THE FISHER EQUATION EXAMINED: IMPLICATIONS FOR THE MONEY DEMAND IN TURKEY

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In partial fulfillment of the requirements for the degree of Master of Arts

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Budapest, Hungary 2007

Abstract

This thesis investigates the money demand in Turkey using monthly data from 1986:1 to 2003:12. The investigation starts off by testing the Fisher equation and results suggest that the Fisher equation does not hold in Turkey. This result justifies the inclusion of the inflation variable in the estimation of money demand function. The empirical analysis carried out by means of the Johansen multivariate cointegration analysis and, cointegration analysis indicates that there is a stationary long-run relationship between money, output, inflation and interest rate. Robustness of the analysis is checked by estimating the money demand function when excluding the inflation variable and the results are not supportive of exclusion of inflation rate. Finding a stable money demand function in a period characterized as politically and economically instable might be surprising, but it might also provide suggestion of using the money aggregates as policy instrument. Moreover the variables in a stable money demand function might be important while forecasting the inflation as well.

Acknowledgements

I would like to thank Professor Max Gilman for his help in choosing this topic and for his kind guidance in the further steps. Special thanks are also addressed to Srdan Bejakovic, my family and my unnamed friends for their support and ensuring my wellbeing.

TABLE OF CONTENTS

1. Introduction	1
2. Turkish economy background	5
3. Econometric modelling	10
3.1 Data description	10
3.2 Integration	10
3.3 Fisher Equation	
3.4 Money Demand Estimation	14
3.4.1 Money Demand without Inflation:	
5. Conclusion	

1. Introduction

Economic theory has long postulated a connection between money, interest rates, and inflation. The Fisher equation traditionally describes the simple relationship hypothesized to exist between nominal interest rate and the inflation (Crowder, 1997). Similarly, classes of functions have been studied linking the demand for money to the interest rate such as the constant semi-interest elasticity model of Cagan (1956) and the constant interest elasticity model of Baumol (1952). Given the general interest and importance of inflation, and the fact that most central banks place controlling the price level at the top of their list of responsibilities, it is not surprising that there has been much research in estimating and refining these relationships, in the hope that they will provide insight into future inflation trends and a way of influencing the level of inflation.

There are two possible channels through which monetary policy might influence the price level. The first one is based on affecting the financial flows between borrowers and lenders and the interest rate is generally preferred as a policy instrument over restricting the amount of flows. The other one is based on altering the money aggregate. Central Banks can influence both channels, meaning that they are not exclusive.

However, interest rates have mainly come to play a dominant role in central bank policies. The United States Federal Reserve implements monetary policy controlling the short term interest rate by open market operations. Also one of main tool of disinflation programs implemented by Turkish Central Bank has been interest rate. For instance, there is a broad empirical literature about the demand for money in the United Stated, and this literature mostly provides a skeptical attitude about using the money aggregate as an information variable to guide monetary policy decisions because of its relatively high instability .This obscures the value that the money aggregate would have as a predictor of inflation, and reduced its possible value as a policy tool for reducing inflation. (Estrella and Mishkin, 1997). Stock and Watson (1993) investigate the long-run money demand in the U.S for the period between 1900 and 1989 and their results about the parameters of money demand are inconclusive. In contrast, Ball (1998) extends the data used by Stock and Watson through 1996 and the author finds fairly precise estimates.

More recently, researchers have once again begun to focus on money aggregates. For instance, researches done by conducting the data of European Union countries point to the existence of stable money demand function.(e.g. Fagan and Henry, 1999; Coenen and Vega, 1999). For instance, Brand and Cassalo (2004) estimates a demand function for real M3 in the euro area, and their finding suggests no major distortions in the stability of money demand. Also, the European Central Bank (ECB), with the goal of finding stable money demand in the Euro area in 1998, granted money an important role in its policy. The role of money requires the ECB to analyze the development in monetary aggregates, and use this information while taking policy decisions. Following the decision by ECB, many authors tried to investigate the relation between monetary aggregate and future price developments.(e.g. Gerlach and Svensson, 2000). This increasing interest in the money aggregate does not discount the importance of the interest rate, but suggests that, particularly in the middle and the long run, money aggregates are a useful tool for predicting and controlling inflation. In the words of Alvarez (2001: 219), "while control of monetary aggregates is the key to long-run average inflation rates, an interest-rate policy can improve the short run behavior of interest rate and prices."

There is an increasing interest to focus on the stability of money demand in developing countries as well, though it is still a challenge to conduct a study on money demand in those countries, because of the lack of confidence in data quality. This fact is also indicated by Gillman and Cziraky (2005) in a study which the authors examine the money demand in Croatia, an EU accession country. Their findings are supportive of stability of money demand function using inflation as one of the variables. The inclusion of inflation in the money demand function is justified by finding a failure of Fisher equation.

This thesis follows the study of Gillman and Cziraky(2005), and starts off with the investigation of Fisher equation. The Fisher hypothesis is based on the relationship between nominal interest rate and inflation. There is a rich literature testing this relation, and the early studies are using U.S time series data. Although overall the results are, at best, rather mixed, it is still to say that early findings demonstrate low Fisher effect (e.g. Evans and Lewis, 1995) whereas more recent studies use more advance econometric methodology and they find evidence supporting that the long-run Fisher effect are very close to the theoretically implied value of 1.0 or greater. (e.g Crowder and Hoffman, 1996).

In case of finding a failure of Fisher equation, the standard money demand function needs to be modified, because the idea that interest rate reflect the inflation rate changes is not valid anymore. The findings in this thesis are not supportive for the evidence of such a relationship between interest rate and inflation. That is why while estimating money demand function, inflation rate is also included as one of the variables. After the extension of money demand specification, the finding in this study suggests a stable money demand function in Turkey. This result might be little bit surprising because of the emphasis of the Turkish Central Bank on the interest rate to control the inflation rate as a policy tool and also because of the existence of financial crises.

All the series used in the estimations are monthly and, they extend from 1986:1 to 2003:12. The Fisher equation is tested by using different definitions and extensions and, money demand equation is estimated by using the Vector Error Correction Models (VECM). . For the purpose of checking the robustness of the baseline model, the money demand function is also estimated with the assumption that the Fisher equation does hold.

The remainder of the paper is organized as follows. In section 2, the macroeconomic developments between 1980 and 2003 are described in order to get better insight about the variables used in the paper. The first and second part of the section 3 contains the data description and then the findings about the integration of variables. The third and forth part of section 3 illustrates the estimation results of Fisher equation and Money demand function. Finally, section 5 contains the results.

2. Turkish economy background

In this section, we will review the macroeconomic developments as well as policies implemented in Turkey over the last two decades, which are related to this paper because of their influence on the variables used in the estimations. Turkey pursued an import-substitution policy until the end of 1970s. The crude oil shocks in the 1970s and the subsequent balance of payments problems made the inward-looking development strategy impossible to maintain. A broad stabilization and liberalization program was introduced from 1980 onwards and the reforms took place gradually.

One of the major attempts to reverse the import-substitution policy and strengthen the export incentives was to devalue the Turkish lira to enhance its competitiveness. The fixed exchange rate policy based on government decision for the determination of Turkish Lira value was abandoned by the 1980 stabilization program, which initiated a managed floating exchange rate scheme. In 1984, when the exchange rate regime was liberalized, the reforms allowed residents and exporters to hold a portion of their income as foreign exchange deposits, and commercial banks to operate in foreign exchange market in proportion to their foreign exchange liabilities. Moreover, the permission of the non-residents to purchase foreign denominated securities and to hold Turkish Lira accounts was made possible.

The Capital account liberalization which started in 1980 was completed by the serious steps taken by government in 1989. Soon after the introduction of capital account liberalization, banks and brokerage houses started to compete for deposits by offering high interest rates, and high interest rates pushed the economy into the financial crisis in 1982, because banks could not utilize their high cost deposits. From 1986, the central bank implemented policies controlling on Turkish lira reserves of the banking system

with the goal of indirectly controlling money supply by targeting broad money supply M2. Due to liberalization of capital account and in the absence of interbank money market, the central bank lost its control over money aggregates by 1989. Furthermore, monetary policy was highly dependent on fiscal policy. In the words of Pongsaparn (2002: 5), "Priority was given to financial stability rather than controlling inflation in the face of increasing currency substitution as seen from a rise in the share of foreign currency denominated bank deposit in total deposits from 24% in 1989 to 46% in 1999." In May 1985, the auctioning of government securities in the a secondary bills and bonds market ,which set up the Istanbul Stock Exchange, started for securities with one year security, and in a little while the short-run securities also started to be auctioned. After these developments in the government securities market, in April 1986, interbank money market was established. The main tool of the Central bank for monetary policy implementation has been through the open market operations by using government securities since 1987. The Central bank became able to use market based monetary instruments in conducting its monetary policy whereas its ability to control money had been limited before by financial liberalization Furthermore, a foreign exchange market where the value of Turkish lira was determined according to the demand and supply of foreign exchange rate by the market participants (i.e. banks and authorized exchange branches) opened in September 1988. As a result of all these reforms, the Central Bank was allowed to conduct exchange rate, monetary and interest rate policy through market mechanism.

High interest rates followed by the liberalization of capital account also attracted the short run capital inflows to the country. The short term capital inflows, so called hot money, led the exchange rate to rise, hence hindered the investment and raised credit cost for real sector. All of these developments resulted in an exchange rate crises in the first half of 1994 and the annual inflation rate exceeded 100%. An explanation of the jump in the inflation rate comes from Rodrik (1991) who examined the "premature liberalization and incomplete stabilization" in Turkey. Rodrik claims that the liberalization of the capital account followed by an increase in dollarization led to a fall in demand for reserve money which put the authority to increase inflation so as to earn seigniorage revenue.

The Turkish government introduced new disinflation measures to stabilize the economy after the 1994 financial crisis, however this did not last long because of the Russian crisis in 1998, general elections in 1999 and the earthquake in August 1999. Increasing subsidies to agriculture raised enormously the "duty losses" of the banking sector which jumped from 0.7% of GNP in 1993 to 16.7% in 1999 and this also contributed to banking system volatility. Banking sector volatility was perceived as a factor contributing to the crisis in 2001.

The so called three-year program was introduced in 1999 and it was essentially established upon an exchange stabilization program supplemented by fiscal adjustment and structural reforms. One of the identifying characteristic of the three-year plan is that it provided more structural and regulative reforms to settle a market-oriented economy and foster growth. Via these reforms, the aims were to strengthen and regulate the banking sector, diminish the public sector deficit and, reach to single digit inflation level in the medium term.

The main policy tool change in 2000-02 disinflation program was actually the adoption of a crawling-peg regime which is based on fixing the percentage change of

7

Turkish lira value of a basket of foreign currencies for a year and half. Initially, the program was quite successful and it achieved remarkable results such as a dramatic fall in interest rate, slowed down inflation, increase in production and demand. Nevertheless, a medium size bank having large holdings of government securities pushed the economy into another financial crisis because of its extremely risky position. The government had to abandon the crawling peg and switched to a floating regime. "Over 2001 the GDP contracted by 7.4% in real terms, whole sale price inflation soared to 61.6%, and the currency lost 51% of its value against the major foreign monies." (Yeldan, 2006). According to Kibritcioglu (2004), even though factors such as the real appreciation of the Turkish lira may have played a role in the occurrence of crisis, the main reasons were the unsustainable domestic debt of the public sector and the unhealthy structure of the Turkish financial sector and these arguments are well accepted by many other authors.

In order to overcome the negative impact of crisis, a new agreement was made with IMF in May 2001 and it was revised in early 2002 for the period of 2002-04. This program was more stringent than the previous adjustment and reform program. The new plan mainly aimed to reduce uncertainty in the financial sector, especially through institutional reforms, and to strength public finance and administration so as to ensure debt sustainability and to bring down inflation permanently. The institutional reforms in the banking sector consisted of restructuring the public banks and improving regulation and supervision of private banks.

However, the banking sector still does not fulfill the role of being a channel between financial and real sector to foster investment. According to Pongsaparn (2002), the treasury bills and bond are the dominant assets of the balance sheets of banks and,

8

this contributes the need for liquidity and shot up interest rates. Highly volatile output and risk also contributes to the reason why banks are secondary source of finance for many corporate firms, while larger corporates prefer to borrow directly from abroad.

3. Econometric modelling

3.1 Data description

The data¹ used in the estimation are defined as follow: *m* is the narrow money (M1 money) which includes demand deposits in commercial banks and time deposits in the Central Bank, *p* is the consumer price index (1995=100), π is the monthly rate of inflation which derived as monthly change in CPI. (i.e. $\pi = \log(cpi_t) - \log(cpi_{t-1})$; where cpi refers to consumer price index.), *i* is the industrial production for output variable and it is seasonally adjusted. (1995=100) and, *r* is the interest rate on government bonds (monthly rate- annual compound rate converted to a monthly rate).

All the series in the estimation are used in natural logarithms- except interest rate is used without natural logarithm in the money demand estimation. The estimation sample extends from 1986:1 to 2003:12 and series are with monthly frequency. It is important to use monthly data because of the historically high levels of inflation in Turkey. In such conditions, economic agents make their decisions and change their behavior frequently, and quarterly data might not represent this adequately.

3.2 Integration

Before the investigation of the Fisher equation and money demand function, the univariate unit roots were performed to determine the order of integration of variables by the Augmented Dickey Fuller (ADF) process. The unit root tests are given for the level and first differences of the data and detailed ADF test is reported in Table 1. The optimal lag length was determined by using the Akaike (AIC) information criteria. Unit roots

¹ The data is obtained from the Central Bank of the Republic of Turkey website (<u>www.tcmb.gov.tr</u>). I also would like to thank Irfan Civcir (Faculty of Political Science, Ankara University) for helping me to extend the dataset.

tests are first performed for two roots, and if two roots are rejected then single unit root is tested. Tests are carried out with and without trend.

Test result shows that none of the variables seems to have evidence of two unit roots, and all the variables are not able to reject the null hypothesis of single unit root at the 5% significance level. That is, all the variables are non-stationary in level, but stationary after first differencing.

Variables k		А	В	
Levels				
m	14	-0.679261	-1.595982	
m-p	14	-1.161959	-1.935575	
π	4	-0.969384	-0.227181	
r	1	-1.715459	-1.643231	
i	13	-1.124310	-2.613885	
First Differences				
$\Delta(m)$	14	-3.504157*	-3.51221*	
Δ (m-p)	14	-4.385504*	-4.47381*	
$\Delta(\pi)$	3	-6.48303*	-6.537404*	
$\Delta(\mathbf{r})$	0	-11.60827*	-11.60827*	
Δ (i)	12	-4.40736*	-4.379282*	
1% critical value		-3.462737	-4.004132	
5% critical value		-2.875680	-3.432226	
k is the number of lagged de	pendent variable C	olumns A and B give th	ne t-statistics from	

k is the number of lagged dependent variable. Columns A and B give the t-statistics from ADF regression including constant, and trend, and constant, respectively.

3.3 Fisher Equation

The Fisher equation can be represented as $r_t = \rho_t + \Pi_t$, where r_t is nominal interest rate, ρ_t is real interest rate and, Π_t is inflation rate in period t,. (Fisher, 1930; see also Gillman and Cziraky, 2005). With an additional assumption that $\rho_t = \hat{\alpha} + \hat{\varepsilon}_t$ (i.e real interest rate is constant), where $\varepsilon_t \sim i.i.d$, the Fisher equation becomes $r_t = \hat{\alpha}_t + \Pi_t + \hat{\varepsilon}_t$. This equation implies independence of the real interest rate and inflation, in other words "no direct and consistent connection of any real significance exists between price changes and interest rate" (Pelaez quoted by Dimand, 1999: 745). The equation is usually estimated in log levels as $\ln(r_t) = \hat{\beta}_0 + \hat{\beta}_1 \ln(\Pi_t) + u_t$, where constant $\hat{\beta}_0$ can be interpreted as the long-run equilibrium real interest rate and, $\hat{\beta}_1$ is expected to be 1 to hold the long run validity of the Fisher equation. (Gillman and Czikary 2005, 14). Note that, when the variables are in logarithms, inflation is measured as $\ln(\Pi_t) = \ln(p_t / p_{t-1})$, i.e., $\Delta \ln(p_t)$. With all additional assumptions and modifications, Fisher equation can be shown as

$$\ln(r_t) = \hat{\beta}_0 + \hat{\beta}_1 \Delta \ln(p_t) + \hat{u}_t, \quad \hat{u}_t \sim i.i.d., \quad \hat{\beta}_1 = 1$$

Initially ignoring the order of the integration, the estimated equation is

$$\ln(r_t) = 4.21 + 0.0006\Delta \ln(p_t),$$

The standard errors are in parentheses and R-squared is equal to 0.000032, S.E of regression is equal to 0.302, and DW is equal to 0.0489. It is evident that the null hypothesis $H_0: \hat{\beta}_1 = 0$ cannot be rejected, and in addition, a low Durbin Watson statistics implies dynamic misspecification and serial correlation between residuals. The ADF unit root test on residual produces a t-value of 0 -1.5112 where the highest significant lag is 2, which clearly cannot reject that u_t is I (1) (i.e integrated of order 1).

Following Gillman and Czikary (2005), the estimation of Sargent's (1972) extended Fisher equation with n=m=3 is estimated and the estimation result is as follows

$$\ln(r_{t}) = 15.213 - 0.548 \ln(m_{t}) - 0.108 \ln(m_{t-1}) - 0.04 \ln(m_{t-2}) - 0.69 \ln(m_{t-3})$$

$$(0.91) \quad (0.303) \quad (0.373) \quad (0.375) \quad (0.286)$$

$$+ 2.997 \ln \Delta(p_{t}) - 0.801 \ln \Delta(p_{t-1}) - 0.002 \ln \Delta(p_{t-2}) - 0.77\Delta \ln(p_{t-3}),$$

$$(0.568) \quad (0.99) \quad (0.99) \quad (0.60)$$

with R-square equal to 0.6384, standard error of regression is equal to0.1847, and DW is equal to 0.255. Because DW is significantly smaller than 2, there is a possible remaining residual autocorrelation, although the fit improved and the residuals are stationary. The ADF t-value was -4.681 with 3 lags included in regression, which is above the 5% critical value of -2.875 with constant). This is also seen in the long run relation:

$$\ln(r_t) = 16.743 - 1.552 \ln(m_t) + 1.597 \Delta \ln(p_t),$$
(0.803) (0.099) (0.102)

When the long run relation restrictions are imposed on coefficients, the Wald $\chi^2_{(2)} = 1485$ and, it is highly significant. Even though the sign of coefficient are as expected, both coefficients are insignificant. Moreover, t-statistic from ADF (-2.858) implies unit root which confirms the previous conclusion about integration order of variables.

Alternatively, again following Gillman and Cziraky(2005), I consider a bivariate VECM system formed with nominal interest rate and inflation using the Johansen technique. Initially, optimal lag length was determined by LR statistics which assures no serial correlation between residual in the system, and the suggested lag length is 5 for the model. The model representation with vectors is as follows

$$\begin{pmatrix} \ln \ \Delta \ r_{t} \\ \ln \ \Delta \ p_{t} \end{pmatrix} = \begin{pmatrix} \tau_{1} \\ \tau_{2} \end{pmatrix} + \sum \begin{pmatrix} \kappa \ {}^{(i)}_{11} \ \kappa \ {}^{(i)}_{12} \\ \kappa \ {}^{(i)}_{21} \ \kappa \ {}^{(i)}_{22} \end{pmatrix} \begin{pmatrix} \ln \ \Delta \ r_{t-i} \\ \ln \ \Delta \ p_{t-i} \end{pmatrix}$$
$$+ \begin{pmatrix} \chi_{11} \ \chi_{12} \\ \chi_{21} \ \chi_{22} \end{pmatrix} \begin{pmatrix} \theta_{11} \ \theta_{12} \\ \theta_{21} \ \theta_{22} \end{pmatrix}' \begin{pmatrix} \ln \ r_{t-1} \\ \ln \ \Delta \ p_{t-1} \end{pmatrix}$$

The system's λ -trace and λ -max statistics are 22.317 and 19.162and 19.38704, whereas 95% critical values of λ -trace and λ -max tests are 19 and 25.3. These results imply that there is no cointegration between the interest rate and inflation. The long-run Fisher equation does not hold in Turkey. That is why inflation will be added into the system of money demand.

3.4 Money Demand Estimation

In this section, the Vector Error Correction Models (VECM) is applied to gain an insight into dynamic of the money demand function and allow for feedbacks among endogenous variables of the function. The standard VECM is obtained from a vector autoregressive (VAR) model;

$$x_{t} = \mu_{t} + \sum_{i=1}^{k} A_{i} x_{t-i} + u_{i}$$

Here, x_i is (nx1) dimensional vector of endogenous variables, μ_i contains deterministic terms like constant and time trend, A_i are (n × n) dimensional coefficient matrices and $u_i \sim (0, \sigma_u)$ is serially uncorrelated term. In case of serial correlation, it can be absorbed by including appropriate number of lags. Subtracting x_{t-1} and rearranging terms yields the VECM:

$$\Delta x_{t=1} = \mu_t + \prod x_{t-1} + \sum_{i=1}^{k=1} \Gamma_i \Delta x_{t-i} + u_t,$$

where x is a vector of nonstationary (in levels) variables and, Π and Γ_i are function of the A_i . The matrix Π can be decomposed into two (n × r) dimensional matrices α and β' : $\Pi = \alpha\beta$ where α is adjustment matrix containing adjustment coefficients which show the amount of changes in the variables to bring the system back to equilibrium and, β' comprises the cointegrating vectors which show the long run equilibrium relationship between levels of variables, and r is number of linearly independent cointegrating vectors.

Following Gillman and Czikary et al. (2005), the vector x comprises the following variables: real money $\ln (m - p)_t$, inflation $\ln (\Pi_t)$, industrial production $\ln (i_t)$ used as output variable, interest rate R_t .

The four variable system is represented as

$$\begin{pmatrix} \Delta(m-p)_{t} \\ \Delta y_{t} \\ \Delta \pi_{t} \\ \Delta R_{t} \end{pmatrix} = \begin{pmatrix} \omega_{1} \\ \omega_{2} \\ \omega_{3} \\ \omega_{4} \end{pmatrix} + \sum_{i=1}^{12} \begin{pmatrix} \phi_{11}^{(i)} & \phi_{12}^{(i)} & \phi_{13}^{(i)} & \phi_{14}^{(i)} \\ \phi_{21}^{(i)} & \phi_{22}^{(i)} & \phi_{23}^{(i)} & \phi_{24}^{(i)} \\ \phi_{31}^{(i)} & \phi_{32}^{(i)} & \phi_{33}^{(i)} & \phi_{34}^{(i)} \\ \phi_{41}^{(i)} & \phi_{42}^{(i)} & \phi_{43}^{(i)} & \phi_{44}^{(i)} \end{pmatrix} \begin{pmatrix} \Delta(m-p)_{t-i} \\ \Delta y_{t-i} \\ \Delta \pi_{t-i} \\ \Delta R_{t-i} \end{pmatrix}$$
$$+ \begin{pmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} \end{pmatrix} \begin{pmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} \end{pmatrix} \begin{pmatrix} (m-p)_{t-1} \\ y_{t-1} \\ \pi_{t-1} \\ R_{t-1} \end{pmatrix}$$

$$+ \begin{pmatrix} \boldsymbol{l}_{1t} \\ \boldsymbol{l}_{2t} \\ \boldsymbol{l}_{3t} \\ \boldsymbol{l}_{4t} \end{pmatrix}$$

The lag order of the estimated VECM was determined by using Akaike (AIC) information criteria. Gordon (1995) suggests that according to various criteria different number of lagged differences may arise. I follow the strategy to select the minimal lag length suggested by statistics which ensures the error term is not serially correlated. The suggested lag order by AIC is 14 for the model, and it also justified by sequential modified LR statistics at 5% level. I started estimating a VAR(14) with constant and term. The diagnostics results in the form of vector statistics indicate that our VAR model is satisfactorily a close approximation to the actual data process, with the exception of some non-normality of residuals: The result of the VAR stability test shows that no root lie outside the unit circle but there were two quasi-unit roots (modulus>0.98) and, the LM results $\chi_{(14)}^2 = 9.38$ suggests that the model residuals are not serially correlated whereas normality test $\chi_{(8)}^2 = 181.65$ implies non-normality of residuals.

In order to determine the number of the cointegrating relationship, the Johansen(1988) maximum likelihood method is preferred instead of Engle-Granger twostep method, because Johansen method provides more robust results, especially when more than 2 variables are included in the model.(Gonzalo, 1994). The Johansen approach is based on the relationship between the rank of a matrix derived from coefficient matrices and its characteristic roots. The Johansen cointegration test provides two different tests to determine the number of cointegrating vectors which are trace and maximum eigenvalue tests. The null hypothesis of the trace test is that there are at most r cointegrating vectors while the alternative hypothesis is a general one. In the maximum eigenvalue test, the null hypothesis is that there are r cointegrating vectors and it is tested against r+1 cointegrating vectors.

Both the maximum eigenvalues and trace test statistics strongly reject the null hypothesis of no cointegration in favor of one cointegration relationship which is given in Table- . On the other hand, they show inconsistent results for more than one cointegrating relationship. Because in the model with too many variables or lags the Johansen procedure tends to over estimate the number of cointegrating vector, I prefer to go with 1 cointegrating relationship which was approved by both test statistics.

Table 2- Cointegration test results	S
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Hypotheses	Eigenvalue	$\lambda_{_{trace}}$	95% Critical Value	$\lambda_{_{ m max}}$	%95 Critical Value
r =0	0.134449	59.49*	47.856	47.85*	27.58
r<= 1	0.082587	30.33*	29.797	29.79	21.13
r<= 2	0.040415	12.91	15.494	15.45	14.26
r<=3	0.022443	4.58*	3.841	3.84*	3.84

The estimation using the Johansen maximum likelihood technique does not contain the trend term. First of all trend coefficient was insignificant in VAR(14) and this result is also visually justifiable by individual graphs of variables. Finally, the estimation results for the unrestricted cointegrating and adjustment coefficient matrices are as follow:

$$\beta' = \begin{pmatrix} 1.000 & -1.143 & 0.044 & 0.009 \\ -18.583 & 1.000 & 0.201 & 0.002 \\ -7.554 & 12.146 & 1.000 & -0.054 \\ 202.916 & 31.997 & -23.148 & 1.000 \end{pmatrix}$$
$$\alpha = \begin{pmatrix} -0.006 & 0.006 & 0.003 & -0.001 \\ 0.007 & -0.001 & 0.004 & 0.004 \\ 0.000 & 0.001 & -0.002 & 0.001 \\ -0.929 & -0.557 & -0.197 & 0.239 \end{pmatrix}$$

For the purpose of investigating the possibility of long run weak exogeneity of the variables with respect to the cointegrating parameters, various restrictions were imposed on the parameters of alpha matrix and, the only hypothesis that cannot be rejected was that inflation is weakly exogeneous with respect to the long-run parameter with a test statistic $\chi^2(1) = 0.129$. With the valid restriction of weak exogeneity of inflation imposed the estimates of β' and α becomes:

$$\beta' = (22.59 - 26.32 \quad 1.05 \quad 0.21) \quad \alpha = \begin{pmatrix} -0.006 \\ 0.007 \\ - \\ -0.940 \end{pmatrix}$$

All the coefficients in the cointegrating vector have anticipated signs and, they provide economically meaningful representation of a money demand function. Namely, the cointegrating vector suggests a positive relationship between money demand and output whereas negative relationship can deduced for money demand and interest rate and inflation. After normalizing the cointegrating vector relation to $(m - p)_t$ and writing the long run relationship in equation format, the long run money demand equation becomes

$$(m-p)_t = 1.16(y_t) - 0.046(\pi_t) - 0.009R_t$$

Inflation has a semi elasticity of 0.05 percent and, even when the weak exogeneity of inflation is imposed on cointegrating vector, the coefficient on the inflation does not change significantly. This relation supports the view that agents decrease their money holding in favor of real assets when the inflation is expected to rise. The equation also indicates long run unit income elasticity which means that there is a one-for-one relation between changes in money demand and changes in income.



Figure 1 Velocity and Nominal Interest Rate

However, these results on income elasticity and interest elasticity are contradictory with Baumol's study(1952) which predicts that both the income elasticity and the interest elasticity of money demand is one half.

Moreover the interest rate coefficient is not so big which implies a weak relationship between money demand and interest rate and, another way to interpret this result would be relating it with velocity which is defined as output divided by real money.. As graphs also indicate, if the interest rate coefficient was large, a decreasing interest rate would cause a decrease in money velocity throughout 1994. But as we can also see from the graph above, the sharp decrease in interest rate did not affect the velocity much and velocity continued to rise.

The adjustment coefficients for the money demand and inflation are small. Hence, they suggest small reactions by money demand and inflation to a deviation from the long run equilibrium, whereas interest rate coefficient is much bigger in the short-run than long-run.

3.4.1 Money Demand without Inflation:

After investigating that the Fisher equation does not hold for Turkey, including inflation rate into the money demand function was justified. For the purpose of checking the robustness of the baseline model, the money demand function is now a three variable VECM instead of four variable one with the assumption that the Fisher equation does hold. The optimal lag order suggested by AIC is 15 in this case, and the test statistics of the Johansen procedure suggest no cointegration. The test statistics without the trend in CE is the first one, and latter is the result with the trend in CE:

Hypotheses	Eigenvalue	$\lambda_{_{trace}}$	95% Critical Value	$\lambda_{ m max}$	%95 Critical Value
r =0	0.094357	24.07058	29.79707	19.92120	21.13162
r<= 1	0.017764	4.149379	15.49471	3.602644	14.26460
r<= 2	0.002716	0.546735	3.841466	0.546735	3.841466

Table 4- Cointegration test statistics with the trend in cointegrating equation:

Hypotheses	Eigenvalue	λ_{trace}	95% Critical Value	$\lambda_{ m max}$	%95 Critical Value
r =0	0.101244	35.04890	42.91525	21.45559	25.82321
r<= 1	0.050219	13.59331	25.87211	10.35637	19.38704
r<= 2	0.015975	3.236946	12.51798	3.236946	12.51798

5. Conclusion

This thesis models the long run and short run money demand relationship in Turkey for the period of 1986:1-2003:12. Throughout the period, Turkey experienced two financial crises (1994, 2001), many reforms and institutional changes in the economy; the Capital account liberalization which started in 1980 was completed by the serious steps taken by government in 1989, the fixed exchange rate policy based on government decision for the determination of Turkish Lira value was abandoned by the 1980 stabilization program, and a managed floating exchange rate scheme was introduced, amount of dollarization increased dramatically, introduction of financial innovation driven mainly by an increasing government debt mostly caused by moralhazard problem and financial liberalization. The period is also characterized by a high inflation rate, increasing money supply, unstable exchange and interest rates.

Empirical analysis started off by investigation of Fisher economy in Turkey. After using sequence of tests derived by different approaches, the results reveals that Fisher equation does not hold in Turkey, meaning that the nominal interest rate and inflation rate does not move together and also they are not interchangeable in the money demand function. Thus only interest rate is not appropriate to represent the cost of money and, a modification of the standard money demand function by including inflation rate was needed to model the money demand relationship in Turkey. The analysis about money demand function was carried out by means of Johansen multivariate cointegration analysis methods. The results suggest that there is a stationary long-run relationship between money demand, output, inflation and interest rate on government bonds between 1986:1 and 2003:12, a period which is politically and economically less than calm. The cointegration analysis indicates that income elasticity is close to unity in accordance with quantity theory of money, and interest rate and inflation have correct sign in the long run. In the short run, the adjustment coefficients for the money demand and inflation are small. Hence, they suggest small reactions by money demand and inflation to a deviation from the long run equilibrium, whereas interest rate coefficient is much bigger in the short-run than long-run.

The robustness of the results was checked by analyzing the money demand relation without inflation variable. The result indicates no cointegration between money demand, interest on government bonds and output and not supportive of stable money demand relation without inflation rate in the function.

These results might provide a guide for the monetary authority to use money aggregates as policy tool, though this does not necessarily mean that money should be the only instrument for monetary policy. The relationship between variables would also be helpful for the monetary authorities, since one of their main tasks is to forecast the inflation.

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