MODELLING THE TURKISH BROAD MONEY DEMAND

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Abstract

This paper analyzes broad money demand in Turkey between 1987 and 2001, a period characterized by a process of financial sector liberalization, implemented using various structural reforms and deregulations. It presents the historical background and the pace of liberalization, accompanied by a discussion on main economic indicators. It gives a brief summary on theory for the analysis of money demand and constructs an error correction model for M2X using quarterly data, where the long run relationship is established using real income, interest rate on deposits, interest rate on government securities, inflation rate and real exchange rate. The results show that, both exchange rate and inflation rate have substantial impact on the Turkish broad money demand.

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1. Introduction

The expansion of monetary aggregates is substantially important for monetary policy authorities, especially in the context of economic programs in which performance criteria are determined by using limits on monetary base or on other monetary aggregates. Hence, the role of monetary aggregates is determined through a policy-making perspective. Estimating money demand becomes a vital focus, as the empirical relationship represented by the money demand equation enables one to examine the interaction between monetary aggregates and other economic indicators.

In light of the fundamental changes to the financial system, the Turkish economy has altered in the last two decades. Implementation of various structural reforms and deregulations together with the introduction of new financial products has changed the structure of the financial system. In the view of the fact that broad money comprises a wider range of financial instruments reflecting the consequences of the financial innovations and the recent changes in the Turkish financial system, M2X demand is the scope of this study.

The purpose of this paper is to develop an appropriate money demand function for broad money and to examine the constancy of this relationship during 1987 and 2001 period, in which the Turkish economy has been in a process of financial liberalization. The broad money demand is constructed by means of cointegration using quarterly data, followed by an error correction model.

The plan of this paper is as follows: in Section 2, the historical background and the financial developments in Turkey are overviewed. Section 3 discusses variables entering the money demand equation and analyzes the theoretical approach to long run money demand. Section 4 presents data used in the analysis, followed by Section 5 discussing the estimation procedure, including the unit root test results, the cointegration analysis and the development of the model. Finally, Section 6 examines the results of the estimation and their implications, assessing some of the probable conclusions that can be drawn.

2. Historical Background and Financial Developments in Turkey

Over the last few decades, Turkey has been experiencing extensively high inflation rates sustaining difficulties that influence both the financial and the banking systems. For the improvement of the system, the Turkish Government established a stabilization program in the early 1980's. Accordingly, by the introduction of several financial reforms, the structure of the Turkish financial system altered. These reforms include liberalization concerning foreign exchange and interest rates that led the development of new monetary instruments. The expansion of government securities caused the enlargement of the interbank market as well as the financial market. Moreover, high levels of real interest rates on government securities and the growth of foreign exchange currency denominated holdings, which were mainly in DM or USD, directed a currency substitution in Turkey. Let us now overview in detail the evolution of financial liberalization in Turkey.

Until 1980, raising borrowings and increasing imports created a substantial imbalance between exports and imports, grounding enormous external debt. This period is also characterized by a decrease in production and an increase in money that finances the budget deficit. The adoption of a new development policy then became indispensable and so an economic program to stabilize the economy and to reduce inflation is set in the beginning of 1980. Consequently, there was a reduction of the monetary growth and a decrease in the real exchange rate due to the devaluation of the national currency. Financial liberalization is then initiated with the new strategy.

The deepening in the financial sector is established progressively by the introduction of new series of measures in the financial sector. One of the changes was the liberalization of the deposit and loan interest rates, and the introduction of certificates of deposits in July 1980. But the liberalization in the financial system brought a high competition between depository banks and brokerage houses, both offering high level interest rates, creating high costs. Accordingly in 1982, the breakdown of some banks and most of the brokerage houses led to a financial crisis, necessitating the implementation of some regulation of interest rate on deposits by maintaining it positive in real terms until 1988, when the rates are liberalized once more. The implementation of interbank money market including open market operations became necessary since the absence of indications concerning the financial system delimited the control of the Central Bank on the banking system. The development of auctioning of

Turkish government securities, started in 1985, the establishment of interbank money market, the re-opening of Istanbul Stock Exchange in 1986, the introduction of open market operations with government securities in 1987 and the implementation of some deregulations were some of the important reforms that encouraged financial deepening. Accordingly, new monetary instruments could be used in policy making.

In the context of foreign exchange regime, liberalization took place during the same period. One of the important reforms was due to the permission given to depository banks to thereby take role in foreign exchange operations and transactions and also to accept foreign exchange denominated deposit accounts from residents. Another important measure of liberalization was the establishment of official foreign exchange market under the patronage of the Central Bank, in September 1988, which allowed the exchange rate for the Lira to be determined according to demand for and supply of foreign exchange. All these developments once more allowed the liberalization of interest rate on deposits.

In parallel, foreign residents were permitted to enter in the market of government securities and to make transfers; this internalization allowed the export of capital. These developments formed a probable base for a financially open economy. Nevertheless, due to the financial instability directed by these innovations, Turkish Lira deposits swayed to shorter terms. Besides, there was an emerging demand for foreign currency deposits, so as to prevent the effects of potential price fluctuations and devaluation of national currency. Consequently, with a substantial growth, foreign exchange deposits nearly reached the level of Turkish Lira denominated deposits, favoring potential currency substitution.

Financial liberalization facilitated the development of the economy but increased the risk of confrontation with international shocks. Financial liberalization together with privatization, accompanied financial instability of the whole economy, reflecting frankly on the instability of interest rates and foreign exchanges. Moreover, liberalization altered the balance sheets of the banking sector, as the increase in foreign assets and liabilities led an increase in open short positions. Meanwhile the volume of domestic debt intensified. All directed to the financial crisis in 1994, upsetting the financial system. Subsequent to this crisis, a stabilization program assisted by the International Monetary Fund (IMF) was adopted, but two serious events, the Russian crisis in 1998 and the earthquake occurred in 1999 troubled the implemented program. Another disinflation program, utilizing the crawling

peg regime, was settled by the end of year 1999; with the implementation of new laws concerning the banking sector and the establishment of "The Banking Regulation and Supervision Agency", where the aim was to relieve the fragile banking sector. As stated in the program, the fundamental goals of this agreement were "to reduce real interest rates to plausible levels, to increase the growth potential of the economy, to provide a more effective and fair allocation of the resources in the economy". Although the macro indicators drew a nice portrait during year 2000, like the falling inflation rate and growing GNP, there were some troubling signals in November, and a few months later, in spite of the banking reforms, a financial crisis occurred at the beginning of the year 2001, whose effects menaced the whole economy. Recently, the development of the financial system initialized by financial liberalization, continues its growth despite some difficulties.

3. Variable Selection and Long Run Determination of Money Demand Function

There is an extensive literature on the theory of money demand and the influencing factors. In general, the real money balances are related to some scale measure, such as income or wealth, and some opportunity cost measures, such as inflation, interest and exchange rates. Analogously, there are various discussions on the form of the money demand function and the selection of the variables entering in the equation. Thus the choice of economic indicators varies in different country experiences due to the distinction in different financial systems.

The choice of an appropriate monetary aggregate for the estimation of a meaningful money demand function is complicated. Either a broad or a narrow definition of money can be used as the monetary variable depending on the issue of the monetary authorities. Generally it may be thought that a narrow definition of money (like monetary base or M1) tends to be more flexible and reactive to market operations and thus to interest rate policies. Narrow money can have a close relationship with prices since it can easily be influenced by economic variables, however it cannot always be adequate to capture all the information related to the financial system. Although narrowly defined aggregates are easy to control, their relationship with income appears subject to considerable variability. One main cause of this insufficiency is due to banking habits of money holders, as they wish to hold their savings not only in demand deposits, but also in time deposits or other different financial instruments. For that reason, a broader definition of money, such as M2 or M2X, can comprise a wider range of the financial system, however it may be less sensitive to the changes in the economy.

The first determinant of the money demand function is a scale variable measuring the level of economic activity. The holding of money and thus the demand for money are related to the volume of the transactions, using the fact that the amount of the transactions is proportional to the level of income. Either a wealth variable or an income variable can be used as a scale variable. Generally, when wealth data is not available, an income variable like the Gross National Product (GNP) or Gross Domestic Product (GDP) can be taken into consideration.

Money demand is directly proportional to income, but inversely related to market interest rates and yields on different financial assets. The interest rate concerning time deposits is thought to be the nominal return of holding money if the broad definition of money is considered, hence has a positive sign in the money demand equation.

Another important variable, which measures the rate of return of an opportunity cost, is the interest rate on government securities. As currency substitution can occur either by switching into foreign denominated deposits or by switching to bonds or securities, the rate of interest on government securities is a measure of the rate of return of an opportunity cost, and its expected sign in the equation is therefore negative.

The relationship between inflation and the demand for money has been studied widely. If there are high fluctuations in prices, the rate of inflation becomes an important determinant of the money demand function. Money demand (in real terms) is inversely related to expected inflation rate, since an increase in inflation increases the cost of holding money. Especially, in developing countries, the long-run inflation elasticity is generally expected to be high, as the range of financial instruments outside money is limited and real assets represent a substantial part of the public's portfolio (Nachega, 2001). Because the Turkish economy is subject to not only a high degree of price level but also a high variability in the prices, the price level has a considerable impact on the return of financial assets; as money holders will have difficulties in predicting the prices, the risk in saving money will raise and consequently the holding of money will tend to decrease.

The foreign exchange rate is also an important determinant in the demand equation since it measures the rate of return on holding foreign currency. The sign of exchange rate is negative since when the deposit holders increase their demand for foreign currencies, the

domestic currency will depreciate. In an open economy, the return of foreign assets is usually denoted by some exchange rate variable, which may have an increasing role due to the high level of financial globalization.

In theory, money demand can be represented as a function of above discussed variables: income, own return of money and opportunity cost of holding money. The money demand function is said to be in log-linear form since the monetary aggregate as well as the output variable are expressed in logarithms, and can be written as below for the long run:

$$m_{r(t)} = e_y y_{(t)} + e_1 r_{1(t)} + e_2 r_{2(t)} + d_{i(t)} D_{i(t)} + \epsilon_{(t)},$$

where $m_{r(t)}$ is the real monetary aggregate at time t, $y_{(t)}$ is the real income, $r_{1(t)}$ and $r_{2(t)}$ are the own return of holding money and the opportunity cost of holding money respectively while $D_{i(t)}$ represent dummies at time t. The coefficients of variables in logarithms specify the long run elasticities (i.e. income elasticity) whereas the coefficients of other variables ($r_{1(t)}$ and $r_{2(t)}$) that are not expressed in logs, are the semi-elasticities.

If there are structural shifts due to different reasons (i.e. financial innovations or potential policy differences), the inclusion of these variables in the long run equation may be necessary. However, measuring financial and economical disturbances may be difficult. One way to identify these is the induction of additional dummies in the model that will serve to capture potential shifts in the velocity of the monetary aggregate, which can affect the long run behavior of the variable. In some other cases, it may be necessary to incorporate direct quantified variables to proxy shifts in money demand. Boughton (1992) presents the sources of disturbances that can affect the elasticities of variables in the long run equation. Inflation expectations, altering over time, is the first important factor that may affect real return of assets which is an important element of the money demand equation. Inflationary expectations is generally proxied by the inflation rate, thus it is necessary to examine the inflation data before inserting in the money demand equation. The second important source of variability is the change in the exchange rate. Therefore the relationship between the exchange rate mechanism and the dynamics of real money balances is important, justifying the addition of the real effective exchange rate into the model. Another cause of a probable change in money demand may be a change influencing the interest rate. Generally the interest rate used in the money demand equation is the short-term interest rate. Any disturbance in the term structure of interest rates can cause a shift in the money demand equation. In this case, one remedy to

this problem is to use long-term interest rates in the money demand equation. Another solution is to use a spectrum of interest rates instead of using a single one, while another way is to use a combination of interest rates in money demand equation, which is rather preferable.

The last source of disturbance that can influence the structure of money demand is the innovations in the financial system. The inclusion of new markets in the system can have serious results on the monetary policy applied by central banks; there may be a change in the monetary regime according to the level of change in the financial sector. Yet, the quantification of financial innovations is not always trivial: shift dummies or trends can be used. One solution to this problem is the inclusion of proxies that can identify the innovation term, while the use of yields on new financial assets.may be another possibility. It is usually expected that the financial innovations have more influence on narrow aggregates, whereas the effect of these innovations is expected to reduce in broader monetary definitions. In this study, various ratios, "CC/M2X", "M1/M2X" and "M2/M2X"[1] are inserted into the model as financial innovation variables but none of them is found to be significant.

4. Data Issues

Data subject to the study are end of period series concerning the period 1987-2001. The Turkish broad money (M2X), composed of narrow money M1 (currency in circulation plus demand deposits) plus time deposits in domestic currency plus deposits denominated by foreign currencies, is used as the monetary aggregate and deflated using the consumer price index (CPI). Figure 1 shows the natural logarithm of the real money aggregate M2X where it can be seen that there is an upward trend, especially after 1997 reflecting the (rapid) substitutability between Turkish Lira and foreign currency (especially USD and DM) strengthened by high inflation. The upward pattern may also be the consequences of not only the tendency of money holders to hold their wealth in less liquid assets, but also the reforms made in the banking system.

[1] CC: Currency in Circulation, M1: narrow money composed of currency in circulation plus sight deposits, and M2: M1 plus time deposits.

Figure 1: Broad Monetary Aggregate

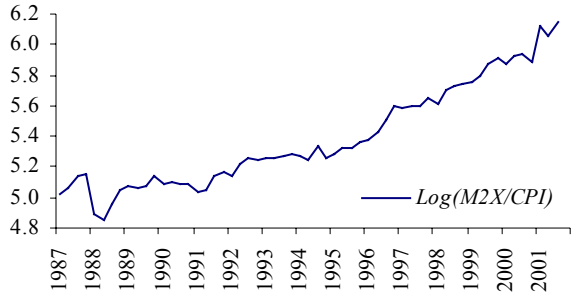


Figure 2: Gross Domestic Product

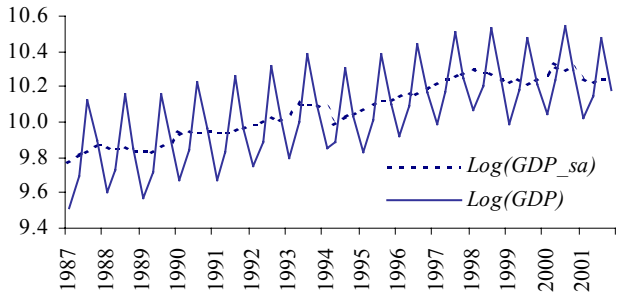


Figure 3: Interest Rate on Deposits

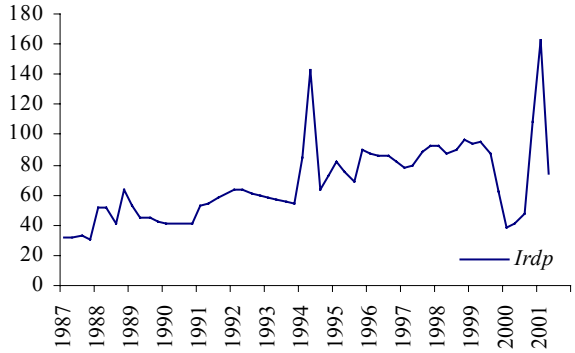


Figure 4: Interest Rate on Government Securities

Figure 5: CPI Based Real Effective Exchange Rate

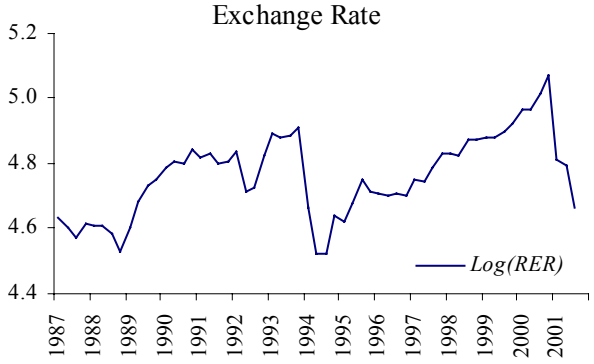
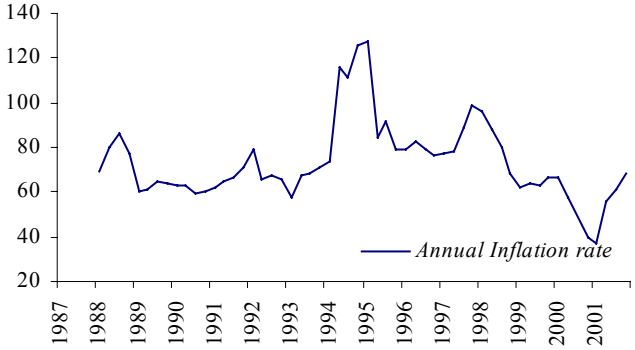


Figure 6: Annual Inflation rate



The income variable used in the analysis is the real GDP (at fixed 1987 prices) and due to high seasonality, is seasonally adjusted using TRAMO/SEATS, a program developed by Bank of Spain and promoted by Eurostat. Atuk and Ural (2002) discuss the performance of two adjustment methods X-12 ARIMA and TRAMO/SEATS on monetary aggregates and state that "TRAMOSEATS method removes completely seasonal effects from the series"[2]. The seasonally unadjusted and adjusted real GDP series in natural logs are illustrated in Figure 2. Three considerable decreases in income for the periods 1994 (the economical shock), 1999 (the earthquake shock) and 2001 (financial crises) are depicted in both of the series.

For broad money, the own rate of money is represented by interest rate on demand deposits. For this, a combination of compound interest rates is used, weighted by the share of deposits by maturity. As the rate of return on alternative assets, the rate on government securities, the annual inflation and the real effective exchange rate are included in the model. The interest rate on deposits (IR*dp*) shown in Figure 3, declines after 1994 crises, but shows an upward trend in general up to the decline in 2000 due to the disinflation program implemented in the beginning of the year. The interest rate on government securities (*IRtb*) shown in Figure 4, is the weighted quarterly average calculated using the respective amounts sold in Treasury auctions. There is an upward shift up to 1994 where the rate on government securities rises tremendously just after the economical crisis. It declines after the 1994 crisis, and fluctuates around 100 percent until 1998. After this date, with the lowered inflationary expectations and capital inflows, interest rates displays a downward trend. The interest rate on government securities, is then touched by the financial crises at the end of 2000 and beginning of 2001. Generally both of the interest rates follow the similar pattern until the 1994 financial crisis.

Starting from October 2001, the Central Bank of the Republic of Turkey has started to publish the CPI based real effective exchange rate, obtained by deflating the nominal effective exchange rate with price indices. This index is one of the most commonly used indicator of international competitiveness. The natural logarithm of the index is given in Figure 5. An increase in the index indicates appreciation of the Turkish Lira, whereas a decrease denotes depreciation. The Turkish economy after 1987 is characterized generally by a real

[2] See Atuk and Ural (2002) for further discussions.

appreciation of the domestic currency until the crisis of 1994, where the Turkish Lira is devaluated significantly. Then the real effective exchange rate pursued its increasing pattern; the Lira appreciated due to the fixed exchange rate regime by the end of 2000. At the beginning of year 2001, the real effective exchange rate dropped sharply owing to the financial crisis, when the policy switched to the floating exchange rate regime.

Annual price inflation based on consumer price index (CPI) is put in the money demand equation to depict the opportunity of holding money on real assets. From 1988 till 1994, high annual inflation around 60 percent is observed (Figure 6). The financial shock of 1994 caused the inflation rate jump to three-digit levels. Even if the inflation decreased after the economical crisis, a level shift is observed since annual inflation insisted to fluctuate around 75 percent, which was much higher than its previous level. Between 1996 and 1997, annual inflation recorded an increasing trend. In 1998, the Turkish Government established monetary and fiscal programs to deal with high inflation; consequently the inflation rate decreased considerably. Supported with the stabilization program, the downward trend of inflation continued until the financial shocks, which took place at the end of 2000 and the beginning of 2001, whose effects will be seen henceforth.

5. Estimation

In an econometric study, the time series properties of the economic variables that are dealt with should be determined in the first place. The verification of whether a time series is stationary or not, is an important issue since the ignorance or misspecification of non-stationarity may cause spurious regression and misleading results.

The fact that many of economic time series contain unit root, consequently urged the development of the theory on non-stationary time series analysis. It is generally true that any linear combination of non-stationary series is also non-stationary, however Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If the variables are integrated of order one and there exists a linear combination of their levels that converge to stationarity, in other words their linear combination produces stationary error terms, then the variables are said to be cointegrated. The economic interpretation of cointegration is the presence of a long run equilibrium among a set of variables. That means, there is a tendency of the variables to move together over time in the

long run, and even if there is a disturbance by exogenous shock and thus the variables are driven out of the equilibrium, variables tend to revert to their previous equilibrium condition. In this study, Augmented Dickey-Fuller (ADF) test is used for testing stationarity, the Johansen procedure is used for testing cointegration, followed by an error correction model, representing not only the short run dynamics, but also the long run equilibrium.

5.1. Integration

When the main point is to deal with the issue of testing for cointegration between first order integrated series, firstly unit root tests are carried out for testing whether the series are I(1). The results from the unit root tests concerning the logarithm of M2X deflated by CPI *Log(M2X/CPI)*, interest rate on deposits (*Irdp*), interest rate on government securities (*Irtb*), seasonally adjusted GDP (*Log(GDP_sa)*), the logarithm of real exchange rate (*Log(RER)*), and annual inflation rate (π) are given in Table 1. ADF tests are conducted with both including and excluding trend.

The unit root test results states that, here in the case of Turkish data, apparently none of the variables has two unit roots. All variables are I(1).

Table 1: Unit Root Test Results

	Augmented Dickey-Fuller Test								
	Levels					First Differences			
	Intercept		Trend and Intercept			Intercept		Trend and Intercept	
	t - Test Statistic	Lag Length	t - Test Statistic	Lag Length		t - Test Statistic	Lag Length	t - Test Statistic	Lag Length
Log(M2X/CPI)	-1.057	0	-2.174	0	*ΔLog(M2X/CPI)*	-7.098**	1	-7.387**	1
Log(GDP_sa)	-1.493	0	-2.321	0	*ΔLog(GDP_sa)*	-7.353**	0	-7.345**	0
Irdp	-1.937	4	-3.029	4	*ΔIrdp*	-7.697**	1	-7.590**	1
Irtb	-2.853	1	-2.900	1	*ΔIrtb*	-7.256**	1	-7.225**	1
Log(RER)	-2.571	1	-2.588	1	*ΔLog(RER)*	-3.520*	3	-3.496*	3
π	-2.580	2	-2.554	2	$\Delta\pi$	-7.198**	0	-7.121**	0

The superscripts ** and * denote rejection of hypothesis of a unit root at 1% and 5% significance levels respectively.

5.2. Cointegration

In the beginning of the estimation procedure, the first issue is the determination of the lag number of the model. The number of lags in the VAR is chosen based on Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). However, in order not to overlook any other possible cases, all the combinations are tried considering that the maximum number of included lags should be four since quarterly data is used. According to both methods, the model satisfying the minimum AIC and SBC criteria has one lag, in which each of the estimated parameters has the expected theoretical signs. Although the signs of the estimated parameters are as expected, with the idea that their magnitudes could be improved, two dummies concerning financial crises occurred in 1994 and 2001 are included in the model in alternative ways. The model, in which 2001 dummy is included, turned out to be feasible.

In the next step, the existence of a cointegrating vector is tested based on trace and maximum eigenvalue tests. The cointegration results are presented in Table 2. According to the trace test, the hypothesis that "no cointegrating vector exists" is rejected in favor of "at least one cointegrating vector exists" both at 5 and 1 percent significance level, on the other hand the existence of at most two cointegrated vectors is not rejected at 5 percent level. Similarly, the maximum eigenvalue test indicates the existence of at most two cointegrating vectors at 5 percent significance level. Based on this model, the cointegrating vector representing the long-run money demand function for real M2X is as below:

$$Log(M2X/CPI)_t = 1.004*Log(GDP\_sa)_t + 0.023*IRdp_t - 0.006*IRtrb_t - 0.937*Log(RER)_t - 1.796\,\pi_t$$

The long-run money demand function has unit income elasticity, consistent with the theory. The interest rate on deposits has a positive sign as it represents the own rate of return, whereas the interest rate on government securities has a negative sign indicating an alternative return of money. The real exchange rate has also a negative sign; as an increase in the real exchange rate implies an appreciation of Turkish Lira, when the domestic currency appreciates, the demand for M2X tends to decrease. On the other hand, broad money demand is negatively affected by the annual rate of inflation since it shows the return on real assets. The semi-elasticity of the inflation rate is -1.795, which means that the impact of the expected inflation on real balances is substantially important in the model. Besides, the negative sign designates that the economic agents tend to hold real assets instead of money in the case of high inflation expectations in accordance with the economic theory. From another perspective, the long run

inflation elasticity can be calculated as 1.32, the product of the semi-elasticity and the sample mean of the inflation rate, which is 73.5 percent. Then, when compared to exchange rate elasticity 0.937, it can be said that there is a higher degree of substitution between money and real assets than between money and holdings of non-domestic currency.

The weak exogeneity and significance tests on individual variables are conducted under the assumption of two cointegrating vectors. Weak exogeneity tests reveal that real broad money, interest rate on deposits, and the inflation rate are not weakly exogeneous, however, weak exogeneity cannot be rejected for real income, interest rate on government securities and real exchange rate. Therefore each of the three variables has a long run relationship, but since the focus of the paper is money demand, the paper proceeds to an error correction model of money demand, accepting the trace test results at 1 percent significance level. The coefficients of all variables except interest rate on government securities and real exchange rate are significantly different from zero at 1 percent significance level, yet the insignificance of real exchange rate coefficient is rejected at 10 percent significance level.

Once the determinants of the cointegrating relationship are determined, the next step is to estimate the short-run demand for broad money using error correction model (ECM). The short-run model reveals how the adjustment mechanism works to revert to the equilibrium condition when it is disturbed by exogenous shocks and thus deviations from the long-run level occur. The dynamics affecting the short-run real money demand are the differenced forms of the variables used in the long run. Fundamentally, the ECM contains the one lagged error term to capture the long run dynamics in the short run which represents excess money in the previous period. The error term coefficient should have a negative sign not larger than one. The coefficient provides information on how much of the disturbance is adjusted in one period. In other words, the inverse of the coefficient shows how many periods later the effect of the disturbance fades.

Table 2: Cointegration Analysis for Turkish Broad Money Demand

	Cointegration Rank Tests [1]					
Null hypothesis	r = 0	r ≤ 1	r ≤ 2	r ≤ 3	r ≤ 4	r ≤ 5
Eigen-value	0.509	0.450	0.252	0.222	0.095	0.000
λ *trace*	101.425**	64.394*	33.297	18.221	5.193	0.015
5% Critical Value	82.490	59.460	39.890	24.310	12.530	3.840
1% Critical Value	90.450	66.520	45.580	29.750	16.310	6.510
λ *max*	37.031*	31.097*	15.076	13.027	5.178	0.015
5% Critical Value	36.360	30.040	23.800	17.890	11.440	3.840
1% Critical Value	41.000	35.170	28.820	22.990	15.690	6.510

	Standardized Eigenvectors					
	Log(M2X/CPI)	*Log(GDP_sa)*	*Irdp*	*Irtb*	*Log(RER)*	π
	1.000	**-1.004**	**-0.023**	**0.006**	**0.937**	**1.796**
	0.109	1.000	-0.010	0.006	-2.010	-0.811
	-43.821	-4.563	1.000	-1.053	50.064	83.797
	-80.103	-219.896	0.448	1.000	516.442	106.882
	2.312	-2.592	0.023	0.028	1.000	7.009
	1.432	-1.967	0.011	-0.012	2.500	1.000

	Adjustment Coefficients					
Δ*Log(M2X/CPI)*	-0.004	0.016	0.007	0.005	-0.007	0.000
Δ*Log(GDP_sa)*	0.001	0.006	0.000	0.004	-0.003	-0.000
Δ*Irdp*	6.877	4.468	-0.487	0.118	3.575	0.125
Δ*Irtb*	0.294	-0.670	5.301	0.609	4.157	0.088
Δ*Log(RER)*	-0.001	0.006	0.006	-0.019	-0.004	-0.000
$\Delta\pi$	-0.047	0.015	-0.014	0.000	0.019	-0.000

	Weak Exogeneity Test Statistics [2]					
	Log(M2X/CPI)	*Log(GDP_sa)*	*Irdp*	*Irtb*	*Log(RER)*	π
$\chi^2(2)$	6.577*	2.741	10.876**	0.066	0.565	12.879**

	Statistics for Testing the Significance of a Given Variable [2]					
	Log(M2X/CPI)	*Log(GDP_sa)*	*Irdp*	*Irtb*	*Log(RER)*	π
$\chi^2(2)$	11.103**	9.394**	14.698**	3.378	5.733	12.562**

The superscripts ** and * denote rejection of hypothesis at 1% and 5% significance levels respectively.
[1] The statistics λ*trace* and λ*max* are Johansen's trace and maximal eigenvalue statistics for testing cointegration.
[2] The weak exogeneity and the significance test statistics are evaluated under the assumption that the cointegration rank is r=2 and so asymptotically distributed as $\chi^2(2)$.

Based on the ECM theory, a full model is constructed in the form of a single equation for the analysis of the short run dynamics of real broad money. Being the first difference of real M2X on the left hand side of the equation; the right hand side comprises four lagged terms of differenced real M2X, first differences of other variables and their four lags, one lag of the stationary error term and two financial crises dummies. With the aim of finding a valid model for short run broad money demand function, the insignificant coefficients are removed step by step using backward elimination methodology and the model is reduced to a parsimonious one, as reported in Table 3. The reduced form of the equation looks as below:

$$\Delta Log(M2X/CPI)_t = 0.010 - 0.362*\Delta Log(M2X/CPI)_{t-2} + 0.737*\Delta Log(GDP\_sa)_t + 0.529*\Delta Log(GDP\_sa)_{t-1} + 0.001*\Delta Irdp_t + 0.001*\Delta Irdp_{t-3} - 0.001*\Delta Irtrb_{t-2} - 0.277*\Delta Log(RER)_t - 0.346*\Delta Log(RER)_{t-2} - 0.370*\Delta\pi_t - 0.084*ECM_{t-1} + 0.103*D94$$

The negative coefficient of the error correction term is significant, assuring that the cointegrating relationship between the variables is valid. Essentially, it implies that when an exogenous shock disturbs the equilibrium condition, 8.4 percent of its effect is adjusted in one period. Looking at the other coefficients, the income coefficient falls to 0.74, the interest rates remaining at similar levels, whereas the impacts of real exchange rate and the annual inflation rate decrease considerably in the short run.

Table 3: Short Run Model

Dependent Variable: *ΔLog(M2X/CPI) t*		Adjusted Sample: 1988:2 2001:2	
Method: Least Squares		Observations (N): 53	
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Constant	0.010	0.007	1.443	0.157
ΔLog(M2X/CPI) t-1	-0.362	0.099	-3.635	0.001
ΔLog(GDP_sa) t	0.737	0.272	2.714	0.010
ΔLog(GDP_sa) t-1	0.529	0.240	2.199	0.034
ΔIrtb t-2	-0.001	0.000	-3.502	0.001
ΔIrdp t	0.001	0.000	2.252	0.030
ΔIrdp t-3	0.001	0.000	2.704	0.010
ΔLog(RER) t	-0.277	0.092	-3.026	0.004
ΔLog(RER) t-2	-0.345	0.106	-3.254	0.002
Δπ t	-0.370	0.076	-4.875	0.000
ECM t-1	-0.084	0.019	-4.458	0.000
D94	0.103	0.060	1.724	0.092
Adjusted R-squared	0.539	F-statistic		6.532
Durbin-Watson stat	2.021	Prob(F-statistic)		0.000

The diagnostic tests confirm no predicament with autocorrelation, autoregressive conditional heteroscedasticity (ARCH) effect and normality concerning residuals (See Table 4). Therefore, the model results are applicable. In consequence of the stability tests, when 1994 financial crises is taken to be the breakpoint, Chow test results imply that the estimated short-run model is stable despite the fluctuations in the inflation rate, financial crises and financial liberalization and there is no structural change in the relationship.

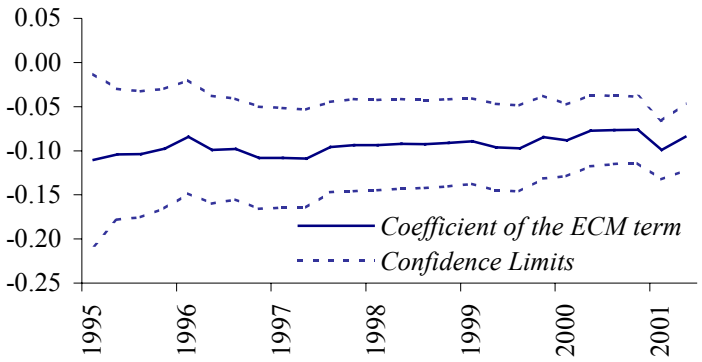
Table 4: Diagnostic Tests of Short Run Model

Tests on Residuals				
Breusch-Godfrey Serial Correlation LM Test:				
Lag: 1	F-statistic	0.251	Prob.	0.619
	N*R-squared	0.331	Prob.	0.565
Lag: 4	F-statistic	0.952	Prob.	0.445
	N*R-squared	4.944	Prob.	0.293
ARCH Test:				
Lag: 1	F-statistic	0.181	Prob.	0.672
	N*R-squared	0.188	Prob.	0.665
Lag: 4	F-statistic	1.811	Prob.	0.144
	N*R-squared	6.926	Prob.	0.140
Normality Test:				
Jarque-Bera Statistic		0.817	Prob.	0.665

Stability Tests			
Chow Breakpoint Test: 1994:1			
F-statistic	0.280	Prob.	0.985
Chow Forecast Test: Forecast from 1994:1 to 2001:2			
F-statistic	1.143	Prob.	0.420

Additionally, according to the graphical test shown in Figure 7, the recursive coefficient estimates of the error correction term remain stable within the 95 percent confidence limits. Since the coefficient does not display significant variation as new observations are added to the data set, there is no evidence of a major instability over the sample period.

Figure 7: Recursive Coefficient Estimates of the ECM Term



6. Conclusion

The cointegration analysis indicates that there is a long run relationship for real broad money in Turkey. In this long run equilibrium, the income elasticity is found to be near unity, a result that is consistent with the economic theory. Moreover, the interest rate on deposits is positively related to real broad money demand, representing the own rate of return, while interest rate on government securities has a negative impact, representing an opportunity cost. Likewise, the inflation rate and the real effective exchange rate are both included in the long run relationship as return of alternative assets; the economical agents are sensitive to exchange rate and inflation rate movements in the long run. To determine the movements of the real exchange rate, the new measure for the real effective exchange rate published by the Central Bank of Turkey is inserted into the model, giving a new approach to foreign opportunity cost. Since the elasticity of inflation is found to be larger than that of the real exchange rate, it may be concluded that, in the long term, there is a higher degree of substitution between money and real assets than between money and holdings of non-domestic currency. On the other hand, dummy variables representing the crises of 1994 and 2001, two important events that disturb data are included into the model. Other dummies concerning the financial innovation and some deregulations are also tried, but turned out to be insignificant in the model, even while there is progressive liberalization process.

The short run elasticities and semi-elasticities, also consistent with theory, are generally weaker in magnitude than those related to long run equilibrium. In the short run, the coefficients of the lagged interest rate on deposits differential and the lagged interest rate on government securities differential are nearly equal in magnitude. This result shows the interest rate sensitivity profile of the financial savings. Also, the magnitude of the inflation and exchange rate coefficients are relatively important, a result that is expected to be observed in developing countries, like Turkey, where real assets have an important role in money holders portfolio since the use of alternative financial assets is quite restricted despite financial innovations.

The money demand equations should certainly be revised according to the economical developments in Turkey. In particular, models can be constructed using higher frequency data with the same econometric procedure.

APPENDIX: DATA DEFINITIONS

This appendix lists and presents a detailed explanation of data under study. Quarterly data from 1987 to 2001 are used.

Variable	Name	Explanation	Transformation	Unit	Source
Broad monetary aggregate	M2X	Composed of currency in circulation, demand and time deposits plus deposits denominated by foreign currencies	The natural logarithm of M2X deflated by CPI. End of period data.	Billions Turkish Lira (TL)	CBRT EDDS [1]
Real income	GDP_sa	Real gross domestic product at 1987 prices	The natural logarithm of seasonally adjusted data using TRAMO-SEATS.	Index	SIS [2]
Interest rate on demand deposits	IRdp	Weighted average of 1-month, 3-month, 6-month and 1-year time deposits' compound interest rates	Weighted by the share of deposits by maturity to total time deposits. End of period data.	Annual rate	CBRT EDDS [1]
Interest rate on government securities	IRtb	Weighted quarterly average of simple interest rate for discounted Treasury auctions.	Weighted by the share of respective amounts sold in auctions.	Annual rate	Turkish Treasury
Annual inflation	π	Annualized inflation of the Consumer Price Index (CPI)	Annualized percentage change of the CPI index	Annual rate	SIS [2]
Real effective exchange rate	RER	CPI based real effective exchange rate (An increase indicates an appreciation of TL).	The natural logarithm of the index. End of period data.	Index	CBRT [3]
Dummy variables	D94 D01	1994 Financial Crisis Dummy 2001 Financial Crisis Dummy	Unity for 1994 Q2, zero otherwise. Unity for 2001 Q1, zero otherwise.	Dummy Dummy	-

[1] Available at CBRT official website www.tcmb.gov.tr , Electronic Data Delivery System
[2] Republic of Turkey, Prime Ministry State Institute Of Statistics
[3] Available at CBRT official website www.tcmb.gov.tr , Periodic Publications

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