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THE DEMAND FOR MONEY IN GREECE: EVIDENCE THROUGH A SHOPPING-TIME TECHNOLOGY MODEL AND COINTEGRATION

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Abstract

The objective of this paper is to estimate a long-run version of money demand in Greece through cointegration tests and over the period 1978-1995. The feature that distinguishes this paper from the conventional *ad-hoc* money demand models is that the money demand function is derived through a shopping-time technology which seems the proper approach when the reason for holding money balances is the motive of minimizing the transactions costs. (JEL Classification System: E 41)

1. Introduction

Macroeconomic models, known as representative agent models, including money demand models, have extensively been constructed from aggregate demand and supply relationships, justified as 'micro-foundations'. In particular, Samuelson's (1958) overlapping — generations (OLG) models justify money as an inferior asset to interest-bearing claims, since it pays no interest. These models accept that money must offer a yield equal to that of bonds, or it cannot be held. In this way, they examine how money can co-exist with other assets as a store of value. Money is not necessary for transaction purposes. After all, why any central monetary authority is obliged to print money when bonds can be issued. If money has no use, it becomes valueless. Conclusively, the OLG approach cannot be used to construct and explain why money demand exists. McCallum (1983) and Sargent and Wallace (1983) argue that OLG solutions present an incomplete and in some respects flawed picture of the value of money as it is compared to other assets. The source of this problem is that individuals' demand for monetary assets is no different from that of other assets and, thus, the money is called to play no particular role in a general equilibrium model. In a OLG model, money does not perform a distinguish role, since it will not be held in cases that its return is dominated by the return of a productive capital asset. Nevertheless, Sargent and Wallace as well as McCallum find the OLG approach to money demand as an attractive place for monetary theory, since the demand for money arises endogenously as the result of the optimizing decisions of rational individuals.

By contrast, Lucas's (1986), Lycas and Stokey (1987), and Cooley and Hansen (1988) 'cash-in-advance' model assumes that spending can only be carried out with money. In other words, the cash-in-advance model treats money primarily as a medium of exchange. According to Tsiang (1989), money demand is determined by the transactions motive. However, the 'cash-in-advance' approach assumes, but does not explain, the use of money for transactions. In particular, the motivation behind a transactions demand for money is that market imperfections create a need for a medium of exchange that does not exist in a frictionless Walrasian world. The cash-in-advance model fails to capture any short-run effects of money because it tends to minimize the presence of any frictions in the economy. Certain models make the assumption that money 'has utility' and, therefore, it can be introduced as an explicit argument into the representative agent's utility function. However, the opponents of this approach argue that assets (including money) do not yield utility directly. Money is held because it reduces transactions costs. Brock (1974), McCallum (1983), King and Plosser (1984), Feenstra (1986), and Kydland (1987) argue that money is allowed to enter the utility function only if the latter is an indirect one. They propose a microfoundations model of money which functionally is tantamount to the money in the utility function approach. This is the shopping-time model, first developed by Saving (1971). This approach justifies the role of money as an instrument that facilitates transactions. In particular, agents value leisure so they dislike shopping, i.e., the more time they spend on shopping, the less leisure as well as utility they have. Money reduces the amount of time agents spend on shopping and thus increases both the amount of leisure and utility. Which approach seems to be the proper one is a matter of a case-by-case study. In particular, if we feel that money plays a minor role in the system, then money as a direct argument in the utility function seems to be the solution. By contrast, Croushore (1993) argues that if the objective of a study is to investigate money demand issues and the impact of any regime change on it, e.g., financial innovation, then the shopping-time technology is preferable. In general, the money in the utility function model and the shopping time technology model are functionally equivalent (Feenstra, 1986).

Overall, in the three models, i.e., cash-in-advance, money in the utility function, and shopping-time technology, only two explanations can be offered for the role of money. According to the first, money emerges as a dominating means of exchange among all assets. The second explanation states that the government imposes legal restrictions to make money necessary in transactions. In any explanation the major implication is that the competitive equilibrium allocation is Pareto optimal.

By contrast, Bewly (1983) argued that a monetary equilibrium does not exist when agents face risks, e.g., liquidity constraints, which in turn stimulate the holding of precautionary balances for which there would be nonsatiation. In Bewley's model environment money serves as an inventory. If then the inventory is risky or costly to hold, the Pareto optimal result yields zero inventory with positive probability. Townsend (1983) has also argued that money cannot have value in a general equilibrium model unless transactions are made costly or certain constraints on who can trade with whom are imposed. Since the objective of this paper is not to handle money demand issues under liquidity or any other constraint, no further analysis is attempted. Finally, Hahn (1965) states that in a general equilibrium model money has value, i.e., there is a demand for it, only if the model includes a precautionary motive for holding money. However, in case that this precautionary demand for money is insatiable, then a Pareto equilibrium does not exist and this approach to include money in a general equilibrium model seems problematic.

The majority of empirical studies in the demand for money literature have focused on an effort to determine what the appropriate variables that could be used as the explanatory variables are (Fisher, 1992; Hoffman, 1996). Over the last years the methodology of vector autoregressive (VAR) models has been extensively used to test specific forms of the 'appropriate' money demand function. In addition, the bulk of the empirical analysis have made use of the cointegration techniques and the associated error correction mechanism (Hoffman and Rasche, 1989; Hafer and Jansen, 1991).

As regards the Greek case, Karfakis (1991) tested whether the existence of a long-run MI velocity function is consistent with the time series analysis of the Greek data by means of the cointegration methodology developed by Johanson and Juselius (1990), this justifying the adoption of MI as a useful monetary target. The results supported the presence of a systematic relationship between Ml velocity, The rate of interest, and the exchange rate as well as the presence of a bi-directional causality between the exchange rate and velocity. Psaradakis

(1993) exmained the relationship between the demand for real money and its determinants in Greece, in the context of linear dynamic structural models (SEM's) derived by sequential reduction of an underlying statistically well-specified vector autoregressive (VAR) representation of data. Karras (1994) examined the role of different kinds of shocks and their relative importance for the observed macroeconomic fluctuations of the Greek economy in the 1975-1987 period. Monetary and aggregate demand shocks are found to dominate output variability in the short-run and aggregate supply shocks in the long-run. Monetary expansions and positive shocks to the exchange rate (e.g., the depreciation of the drachma) have positive effects on output initially, but they tend to reduce output in the long-run. Unfavorable supply shocks, higher money growth, and depreciations also contribute to inflation. Fiscal expansions put significant pressure on the money supply but have negligible effects on the other variables. Apergis (1996) examines the role of opportunity cost in the Greek demand for money function, through cointegration tests. The results reveal that all of the three types of opportunity cost, interest rates, expected inflation, and expected depreciation must be simultaneously included in the demand for money function. Papadopoulos (1997) investigates the determinants and the stability of money demand in Greece. The results show that Ml is unstable and M2 is not unambiguous enough to provide a basis for the set of a monetary target. He also suggest that Greece cannot have a monetary policy which does not depend upon other European Union Countries, in order to reduce the inflation rate. Apergis (1997) examines the relationship between money demand and inflation uncertainty. In particular, he uses an extended money demand equation through an Autoregressive Conditional Heteroskedasticity (ARCH) process. The empirical findings suggest the presence of a link between the deregulation process in the Greek financial system and money demand structural instabilities.

The objective of this paper is to re-estimate the Greek money demand function. However, the majority of the empirical studies have proceeded with the estimation of a money demand function whose arguments are *ad hoc* introduced into the functional form. It seems desirable to work out the analysis in terms of an optimizing model, which takes explicity into consideration specific microfoundation tools, i.e., consumer's preferences.

The structure of the paper is as follows. Section 2 presents a theoretical intertemporal optimizing model with money introduced through the shopping-time technology. The model allows the explicit derivation of the demand for real balances. Section 3 continues with the empirical analysis for the case of Greece, while Section 4 concludes the paper.

2. A Theoretical Model

Before presenting the structure of a theoretical model it seems important to us to mention that despite certain deregulatory reforms, occurred in 1988, the monetary sector in Greece remains to an underdeveloped institution stage, e.g., direct restrictions on the maximum interest rates paid on bank deposits and bank credit, which along with the presence of an underdeveloped capital market result in the prosence of a limited range of financial assets available to investors. In other words, very limited assets, e.g., stocks, can be used as explicit arguments in a theoretical model. Nevertheless, the deregulation has allowed potential investors to receive positive real interest rates, resulting in the introduction of bonds as potential investment instruments.

In similar theoretical models, a representative household is considered who is allowed to make decisions in two separate steps. In the first stage he decides on his labor supply and this decision determines his labor income. Next, in the second stage, by taking labor income as given, he decides on consumption and portfolio allocation. To keep things as simple as possible, we deal only with the second step by assuming that income is determined through an exogenous process, i.e., an endowment (we could also have specified a labor supply function that determines output behavior and is introduced explicity into the maximization process). Moreover, it is assumed an economy with one good and two assets. Assets consist of money and an alternative which is referred as 'bond'. The representative consumer derives direct utility at any date t from same period real consumption and leisure as well as indirect utility from transaction services rendered by real money balances. Next, the consumer seeks to maximize total discounted utility given by:

$$\sum_{0}^{\infty}\beta^{t}\,U(c_t,\, l_t) \tag{1}$$

Here c_t and l_t are the consumer's real consumption of goods and leisure at period t, respectively. Both c_t and l_t are considered as normal goods, i.e., utility is increasing in both consumption and leisure. In addition, marginal utility is decreasing in the two arguments. The parameter β is the discount factor; that is positive but less than one. However, the household in an attempt to maximize his utility, faces a budget constraint. The structure of such a constraint yields:

$$R_tY_t + B_{t-1}\,(1 + R_{t-1}) + M_{t-1} = P_tC_t + M_t + B_t \tag{2}$$

with P, Y, B, R, M and C being the price level, nominal income, the nominal stock of bonds, the nominal interest rate, nominal balances, and nominal consumption, respectively. The left-hand side describes the sources of funds available to the household from income in the current period, money balances carried over the previous period, and bonds purchased from the previous period. The right-hand side describes household's total expenses in consumption and bonds, and money balances held at the end of the current period.

Money is considered to be the essential medium of exchange, in essence that only through it the household is capable of acquiring consumption goods. However, the household in order to acquire those consumption goods that satisfy his utility must spend time and energy in shopping. In particular, a time technology function yields:

$$l_t = l(c_t, m_t) \tag{3}$$

According to (3), the amount of time and energy spent on shopping depends positively on real consumption, c and negatively on real money balances, m (M/P). Therefore, leisure is negatively related to consumption and positively related to real money balances.

In order to get a solution for money balances, an analytical mathematical function for utility must be explicity introduced. Following McCallum (1989), a specific functional form of the utility function yields:

$$U(c_t, l_t) = c_t^{1-a}\, l_t^{a} \tag{4}$$

with $0<a<1$. The analytical solution we expect to get is based on the utility function described by (4). Since the stability and the uniquences of perfect foresight equilibria are sensitive to properties of the utility function, such an alternative utility functional form was also utilized (see the Appendix). The theoretical solution results were similar as before. Moreover, a specific functional form of (3) yields:

$$l(c_t, m_t) = c_t^{-b}\, m_t^{b} \tag{5}$$

with $0<b<1$.

2.1. The solution of the model

The problem to be solved is:

$$\max \sum_{0}^{\infty} \beta_t\, U(c_t, l_t)$$

$$\text{s.t. } l_t = l(c_t, m_t) \text{ and}$$

$$P_tY_t + B_{t-1}(1 + R_{t-1}) + M_{t-1} = P_tC_t + M_t + B_t$$

If we incorporate the leisure function in the utility function we get a standard money in the utility function model:

In order to transform the nominal budget constraint into real terms we divide all terms by P_t:

$$Y_t + \frac{B_{t-1}}{P_t}(1 + R_{t-1}) + \frac{M_{t-1}}{P_t} = c_t + \frac{M_t}{P_t} + \frac{B_t}{P_t}$$

Denoting $b_t = \frac{B_t}{P_t}$ and $m_t = \frac{M_t}{P_y}$ we have:

$$Y_t + \frac{B_{t-1}}{P_{t-1}} \frac{P_{t-1}}{P_t} (1 + R_{t-1}) + \frac{M_{t-1}}{P_{t-1}} \frac{P_{t-1}}{P_t} = c_t + m_t + \beta_t \Rightarrow$$

$$Y_t + b_{t-1} (1 - \pi_t) (1 + R_{t-1}) + m_{t-1} (1 - \pi_t) = c_t + m_t + b_t$$

where $\pi_t = \frac{P_t - P_{t-1}}{P_t}$

We set up the Lagrangian:

$$L = \sum_0^\infty \beta^t U (c_t, m_t) + \sum_0^\infty \gamma_t [Y_t + b_{t-1} (1 - \pi_t) (1 + R_{t-1}) + m_{t-1} (1 - \pi_t) - c_t - m_t - b_t]$$

We now take the first order conditions with respect to the choice variables:

$$\frac{\partial L}{\partial c_t} = \Leftrightarrow \beta^t U_c - \gamma_t = 0 \tag{6}$$

$$\frac{\partial L}{\partial m_t} = \Leftrightarrow \beta^t U_m - \gamma_t + \gamma_{t+1} (1 - \pi_{t+1}) = 0 \tag{7}$$

$$\frac{\partial L}{\partial b_t} = \Leftrightarrow \gamma_t = \gamma_{t+1} (1 - \pi_{t+1}) (1 + R_t) \tag{8}$$

From equation (8) we derive $\gamma_{t+1} = \frac{\gamma}{(1 + R_t)(1 - \pi_{t+1})}$

Substitute (8) into (7):

$$\beta^t U_m + \frac{\gamma_t (1 - \pi_{t+1})}{(1 + R_t)(1 - \pi_{t+1})} - \gamma_t = 0 \Rightarrow \beta^t U_m = \gamma_t \frac{R_t}{1 + R_t}$$

Using (6) we derive:

$$\beta^t U_m = \beta^t U_c \frac{R_t}{1+R_t} \Rightarrow U_m = U_c \frac{R_t}{1+R_t} \tag{8α}$$

The partial derivatives of the utility function U (c_t, m_t) = c_t^{1-a-ab} m_t^{ab} which we get combining (4) and (5) are:

$$U_c = (1 - \alpha - \alpha b)\, c_t^{-a-ab}\, m_t^{ab}$$

$$U_m = \alpha b\, c_t^{1-a-ab}\, m_t^{ab-1}$$

Substituting these into (8a) we have:

$m_t = \dfrac{ab}{1-\alpha-ab}\left(1 + \dfrac{1}{R_t}\right) c_t$ and by taking logarithms it yields:

$$\ln (m_t) = \ln (ab) - \ln (1 - a - ab) + \ln (1 + \frac{1}{R_t}) + \ln c_t \tag{9}$$

If c_t is replaced (through the clearing market condition implying that real consumption equals real income) by y_t, then equation (9) describes a conventional money demand function and it can be written as:

$$\ln m_t = k_0 + k_1 \ln y_t - k_2 \ln R_t \tag{10}$$

with k_0 being equal to ln(ab) - ln(l-a-ab) and ln(l+l/R_t) being approximated by -lnR_t. The model has demonstrated that a positive effect of real income on real money balances exists, while a negative effect of the interest rate on real money balances is also present. Equation (10) can also be written as:

$$\ln m_t = f_o + f_1 \ln y_t + f_2 \ln R_t \tag{11}$$

with $f_1>$ and $f_2<0$.

Finally, we should note here that the optimal solution for money demand was obtained by assuming a perfect foresight model in which the values of future variables were known with certainty by the household. Needless to say, the individual operates within an environment of uncertainty. However, optimal control models, by assuming rational expectations (the Neoclassical approach), can escape the mathematical complexity of their solution, and the perfect foresight short-cut does not alter the obtained results.

3. Empirical Analysis

3.1. Data

The data set used in our empirical analysis consists of quarterly data on real income measured by the industrial production index (1990=100), prices (P) measured by CPI (1990=100), money (M) measured by Ml, and interest rates measured by the yield on short-term savings deposits with commercial banks were employed over the period 1978-1995. Data were obtained from the OECD Main Economic Indicators CD-ROM as well as from the Monthly Statistical Bulletin of the Bank of Greece.

3.2. Integration analysis

We test for unit root nonstationarity by using augmented Dickey-Fuller (ADF) unit root tests proposed by Dickey and Fuller (1981). The results are reported in Table 1. The hypothesis of a unit root was not rejected for all the series in levels at the 5 percent significance level. When first differences were used, unit root nonstationarity was rejected in all cases.

3.3. Cointegration analysis

The cointegrating vector is based on a Vector Autoregressive (VAR) model. The number of lags was based on Sims' (1980) Likelihood Ratio (LR) test corrected for the degrees of freedom. The LR test statistic selected a 4-lag VAR. The estimation of the cointegration equation was obtained via the methodology developed by Johansen and Juselius (1990) who utilize a maximum likelihood procedure which estimates the number of cointegrating vectors. The results from the cointegration tests are recorded in Table 2. According to these results, both the maximum eigenvalue test and the trace test statistic imply that a single possible cointegrating vector exists. The cointegrating vector, therefore, yields:

$$\ln m = -1.1965 + 2.438 \ln y - 0.116R - 0.452\, DUM \tag{12}$$

$$(-2.83)^{*} \quad (2.42) \quad (-2.35)^{*} \quad (-2.98)^{*}$$

$R^2 = 0.61$ LM = 3.72[0.27] NO= 2.76 [0.39]

where lnm is the logarithm of real money balances, lny the logarithm of real income, R the nominal interest rate, and DUM a dummy variable with 0 values up to 1987:4 and 1 thereafter. The dummy variable accounts for the regime change related to the deregulation of the monetary system occurred in 1988 (Alexakis and Apergis, 1994)[1]. Numbers below the coefficients denote t-statistics, LM statistic accounts for residual serial correlation, NO is a normality test, and numbers in brackets denote p-values. According to the above diagnostic statistics, the cointegrating vector in (12) provides an adequate characterization of a money demand function that depicts residuals which are serially uncorrelated and approximately normally distributed.

4. Concluding Remarks

This paper has presented an empirical estimation of money demand consistent with the shopping-time technology approach. First, a theoretical intertemporal model was introduced in which money balances are introduced through the shopping time technology. After solving the model through its first order conditions, an analytical form of the money demand function was obtained which allowed its empirical estimation for the case of Greece over the period 1978-1995. In particular, after investigating the integration properties of the variables under study, the cointegration space was estimated. The presence of a single cointegrating vector was established which corresponds to a long-run money demand as a function of both income and interest rates. The demand for money appeared to be substantially affected by income as well as short-term interest rates. The estimated long-run money demand equation seems to conform well.

Appendix

In the Appendix, an alternative utility function described as: $U(c_t, m_t) = \frac{1}{\gamma}(c_t^{\delta} m_t^{1-\delta})^{\gamma}$ for $g \neq 0$, is utilized, where δ is a preference parameter capturing the relative importance of consumption and real money balances in the utility function and γ is a preference of risk parameter. The optimization process yielded the following results:

1. Hansen-Johansen (1993) recursive analysis tested for stability of the cointegration vector. 1988:1 was used as a starting point. The results suggested that there was a break in the cointegrating vector related to the 1988 event of the monetary regime change (the results are available upon request by the authors).

$$U_c = \delta c_t^{\gamma\delta-1} m_t^{\gamma(1-\delta)}$$

$$U_m = (1 - \delta) c_t^{\gamma\delta} m_t^{\gamma(1-\delta)-1}$$

Substitute these into (6) in the main text yields:

$$(1 - \delta) c_t^{\gamma\delta} m_t^{\gamma(1-\delta)-1} = \delta c_t^{\gamma\delta-1} m_t^{\gamma(1-\delta)} \frac{R_t}{1+R_t} \Rightarrow$$

$$m_t = \frac{1-\delta}{\delta} \frac{1+R_t}{R_t} c_t \Rightarrow$$

$$\ln m_t = \ln (1 - \delta) - \ln\delta + \ln \left(1 + \frac{1}{R_t}\right) + \ln c_t$$

which is similar to equation (9) obtained in the main text.

TABLE 1

Unit root tests

	m	y	R
Levels	-1.699(3)	-2.430(4)	-0.235(2)
First differences	-3.988*(2)	-5.100*(3)	-4.088(2)

Notes: m denotes the logarithm of real money balances, y the logarithm of real income, and R the nominal interest rate. Figures in parentheses show the number of lags in the augmented term. The optimal number of lags was determined according to the Akaike * indicates significance at 5%.

TABLE 2

Johansen-Juselius Maximum Likelihood Tests for Cointegration:

$$\ln m_t = f_0 + f_1 \ln y_t + f_2 R_t + \varepsilon_{1t}$$

List of variables included in the cointegrating vector:

lnm lny R intercept

Estimation period: 1978:4 - 1995:4. Maximum lag in VAR = 4.

r	n-r	m.λ.	95%	Tr	95%
r = 0	r = 1	35.2261	22.0020	51.4189	34.9100
r<= 1	r = 2	14.0512	15.6720	16.1989	19.9640
r<= 2	r = 3	0.1438	9.2430	0.1438	9.2430

Notes: r = number of cointegrating vectors, n-r = number of common trends, m.λ = maximum eigenvalue statistic, Tr = trace statistic.

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