Money Demand in Romania

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ABSTRACT

Finding a stable money demand relationship is considered essential for the formulation and conduction of an efficient monetary policy. Consequently, numerous theoretical and empirical studies have been conducted in both developed and developing countries to evaluate the determinants and the stability of the demand for money function for various monetary aggregates. This paper briefly reviews the theoretical work, tracing the contributions of several researchers beginning from the classical economists, and explains relevant empirical issues in modelling and estimating money demand function for Romania. The paper models the empirical relationship between broader definition of money, output, interest rates, inflation and exchange rate in Romania and examines the constancy of this relationship, especially in the light of financial reform and deregulation of financial markets.

The demand for broad money in Romania has been stable between 1996 and 2002 despite of a pronounced financial liberalization. The analysis suggests that, in Romania in the long run the inflation is weakly exogenous for the money demand, which means that inflation is not a monetary phenomenon.

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1. INTRODUCTION

The modelling of the demand for money has been a major focus of interest in macro econometrics since the early 1970s. This is not surprising considering its importance for monetary policy and its role in modern economies.

The demand for money is one of the most important components of the transmission mechanism of monetary policy in a market economy. A stable money demand function is a condition in the conduct of monetary policy as it enables a policy-driven change in monetary aggregates to have predictable influences on output, interest rate, and ultimately price. The analysis of the demand for money plays an important role in the decision-making process of central banks including the European Central Bank which has been working on a demand-for-money analysis intensively.

The analysis of money demand is complicated by the development of new financial products like derivatives, changes in payments agreements, the development of non-banking financial institutions, financial crises, as well as other factors.

The purpose of this paper is to point out the developments in the demand for money in Romania between 1996 and 2002[1] and its determinants.

The paper is organized as follows. In the first part, a brief theoretical background on the examination of the demand for money is outlined. The second part includes data, a methodological determination of the analysis, and an econometric analysis of the problem. The examination is based on the Johansen procedure for cointegration. Thereafter, a time-varying parameters model is estimated using Kalman filter. Finally, the third part contains some concluding remarks.

[1] The study does not include an analysis before 1996 due to the irregular monetary and economic developments in this period.

2. THE ROLE OF THE DEMAND FOR MONEY IN THE TRANSMISSION MECHANISM OF MONETARY POLICY

The demand for money reflects the desirability to hold money for firms, households, individuals and other economic entities. In nominal terms, it indicates the attractiveness of a certain amount of money; in real terms it shows how attractive is to hold money corresponding to the number of units of assets and services that may be acquired with the money.

Although about the necessity of dealing with the demand for money is not fundamental doubts, opinions concerning its specific impact on the economy differ depending on the theoretical bases taken into account. Thus, about long term view there are few basic approaches: the *Keynesian approach*, emphasizing the importance of the demand for money in the economy and motives for holding real money balances, and the *monetarist approach*, stressing the effects of the exchange area on demand for money developments as represented by developments in nominal GDP. At present these approaches represent alternative theoretical concepts based on different methodological viewpoints.

3. BASIC THEORETICAL APPROACHES TO EXAMINATION OF THE DEMAND FOR MONEY

3.1 Quantity theory

According to classical economics, all markets are in equilibrium and is always a full employment. The role of money is simple: it serves as the numeraire, that is, a commodity whose unit is used in order to express prices and values, but whose own value remains unaffected by this role (Sriram, 1999). It also facilitates the exchange of goods. Money is "neutral" with no consequences for real economic activity.

The quantity theory emphasized a direct and proportional relationship between money and price level. This relationship was developed in classical equilibrium framework by two alternative but equivalent expressions:

1. *"Equation of exchange" – associated with Irving Fischer's equation*:

$$MV = PT \tag{1}$$

where M is the quantity of money in circulation, V is "transactions velocity of circulation of money", T is the volume of transactions and P is the price level. Money is held only to facilitate transactions and has no intrinsic utility.

2. *"Cambridge approach or cash balance approach"* - associated with the Cambridge University economists, especially A.C. Pigou. This alternative paradigm relates the quantity of money to nominal income and stresses the role and importance of money demand in determining the effect of money supply on the price level. Money is held not only as a medium of exchange as in Fischer's case, but also as a store of value that provides satisfaction to its holder by adding convenience and security. Cambridge economists pointed out the role of wealth and the interest rate in determining the demand for money.

3.2 Keynesian theory[2]

In a Keynesian economy, the most important relationship is the relationship between economic growth and the level of investments. This relationship is related to demand for money, where demand for money induces the money supply. In the long run, money demand and money supply are balanced. In comparison with monetary approach, Keynesian theory assigns to the monetary policy a lower efficiency in the effects on economic development.

Keynes postulated that the individuals hold money with three motives:

➢ ***The transactions-motive***, i.e. the need of cash for the current transaction of personal and business exchanges. The transactions demand for money arises because of the no synchronization of payments and receipts.

[2] An comprehensive explanation of the principles of Keynesian, neo-Keynesian, and post-Keynesian theory exceeds the scope of this study.

- ***The precautionary-motive*** – provides a contingency plan for unscheduled expenditures during unforeseen circumstances.
- ***The speculative-motive*** – i.e. "the object of securing profit from knowing better than the market what the future will bring forth"[3]. The speculative demand for money is what Keynes called as "liquidity preference."

The theory of "liquidity preference" provides an answer to why economic entities demand and hold money that does not yield any interest, instead of securities or similar assets.

Keynes adopted the *transactional motive* from the monetarist approach of the Cambridge school (A. Marshall, A. Pigou, et al) and considered the fact that a part of the demand for money is associated with transactions related to income developments.

The *speculative motive* of money possession is introduced by Keynes. Formal, Keynes's approach can be written as follows:

$$M = L_1(Y) + L_2(i) \tag{2}$$

where L_1 expresses the transactional and precautionary motive, L_2 expresses the speculative motive of liquidity preference, *Y* is nominal GDP and *i* is the interest rate (Keynes, 1953).

These motives exert influence simultaneously and are mutually independent and consequently M is a total money demand.

Keynes considered only nominal level of money demand. After Keynes, according to Dornbusch and Fischer[4] "people possess money because of its purchasing power, i.e. the quantity of goods and services that they can purchase with money", what means that we must consider the real level of money demand.

3.2 Neo-Keynesian theory of money demand

The neo-Keynesian interpretation of the money demand is based on Keynes's principles. The transactional motive and precautionary motive are expressed as directly

[3] Keynes, J. M – "Keynes J. M.: The General Theory of Employment, Interest, and Money", 1953
[4] Dornbusch R., Fischer S. (1994)- "Macroeconomy", McGraw Hill Inc

proportional to income. The demand for money for the speculative motive is dependent to interest rates. Formally, such dependence can be formulated as:

$$M_{da} = kY \text{ and } M_{ds} = \alpha - \beta i \qquad (3)$$

where M_{da} is demand for active balances, k is the share of active balances in GDP, Y is nominal GDP, M_{ds} is speculative demand for money, α and β are parameters and i is the interest rate.

The relationship between GDP and precautionary demand for money should be formulated as anti-cyclical instead of pro-cyclical, similar to the transactional motive.

Thus, the demand for money can be expressed as follows:

$$M_d = L(Y, i) \qquad (4)$$

where M_d is demand for money, L is the "liquidity preference function", Y is nominal GDP, and i is an interest rate.

This approach was developed by Baumol (1952) and Tobin (1956) to an approach based on the possession of money as inventory, where the transactional motive of liquidity preference is particularly emphasized. Results of such considerations lead to the well-known formula:

$$M_d / P = \sqrt{cY / 2i} \qquad (5)$$

where M_d is demand for real balances, c is transactional costs, Y is real GDP and i is the interest rate. The Bauman-Tobin model assumption of cost stability in a transaction (c – parameter) is not realistic in the long run.

3.3 Post-Keynesian theories of money demand

Two characteristics of money demand provide the starting point for many of these theories. In transactions models inventory models assume the level of transactions to be known and certain and in the precautionary demand models net inflows are certain. The special characteristics of money lead to formulation of theories that are based on explicit motives to holding it.

Post-Keynesian economics emphasizes the role of uncertainty associated with the historical developments of the economy and puts the demand-for-money concept into a broader context.

The volume of money in the economy is the result of a demand and supply process interaction. Through its instruments, the central bank is able to influence the conditions for issuing loans due to the impact of such instruments on interest rate developments. Additionally, the behaviour of the banking sector towards economic entities applying for loans is significantly influenced by institutional characteristics of the banking sector. In this context, an important role is maintained by banking regulation and banking supervision functions (see Dow, Rodríguez-Fuentes in Arestis, Sawyer, 1998).

Post-Keynesian economics differs from neo-Keynesian especially in the inclusion of the *financial motive* in the demand for money. The financial motive reflects the fact that entrepreneurs must maintain certain money balances in the course of time, so that they are able to meet their liabilities when entering future contracts associated with the purchase of inputs necessary for the production. If the planned investments do not change, the money balances will remain permanent; if they increase additional financial demand for money is created.

In this approach, the demand for money is usually expressed in nominal terms. For transformation to the real demand for money form, it is necessary to consider inflation.

Most economists, however, ignore the fourth motive of holding money balances (i.e. financial motive). Philip Arestis is one important post-Keynesian scholars working on the demand for money theory. In his article[5] discusses the demand for money in a small, open economy. His approach to the demand for money can be expressed using the following equation:

$$M_d = K(Y_r)^a (P^e)^{-b} (CR)^{-c} (ER^e)^{-d} u \tag{6}$$

where M_d are real money balances, *K* is the Cambridge coefficient, which is a function of GDP growth, prices and the volume of money in circulation and is expressed by a reversed value of money velocity, Y_r is real GDP, P^e is the expected rate of inflation, *CR* is an

[5] Arestis Ph.: *The Demand for Money in Small Developing Economies: An Application of the Error Correction Mechanis*m (1988).

estimated variable for credit limitations, ER^e is the expected appreciation or depreciation rate of the currency, *u* is a non-systematic component and *a, b, c,* and *d* are elasticity values.

Arestis's model in the previous expression, however, is not ideally suited for conditions prevailing in Romania. At present, quantifiable credit limitations do not exist in the Romanian economy.

3.4 Modern monetarist approach

The monetarist approach analysis is based on the assumed direct influence of the volume of money in the economy and nominal income, usually expressed by nominal GDP.

In monetary approach of the economy, money plays a primary role with the money supply being a decisive factor.

Modern monetarists withdrew from the notion of an exclusive tie between the demand for money and nominal income. They emphasize the influence of both interest rates and yields of other tangible and financial assets.

Among of modern monetarists, Milton Friedman refreshed the traditional quantitative money theory in the Cambridge version. According to Friedman, development of the demand for money depends on the overall wealth of society in various forms (money, bonds, securities, material and human resources) as well as on the taste and preferences of holders of the wealth.

Stability of demand-for-money development is an important assumption on which Friedman and other monetarists base their expansions of the theory. Formally, the demand for money in Friedman's concept may be expressed as follows:

$$M_d = F(Y, W, r_m, r_e - r_m, r_b - r_m, \frac{1}{P}\frac{dP}{dt}, u) \qquad (7)$$

where M_d is demand for real money balances, Y is the overall wealth, *W* is a share of accumulated human resources in the overall wealth, r_m is the expected money yield, r_b is the expected yield of bonds, r_e is the expected yield of securities, $\frac{1}{P}\frac{dP}{dt}$ is the expected change in commodity prices and *u* is the influence of other factors.

The equation (7) indicates the wide range of Friedman's view of demand-for-money issues.

4. MONEY DEMAND ESTIMATES IN EASTERN EUROPE

In this section we will point out several empirical works which deal with the money demand in some of the transition coutries from Eastern Europe.

Klacek and Smidkova (1995) estimated the long-run demand for broad and narrow money in the Czech Republic since transition. The authors initially include GDP as a scale, but the estimated function did not characterize a money demand function due to incorrectly signed parameters. Private consumption was then used, since it may give a better approximate of the volume of transactions. This estimated model had the correct signs, with private consumption having a significant effect. The inflation term was significant for narrow money, while the interest rate on foreign (German) bonds was significant for broad money.

Van Aarle and Budina (1996) estimated money demand and specifically the effect of currency substitution using the portfolio balance approach for Poland, Hungary, Romania, and Bulgaria during transition. As a result of the reform taking place in former centrally planned economies, this has led to the liberalization of foreign exchange restrictions and so legally allows the possibility of foreign currency to replace domestic as a means of payment and a store of value. The authors in most cases found a long-run relationship between money and income and interest rates. An important contribution to this paper is that the authors investigate the impact of currency substitution on money demand.

Arlt, Guba, Radkovsky, Sojka and Stiller (2001) estimated money demand for Czech Republic in period 1994-2000. It is clear from them results of the analysis that, in its wide concept, the real demand for money in the Czech Republic had developed mostly under the influence of real GDP and nominal interest rate development. The influence of an external economic environment in the development of the demand for money has not been econometrically proved.

Erwin Nijsse and Elmer Sterken (1996) estimated a household money demand function for Poland from 1969 to 1995. Contrary to theoretical belief and earlier empirical evidence portfolio arguments are found to be significant. Despite regime shifts during the 1980s and full liberalization of the Polish economy in the beginning of 1990, cointegration relationships are found between broad real money holdings, real household income, interest rate on an alternative asset, the inflation rate and shortage of goods. The author's tests confirm stability of long-run income and interest elasticities.

Also, Antoni Chawluk (2000) analysed the same household money demand and consumption for Poland. Variables that measure shortage and expectations about its future course are introduced to capture the effects of the transition from centrally planned to market economy. The Johansen procedure issued to identify a system of the two cointegrating vectors. The reported results show that disequilibrium in household sector money holdings has a strong influence on consumption.

5. MONEY DEMAND IN ROMANIA

5.1 Background

The demand for money in Romania between 1996 and 2002 has to be analyzed in the broader context of the transition to the market economy, which implies the transformation of the institutional structures and changes in monetary policy (box 1): in the beginning of 1997 exchange rate and prices were liberalized and NBR adopted a controlled floating regime for the exchange rate; in 1997, NBR simultaneously targeted the exchange rate and reserve money (M0); at the end of 1998 and in 1999 tried to restore external competitiveness by using a real depreciation of exchange rate; from 1999 to present, the monetary policy framework seeks to strike a balance between two potentially conflicting objectives of: reducing inflation through a degree of exchange rate stability, and safeguarding the external position.

Box 1 – Trends in the monetary and exchange rate policy in Romania during 1996-2002

- ***Gradual renouncing to direct monetary policy instruments and orientation towards indirect monetary instruments.*** After 1997, the open market operations have become the main instrument used by NBR, although it is more costly.

- ***Improving institutional framework of monetary policy.*** In 1998 crucial laws for the central and commercial bank activity were adopted: The National bank of Romania Act, The Banking Act and The Bank Insolvency Act. These laws had an important impact on the conducting of monetary policy: they established the central bank autonomy and independence vs. the other state institutions, the price stability became the monetary policy primary objective and the transparency of the monetary transmission mechanism increased.

- The conducting of monetary policy had to overcome three ***major constraints***: the weak corporate management from the public sector, the fragility of the banking system and the external debt situation.

Weak corporate governance of the large state-owned enterprises leaded to inflationary pressures caused by inter-enterprises arrears.

Over the last years, the conducting of monetary policy has been complicated by the ***fragile condition of the banking system***. It is the case of the two former large insolvent state-owned banks – Bancorex and Banca Agricola.

The external debt crisis occurred in 1999 when Romania had larger repayments on the previously contracted loans. The problem of insolvency was successfully surpassed without foreign support given the rising hostility of the international financial markets. The monetary policy in 1999 was focused primordially on the repayments of the external debt.

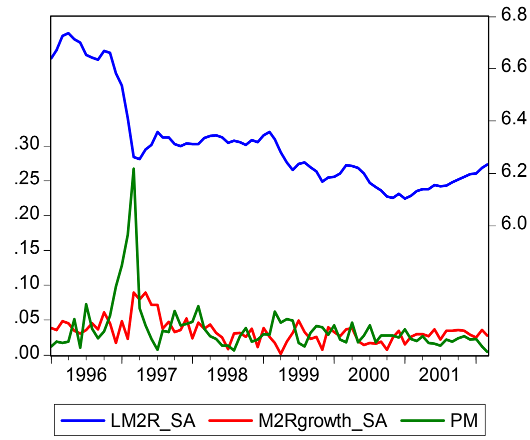
As a main anchor for the monetary policy (intermediary target), the NBR used the broad money M2. The goal was an increase in the quantity of money lower than the increase in national income in order to mitigate inflationary pressures. Figure 1 shows the evolution of broad money less foreign currency deposits in real terms. The broad money in real terms (in logarithm – LM2R), as well as its growth, are seasonally adjusted by the Tramo-Seats procedure[6].

The evolution of the monetary aggregates after 1990 recorded numerous climbs and descends as the NBR was forced to accommodate large fiscal and quasi-fiscal deficits, or loss making state-owned enterprises in general and of the agricultural sector in particular.

[6] In the estimations we used the econometric program Eviews 4.0.

Figure 1 suggests that relationship between money and prices (monthly inflation-PM) was rather loose between 1996 and 2002, though a positive correlation has become somewhat clear over the past three-four years.

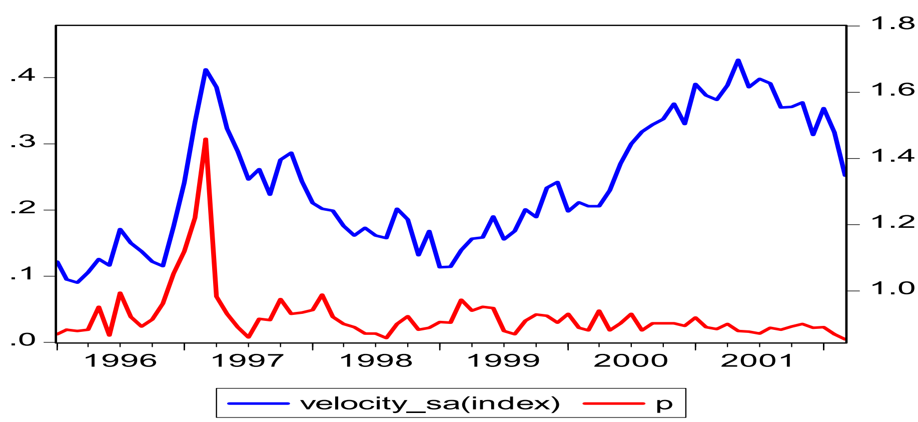
Figure 1 The evolution of broad money and inflation during 1996-2002



The higher inflation rate in 1997 associated with price liberalization from January and with exchange rate liberalization from March leaded to a sharp decline of the broad money in real terms. Using a tight monetary policy, the NBR achieved the mitigation of inflationary pressure, but broad money resumed its upward trend starting from late 2000.

The use of monetary anchor M2 was hampered by the instable money velocity (figure 2). Starting with 1996, money velocity has had large fluctuations, recording its highest levels in 1997 and 2001.

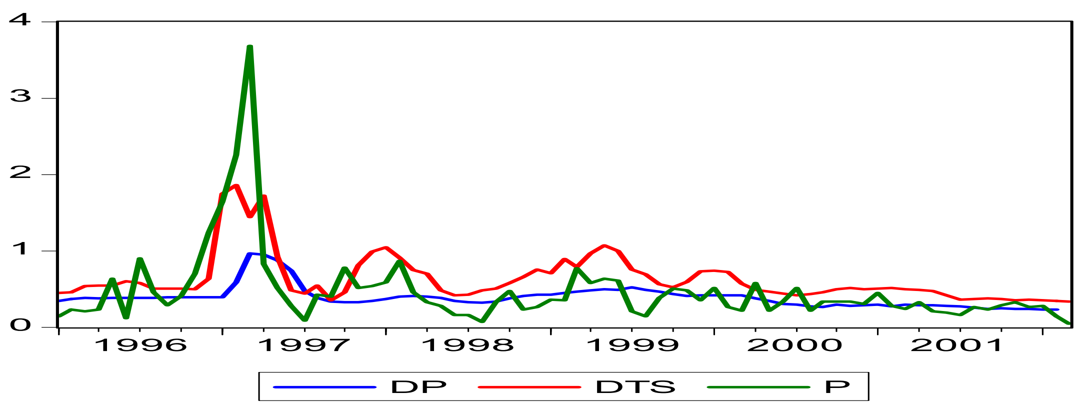
Figure 2 Money velocity and inflation



These high levels of money velocity express a loss of confidence in domestic currency and a decrease in money demand. They were accompanied by high levels of inflation in 1997-1998 and a faster expand of output relative to money growth in the context of continuously decrease in inflation in 1999-2001. Although the inflation was brought under control after the shocks from January-March 1997, an increase in the rate of inflation in early 1999, but not as higher as it was in 1997, produced an upward trend for money velocity.

Financial markets in Romania remained relatively undeveloped, so the financial intermediation has been low, the capital market plays a less important role than it should, and for many periods the real interest rates were negative.

Figure 3 The evolution of real deposit interest rate (DP), T-bills interest rate (DTS) and inflation (P)



5.2 Money demand modelling in Romania

The empirical modelling of the money demand typically[7][8] has as a starting point a general specification for the long run[9] money demand as follows:

$$M^d = f(y; r; x)$$

where, M^d is the money demand in real terms, y is a scale variable measuring the level of economic activity, r is a vector of variables pointing out the opportunity cost of holding

[7] Sriram, S.S. (1999a)
[8] Ericsson, N.R. (1998
[9] In this paper the long run does not mean a very long period. We are interested in a period covering five years and three months and we use monthly data.

money, and x is a vector of other variables (including dummy variables) which will be included in the model. The relation assumes an instant adjustment of the actual money holdings to their "desired" long term level, which implies equilibrium between the real demand and supply of money. This is not very plausible given the costs of the transactions and the uncertainty. More, the "desired" level of money balances is unobservable. Due to the market clearing mechanism, we can assume that $M^d = M^s = M$ (money supply is equal to money demand). So, we can use in money demand analysis series of data for money supply.

The money balances are measured as Lei M2 defined as lei currency outside banks plus demand deposits plus household savings plus time and restricted deposits. The foreign currency deposits (FCD) are excluded from the definition of broad money in part due to the lack of data on foreign currency cash holdings of population which are suspected to be significant. Although the weight of foreign currency deposits in M2 is significant, accounting for about 30% in the last years, there is no empirical prove that the foreign currency was used significantly as a mean of payment or unit of account. FCD are assets used by the population in a high inflation and volatile exchange rate environment to substitute the national currency deposits.

As a scale variable we use the real industrial production index (deflated by the consumer price index CPI) as a proxy for GDP which is not calculated monthly in Romania.

The appropriate measure of the opportunity cost of holding money in Romania is difficult to determine a priori due to the limited and evolving availability of alternative domestic and foreign financial assets during the sample period: 1996-2002 (box 2).

In our analysis we used the following costs of opportunity:

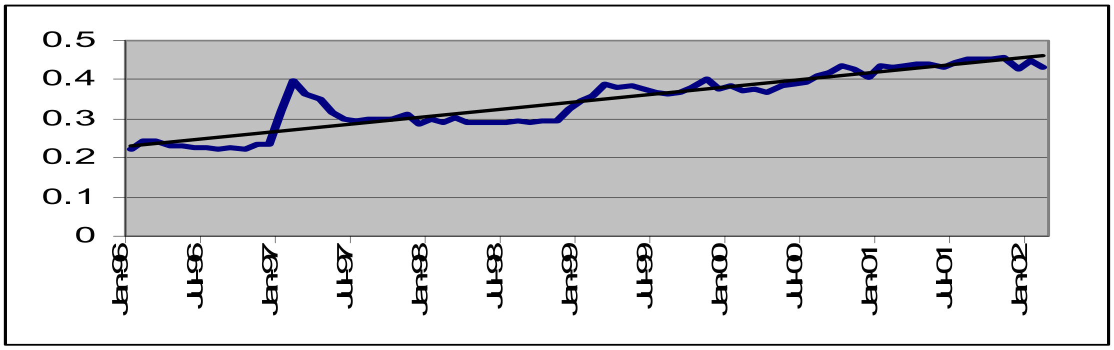
- Deposit interest rate for non-bank clients – measures the rate of return on lei time deposits (R_t^{own}).
- T-bills interest rate – measures the rate of return on assets outside of M2 (R_t^{out}).
- Expected inflation rate – proxied by current inflation rate p – capture the return on real assets. The inclusion of the expected rate of inflation was necessary because in

developing economies with weak financial systems, the real assets offer protection against inflation and they are an alternative asset for the nonbank agents[10].

Box 2 – Alternative financial assets in Romania

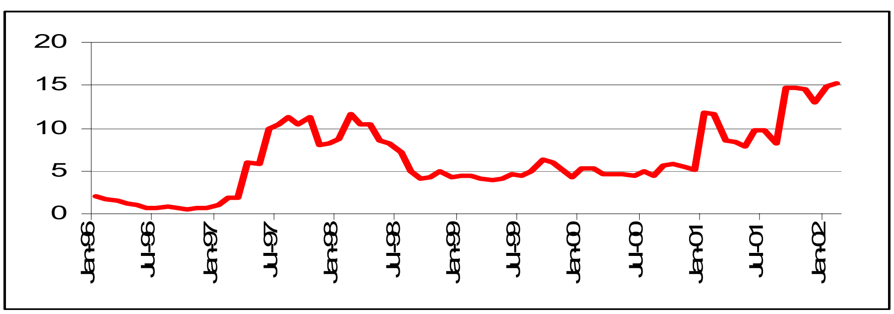
The relative importance of the relative assets to money has varied greatly over the last years. Foreign currency denominated deposits has constituted an important alternative for the domestic denominated money balances (figure 4) notably after the liberalization of the foreign currency market in March 1997.

Figure 4 Weight of FCD in total M2



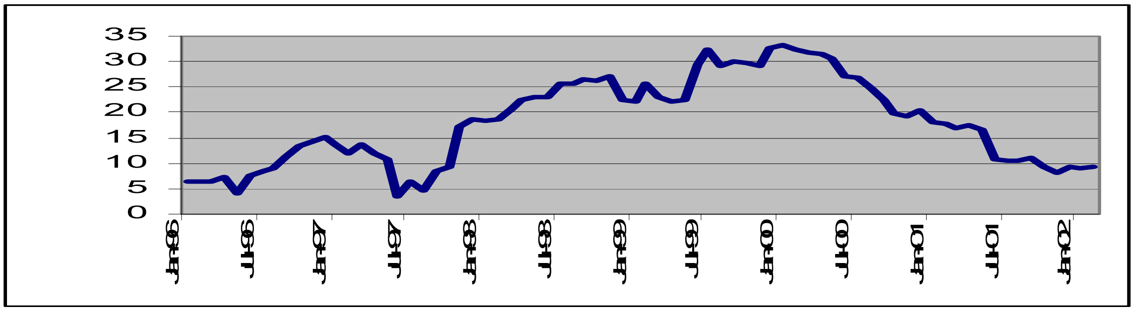
The development of the capital market in Romania provided alternatives to bank deposits: securities, investment funds and T-bills. However, the market capitalization for these assets continues to be very low (figure 5). The market capitalization of the equities accounted for only 2% of GDP in the last three years. The investment funds assets for less than 1% of GDP. The government securities had an interesting evolution (figure 6). For many periods, the government securities had better yields than bank deposits. Over the last years a secondary market for this type of securities has developed in Romania. A sharp decline in the yield of the T-bills since 2000 was accompanied by a sharp decline in the investment in these assets.

Figure 5 Weight of market capitalization in M2 (%);



[10] The basic idea is that in developing economies with limited alternatives of investments on the capital market, assets substitution usually means replacement of the money balances with real assets rather than financial assets. This idea is not very plausible for the analyzed period in Romania, where the government securities play an important role in determining the demand for money in the long run, while inflation has a greater influence in the short run.

Figure 6 Weight of government credit in M2



➢ Expected depreciation of the lei-dollar exchange rate. Captures the return on holding US dollars, important assets outside of M2. The actual depreciation was used as proxy for the expected rate.

We will analyze three specifications (models):

1. *The first model* – essentially a closed economy model in which the opportunity cost variables are limited to those on lei assets. In our estimations we will use a (semi) log – linear form:

$$m_t^d = \gamma_0 + \gamma_1 y_t + \gamma_2 R_t^{own} + \gamma_3 R_t^{out} + \gamma_4 p_t \qquad (8)$$

where variables with small caps are in logarithm, and m_t^d is real money demand, R_t^{own} and R_t^{out} are nominal rate of return on assets included, respectively excluded from the monetary aggregate, and p is the annualized rate of inflation. Relation (8) assumes price homogeneity of money demand in the long run.

In equation (8), γ_1 measures the log run income elasticity of the money demand, while γ_2, γ_3 and γ_4 are semi-elasticities. We expect, according to economic theory that $\gamma_1 > 0, \gamma_2 > 0, \gamma_3 < 0, \gamma_4 < 0$ and possibly, $\gamma_2 = -\gamma_3$. In the last case, the long run money demand can be expressed as function of the spread $R^{out} - R^{own}$, which can be interpreted as an opportunity cost of money holdings. In general the coefficient of inflation has to be negative. However, it is possible that inflation has a positive coefficient in the long run relation of money demand because when agents expect a rise in inflation, then increase their money balances expecting a rise in planed expenditures (Jusoh (1987)).

Values for γ_1 greater than one can be found in many empirical studies of the demand for broad money (M2) because of the presence of wealth effects.

2. *The second model* – a model for an open economy in which opportunity costs variables include the rate of return on foreign assets measured by the exchange rate depreciation. In our estimations we will also use a (semi) log –linear form:

$$m_t^d = \gamma_0 + \gamma_1 y_t + \gamma_2 R_t^{own} + \gamma_3 R_t^{out} + \gamma_4 p_t + \gamma_5 ED \qquad (9)$$

where ED is the exchange rate depreciation calculated as $\frac{E_t - E_{t-1}}{E_{t-1}}$, E_t being the exchange rate at the moment t expressed in lei per US dollar. According to the economic theory we can expect that $\gamma_5 < 0$, which means that a rise in the expected depreciation of the exchange rate will lead to rise in the rate of return on foreign assets and consequently the agents will substitute assets in domestic currency with foreign assets (Simmons[11] (1992)).

3. *The third model* – includes the level of exchange rate as a proxy for convertibility risk. The form used in our estimates will be:

$$m_t^d = \gamma_0 + \gamma_1 y_t + \gamma_2 R_t^{own} + \gamma_3 R_t^{out} + \gamma_4 p_t + \gamma_6 E \qquad (10)$$

The variables used are presented in table 1. As many of the series exhibit regular seasonal patterns, it is necessary to take account of the seasonal factors in the estimation. This is done in two ways: first we will seasonal adjust the data using Tramo-Seats procedure; and second, we will use the raw series with monthly seasonal dummies[12]. It is noticeable that if standard 0-1 dummy variables are included, they will affect both the mean and the trend of the series. To handle this we used centred seasonal dummy variables as Johansen suggested. These variables affect the mean but have no influence on trend.

[11] Simmons emphasizes the possibility of obtaining both a positive and negative relation between the exchange rate depreciation and the domestic money balances. The impact can be negative if the depreciation of the domestic currency will lead to anticipations for future depreciation. On the other hand, the impact can be positive if the depreciation leads to expectations for a future appreciation.

[12] A priori, it is difficult to choose between these two techniques. The use of seasonally adjusted data may impact dynamic specification (Ericsson, Hendry and Tran (1994)). The alternative approach of including seasonal dummy in the estimations is not without costs as it imposes constant seasonal factors (unlike Tramo-Seats which permits the factors to evolve through time) and uses up degrees of freedom, thereby reducing the power of tests statistics. Tramo-Seats has the advantage, unlike other methods to give better results in presence of outliers.

Table 1 Time series used

VARIABLE	*DESCRIPTION*
LM2R	Real broad money (logarithm)
LM2R_SA	Real broad money (logarithm) seasonally adjusted
LYRIBF	Industrial production index (volume index, logarithm, December 1995=1)
LYRIBF_SA	Industrial production index seasonally adjusted
p	Monthly inflation (annualized)
***p*_sa**	Monthly inflation seasonally adjusted
LE	Nominal exchange rate USD/ROL (logarithm)
ED	Exchange rate depreciation (annualized)
DP	Deposit interest rate for non-bank customers (percent per annum)
DTS	Average return for T-bills (interest-bearing T-bills and discount T-bills)

5.3 Estimation results

The estimations are conducted in a number of steps. First, unit root tests are applied to all variables of interest to determine the stationarity of the individual variables. As in most other studies of money demand, real money is found to have a single unit root, implying that it is stationary in first differences.

The estimations were performing using monthly data for January 1996 until March 2002. Data through end-September 2001 were used for estimations, with the remaining observations reserved for out-of-sample forecasting.

The stationarity properties of the series were examined using both Augmented Dickey Fuller and Philips Perron tests (appendix I). The results are reported in table 2[13]. The number of lags used in these tests was chosen using Akaike information criterion and Schwarz criterion.

[13] The results of stationarity tests must be regarded with circumspection, given the low power of such tests in presence of structural breaks.

With the exception of the exchange rate depreciation and inflation, the variables were found to be integrated of order one in levels, which is consistent with a stationary representation in first differences.

Table 2 Test for unit root

Variable	ADF test	PP test
Real broad money*	**I(1) C**	**I(1) C**
Real output*	**I(1) C**	**I(1) C**
Exchange rate*	**I(1) C T**	**I(1) C T**
Exchange rate depreciation	**I(1) C or I(0) C**	**I(0) C**
Inflation	**I(1) C or I(0) C**	**I(1) C or I(0) C**
Deposit interest rate	**I(1) C T**	**I(1) C T**
T-bills interest rate	**I(1) C T**	**I(1) C T**
Seasonally adjusted variables		
Real broad money*	**I(1) C**	**I(1) C**
Inflation	**I(1) C or I(0) C**	**I(1) C or I(0) C**
Real output*	**I(1) C**	**I(1) C**

*variables are in logarithm

As unit root tests shows that the variables are I(1), the cointegration technique is appropriate to estimate the long run money demand. Table 2 suggest that none of the variables is integrated of order 2 (I(2)) or more. Inflation and depreciation of exchange rate is probably I(0). Even in this case it does not mean that they must be excluded from cointegrating vector (Dickey and Rossana, 1994).

We chosen the number of lags included in cointegration tests (appendix II) estimating a VAR with variables of interest and using criteria like LR, FPE, AIC, SC and HQ. If the optimum lag in VAR is p, then we estimate the VEC with p-1 lags.

First, the tests were conducted with seasonally adjusted data and including dummy variables for the 1997 shocks (dummy9701-take value 1 in January 1997 and 0 in rest and dummy9703-take value 1 in March 1997 and zero in rest[14]). The results including dummy variables were unsatisfactory, the coefficients of dummy variables being statistically insignificant, and consequently we reestimated the relations without dummy (table 3).

[14] The results of a VEC with standard 0-1 dummy must be interpreted with caution.

Table 3 Long run cointegration relationship 1/

	Output			*Deposit interest rate*			*T-bills interest rate*			*Inflation*		
	Coef.	SE 2/	t 3/	Coef.	SE	t	Coef.	SE	t	Coef.	SE	t
I 6/	**1.39***	0.49	2.78	**3.52***	0.95	3.69	**-2.13***	0.55	-3.85	**-0.48***	0.18	-2.65
II 7/	**1.33***	0.19	6.73	**2.92***	0.4	7.16	**-0.65***	0.19	-3.36	**-0.31***	0.07	-4.31
III 8/	**1.46***	0.21	6.73	**3.57***	0.29	12.05	**-1.27***	0.15	-7.97	**-0.47***	0.05	-9.00
	Depreciation			*Exchange rate*			*Speed of adjustment*			*RMSE 4/*		
	Coef.	SE	t	Coef.	SE	t	Coef.	SE	t	static		dynamic
I 6/							**-0.04***	0.01	-2.43	0.02		0.09
II 7/	**-0.46***	0.09	-4.98				**-0.10***	0.02	-4.17	0.03		0.12
III 8/				**-0.34***	0.2	1.69	**-0.11***	0.02	-4.54	0.02		0.08

* significant at 5%; ** significant at 1%

Table 4 Weak exogeneity tests 1/ ($\alpha_i = 0$, α_i represent speed of adjustment)

	Δ **LM2R_SA**	Δ **LYRIBF_SA**	Δ **DP**	Δ **DTS**	Δ **P_SA**	Δ **ED**	Δ **LE**
I	$\chi^2(1) = 5.5$ [0.018] 5/ *	$\chi^2(1) = 1.99$ [0.16]	$\chi^2(1) = 0.22$ [0.64]	$\chi^2(1) = 8.9$ [0.002]**	$\chi^2(1) = 0.01$ [0.92]		
II	$\chi^2(1) = 12.4$ [0.00]**	$\chi^2(1) = 0.77$ [0.38]	$\chi^2(1) = 1.80$[0.18]	$\chi^2(1) = 4.24$[0.04]*	$\chi^2(1) = 0.13$ [0.72]	$\chi^2(1) = 1.28$ [0.25]	
III	$\chi^2(1) = 20.03$ [0.00]**	$\chi^2(1) = 0.60$ [0.43]	$\chi^2(1) = 0.45$ [0.50]	$\chi^2(1) = 18.04$ [0.00]**	$\chi^2(1) = 0.00$ [0.98]		$\chi^2(1) = 0.00$ [0.98]

1/ Seasonally adjusted data; 2/ Standard errors; 3/ T-statistic; 4/ Root mean square error for forecast; 5/ null hypothesis is that there is weak exogeneity (in squared brackets - probability); 6/ VEC has be estimated with 4 lags; 7/ VEC has be estimated with 3 lags; 8/ VEC has be estimated with 4 lags; ** and * indicates rejection of null hypothesis at 1% respectively 5%.

5.3.1 Discussion on estimated coefficients

Estimates for each of the models on the basis of seasonally adjusted data have the anticipated signs (according with economic theory) and there is relatively little variation in the estimates of key parameters[15].

The output elasticity in the long run relationship is greater than one like we expected for broad money aggregate. Output decrease in Romania, especially in the first half of the last decade was accompanied by a demonetization. At the same time when the output decrease stopped a remonetization took place, but the initial level of monetization was not reached.

Elasticity for output greater than one can be the result of the omission of some important factors for the money demand. Two important factors for money demand dynamics in Romania might be the financial arrears or barter, but due to the lack of data we couldn't include them in our analysis. Soft budgetary constraints on the enterprises in transition countries lead to a proliferation of arrears, which were used as a substitute for money. The level of inter-enterprise arrears in Romania, according to an IMF report (January 2001) were equivalent to 42 percent of GDP, and apart from a fall in 1997, has risen steadily each year from around 20 percent of GDP as at end-1994.

Like magnitude, income elasticity does not differ significantly from 1 (for model I, if we assume B(1,1)=1 and B(1,2)=1 we obtain $\chi^2(1) = 2.28[0.13]$), which is consistent with the quantity theory of money. The fact that we cannot reject unit income elasticity of money demand suggests that in the analyzed period, real output change produced a proportional change in the real money demand. This does not necessary imply that money velocity is stationary. As a matter of fact, as figure 2 shows, money velocity was not constant due to shocks during the analyzed period.

The differences in size between interest rates coefficients in models I and II may due to the fact that multi-collinearity problem become more acute in the case of model II due to the close correlation (appendix II) between exchange rate depreciation and inflation.

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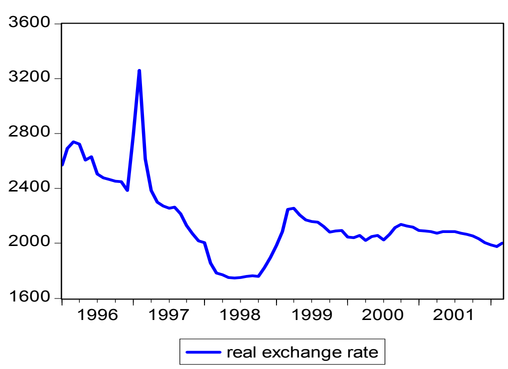
[15] Like magnitude, the estimated coefficients are similar with those obtained in other empirical works performed in other countries from Central and Eastern Europe - Ante Babic for Croatia, Guba, Sojka, Stiller and Don Bredin for Cehia, or Ericsson and Sharma (1998) for Grecia and Nachega (2001) for Camerun.

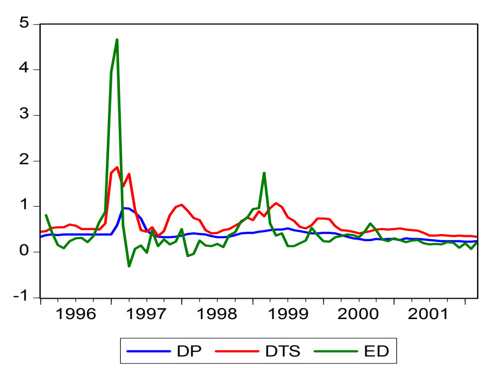
Deposit interest rate semi-elasticity of money demand is positive and has an opposite sign to the T-bills interest rate semi-elasticity. It is also greater than the T-bills interest rate semi-elasticity, which suggests a smaller elasticity of money demand to a change in T-bills interest rate. A test imposing equals semi-elasticities (in absolute value) is statistically rejected for models II ($\chi^2(1) = 11.01[0.00]$ and III ($\chi^2(1) = 22.8[0.00]$, while for model I it cannot be rejected ($\chi^2(1) = 1.05[0.30]$).

The exchange rate depreciation coefficient has a negative sign (consistent with economic theory) and is statistically significant, which indicates the existence of a currency substitution in Romania. This is outlined also by the increase in weight of foreign currency deposits in total broad money (figure 4).

The coefficient of depreciation is relatively small (the exchange rate depreciation elasticity of money demand being 0.46*0.43=0.19, where 0.43 is an annualized average depreciation of the exchange rate). This is explained by the fact that on average, the national currency appreciated in real terms (figure 7) excepting the 1997 shocks (price and exchange rate liberalization) and 1999 (the pressure induced on the real exchange rate depreciation by a peak in the payment of external debt), and the deposit interest rate was on average greater than the yield for foreign exchange deposits, which was very obvious since 2001. The small coefficient of exchange rate might be the cause of dollarization hysteresis and/or a high risk premium in Romania.

Figure 7 Real exchange rate, depreciation and interest rates





The inflation semi-elasticity of money demand is 0.47, which involves a long term elasticity of 0.33 (figure obtained by multiplying the annualized monthly average inflation by 0.47), considered relatively high. This is not surprising for a country like Romania in which financial assets outside broad money are limited and the agents hold significant quantities of real assets.

5.3.2 Weak-exogeneity tests

Weak exogeneity hypothesis is accepted both separately (table 4 - for output, deposit interest rate, inflation, depreciation and exchange rate) and jointly (table 5). It is rejected for broad money and T-bills. The deposit interest rate weak exogeneity suggests that it is determined outside the system (it is not caused by money demand, but it determines money demand). The T-bills interest rate is not weak exogenous and it adjust to the money demand disequilibria from the long term level.

The relationship between inflation and broad money is from inflation to broad money and not vice versa, the inflation being weak exogenous for the money demand. It is not the rise in broad money which generates inflation, but it is the broad money which is accommodated to inflation as this monetary aggregate rises to reach the equilibrium. Consequently, we can state that inflation is not a monetary phenomenon.

Table 5 Weak exogeneity jointly tests ~ 1/

	(1,2,3,4=0)	(1,2,4=0)	(1,2,3,4,5=0)	(1,2,4,5=0)	(1,2,3,4,5,6=0)
I	$\chi^2(4) = 9.26$ [0.054]	$\chi^2(3) = 2.49$ [0.48]			
II	$\chi^2(4) = 8.30$ [0.08]	$\chi^2(3) = 3.24$ [0.35]	$\chi^2(5) = 10.69$ [0.057]	$\chi^2(4) = 3.93$ [0.41]	
III	$\chi^2(4) = 23.1$ [0.00]*	$\chi^2(3) = =1.01$ [0.79]			$\chi^2(6) = 23.33$ [0.00]*

~Seasonally adjusted data; 1/ 1,2,3,4,5,6 represent speed of adjustment (α) for output, deposit interest rate, T-bills interest rate, inflation, depreciation and exchange rate; ** and * indicate rejection of null hypothesis (there is weak exogeneity, in square brackets – p-value) at 1% respectively 5%.

The coefficients representing speed of adjustment (table 3) indicate relatively rapid adjustment of real money demand to disequilibria. The negative sign of speed of adjustment suggests that if in the previous month the money demand exceeded the long term level in the current month money demand would decrease. We can say that the central bank accommodates relatively quickly these disequilibria (for model II and III 10% from the previous month disequilibrium is adjusted in the current month, leading to an accommodation of this disequilibria in about 10 months; for model I, 4% from the previous month disequilibrium is adjusted in the current month).

As an alternative for the above estimates, we estimated the models using unadjusted data and introducing seasonally centred (orthogonalised) dummy variables in order to point out seasonality. The results were not consistent in economical and econometrical terms unless in the case of closed economy model (table 6), the other models leading to statistically insignificant coefficients.

Table 6 Long run cointegrating relation 1/

	Output	***Deposit interest rate***	***T-bills interest rate***	***Inflation***	***Dummy9701*** [16]	***S1*** [17]	
Coef.	**1.07***	**7.84***	**-4.28***	**-0.28***	**-0.05**	**-0.09***	
SE 2/	0.56	1.4	0.8	0.1	0.03	0.03	
t 3/	1.9	5.57	-5.3	-2.7	-1.33	-2.86	
	S3	***S10***	***S11***	***S12***	***Speed of adjustment***	**RMSE 4/**	
						static	**dynamic**
Coef.	**-0.05**	**-0.04***	**-0.03**	**0.06***	**-0.04**	**0.03**	**0.024**
SE 2/	0.04	0.01	0.01	0.01	0.03		
t 3/	1.15	-2.15	-1.64	3.36	-1.33		

* Significant at 5%; 1/ seasonally unadjusted data; 2/ Standard error; 3/ T-statistic; 4/ Root mean square error for forecast;

The key parameters estimated in table 6 are consistent with other research studies related to money demand and they are similar as size with those estimated for other transition economies. The dummy9701 variable has a negative coefficient implying that money demand was lower in January 1997, and S12 has a positive coefficient showing the rise in money demand in December each year.

Figure 8 shows the cointegrating vector obtained following Johansen procedure. The cointegrating vectors show the deviation of the money demand from its long term level. In the context of money demand models, the positive (negative) difference between actual holdings of money and the long term level can be interpreted as a measure of ***monetary overhang (shortfall)***.

[16] Dummy for price liberalization from January 1997 – is 1 for January 1997 and 0 in rest.

[17] S-seasonally centered dummy for January (S1 - the increase in money supply following the payment of the 13-th wage), March (S3 - the increase in prices in March), October and November (S10 and S11-the increase in output), and December (S12-the increase in money demand).

Figure 8 The unrestricted cointegrating relation (used as error correction term in dynamic model)

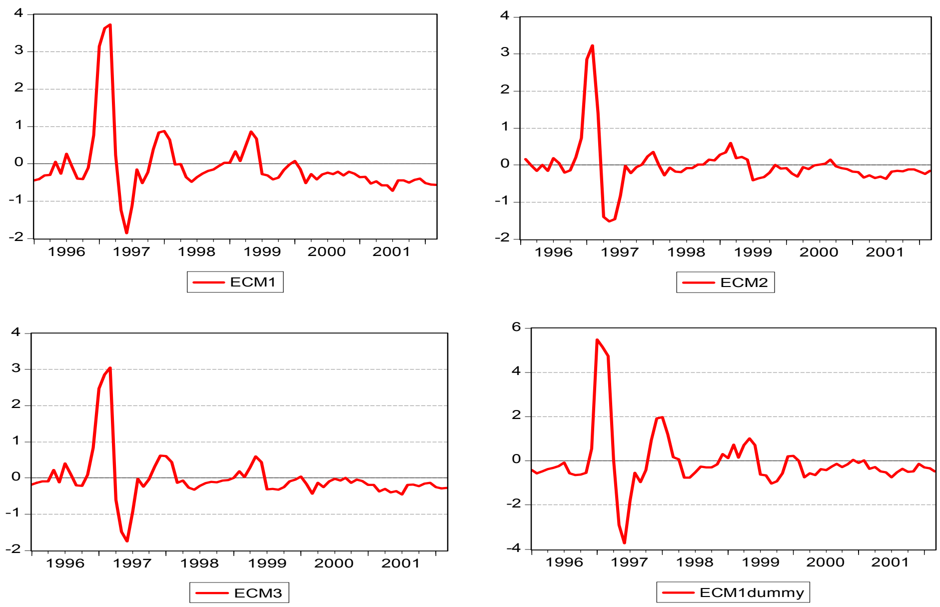


Figure 8 shows that during 1996-2002 the deviation of money demand from its long term level for the three models and model I with unadjusted data is stationary, so we can use it in an error correction mechanism. More, this deviation is relatively small, excepting 1997 when in the first three months there was an obvious monetary overhang, and in the next two months a shortfall occurred due to pressures made by NBR to rise the interest rates, after which the situation came back to normal.

5.3.3 The stability of parameters in the long run equilibrium

The stability of the parameters is essential for a good specification of money demand. Instability can occur during and immediately after a financial crisis, and the main factors of money demands can change. In order to asses the stability of the parameters we will recursively re-estimate the parameters from the unrestricted ECM.

In figures 9-12 are presented the CUSUM tests, recursive residuals, N-step forecast test and the recursive coefficients.

Figure 9 Recursive diagnostic graphs of the short run unrestricted ECM - model I

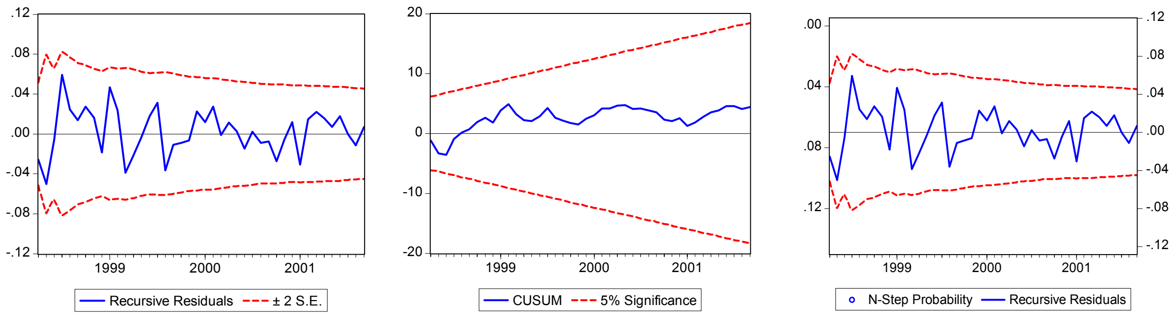


Figure 10 Recursive diagnostic graphs of the short run unrestricted ECM - model II

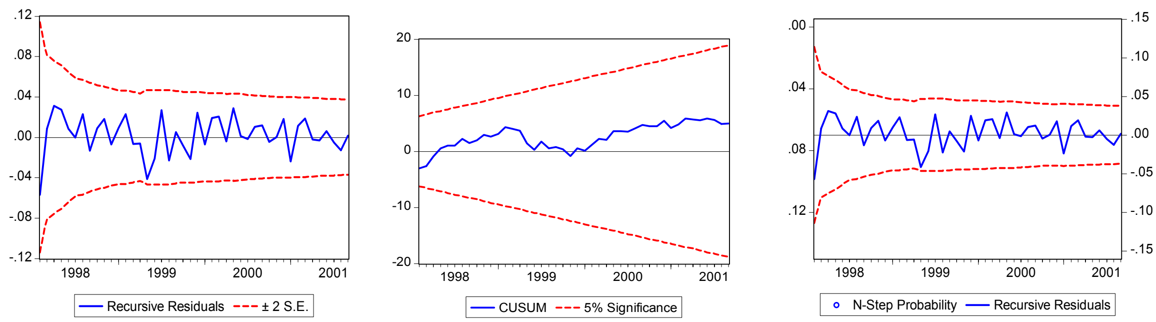
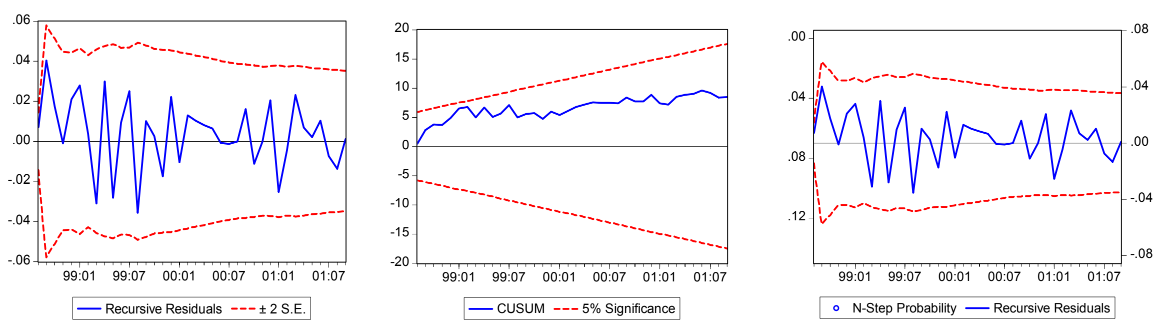
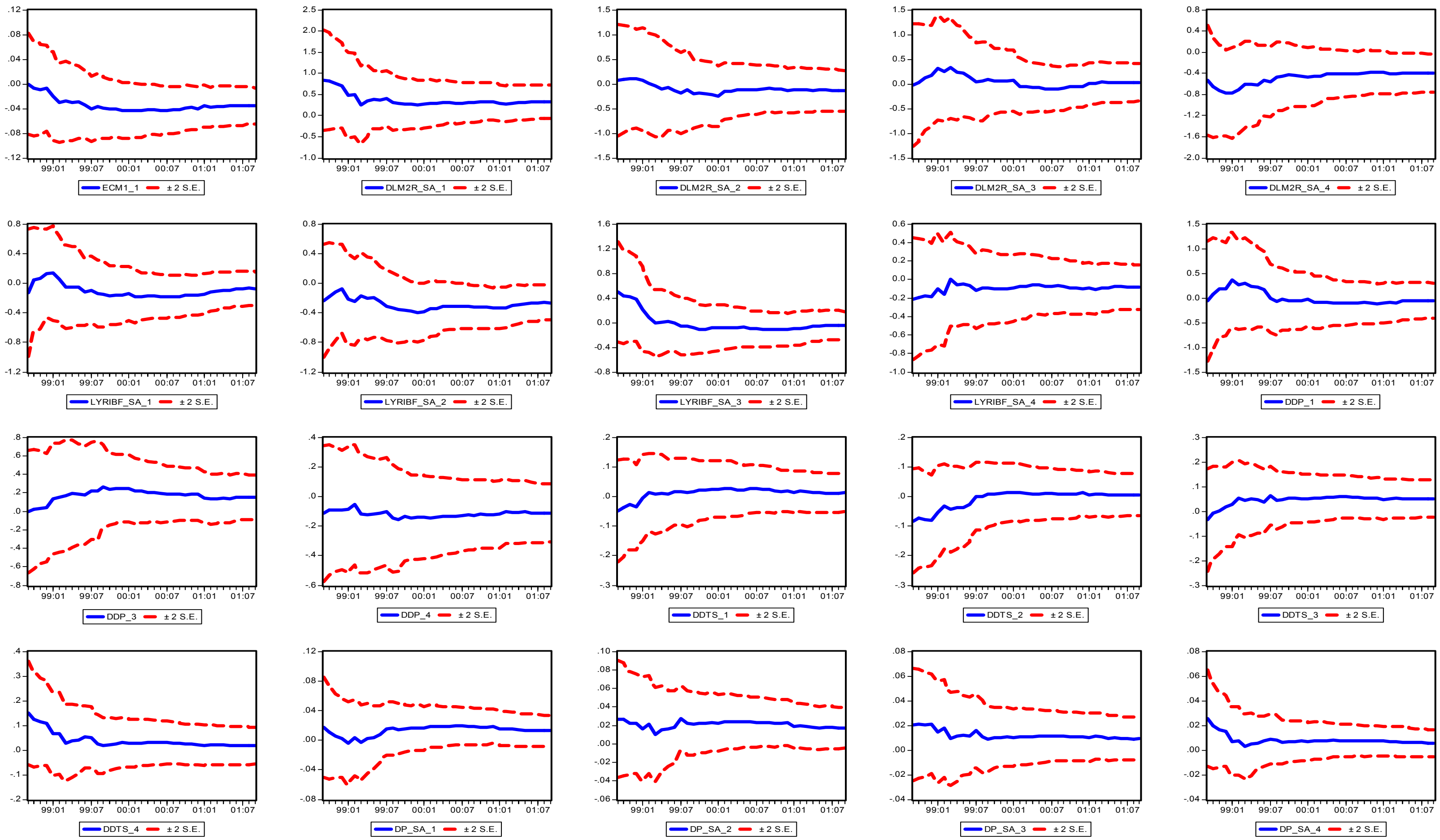


Figure 11 Recursive diagnostic graphs of the short run unrestricted ECM - model III



According to the tests performed, the estimated coefficients are constant over time, although in1997 there are some signs of instability. The stability of parameters suggests that the determinants of the money demand were constant over the analyzed period. This stability is quite remarkable if we take account of the period of transition and the changes in the economic policy which took place in Romania.

Figure 12 Graphs of the recursive coefficients of the short run unrestricted ECM - model I



An explanation for the stability of the parameters in the case of seasonally adjusted data may be the use of the Tramo-Seats procedure which gives good results in the presence of outliers and incorporates very well structural breaks.

In spite of this, the stability of parameters could be explained. A series of factors contributed to the stabilization of the economic environment including a restrictive monetary policy conducted by the NBR. For example, when in 1997 a sharp decline in money demand occurred, the NBR stimulated its recovery through a rise in the level of interest rates.

Because of the insufficient number of observations until 1997:01 (12 observations), the models cannot be estimated separately for the two sub-periods; this is the reason why a Chow test for a structural break in 1997 cannot be performed.

In order to test if the 1997 shock produced only a one time jump in the determinants of money demand and left them unmodified, we re-estimated the cointegrating relation for the 1997:07-2001:09 period. For the log run we obtained parameters similar to those obtained for the entire sample. For example, in model II, if we restrict all the long run coefficients estimated for the 1997:06-2001:09 sample to be the same with those estimated for the entire sample we cannot reject the null hypothesis: $\chi^2(5) = 5.73[0.34]$.

5.3.4 Short run error correction model (ECM)

The estimated cointegrating equations include the factors affecting the real money demand in the long run. In the short run deviations from these relations can occur reflecting shocks in the relevant variables. More, the short run elasticities differ from the long run elasticities. Engle and Granger (1987) proved that if there is a cointegrating relation between non-stationary variables, then there is a correction representation towards equilibrium. In this section we will estimate a short run parsimonious error correction model as follows:

$$\Delta LM2R = C + \sum_{j=1}^{5}\sum_{i=1}^{6}\gamma_{ji}\Delta V_{j,t-i} + \gamma_1 ECM_{t-1} + \varepsilon_t \qquad (11)$$

where V is the vector of variables (broad money, output, deposit interest rate, T-bills interest rate and inflation). Using a general-to-specific methodology (D. Hendry) by eliminating insignificant lags we obtain the parsimonious model from table 7.

Table 7 Parsimonious error correction model - model I

Dependent Variable: D(LM2R_SA)				
Method: Least Squares				
Sample(adjusted): 1996:03 2001:09				
Included observations: 67 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECM1_1	-0.013942	0.004046	-3.446164	0.0010
DLM2R_SA_1	0.313701	0.115123	2.724918	0.0083
DDTS	-0.026417	0.011747	-2.248838	0.0281
DP_SA	-0.014734	0.001866	-7.894747	0.0000
C	-0.005467	0.002521	-2.168777	0.0339
R-squared	0.667695	Mean dependent var		-0.007540
Adjusted R-squared	0.646256	S.D. dependent var		0.032469
S.E. of regression	0.019311	Akaike info criterion		-4.984542
Sum squared resid	0.023122	Schwarz criterion		-4.820013
Log likelihood	171.9822	F-statistic		31.14393
Durbin-Watson stat	2.144583	Prob(F-statistic)		0.000000
Q-stat(6)			6.51[0.368]	
ARCH(6)			0.79[0.58]	
White			0.64[0.73]	

Like in the unrestricted model, in the restricted model the error correction term has a negative sign and is statistically significant. A negative sign implies that the money demand adjusts in the current month following disequilibrium in the previous month. In other words, if there is an excess of money in the current month, in the next month the agents will reduce their money holdings. In terms of size, the adjusting parameter is small which means that either the cost of disequilibrium is reduced or the cost of adjustment is high.

Figure 13 Normality test of residual for parsimonious ECM – model I

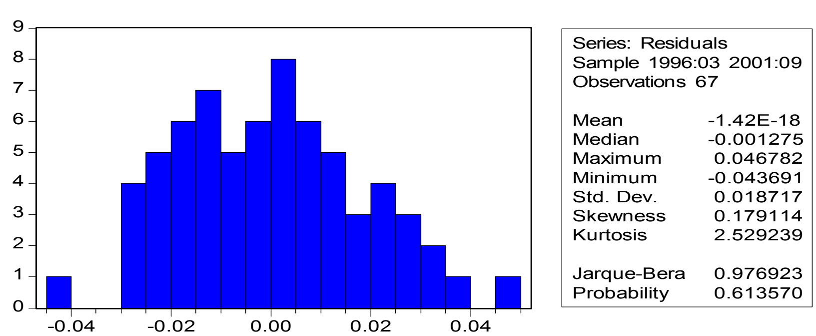
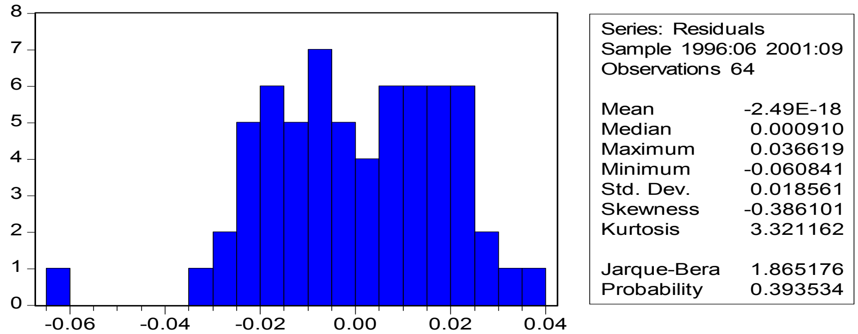


Figure 14 Normality test of residual for unrestricted ECM – model I



While the change in output and in deposit interest rate does not affect the short run changes in money demand, the money demand is influenced in the short run by changes in T-bills interest rate and inflation. In this way we point out the reaction of the public to changes in inflation rate, which suggests that in the short run like in the long run the agents purchase goods in exchange of money holdings when they anticipate a rise in inflation. The money demand is also affected in the short run by its first order lag.

Figures 15 and 16 present the diagnostic tests for parsimonious ECM from table 7. Comparing the unrestricted model to parsimonious model, we observe that the last is better in qualitative terms, and this is confirmed by the normality tests of residuals (figures 13 and 14). The tests from table 7 indicate that there are no signs of serial correlation and heteroskedasticity in residuals. It is noticeable that although the model is parsimonious, the equation has an adjusted R-squared of 0.64, which indicates a strong determination of the dependent variable by the independent variables.

Although the unrestricted model also has stable coefficients, the coefficients from the parsimonious model are more stable, the error bands decreasing rapidly. After 1997, the coefficients from the parsimonious ECM are virtually constant.

Like in the case of unrestricted ECM, the stability of the parameters from the parsimonious ECM is remarkable, considering the great number of economical reforms implemented during the analyzed period. This indicates that the events capable to create outliers or structural breaks were incorporated very well in the model.

Figure 15 Recursive diagnostic graphs of the short run parsimonious ECM - model I

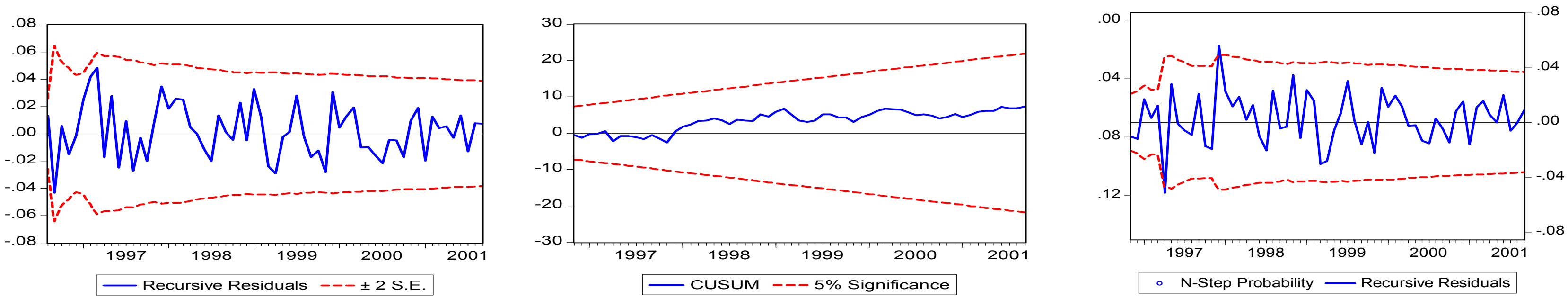
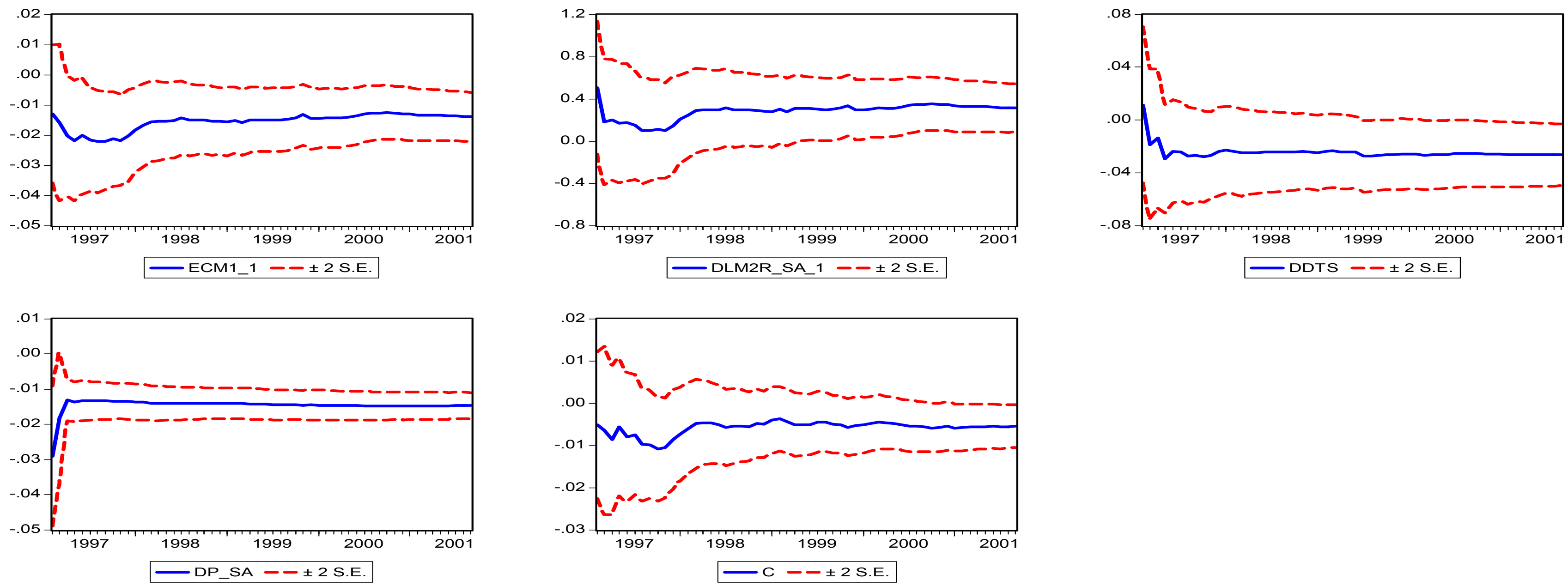


Figure 16 Graphs of the recursive coefficients of the short run parsimonious ECM - model I



5.3.5 Forecasting ability

Like we stated above, all estimation were performed for the 1996:01-2001:09 period. Extending the model for the period 2001:10-2002:03 we can make a series of judgments regarding the stance of monetary policy during October 2001-March 2002, although this is subject to errors.

For the static forecasting, the forecasted value of money demand at moment t is calculated as $\overline{m_t} = m_{t-1} + \Delta\overline{m_t}$, where $\Delta\overline{m_t}$ is based on the estimated ECM. For the dynamic forecasting, the forecasted value of money demand at moment t is calculated as $\overline{m_t} = m_0 + \sum_{j=1}^{t} \Delta\overline{m_j}$, estimation errors get cumulated over time.

Figure 17 M2 actual vs. fitted model I

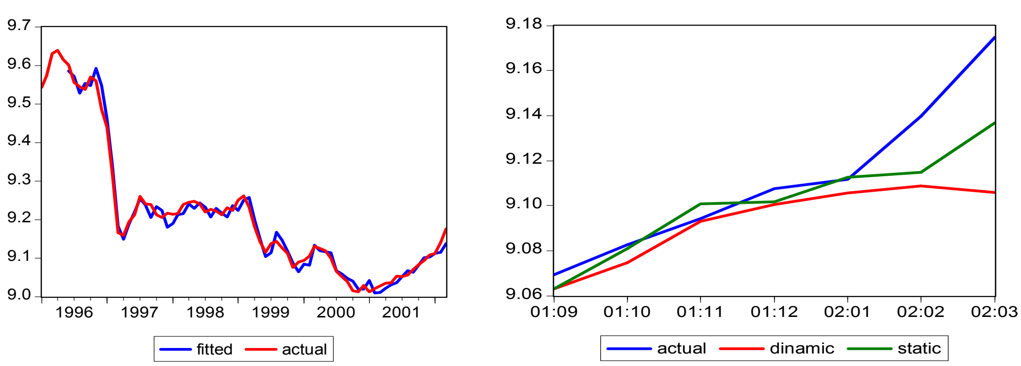


Figure 18 M2 actual vs. fitted –model II

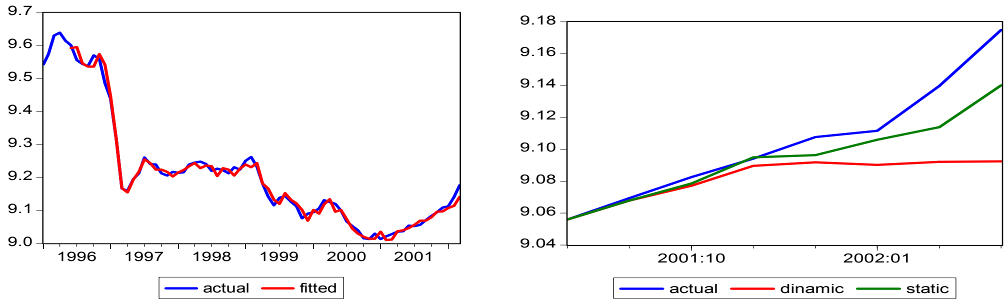


Figure 19 M2 actual vs. fitted model III

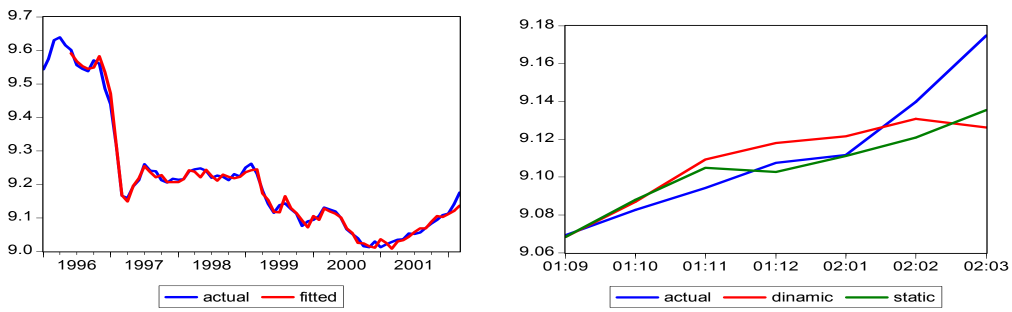
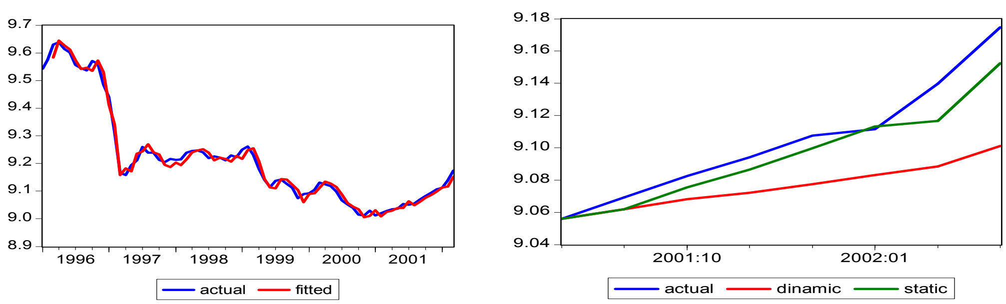
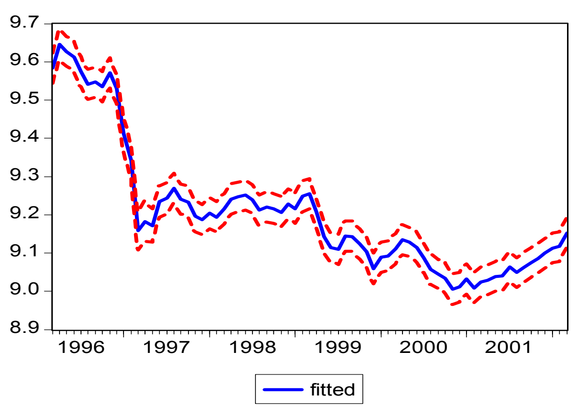


Figure 20 M2 actual vs. fitted model ECM parsimonious





Forecast: LM2R_SAF
Actual: LM2R_SA
Forecast sample: 1996:01 2002:03
Adjusted sample: 1996:03 2002:03
Included observations: 73

Root Mean Squared Error	0.018253
Mean Absolute Error	0.014995
Mean Abs. Percent Error	0.162360
Theil Inequality Coefficient	0.000991
Bias Proportion	0.002481
Variance Proportion	0.002368
Covariance Proportion	0.995151

Within sample static (one-step ahead) and dynamic forecasts suggest that the models provide a reasonable approximation of the actual money demand process during 1996-2002, especially the parsimonious ECM.

In particular, the forecast for 2001:10-2002:03 can give us a clue about the stance of monetary policy, indicating that on average the actual real money demand was larger than the estimated money demand during this period, which generated a monetary overhang, the monetary policy being more relaxed.

5.4 A state space model for the money demand in Romania

In this section a state space model (time-varying parameters) model is estimated on the demand for money (M2) in Romania, following an approach similar to Bomhoff (1991) and Stracca (2001).

The estimates performed in the previous sections were based on the stability of the parameters. As a plus vs. the previous estimates, a time-varying parameters model can underline possible changes in parameters over time using Kalman filters. Another advantage of this model is the fact that it can asses the impact of financial innovation onto money holdings.

Concretely, we will specify a state space model where we will explicitly allow the deposit interest rate elasticity of money demand to vary. The model is specified as:

$$m_t^d = k + \alpha * y_t + \beta_t * DP + \gamma_t * DTS + \delta_t * p_t + \varepsilon_t \tag{12}$$

$$\beta_t = \beta_0 + \beta_1 \beta_{t-1} + u_t \tag{13}$$

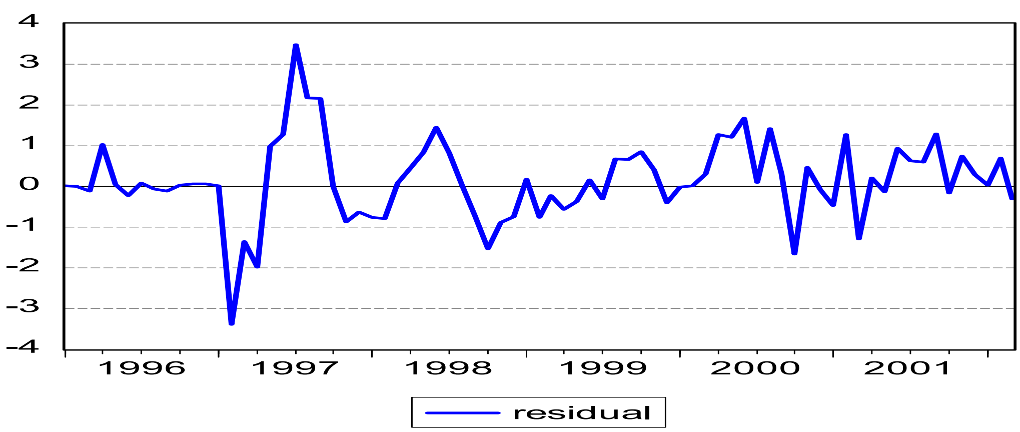
In this specification, a shock is introduced to the deposit interest rate elasticity of money demand like in Stracca (2001). β_t will be a state series like γ_t and δ_t. This inclusion is reasonable also because theoretical research (for example Ireland, 1995 and Glenon and Lane, 1996) has shown that the financial innovation such a introduction of new monetary instruments by financial intermediaries may have significant effects on interest rate elasticity of the demand for the existing monetary assets.

Theoretically, the parameter α can be estimated freely. In practice, the income elasticity is kept fix at 1.35[18] in order to gain degrees of freedom. The state series β_t is modelled as an auto-regressive process as in (13) with β_0 and β_1 constant. The auto-regressive coefficient β_1 is freely estimated. In practice, the state series β, γ, δ are subsequently modelled as random walk processes. ε is the error term assumed to have a zero mean, constant variance and to be uncorrelated with the error u.

The cointegrating vectors estimated previously can be considered particular cases for a "time-varying-parameters" specification as in the equation (12) where the state variables have zero variances. It should also be stressed that there is no guarantee that the "time-varying-parameters" model really captures a money demand relationship, i.e. the structural interpretation cannot be tested. However, given the similarity with the fixed parameters specification for which a test of the structural interpretation exists, it is very likely that the model actually capture a money demand relationship.

The time-varying-parameters model in (12) and (13) is estimated by means of a Kalman filter over the full sample period from 1996:01 up to 2002:03. This procedure requires maximizing the likelihood function using an optimization algorithm (in particular the BHHH – Berndt-Hall-Hall-Hausman algorithm). The fact that the variables are I(1) does not represent a problem as "time-varying-parameters" model is well design to deal with non-stationary data, because states are always taken conditional on their last realization.

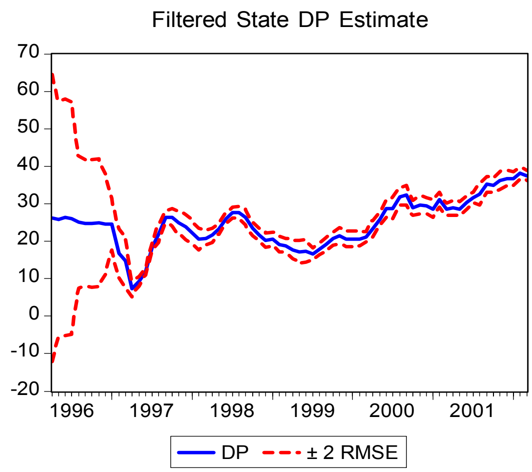
Figure 21 Residual from Kalman filter



[18] The freely estimate for this elasticity tends to give a value close to 1.35. This is also close to the value of 1.39 estimated by Johansen procedure.

The model appears to be well specified and the residual appear to be stationary (figure 21). Being the model in (12)-(13) specified in terms of the long run relationship, the residual have some positive autocorrelation (Q statistic Q(6)=14.35[0.00]), reflecting the existence of adjustments costs in bringing monetary holdings to the desired equilibrium value.

Figure 22 The deposit rate elasticity of the money demand



A reduced but noticeable increase in absolute value of the deposit interest rate elasticity of money demand is visible beginning from the first half of 2000 (figure 22). This means that in the context of a progress towards a more reduced and predictable inflation, reduced and stable interest rates, the preference for liquidity of the agents increases.

Another remark is related to the sharp decline in the deposit interest rate elasticity of money demand at the beginning of 1997. This is due to the high level of deposit interest rate (up to120-130% for term deposits) for this period which caused the money demand not to vary significantly at one percent change in the deposit interest rate.

The interest rate elasticity is stronger the lower the interest rate, for instance because under a certain threshold the forgone interest rate income does not adequately compensate for the learning and transactions costs associated to investing in securities (Mullighan and Sala-i-Martin, 1996).

6. CONCLUSIONS

Judd and Scadding (1982, p. 993) state “a stable demand function for money means that the quantity of money is predictably related to a small set of key variables linking money to the real sector of the economy.” Judging by this principle, this paper obtained a stable money demand function for Romania in 1996-2002 period.

The paper has carefully studied developments in the macroeconomic situation and the financial system, and identified only few but highly relevant variables exercising influence on real M2 under both the closed- and open-economy formulations.

Empirical analysis carried out by means of Johansen multivariate cointegration analysis and parsimonious error correction models. Cointegration analysis reveals that there is a stationary long run relationship between real broad money balances, real output, deposit interest rate, T-bills interest rate, inflation and exchange rate depreciation. Cointegration between money and other variables has no implications *per se* for predicting inflation or for monetary targeting. Rather, the role of excess money in the determination of inflation turns on the weak exogeneity of prices or the lack thereof[19]. In Romania, as we have seen, the inflation is weekly exogenous for money demand, which means that inflation is not a monetary phenomenon.

The long run income elasticity is higher than one but not statistically significant different from one. The opportunity cost variables carry the expected sign according to economic theory.

The depreciation of exchange rate elasticity of the money demand indicates currency substitution in Romania.

In the short run, the money demand is not influenced by changes in output and deposit interest rate, but changes in T-bills interest rate and inflation.

The results suggest that both the long- and short-run models are well specified. The demand for real money (M2) is stable for the period analyzed, although in1997 there are some signs of instability.

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[19] Sriram (1999a).

Standard diagnostic and stability tests confirm the good statistical performance of the models. Further evidence in support of the stability of the model derives from its positive forecasting performance.

The increase in deposit interest rate elasticity suggested by the time-varying-parameter begin from the first half of 2000, means that in the context of a progress towards a more reduced and predictable inflation, reduced and stable interest rates, the preference for liquidity of the agents increases.

The important findings is that both in the long and in the short-run the demand for real M2 is stable providing justification for the monetary authorities to use M2 aggregate like intermediary target in conducting his policy.

Changes in policy-makers' rules or reaction functions may change the cointegration and/or exogeneity properties of the system.

The results of our analysis should be taken into account with some caution. However, the estimated elasticities must be used cautiously, as it is difficult to interpret them as true long-run elasticities given the short time series available. Moreover, the money demand function is likely to continue to change in line with structural changes in the Romanian economy. For further research, we should consider other monetary aggregates to, like M0 or M1 or a broader aggregate like M2 plus T-bills.

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APPENDIX I

Unit root tests

Output							
Level							
ADF Test Statistic	-0.61121	1% Critical Value*	-4.089	PP Test Statistic	-1.10357	1% Critical Value*	-4.0853
2 lagged differences		5% Critical Value	-3.472	3 truncation lag		5% Critical Value	-3.4704
		10% Critical Value	-3.163			10% Critical Value	-3.162
First difference							
ADF Test Statistic	-4.24417	1% Critical Value*	-4.091	PP Test Statistic	-10.0434	1% Critical Value*	-4.0871
2 lagged differences		5% Critical Value	-3.473	3 truncation lag		5% Critical Value	-3.4713
		10% Critical Value	-3.164			10% Critical Value	-3.1624
Broad Money							
Level							
ADF Test Statistic	-2.12306	1% Critical Value*	-4.089	PP Test Statistic	-1.33066	1% Critical Value*	-4.0853
2 lagged differences		5% Critical Value	-3.472	3 truncation lag		5% Critical Value	-3.4704
		10% Critical Value	-3.163			10% Critical Value	-3.162
First difference							
ADF Test Statistic	-4.89789	1% Critical Value*	-4.091	PP Test Statistic	-4.97097	1% Critical Value*	-4.0871
2 lagged differences		5% Critical Value	-3.473	3 truncation lag		5% Critical Value	-3.4713
		10% Critical Value	-3.164			10% Critical Value	-3.1624
Deposit interest rate							
Level							
ADF Test Statistic	-1.04431	1% Critical Value*	-2.595	PP Test Statistic	-0.98484	1% Critical Value*	-2.5941
2 lagged differences		5% Critical Value	-1.945	3 truncation lag		5% Critical Value	-1.9447
		10% Critical Value	-1.618			10% Critical Value	-1.618
First difference							
ADF Test Statistic	-4.94863	1% Critical Value*	-2.595	PP Test Statistic	-4.99154	1% Critical Value*	-2.5945
2 lagged differences		5% Critical Value	-1.945	3 truncation lag		5% Critical Value	-1.9448
		10% Critical Value	-1.618			10% Critical Value	-1.6181

T-bills interest rate							
Level							
ADF Test Statistic	-1.36352	1% Critical Value*	-2.595	PP Test Statistic	-1.39093	1% Critical Value*	-2.5941
2 lagged differences		5% Critical Value	-1.945	3 truncation lag		5% Critical Value	-1.9447
		10% Critical Value	-1.618			10% Critical Value	-1.618
First difference							
ADF Test Statistic	-4.28424	1% Critical Value*	-2.595	PP Test Statistic	-7.32255	1% Critical Value*	-2.5945
2 lagged differences		5% Critical Value	-1.945	3 truncation lag		5% Critical Value	-1.9448
		10% Critical Value	-1.618			10% Critical Value	-1.6181
Inflation							
Level							
ADF Test Statistic	-1.855424	1% Critical Value*	-2.5945	PP Test Statistic	-2.266209	1% Critical Value*	-2.5941
1 lagged differences		5% Critical Value	-1.9448	3 truncation lag		5% Critical Value	-1.9447
		10% Critical Value	-1.6181			10% Critical Value	-1.6180
Exchange rate depreciation							
Level							
ADF Test Statistic	-3.38151	1% Critical Value*	-3.527	PP Test Statistic	-4.37948	1% Critical Value*	-3.5213
4 lagged differences		5% Critical Value	-2.904	3 truncation lag		5% Critical Value	-2.9012
		10% Critical Value	-2.589			10% Critical Value	-2.5876
Exchange rate							
Level							
ADF Test Statistic	-1.7858	1% Critical Value*	-4.089	PP Test Statistic	-1.77385	1% Critical Value*	-4.0853
2 lagged differences		5% Critical Value	-3.472	3 truncation lag		5% Critical Value	-3.4704
		10% Critical Value	-3.163			10% Critical Value	-3.162
First difference							
ADF Test Statistic	-3.7067	1% Critical Value*	-4.091	PP Test Statistic	-4.43876	1% Critical Value*	-4.0871
2 lagged differences		5% Critical Value	-3.473	3 truncation lag		5% Critical Value	-3.4713
		10% Critical Value	-3.164			10% Critical Value	-3.1624

APPENDIX II

Cointegration tests

Model I

Sample(adjusted): 1996:06 2001:09
Included observations: 64 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LM2R_SA LYRIBF_SA DP DTS P_SA
Lags interval (in first differences): 1 to 4
Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.435062	79.24148	68.52	76.07
At most 1	0.247704	42.69498	47.21	54.46
At most 2	0.199047	24.47893	29.68	35.65
At most 3	0.141070	10.27393	15.41	20.04
At most 4	0.008426	0.541568	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 1 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None *	0.435062	36.54651	33.46	38.77
At most 1	0.247704	18.21604	27.07	32.24
At most 2	0.199047	14.20500	20.97	25.52
At most 3	0.141070	9.732363	14.07	18.63
At most 4	0.008426	0.541568	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 1 cointegrating equation(s) at the 5% level
Max-eigenvalue test indicates no cointegration at the 1% level

Model II

Sample(adjusted): 1996:06 2001:09
Included observations: 64 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LM2R_SA LYRIBF_SA DP DTS P_SA ED
Lags interval (in first differences): 1 to 3
Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.523210	112.3711	94.15	103.18
At most 1	0.402448	64.96762	68.52	76.07
At most 2	0.169961	32.01312	47.21	54.46
At most 3	0.147275	20.09107	29.68	35.65
At most 4	0.134950	9.894731	15.41	20.04
At most 5	0.009591	0.616786	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 1 cointegrating equation(s) at both 5% and 1% levels

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.523210	47.40345	39.37	45.10

At most 1	0.402448	32.95450	33.46	38.77
At most 2	0.169961	11.92205	27.07	32.24
At most 3	0.147275	10.19634	20.97	25.52
At most 4	0.134950	9.277945	14.07	18.63
At most 5	0.009591	0.616786	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 1 cointegrating equation(s) at both 5% and 1% levels

Model III

Sample(adjusted): 1996:06 2001:09
Included observations: 64 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LM2R_SA LYRIBF_SA DP DTS P_SA LER
Lags interval (in first differences): 1 to 4
Unrestricted Cointegration Rank Test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.728816	155.3077	94.15	103.18
At most 1 *	0.357755	71.79039	68.52	76.07
At most 2	0.269608	43.45209	47.21	54.46
At most 3	0.208193	23.34499	29.68	35.65
At most 4	0.114380	8.404953	15.41	20.04
At most 5	0.009812	0.631066	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at the 5% level
Trace test indicates 1 cointegrating equation(s) at the 1% level

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	1 Percent Critical Value
None **	0.728816	83.51732	39.37	45.10
At most 1	0.357755	28.33830	33.46	38.77
At most 2	0.269608	20.10710	27.07	32.24
At most 3	0.208193	14.94004	20.97	25.52
At most 4	0.114380	7.773887	14.07	18.63
At most 5	0.009812	0.631066	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates 1 cointegrating equation(s) at both 5% and 1% levels

Correlation matrix

	T-bills interest rate	Deposit interest rate	Depreciation	Exchange rate	Inflation
T-bills interest rate	1.00	0.67	0.60	-0.39	0.69
Deposit interest rate	0.67	1.00	0.11	-0.49	0.55
Depreciation	0.60	0.11	1.00	-0.19	0.53
Exchange rate	-0.39	-0.49	-0.19	1.00	-0.30
Inflation	0.69	0.55	0.53	-0.30	1.00