrium relations.

The fact that fiscal deficit affects inflation is no subject of debate. But the way in which this influence takes place differs according to theory we choose: the monetarist theory or the fiscal theory of the price level. The dispute is about which one of the above two equations determines the price level: the money demand equation or gouvernment budget constraint.

2.1. The Monetarist Theory

The monetarist theory states that the price level is determined by money demand equation. The central bank chooses the money supply and the price level is determined each period by equation (2.4), given money demand. Refering to the fiscal policy role in price pevel determination, Carlstrom and Fuerst (2000) distinguish two cases.

The first case is the monetary dominance regime, in which the central bank sets a target level for inflation and from equation (2.4) results a certain level of seigniorage. The gouvernment budget constraint forces the fiscal authority to adjust the fiscal deficit because public debt, seigniorage and the price level are predetermined. In this kind of regime, fiscal policy doesn't influence inflation.

In the second case, the fiscal dominance regime, fiscal authority chooses the fiscal deficit according to the needs of fiscal policy and this deficit it is then assigned the central bank. The central bank must increase the monetary base and then the rate of money growth determines the rate of inflation.

The difference between the two regimes is given by who sets the money supply and inflation is still a monetary phenomenon. Fiscal policy can affect inflation only by intervening on the monetary policy rule. This has led to the conclusion that an independent central bank who's main objective is maintaining price stability is enough to have a low inflation.

2.2. The Fiscal Theory of the Price Level

The central point of the fiscal theory of the price level (FTPL), as shown by Cochrane (1999), is the way in which the gouvernment budget constraint is viewed. Cochrane argues that this is not a constraint but an evaluation equation of the public debt. FTPL treats the monetary and the fiscal authority together and the public debt to the private sector in FTPL is the sum between gouvernment debt and monetary base. The gouvernment budget constraint can be rewritten to reflect the total debt of the public authority:

$$\frac{B_{t-1} + M_{t-1}}{P_t} = \sum_{j=0}^{\infty} \frac{1}{r^j} (\tau_{t+j} - g_{t+j} + \frac{R-1}{R} m_{t+j}) \qquad (2.5a)$$

According to Cochrane (2000) this is a valuation equation for the public debt and not a constraint in the same way in which the valuation equation for a stock is not a constraint for a company:

$$\frac{No.\ shares}{price} = present\ value\ of\ \ future\ profits$$

$$price = {}^{1}\!/_{share\ price}$$

The FTPL sees the public authority debt as a residual right on future gouvernment surpluses, like it is the case in a company in which the stocks are a residual right on firm's profits.

Equation (2.5a) is not satisfied for every path of future gouvernment surpluses, so we eliminate the cases in which the gouvernment fixes whatever path for gouvernment spending and the price level adjusts to reach an equilibrium. In order to have an equilibrium, monetary and fiscal policy must be coordinated and the paths of future surpluses must meet certain conditions.

3. ECONOMETRIC RESULTS

For the estimation of influence of budget deficit on inflation, we start from the gouvernment budget constraint:

$$\frac{B_{t-1}}{P_t} = \sum_{j=0}^{\infty} \frac{1}{r^j} (\tau_{t+j} - g_{t+j} + \frac{M_{t+j} - M_{t-1+j}}{P_{t+j}}) \qquad (3.1)$$

We restrict our attention to a particular case, when the public debt cannot grow, so the entire budget deficit is financed through seigniorage.

Figure 1 shows the real public debt and the real foreign debt (expressed in national currency) so we can analyse in what measure we can accept the above assumption. The difference between the two lines is the domestic debt which is not significant. Because most of the debt is denominated in foreign currency we present the the public debt in real terms in order to capture any real inflows and outflows. Starting from 1996 the real public debt although is growing, the pace is very slow compared with the prior period so we can validate the assumption.The

relative stability of the public debt can be explain by adverse market conditions due to Asia's financial crisis in 1997 and Russia's default an its external debt in 1998 which determined a reduction in capital flows to emerging markets. The fact that Romania had to repay 2.9 million USD to its foreign creditors diminished the gouvernment's chances to obtain new loan from foreign financial institutions at resonable interest rates.

Imposing our restriction on the public debt we obtain :

$$\frac{B_{t-1}(t)}{P_t} = \tau_t - g_t + \frac{M_t - M_{t-1}}{P_t} \qquad (3.2)$$

where B(t) is the debt with the maturity in period t that has to be payed and is not rolled-over.

This can be rewritten:

$$\frac{B_{t-1}(t)}{P_t} - \tau_t + g_t = \frac{M_t - M_{t-1}}{P_t} \qquad (3.3)$$

The left term is the budget deficit formed from fiscal deficit and repayment of public debt with the maturity in period t and the right term is seigniorage. Seignorage revenues (S) can be written as a function of the inflation rate and real money supply:

$$S = f(\pi_t)\frac{M_t}{P_t} \qquad (3.4)$$

where f(π) is a reduced form money demand equation.

We consider that seigniorage is increasing with inflation rate (we are on the right side of the Laffer curve) and combining equations (3.3) and (3.4) we obtain the equation estimated by Catao and Terrones (2001) which explains the inflation rate by budget deficit and money supply:

$$\pi_t = \beta \frac{d_t P_t}{M^s_t} \qquad (3.5)$$

$$d_t \equiv g_t - \tau_t - b^s_{t-1}(t)$$

$$\beta \equiv f^{-1}$$

If we divide by nominal GDP (Y) we obtain a relation between the size of the budget deficit (D) in GDP and the level of inflation:

$$\pi_t = \frac{\frac{D_t}{Y_t}}{\frac{M_t}{Y_t}} \qquad (3.6)$$

The influence of budget deficit on inflation is nonlinear: the higher is the inflation rate, the greater the impact of a reduction in the budget deficit on inflation. This is because real money supply shrinks with rising inflation as a result of reduced confidence in national currency. And in this case financing a given real budget deficit requires a faster increase of the monetary base because the base of seigniorage reduces .

$$S = \frac{\partial M / \partial t}{M} \frac{M}{P}$$

Relation (3.5) is the equation we will try to estimate and find an estimator for β**.**

The Data

The data used in estimation are from the Annual and Monthly Reports of the National Bank of Romania.

D – the deficit of the state budget in billions ROL (we use a negative sign for budget deficit)

π – the growth rate of the consumer price index

M1 – money supply M1 (billions ROL)

BM – monetary base computed as the money issuance from the balance sheet of the central bank (billions ROL)

We use quaterly data for the period 1991:1 – 2001:4 and we will estimate two cases for relation (3.5) using as narrow money once M1 and in the second time monetary base.

Testing series' stationarity

Before estimating equation (3.5) we verify if the series are stationary with Augmented Dickey-Fuller Test. After computing the test for the inflation rate, budget deficit/M1 and Budget deficit/ monetary base, we cannot reject the null hypothesis for any series so the series are not stationary (Tables B1-B3). This fact is due to the macroeconomic instability of Romania's economy in the observed period.

ESTIMATION WITH M1 FOR MONEY SUPPLY

Because we do not have stationary series we use an error correction model to estimate (3.5). We first test whether the series are cointegrated with Johansen test without including any lags, intercept or trend in the data. For the period 1991:1-2001:4, we accept at 5% significance level the existence of 2 cointegration relations. Because we are interested in finding a robust relation between deficit and inflation we repeat the Johansen Test by successively

eliminating the first observation from the sample. And we accept at 5% significance level the existence of one cointegration equation starting from 1993:4 (Table B4).

We estimate the VECM for the period 1994:1-2001:4 with no lags, trend or intercept. In order to capture the effect of readjustement of admistrative prices in the first quarter of 1997 we have included a dummy variable. In choosing the right number of lags we have used the Likelihood Ratio Test which favors a model with 3 lags. In the same time Schwartz Information Criteria and Akaike Information Criteria favor a model with no lags (test results are presented in Appendix A). We have chosen to estimate a model with no lags due to reduced number of observation (more lags decreases the precision of the estimation) and due to the fact that no substantial gains in the regraession fit were seen after adding new lagged variables.

Table B5 shows the results. For the period 1994-2001, budget deficit scaled by narrow money explains in a large part the dynamics of inflation (R^2=0.85). The estimator β is equal to 0.48 with a very high t-ratio (t-statistic=7.21) which indicates a robust relation between budget deficit and inflation.

Regarding the residuals (Table B7), the White Test reject the null hypothesis of no heteroskedasticity at 1% significance level and the Breusch-Godfrey test indicates the presence of autocorrelation at 5% significance level. This means that the estimator obtained it is consistent but the standard-errors cannot be used in statistical inferences.

The signs are according to what economic theory predicts, an increase of the budget deficit results in a higher inflation rate. If we consider that the share of money supply M1 is around 6% in GDP (Figure 2) as it was at the end of the observation period, a reduction with 1 procentual point of the share of the annual budget deficit in GDP can determine a decrease with 8.2 procentual points of the annual inflation rate. To assess the effect of a deficit cut on annual inflation rate, we started with equation (3.6) and assumed a decrease with 0.25 procentual points of the quaterly budget deficit in GDP. This determine a reduction with 2

procentual points of quaterly inflation. A decrease with 0.25 procentual points of the quarterly deficit in GDP in each quarter means a cut with 1 procentual point of the annual deficit in GDP which determines a reduction with 8.2 procentual points of annual inflation. The deficit effect on inflation has been estimated assuming that the share of money supply in GDP remains constant. This can be justified by the fact that monetization and demonetization are asymetric. High inflation quickly reduces money demand while in a low inflation money demand will only grow gradually – Gosh (1997).

Because we previously accepted the assumption that public debt is constant from 1996, to avoid an estimation error we re-estimate the model for the period 1996-2001.We obtained that β is 0.52 (Table B6) and a slightly improved regrassion fit (R^2=0.87). Regarding residuals (Table B7), we cannot reject the null hypothesis of no autocorrelation and no heteroskedasticity, so the standard errors are no longer biased. The only estimator who changed significantly is the cointegration term and the autocorrelation detected in first case didn't affect the long run relation between the deficit and inflation.

Reducing the budget deficit with 1 procentual point in GDP determines a reduction with 8.9 procentual points of annual inflation (very close of 8.2 p.p. in the previous case). Given that the residuals don't display heteroskedasticity or autocorrelation, this supports the strong result we have obtained for the effect of the budget deficit upon the inflation rate and indicate that disinflation requires a more stricter fiscal discipline.

The high level of the speed of adjustment obtained in both cases (0.75 and 0.85) means the the inflation rate adjust to its long-run value in about 2 quarters so the transmission mechanism is very short and explains why we do not need lagged differences in the error correction vector. According to the monetarist point of view, this means that any increase in the budget deficit translates into a raise of the money supply that determines a higher price level. Because the fiscal shock is absorbed by the price level very quickly this means that any increase in money supply translates in higher inflation so an

expansionary monetary policy cannot stimulate economy through money demand channel.

According to the fiscal theory of the price level, this means that the fiscal policy lacks credibility. The market expects that the current increases in the budget deficit will not be compensated with future surpluses, so the value of the public authority's real debt (narrow money) is reduced by an increase in the price level. The transmission channel this time is as follows: the higher deficit increases aggregate demand which results in higher inflation.

ESTIMATION WITH MONETARY BASE (BM)

We use Johansen test to determine whether inflation rate and budget deficit scaled by monetary base are cointegrated and we accept the existence of 1 cointegration equation from 1993:4 (Table B8).

Estimating a VECM for the period 1994-2001 (Table B9) with no lags, trend or intercept and with a dummy for price readjustements in the first quarter of 1997 we find β equal to 0.3 (t-statistic=7.91) and a high regression fit (R^2=0.85).

This time a 1 procentual point reduction of the budget deficit in GDP determines a decrease with 7.7 procentual points of annual inflation (compared with 8.2-8.9 p.p. in previous cases). The share of monetary base was around 4% in GDP at the end of the period (Figure 3).

Analysing residuals (Table B11) the White test indicates the precence of heteroskedasticity at 5% significance level and the LM test rejects the null hypothesis of no autocorrelation at 5% significance level.

When we re-estimate for the period 1996-2001 (Table B10), to comply with the assumption we made in derivind relation (3.5), we find β to be 0.33 and more statisticaly significant (t-ratio=9.70). The quality of the regression is improved (R^2=0.88) and White test (Table B11) cannot reject the null hypothesis of no heteroskedasticity. Testing the serial correlation of the residuals, the Breusch-Godfrey test cannot reject the null hypothesis of no autocorrelation at

10% significance level. The effect of a reduction of 1 procentual point of the budget deficit in GDP is a decrease with 8.5 procentual points of annual inflation.

Compared wirh the estimation with M1, scaling deficit by monetary base leads to an estimator with a smaller standard error. No matter what definition of money supply we used, eliminating from the sample the observation from 1994-1995 led us to obtain a better fit of the regression and uncorrelated disturbances, due to the fact that public debt was relatively stable only after 1996.

Using the Granger test to verify if budget deficit scaled by narrow money Granger-cause the inflation rate we can reject the null hypothesis at 1% significance level so the cauzality runs from deficit to inflation rate. We constructed the test with 2 lags and a dummy for period 1996-2001 both with M1 and monetary base (Table 12).

To sum up, we obtained that a 1 procentual point cut of deficit in GDP determines a decrease with 7-9 procentual points of annual inflation. The very high t-ratios of the estimators, the good fit of the regression and uncorrelated residuals (when we estimated for period 1996-2001) support the results.

Catao and Terrones estimate the same equation for a panel of 23 emerging markets and find β equal to 0.35 using M1 for narrow money. The large difference from our estimator (0.52) is expained by the fact that we used quarterly data and not annual date. They found that 1 procentual point cut of the budget deficit in GDP cause annual inflation to reduce with 5.8 procentual points. The gap from our results can in part be explained by the fact that they obtained a mean estimator for the countries included. Another reason is that their estimation period is 1970-2000, a period long enough so that the restriction we impose (the public debt cannot grow) isn't satisfied by a large mesure. When the gouvernment can issue long term debt, a current deficit no longer coincides with inflation, as shown by Cochrane(2001), and the increase of inflation is postponed for the next periods. Hence, this tends to reduce the effect of the budget deficit upon inflation. Still, our result may be too powerful because we didn't included a measure for quasi-fiscal deficit which could have reduced this effect. Catao and Terrones (2001) estimate a broader deficit for some of the countries they

included and that quasi-fiscal deficit and the fiscal deficit tend to move together. So we can conclude, that although our results may be too strong, they show that fiscal imbalances are the main cause of inflation in Romania.

Fischer, Sahay and Vegh (2000) using a broad cross-country panel have found that 1 procentual point reduction of budget deficit in GDP leads to 4.2 procentual points decrease of annual inflation. They have used a regression in which inflation rate was explained by budget deficit in GDP. They found no evidence of a significant relationship between infation and fiscal balances for low inflation countries.

4. CONCLUSION

Although economic theory postulates a cauzal relation between the size of budget deficit and the inflation rate, this is not easy to find in the data. Analysing the period 1991-2001 in Romania we found a long run relation between the inflation rate and budget deficit only from 1994 when inflation reduced at 2 digits.

We explained the inflation rate by regressing it to the budget deficit scaled to money supply. The estimators obtained show a positive correlation between the size of the deficit and the level of inflation and a 1 procentual point reduction of the budget deficit in GDP can reduce the inflation rate with 7.7-8.9 procentual points. The stong effect of the deficit on inflation is explained by the low level of money supply in GDP which has to increase faster to finance a given deficit. Also, the result may be too high because we didn't include the quasi –fiscal deficit which could have reduced our estimator. Nonetheless, the high regression fit we obtained is evidence to the fact that fiscal imbalances plays the main role in maintainig a high level of inflation in Romania.

The high adjustment speed of the inflation rate to the its long-term equilibrium indicates that the lag of the transmission channel is very short because agents anticipate the persistence of deficits, according to the fiscal theory of the price level. In this view, a disinflation program must include a

commitment to permanently cut deficits instead of following a program that uses as nominal achor the exchange rate and/or the monetary aggregates which eventualy fail, as shown by Calvo and Vegh (1994).

Future studies may want to extend the model estimated to include output and the public debt, and determine how much this changes the results obtained. Also, computing a measure for quasi-fiscal deficit may reduce from the power of the deficit effect we have obtained.

BIBLIOGRAPHY

[1] Alesina, A. and A. Drazen (1991), "Why Are Stabilizatilon Delayed", *American Economic Review*, 81, 1170-1188.

[2] Anand, R. and S. van Wijnbergen (1989), "Inflation and the Financing of Gouvernment Expenditure : an Introductory Analysis with an Application to Turkey", *The World Bank Economic Review* ,vol.3, no.1,17-38.

[3] Blanchard, O. and S. Fischer (1989), *Lectures on Macroeconomics*, Cambridge, MA : The MIT Press, 512-517.

[4] Budina, N. and S. van Wijnbergen (2000), "Fiscal Deficits, Monetary Reform and Inflation Stabilization in Romania", Word Bank, working paper no. 2298.

[5] Buiter, W. H. (1999), "The Fallacy of the Fiscal Policy of the Price Level", NBER working paper no.7302.

[6] Calvo, G. and C. Vegh (1994), "Inflation Stabilization and Nominal Anchors", *Contemporary Economic Policy*, 12: 35-45;

[7] Calvo, G. and C. Végh (1999), "Inflation Stabilization and BOP Crisis in Developing Countries", NBER working paper no. 6925.

[8] Carlstrom, C. T. and T. Fuerst (2000), "The Fiscal Theory of Price Level", Federal Reserve Bank of Cleveland, *Economic Review*, Q I, 22-32.

[9] Cataõ, L. and M. Terrones (2001),"Fiscal Deficits and Inflation: A New Look at the Emerging Market Evidence", IMF working paper no. 74/01.

[10] Cochrane, J. H. (1999), "A Frictionless View of U.S. Inflation", in B. S. Bernanke and J. J. Rotemberg, eds., *NBER Macroeconomics Annual*, Cambridge, MA : The MIT Press , 323-384.

[11] Cochrane, J. H. (2000), "Money as Stock : Price Level Determination with no Money Demand",NBER working paper no. 7498.

[12] Cochrane, J. H. (2001),"Long Term Debt and Optimal Policy in the Fiscal Policy of Price Level", *Econometrica*, 69,69-116.

[13] Cukierman, A. ; S. Edward and G. Tabellini (1992), "Seniorage and Political Instability", *American Economic Review*, 82, 537-555.

[14] Daianu, D. (2000), *Incotro se indreapta tarile postcomunite?: curente economice in pragul secolului*, Iasi: Polirom.

[15] Dupor, B. (2000), "Exchange Rates and the Fiscal Policy of the Price Level", *Journal of Monetary Economics*, 45, 613-630.

[16] Fischer, S.; R. Sahay and C. Vegh (2000), "Modern Hyper and High-Inflations", *Journal of Economic Literature*, Forthcoming.

[17] Gosh , R. A. (1997), "Inflation in Transition Economies: How Much? and Why?", IMF working paper no. 97/80.

[18] Hansen, L. P. ; W. Roberds and T. J. Sargent (1991), "Time Series Implications of the Present-Value Budget Balance and of Martingale Models of Consumption and Taxes", in Hansen, L. P. and T. J. Sargent, eds*., Rational Expectations Econometrics*, Westview Press, 121-161.

[19] King, R. and C. Plosser (1985),"Money, Deficits and Inflation", *Carnegie-Rochester Conference Series on Public Policy*, 22, 147-196.

[20] Leeper, E. (1991), "Equilibria under 'Active' and 'Pasive' Monetary and Fiscal Policy ", *Journal of Monetary Economics*, 27, 129-147.

[21] McCallum, B. T. (1998), "Indetreminacy, Bubbles and the Fiscal Theory of the Price Level Determination", NBER working paper no. 6456.

[22] Obstfeld, M. and K. Rogoff (1983), “Speculative Hyperinflation in Maximizing Models : Can We Rule Them Out?”, *Journal of Political Economy*, vol. 91, no. 4, 675-687.

[23] Sargent, T. J. and N. Wallace (1981), “Some Unpleasant Monetaristic Arithmetic”, Federal Reserve Bank of Minneapolis, *Quaterly Review* Fall 1981.

[24] Sims, C. (1995), “Econometric Implications of Gouvernment Budget Constraint”, *Journal of Econometrics*, 83, 9-19.

[25] Sims, C. (1999), ”Domestic Currency Denominated Gouvernment Debt as Equity in the Primary Surplus”, unpublished, Princeton University.

[26] Taylor, J. B. (1993), “Descretion versus Policy Rules in Practice”, *Carnegie-Rochester Conference Series on Public Policy*, 39, 195-214.

[27] Woodford, M. (1994), “Monetary Policy and Price-Level Determinacy in a Cash-in-Advance Economy”, *Economic Theory*, 4, 345-380.

[28] Woodford, M. (1995), ”Price-Level Determinacy Without the Control of a Monetary Aggregate”, *Carnegie-Rochester Conference Series on Public Policy*, 43, 1-46.

[29] Woodford, M. (1996), “Control of Public Debt : A Requirement or Price Stability?”, NBER working paper no. 5684.

[30] Woodford, M. (1998), “Doing Without Money : Controlling Inflation in a Post-Monetary World”, *Review of Economic Dynamics*, 1, 173-219.

[31] Woodford, M. (2001), “Fiscal Requierments for Price Stability”, NBER working paper no. 8072.

Appendix A - Testing the number of lags in the vector of error correction

Tabel A1. Statistics for VECM with M1

Cointegration equation: $\pi = \frac{D}{M1}$ Period: 1994:1 2001:4			
Number of lag differences in VEC	Log-likelihood ℓ	Akaike Information Criteria	Schwartz Information Criteria
0	42.44	44.36	44.45
1	47.26	47.51	47.70
2	51.71	52.09	52.36
3	61.96	62.46	62.83
4	62.77	63.40	63.86

LR= -2*($\ell_i - \ell_k$) where i,k are the number of lags in VEC and has LR distribution is χ^2 (k-i).

Tabel A2. LR test for VECM with M1

H_0	H_1	LR	p-value
r=0	r=1	6.05	0.04
r=1	r=2	8.89	0.01
r=2	r=3	20.49	0.00
r=3	r=4	1.62	0.44

(r is the number of lag differences)

Tabel A3. Statistics for VECM with monetary base (BM)

Cointegration equation: $\pi = \frac{D}{BM}$ Period: 1994:1 2001:4			
NO. of lag differences in VEC	Log-likelihood ℓ	Akaike Information Criteria	Schwartz Information Criteria
0	44.67	44.79	44.88

1	47.76	48.01	48.19
2	52.01	52.39	52.66
3	62.96	63.46	63.82
4	64.13	64.75	65.21

Tabel A4. LR test for VECM with monetary base

H_0	H_1	LR	p-value
r=0	r=1	6.18	0.04
r=1	r=2	8.51	0.01
r=2	r=3	21.88	0.00
r=3	r=4	2.34	0.31

APPENDIX B – Tables

Table B1. Dickey-Fuller Tests Inflation Rate

ADF Test Statistic	-2.200770	1% Critical Value*	-3.6067
		5% Critical Value	-2.9378
		10% Critical Value	-2.6069

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INF)
Method: Least Squares
Sample(adjusted): 1992:2 2001:4
Included observations: 39 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF(-1)	-0.448762	0.203911	-2.200770	0.0349
D(INF(-1))	-0.188266	0.217290	-0.866431	0.3925
D(INF(-2))	-0.101092	0.209011	-0.483667	0.6318
D(INF(-3))	-0.046298	0.193169	-0.239678	0.8121
D(INF(-4))	0.004107	0.165903	0.024755	0.9804
C	0.064274	0.044415	1.447120	0.1573

R-squared	0.323052	Mean dependent var	-0.010360
Adjusted R-squared	0.220484	S.D. dependent var	0.162464
S.E. of regression	0.143439	Akaike info criterion	-0.905170
Sum squared resid	0.678971	Schwarz criterion	-0.649237
Log likelihood	23.65081	F-statistic	3.149639
Durbin-Watson stat	1.937806	Prob(F-statistic)	0.019653

Table B2. Dickey-Fuller Test Budget deficit/M1

ADF Test Statistic	-1.938341	1% Critical Value*	-3.6067
		5% Critical Value	-2.9378
		10% Critical Value	-2.6069

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(R1)
Method: Least Squares
Sample(adjusted): 1992:2 2001:4
Included observations: 39 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
R1(-1)	-0.473639	0.244353	-1.938341	0.0612
D(R1(-1))	-0.525057	0.256106	-2.050157	0.0484
D(R1(-2))	-0.593864	0.238163	-2.493520	0.0178
D(R1(-3))	-0.608145	0.210581	-2.887932	0.0068
D(R1(-4))	-0.148103	0.170492	-0.868678	0.3913
C	-0.078132	0.034930	-2.236800	0.0322

R-squared	0.594396	Mean dependent var	-0.002685
Adjusted R-squared	0.532940	S.D. dependent var	0.119577
S.E. of regression	0.081721	Akaike info criterion	-2.030372
Sum squared resid	0.220385	Schwarz criterion	-1.774439
Log likelihood	45.59225	F-statistic	9.672010
Durbin-Watson stat	1.991189	Prob(F-statistic)	0.000009

Table B3. Dickey-Fuller Tests for Budget Deficit/Monetary Base

ADF Test Statistic	-2.534142	1% Critical Value*	-3.6067
		5% Critical Value	-2.9378
		10% Critical Value	-2.6069

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(R)
Method: Least Squares
Sample(adjusted): 1992:2 2001:4
Included observations: 39 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
R(-1)	-0.734546	0.289860	-2.534142	0.0162
D(R(-1))	-0.281518	0.279965	-1.005547	0.3220
D(R(-2))	-0.349229	0.244665	-1.427377	0.1629
D(R(-3))	-0.463265	0.208299	-2.224037	0.0331
D(R(-4))	-0.074308	0.162926	-0.456082	0.6513
C	-0.189562	0.070606	-2.684787	0.0113

R-squared	0.617177	Mean dependent var	-0.005261
Adjusted R-squared	0.559174	S.D. dependent var	0.207981
S.E. of regression	0.138089	Akaike info criterion	-0.981204

Sum squared resid	0.629260	Schwarz criterion	-0.725271
Log likelihood	25.13347	F-statistic	10.64035
Durbin-Watson stat	2.022946	Prob(F-statistic)	0.000004

Table B4. Johansen Test – Inflation Rate and Deficit/M1

Sample: 1993:4 2001:4
Included observations: 33
Test assumption: No deterministic trend in the data
Series: INF R1
Lags interval: No lags

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.371521	19.03551	12.53	16.31	None **
0.106296	3.708559	3.84	6.51	At most 1

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Table B5. VECM with M1 as narrow money for period 1994-2001

Sample: 1994:1 2001:4
Included observations: 32
Standard errors & t-statistics in parentheses

Cointegrating Eq:	CointEq1	
INF(-1)	1.000000	
R1(-1)	0.488807	
	(0.06771)	
	(7.21899)	
Error Correction:	**D(INF)**	**D(R1)**
CointEq1	-0.753826	0.006182
	(0.07546)	(0.15296)
	(-9.98954)	(0.04041)
D7	0.633786	-0.002942
	(0.06316)	(0.12802)
	(10.0350)	(-0.02298)
R-squared	0.855914	-0.000194
Adj. R-squared	0.851111	-0.033534
Sum sq. resids	0.117975	0.484756
S.E. equation	0.062710	0.127116
Log likelihood	44.24226	21.63150
Akaike AIC	44.36726	21.75650
Schwarz SC	44.45887	21.84811
Mean dependent	-0.010989	0.001985
S.D. dependent	0.162519	0.125037
Determinant Residual Covariance		3.79E-05
Log Likelihood		72.07151
Akaike Information Criteria		72.44651
Schwarz Criteria		72.72133

Table B6. VECM with M1 as narrow money for period 1996-2001

Sample: 1996:1 2001:4
Included observations: 24
Standard errors & t-statistics in parentheses

Cointegrating Eq:	CointEq1	
INF(-1)	1.000000	
R1(-1)	0.520370	
	(0.06359)	
	(8.18308)	
Error Correction:	**D(INF)**	**D(R1)**
CointEq1	-0.851639	-0.018736
	(0.09247)	(0.16837)
	(-9.21024)	(-0.11128)
D7	0.637625	-0.000593
	(0.06509)	(0.11852)
	(9.79629)	(-0.00500)
R-squared	0.878995	-0.000901
Adj. R-squared	0.873495	-0.046396
Sum sq. resids	0.091591	0.303665
S.E. equation	0.064523	0.117486
Log likelihood	32.76717	18.38410
Akaike AIC	32.93384	18.55077
Schwarz SC	33.03201	18.64894
Mean dependent	-0.001771	0.004328
S.D. dependent	0.181410	0.114852
Determinant Residual Covariance		2.90E-05
Log Likelihood		57.28321
Akaike Information Criteria		57.78321
Schwarz Criteria		58.07772

Table B7. Residual Tests for the estimation with M1

Period	1994-2001	1996-2001
White - $\chi^2(3)$	11.78 (p_v=0.00)	1.62 (p_v=0.65)
LM - $\chi^2(4)$	9.53 (p_v=0.04)	7.51 (p_v=0.11)
ARCH LM $\chi^2(4)$	6.22 (p_v=0.18)	1.67 (p_v=0.79)
Jarque-Bera $\chi^2(2)$	0.92 (p_v=0.62)	1.78 (p_v=0.40)

*White – White test for heteroskedasticity (includes cross-products)

LM –Breusch – Godfrey test for autocorrelation with 4 lags

ARCH-LM – testul LM (Lagrange Multiplier) for ARCH effects with 4 lags

Jarque-Bera – test for normality distribution

p_v – p-value of the test

Table B8. Johansen Test – Inflation Rate and Deficit/Monetary Base

Sample: 1993:4 2001:4
Included observations: 33
Test assumption:
No deterministic
trend in the data
Series: INF R
Lags interval: No lags

Eigenvalue	Likelihood Ratio	5 Percent Critical Value	1 Percent Critical Value	Hypothesized No. of CE(s)
0.393927	20.32677	12.53	16.31	None **
0.108819	3.801839	3.84	6.51	At most 1

*(**) denotes rejection of the hypothesis at 5%(1%) significance level
L.R. test indicates 1 cointegrating equation(s) at 5% significance level

Table B9. VECM with monetary base period 1994-2001

Sample: 1994:1 2001:4
Included observations: 32
Standard errors & t-statistics in parentheses

Cointegrating Eq:	CointEq1	
INF(-1)	1.000000	
R(-1)	0.305873	
	(0.03866)	
	(7.91097)	
Error Correction:	**D(INF)**	**D(R)**
CointEq1	-0.774299	0.044883
	(0.07617)	(0.26243)
	(-10.1648)	(0.17102)
D7	0.620564	0.024638
	(0.06217)	(0.21419)
	(9.98158)	(0.11503)
R-squared	0.859732	0.000991
Adj. R-squared	0.855057	-0.032310
Sum sq. resids	0.114849	1.363164
S.E. equation	0.061873	0.213164
Log likelihood	44.67198	5.088803
Akaike AIC	44.79698	5.213803
Schwarz SC	44.88859	5.305411
Mean dependent	-0.010989	0.004916
S.D. dependent	0.162519	0.209801
Determinant Residual Covariance		9.77E-05
Log Likelihood		56.92853
Akaike Information Criteria		57.30353
Schwarz Criteria		57.57836

Table B10. VECM with monetary base for period 1996-2001

Sample: 1996:1 2001:4
Included observations: 24
Standard errors & t-statistics in parentheses

Cointegrating Eq:	CointEq1	
INF(-1)	1.000000	
R(-1)	0.336704	
	(0.03470)	
	(9.70293)	
Error Correction:	**D(INF)**	**D(R)**
CointEq1	-0.888310	0.014226
	(0.09136)	(0.27181)
	(-9.72320)	(0.05234)
D7	0.618301	0.027266
	(0.06208)	(0.18469)
	(9.95997)	(0.14763)
R-squared	0.889079	-0.001085
Adj. R-squared	0.884037	-0.046589
Sum sq. resids	0.083958	0.743163
S.E. equation	0.061776	0.183794
Log likelihood	33.81133	7.644198
Akaike AIC	33.97800	7.810865
Schwarz SC	34.07617	7.909036
Mean dependent	-0.001771	0.008402
S.D. dependent	0.181410	0.179656
Determinant Residual Covariance		5.73E-05
Log Likelihood		49.09614
Akaike Information Criteria		49.59614
Schwarz Criteria		49.89065

Table B11. Residual Tests for VECM with monetary base

Period	1994-2001	1996-2001
White - $\chi^2(3)$	9.92 (p_v=0.01)	1.50 (p_v=0.68)
LM - $\chi^2(4)$	9.55 (p_v=0.04)	7.09 (p_v=0.13)
ARCH LM $\chi^2(4)$	6.27 (p_v=0.17)	0.89 (p_v=0.92)
Jarque-Bera $\chi^2(2)$	0.78 (p_v=0.67)	1.69 (p_v=0.42)

Table 12. Granger Tests : Inflation rate – Deficit/Monetary base

Dependent Variable: INF
Method: Least Squares
Sample: 1996:1 2001:4
Included observations: 24

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF(-1)	0.096860	0.096438	1.004381	0.3278
INF(-2)	0.006283	0.093567	0.067151	0.9472
R(-1)	-0.164353	0.079205	-2.075034	0.0518
R(-2)	-0.112499	0.083931	-1.340367	0.1959
D7	0.636128	0.063737	9.980438	0.0000

R-squared	0.847464	Mean dependent var	0.128316
Adjusted R-squared	0.815351	S.D. dependent var	0.142280
S.E. of regression	0.061139	Akaike info criterion	-2.568280
Sum squared resid	0.071022	Schwarz criterion	-2.322852
Log likelihood	35.81936	F-statistic	26.39012
Durbin-Watson stat	1.310116	Prob(F-statistic)	0.000000

Wald Test:
Equation: GRANGER_BM

Null Hypothesis:	C(3)=0 C(4)=0		
F-statistic	7.567174	Probability	0.003827
Chi-square	15.13435	Probability	0.000517

Figure 1. Real public debt of Romania

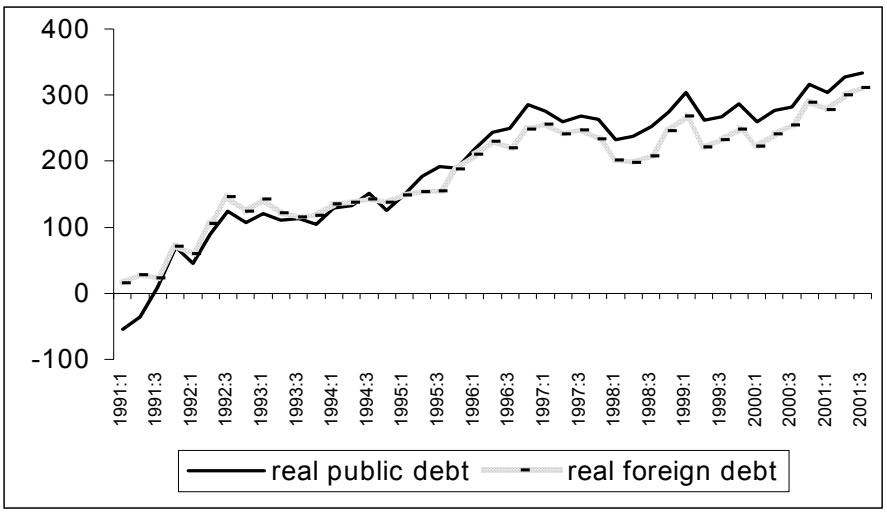


Figure 1. Money supply M1 in GDP (%)

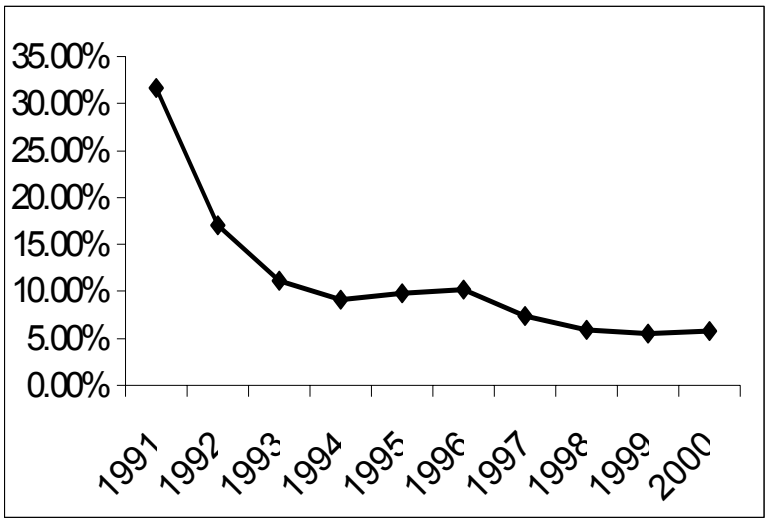
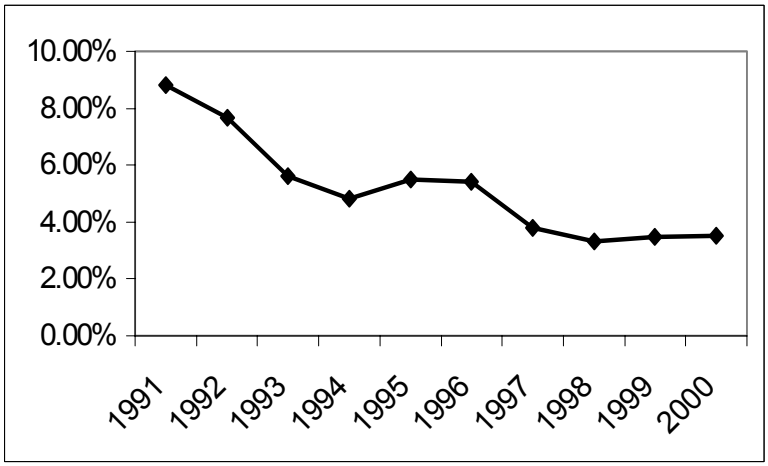


Figure 3. Monetary base in GDP (%)



OBS	DEFICIT (bill. ROL)	INFLATION RATE	M1 (bill. ROL)	MONETARY BASE (bill. ROL)
1991:1	6.7	0.238713	237.7	93.9
1991:2	-16.2	0.356105	267.1	115
1991:3	-12.2	0.306528	309.4	146.1
1991:4	-19.4	0.39207	696.5	194.5
1992:1	15	0.478813	718.9	213
1992:2	-40.8	0.224156	688.9	272.3
1992:3	-39.4	0.174864	850.6	330.1
1992:4	-167.9	0.408163	1028.2	461.6
1993:1	-56.8	0.317422	1111.5	461.8

1993:2	-117.9	0.513292	1370	589.1
1993:3	-17.7	0.39097	1820.1	884
1993:4	-328.8	0.426429	2231.3	1125.7
1994:1	84.3	0.203095	2132.8	1173.4
1994:2	-150.3	0.143015	2670.1	1513.6
1994:3	-763.4	0.074625	3320.8	1896.5
1994:4	-1240.8	0.09577	4534.2	2399.3
1995:1	-38.5	0.043589	4068.7	2232.7
1995:2	-849.7	0.040529	4638.9	2711.4
1995:3	-752.5	0.05284	5516.3	3216.8
1995:4	-1329.7	0.1173	7083.1	3952.7
1996:1	-794.6	0.048759	6416.1	3450.5
1996:2	-448.3	0.083737	7347.2	4105.8
1996:3	-1616.8	0.14263	8506.4	4521.3
1996:4	-2449.5	0.206651	11173.4	5905.7
1997:1	-1982.5	0.765438	8948.2	5128.7
1997:2	-1166.2	0.140611	11854.1	6841.8
1997:3	-2739.6	0.076639	14762.9	8828.3
1997:4	-3173.8	0.160781	18731.1	9630.5
1998:1	-2880.1	0.16726	15366.3	8750
1998:2	-4149.5	0.064279	17311.5	10896.2
1998:3	-225.6	0.046593	18638	11875.8
1998:4	-3145.8	0.082033	22109.7	12305.9
1999:1	-1654.4	0.127702	19301.7	12346.3
1999:2	-5468.1	0.159825	22466	14819.4
1999:3	-1685.9	0.062139	24340.9	16609
1999:4	-2856.9	0.115107	29668.9	18676.3
2000:1	-8260.3	0.085133	25990.4	17253.9
2000:2	-9750.8	0.096736	32268.9	22821.2
2000:3	-4315.6	0.091504	35685.9	24193.5
2000:4	-6500.4	0.08304	46331.1	28108.7
2001:1	-8652.1	0.082068	39107.5	25607.6
2001:2	-14037	0.06117	46000.5	31758.4
2001:3	-7728	0.054956	51072.8	34925.2
2001:4	-5392	0.074784	64308.6	40010.4