Inflationary Expectations and the Demand for Money: The Greek Experience

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I. Introduction

The demand for money, which is a basic issue of monetary theory, has been the subject of extensive theoretical and empirical research. This demand is usually expressed as a function of some concept of real income (or wealth), of prices and of a variable representing the opportunity cost of holding money. The latter may be expresesd in terms of financial or real assets, the choice often being made on empirical grounds. The nominal interest rate is an index of the opportunity cost of money in terms of financial assets. When on the other hand substitution is hypothesised between money and real assets, the expected rate of inflation is the appropriate index of the opportunity cost on the assumption that the real rate of return on real assets remains constant.[1]

The purpose of this study is to investigate empirically the demand for money function in Greece for the period 1955 - 1978. Specifically, we examine whether the interest rate or inflationary expectations are more important in the demand for money (money defined both narrowly — M1, i.e. currency in circulation and private sight deposits with the banking system — and broadly — M2, i.e. M1 plus private savings deposits). The role of inflationary expectations is examined using alternative hypotheses as to the formation of expectations. A non linear estimation procedure is applied allowing a unique determination of the parameters of the demand for money function and of the adjustment coefficient in one of the hypotheses describing the formation of expectations, namely the error learning hypothesis.

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[1] Substitution may extend to include foreign assets as well. In this case, foreign interest rates or exchange rates represent an alternative opportunity cost variable. In certain countries, however, with exchange restrictions and controls on capital flows, this variable becomes irrelevant.

A central question in the investigation is the stability of the demand for money function during the sub-interval 1964 - 78 in which the income velocity of circulation of M1 was relatively flat but also during the period 1973 - 78 of high inflation. Knowledge of the features of the Greek demand for money is essential as this demand plays an important role in the formulation and transmission of monetary policy. Moreover it would be useful in an eventual coordination of monetary policies in the European Communities in which Greece soon becomes a full member.

II. Specification of the Demand for Money Function

A simple form of the equilibrium (long-run) function of the demand for money is given by

$$M_t = a_0 + a_1 Y_t + a_2 P_t + a_3 R_t \tag{1}$$

where M: the quantity of money

Y: real income

P: the price level

R: a representative interest rate

Equation (1) is not restricted a priori to be homogeneous of first degree in prices. Assuming that adjustment to equilibrium is not instantaneous and using the partial adjustment hypothesis

$$M_t - M_{t-1} = \lambda (M_t^* - M_{t-1}) , \qquad 0 < \lambda \leqslant 1 \tag{2}$$

with M* the equilibrium demand for money and λ the adjustment coefficient, the following form is obtained

$$M_t = \lambda a_0 + \lambda a_1 Y_t + \lambda a_2 P_t + \lambda a_3 R_t + (1 - \lambda) M_{t-1} \tag{3}$$

With the expected rate of inflation as an alternative opportunity cost variable the demand for money in equilibrium is

$$M_t = a_0 + a_1 Y_t + a_2 P_t + a_3 \dot{P}_t^e \tag{4}$$

where $\dot{P}^e$ is the expected rate of inflation. The expectational variable is not observable and we need therefore to specify how expectations are formed. The hypotheses most used in empirical research are: a) the rational expectations hypothesis and b) the adaptive expectations (error learning) hypothesis (see *Frisch*, 1977).

In the first hypothesis due to *Muth* (1961) rational expectations (or "the subjective probability distribution of outcomes") are essentially the same as the predictions of the relevant economic theory (or "the objective probability distribution of outcomes"). Expectations may be stochastic but, consistently with the approximation (1) to the true money demand equation, we would assume that the actual rate of inflation is a valid approximation to the expected rate. Then (4) becomes

$$M_t = a_0 + a_1 Y_t + a_2 \dot{P}_t + a_3 P_t \tag{5}$$

or

$$M_t = \lambda a_0 + \lambda a_1 Y_t + \lambda a_2 P_t + \lambda a_3 \dot{P}_t + (1 - \lambda) M_t \tag{6}$$

when the partial adjustment mechanism is applied.

According to the adaptive expectations hypothesis due to *Cagan* (1956), the expected rate of inflation is connected with the actual by the following relation

$$\dot{P}_t^e - \dot{P}_{t-1}^e = \mu (\dot{P}_t - \dot{P}_{t-1}^e) , \qquad 0 < \mu \leqslant 1 \tag{7}$$

From the equivalent representation of (7)

$$P_t^e = \mu \sum_{i=0}^{\infty} (1 - \mu)^i \dot{P}_{t-i} \tag{8}$$

it can be seen that if μ is close to one the weights decline rapidly and individuals have a short memory when forming their expectations. The opposite is true if μ is very small.

Combining (4) with (7) gives us

$$M_t = \mu a_0 + a_1 Y_t - (1 - \mu) a_1 Y_{t-1} + a_2 P_t - (1 - \mu) a_2 P_{t-1} + \\ + \mu a_3 \dot{P}_t + (1 - \mu) M_{t-1} \tag{9}$$

Finally, (4), (7) and (2) give us

$$M_t = \mu \lambda a_0 + \lambda a_1 Y_t - (1 - \mu) \lambda a_1 Y_{t-1} + \lambda a_2 P_t - (1 - \mu) \lambda a_2 P_{t-1} + \\ + \mu \lambda a_3 \dot{P}_t + [(1 - \lambda) + (1 - \mu)] M_{t-1} - (1 - \lambda)(1 - \mu) M_{t-2} \tag{10}$$

III. Empirical Results

The above equations of the demand for money were estimated in log-linear form using data for the period 1955 - 78 and the M1 and M2 definitions of money. The variable definitions are the following:

M1: currency in circulation plus private sight deposits, annual average

M2: M1 plus private savings deposits, annual average

Y: gross national product at 1970 prices

P: GNP deflator

RS: interest rate on savings deposits with commercial banks

The estimates of the demand functions (1) and (3) for M1 are given in Table 1. The interest rate is insignificant in the long run function. The application of the partial adjustment mechanism produces a significant coefficient of this variable and moreover eliminates the autocorrelation of the residuals which is present in (1) and raises the long run income elasticity from 0.62 to 1.12.

The influence of the interest rate on money demand is known to be reflected on the income velocity of circulation. Over the period 1955 to 1963 the velocity of M1 declined at a steady rate which is consistent with the monetisation of the economy, and remained relatively flat after that period. This probably differentiates the behavior of the money demand function after 1964. The estimates of the function for the period 1964 - 1978 are also presented in Table 1 (equations 5 and 6). The application of the *Chow* test (*Johnston*, 1963, p. 137) indicates that these estimates are different at the 5 per cent level from those of the earlier period. The interest rate has now a positive effect on the demand for M1 and this indicates that it may not be the appropriate opportunity cost variable.

It should be noted that the adjustment coefficient λ takes in the period 1955 - 78 a values which is half that of the period 1964 - 78. The faster adjustment of money balances during the last period may be explained by the fact that this period includes years of rapid inflation (1973 - 78) in which individuals seek faster information as to the changes in the factors affecting their demand for money.

It is also interesting to note that there appears to be no shift in the parameters of the demand for M1 function during the inflationary period 1973 - 78. This conclusion is reached by breaking the period 1964 - 78 into the sub-intervals 1964 - 72 and 1973 - 78 and applying again the Chow test. The evidence as regards the stability of the demand for M1 function in other countries during the recent inflation is mixed. In some countries like Germany and the United Kingdom the demand schedule appears to have been insensitive to the conditions of severe

Table 1: **Regression Results for the Demand for M 1 Functions**

	Constant term	Coefficient of					First order serial correlation coefficient	R^2	DW
		$\ln Y_t$	$\ln P_t$	$\ln RS_t$	$\ln (P_t/P_{t-1})$	$\ln M1_{t-1}$			
				Period 1955 - 1978					
1.	3.10	0.62	1.02	0.02	—	—	0.90	0.9988	1.92
	(1.35)	(3.47)	(8.46)	(0.22)			(9.74)		
2.	− 1.32	0.41	0.39	− 0.10	—	0.67	—	0.9986	0.20*
	(− 1.29)	(2.49)	(3.28)	(− 1.74)		(6.05)			
3.	3.19	0.61	1.02	—	0.06	—	0.90	0.9988	1.93
	(1.43)	(3.50)	(9.91)		(0.30)		(9.75)		
4.	0.001	0.08	0.07	—	0.71	0.91	—	0.9989	0.05*
	(0.001)	(0.54)	(0.90)		(2.95)	(10.38)			
				Period 1964 - 1978					
5.	− 0.68	0.89	0.97	0.12	—	—	0.45	0.9983	1.81
	(− 0.42)	(7.06)	(10.42)	(1.41)			(1.89)		
6.	− 1.17	0.64	0.61	0.12	—	0.34	—	0.9988	0.51*
	(− 1.49)	(4.53)	(4.86)	(1.81)		(2.73)			
7.	0.64	0.80	1.08	—	− 0.13	—	0.59	0.9981	1.57
	(0.31)	(4.88)	(12.42)		(− 0.56)		(2.72)		
8.	− 0.54	0.47	0.51	—	0.32	0.50	—	0.9984	0.48*
	(− 0.53)	(2.20)	(2.31)		(1.25)	(2.42)			

* Absolute values of Durbin's h test statistic (see Durbin, 1970).

inflation but in the other countries like the United States, Italy and France there appears to have been instability (see *Goldfeld* 1976, *Coghlan* 1978, *Boughton* 1979).

The estimates of equation (3) presented in Table 1 (eqs 2 and 6) reveal that money demand is homogeneous in the price level. Indeed, the long run elasticity of demand with respect to prices is not significantly different from unity[2]. A similar result has been found among other countries for Italy (*Spinelli*, 1980), Germany[3] (*Courakis*, 1977) and the United Kingdom (*Coghlan*, 1978). In most studies, however, on the demand for money, homogeneity in prices is assumed a priori.

The results also indicate that the demand for M1 has unitary elasticity with respect to real income. This finding conforms with recent evidence for countries like France, Germany and the United Kingdom while it differs from the evidence from other countries (e.g. United States and Italy), where the long run income elasticity is reported to be well below or above unity (see *Boughton*, 1979).

The finding that the demand for money narrowly defined is homogeneous in income and the price level appears to validate the Bank of Greece's practice of setting monetary targets for the growth of the money stock corresponding approximately to the sum of the expected growth of real income and prices.

Using the expected rate of inflation instead of the interest rate and assuming that expectations are formed rationally we find that this variable is insignificant in the long run function both during the entire period and during the subperiod 1964 - 78 (eq. 3 and 7, Table 1). In the short run function the expected rate of inflation is significant but carries a positive sign. In this case, however, income and the price level lose their significance. This may be attributed to the correlation between $1nM1_{t-1}$ and $1n(P_t/P_{t-1})$ in the period before 1964 as the mechanism of partial adjustment does not affect the significance of the independent variables of the function neither in the subperiod 1964 - 78 nor in the entire period when the interest rate is used as the opportunity cost variable.

The expected rate of inflation does not affect significantly the demand for M1 during the period 1964 - 78. Real income and the price level are

[2] For the method of testing see *Courakis* 1977, p. 40 and *Kmenta* 1971, p. 372.
[3] In *Courakis* (1977) the result refers to central bank money.

Table 2: **Estimates of Money Demand Functions**

	Dependent variable	a_0	a_1	a_2	a_3	μ	λ	R^2	DW
				Period 1964 - 1978					
1.	$\ln M1_t$	0.65	0.80	1.08	− 0.09	0.44	—	0.9983	1.83
		(0.27)	(4.19)	(9.21)	(− 0.16)	(2.21)			
2.	$\ln M1_t$	− 1.27	0.95	1.01	0.56	0.90	0.53	0.9984	1.86
		(− 0.53)	(5.12)	(8.59)	(0.56)	(1.44)	(1.37)		
				Period 1955 - 1978					
3.	$\ln M2_t$	− 6.40	1.48	1.38	− 1.09	1.13	0.19	0.9997	
		(− 2.50)	(7.61)	(6.33)	(− 1.44)	(4.95)	(5.0)		2.18
				Period 1964 - 1978					
4.	$\ln M2_t$	− 10.61	1.77	1.01	− 0.98	1.11	0.53	0.9999	1.65
		(− 15.01)	(29.93)	(22.86)	(− 5.26)	(8.63)	(4.13)		

both significant. The long run price and income elasticities from equation 8 (Table 1) satisfy again the homogeneity property.

Free estimation of equations (9) and (10) will not give unique values of the parameters a_0, a_1, a_2, a_3, μ and λ as the number of coefficients to be estimated exceeds the number of these parameters. For this reason the equations have been estimated by a non linear estimation procedure[4]. The results of estimation for the subperiod 1964 - 78 are shown in Table 2 while those for the total period have not been found satisfactory in terms of the size of elasticities, significance of coefficients, etc. The last outcome may be explained by the non uniform operation over the whole period of the error learning process as regards the formation of expectations and of the partial adjustment mechanism as regards the adjustment of money balances. From equation 2 (Table 2) it may be seen that the expected rate of inflation is not significant and the long run income and price elasticities do not differ substantially from those estimated in equation 8 (Table 1). The adjustment coefficient in the error learning hypothesis has a very high value ($\mu = 0.90$) which means that inflationary expectations are largely formed on the basis of the current rate of inflation. Also, the estimate of λ is not at variance with that of equation 8 (Table 1).

Taken together, the previous results imply that the market for M1 in Greece is segmented from the markets for either financial or real assets, a feature which is unique to the Greek experience. In contrast, all studies of the demand function for narrow money pertaining to other economies find some role to at least one opportunity cost variable. Most studies use the interest rate as the opportunity cost but more recent studies such as *Goldfeld* (1973) for the United States, *Melitz* (1976) for France and *Coutière* (1976) for several developed countries have found that inflation is important in the demand for money.

Demand for M2 includes the demand for money both for transaction purposes and for the accumulation of wealth. Thus the effect of the interest rate is expected on balance to be non negative because it involves a negative effect related to the demand for M1 and a larger

[4] The non linear estimation procedure employed allows an equation which is not linear in parameters to be estimated by least squares. The equation is expanded in a Taylor series about some initial values of the parameters and is truncated after the linear terms. The parameters are determined in a sequence of iterations which end when the final values of the parameters exceed those of the previous iteration by less than a predetermined level.

positive effect related to the demand for savings deposits. As the interest rate employed in the estimation of the demand for M1 functions refers to a component of M2, the interest rate (RT) on the closest substitute of M2, namely time deposits, should be included in the demand for M2 function as the opportunity cost variable. The estimates of equations (1) and (3) are presented in Table 3. From equation 1 (Table 3) it may be seen that the coefficient of RS has a positive sign but is insignificant, while RT has the expected negative sign and is significant at the 10 per cent level. The last finding indicates the existence of substitution between M2 (and in particular savings deposits) and time deposits.

The demand function for M2 was also estimated using the expected rate of inflation instead of the interest rates. The expected rate of inflation, whether determined by the rational expectations hypothesis or by the adaptive expectations hypothesis, is significant and carries the expected negative sign during the period 1964 - 78 which includes the inflationary period 1973 - 78. Furthermore, over the whole period this variable is significant at the 10 per cent level. This suggests that substitution between M2 and real assets is also important, although the relevant elasticity of substitution is smaller than in the case of substitution with time deposits.

The income elasticity of M2 exceeds unit and has risen in the last subperiod. Income elasticity of the demand for broad money greater than unity has been almost uniformly found for other countries *(Boughton,* 1979). A unitary price elasticity is recorded in the case of M2 too, for the period 1964 - 78.

The size of μ in the error learning hypothesis is slightly greater than unit[5] implying that individuals overadjust their money balances during the current period. In the following periods, however, a correction of this adjustment takes place so that money balances are eventually restored to the desired levels. Comparing the sizes of the coefficient μ in the equations for M1 and M2 we see that during the period 1964 - 78 this coefficient has a slightly higher value in the case of M2. The interpretation is that individuals do not form their inflationary ex-

[5] The adjustment coefficient μ was assumed to lie in the range (0,1). In this case the weights in (8) are positive and decline geometrically. When μ has a value greater than one and less than two the function of the demand for money is still stable but the weights alternate in sign and converge in absolute value to zero.

Table 3: **Regression Results for the Demand for M 2 Functions**

	Constant term	Coefficient of						First order serial correlation coefficient	R^2	DW
		$\ln Y_t$	$\ln P_t$	$\ln RS_t$	$\ln RT_t$	$\ln (P_t/P_{t-1})$	$\ln M2_{t-1}$			
					Period 1955 - 1978					
1.	− 5.47	1.37	1.12	0.27	− 0.41	—	—	0.73	0.9990	2.45
	(− 3.11)	(10.04)	(8.78)	(1.10)	(− 1.55)			(5.03)		
2.	− 0.88	0.26	0.28	0.09	− 0.14	—	0.81	—	0.9997	0.60*
	(− 1.15)	(2.39)	(3.70)	(0.56)	(− 0.76)		(14.03)			
3.	− 3.51	1.20	1.10	—	—	− 0.52	—	0.81	0.9991	2.48
	(− 1.94)	(8.31)	(10.48)			(− 2.22)		(6.52)		
4.	− 1.17	0.27	0.26	—	—	− 0.24	0.81	—	0.9997	0.80*
	(− 1.76)	(3.37)	(7.45)			(− 1.69)	(24.80)			
					Period 1964 - 1978					
5.	− 7.57	1.58	1.17	1.00	− 1.37	—	—	—	0.9984	1.66
	(− 5.59)	(16.71)	(8.68)	(1.40)	(− 1.60)					
6.	− 1.50	0.26	0.20	− 0.07	− 0.01	—	0.87	—	0.9995	0.42*
	(− 0.85)	(0.77)	(0.77)	(− 0.13)	(− 0.01)		(3,92)			
7.	− 9.39	1.66	0.98	—	—	− 0.79	—	—	0.9995	2.17
	(− 17.30)	(38.29)	(31.32)			(− 5.94)				
8.	− 5.31	0.95	0.59	—	—	− 0.54	0.44	—	0.9997	0.43*
	(− 3.08)	(3.20)	(3.61)			(− 3.54)	(2.45)			

* Absolute values of Durbin's h test statistic.

pectations uniformly but are more sensitice when they demand money as a means for accumulating their wealth.

IV. Conclusions

The main conclusions derived from the estimation of the demand for money in the Greek economy are the following:

a) The demand for M1 was found to have certain interesting characteristics: it is homogeneous in prices and real income, is independent of the demand for financial or real assets and remained stable during the period 1973 - 78 of high inflation. These characteristics, close to those found for other European countries, suggest that Greece is not likely to pose any problem in an eventual attempt at coordinated monetary policies in the context of E.E.C.

b) From the estimates of the demand for M2 function, substitution was evidenced between savings and time deposits and between savings deposits and real assets, the elasticity of substitution being higher in the former case. As in the case of M1, the demand for M2 function is also homogeneous in the price level, while the income elasticity is clearly greater than unity.

c) It has been found that over the period 1964 - 78 actual money balances adjust to their desired levels with a lag. In the current period money balances adjust by 50 - 55 per cent when money is defined either as M1 or as M2.

d) As regards inflationary expectations, when these are assumed to be formed through an error learning process, the adjustment coefficient takes a value approximating unity during the period 1964 - 78 independently of whether money is defined as M1 or M2. This implies that individuals form their expectations in accordance with the most recent developments in the rate of inflation, a situation which corresponds closely to perfect foresight.

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Zusammenfassung

Inflationserwartungen und Geldnachfrage: Die Erfahrungen Griechenlands

In der Geldnachfragefunktion für Griechenland werden Inflationserwartungen als Alternative zum Zinssatz der Oppotunitätskostenvariablen eingesetzt. Es werden zwei Hypothesen zur Erwartungsbildung berücksichtigt, und Geld wird sowohl im engeren als auch im weiteren Sinne definiert. Die empirischen Ergebnisse zeigen, daß sich die Geldnachfragefunktion 1964 verschob, dagegen während der Zeit hoher Inflation von 1973 bis 1976 stabil blieb. Es wurde herausgefunden, daß die Nachfrage nach M1 hinsichtlich der Preise und dem realen Einkommen homogen und darüber hinaus unabhängig von der Nachfrage nach Finanz- oder Realvermögen ist. Eine Substitution zwischen M2 und Termineinlagen und M2 und Realvermögen wurde nachgewiesen. Schließlich wurde festgestellt, daß Einzelne ihre Erwartungen in Übereinstimmung mit den neuesten Entwicklungen der Inflationsrate bilden, d. h. ihre Erwartungen nähern sich der perfekten Voraussage stark an.

Summary

Inflationary Expectations and the Demand for Money: The Greek Experience

Inflationary expectations are used in the demand for money function for Greece as an alternative to the interest rate opportunity cost variable. Two hypotheses as to the formation of expectations are employed and money is defined both in the narrow and broad sense. The empirical results reveal that the demand function shifted in 1964 but remained stable during the period 1973 - 78 of high inflation. The demand for M1 was found to be homogeneous in prices and real income, and independent of the demand for financial or real assets. Substitution was evidenced between M2 and time deposits and M2 and real assets. Finally it was found that individuals form their expectations in accordance with the most recent developments in the rate of inflation i.e. their expectations correspond closely to perfect foresight.

Résumé

Anticipations de l'inflation et demande monétaire: l'expérience de la Grèce

Dans la fonction de demande monétaire pour la Grèce, les anticipations de l'inflation ont été introduites comme alternative au taux d'intérêt des variables des coûts d'opportunité. L'on a considéré deux hypothèses d'anticipation, la monnaie étant définie au sens large et au sens étroit. Les résultats empiriques montrent que la fonction de demande monétaire évolua en 1964, mais qu'elle demeura stable en période d'inflation accélérée de 1973 à 1976. L'on découvrit que la demande de M1 relative aux prix et au revenu réel était homogène et au surplus indépendante de la demande d'avoirs financiers ou réels. Une substitution entre M2 et les dépôts à terme d'une part et M2 et les avoirs réels d'autre part a pu être mise en évidence. Et il fut établi en conclusion que des particuliers forment leurs anticipations en concordance avec les plus récents développements des taux d'inflation, c.à.d. que leurs anticipations sont près de s'identifier à des prévisions parfaites.