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The Faculty of Finance, Insurance, Banking and Stock Exchanges
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Determinants of Demand for Money in Romania

Coordinator: Professor Moisa Altar

Author:
Andreea Paunescu

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SUMMARY

1. INTRODUCTION

Demand for money plays a major role in macroeconomic analysis, especially in selecting appropriate monetary policy actions. Consequently a steady stream of theoretical and empirical research has been carried out world-wide over the past several decades.

The interest on developing countries has heightened in recent years, triggered primarily by the concern among central banks and researchers on the impact of the movement toward the flexible exchange rate regime, globalisation of capital markets, ongoing domestic financial liberalisation and innovation and country specific issues.

The permanent need to search for a model of the demand for money which to be both theoretically coherent, empirically stable (in the sense that the parameters of a given specification would not change significantly over time) and robust (in the sense that a different search procedure or a different sample period would not substantially alter the selected specification) is one of the most important issues in macroeconomic policy.

It is central for the elaboration of any general macroeconomic model and especially to the transmission mechanism of monetary policy. (Cuthbertson and Taylor 1987). The origins of this search can be found in Milton Friedman's paper "Optimum Quantity of Money – A Restatement" (1956) which has marked the beginning of an assiduous search for a money demand function definition by many economists, search that continues even today.

The reason for this continuous search of an estimated demand for money function is that if a stable demand function containing a limited number of explanatory variables exists, policy actions which alter the money stock can be expected eventually to have predictable effects on ultimate target variables. Therefore, the knowledge of a stable demand function decreases the outcome uncertainty of monetary and fiscal policy. In other words, the stability of the demand for money function means that the demanded quantity of money is predictable related to a small set of variables linking money to the real sector of the economy.

This issue is even more important for the emerging economies with big shifts in all sectors of the economy and high inflation. The authorities should be able to determine what money stock is actually “desired” in the economy, in order to avoid excessive supply of money which to lead to accelerating inflation or excessive demand for money contributing towards recession. Monetary mismanagement and subsequent acceleration inflation result in big economic and social losses: restructuring of the economy proceeds slower, the distribution of income becomes more uneven and the opposition for economic reforms gets stronger.

Due to this importance of money demand models and to the difficulties appeared in the search of theoretically coherent yet empirically stable and robust models of the demand for money, a tremendous amount of work has been done in this field. Following this hard work, the progresses made were possible because of the interaction between theory and empirical evidence. Lately, the advances made in the analysis and modelling of the money demand are being made by the application of new econometric techniques rather than through significant theoretical new findings.

The purpose of this thesis is to test for the existence of a stable long-run relationship between demand for money in Romania (both for M1 and M2) and four of the most significant determinants in dimensioning the monetary aggregates in Romania, from the demand point of view.

2. Overview of main economic and monetary developments in Romania after 1990

In Romania, the inflationary process lasted much longer than in the majority of the ex-communist countries in the Central and Eastern Europe. This was due to many factors, among them the most important being the multiple and contradictory goals of the monetary policy between 1990 – 1996 which reduced the ability of the National Bank of Romania to focus on the efficient control of inflation.

Starting with 1997, the monetary policy has been relieved from the duties regarding the financing of agriculture, energetic field and budgetary deficit. The loans for energy and agriculture were cancelled, and the new credits have been given at market interest. The new Law regarding the National Bank of Romania Statute sets as main and unique goal of monetary policy the assurance of the national currency stability, as cause of prices stability.

The intermediate objectives of monetary policy in Romania between 1990-2001 were: money supply (broad or narrow), the interest rates – starting at the end of 1993 – and the exchange rate as a nominal anchor for inflation – until the end of 1996.

Starting 1994, the liquidity control objective centered on the money supply control and on the precise evaluation of money supply multipliers and these two new measures allowed the control of the larger monetary aggregates.

Once a restrictive anti-inflationary monetary policy was applied, at the end of 1993, National Bank of Romania started a decisive action to set the bank interest at a real-positive level.

From that moment until today, National Bank of Romania set as additional goal to that of liquidity controlling, the assurance of a real-positive level of interests in the banking field.

Starting 1996, the monetary policy based on the control of the exchange rate was abandoned, the exchange rate was allowed for a free fluctuation.

In May 1991 was adopted the Law regarding the National Bank of Romania Statute which invested the Central Bank as the monetary authority in Romania.

In September 1991 the credits and interests ceilings have been abolished, and starting 1992, the conduct of monetary policy relied on refinancing mechanism, that anticipated rediscount, open-market operations and the collateral loan.

Also, in 1992 the minimum reserves were introduced and getting the interests rates at real-positive levels became a target to be achieved through the refinancing rates used by National Bank of Romania.

Although most of the time during 1992 – 1994 liquidity in the market remained excessive, some dis-inflationary performances were still made, especially in 1994 and 1995, when National Bank of Romania started an anti-inflationary policy, based on the hard control of liquidity and on the high raise of interests.

In 1997, the liberalization of the other prices that had remained under authority control was realized in the first half of the year, together with the complete liberalization of the foreign exchange market. A peak of inflation was reached in March 1997 (monthly inflation of 30.4%).

As for the monetary policy instruments, during 1997, in order to sterilize the foreign currency influx, a new instrument with market characteristics has been introduced, namely the deposits influx from the commercial banks to Central Bank – which would become the absorption instrument mainly used by the National Bank of Romania.

The performance referring to inflation reduction materialized by achieving a monthly inflation rate of 0.7% in July, but it had a cost materialized in output reduction for the first 8 months from 1997, compared with the same period from 1996, and a brutal compression of real wages.

In these conditions, the Government resigned in front of the pressures occurred by the salary demands and more, abandoned a great part of the reform program. Almost immediately inflation started to grow, in order to arrive during 1997 at a three numbers figure.

In 1998, the monetary and tax policies remained restrictive, but the salary policy has grown until the fall of 1998, on the ground of social pressures. Moreover, the restructuring of the real economic field had a slow growth. The external deficit rose substantially on the ground of a real ROL appreciation, as result of capital influx and reduction of protectionist obstacles for imports.

Starting with May 1999 and until the end of the year 2000, the National Bank of Romania was confronted with struggle between the monetary and foreign exchange market objectives.

On the ground of a foreign currency excess supply on the foreign exchange market, National Bank of Romania made important acquisitions of foreign currency. Those buys contributed to remaking and consolidation of the official foreign currency reserves, decreased by the payment of public debt..

But, however, they represented a powerful infusion of liquidity on the market, jeopardizing the restrictive anti-inflationary policy, based on the strict controlling the monetary supply.

The liquidity excess was also increased by the special granted loans to banks having difficulties (the fusion between BCR-Bancorex, Banca Albina, BCR liquidity needs, the loan granted to the Deposits Guaranty Fund in the Banking System). The NBR sterilisation efforts in order to attract deposits and to increase the minimum reserves rate weren't enough. As result, the inflation goals for 1999 and 2000 were compromised.

Regarding the foreign exchange policy and the exchange rate evolution during the analyzed period until 1996, the authorities permanently interfered in order to limit the national currency excessive depreciation, which in fact showed the reduced performance level of Romanian economy.

As a result, the exchange rate didn't reflect the real relationship between supply-demand, an un-transparent foreign exchange market, which made multiple exchange rates to coexist: the official one – often unrealistic, over-evaluated - , and those of parallel markets: the so-called "black market".

The procedure for establishing the exchange rate was that of daily auctions at the National Bank of Romania.

At the end of February 1997, the re-confirmation (on license basis) as dealer of all banks generated an overshooting event (crashing of national currency) which rapidly finished its resources, on the ground of a restrictive monetary policy and of some large capital inputs, which fed the foreign currency supply on the market.

In March 1999, a new ROL crash happened, when national currency lost in 15-19 March 9,36% compared to the last week's value. One of the reasons that leaded to this was the great foreign currency demand from some commercial banks. The unsafe situation in Romanian economy made many foreign investors to close their business and to repatriate the funds. Banks fulfilled all the purchase orders from the customers. So, because of the large foreign currency demand and of growth of panic, there has been an unexpected fall of the national currency.

In the next days, the National Bank of Romania interfered as possible, but its intervention was limited because of the currency reserves seriously reduced by the payment of external debt. It sold USD to Commercial Banks, and it also interfered on the money market, by attracting deposits for one week and offering an interest of an annually maximum 200%. In that way, starting Friday, March 19th, things started to become normal.

Together with the National Bank of Romania interventions, we should mention the foreign currency sells made by the Romanian Bank for Development – which was appreciated as supportive towards national currency – and some foreign banks subsidiaries – the last ones being sure that the situation will eventually calm down and that ROL will soon appreciate, realized significant profits.

Practically, after this sudden growth, the exchange rate was almost stabilized even starting the next week, at a 14.700 ROL/USD level. Starting with May 1997, the activity on the foreign exchange market improved, even the market registered an excessive foreign currency supply. As result, the National Bank of Romania became an important net buyer on the market, in order to avoid the appreciation of the exchange rate above the level sustained by the Romanian economy performances.

These purchases served for a second objective, to remake the national bank of Romania's foreign currency reserves, seriously damaged after paying, at the beginning of 1999, a substantial service of external debt.

The free activity of the foreign exchange market had some positive effects. The integration of foreign exchange market segments and the disappearing of multiple exchange rates reduced the incertitude and increased the economic agents trust. As result, the currency risk margins included in sale prices reduced.

At the beginning of 1997 – as previously mentioned – the NBR changed to a managed floating exchange rate determined on the market, allowing the Banks to act as dealers in the market. The financial sector became more and more competitive, as new banks emerged, and the privatization of state-owned ones was launched at the end of 1998 by selling the majority stake in Romanian Development Bank ("BRD") to a group of foreign investors.

As for the evolution of money aggregates and interest rates during the last two years of the analyzed period (2000-2001) M2 (broad money) increased by 6.5% in real terms, due to the increase by 20.6% of M1 (narrow money) and the increase of FCY deposits by 22.8%.

During the same period, given the decreasing inflation rates, the interest rates were also falling reaching, in some periods, even real- negative levels.

As a consequence of this low levels of interest rates came the restructuring of M2, as follows: the liquidity part of M2 increased in real terms (the cash balances by 19% and the sight deposits by 23%) and the savings of the population materialized in time deposits reduced in real terms (by 16.9%) which shows the lack of trust in the national currency as a mean of keeping the savings.

The increase of the liquidity part of M2 and the decrease of time deposits can also be explained by the decrease of the opportunity cost of holding M1. The potential loss that the economic agents might have suffered as a consequence of holding cash balances (expressed by the interest rates at time deposits in ROL) reduced and was in some periods even zero under the real – negative interest rates conditions.

Consequently the agents preferred to hold a greater percentage of their incomes in cash and sight deposits, which increased the transactional demand for money.

Due to the lack of stimulation for time deposits in ROL, the agents chose alternative intruments such as FCY deposits (which increased in real terms although the interest rates decreased) and Tbills which had a positive real interest rate during the whole period.

The opportunity cost of holding M2 increased as the Tbills were in some periods the only instruments offering a positive real interest rate.

3. Survey of theories on demand for money

Money is the modern medium of exchange and the standard unit in which prices and debts are expressed. Basically, it serves four major functions-medium of exchange, store of value, unit of account and source of deferred payment. In general, demand for money is demand for real balances. Money demand theories have evolved over time and this section briefly touches upon the developments beginning from the classical tradition to the recent ones.

Classical Economics

Economists beginning from the classical tradition prevailed upon the four major functions as mentioned above to formulate their theories of money. According to the classical theory, all markets for goods continuously clear and relative prices flexibly adjust to ensure that the equilibrium is attained.

The economy is always in full employment levels except for the transitory deviations as a result of real disturbances. In such an economy, 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 his role. It also facilitates the exchange of goods (medium of exchange). However, it does not influence the determination of relative prices, real interest rates, the equilibrium quantities of commodities and thus aggregate real income. Money is "neutral" with no consequences for real economic magnitudes. Its role as a store of value is perceived as limited under the classical assumption of perfect information and negligible transactions costs.

The roots of the modern theory of money demand began to implant from the early contributions of Leon Walras whose money demand theory is simply a part of his general theory of economic equilibrium. Apart from Walras, there was little emphasis on money demand per se in the pre-1900 contributions of classical economists like Mill (1848) and the early 20th century neoclassical economists like Wicksell (1906) despite a clear recognition by these analysts that some particular quantity of real money holdings would be desired by the economic agents under a specified set of circumstances. The concept of money holdings began to take a formal shape in the quantity theory especially through the writings of Pigou (1917). Earlier, Fisher (1911) provided the famous formulation of quantity theory through the so-called equation of exchange.

Quantity Theory

The quantity theory brings forth a direct and proportional relationship between the quantity of money and the price level. This relationship was developed in the classical equilibrium framework by two alternative but equivalent expressions. The first version called "equation of exchange" is associated with Irving Fisher of Yale University and the second "Cambridge approach or cash balance approach" is associated with the Cambridge University economists, especially A.C. Pigou. Both versions are primarily concerned with money as a means of exchange, and hence, they yield models of the transaction demand for money. While Fisher (1911) concentrated on institutional details of the payment mechanism in his analysis, Cambridge economists focused on motives for holding money by individuals.

Fisher's "equation of exchange"

In the classical quantity theory, demand for money was not even mentioned, instead what stressed was a concept called "transaction velocity of circulation of money" which measures the average number of times a unit of money is employed in carrying out transactions in the given period. This approach associated with Fischer (1911) is based upon the "equation of exchange" $M_S V_T = P_T T$, which relates the quantity of money in circulation M_S to the volume of transactions T and the price level of articles traded P_T in a given period through the proportionality factor V_T called the "transaction of velocity of circulation". This equation is not an identity rather an equilibrium condition. Money is held only to facilitate transactions and has no intrinsic utility.

Referring to Fischer's writings, Schumpeter (1954) has pointed out that in the equation of exchange M_S is normally the most important "active" variable and P_T is the "passive" element. Although, M_S, V and T are only "proximate causes" of P_T, there are scores of other variables which act through M_S, V and T on P_T. The velocity variable incorporates the technological factors and institutional arrangements of the monetary system governed by non-monetary factors and is assumed to be stable in the short run.

The quantity of money is assumed to be determined independent of other variables shown in the quotation so is the employment equilibrium, it is assumed that there exists a stable ratio between the level of transaction and the output. Given these considerations, the equation of exchange can be shown as $\overline{M}_S \, \overline{V}_T = P_T\overline{T}$, where bars over M_S, V_T and T signify that the these variables are determined independently of others. It is evident from this framework of treating $\overline{M}_S$ exogenous and holding $\overline{V}_T$ and $\overline{T}$ constant, the equilibrium price level moves in strict proportion to the quantity of money, that is, money is "neutral".

Cambridge approach

An alternative paradigm to the quantity theory relates the quantity of money to nominal income and stresses the role and importance of money demand in determining the effect of money supply in the price level. This so-called Cambridge approach or cash balance approach, is primarily associated with the neoclassical economist Pigou, in particular, and Marshall (1923), among others associated with the Cambridge University.

Three issues are different in the cash balance approach compared to the earlier one. First, the emphasis is made on individual choice rather than on market equilibrium. The Cambridge University economists asked what determines the amount of money an individual agent would wish to hold given that the desire to conduct transactions makes money holding attractive at all in contrast to the earlier approach by Fisher, who raised the question what determines the amount of money an economy needs to carry out a given volume of transactions.

That is, the focus has changed from a model where V was determined by the payment mechanism to one where agents have a desired demand for money. Second, money is held not only as a medium of exchange as in Fisher's case, but also as a store of value that provides satisfaction to its holder by adding convenience and security. And third, the concept of money demand comes across more explicit as discussed below. In this connection, Cambridge economists pointed out the role of wealth and the interest rate in determining the demand for money.

When formalizing the model, particularly Pigou, chose to simplify it by assuming that, for an individual the level of wealth, the volume of transactions and the level of income-over, short periods at least-move in stable proportions to one another. When other things are being equal, the demand for money in nominal terms (M_d) is proportional to the nominal level of income (P_y) for each individual and hence for the aggregate economy as a whole, that is $M_d = k\ P_y$. It was recognized that k might depend on other variables in the consumer allocation problem such as the interest rate and wealth, but the main focus was the level of transactions.

Incorporating the money market equilibrium condition of M_s=M_d and equivalent expression of $M_s * (1/k) = M_sV = P_y$ can be obtained. Since M_s=M_d=M in equilibrium, the equivalent expressions leads to the familiar quantity theory formulation of MV=P_y relating the quantity of money to the nominal income. Unlike in Fisher's formulation V is termed here as the "income velocity of circulation", determined by technological and institutional factors and is assumed to be stable. Given that the real income y is at the full employment level and V being fixed, an increase in the quantity of money results in a proportional increase in P – that is, money is "neutral", the famous quantity theory exposition.

The Cambridge formulation of the quantity theory provides a more satisfactory description of monetary equilibrium within the classical models, focusing on the public's demand for money, especially the demand for real money balances, as the important factor determining the equilibrium price level consistent with a given quantity of money. The emphasis the Cambridge formulation places on the demand for money is notable because it influences both the Keynesian and Monetarist theories. Most importantly, the analytical thinking has been redirected from the institutional factors and the needs of the community at large, to the individual behavior of choice.

Other Neoclassical Approaches

The neo-classical economists considered the primary role of money as a medium of exchange. It was sought for the command over goods and services that provided. Money was economically interesting as it was spent and circulated throughout the system. Its store of, value function was also emphasised. One shortcoming, however, was that there was no explicit role for interest rates in determining the demand for money in their writings. They attributed rather various other factors affecting the demand for money. For example, Mashall and Pigou suggested that the uncertainty about the future was a factor influencing the demand for money Canon postulated a negative relationship between money demand and the anticipated inflation, which was recognised by Marshall.

Previously, the Cambridge economists implicitly stated the potential importance of the interest rate as a key variable affecting money demand by the term “other things being equal”, where, the factor k in the Cambridge model as discussed above contained possible influence of the rate of return on alternative assets. Lavington identified the interest rate as a key determinant of the marginal opportunity cost of holding money, that Fisher (1930) later concurred. Hicks (1935) argued that the money demand theory should be built within a framework of traditional value theory, in which money demand is the outcome of a problem of choice among alternative assets subject to a wealth (balance sheet) constraint and hence, is influenced mainly by anticipations of yields and risks of these assets as well as by the transactions costs. However, it was Keynes who provided a convincing explanation on the importance of the interest rate variable affecting money demand and emphasized the significance for macroeconomic analysis of the interest sensitivity of money demand, “liquidity preference”.

Keynesian Theory

Keynes provided a more rigorous analysis than his predecessors and looked at the money demand issue in a completely different analytical angle. When the classical and neoclassical economists analyzed the money demand mainly in terms of “money in motion” that is, there is no boarding possibility as all income is spent, Keynes analyzed money in terms of “held” (as in Cambridge approach of the quantity theory) and focused on the motives that lead people to hold money and the money demand arising from these motives. In this respect, Keynes associated himself with the Mercantilist views.

Keynes postulated that the individuals held money with three motives: transactions, precautionary and speculative. The transactions motive is similar to the emphasis of quantity theories placed on money as a medium of exchange. He theorized that the level of transactions conducted by an individual, and also by the aggregate of individuals bears a stable relationship to the level of income thereby suggesting that the “transactions demand” for money depends on the level of income.

The transactions demand for money arises because of the nonsynchronization of payments and receipts. Individuals are also uncertain about the payments they might want, or have to make. He hypothesized that this precautionary motives also creates a demand for money. Therefore, the precautionary demand for money provides a contingency plan for unscheduled expenditures during unforeseen circumstances. Money serves as a medium of exchange in this motive, and by and large, it depends on the level of income as well. His significant contribution to the money demand theory, however came from the role the speculative motive plays.

The speculative demand for money is what Keynes called as “liquidity preference”. Keynes tried to formalize one aspect of the suggestions earlier made by Marshall and Pigou that uncertainty about the future was a factor influencing the demand for money. Instead of talking uncertainty in general , Keynes focused on one economic variable the future level of the interest rate, in specific, the future yield on bonds.

The store-of-value function is emphasized in the speculative motive of the demand for money. Individuals can hold their wealth either in money or in bonds. The price the individuals are willing to pay for bonds depends on the rate of interest as the respective buyers would wish to earn at least the going rate of interest on their bond portion of their portfolio. Keynes argued that, at any time, there was a value, or perhaps a range of values, of the rate of interest that could be regarded as normal. When the rate is above this normal range there is a tendency for people to expect it to fall, and rise when the rate is below this range.

For an individual agent with given and precise expectations about the future value of the interest rate, the speculative demand for money is a discontinuous function of its current level. However, for the economy as a whole, people may have different expectations about the rate of change of the interest rate toward their own precise estimates of its future value. Provided that there is some diversity of opinion about the expected rate of interest at any moment, and the money and bond holdings at each agent are insignificant relative to the total amount in the economy, the aggregate speculative demand for money function becomes a smooth and negative function of the current level of the interest rate.

Thus the interest rate was formally introduced in the money demand function and the function now can be represented as $m^d = f(y,i)$, where the demand for real money balances m^d is a function of real income y and interest rate i. Thus the Keynesian theory of money demand, like his predecessors, is a theory of demand for real money. The major implication of the Keynesian analysis is that when the interest rate is very low, everyone in the economy will expect it to increase in the future, and hence, prefers to hold money whatever is supplied. At this stage, the aggregate demand for money becomes perfectly elastic, with respect to the interest rate. The economy gets into a situation called "liquidity trap" in which the interest elasticity of money demand can be infinite at low levels of interest rate.

Upon Keynes' contribution to the theory of money demand researchers put forward a number of other theories by including both income and interest rates as arguments to examine the nature and the determinants of the money demand functions. These theories implicitly address a broad range of hypotheses by emphasizing the transactions, speculative, precautionary, or utility considerations of holding money. The following subsection discusses briefly major aspects of these theories.

Post-Keynes Theories of Money Demand

Two characteristics of money provide the starting point for any of these theories. The medium of exchange function leads to transactions models of which inventory models assume the level of transactions to be known and certain, and the precautionary demand models treat net inflows as uncertain. The store-of-value function gives rise to asset or portfolio models where money is held as part of the portfolio of assets of the individuals. Thus the special characteristics of money lead to formulation of theories that are based on explicit motives for holding it. There are also theories which ignore the motives aspect altogether but instead assume that people do hold money, and analyze the demand for money in a general consumer demand theory framework. The discussion begins with the inventory-theoretic models.

Inventory-theoretic approach

Baumol (1952) and Tobin (1956) used this approach to develop in a deterministic setting a theory of money demand in which money was essentially viewed as an inventory held for transactions purposes. Although liquid financial assets other than money offered higher yields, the transactions costs of going between money and these assets justified holding such inventory. These models assume the presence of two stores of value (money and an interest-bearing alternative asset), a fixed cost of making transfers between money and the alternative asset, and exogenous receipt and expenditure streams. All payments are made with money and all the relevant information is assumed to be known with certainty.

The household's portfolio problem, therefore, involves balancing of two component factors: one is that earning assets pay interest while money does not and the other is that money, however, is required to make transactions due to lack of synchronization between receipts and expenditures. Brokerage costs may be incurred when earning assets must be sold to finance a transaction. Consequently, higher average holdings of money help minimize such transaction costs, but also mean greater forgone earnings of interest. Therefore, even though the holdings of assets may be for shorter periods, the interest earnings may be worth the cost and inconvenience of financial transactions involved.

The optimal transaction frequency, therefore, involves a balance between the increase in transaction costs and the reduction in interest costs. The agents minimize the sum of brokerage costs and interest income forgone. These models lead to a well-known, "square-root" formula" $m^* = \sqrt{(a_0 y)/2r}$, which says that optimal demand for real money balances (m^*) is directly proportional to transactions costs (a_0) and real income (y), and inversely proportional to the interest rate (r).

Another class of models that emphasizes the transaction role of money is the “cash-in-advance models”. These are equilibrium models which incorporate a specific sort of restriction that purchases in a given period should be paid for by currency brought in from the previous period. This type o limitation is commonly known as “call-in-advance constraint” (from the fact that the buyers need cash in advance) or “Clower constraint” (bearing the researcher’s name who first developed this type of constraint). It provides an alternative for including money in the utility function and offers an intuitively appealing and simple analytical tool to investigate why rational agents may hold money. Lucas (1980) made seminal contributions in developing the cash-in-advance models to provide micro foundations for money and to extend the theoretical support for transactions demand for money. He incorporated the optimizing behavior of individuals as discussed in Baumol and Tobin and the cash-in-advance constraint in a macroeconomic equilibrium setting to study the transactions demand for money.

Although there are many variations exist, in general, the cash-in-advance models have the following five elements: first, there are a large number of identical agents deriving utility, over time by consuming goods; second, the agents have certain environments which are allowed to trade with other agents for money that was brought in from the previous period; third, the total amount of consumption goods acquired should not exceed the total amount of money, thus the available money establishes a ceiling for the goods to be consumed; fourth, the trading is conducted according to some strict rules regarding the time, place, and interval of trading; and fifth, in equilibrium, total amount of production equals consumption and the demand for money is exclusively the transaction demand.

However, there are a number of problems associated with this theoretical apparatus. First of all, it failed to provide a convincing explanation why people use money or what objects circulate as money, in short, it could not provide the micro-foundations for money which it intended to do. It also put severe restrictions in terms of timing and interval of transactions. As the cash-in-advance constraint puts a strict upper limit on purchases during a given period, the demand for money tends be less sensitive to interest-rate changes.

Since introducing uncertainty in the model brings in not only the transactions demand for money but also the precautionary and demand for money as a store of value, McCallum and Goodfriend (1987) proposes a “shopping-time” model to bring out the medium-of-exchange role of money more explicitly.

Precautionary demand for money approach

As next to the transactions motive, people do hold money for the precautionary motive. The precautionary demand for money arises because people are uncertain about the payments they might want, or have, to make (Whalen (1966)). In this framework, the more money an individual holds, the less likely he or she is to incur the costs of illiquidity. But the more money the person holds, the more interest he or she is giving up. Therefore, the person optimizes the amount of precautionary cash balances to hold by carefully weighting the interest costs against the advantages of not being caught illiquid.

The precautionary money demand models are developed by relaxing the assumption underlying the inventory models that receipts and payments are known with certainty. However, the probability distribution of receipts and expenditures are assumed to be known. For example, Miller and Orr (1966 and 1968) applied a stochastic framework for the inventory models by assuming a random flow of receipts and expenditures. Patinkin (1965) assumed that an economic unit faces a given amount of net expenditures over a discrete interval, but the timing of cash inflows and outflows during the period is uncertain. The unit holds a precautionary cash balance to guard against the possibility of a string of cash outflows that would otherwise exhaust liquid resources during that period. One implication of the model is that an increase in the overall volume of transactions would lead to a less than proportional increase in money holding.

Money as an asset approach

Many theories have been put forth by treating money as an asset by emphasizing its store-of-value function. These so-called asset or portfolio models are often associated with the “Yale School” which view the demand for money in the context of a portfolio choice problem. The demand for money, in this framework, is interpreted more broadly as part of a problem of allocating wealth among a portfolio of assets that includes money with each asset generating some mix of explicit income and implicit (or non-pecuniary) service flows. Major emphasis is placed on risk and expected returns of the assets. In the case of money, the pecuniary yield includes the services such as the ease of making transactions (as the transactions models imply), in addition to rendering liquidity and safety (Judd and Scadding (1982)). These models are being developed to show the relationship between the interest rates and the demand for real money. They also consider the importance of wealth and liquidity as other key variables in determining the money demand.

As an alternative explanation for Keynes's original liquidity preference schedule arising from the differences in expectations of future interest rates, Tobin (1958) demonstrated that the theory of risk-avoiding behavior of individuals provided basis for the liquidity preference and for a negative relationship between the demand for money and the interest rate. Actually, the risk-aversion theory is based on the simple principles of portfolio management. In this framework, the risk/reward characteristics of various assets together with the taste of the individual determine the optimal portfolio structure which is obtained by maximizing the utility consistent with the available opportunities.

Tobin (1958) postulated that an individual would hold a portion of his/her wealth in the form of money in the portfolio because the rate of return on holding money was more certain than the rate of return on holding earning assets. Therefore, it is riskier to hold alternative assets in comparison with holding just money alone. The difference in riskiness may arise because government bonds and equities are subject to market price volatility, while money is not. In spite, the individual is willing to face this risk because the expected rate of return from the alternative assets exceeds that of money. Consequently, the risk-averse economic agents may want to include some money in an optimally structured portfolio.

However, Fischer (1975) has shown that the risk-aversion behavior of the economic agents alone does not provide a basis for holding money. It is primarily because money is not completely riskless as Tobin (1958) postulated above since it is subject to the risk of price level changes. There are other assets, such as time deposits, that have preciously the same risk characteristics as money but yield higher returns. The safe asset is, therefore, an indexed bond.

A class of models called "overlapping-generations models" also emphasizes the store- of-value function of money. Originally pioneered by Samuelson (1958), two classical macro economists, Thomas Sargent and Neil Wallace, among others brought these models to prominence in the 1980s. The overlapping-generations models are dynamic equilibrium models which emphasize the differing perspectives on saving of young and old individuals. For a simple exposition, the agents are assumed to live in two periods (periods 1 and 2) so that at any moment half the economy's population is young and the other half is old, enabling the generations to overlap.

Money is considered purely as an asset in these models with its medium-of-exchange function to facilitate current transaction being completely ignored; money, instead, makes it possible otherwise impossible intergenerational transactions. Each agent receives at birth a certain endowment of consumption goods, which are nondurable that cannot be stored for consumption in the next period. However, the endowment can be exchanged for money which can be stored between periods. In each period, the young exchanges some of its endowment of consumption goods for money from the old generation, thereby facilitating the older generation to smooth out its consumption across periods. Introduction of money in this framework has opened up the possibility of intergenerational trade which brings the benefits to all concerned.

It looks like money is playing the role of medium of exchange in these models, but it is the durability or its capacity to act as a store of value is facilitating the intertemporal shift of consumption possibilities. Thus, these models provide a vehicle to understand the demand for money as an asset rather than as a means of exchange. The major criticism, however, is that they fail to explain the observed tendency for agents to hold money when other assets exist which are devoid of nominal risks but pay positive interest rates.

Consumer demand theory approach

Alternatively, money is also analyzed under the consumer demand theory approach (Friedman (1956) and Barnett (1980)), where goods are held because the individuals derive utility from them. This approach is often associated with the "Chicago School" which considers the demand for money as a direct extension of the conventional theory of demand for any durable good.1o This was the case in "restatement of the quantity theory," in which, Friedman (1956) argues that the demand for assets should be based on axioms of consumer choice. He begins with the general demand theory as an explicit starting point by treating money as any other asset yielding a flow of services and using a broad measure of wealth (human and non-human) as the appropriate budget constraint.

Instead of asking what prompts the individuals to hold money as Keynes did, Friedman assumes that people do hold money as in the Cambridge approach of the quantity theory and analyzes how much money people want to hold under various circumstances. One minor difference is that the measure Friedman uses in his analysis corresponds to broad money while the earlier approach refers to narrow money. He went along with the views of the neo- Keynesians' portfolio approach of money demand where money was part and parcel of financial assets, but added further that the real goods should also be included in the portfolio as they yield a stream of services.

Consequently, he suggested that significantly broad range of opportunity cost variables including the expected rate of inflation (as a proxy for yield on real goods) have theoretical relevance in a money demand function. He also demonstrated wealth as a key determinant *of* money demand.

In the recent literature, the consumer demand theory approach has been playing a lead role in the area of monetary aggregation theory. The idea is that the calculation of monetary aggregates such as MI, M2, M3, and L as in the case of the United States (which may vary in other countries), use equal weights for their components. This procedure implicitly assumes that the different segments of nonbank public treat each component of the monetary aggregates they hold as perfect substitutes. In reality, however, the economic agents do not consider these components held in their portfolio as perfect substitutes as each component may have different opportunity cost. Hence, an alternative measure to construct the "consistent" aggregates will be applying weights appropriately that reflect the extent to which the assets provide liquidity and transaction services.

The weights are calculated based on the moneyness of assets or the substitutability among them by applying the principles of micro-economics. The assets formally enter as inputs into the production function of money services and are consistently aggregated based on their joint contribution to the output of money services. The greater the contribution the larger the weight the particular asset gets. The earlier impetus of this approach was provided by Chetty (1969) who employed a constant elasticity of substitution production function to find the degree of substitution between money and other financial assets. The elasticity estimates are then used to aggregate the money and other financial assets.

The recent papers by Anderson, Jones, and Nesmith show various new formulations and the aggregation techniques used to calculate the monetary aggregates. The aggregates are usually approximated by statistical numbers generated based on the theory of index numbers. One such common monetary aggregate frequently employed in the recent empirical literature is "divisia index".

Conclusion

So far we have traced the theoretical developments on money demand beginning from the classical tradition. In the classical school, money served as a numeraire. The quantity theory provided some important insights into the concept of money demand, especially through the writings of Pigou. The cash balance approach of the Cambridge University economists explicitly stressed the demand for money as public demand for money holdings and laid out the formal relationship between demand for real money and the real income.

Keynes built upon the Cambridge approach and developed the money demand theory based on explicit motives that prompt people to hold money and formally introduced the interest rate as an additional explanatory variable in determining the demand for real balances.

The post-Keynes economists developed a number of models to provide alternative explanations to confirm the formulation relating real money balances with real income and interest rates. The medium-of-exchange function of money led to the inventory-theoretic formulation that emphasized the transactions costs under certainty and to the precautionary demand for money models that introduced the concept of uncertainty in otherwise transactions cost models. The cash-in-advance models further exemplified money's medium- of-exchange function.

The asset function of money led to asset or portfolio approach which evaluated the demand for money under the optimization of portfolio framework where money was held as part of a portfolio of many assets which inherently differed in the yield and risk characteristics. The overlapping generations models went to an extreme by completely ignoring money's medium-of-exchange role and emphasizing only the asset role does the money play. The consumers demand theory approach retained the characteristics of the portfolio approach but considered money as any other consumer good providing flow of services and analyzed the demand for it under the utility maximization framework. In short, all these models can be broadly lumped into three separate frameworks namely transactions, asset, and consumer demand theories of money.

The interesting point is while all these models analyzed the demand for money in different angles, the resulting implications are almost the same. In all instances, the optimal stock of real money balances is inversely related to the rate of return on earning assets, that is the interest rate, and positively related to real income. The differences, of course, arise in terms of using the proper transaction (scale) variable and the opportunity cost of holding money. The empirical analysis of money demand estimation takes this conclusion as a starting point.

Empirical perspective - Error-correction models

The ECMs have proved to be one of the most successful tools in applied money demand research. This type of formulation is a dynamic error-correction representation in which the long-run equilibrium relationship between money and its determinants is embedded in an equation that captures short-run variation and dynamics (see Kole and Meade (1995». The impetus came from the findings that in modeling the demand for money, due consideration be given not only in selecting appropriate theoretical set up and the empirical make up, but also in specifying the proper dynamic structure of the model.

Accordingly, the economic theory should be allowed to specify the long-term equilibrium while short-term dynamics be defined from the data. The new research shows that the dynamic adjustment process is far more complex than as represented in the PAMs and BSMs. In fact, one of the major reasons for the failure of these two types of models is that they severely restricted the lag structure by relying solely on economic theory or naive dynamic theory without thoroughly examining the actual data (and the underlying data generating process).

Work done by researchers like Hendry (1979 and 1985) constantly questioned whether the observed instability in the U.K. and the U.S. money demand functions could be a spurious phenomenon due to incorrect specification.4s Transformation of variables from levels into first differences to overcome the nonstationarity problem (and hence spurious regression problem) as carried out by Hafer and Hein (1980), Fackler and McMillin (1983), and Gordon (1984a) is not a solution because it loses valuable information on long-term relationship that the levels of economic variables convey.

There was also a constant tension in applied money demand work between the long-run equilibrium and short-run dynamics and the difficulty in specifying explicit plausible methods of expectations formations or dynamic adjustment. The cointegration and ECM framework seem to provide answers to these modeling, specification, and estimation issues. The cointegration technique, if carefully applied, allows inferences on the long-run relationship providing a firm basis for the investigation of short-run dynamics.

The ECM is shown to contain information on both the short- and long-run properties of the model with disequilibrium as a process of adjustment to the long-run model. Granger (1983 and 1986) has shown that the concept of stable long-term equilibrium is the statistical equivalence of cointegration. When cointegration holds and if there is any shock that causes disequilibrium, there exists a well defined short-term dynamic adjustment process such as the error-correction mechanism that will push back the system toward the long-run equilibrium. In fact, cointegration does imply the existence of a dynamic error-correction form relating to variables in question.

Since the long-run specification is based on the theory and the short-run behavior is modeled after carefully examining the underlying data generating process, the model formulation is not standard across the board but may differ from case to case. As they have demonstrated their ability to incorporate the difficult empirical issues in modeling and estimating money demand and showed the richness in their implications, the ECMs have attracted significant research interest among the economists from around the world. They also encompass previously discussed models as restrictive cases. Consequently, within the past decade, the estimation of cointegrating relationship together with largely unconstrained dynamic adjustment processes have become a useful generalization of the PAMs and the BSMs that dominated the literature in the 1970s and early-1980s.

Arize and Shwiff (1993) summarize the desirable properties of the ECM as follows: "First, it [ECM] avoids the possibility of spurious correlation among strongly trended variables. Second, the long-run relationships that may be lost by expressing the data in differences to achieve stationarity are captured by including the lagged levels of the variables on the right-hand side. Third, the specification attempts to distinguish between short-run (first-differences) and long-run (lagged-levels) effects. Finally, it provides a more general lag structure, which does not impose too specific a shape on the model.

There is a growing literature on the application of cointegration with or without ECM to examine the demand for various definitions of money in the past ten years. One major contribution of this new procedure is that it allows the researchers handle the question on the appropriate formulation of the dynamic elements of the model independent of the specification of long-run parameters.

In the money demand literature, these techniques initially were applied to examine the demand for money in the United States and United Kingdom as traditionally these countries dominated the research on money demand. A significant degree of additional effort was directed in these countries to explain the instability of money demand observed in the 1970s.

The new techniques were also used, to certain extent as in the case of previous models, for studies dealing with other industrial countries as the central banks in these countries have always been interested in analyzing the demand for money because of its implications in conducting the monetary policy.

The ECM approach received only scant attention to analyze the demand for money in developing countries in the 1980s with some exceptions such as Domowitz and Elbadawi (1987) on Sudan, Arestis (1988a) for a group of small developing economies, and Gupta and Moazzami (1988, 1989, and 1990) for Asia. With the encouraging results from these earlier studies researchers expanded their focus to analyze the demand for money in a wide range of countries. Table AI summarizes the salient features of selected papers analyzing the demand for money for a number of countries, especially in developing world, using this approach.

The earlier ECMs on money demand tended to be based on bivariate cointegrating relationship between money and the chosen scale variable as developed by Engle and Granger (1987). However, further research suggested that multivariate cointegrating vectors encompassing a broader number of variables provided a fuller characterization of the long-run determinants of demand. The specification of such multiple cointegrating vect9rs between nonstationary variables primarily employs the procedures developed by Johansen (1988) and Johansen and Juselius (1990) which make the original Engle-Granger framework as a special case.

In terms of the study objectives, majority of the papers were interested in estimating cointegrating relationships and setting up appropriate short-run dynamic ECMs. Only a very few focused on estimating just the long-run cointegrating relationship (see Hafer and Jansen (1991), Eken and others (1995), Haug and Lucas (1996), for example). With regard to estimation techniques, the two widely used approaches are Engle and Granger (1987); and Johansen (1988) and Johansen and Juselius (1990). Within these two procedures, the latter has become more prominent as it provides an opportunity to evaluate the presence of multiple cointegrating vectors and has shown that it is more efficient than the former.

The former approach was used only in a few studies especially during the early part of the 1990s (although, not shown in the table, this technique was very commonly employed in the studies done in the 1980s). In a way, the papers published in the mid- to late-1980s exclusively used the former procedure. The research papers came out in the end-1980s and beginning of the 1990s applied both procedures. The recent papers most often apply multivariate procedures especially of Johansen (1988) and Johansen and Juselius (1990).

The most common unit root test is the augmented Dickey-Fuller (ADF) test although the number of lags to start with varied across studies. The other unit root tests such as Dickey-Fuller (DF), Kwiatkowski, Phillips, Schmidt, and Shin (KPSS), Phillips and Perron, and CRDW also received some attention. In terms of results, majority of the papers did find cointegrating relationship between the monetary aggregates and the arguments of the money demand function. The caveat, however, is that sometimes conflicting results were obtained from different tests being used. One important finding is that generally a stable relationship between money and its arguments is obtained. The Chow test was primarily used for examining the stability.

It is interesting and surprising to find stable money demand relationships considering the big debate on monetary instability of the 1970s. A point worth noting is that by applying the new ECM framework some studies have even concluded that the demand for broad money in Japan, the United Kingdom, and the United States remained stable during those years which the overwhelming past research employing the conventional models identified as the period of monetary instability (see Rose (1985), Baba, Hendry, and Starr (1988), Hendry and Ericsson (1991b), and Mehra (1993) for the United States; Corker (1990) and Yoshida (1990) for Japan; and Adam (1991), Hendry and Ericsson (1991b) for the United Kingdom). These observations just confirm that indeed the earlier models did suffer from specification problems and the ECM models provide an appropriate framework to model the money demand.

Conclusion of ECM

Significant amount of work has been done in estimating money demand functions both in developed and, increasingly, in developing countries as discussed in the section. The empirical work begins with an objective that for a stable money demand function it is imperative to have as fewer arguments as possible linking money with the real sector. The literature review confirms the earlier theoretical assertion that the major determinants of money demand are scale variable and opportunity cost of holding money which are represented by various alternatives.

Since the availability and definitions of monetary aggregates vary among countries, the typically employed aggregates included narrow and broad money. The narrow money usually represented by M1 and the broad money by M2, M3, M4, M5, among others. A number of other aggregates in between these two broad categories are also used. Some studies also estimated the demand for individual components of these monetary aggregates (disaggregated by type of assets and by type of holders), while some others tried the divisia aggregates for the broad categories. The scale variable is represented by two broad choices namely income and wealth. Here again, possible representation for income comprised of GNP, GDP, NNP, national income, industrial output, and so on; and for wealth, permanent income, consumption expenditure, for instance.

For opportunity cost of holding money, the theory called for own rate and the return on alternative assets. However, the empirical work requires inclusion of some representative rate rather than focusing on any specific interest rate. For developing countries characterised by underdeveloped financial sector or those where the interest rates are regulated by government, the expected inflation enters as an additional variable or used as the only variable to represent the opportunity cost of holding money. In hyper-inflation countries, the expected inflation variable is solely used in place of any type of interest rates mainly because the rate of return on alternative financial assets is dominated by the rate of return on real assets.

The recently promising open-market economy models require to include some combination of appropriate exchange rates and foreign interest rates in addition to the variables discussed above. In fact, in the world of international capital and financial market integration, the recent studies indicate that the influence of international monetary developments on domestic money holdings should be explicitly taken into account in specifying the money demand function. This is true for both industrial and many developing countries.

Although different approaches are used, the error-correction models have now become the work horse of the money demand research and have proved to be successful. Hence, they have appeared to be the likely replacement of the partial adjustment specification that had dominated the money demand literature in the past. Another advantage of these models is that the possible endogeneity problem often encountered in the empirical research is avoided because each variable is considered as potentially endogenous. The importance of this technique is underscored by the fact that some researchers have concluded that the instability of money demand as noticed earlier under the partial adjustment scheme has disappeared under the error-correction framework.

Three important points come out of the analyses presented in the section.

First both the model specification and the estimation technique are equally important. With a well specified model and an estimation technique such as cointegration/error-correction model the recent research has shown that it is possible to obtain stable money demand function with meaningful parameter estimates.

Second, it is clear from across a wide range of countries that the real money balances are cointegrated with the traditional arguments in the money demand function and the dynamic process can be estimated so as to explain short-run fluctuations as well.

Third, recent studies are finding more and more evidence supporting the foreign influence on the domestic money demand function as national financial markets are increasingly integrated with the world economy and a number of countries follow flexible exchange rate regime.

4. Econometric background in approaching Vector Autoregressions, Unit Roots and Cointegration

Time Series Analysis

A time series is a sequence of numerical data in which each item is associated with a particular instant in time. In this paper we run a *multiple time-series analysis*, this is an analysis of several sets of data for the same sequence of time periods. The purpose of time series analysis is to study the dynamics or temporal structure of the data.

Stationary and Nonstationary Time Series

One way of describing a stochastic process (the word *stochastic* has a Greek origin and means "pertaining to chance") is to specify the joint distribution of the variable X_t. This is quite complicated and not usually attempted in practice . Instead, what is usually done is that we define the first and second moments of variable X_t. These are:

1. The mean: $\mu (t) = E (X_t)$
2. The variance: $\sigma^2 (t) = var (X_t)$.

One important class of stochastic processes is that of stationary stochastic processes. Corresponding to this we have the concept of stationary time series.

A time series is said to be ***strictly stationary*** if the joint distribution of any set of n observations $X(t_1), X(t_2), X(t_3), \ldots X(t_n)$ is the same as the joint distribution of $X(t_1+k), X(t_2+k), X(t_3+k), \ldots X(t_n+k)$ for all n and k. Substituting n = 1 we get $\mu (t) = \mu$ a constant and $\sigma^2 (t) = \sigma^2$ a constant for all t.

For a strictly stationary time series the distribution of X(t) is independent of t. Thus that is not just the mean and the variance that are constant, all higher order moments are independent of t.

In practice this is a very strong assumption and it is useful to define stationarity in a less restrictive way. This definition is in terms of first and second moments only. No assumptions are made about higher order moments. This is called the ***weak stationarity.***

The order of integration is the number of differencing operations it takes to make the series stationary.

Vector Autoregressions (VAR)

VARs, unit roots and cointegration are three major developments during the last two decades. The VAR model is a very useful starting point in the analysis of the interrelationships between the different time series. The literature on unit roots studies nonstationary time series which are stationary in first differences. The theory of cointegration explains how to study the interrelationships between the long-term trends in the variables.

When we have several time series we need to take into account the interdependence between them. Therefore we use the VAR approach which is just a multiple time-series generalization of the AR model.

The VAR model with only one lag in each variable (suppressing constants) would be:

$$Y_{1t} = \alpha_{11} * y_{1,\,t-1} + \alpha_{12} * y_{2,\,t-1} + \varepsilon_{1\,t}$$
$$Y_{2t} = \alpha_{21} * y_{2,\,t-1} + \alpha_{22} * y_{2,\,t-1} + \varepsilon_{2\,t}$$

In practice there would often be more than two endogenous variables and often more than one lag. In this case with k endogenous variables and p lags, we can write the VAR model in matrix notation as:

$$Y_t = A_1\, y_{t-1} + \ldots\ldots + A_p\, y_{t-p} + \varepsilon_t$$

where Y_t and its lagged values and ε_t are k*1 vectors and A_1 ,……. A_p are k*k matrices of constants to be estimated.

We can also express Y_{1t} (and Y_{2t}) as functions of the current and lagged values of ε_{1t} and ε_{2t}. These are known as the *impulse – response functions*. They show the current and lagged effects over time of changes in ε_{1t} and ε_{2t} on Y_{1t} and Y_{2t}.

One problem with VAR is the ***overparameterization***. Suppose that we consider say six lags for each variable and we have a small system with four variables. Then each equation will have 24 parameters to be estimated and we thus have 96 parameters to estimate overall. In this case other extensions using some restrictions on the parameters of the VAR models should be used.

Unit Root Tests – AD, ADF and PP tests

To illustrate the use of DF Test consider first an AR(1) process:

$$Y_t = \mu + \rho Y_{t-1} + \varepsilon_t$$

where μ and ρ are parameters and ε_t is assumed to be white noise. If the absolute value of ρ is greater than 1 the series is explosive. Therefore the hypothesis of a stationary series can be evaluated by testing whether the absolute value of ρ is strictly less than one. Both the DF and the PP tests take the unit root as null hypothesis $H_0 : \rho = 1$. Since the explosive time series do not make much economic sense , this null hypothesis is tested against the one-sided alternative $H_1 : \rho < 1$.

The test is carried out by estimating an equation with Y_{t-1} substracted from both sides of the equation:

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \varepsilon_t$$

where $\gamma = \rho - 1$, so that:

$$H_0 : \rho = 0, \qquad H_1 : \rho < 0.$$

The simple unit root test described above is valid only if the series is an AR(1) process. The ADF and PP tests use different methods to control for higher order serial correlation in the series by assuming that the y series follows an AR(p) process and adjusting the test methodology.

The ADF adds lagged difference terms of the dependent variable y to the right-hand side of the regression:

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \delta_1 \Delta Y_{t-1} + \delta_2 \Delta Y_{t-2} + \ldots + \delta_{p-1} \Delta Y_{t-p+1} + \varepsilon_t$$

This augmented specifiaction is then used to test:

$H_0 : \gamma = 0, \quad H_1 : \gamma < 0.$

The null hypothesis (H_0) in unit root tests is that of nonstationarity. In the theory of testing of hypothesis the null hypothesis and the alternative are not on the same footing. The null hypothesis is on a pedestal and it is rejected only when there is overwhelming evidence against it. That is why one uses a 5% and a 1% significance level.

Performing the ADF test yields two practical issues: first one should decide the number of lagged first difference terms to add to the test regression (selecting zero yields the DF test; choosing numbers greater than zero generate ADF test) and second the decision about whether to include other exogenous variables in the test.

While the ADF test corrects for higher order serial correlation by adding lagged differenced terms on the right-hand side, the PP test makes a correction in the t-statistic of the γ coefficient from the AR(1) to account for the serial correlation in ε .

The null hypothesis of a unit root is rejected against the one-sided alternative if the t-statistic is less than (lies to the left of) the critical value.

Cointegration and Error Correction Model

An important issue in econometrics is the need to integrate short-run dynamics with long-run equilibrium. The analysis of short-run dynamics is often done by first eliminating trends in the variables, usually by differencing.

Suppose $y_t \sim I(1)$ and $x_t \sim I(1)$. Then y_t and x_t are said to be cointegrated if there exists a β such that: $y_t - \beta * x_t$ is I(0). This is denoted by saying that y_t and x_t are CI (1,1).

What this means is that the regression equation

$$y_t = \beta * x_t + u_t$$

makes sense because y_t and x_t do not drift too far apart from each other over time. Thus there is a long-run equilibrium relationship between them. If y_t and x_t are not cointegrated, that is $y_t - \beta * x_t$ is also I(1), they can drift apart from each other more and more as time goes on. Thus there is no long-run relationship between them.

An ECM model is of the form:

$$\Delta y_t = \gamma * \Delta x_t + \delta * (y_t - \beta * x_t) + u_t$$

it relates the change in y to the change in x and the past period' s disequilibrium.

A VEC model is a restricted VAR that has cointegration restrictions so that it is designed to for use with nonstationary data that are known to be cointegrated. The VEC specification restricts the long-run behaviour of the endogenous variables to converge to their cointegrating relationship while allowing a wide range of short-run dynamics.

The coefficient δ measures the speed of adjustment.

Engle and Granger suggest estimating the cointegrating regression first (this is a static regression, that is a regression with no dynamics or lags) and then estimating the short-run dynamics through the ECM.

In the case of a multiplicity of cointegrated vectors we have an identification problem, and unless we have some extraneous information we can not identify the long-run equilibrium relationship. Each of them is a long-run equilibrium relationship and all linear combinations are equilibrium relationships. This need not worry us too much since cointegrated relationship need not necessarily have an exact economic meaning. The cointegrated relations are of value only in determining the restrictions of the VAR system.

5. The Determinants of Demand for Money in Romania

5.1. Data Description

We will consider the data from March 1997 till December 2001. All time series are based on monthly observations. This gives 57 observations. Although the series is a quite short one, by chosing this sample we tried to study the behaviour of the demand for money after the period at the beginning of 1997 when the market was liberalised.

The observed variables are described below:

ln_real_m1 = logarithm of real narrow money (M1) which includes currency in circulation outside the banking system and sight deposits at commercial banks of the non-bank economic agents. Expressed as a monthly average taken from the reports of the NBR and deflated by the CPI. (billion)

ln_real_m1 = logarithm of real broad money (M2) which includes narrow money M1 and time deposits at commercial banks of the non-bank economic agents. Expressed as a monthly average taken from the reports of the NBR and deflated by the CPI. (billion)

ln_rio = logarithm of the real output in the industrial sector (to approximate GDP). The RIO is calculated starting from yhe nominal output in the industrial sector deflated by IPI (Industrial Production Index) which reffer to real avriation and is taken from the NBR monthly reports. The nominal value is taken from the 1997 NBR statistics, as it ceased to be publicated since 1998.

int_rate_depos = monthly average nominal interest rate for deposits at commercial banks as reported in NBR statistics.

ln_fx_rate = logarithm of monthly average foreign exchange rate of ROL against USD. The monthly average exchange rates are reported by the NBR and are computed from the the actual daily exchange rate weighted with the value of transactions.

cpix = consumer price index computed by taking March 1997 as a basis.

inflation = monthly inflation rate computed from consumer price index.

All time-series are sesonally unadjusted in order not to affect the short-run dynamics.

5.2. Time-Series Properties and Cointegration Results

The basic model resulting from the literature survey in the third chapter can be summarised as follows:

$$(M^d / P) = f(y, R, I, e) \qquad (1)$$

where

M^d / P = demand for real money balances (either M1 or M2)

y = scale variable

R = rates of return

I = inflation rate

e = fx rate.

This specification represents the long-run real demand function which is assumed increasing in y, decreasing in those elements of R representing rates of return on alternative assets, increasing in rates of return associated with assets included in M, decreasing in I and also decreasing in exchange rate.

In the attempt to find a general long-run relationship between the real money balances and the above specified variables / determinants we will use the cointegration analysis using Johansen's procedure. The estimations will consider both M1 and M2.

There are some data issues and limitations that we should mention from the very begining.

The concepts of own rate of return and alternative assets rate of return refer to returns on assets from inside the selected money aggregate and from outside, respectively. Due to the fact that in Romania the Tbills operations have a very recent history (starting 1997) and data on monthly rates of return is available in NBR statistics only since January 1999, they couldn't be taken into consideration in the vector of returns. On the other hand the Romanian market is not enough developed as to offer the Tbills as a real alternative to holding M2.

That's why the only rate taken into consideration is the monthly average interest rate on deposits at commercial banks.

Following the traditional approach the equation (1) is specified in a log-linear form, with the exception of inflation and interest rate:

$$\ln(real\_M1) = a_0 + a_1 y_t + a_2 I_t + a_3 e_t + a_4 R_t + \varepsilon_t \qquad \textbf{(2a)}$$

$$\ln(real\_M2) = a_0 + a_1 y_t + a_2 I_t + a_3 e_t + a_4 R_t + \varepsilon_t \qquad \textbf{(2b)}$$

Unit Root Tests

The empirical investigation commences with an analysis of the time series properties. The augmented Dickey-Fuller test (ADF) is used to determine the order of integration of data for each variable. The results of the test are showed in Appendics. All the series are I(1) in levels and they turned out to be stationary in first differences, except the inflation which is I(0).

After determining the order of integration in the avriables of interest, the Johansen procedure is applied to a VAR version of equations (2a) and (2b) to test for cointegration among real narrow money, real industrial output, inflation, exchange rate and interest rate on deposits {eq. (2a)} and among real broad money, real industrial output, inflation, exchange rate and interest rate on deposits {eq. (2b)}.

Johansen Cointegration Procedure for Eq. (2a)

Owing to the short–length of the available time–series I began with a general four order (a quarter of the year) VAR and found on the basis of the Likelihood Ratio and Akaike criteria that the optimal number of lags to be included in the VAR is 4. This makes sense intuitively taking into account that the data is monthly and the sample is relatively short.

VAR Lag Order Selection Criteria

Endogenous variables: LN_REAL_M1 LN_RIO INFLATION LN_FX_RATE INT_RATE_DEPOS
Exogenous variables: C

Date: 06/13/00 Time: 06:36

Sample: 1997:04 2001:12

Included observations: 53

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-183.8987	NA	0.000858	7.128255	7.314131	7.199734
1	87.61926	481.5602	7.86E-08	-2.174312	-1.059052*	-1.745437*
2	121.7364	54.07244	5.72E-08	-2.518355	-0.473712	-1.732084
3	149.1735	38.30846	5.57E-08	-2.610322	0.363703	-1.466656
4	183.6294	41.60704*	4.45E-08*	-2.967146*	0.936263	-1.466083

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Lag Length Criteria computes various criteria to select the optimal lag order of an unrestricted VAR. The table displays various information criteria for all lags up to the specified maximum. The table indicates the selected lag from each column criterion by an asterisk "*". For columns 4-7, these are the lags with the smallest value of the criterion.

Akaike info criterion $AIC = T * \log |\Sigma| + 2 N$

Schwartz criterion: $SC = T * \log |\Sigma| + N * \log (T)$

where T = number of usable observations

$\log |\Sigma|$ = natural logarithm of the edterminant of Σ (variance/covariance matrix)

N = the total number of estimated parameters in the VAR

The sequential modified likelihood ratio (LR) test is carried out as follows. Starting from the maximum lag, test the hypothesis that the coefficients on lag l are jointly zero using the χ^2 statistics:

$$\text{Likelihood Ratio } LR = (T - m)\{\log|\Omega_{l-1}| - \log|\Omega_l|\} \sim \chi^2(k^2)$$

where m is the number of parameters per equation under the alternative. Note that we employ Sims' (1980) small sample modification which uses (T – m) rather than T. We compare the modified LR statistics to the 5% critical values starting from the maximum lag, and decreasing the lag one at a time until we first get a rejection. The alternative lag order from the first rejected test is marked with an asterisk (if no test rejects, the minimum lag will be marked with an asterisk).

Thus we found that for eq. (2a) the optimal numaber of lags in the VAR is 4.

We now test the existence of a cointegration realtionship between the variables in eq (2a).

Date: 06/13/00 Time: 07:22
Sample(adjusted): 1997:08 2001:12
Included observations: 53 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LN_REAL_M1 LN_RIO INFLATION LN_FX_RATE INT_RATE_DEPOS
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 **	0.545689	93.20905	68.52	76.07
At most 1 *	0.378232	51.39343	47.21	54.46
At most 2	0.238052	26.20844	29.68	35.65
At most 3	0.133898	11.79894	15.41	20.04
At most 4 *	0.075839	4.180037	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 **	0.545689	41.81562	33.46	38.77
At most 1	0.378232	25.18499	27.07	32.24
At most 2	0.238052	14.40949	20.97	25.52
At most 3	0.133898	7.618907	14.07	18.63
At most 4 *	0.075839	4.180037	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

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LN_REAL_M1	LN_RIO	INFLATION	LN_FX_RATE	INT_RATE_DEPOS
20.41036	-10.48804	-1.169868	1.696621	0.001301
-20.80493	5.820683	-0.682139	-2.493785	-0.009382
19.84872	-21.31519	0.398172	4.039212	-0.080074
-0.641112	9.673583	-0.556449	2.063839	0.293763
-3.988804	-2.335767	0.116647	-2.171784	0.028276

Unrestricted Adjustment Coefficients (alpha):

D(LN_REAL_M1)	-0.005388	0.020162	-0.025153	0.001085	-0.000593
D(LN_RIO)	-0.001719	0.014824	0.023038	-0.002129	-0.000674
D(INFLATION)	0.726786	-0.102925	0.076753	0.093578	-0.154504
D(LN_FX_RATE)	0.008490	0.001335	0.001375	-0.000120	0.002737
D(INT_RATE_DEPOS)	0.215663	-0.290756	-0.097853	-0.436238	-0.129298

1 Cointegrating Equation(s): Log likelihood 157.9327

Normalized cointegrating coefficients (std.err. in parentheses)

LN_REAL_M1	LN_RIO	INFLATION	LN_FX_RATE	INT_RATE_DEPOS
1.000000	-0.513859	-0.057317	0.083125	6.37E-05
	(0.11653)	(0.01133)	(0.02397)	(0.00225)

Both tests (maximal and trace eigenvalue statistics) found one cointegtating relationship between the variables at 1% significance level. This can be interpreted as defining the long-run edmand for narrow money function in Romania:

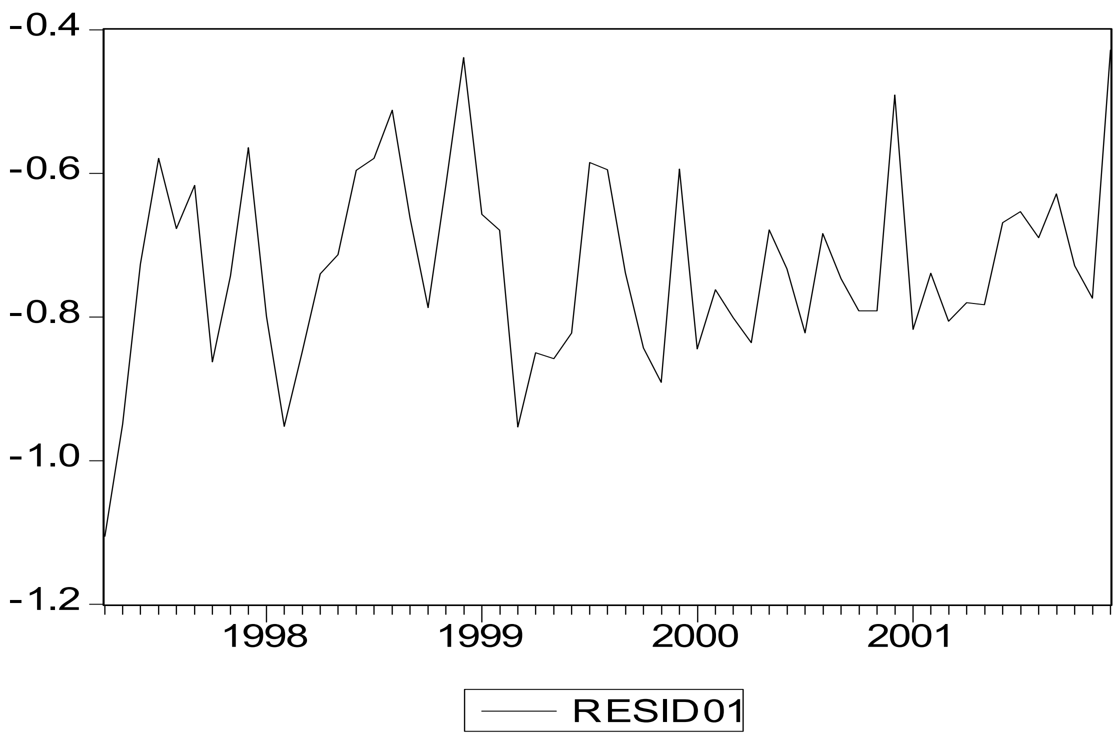
$$\textbf{ln\_real\_m1} = 0.5139 \cdot \textbf{ln\_rio} + 0.0573 \cdot \textbf{infl} - 0.0831 \cdot \textbf{ln\_fx\_rate} - 6.3 * 10^{-5} \cdot \textbf{int\_rate}$$

(rel. 3a)

We will compute the series of residuals from the long-run equilibrium relationship and test the resulting series for stationarity:

$$\textbf{Resid01} = \textbf{ln\_real\_m1} - 0.5139 \cdot \textbf{ln\_rio} - 0.0573 \cdot \textbf{infl} + 0.0831 \cdot \textbf{ln\_fx\_rate} + 6.3 * 10^{-5} \cdot \textbf{int\_rate}$$

Plot of the residuals from the long run relationship between lnrm1, ln_rio, inflation, ln_fx_rate and int_rate_depos



Unit root test for residuals series:

1 lagged differences

ADF Test Statistic	-5.415923	1% Critical Value*	-3.5523
		5% Critical Value	-2.9146
		10% Critical Value	-2.5947

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

2 lagged differences

ADF Test Statistic	-4.590447	1% Critical Value*	-3.5547
		5% Critical Value	-2.9157
		10% Critical Value	-2.5953

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

3 lagged differences

ADF Test Statistic	-3.720660	1% Critical Value*	-3.5572
		5% Critical Value	-2.9167
		10% Critical Value	-2.5958

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

As one can see from the tests we can reject the null hypothesis of unit root in the series of residuals even at 1% significance level which means that (rel. 3a) represents indeed a long run cointegration realtionship between the specified variables.

Johansen Cointegration Procedure for Eq. (2b)

Owing to the short–length of the available time–series I began with a general four order (a quarter of the year) VAR. On the basis of Akaike Criterion we found that the optimal number of lags to be included in VAR is 4, and even if the Likelihood Ratio shows 2 lags, we still chose 4 in order to be consistent with the first analysis regarding M1. On the other hand, this makes sense intuitively taking into account that the data is monthly and the sample is relatively short.

VAR Lag Order Selection Criteria
Endogenous variables: LN_REAL_M2 LN_RIO INFLATION LN_FX_RATE INT_RATE_DEPOS
Exogenous variables: C
Date: 06/13/00 Time: 09:15
Sample: 1997:04 2001:12
Included observations: 53

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-158.6558	NA	0.000331	6.175692	6.361569	6.247171
1	136.6908	523.8223	1.23E-08	-4.026066	-2.910806*	-3.597191*
2	169.4568	51.93103*	9.44E-09*	-4.319123	-2.274480	-3.532852
3	192.8074	32.60284	1.07E-08	-4.256884	-1.282859	-3.113218
4	223.0447	36.51290	1.01E-08	-4.454516*	-0.551108	-2.953453

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Thus we found that for eq. (2b) the optimal number of lags in the VAR is 4.

We now test the existence of a cointegration realtionship between the variables in eq (2b)

Date: 06/13/00 Time: 09:28
Sample(adjusted): 1997:08 2001:12
Included observations: 53 after adjusting endpoints
Trend assumption: Linear deterministic trend
Series: LN_REAL_M2 LN_RIO INFLATION LN_FX_RATE INT_RATE_DEPOS
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 **	0.400773	79.87141	68.52	76.07
At most 1 *	0.375992	52.72935	47.21	54.46
At most 2	0.266496	27.73494	29.68	35.65
At most 3	0.115473	11.30907	15.41	20.04
At most 4 *	0.086686	4.805825	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	0.400773	27.14206	33.46	38.77
At most 1	0.375992	24.99441	27.07	32.24
At most 2	0.266496	16.42587	20.97	25.52
At most 3	0.115473	6.503244	14.07	18.63
At most 4 *	0.086686	4.805825	3.76	6.65

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Max-eigenvalue test indicates no cointegration at both 5% and 1% levels

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LN_REAL_M2	LN_RIO	INFLATION	LN_FX_RATE	INT_RATE_DEPOS
-0.180791	2.805238	-1.463058	1.772399	0.084483
-17.04765	-10.14768	1.064546	1.279880	-0.057502
2.067824	2.271229	1.050768	1.499867	-0.063299
3.867933	-8.126808	-0.073988	-2.125792	-0.277601
51.07125	-13.21835	0.045248	-1.404742	-0.177058

1 Cointegrating Equation(s): Log likelihood 196.6800

Normalized cointegrating coefficients (std.err. in parentheses)

LN_REAL_M2	LN_RIO	INFLATION	LN_FX_RATE	INT_RATE_DEPOS
1.000000	-15.51645	8.092525	-9.803566	-0.467294
	(18.2027)	(2.34327)	(3.59352)	(0.34439)

As on can see from the result of the cointegration test there is little evidence of the existence of a cointegrating relationship between the time-series considered (real M2, ln_rio, inflation, ln_fx_rate, int_rate_depos). This observation is induced by the following elements:

- the trace test indicates only one cointegrating relationship at 1% significance level, but the max-eigenvalue indicates none;
- the normalised cointegrating equation posted by the cointegration test have coefficients with no economic significance.

These lead us to conclude that there is no cointegration between real M2 and the selected variables. This conclusion is not very surprising given the way than we constructed the model for M2 which is very unconsistent with the theory. The reason is the lack of statistical data for a rate that could be assimilated with an opportunity cost for holding M2.

5.3. Error Correction Model

The next stage in the process in the money demand model building is to to construct the Error Correction Model which captures the behaviour of the demand for money in the short-run. In the typical error correction model, the first-difference of the dependent variable, in this case the first-difference of logarithm of real narrow money, is regressed on the 1 lag lagged value of the error correction term (the residuals from the long-run relationship), lagged first-differences of time series from the long-run relationship and random disturbance.

The starting point is to model changes in real narrow money balances as a response to edpartures from the stationary linear combination of the I(1) variables , augmented by short-term dynamics from the current and algged first differences of the avriables included in the cointegrating vector.

From the VEC model we also get the *speed of adjustment* meaning the speed with which the past deviations from the equilibrium level are compensated in the current values.

Estimation Proc:
===============================
EC(C,1) 1 3 LN_REAL_M1 LN_RIO INFLATION LN_FX_RATE INT_RATE_DEPOS

VAR Model:
===============================
D(LN_REAL_M1) = A(1,1)*(B(1,1)*LN_REAL_M1(-1) + B(1,2)*LN_RIO(-1) + B(1,3)*INFLATION(-1) + B(1,4)*LN_FX_RATE(-1) + B(1,5)*INT_RATE_DEPOS(-1) + B(1,6)) + C(1,1)*D(LN_REAL_M1(-1)) + C(1,2)*D(LN_REAL_M1(-2)) + C(1,3)*D(LN_REAL_M1(-3)) + C(1,4)*D(LN_RIO(-1)) + C(1,5)*D(LN_RIO(-2)) + C(1,6)*D(LN_RIO(-3)) + C(1,7)*D(INFLATION(-1)) + C(1,8)*D(INFLATION(-2)) + C(1,9)*D(INFLATION(-3)) + C(1,10)*D(LN_FX_RATE(-1)) + C(1,11)*D(LN_FX_RATE(-2)) + C(1,12)*D(LN_FX_RATE(-3)) + C(1,13)*D(INT_RATE_DEPOS(-1)) + C(1,14)*D(INT_RATE_DEPOS(-2)) + C(1,15)*D(INT_RATE_DEPOS(-3)) + C(1,16)

VAR Model - Substituted Coefficients:
===============================
D(LN_REAL_M1) = - 0.1099725159*(LN_REAL_M1(-1) - 0.5138588964*LN_RIO(-1) - 0.05731737609*INFLATION(-1) + 0.08312549112*LN_FX_RATE(-1) + 6.374730187e-05*INT_RATE_DEPOS(-1) + 0.7239219843) - 0.6656549525*D(LN_REAL_M1(-1)) - 0.2265403831*D(LN_REAL_M1(-2)) + 0.2003159449*D(LN_REAL_M1(-3)) + 0.3566877817*D(LN_RIO(-1)) + 0.5400513137*D(LN_RIO(-2)) + 0.5087917017*D(LN_RIO(-3)) - 0.01905925299*D(INFLATION(-1)) - 0.007448293855*D(INFLATION(-2)) - 0.002961759247*D(INFLATION(-3)) + 0.4001598402*D(LN_FX_RATE(-1)) - 0.8777364931*D(LN_FX_RATE(-2)) + 0.5836489162*D(LN_FX_RATE(-3)) - 0.002446832921*D(INT_RATE_DEPOS(-1)) - 0.00109833907*D(INT_RATE_DEPOS(-2)) - 0.002284587567*D(INT_RATE_DEPOS(-3)) - 0.01029582013

Speed of adjustment : 0.11

The error correction term coefficient of (-0.11) suggest that convergence towards equilibrium is rather slow.

Testing the stability of the short-run relationship

We generate the series of the residuals of the errror correction equation Resid02 and test the way it responds to various tests.

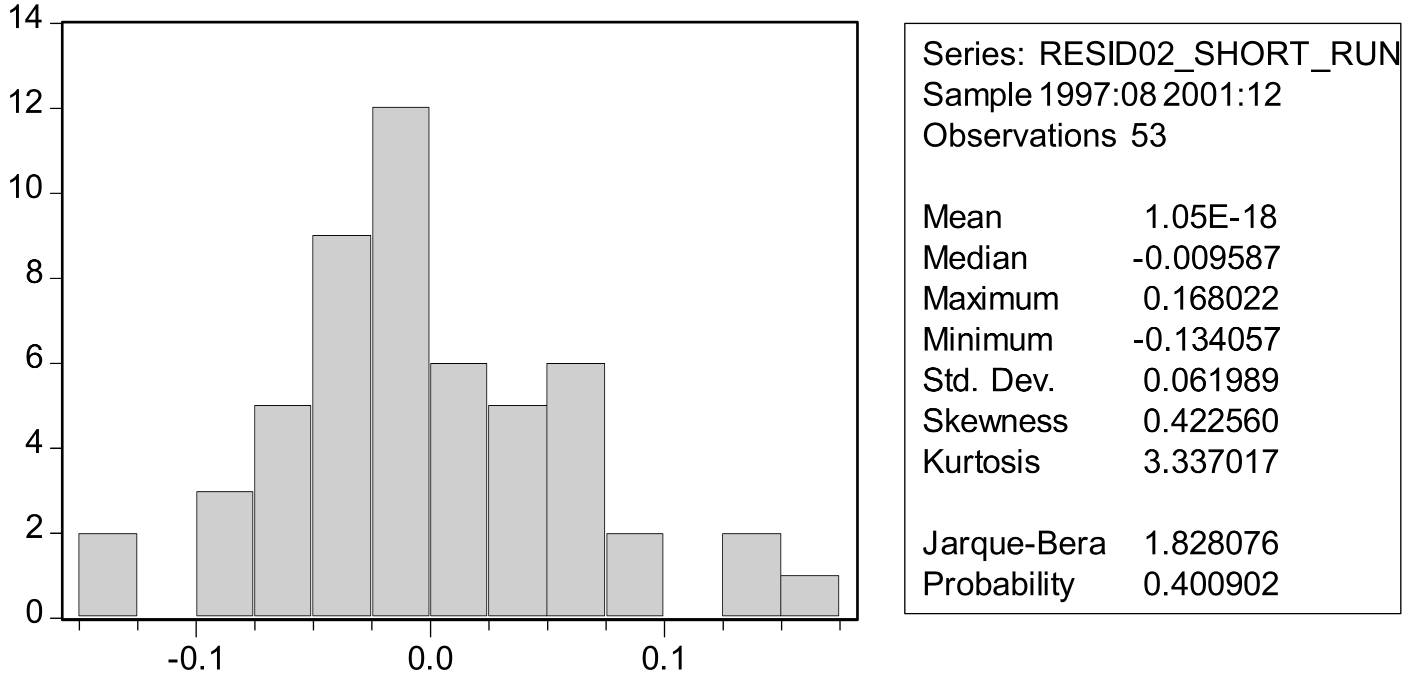
Correlogram of Resid02

Date: 06/13/00 Time: 10:46
Sample: 1997:04 2001:12
Included observations: 53

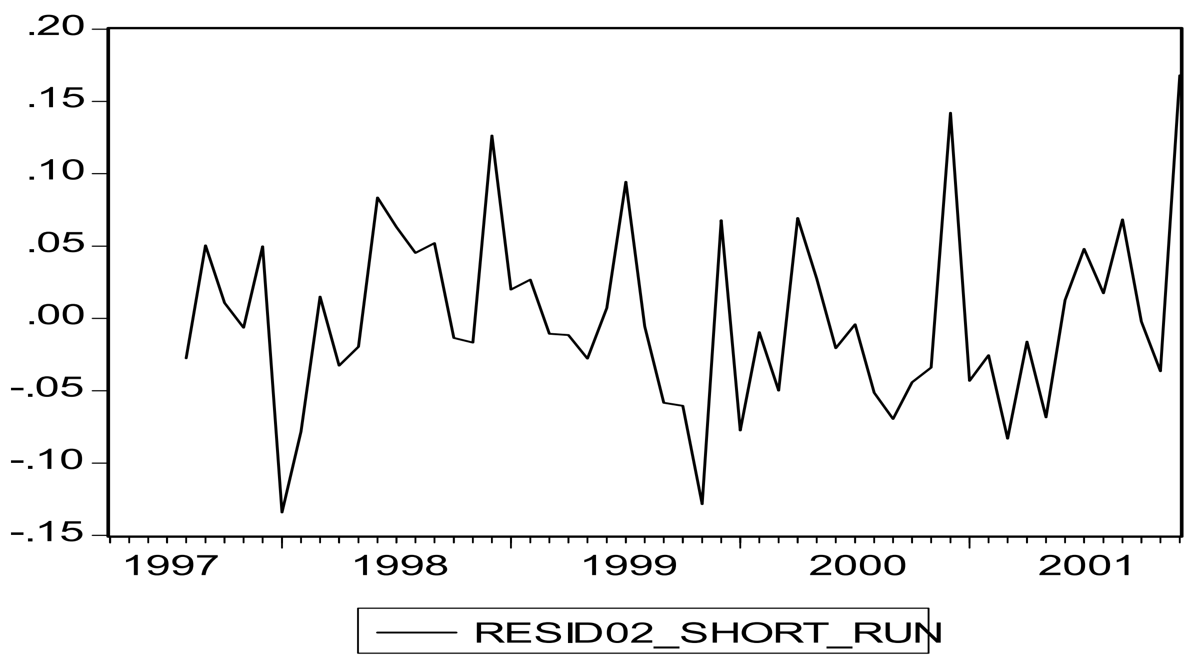
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	0.032	0.032	0.0577	0.810
. | . |	. | . |	2	0.046	0.045	0.1805	0.914
. | . |	. | . |	3	-0.028	-0.031	0.2275	0.973
.*| . |	.*| . |	4	-0.118	-0.119	1.0540	0.901
. | . |	. | . |	5	-0.022	-0.012	1.0828	0.956
. | . |	. | . |	6	0.050	0.063	1.2358	0.975
. | . |	. | . |	7	0.038	0.030	1.3255	0.988
. | . |	. | . |	8	0.005	-0.018	1.3272	0.995
. | . |	. | . |	9	-0.014	-0.020	1.3409	0.998
. | . |	. | . |	10	-0.039	-0.023	1.4424	0.999
**| . |	**| . |	11	-0.279	-0.272	6.8590	0.810
. |** |	. |*** |	12	0.300	0.345	13.253	0.351
**| . |	**| . |	13	-0.221	-0.301	16.800	0.209
.*| . |	.*| . |	14	-0.071	-0.072	17.182	0.247
.*| . |	.*| . |	15	-0.119	-0.170	18.265	0.249
. | . |	. |** |	16	0.041	0.209	18.395	0.301
. | . |	. | . |	17	0.042	-0.039	18.538	0.356
.*| . |	.*| . |	18	-0.072	-0.168	18.966	0.394
. | . |	. | . |	19	0.019	0.036	18.996	0.457
. | . |	. | . |	20	-0.008	0.028	19.002	0.522
. | . |	. | . |	21	0.004	0.039	19.003	0.585
. | . |	.*| . |	22	0.023	-0.138	19.051	0.642
.*| . |	. | . |	23	-0.168	0.025	21.780	0.534
. |*. |	. | . |	24	0.189	-0.047	25.357	0.387

The residuals series responds well to correlogram test (no autocorrelation).

Normality Test



Plot of the series of residuals Resid02



6. Implications and conclusions

We intended to estimate two cointegrating equations for real M1 and real M2 on a set of four variables known to influence the monetary aggregates.

The results we got on M1 is the following long-run relationship which we demonstrated to have nonstationary residuals:

$$\mathbf{ln\_real\_m1 = 0.5139 \cdot ln\_rio + 0.0573 \cdot infl - 0.0831 \cdot ln\_fx\_rate - 6.3 * 10^{-5} \cdot int\_rate}$$

The proposed long-run model suggests that real demand for narrow money depends on the income (real industrial output), inflation (with the reserve that also the actual high level of inflation has a significant impact), foreign exchange rate and in a less measure (obseravation valid only for the period studied) on interest arte on deposits.

We chose on purpose the sample 1997:4 - 2001:12 in order to laeve behind the peaks of inflation at the beginning of the year 1997 due to foreign exchange market liberalisation.

The coefficients in this regression are significant and can be interpreted as the long run elasticities.

The coefficient of logarithm of real industrial output has a positive sign, meaning that a increase of 1% in the industrial output generates an increase of 0.5139% in the demand for real narrow money. This is an expected result since based on the underlying theory the income (GDP) elasticity of money demand should be positive.

The sign of the coefficient of inflation is also positive, meaning that a increase in the inflation rate generates an increase in the demand for real narrow money. Although not expected, at least in a developed country, the sign of this coefficient has particular meaning in Romania and can be justified by:

- an increase in the stock of money holdings due to anticipated higher expenditure in the future given the increased level of prices
- the lack of alterantive assets which makes currency in circulation, deposits and real assets almost the only possible means of holding wealth.

The sign of the coefficient of logarithm of average nominal interest rate for deposits at commercial banks is neagtive (as expected, given that based on the underlying theory the interest rate elesticity of money demand should be neagtive) but it has a low absolute value, denoting that the agents didn't perceived during the studied period the interest rate at deposits as a guide for whether or not to keep their wealth in cash or deposits. This is also because in many periods the rael interest rate was negative.

The sign of the coefficient of logarithm of foreign exchange arte is neagtive, meaning that an increase of 1% in foreign exchange artes geneartes a decrease of 0.0831% in the demand for real narrow money. This result is expected . recalling that the foreign exchange rate is maesured as an amount of ROL to buy / sell one USD the theoretical work suggest that the depreciation of foreign exchange arte decreases the demand for money because it represents a cost of holding the domestic currency.

After estimating also the short-run relationship, we got the value of the error correction coefficient which is - 0.11. This coefficient means that if narrow money was below equilibrium in the previous period then it must hence be increased in the current period. The value of this coefficient indiactes a rather slow convergence towards equilibrium.

The impact of inflation and foreign exchange rate are similar (contrar signs, but almost equal absolute values) reflects the importance that the agents in Romania give to previous months inflation rates and to current fx rates in predicting the future evolution of the prices and hence in allocating their wealth among alternative assets.

The second long-run relationship that we intended to estimate was that between rael M2 and the same determinants as in the acse of real M1. The econometric results showed that there is no cointegration among them.

This conclusion is not very surprising given the way than we constructed the model for M2 which is very unconsistent with the theory. The reason is the lack of statistical data for a rate that could be assimilated with an opportunity cost for holding M2.

This variable shoul be in the most appropriate case the arte of return on Tbills, but there are several limitations in using this variable:

- although they have been issued even since 1994, data in the NBR statistics is available only since January 1999
- Tbills operations are not available for the individuals, but only for companies, which means that they are not a real alternative of investition.

Among the limitations of the model are the following:

- limited number of factors taken into consideration, especially the lack of different types of interest rates (different maturities, different products ex: Tbills). This can only be achieved with the development of the fianncial sector in Romania
- the speed of transformations in a tranzitional economy makes it unlikely to reach satble results with a high probability of being confirmed in time
- the short time-series considered, which can give little significance to the results.

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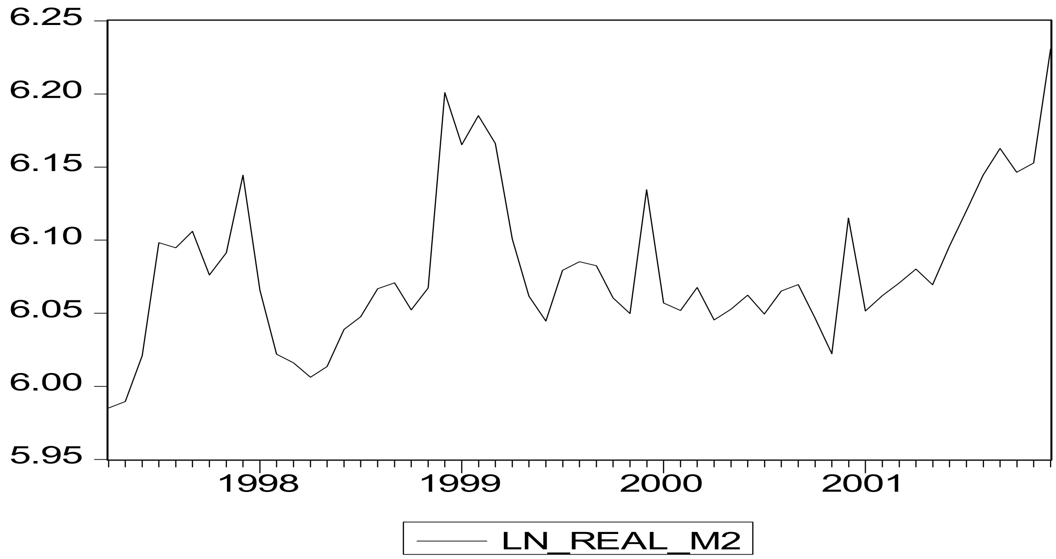
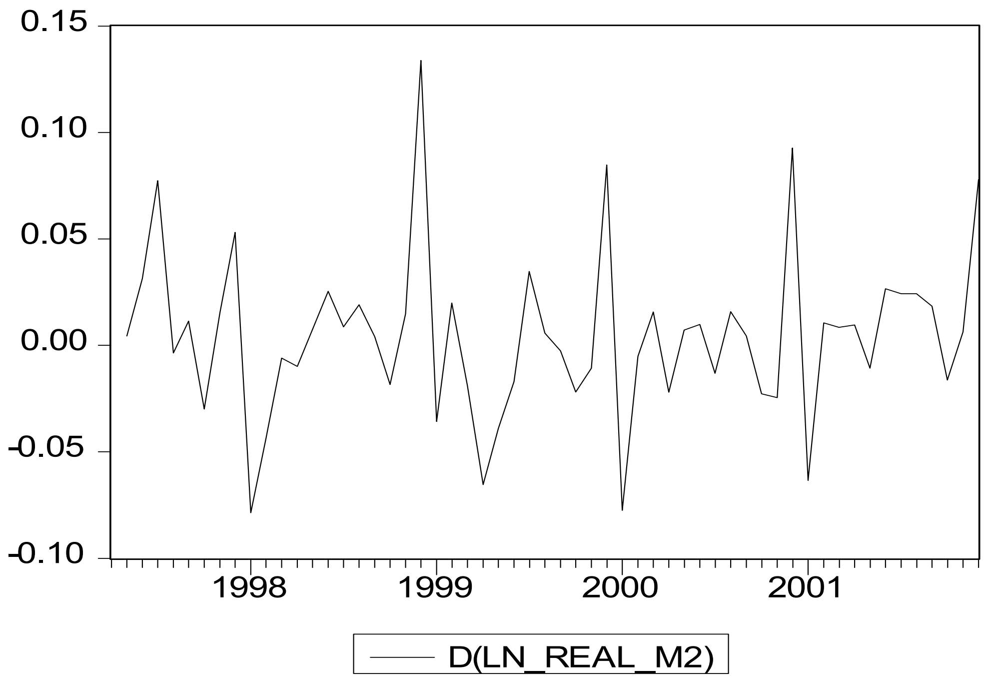
PLOT OF THE SERIES

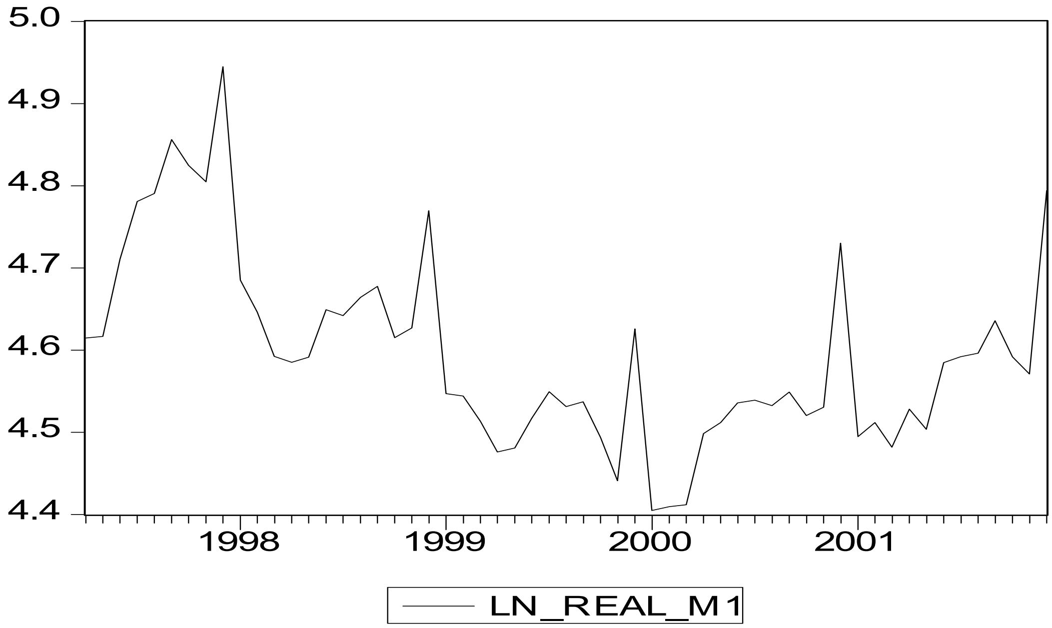
(all series are integarted of order 1 : I(1))

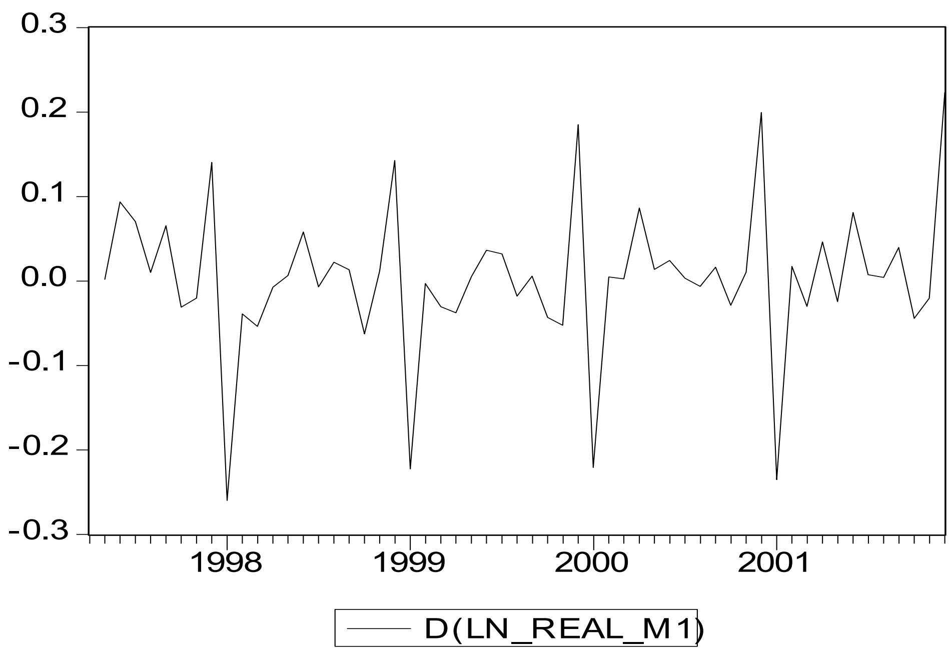
LN_REAL_M2 (level and first differences)



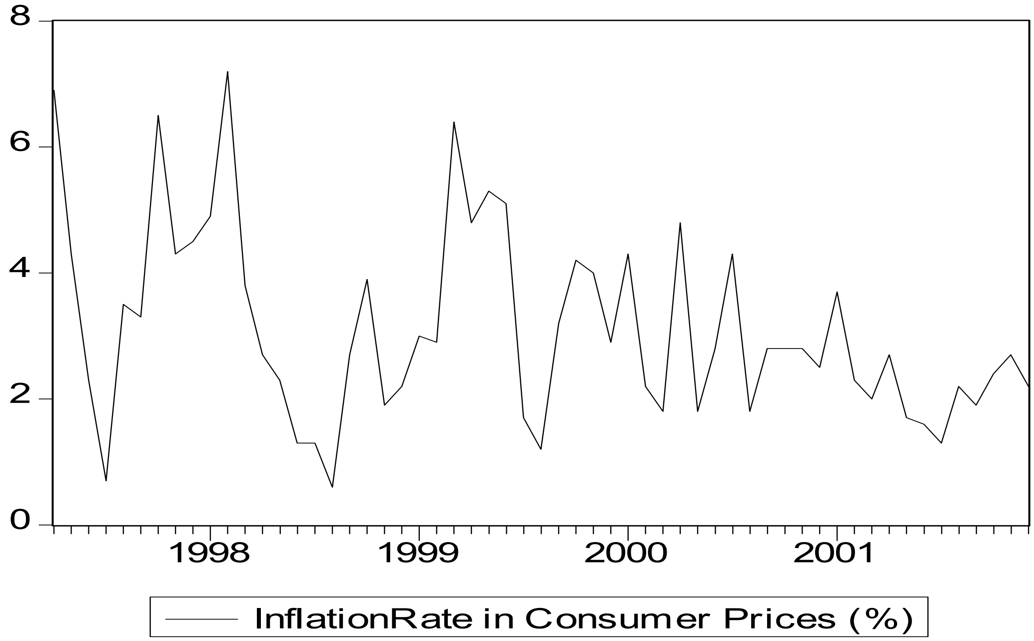


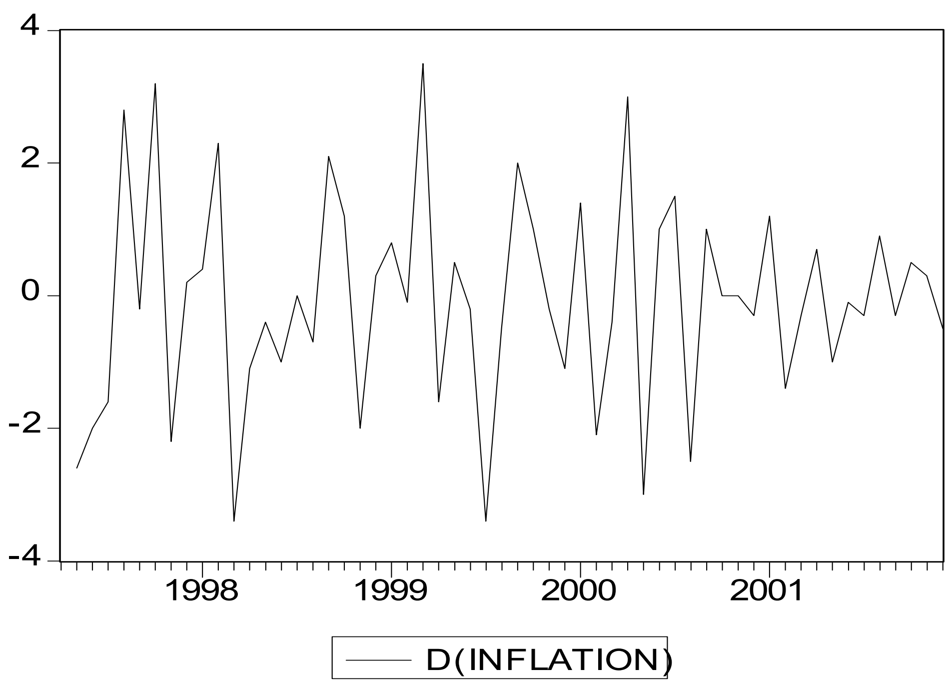
LN_REAL_M1: (level and differences)



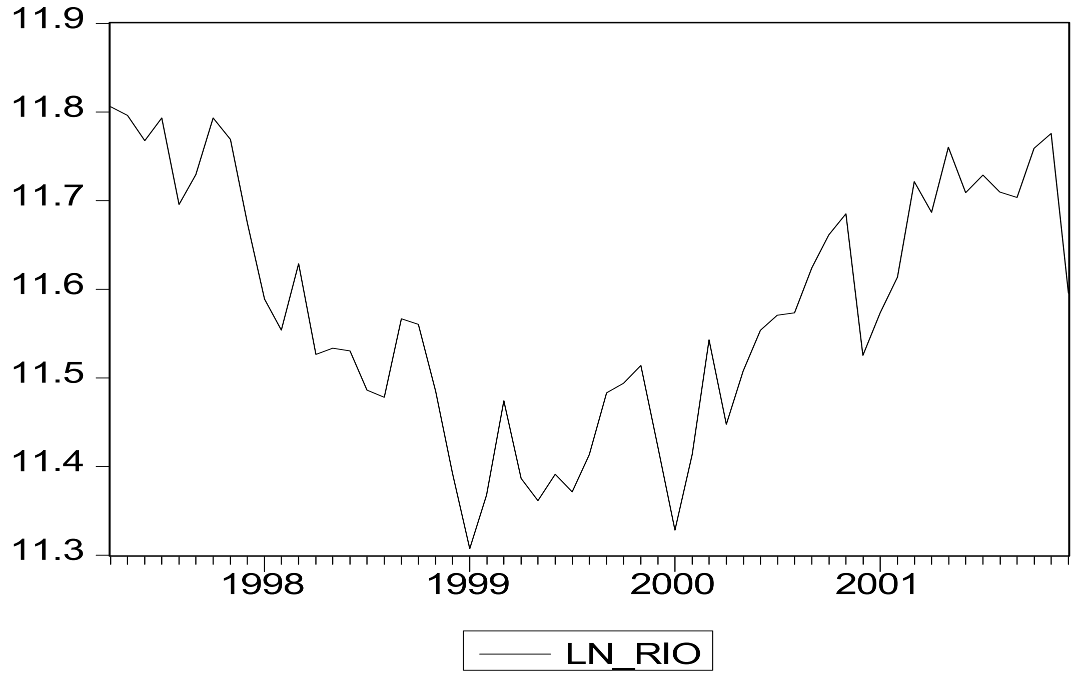


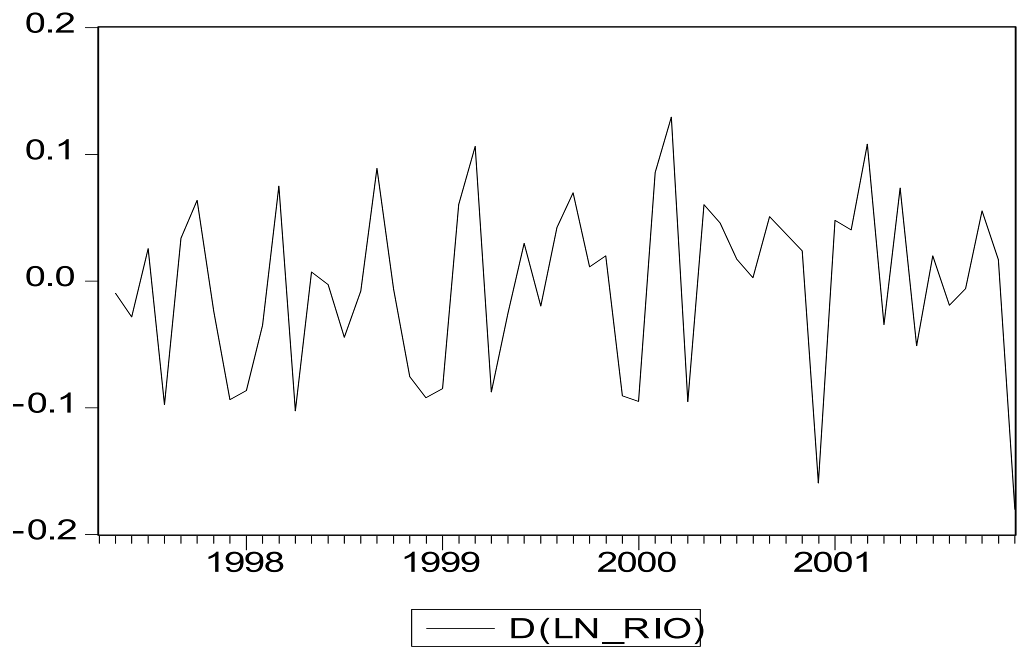
Inflation in Consumer Price Index: level and first differences



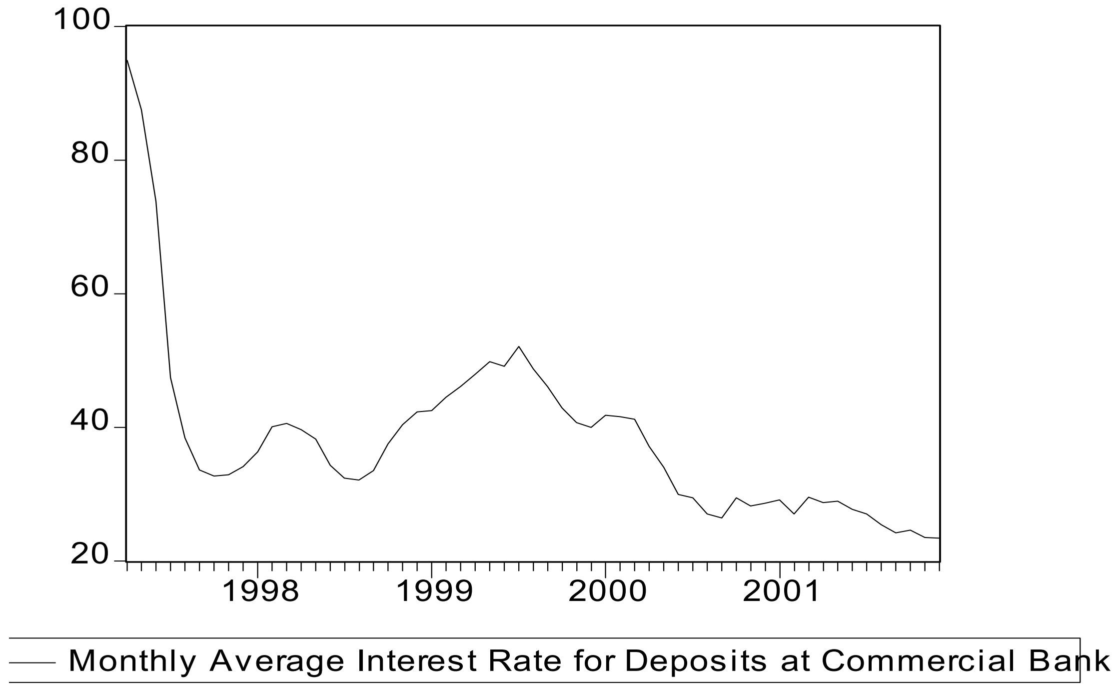


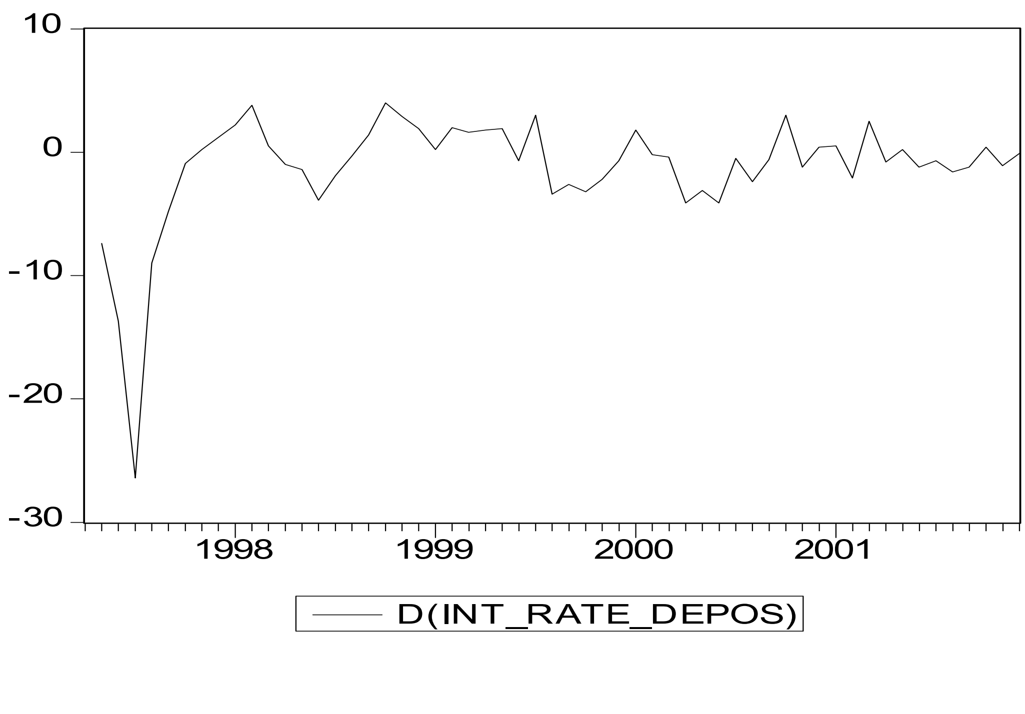
LN_REAL_IND_OUTPUT (level and differences)



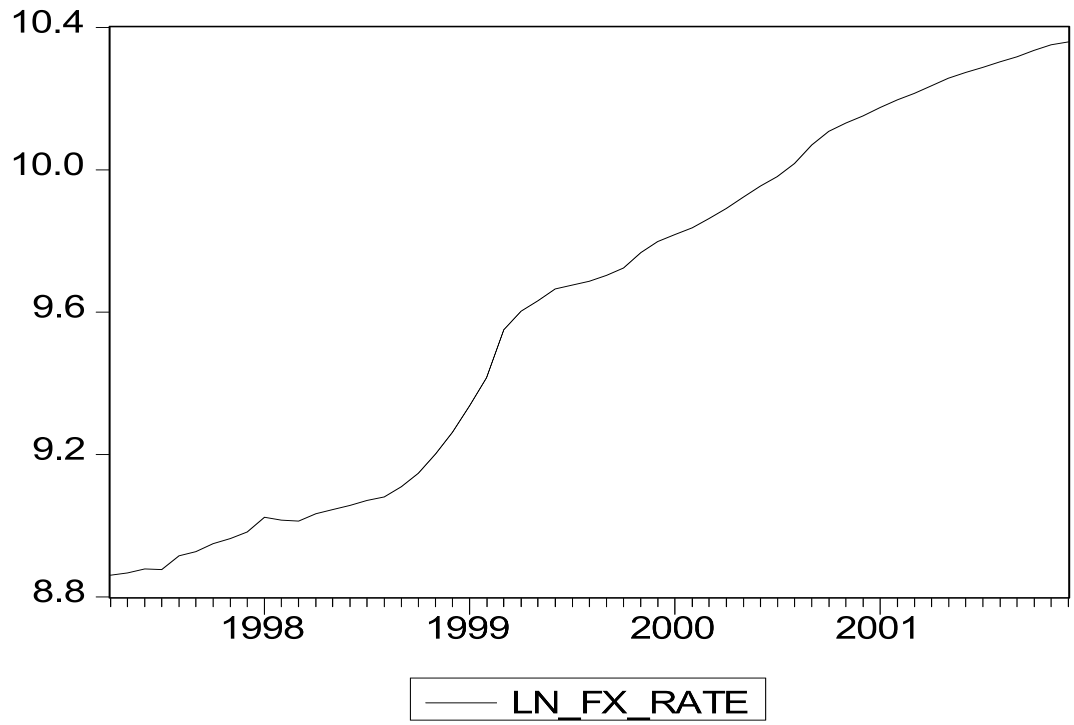


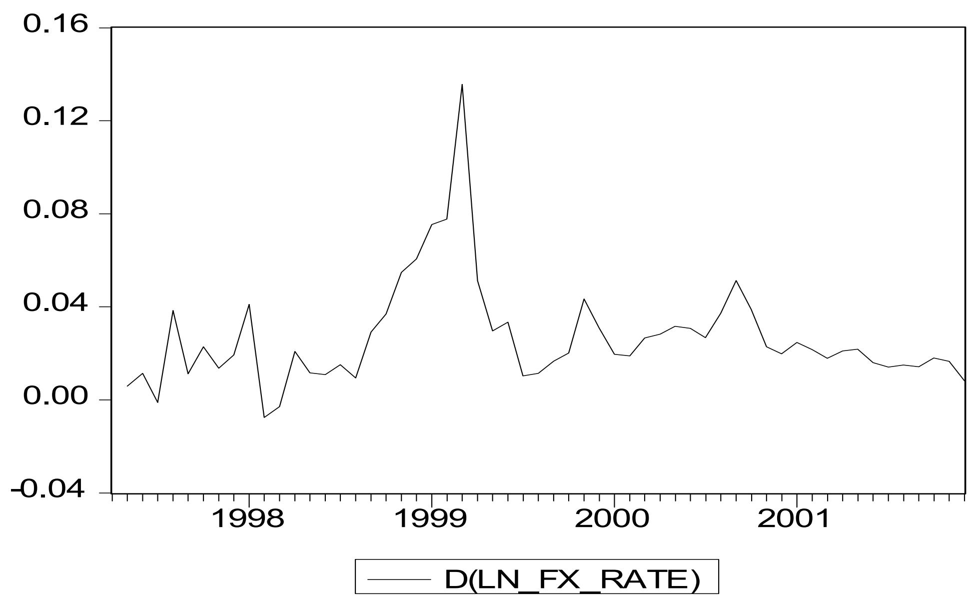
Nominal Interest Rate for deposits at Commercial Banks: (level and differences)





Logarithm of the FX rate (ln_fx_rate) (level and differences)





Results of Unit Root Tests

ln(real_M1)

Level

ADF Test Statistic	-1.940122	1% Critical Value*	-4.1314
		5% Critical Value	-3.4919
		10% Critical Value	-3.1744

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

First difference

ADF Test Statistic	-6.539777	1% Critical Value*	-3.5547
		5% Critical Value	-2.9157
		10% Critical Value	-2.5953

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

ln(real_M2)

Level

ADF Test Statistic	-2.443680	1% Critical Value*	-3.5523
		5% Critical Value	-2.9146
		10% Critical Value	-2.5947

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

First difference

ADF Test Statistic	-6.007663	1% Critical Value*	-3.5547
		5% Critical Value	-2.9157
		10% Critical Value	-2.5953

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

Industrial output

Level

ADF Test Statistic	-2.237889	1% Critical Value*	-4.1314
		5% Critical Value	-3.4919
		10% Critical Value	-3.1744

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

First differences

ADF Test Statistic	-6.531974	1% Critical Value*	-3.5547
		5% Critical Value	-2.9157
		10% Critical Value	-2.5953

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

Inflation
Level - stationary in level

ADF Test Statistic	-4.062981	1% Critical Value*	-3.5523
		5% Critical Value	-2.9146
		10% Critical Value	-2.5947

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

Ln (FX rate)
Level

ADF Test Statistic	-2.218831	1% Critical Value*	-4.1383
		5% Critical Value	-3.4952
		10% Critical Value	-3.1762

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

First difference

ADF Test Statistic	-2.726614	1% Critical Value*	-3.5547
		5% Critical Value	-2.9157
		10% Critical Value	-2.5953

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

Int_rate

Level

ADF Test Statistic	-0.756350	1% Critical Value*	-3.5572
		5% Critical Value	-2.9167
		10% Critical Value	-2.5958

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

First differences

ADF Test Statistic	-5.808501	1% Critical Value*	-3.5598
		5% Critical Value	-2.9178
		10% Critical Value	-2.5964

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