MODELING TURKISH M2 BROAD MONEY DEMAND: A PORTFOLIO-BASED APPROACH USING IMPLICATIONS FOR MONETARY POLICY

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Abstract

In this paper, a money demand model upon M2 broad monetary aggregate for the Turkish economy is examined in a portfolio-based approach considering various alternative cost measures to hold money. Employing multivariate co-integration methodology of same order integrated variables, our estimation results indicate that there exists a theoretically plausible co-integrating vector in the long-run money demand variable space. The main alternative costs to demand for money are found as the depreciation rate of domestic currency and the course of equity prices, for which the former brings out the importance of currency substitution phenomenon settled in the economy. Besides, we find that domestic inflation carries a weakly exogenous characteristic and conclude that the main factors leading to the domestic inflation are determined out of the money demand variable space.

Key words: Broad Money Demand; Co-integration; Currency Substitution; Turkish Economy.

Özet

Bu çalışmada, Türkiye ekonomisi için M2 geniş kapsamlı parasal büyüklüğü üzerine kurulan bir para talebi modeli elde para tutumuna karşı çeşitli almaşık maliyet unsurları dikkate alınarak portföy temelli bir yaklaşım içerisinde incelenmektedir. Aynı dereceden bütünleşik değişkenlerin çok değişkenli eş-bütünleşim tahmin yöntemi kullanılarak incelenmesi şeklinde elde ettiğimiz tahmin sonuçları uzun dönem para talebi değişken uzayı içerisinde kuramsal beklentilerle uyumlu eş-bütünleşik bir vektörün bulunduğunu göstermiştir. Para talebine karşı başlıca almaşık maliyet unsurları ekonomi içerisinde yerleşik para ikamesi olgusunun önemini ortaya koyan yerli paranın değer kayıpları ve hisse senedi fiyatlarındaki gelişmeler şeklinde bulunmuştur. Ayrıca, bulgularımız yurtiçi enflasyonun zayıf dışsal bir özellik taşıdığını göstermiş ve yurtiçi enflasyona yol açan temel etkenlerin para talebi değişken uzayı dışında belirlendiği sonucuna ulaşılmıştır.

Anahtar kelimeler: Geniş Para Talebi; Eş-bütünleşim; Para İkamesi; Türkiye Ekonomisi.

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Introduction

Design of monetary policy for stabilization purposes needs to extract the knowledge of various functional relationships conditioned upon possible discretionary policy tools. Inferences dealing with monetary policy will meet the stylized facts of the economy only if they succeed in constructing foresights consistent with behavioral preferences of the economic agents dominated in the economy and to the extent that such an issue of interest for policy makers can be implemented, *ex-post* realizations of economics policies will be expected to converge to the *ex-ante* expectations of the economic agents.

A useful and widely-used way of analyzing the monetary policy is to examine what pecularities the demand for monetary balances have in the eyes of economic agents and such an analysis can in this manner bring out the pre-requisites in applying to the stabilization programs which requires that app-ropriate tools be chosen to achieve program targets. These will enable policy makers to form policy rules against major economic problems such as the domestic inflationary framework or the role and the extent of currency subs-tituon in the economy as well as the general outlook of what alternative costs against holding money are mainly chosen by the economic agents. Thus, testing a standard money demand equation can provide policy makers with the crucial knowledge of expectations in the monetary markets.

For the empirical purposes, two approaches can be attributed for the behavioral assumptions leading economic agents to demand for money, i.e., the transactions and the asset or portfolio balance approaches. The transactions motives emphasize mainly the money's role as a medium of exchange, and the demand for monetary balances in this approach increases proportionally with the volume of transactions in the economy. However, the portfolio balance approaches consider that people hold money as a store of value and money is only one of the assets among which people distribute their wealth. For the portfolio motives, people consider mainly the the expected rate of return for the various assets held in hand relative to the transactions necessities and take into account the risk factor for these assets because of the changing ratio of returns against each other. Of course, more condensed on portfolio approach, more intruments would be necessary for economic agents to hold in hand.

Given the importance of a stable money demand relationship carrying the knowledge of monetary policy issues, many papers in recent years are conducted by the researchers upon various country cases, such as Sriram (1999), Civcir (2000), Nachega (2001), Kontolemis (2002) and Dreger et al.

(2006). On the other side, papers by the CBRT researchers such as Mutluer and Barlas (2002), Akinci (2003) and Altinkemer (2004) can be considered some recent works upon the Turkish economy. In our paper, our aim is to construct a portfolio-based money demand model as a function of large set of alternative costs to hold money in the Turkish economy. For this purpose, the next section is devoted to the data issues and model specification and the third section conducts an empirical analysis for the Turkish economy, while the last section concludes.

1. DATA and METHODOLOGY

1.1. Model Construction and Data

We now construct a model of money demand for the investigation period of 1987Q1-2006Q4 using quarterly observations. While investigating the demand function, a critical point to be considered is the identification problem which means the non-observability of the money demand. As is generally assumed, for empirical purposes, researchers make on this point an important assumption that the quantity of money supplied and demanded equal each other thus assuming long-run equilibrium in the money market (Laidler, 1993). For transactions purposes, we can suppose that narrowly defined monetary variables are better to be considered, while broadly defined monetary variables used in this paper would be better off for the portfolio balance approaches in the money demand equation. After defining the money demand variable, we need to choose the explanatory factors that affect why economic agents hold monetary balances or that discourage people to hold these balances. We must first choose the scale-income variable which specifies the maximum limit of money balances people can hold in a positive relationship with money balances. Then what is of special concern for us is to determine what alternative costs against holding money are current in the economy. Finally, in order to assume a complete functional money demand relationship, the own rate of return for the money balances considered should be included in the functional form of money demand, which requires a positive relationship with money balances.

For empirical purposes, the monetary variable we used (m/p) is the M2 broad monetary aggregate including currency in circulation plus demand and time deposits in the banking system excluding the foreign currency based deposits. Under the assumption of no money illusion, we suppose that demand

for money is a demand for real money balances. In our case, we use the GDP-deflator to deflate the broad money supply. For the scale-income variable, the real gross domestic product data (y) is used. Following the general specification in Friedman (1956), the alternative cost variables to hold broad money balances in our paper are the maximum rate of interest on the Treasury bills (r_{tb}) representing the financial assets, whose maturity are at most twelve months or less, the quarterly domestic inflation (p) based on the GDP-deflator for the expected return on real assets, which represents the increase of prices of intangible assets under the assumption of substitution between commodities and domestic money, and the Istanbul Stock Exchange (ISE) National-100 index (r_{eq}) to represent the effect of equity prices on money demand. For the equity prices variable, Friedman proposes three alternative forms to be considered, that is, the constant nominal amount agents would receive in a given time period in the absence of any change in p, the increment or decrement to this nominal amount to adjust for changes in p and any change in the nominal price of the equity over time. In our paper, a similar variable specification similar to the first alternative is used given the time series characteristics of the variables below.

Choudhry (1995) emphasizes that a significant presence of the rate of change of exchange rate in the demand function for real money balances may provide evidence of currency substitution in high inflation countries, which reduces domestic monetary control by also reducing the financing of deficit by means of seigniorage and the base of the inflation tax. He indicates that for three high inflation countries, i.e., Argentina, Israel and Mexico, stationary long run money demand relationship only holds with the inclusion of currency depreciation in the money demand function. Since the Turkey is a small open economy with a highly liberalized capital account, such a consideration for the alternative costs to hold money may be crucial for the economic agents. Indeed, the proportion of foreign exchange based accounts in the Turkish banking system grows from 16% in 1987 till 57% by the end of 2001 and 35% by the end of 2006, which reflects a great deal of dollarization and currency substitution for the Turkish economy[1]. Following Civcir (2000), we include

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[1]   Giovannini and Turtelboom (1992), Yılmaz (2005) and Civcir (2005) touch on the difference between the terms dollarization and currency substitution in the sense that in high inflation countries foreign currency is first used as a store of value or unit of account representing dollarization and only at the later used as a medium of exchange. That is, currency substitution is the last stage of the dollarization process. But, for our estimation purposes in this paper, we can ignore such a theoretical distinction.

expected exchange rate depreciation (e) into our model construction to represent the currency substitution. For this purpose, we first ran a regression of producer price index- (PPI-) based real exchange rate series, for which an increase means appreciation of the domestic currency, on a constant and trend and then calculated the deviation of the actual series from the predicted series for real exchange rate misalignment. Civcir also argues that expected exchange rate depreciation adjusted for foreign interest variable would be highly collinear with expected exchange rate depreciation. Besides, when we include the foreign interest variable in our money demand model separately, we find that this variable yields results with an unexpected positive wrong sign. Given also that the foreign interest data take highly trivial values when compared with the relevant Turkish data, no such an adjustment is assumed in this paper. Finally, the own rate of return for the broad money balances is represented by the three-month time deposit rate (r_{own}).

All the data indicate seasonally unadjusted values and are in their natural logarithms except the both interest rate variables and domestic inflation which are in their linear-forms, while no impulse-dummy variable is considered. They are collected from the electronic data delivery system of the Centrak Bank of the Republic of Turkey (CBRT).

This model construction can be expressed in a functional form with appropriate expected signs such as Eq. 1 and Eq. 2 below:

$$m/p = f(y, r_{tb}, p, r_{eq}, e, r_{own}) \hspace{3cm} (1)$$

or in log-linear form:

$$m-p = \alpha + \beta y - \delta r_{tb} - \phi p - \gamma r_{eq} - \eta e + \phi r_{own} + \varepsilon \hspace{1.5cm} (2)$$

where ε is assumed to be a white-noise error term.

1.2. Unit Root Characteristics

We now investigate the time series properties of the variables. Spurious regression problem analysed by Granger and Newbold (1974) indicates that using non-stationary time series steadily diverging from long-run mean will produce biased standard errors, which causes to unreliable correlations within the regression analysis leading to unbounded variance process. In this way, when a non-stationary I (d) process identifies any time series, the standard OLS regression in the level form will possibly produce a good fit and predict statistically significant relationships between the variables where none really

exists (Mahadeva and Robinson, 2004). This means that the variable must be differenced (d) times to obtain a covariance-stationary process. Therefore, individual time series properties of the variables should be elaborately considered. Dickey and Fuller (1979) provide one of the commonly used test methods known as augmented Dickey-Fuller (ADF) test of detecting whether the time series are of stationary form. However, Elliot et al. (1996) propose a more powerful modified version of the ADF test in which the data are detrended so that explanatory variables are taken out of the data prior to running the test regression. Elliot et al. (1996) define a quasi-difference of X_t that depends on the value α representing the specific point alternative against which we wish to test the null:

$$d\,(X_t \,|\, \alpha) = \begin{cases} X_t & \text{if } t = 1 \\ X_t - \alpha X_{t-1} & \text{if } t > 1 \end{cases} \tag{3}$$

An OLS regression of the quasi-differenced data $d\,(X_t \,|\, \alpha)$ on the quasi-differenced $d\,(Z_t \,|\, \alpha)$ yields:

$$d\,(X_t \,|\, \alpha) = d\,(Z_t \,|\, \alpha)' \delta\,(\alpha) + \eta_t \tag{4}$$

where Z_t consists of deterministic constant or constant and trend terms and let $\delta\,(\alpha)$ be the estimated value from an OLS regression. For the value of α, Elliot et al. (1996) consider:

$$\alpha = \begin{cases} 1 - 7/T & \text{if } Z_t = \{1\} \\ 1 - 13.5/T & \text{if } Z_t = \{1, t\} \end{cases} \tag{5}$$

Following these specification issues, generalized least squares (GLS) detrended data X_t^d are:

$$X_t^d \equiv X_t - Z_t' \delta\,(\alpha) \tag{6}$$

The DF^{GLS} substitutes the GLS detrended X_t^d data for the original X_t data in the ADF equation. While the DF^{GLS} t-ratio follows a Dickey-Fuller distribution in the constant only case, the asymptotic distribution differs when included both a constant and trend. Elliot et al. (1996) simulate the critical values of the test statistic in this latter setting for $T = \{50, 100, 200, \infty\}$. We report below in Tab. 1 the DF^{GLS} estimation results:

Table 1: Unit root tests

Variable	Levels		First differences	
	τ_C	τ_T	τ_C	τ_T
m/p	-0.55	-1.19	-2.71*	-11.16*
y	1.82	-1.50	-2.93*	-8.43*
r_{tb}	-1.87	-2.50	-8.66*	-8.98*
p	-1.90	-2.35	-0.55	-9.52*
r_{eq}	1.10	-1.97	-5.63*	-6.86*
e	-1.86	-3.09	-9.76	-10.02
r_{own}	-1.87	-2.33	-8.37*	-8.49*
1% cri. val.	-2.60	-3.68		

Above, τ_C and τ_T are the test statistics with allowance for only constant and constant&trend terms in the DF^{GLS} unit root tests, respectively, while '*' means that the data are of stationary form. All the variables in the level form are found to have a unit root, however the null hypothesis that there is a unit root can easily be rejected when we apply to the differencing. Note that domestic inflation is trend-stationary. Besides, multivariate statistics for testing stationarity obtained from co-integration methodology below verify these findings.

1.3. Methodology

Let us assume a z_t vector of non-stationary n endogenous variables and model this vector as an unrestricted vector autoregression (VAR) involving up to k-lags of z_t:

$$z_t = \Pi_1 z_{t-1} + \Pi_2 z_{t-2} + ... + \Pi_k z_{t-k} + \varepsilon_t \qquad (7)$$

where ε_t follows an i.i.d. process $N(0, \sigma^2)$ and z is ($nx1$) and the Π_i an (nxn) matrix of parameters. Eq. 7 can be rewritten leading us to a vector error correction (VEC) model of the form:

$$\Delta z_t = \Gamma_1 \Delta z_{t-1} + \Gamma_2 \Delta z_{t-2} + ... + \Gamma_{k-1} \Delta z_{t-k+1} + \Pi z_{t-k} + \varepsilon_t \qquad (8)$$

where

$$\Gamma_i = -I + \Pi_1 + ... + \Pi_i \ (i = 1, 2, ..., k-1) \qquad (9)$$

and

$$\Pi = I - \Pi_1 - \Pi_2 - ... - \Pi_k \qquad (10)$$

Eq. 8 can be arrived by subtracting z_{t-1} from both sides of Eq. 7 and collecting terms on z_{t-1} and then adding $- (\Pi_1 - 1)X_{t-1} + (\Pi_1 - 1)X_{t-1}$. Repeating this process and collecting of terms would yield Eq. 8. This specification of the system of variables carries on the knowledge of both the short- and long-run adjustment to changes in z_t, via the estimates of Γ_i and Π. Following Harris (1995), $\Pi = \alpha\beta'$ where α measures the speed of adjustment coefficient of particular variables to a disturbance in the long-run equilibrium relationship and can be interpreted as a matrix of error correction terms, while β is a matrix of long-run coefficients such that $\beta'z_{t-k}$ embedded in Eq. 8 represents up to ($n-1$) cointegrating relations in the multivariate model which ensure that z_t converge to their long-run steady-state solutions. Note that all terms in Eq. 8 which involve Δz_{t-i} are $I(0)$ while Πz_{t-k} must also be stationary for $\varepsilon_t \sim I(0)$ to be white noise of an $N(0, \sigma_\varepsilon^2)$ process.

For the lag length of unrestricted VAR, we consider sequential modified LR statistics which compare the modified LR statistics to the 5% critical values starting from the maximum lag, and decreasing the lag one at a time until first getting a rejection. In our case, reduction of system is first rejected when we test the reduction to 3 lag orders. Thus we construct the unrestricted VAR model with 4 lags. We add a set of centered seasonal dummies which

sum to zero over a year as exogeneous variable. In this way, the linear term from the dummies disappears and is taken over completely by the constant term, and only the seasonally varying means remain (Johansen, 1995). As a next step, we estimate the long run co-integrating relationships by using two likelihood test statistics known as maximum eigenvalue for the null hypothesis of r versus the alternative of $r+1$ co-integrating relations and trace for the null hypothesis of r co-integrating relations against the alternative of n co-integrating relations, for $r = 0, 1, ..., n-1$ where n is the number of endogenous variables.

2. RESULTS

Following the model specification expressed above, we give below the co-integration test results of the money demand model in which no deterministic trend is restricted:

Table 2. Co-integration tests

Null hypothesis ı=	0	r≤1	r≤2	r≤3	r≤4	r≤5	r≤6
Eigenvalue	0.50	0.40	0.36	0.25	0.14	0.07	0.01
λ trace	159.8*	108.0*	70.57*	37.52	16.27	5.42	0.23
5% cri. val.	125.6	95.75	69.82	47.86	29.80	15.49	3.84
λ max	51.78*	37.46	33.05	21.24	10.85	5.19	0.23
5% cri. val.	46.23	40.08	33.88	27.58	21.13	14.26	3.84

* denotes rejection of the hypothesis at the 0.05 level.

Unrestricted Co-integrating Coefficients

m/p	y	r_{tb}	p	r_{eq}	e	r_{own}
-8.823	27.10	-1.944	-23.31	-1.189	-16.43	-0.030
-4.863	10.08	-12.29	27.36	-0.430	-14.08	0.086
-3.089	2.556	1.271	-74.65	-1.140	-14.69	0.097
-12.05	10.36	-11.64	15.84	0.893	-6.967	0.018
2.629	-21.58	4.389	-1.277	0.988	-10.57	-0.126
5.671	13.48	0.011	9.315	-1.355	-14.83	0.020
9.927	6.893	4.056	-2.335	-1.621	0.738	-0.010

1 Co-integrating Equation (t-stat. in parantheses)

m/p	y	r_{tb}	p	e	r_{eq}	r_{own}	Constant
1.000	-3.071	0.220	2.642	1.862	0.135	0.003	19.85
	(-4.69)	(1.07)	(1.80)	(3.33)	(2.75)	(1.06)	

Adjustment coefficients

m/p	y	r_{tb}	p	e	r_{eq}	r_{own}
-0.077	-0.002	-0.131	-0.046	-0.050	-0.354	-0.207
(0.04)	(0.03)	(0.20)	(0.06)	(0.06)	(0.18)	(-0.11)

Multivariate Statistics for Testing Stationarity

	m/p	y	r_{tb}	p	e	r_{eq}	r_{own}
χ^2 (6)	29.97	30.56	42.33	33.80	47.57	29.91	44.66

In Tab. 2, we find that trace test indicates 3 and max-eigen test 1 potential co-integrating vectors lying in the long-run variable space. When we examine the unrestricted co-integrating coefficients in Tab. 2 above, we find that the first vector with the largest eigenvalue seems to be a theoretically plausible money demand vector. Thus, we accept that this vector which is found common to represent a long-run stationary relationship by both rank statistics is the money demand vector we search for. Rewriting the normalized money demand equation under the assumption of $r = 1$ yield in Eq. 10 below[2]:

$$\beta'_{m1}z_{t-k}= m/p\text{-}3.07y+0.22r_{tb}+2.64p+1.86+0.14r_{eq}+0.01r_{own}+19.85 \text{ (11)}$$

The results from Eq. 11 reveal that income elasticity of money demand for the real broad money balances is above unity indicating a monetization

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[2]   When the deterministic trend is restricted in the co-integrating space, we find highly similar estimation results to those with no deterministic trend, but the adjustment coefficient on real money balances turns out to be statistically insignificat in this case. These results not reported here to save space are available upon request.

process in the economy. We estimate that the unit income homogeneity restriction is rejected through $\chi^2(1) = 10.63$ against the $\chi^2(1)$-table value 3.84. All the alternative cost variables have the expected normalized sign, but the statistical significance can only be achieved for the currency substitution and equity price variables. The domestic inflation has also a significance in the margin for the acceptable levels. The t-statistics indicate that as for the significance levels, the main alternative cost for the economic agents to hold broadly defined monetary balances is the depreciation rate inside the period examined. This brings out the importance of an ongoing currency substitution phenomenon settled in the economy when the economic agents make their decisions for their monetary holdings. Besides, we find that for the feedback effects correcting disturbances from the steady-state functional form in the long-run, real income, Treasury bill rate, inflation rate and currency depreciation rate have a weakly exogenous characteristic in the money demand variable space, but the adjustment coefficients of real money balances, equity prices and own rate of return are found statistically significant. As Sriram (1999) emphasizes, in the case of negative significant error correction term of the money demand equation, a fall in excess money balances in the last period would result in higher level of desired money balances in the current period, that is, it is essential for maintaining long run equilibrium to reduce the existing disequilibrium over time. About 8% of the adjustment in money demand disequilibrium conditions to achieve long run static equilibrium is realized within one period. Multivariate statistics for testing stationarity are in line with the DF[GLS] unit root test results obtained above in the sense that no variable alone can represent a stationary relationship in the co-integrating vector.

An important policy conclusion can also be extracted from the Tab. 2 such that no dynamic vector error correction model upon domestic inflation is warranted to be constructed, which can be derived from the money demand co-integrating vector. Such a case would mean that the main factors leading to the domestic inflation are determined out of the money demand variable space considered in this paper. Finally, the model has good diagnostics and fits well to the data generating process in the VEC model using LM (1) = 48.61 (prob. 0.49), LM (4) = 60.25 (prob. 0.13), where LM (1) and LM (4) are the 1st and 4th order VEC system residual serial correlation lagrange multiplier statistics under the null of no serial correlation. For the VEC system residual serial correlation test, probs. come from $\chi^2(49)$.

Concluding Remarks

In this paper, we construct a portfolio-based money demand model upon the Turkish economy employing contemporaneous multivariate co-integration methodology of the same order integrated variables. Our estimation results indicate that income elasticity of money demand for the real broad money balances is above unity indicating a monetization process in the economy. Among the various alternative cost variables, the most statistically significant one is the depreciation rate which brings out the importance of currency substitution phenomenon settled in the economy. Equity prices are also find another main alternative cost variable to hold monetary balances. Besides, we find that domestic inflation is weakly exogenous and conclude that the main factors leading to the domestic inflation are determined out of the money demand variable space.

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