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Estimation of the Demand for Money in Iran

Asadollah Farzinvash[*]
Asghar Shahmoradi[**]
Parisa Tavakol[***]

Abstract

Recent studies of monetary demand indicate that simple sum measurement of monetary aggregates in money demand is invalid; unless the monetary components of aggregates are perfect substitutes. Thus all predictions of monetary policies based on simple sum method of aggregation should be reevaluated.

This paper focuses on the demand for money in Iran and utilizes the demand systems approach in the context of locally Flexible Functional Forms – the Generalized Leontief (GL). It also pays explicit attention to the theoretical regularity conditions of positivity, monotonicity and curvature. Without satisfaction of all these theoretical regularity conditions, the resulting inferences are worthless.

The resulting estimates indicate that the Morishima elasticities of substitution between demand deposits and time deposits are less than unity, which indicates a low elasticities of substitution among these two monetary components.

Key Words: Money Demand, Monetary Components, Simple Sum, Imperfect substitution, Flexible Functional Forms.

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* Associate Professor, Faculty of Economics, University of Tehran.
** Assistant Professor, Faculty of Economics, University of Tehran.
*** Master in Economics, University of Tehran.

1- Introduction

Traditionally money is defined just as the sum of monetary components that no interest is paid on them like currency and demand deposits. It is obvious that this definition is not drawing a complete picture as there are some monetary assets that are paid different interests. The natural question is then arises whether all monetary componets are equal money and their quantities should sum up by equal weights? And if money is an important commodity; so what is its price?

The monetary aggregates currently in use are simple –sum indices in which all monetary components are assigned a constant and equal (unitary) weight. These indices maybe represented as:

$$\mathrm{M} = \sum_{i=1}^{n} x_i \qquad (1)$$

Where x_i is the i^{th} monetary component;

This clearly implies that all monetary components are weighted linearly and equally in the final aggregation and that all components are dollar–for-dollar perfect substitutes. Thus if this aggregation is to represent the actual quantity selected by economic agents the indifference curves over these components must be linear with slopes of minus 1.0, which implies a very restrictive form of the utility function among many possible forms.. The main problem with the simple sum index arises from the fact that in aggregation theory a quantity index must measure the income effects of relative price changes net of substitution effects. The simple-sum index can not untangle income effect from substitution effect if its components are not perfect substitutes.

In the face of cyclically fluctuating incomes and interest rate; the simple-sum approach to monetary aggregation cannot be the best that can be achieved.

Adding to the weakness of the simple sum approach, there may be no change in the aggregate by changing the amount of some of the monetary components. However, M will not change if an increase in the amount of x_i is equal to decrease the amount of x_j .

Building on a literature, which Barnett (1997) calls the "high road" that takes a microeconomic- and aggregation- theoretic approach, we estimate the demand for money in Iran. In this approach money is inserted in a utility function. This utility function is has flexible functional form in which we pay attention to the theoretical regularity conditions of positivity, monotonicity, and curvature as well as the degree of substitutability between money and near monies.

The hypothesis of this paper is the simple sum approach to monetary aggregation is not robust to money demand; This hypothesis is equal to test the hypothesis of low degree of substitutability between the components of money, which this paper is indented to examine.

This paper follows the works by Ewis and Fisher (1984), Serletis and Robb (1986), Fleissig (1994, 1997), and Serletis and Shahmoradi (2004) among others that in the context of locally flexible functional forms they estimate the demand for money in U.S.A, U.K.

The results of this paper, along with the others in this literature, show that the degree of substitutability between components of money is less than 1. So the simple-sum approach to monetary aggregation cannot be the best that can be achieved.

The rest of the paper organized as follows, in section two, the theoretical framework of the demand for money is developed, section three discusses the generalized Leontief flexible functional form, the next section lays out the data and estimation method, the last section concludes the paper.

2- The Theoretical Framework

Consider an economy with identical individuals**,** having three types of goods: consumption goods, leisure, and monetary assets where the services of these three entities enter as arguments in the individual's utility function. Such utility function can be written as

$$u = u(c, l, x) \tag{2}$$

Where c is a vector of the services of consumption goods (durable or nondurable)**,** l is the leisure time, and x is a vector of monetary assets**,** which provide services such as convenience, liquidity**,** and information**.**

The utility function in equation (2) can be maximized subject to a full income constraint:

$$qc + \pi x + wl = y \tag{3}$$

where y is total income, q is a vector of the prices of c, π is a vector of monetary *user cost*; and w is the shadow price of leisure (Barnett 1981). According to neoclassical consumer behavior theory, one can use equations 2 and 3 to investigate the demands for each of the components in the utility function. Since we are interested in the demand for monetary assets, we assume a *weakly separable* utility function in the services of monetary assets, the following neoclassical maximization problem over monetary assets is plausible for a representative agent:

$$u = f(x) \qquad : \sum_{i=1}^{n} \pi_i x_i = m$$

where f defines the monetary utility function, m is the total expenditure on monetary assets and π measures the monetary user cost as before. Following Barnett (1978, 1980), in a certain world, the nominal user cost of the i^{th} component of π is,

$$\pi_i = p\left(\frac{R - r_i}{1 + R}\right) \tag{4}$$

This formula measures the opportunity cost-at the margin-of the monetary services provided by asset i. It is calculated as the discounted value of the interest foregone by holding a dollar's worth of that asset. Here r_i is the expected nominal holding period yield on the i^{th} asset, R is the maximum expected holding-period yield on an alternative asset (the “bench mark " asset) and p is the real cost of living index.

Our objective is to estimate a system of demand equations derived from an indirect utility function. The most important advantage of using the indirect utility approach is that prices enter as exogenous variables in the estimation process and the demand system is easily derived by applying Roy’s identity.

In this paper, the demand system used in estimation is derived by approximating the indirect aggregator function, dual to the direct aggregator function $f(x)$, using a locally flexible functional form, namely, the generalized Leontief (GL) form.

3- Locally Flexible Functional Form-The Generalized Leontief

In this section we briefly discuss the functional forms that we use in this paper-The Generalized Leontief. The generalized Leontief (GL) functional form was introduced by Diewert (1973) in the context of cost and profit functions. Diewert (1974) introduced the GL reciprocal indirect utility function as follows

$$H(V) = a_0 + \sum_{i=1}^{n} a_i v_i^{1/2} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} a_{ij} v_i^{1/2} v_j^{1/2} \tag{7}$$

where $V = [v_1, v_2, ..., v_n]$ is a vector of income normalized user costs, with the i^{th} element being $v_i = m$ where π_i is the user cost of asset i and y is the total expenditure on the n assets. $A = [a_{ij}]$ is an $n * n$ symmetric matrix of parameters and a_0 and a_i are other parameters, for a total of $\frac{n^2 + 3n + 2}{2}$ parameters. Using Diewerts (1974) modified version of Roy's identity

$$s_i = \frac{v_i \, \partial H(V)/\partial v_i}{\sum_{j=1}^{n} v_j \, \partial H(V) \Big/ \partial v_j} \tag{8}$$

where $s_i = v_i x_i$ is the share for i^{th} component and x_i is the demand for asset i, the GL demand can be written in the share format as follows:

$$s_i = \frac{a_i \, v_i^{1/2} + \sum_{j=1}^{n} a_{ij} \, v_i^{1/2} \, v_j^{1/2}}{\sum_{j=1}^{n} a_j \, v_j^{1/2} + \sum_{k=1}^{n}\sum_{m=1}^{n} a_{km} \, v_k^{1/2} \, v_m^{1/2}} \qquad i = 1,...,n \tag{9}$$

Because the share equations are homogenous of degree zero in the parameters we follow Barnett and Lee (1985) and impose the following normalization in estimation

$$2\sum_{i=1}^{n} a_i + \sum_{i=1}^{n}\sum_{j=1}^{n} a_{ij} = 1 \tag{10}$$

The usefulness of flexible functional forms depends on whether they satisfy the theoretical regularity conditions of positivity, monotonicity and curvature.

The regularity conditions are checked as follows:

- **Positivity**

Positivity is checked by direct computation of the values of the estimated budget shares, s_t , It is satisfied if $s_t > 0$, for all *t*.

- **Monotonicity**

Monotonicity is checked by choosing normalization on the indirect utility function so as to make $H(v)$ decreasing in its arguments and by direct computation of the values of the first gradient vector of the estimated indirect utility function.

It is satisfied if $\nabla H(v) < 0$, where $\nabla H(v) = d\left(H(v)/dv\right)$.

- **Curvature**

The indirect utility function should be a quasi-convex function in income normalized prices, this is the curvature condition. Curvature requires that the Hessian matrix is negative semi definite.

Curvature can also be checked by examining the Allen elasticities of substitution matrix, provided that the monotonicity condition holds. It requires that this matrix be negative semi definite.

We follow Serletis and Shahmoradi (2005b) and impose curvature conditions locally on the generalized Leontief model by building on Ryan and Wales (1998) and Moschini (1991).In doing so, we exploit the Hessian matrix of second order derivatives of the indirect utility function. The evaluation of the Hessian matrix is explained in Serletis and Shahmoradi (2004,p6).

3-1 Elasticities

In the demand systems approach to estimation of economic relationships, especially in policy analysis, it is necessary to understand how the arguments of the underlying functions affect the quantities demanded. This is expressed in terms of income and price elasticities and elasticities of substitution. These elasticities can be evaluated at the mean of the data.

From the point of view of monetary policy, the measurement of the elasticities of substitution among the monetary assets is of prime importance.

There are currently two methods employed for calculating the partial elasticity of substitution between two variables, the Allen and the Morishima elasticities of substitution. Following Serletis (2001), the Allen partial elasticity of substitution between two liquid assets i and j, σ_{ij}^{a} can be calculates as:

$$\sigma_{ij}^{a} = \eta_{im} + \frac{\eta_{ij}}{s_i}$$

The Allen elasticity of substitution is the traditional measure and has been employed to measure substitution behavior. When there are more than two goods, the relationship becomes complex and depends on things such as the direction taken towards the point of approximation. In that case the Morishima elasticity of substitution is the correct measure of substitution elasticity:

$$\sigma_{ij}^{m} = s_i \left(\sigma_{ji}^{a} - \sigma_{ij}^{a}\right)$$

where s_i is the share of asset i in the consumer's budget constraint. Notice that the Morishima elasticity looks at the impact on the ratio of two goods (x_i/x_j). Assets will be Morishima complements (substitutes) if an increase in the price of *j* causes *xi/xj* to decrease (increase).

4- Data

We use quarterly data set from (1988:1 to 2005:2). The set consists of monetary quantities and user costs for the three monetary components: currency, demand deposits and time deposits along with the interest rate paid on each monetary component and the implicit price deflator and labor force.

Since we require real per capita data for our empirical work, so we have divided each measure of monetary services by the implicit price deflator and Iran labor population in each period.

To construct user costs, which are appropriate prices for monetary services, we subtract the interest rate paid on each individual component of money from the bench mark rate to calculate and then divided result to $(1+R)$.

$$\pi_i = p\left(\frac{R - r_i}{1 + R}\right)$$

In our empirical work we used arbitrarily the highest interest rate of deposits as a *bench mark* rate, R.

Following equation 9, we use the following model:

$$s_i = \frac{a_i v_i^{1/2} + \sum_{j=1}^{n} a_{ij} v_i^{1/2} v_j^{1/2}}{\sum_{j=1}^{n} a_j v_j^{1/2} + \sum_{k=1}^{n}\sum_{m=1}^{n} a_{km} v_k^{1/2} v_m^{1/2}} \qquad i = 1,\dots,n$$

in this model:

v_1 is the explanatory variable and income normalized user cost of Currency.

v_2 is the explanatory variable and income normalized user cost of demand deposits.

v_3 is the explanatory variable and income normalized user cost of time deposits.

s_i is the dependent variable where s_i is the share of each monetary asset in the total expenditure.

The results of Dickey fuller test indicate that all variables are stationary. All estimation are performed in TSP/Givewin with the full information likelihood method. We estimate three models, the model without imposing curvature condition, this model with imposing curvature, the same model with autoregression correction. The only model which satisfy the regularity conditions at all data points and the same produces the satisfactory results for estimated coefficients in terms of p-values, is the GL model with imposing curvature condition, we do not report the estimation result and conserve ourselves to report the estimated elasticities based on our estimated model.

5- Conclusions

The own-price elasticities, evaluated at the mean of the data, are all negative (as predicted by the theory), however, currency and demand deposits are elastic and time deposits are inelastic. It seems that the high own price elasticity of demand for currency is due to the high inflation in Iranian economy and the existence of other assets like real estate, cell phones, the stock market, and also the government bonds. Inelasticity of time deposits indicates changes of their interest rates do not have any affect on the volumes of these deposit.

Income elasticities are all positive (suggesting that these monetary components are all normal goods), which is consistent with economic theory. However, there are differences between them. Income elasticities of currency and demand deposit increase over time.

As predicted by theory, Allen own-elasticities of substitution for these components are negatives, i.e. $AL_{11}<0$, $AL_{22}<0$, $AL_{33}<0$ (Table 1).

Because the Allen elasticities of substitution produce ambiguous results off-diagonal, we use the Morishima elasticity of substitution to investigate the substitutability/complementarily relation between assets.

According to Morishima elasticities of substitution-the correct measures of substitution-between currency and demand deposits are $MO_{12} = 5$ and $MO_{21} = 4$ (Table 3). It can be inferred that the substitutability relation between these two monetary assets is greater than the substitution between demand deposits and time deposits. It is interesting to present the graphs for the Morishima elasticities, in Figures 3 to 5.

$MO_{12} = 5$ shows that an increase in the price of π_2 causes $\left(\frac{x_1}{x_2}\right)$ to increase, Since in such situation consumer prefer to keep more currency. Also increase in the price of π_1 causes $\left(\frac{x_2}{x_1}\right)$ to increase too. As noted before, the Morishima approach to the calculation of the elasticity of substitution provides a different estimate depending on which asset price is varied. For instance, figure 3 shows the Morishima elasticity between asset 1and 2 with the price of 1changing, and the same elasticity with the price of 2 changing.

Morishima elasticities of substitution between currency and time deposit are $MO_{13} = 5$ and $MO_{31} = 1$, thus an increase in the π_3 causes $\left(\frac{x_1}{x_3}\right)$ to increase. In the case of high inflation, economic agents prefer to consume their money and do not save money in the time deposit. But an increase in the π_1 does not have any effective changes in the ratio of $\left(\frac{x_3}{x_1}\right)$. (Figure 4).

As a whole and on the basis of measure of Morishima elasticities of substitution, there is an incomplete substitutability relation between monetary components in Iran. Currency and demand deposit have higher substitutability relation than other monetary components.

These results show that the share of any monetary components indicates the share of demand deposit is the highest and the share of currency is the least, (figure, 6).

The share of time deposits has been constant during the study period. This phenomenon indicates that in spite of increasing of the nominal interest rate of banking deposits from the beginning of first plan of economic development, this rate has always been less than inflation rate so is not effective. Also the continuity of expansion of the stock market and the issue of new bonds by the Central Bank of Iran since 1973 have been competing factors for bank deposits and hence caused the share of deposits to decrease.

According to our results, especially Morishima elasticities of substitution, which show very low elasticity of substitution among monetary components, even complementarily relation between assets in some parts, the hypothesis of this paper is verified where, the use of the simple sum approach to monetary aggregation is not correct.

Table 1 : Own Price, Income and the Own Allen elasticities at the mean of date

Elasticities	e_{11}	e_{22}	e_{33}	EM_1	EM_2	EM_3	AL_{11}	AL_{22}	AL_{33}
quantities	-5.13	-1.28	-0.47	1.94	0.72	1.06	-30.3	-1.42	-0.91

Table 2: Cross and Allen elasticities at the mean data

Elasticities	e_{12}	e_{21}	e_{13}	e_{31}	e_{32}	e_{32}	Al_{12}	AL_{13}	AL_{23}
quantities	2.68	0.90	0.50	0.47	-0.34	-1.05	6.43	4.03	-0.70

Table 3: Moroshina elasticity of substitution elasticities at the mean data

Elasticities	MO_{12}	MO_{21}	MO_{13}	MO_{31}	MO_{23}	MO_{32}
quantities	5.85	4.7	5.47	1.19	0.43	0.05

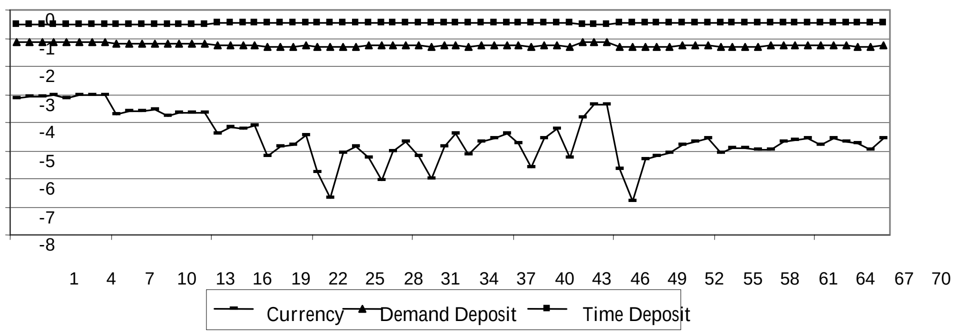

Figure 1: Price Elasticities of Monetary components

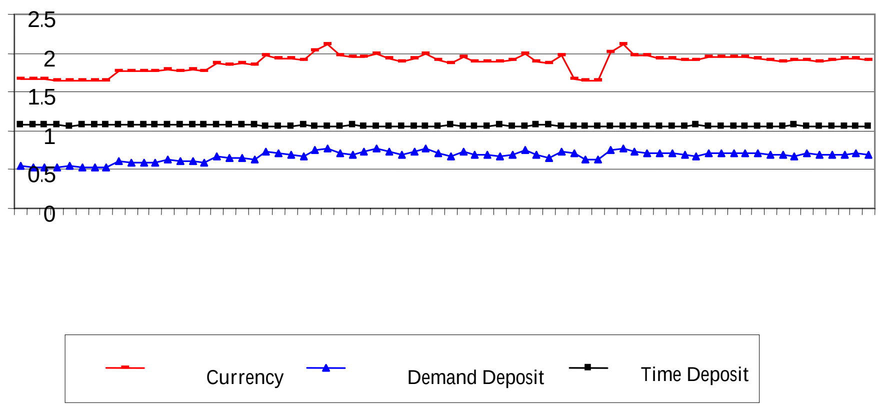

Figure2: Price Elasticities of Monetary components

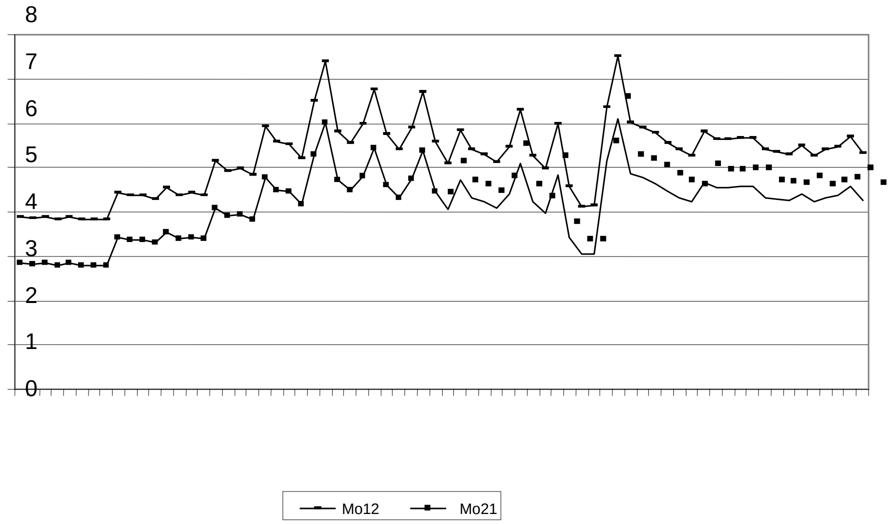

Figure 3: Trend of Substitutional elasticity between paper money Coins and checking deposits.

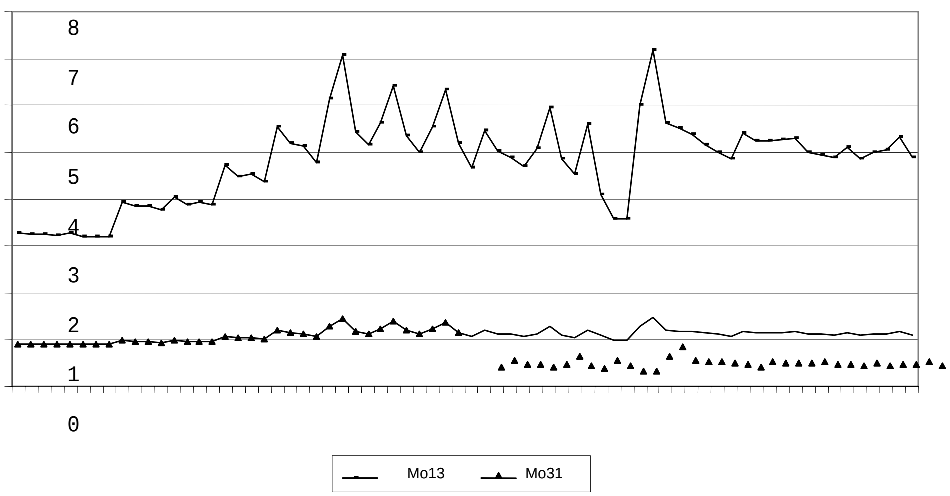

Figure 4: Trend of Substitutional elasticity between paper money, Coins and time deposits.

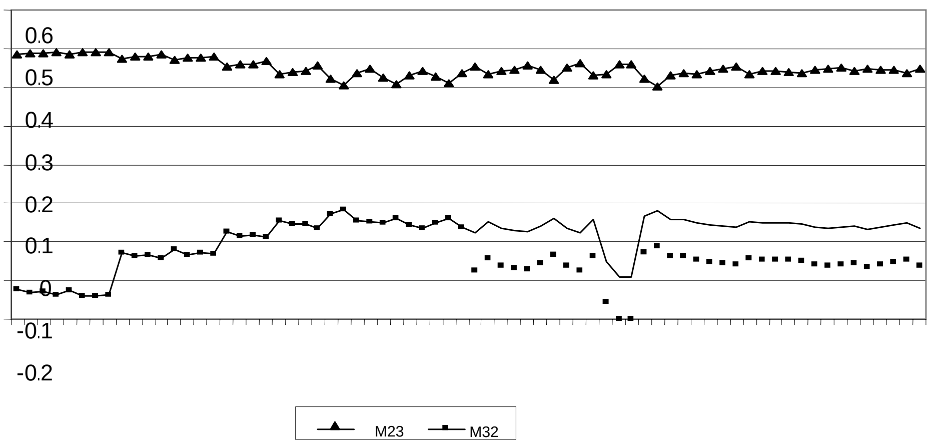

Figure 5: Trend of Substitutional elasticity between checking and time deposits.

Figure 6: Share of each monetary element demanded by in dividable.

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