THE DEMAND FOR MONEY IN GREECE 1962 TO 1998

by

Konstantinos Loizos
(SOAS, University of London)

and

John Thompson
(Liverpool Business School)

The authors wish to thank Professor K Holden, Liverpool Business School, for his helpful comments and suggestions in the preparation of this paper but we would like to emphasise that any errors remaining the paper are entirely our responsibility.

January 2001

ABSTRACT

The paper examines the demand for narrow money in Greece over the period 1962 to 1998. The data is tested to examine the order of integration. Estimation of the demand function follows the two step methodology. The first step entails the specification of the long run equilibrium relationship between real narrow money, the index for industrial production (a proxy for real income), an interest rate and the rate of inflation through the estimation of the cointegrating vector by the Johansen technique. The second step involves an Error Correction Equation being estimated to provide the short-run dynamics. Finally the model is simulated to see how well it tracks the actual values of the dependent variable.

Journal of Economic Literature Classification: E41.

1 Introduction

The demand for money assumes an important component of theoretical models of any economy and as such has been the subject of many studies for a wide variety of countries. In section 1 of this paper we start by providing a brief review of the financial history of Greece and a summary of what we consider to be key studies of the demand for money in Greece. A discussion of the nature of the data is presented in section 2. The empirical results are discussed in sections 3 and 4. The model is tested for its simulation properties in section 5 and our conclusions in section 6.

The Greek financial system was heavily regulated during the post-war period until the mid-eighties. Major characteristics of this system are the administratively set interest rates, the compulsory channeling of a proportion of bank reserves into various uses and sectors indicated by the authorities, the financial support of the government at below-market rates and the control of foreign exchange transactions. Given that banks were the dominant financial intermediaries while capital market was underdeveloped, investment opportunities were heavily dependent to the government priorities.

However, this picture altered, during the late eighties and nineties, through a process of financial liberalization that aimed to restore market conditions throughout the system. Important steps included the gradual deregulation of bank lending and borrowing rates, the removal of credit restrictions imposed on commercial banks, the resumption of Treasury Bills sales directly to the public in 1985 and the abolition of controls in capital movements in 1994. In 1994, the government also lost its privileged access to the Central Bank while its monetary financing was abolished.

With respect to the formulation of the demand for money function the following points are important:

a) The underdevelopment of capital market along with the regulated nature of the system for most of the period indicates the significant role of real assets and hence of inflation (their rate of return) as a determinant of money demand.

b) The constrained opportunities for financial investments restrict the choice of a representative rate of return on financial assets as a rate of interest on bank deposits.

c) Finally, the transition period from regulation to liberalization during the last third of the estimation period raises the interesting question of the stability of demand for money along with the problem of the appropriate independent variables in this function.

Figure 1 shows the growth of M1 during this period and, whilst the financial liberalisation discussed above must have affected the behaviour of the money supply, the pattern in Chart 1 shows no sudden changes or jumps in the time pattern of the growth of nominal narrow money supply. We have therefore not included any dummy variables to represent any of the measures discussed above[1]. In general our approach will be a compromise between the various traditions in the theoretical development of the demand for money and will include as explanatory variables the rate of inflation, the level of real GDP (y) and a representative rate of interest (r). Consequently we include both the return on financial assets (i.e. the representative rate of interest) and also the return on real assets {represented by the expected rate of inflation (infl)} as well as the demand for transaction purposes. This formulation is summarised below:

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[1] The case of the absence of dummy variables is supported by an examination of the cumulative sum and cumulative sum squares diagnostics. In the case of CUMSUM, neither of the 5% level of

$$M/P = F(y, r, infl) \qquad \text{with } F_1 > 0,\ F_2 \text{ and } F_3 < 0 \qquad (1)$$

We now review briefly the existing literature on the demand for money in Greece. These include Apostolou and Varelas [1987], Alexakis [1980], Brissimis and Leventakis [1981,1983 and 1985], Ericsson and Sharma [1998], Himarios [1983, 1986 and 1987], Palaiologos [1982], Panayotopoulos [1983 and 1984], Prodromidis [1984] and Tavlas [1987]. In order to simplify the discussion, we focus on just four studies, which indicate the flavour of the existing literature. These studies can usefully be categorised into those, which use annual data e.g. Himarios [1986], Apostolou and Varelas [1987], and those, which use quarterly data such as Psaradakis [1993], Ericsson and Sharma [1998]. Himarios [1986] employs the partial adjustment hypothesis to explain the demand for M1 and M2. According to Himarios' results, the demand for m_1[2] is better explained by current income and a short-term interest rate. The coefficient for inflation is insignificant at the 5% level. Despite the administrative nature of interest rates, substitution between demand for m_1 and financial assets is indicated by the significance of the interest rate coefficient at the 5% level. Demand for m_2 is best explained by permanent income and expected inflation with strongly significant coefficients whilst interest rates coefficients are insignificant at the 5% level in most equations. Finally, autocorrelation is removed when the lagged dependent variable enters the functions, which may indicate the existence of adjustment costs. A similar approach (i.e. the Partial Adjustment Hypothesis) was followed by Apostolou and Varelas [1987], who also incorporate the level of current income as an explanatory variable in their equation. Their results suggest that the three variables (i.e. income, interest rate and inflation) are all relevant to the explanation of the demand for money in Greece. These results were troubled by the presence of

significance bounds were approached. In the case of the squares the lower boundary was approached only for the period 1979 to 1983.

[2] Upper case letters refer to nominal variables and lower case to real variables.

autocorrelation, which was removed by the Cochrane-Orcutt method of estimation.

The second two studies using quarterly data also use more sophisticated techniques. Psaradakis [1993][3] estimates a vector autoregression model (VAR) for the period 1960 quarter1 to 1989 quarter 1. The estimated model found a role for interest rates, inflation and income in the determination of the demand for money. Whereas the previous studies mentioned all concentrated on M1 or M2, Ericcson and Sharma [1998] examined the stability of broad money M3 over the period 1975 to 1994. They found a role for income, various interest rates and inflation.

As noted earlier, we estimate an equation of the following form to represent the demand for M1:

$$(M/P)^D = f^N(y, r, infl) \qquad (1)$$

where M = M1 (i.e. narrow money), P = the price level, y real income, r a representative rate of interest and infl the actual rate of inflation used as a proxy for the expected rate o inflation. All the variables will be specified in logarithmic form. The exact definition of the variables is discussed in the following section.

2 The Data

Quarterly data on Gross Domestic Product for Greece are not available before 1975 so it is necessary to use some proxy for income in the demand for money function. As noted earlier Psaradakis [1993] used a univariate time series model to construct a synthetic series of national income on a quarterly basis. We have adopted a different approach by using the index of industrial production as a surrogate for national income. We acknowledge that use of the index of industrial production

[3] Since quarterly data on GDP for Greece was not available prior to 1975, Psaradakis interpolated from annual data using a univariate time series model.

represents just one sector (but a major one)[4] of an economy but its value as a proxy is essentially an empirical matter. The correlation coefficient for the natural logarithm values of annual data for GDP deflated by the consumer price index and the index of industrial production is 0.9653 for 1962 to 1997. We would therefore contend that the index of industrial production is a good proxy for real GDP.

The specification of the other variables is less contentious. The rate of interest adopted for the study is the 3 – 6 months' time deposit rate with commercial banks (lrs) and as such represents the return on the closest substitute financial asset. The consumer price index (lp) is used to denote the price level since this is the most widely published index in Greece. In a similar manner the rate of inflation (infl) is the first difference of the logarithm of the consumer price index. The statistics were obtained from International Financial Statistics as recorded by Datastream. Full details are shown in the appendix.

Descriptive statistics of the four variables of interest are shown in Table 1. The first three variables show evidence of negative skewness so that the distribution shows a longer tail to the left. As far as kurtosis is concerned three variables (lrm1, lip and infl) show evidence of positive kurtosis (i.e. leptokurtic) as compared with the normal distribution i.e. the tails of the distribution are slimmer/longer than that predicted by the normal curve. In the case of lrs, there is evidence of fat or short tails (i.e. platykurtic). It would appear that none of the variables are normally distributed and this is confirmed by the results of the Bera-Jacques tests shown in the table.

We now consider the order of integration of the variables[5]. Stationarity tests were carried out the variables (all in logarithmic form) real m1 (lrm1), the industrial production index (lip), the rate of interest (lrs)

[4] However it is a fact that the empirical elasticities of the demand for money with respect to this index are not strictly comparable to those for GDP.
[5] All estimates were carried out using Microfit (version 4) save for the simulations of the estimated equation reported in section 3, which used TSP.

and inflation (infl) using Dickey-Fuller[6] and Phillips-Perron[7] unit root tests. Augmented Dickey-Fuller (ADF) statistics were calculated with lags up to 12 periods thus compressing the data into the period 1965 quarter 2 to 1998 quarter 3. Selection of the appropriate lag was based on the information criteria provided by the Akaike (AIC), Schwarz-Bayesian (SBC) and the Hannan-Quinn (HQC) statistics. In the case of different recommendations provided by the criteria, greater weight was afforded to the SBC and HQ statistics in view of the tendency of the AIC statistic to overestimate the lag[8]. The equation implied by the selected lag was then tested for autocorrelation in the residuals and in no case was the hypothesis of non-autocorrelated residuals rejected. Tests were also carried out to ascertain if it was appropriate to include a time trend in the ADF equation. In general the hypothesis that the time trend was zero was not rejected[9,10]. The results are shown in Table 2.

The degree of integration is clear-cut in the case of lrs. The hypothesis that the variable is stationary (i.e. I(1)) is rejected for levels but accepted for first differences, suggesting that lrs is I(1). There is some ambiguity concerning the results of the test for lrm1. The hypothesis of stationarity is rejected by the ADF test but accepted by the Phillips-Perron test. The hypothesis of stationarity is accepted for the first differences of the variable. In contrast both lip and infl seem to be I(0) with both the ADF and Phillips-Perron statistics indicating stationarity. Both Psaradakis (1993) and Ericsson and Sharma (1998) indicate the existence of unit Root for infl. Therefore, we propose initially to consider both lip and infl as I(1). If the cointegrating vector obtained under this assumption is statistically and theoretically acceptable then it can be assumed that the results of the ADF tests for

[6] See Dickey and Fuller [1981]
[7] See Phillips and Peron [1988]
[8] See Basçi and Zaman [1998]
[9] The relevant critical values were obtained from Dickey and Fuller [1981].
[10] The sole exception was in the case of the Δlip when the time trend was significant in the case of six lags and verged on significance in the case of longer and shorter lags.

lip and infl are misleading. We discuss the estimation of equation (1) in the following section.

3 Estimation

The methodology adopted by us is a two step method using the Johansen method (see for example Johansen [1988]) for estimation of the long run, i.e. cointegrating, relationship between the variables. The second step estimates the dynamic or short-run adjustment through an error correction model (ECM)[11].

It is first of all necessary to examine whether the specific function should include either (or both) a time trend and a constant. We tested for the omission of the two variables individually and collectively. The hypothesis that the coefficient on the time trend was zero was not rejected at the 5% level. In contrast the hypothesis that the constant was zero was rejected at the 5% level. Not unnaturally the joint hypothesis that the coefficient on the time trend and the constant were zero was rejected at the 5% level. These tests left the proposed cointegrating equation including a constant but excluding a time trend.

It was then necessary to decide on the order of the VAR. In line with our earlier comments on the bias of the Akaike criterion we relied on the Schwarz Bayesian criterion which suggested the order to be 4. We then tested for the number of cointegrating vectors within the model. The results of the tests are, to say the least, inconclusive. At the 5% level of significance, the tests based on the maximal eigenvalue and the trace both indicated 2 cointegrating vectors. In contrast to these results, tests based on model selection criteria were contradictory with the Akaike Information, the Schwarz Bayesian and the Hannan-Quinn

[11] The ‘Granger Representation Theorem’ states that, if two variables are cointegrated, then they are generated by ECMs. This theorem has the important result that modelling cointegrated variables we can concentrate on the ECM employing the general to specific approach to arrive at the preferred specification. Again see Engle and Granger [1987].

criteria suggesting the number of cointegrating vectors as 4, 3 and 3 respectively. We selected three as the number of cointegrating vectors and their respective values are shown in Table 3.

Interpretation of estimated cointegrating vectors can be difficult but the first two vectors appear to be defective since either the magnitude or the sign of some of the coefficients do not accord with economic theory. On the other hand, for the third vector, the signs of the estimated coefficients are consistent with theory as indicated with reference to equation 1. The selected cointegrating vector is therefore:

$$lrm1 = 11.072 + 0.814*lip - 0.272*lrs - 0.189*infl \qquad (2)$$

The long-run elasticities indicated in equation 2 seem quite sensible. Both the interest and inflation elasticities are negative and less than 1 suggesting that the demand for real M1 is inelastic with respect to these two variables. Little can be said about the elasticity with respect to the index of industrial production because this variable is a proxy for real GDP. It is instructive to compare elasticities with those obtained in other studies. Examples are shown below:

	rs	infl
Present study	-0.27	-0.19
Himarios [1986]	-0.30	-0.11
Apostolu & Varleas [1987]		
1960 – 1982	-0.16	-0.87
1969 – 1982	-0.26	-0.48
Psaradakis [1993]	n/a	-8.93

With the exception of the inflation elasticity obtained by Psaradakis, our estimates are within the same broad range obtained by the other studies.

In the next section we turn to discuss the dynamic structure of the model.

4 The Dynamic Structure of the Model

We use the general-to-specific approach starting off with the following model[12] of the ECM:

$$\Delta lrm1 = \alpha_0 + \Sigma\beta_i\Delta lip_{t-i} + \Sigma\gamma\Delta lrs_{t-i} + \Sigma\delta\Delta infl_{t-i} + \lambda res_{t-I} + \alpha_1 SR1$$

$$+ \alpha_2 SR2 + \alpha_3 SR3 + \varepsilon_t \quad (3)$$

where res refers to the residuals from the cointegrating equation, SR1, SR2 and SR3 are seasonal dummy variables and ε is the error term.

The ECM was then simplified by a process of sequential elimination of variables for which the coefficients were not statistically different from zero at the 5% level of significance; i.e. we used the general to the specific approach. The preferred ECM is:

$$\Delta lrm1 = 0.058 + 0.185{*}\Delta lip_{t-2} - 0.146{*}\Delta rls_{t-3} - 0.749{*}\Delta infl - 0.450{*}\Delta infl_{t-1}$$

$$-0.135{*}\Delta infl_{t-2} - 0.249{*}res_{t-3} - 0.197{*}S1 \quad (4)$$

Full details of the estimated equation are shown in Table 4. It is worth noting at this stage that:

a) The 't' values of the estimated coefficients indicate coefficients which are significantly different from zero in six cases out of eight; one further case is significant at the 10% level and the remaining coefficient verges on significance at this latter level.

b) Lagging the residual variable 3 periods produced the coefficient with the highest 't' value for this variable,

c) Although three seasonal dummy variables were tried only one proved significantly different from zero at the 5% level. The 'F' test failed to reject the hypothesis that the coefficients on the variables

[12] The selected order of 4 in the cointegrating vector implies a maximum lag of 3 for variables in first difference form.

S2 and S3 were jointly zero. Consequently only S1 appears in the preferred ECM.

d) The significance of the coefficient for the lagged residuals from the cointegrating equation implies that the explanatory variables in the long-run equation are, in fact, cointegrated.

The diagnostics reported in Table 4 suggest that equation (4) passed the autocorrelation and heteroscedascity tests satisfactorily but failed the normality test for the residuals. The most important consequence of this failure is probably to render invalid significance tests in the case of small samples. Given the number of observations in our sample (142) we suggest that our significance tests are valid but we note this defect in the preferred ECM.

Combination of equation (4) and equation (2) produces the final equation (5) explaining the demand for M1 in Greece:

$$\begin{aligned} lrm1 = {} & lrm1(-1) + 0.058 + 0.185*\Delta lip_{t-2} - 0.146*\Delta rls_{t-3} - 0.749*\Delta infl - \\ & 0.450*\Delta infl_{t-1} - 0.135*\Delta infl_{t-2} - 0.249*\{lrm1_{t-3} - (11.072 \\ & +0.814*lip_{t-3} - 0.272lrs_{t-3} - 0.189*infl) \\ & -0.197*S1 \end{aligned} \tag{5}$$

We now move on to see how well the predictions from equation (5) track the actual values of rm1.

5 Model Simulation

We report the results of ex-post static and also dynamic simulation of equation 5 over the period 1963 quarter 2 to 1993 quarter; i.e. including four periods outside the estimation period[13]. The results are depicted in figures 2 and 3 with the area to the right of the dotted line

[13] The data for the period post 1998 quarter 3 required adjustment in three cases. The base years were changed for both the production and price indices so the observations for the post-estimation period were adjusted to the same base as for the previous data. The series we used for the money supply was discontinued so we again adjusted the figures to conform to the earlier data.

indicating post estimation-period simulations. The relevant diagnostic statistics for the within estimation-period simulations are shown in table 5.

A cursory glance at figure 2 suggests that the model tracks the behaviour of LRM1 quite well. There appear to be no significant departures from the observed behaviour of LRM1. This tends to confirm our view that the model did not require the introduction of dummy variables to allow for the various changes in the financial environment.

As far as the static simulation results are concerned, the satisfactory quality of the model as far as tracking actual values of the log of the real money supply is confirmed by the statistics shown in table 5. The correlation coefficient between the simulated and actual values is quite high and the various error statistics quite low. As a yardstick we also obtained the same statistics for the naïve 'no-change model'. These are also shown in table 5 and, in every case are inferior to those relevant to model predictions. The mean error for the model simulation is also not significantly different from zero. This suggests that the model is providing unbiased biased 'in sample' forecasts[14].

Dynamic simulations provide a much more (?excessively) rigorous test of the model. Examination of chart 3 shows that the demand for money was significantly under predicted for the period 1969 to 1986. Outside this period however, the actual behaviour of lrm1 was well tracked. These conclusions are reinforced by examination of the statistics contained in Table 5. In every case, as would be expected, the diagnostic statistics for the dynamic simulations are inferior to both the ex-post static simulations and the naïve forecasts. Furthermore the hypothesis that the mean error is zero is rejected at the 5% level of significance. This is no doubt to the under prediction which occurred in the period 1969 to 1986.

[14] Holden and Peel [1990] contend that this is the best test for unbiasedness.

6 Conclusions

This paper raised the issue of the long-run equilibrium relationship of demand for money and its short run dynamics, in the context of the Greek economy during a period experiencing conflicting developments in its real and financial sector. The function was estimated using a method based on the Granger-Engle two step method. The Johansen procedure that was implemented to obtain the long-run (equilibrium) relationship while the short-run dynamics were obtained through estimation of an ECM which gave significant and correctly signed error correction terms. These results should confirm the existence of long-run stable relationship between M_1 and a three other variables, i.e. the index of industrial production (lip, a proxy for national income), a short rate of interest (lrs) and the rate of inflation (infl). Apart from the failure of the normality test for the residuals, the preferred ECM was satisfactorily estimated. Furthermore, the estimated elasticities indicated the dependence of money demand on inflation both in the long run and short run. Hence, the inclusion of inflation in the function seems justified denoting that real assets were an important alternative to money during that period.

Finally the model tested by simulated the final equation within the sample period. Ex Post Static simulations provided evidence that the final equation tracked the actual variables in a satisfactory manner. The Ex Post Dynamic simulations, whilst providing inferior results to the static simulations, were also reasonably satisfactory given the rigour of this test over 142 observations.

Table 1: Descriptive Statistics: 1962Q1 to 1998Q3

Variable	Mean	Standard Deviation	Skewness	Kurtosis (-3)	Normality¶
lrm1	13.9494	0.3336	-1.2409	1.1923	46.43*
lip	4.3200	0.4823	-1.1107	0.1337	30.33*
lrs	2.3400	0.5852	-0.1872	-1.5260	15.12*
infl	0.0281	0.1215	0.7050	6.5496	273.05*

¶ The Bera-Jacques test for normality.

* Indicates significance at the 1% level.

Table 2: Stationarity Tests: 1965Q2 to 1998Q3

a Level of Variables

Variable	ADF	order of lag	Phillips-Perron Statistic
lrm1	-2.7177	3	-3.3748*
lip	-3.5328*	8	-3.7433*
lrs	-1.6174	1	-1.3946
infl	-11.3031*	1	-15.9351*

b First Difference of Variables

Variable	ADF	order of lag	Phillips-Perron Statistic
Δlrm1	-10.8510*	2	-20.8051*
Δlip	-3.8181*	7	-21.4977*
Δlrs	-8.5542*	0	-7.2936*
Δinfl	-8.9283*	6	-33.3912*

5% critical Value for ADF and Phillips-Perron test = -2.883.

Table 3 Cointegrating Vectors

(Coefficients normalised on lrm1)

	Vector 1	Vector 2	Vector 3
lrm1	-1.0000	-1.0000	-1.0000
lip	1.4943	1.2162	0.81406
lrs	-1.6568	-13.1022	-0.27244
infl	-47.3101	167.3539	-0.18893
constant	13.6999	39.1351	11.0719

Table 4: Error Correction Model

Dependent Variable Dlrm1. Number of Observations 133

Regressor	Coefficient	T-Ratio[Prob]
Constant	0.058331	9.6
Δlip_{t-2}	0.18457	1.9
Δlrs_{t-3}	-0.14609	1.6
$\Delta infl$	-0.74858	20.4
$\Delta infl_{t-1}$	-0.44988	10.8
$\Delta infl_{t-2}$	-0.13453	3.1
res_{t-3}	-0.24934	5.5
sr1	-0.19661	13.9

Diagnostic Statistics

R-Squared	0.8137	
R-Bar-Squared	0.8039	
DW-statistic	2.0541	
		P value
LM test for serial correlation	3.5488	0.47
Test for Heteroscedascity	0.23792	0.63
Bera Jarque test for normality of residuals	21.4205	0.00

Estimation by OLS

Table 5: Simulation Accuracy

Forecast	Static	Dynamic	Naïve lrm(-1)
Correlation Coefficient	0.978	0.562	0.889
Root Mean square Error	0.059	0.403	0.137
Mean Absolute Error	0.043	0.309	0.105
Mean Error	0.003	0.258	0.009
Theil inequality Coefficient [1966]	0.004	0.288	0.010

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Appendix 1: Data Sources

The data resource is IMF International Financial Statistics obtained through Datastream and are described below:

1. Narrow money (M1) is the sum of currency outside deposit money banks and demand deposits other than those of the central government. In IMF statistics this is reported as *GR MONEY SUPPLY: M1 CURN*, code: *GRM1... A*. M1 is expressed in end of period billions of Drachmas.
2. Quarterly data on Gross Domestic Product for Greece are not available before 1975. Hence, we have used as a proxy for real GDP the Industrial Production Index (IP). This is reported in quarterly basis in IMF statistics under the heading *GR INDUSTRIAL PRODUCTION VOLN* and the code: *GRINPRODH*. The index has a base 1980=100.
3. The Consumer Price Index is used to denote the price level. This is reported in IMF statistics as *GR CONSUMER PRICES NADJ*, code: *GRI64... F*, with a base 1990=100.
4. Interest rates on 3 to 6 months time deposits with commercial banks (RS) were used as an indication of the short-term interest rate. The series are reported as *GR COMM BKS 3-6 MO DEPOSITS*, code: *GRI60L* and they are expressed as percent per annum.
5. The observations run from 1962 quarter 1 to 1998 quarter 3.