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Testing The Quantity Theory of Money in Greece: A Note

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TESTING THE QUANTITY THEORY OF MONEY IN GREECE: A NOTE

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Abstract: This paper investigates whether the Greek data actually support the monetarist hypotheses as argued by Karfakis (2002). The results based on both ARDL and Johansen procedures consistently suggest that money and nominal income (prices) are endogenous for the parameters of the long-run evolution of velocity (real money balances). Thus, the basic postulation of monetarism, the exogeneity of money, appears not to be supported by the Greek data.

"Again and again throughout its long history, the exogeneity or endogeneity of money has been at the back of every controversy surrounding the QTM" (M. Blaug, 1995, p. 60).

I. INTRODUCTION

The validity of the quantity theory of money (QTM) has always been at the center of debates in monetary economics. Karfakis (2002) provides a recent contribution to this debate by empirically examining the validity of the QTM for the Greek annual data from 1948 to 1997.

A stable and stationary velocity is one of the *sine quo non* of the QTM. Consider the equation of exchange specified in logarithmic form:

$$m + v = p + x = y \qquad (1)$$

where m is the quantity of money, v is velocity, p is price level, x is real income and y is nominal income. The QTM postulates that each of m, p, x, or their linear combination with a coefficient vector (-1 1 1) is stationary (I(0)). A cointegrated m and y (or, m, p, x) with unitary coefficients is necessary for v to be I(0) but not sufficient for the validity of the QTM. The QTM postulation contains also the exogeneity of money in the velocity variable system. This paper aims to test whether the Greek data considered by Karfakis (2002) actually support the QTM by satisfying also the necessary condition that money is weakly exogenous for the long-run evolution of prices (or nominal income). The following section proceeds with our empirical results.

II. EMPIRICAL RESULTS

Karfakis (2002) considers narrow (M1) and broad money (M2) velocities and finds that the M1 velocity is I(0) around an endogenous break point, whilst M2 velocity is non-stationary. Karfakis (2002) proceeds with Autoregressive Distributed Lag (ARDL) modeling approach to test the validity of the QTM.

For a bivariate k^{th} order Vector Autoregression (VAR(k)) system $z_t = (x_{1t}, x_{2t})$, an ARDL equation for x_{1t} and long-run forcing variable x_{2t} $(x_{1t} \mid x_{2t})$ can be written as:

$$\Delta x_{1t} = a + b_1 x_{1t-1} + b_2 x_{2t-1} + \sum c_i \Delta x_{1t-i} + \sum d_j \Delta x_{2t-j} + \varepsilon_t \qquad (2)$$

where, i = 1, ..n; j = 0, .., n and n = k-1. Pesaran, Shin and Smith (2001) provide the CV bounds to test the null of no cointegration ($b_1 = b_2 = 0$).

Karfakis (2002) adds a one-time dummy variable (d88) taking unity at 1988 and estimates bivariate ARDL models for narrow money (m), nominal income (y) and prices (p) under the restriction that the equations do not contain the current value of the maintained forcing-variable (i.e. $d_0 = 0$ in (2), see Eq. 4 of Karfakis). Karfakis (2002) selects n = 5 on the basis that this "gives most weight to the existence of a long-run relationship" (p. 584, fn. 6). The results interpreted as supporting to the QTM[1], however, may not be invariant to the validity of the maintained conditioning hypothesis and the choice of the lag length. To determine the appropriate lag length we estimated[2] the VAR systems $z_{1t} = (m_t, y_t)$ and $z_{2t} =$

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[1] Note that, even this result may be misleading as Karfakis (2002) compares his estimated F(2,30) statistic (4.45) not with the appropriate CV bound (4.04-4.79) but with the CV of a case for two forcing variables (3.18-4.13).

[2] For comparability, we consider the same sample period and variable definitions with Karfakis (2002), albeit the results were virtually unchanged for an extended period covering also 1998-2000. Following Karfakis (2002), all the equations contain also d88. As the fraction of observation for the

(m_t, p_t) for k = 5,4,3,2,1. Table 1 reports Akaike's and Schwarz's Bayesian Information Criteria, denoted respectively by AIC and SBC, and sequential Likelihood Ratio (LR) tests of system reduction from VAR (k) to VAR(k-j). The AIC chooses k = 4 for both z_{1t} and z_{2t}. The SBC suggests k = 1 or 4 for z_{1t} and k = 2 or 4 for z_{2t}. For both of the systems, the LR tests suggest that only the reduction from VAR(5) to VAR (4) is data-acceptable. Therefore the VAR(4) can be interpreted as an appropriate choice for both z_{1t} and z_{2t}.

[INSERT TABLE 1 ABOUT HERE]

The bounds test ($b_1 = b_2 = 0$) from the estimation of (2) with k = 4 yielded F(2,34) = 13.2 for ($m_t \mid y_t$) equation and F(2,34) = 8.3 for ($y_t \mid m_t$) equation. The tests for ($p_t \mid m_t$) and ($m_t \mid p_t$) equations with k = 4 yielded, F(2,34)= 15.9 and F(2,34) = 11.9, respectively. For each of the systems, these results strongly reject the null of no levels relationship under every alternative conditioning hypotheses (the 1% CV bounds is (7.06, 7.82)). The finding of Karfakis that there is no level relationships for ($m_t \mid y_t$) and ($m_t \mid p_t$) appears to be resulting from imposing $d_0 = 0$ in (2) and selecting an inappropriate VAR lag length.

Given the money-income and money-prices level relationships, the ARDL method is used to estimate the equilibrium correction (ec) models. We started with n=5 and select the optimum lag by SBC. The first column of Table 2 (Eq. 2a) presents the results for the unrestricted ($y_t \mid m_t$) equation which is indeed the same with Table 2 of Karfakis (2002). The second column of the table (Eq. 2b) reports

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dummy variable to the sample size is negligible (0.02), the use of d88 is acceptable (see, Pesaran *et al.* (2001, p. 307)).

the results for $(m_t | y_t)$ equation which is not considered in Karfakis (2002). Both of the equations pass all the diagnostics hence can be interpreted as a valid representation of the data. The equilibrium correction terms are significant in both $(m_t | y_t)$ and $(y_t | m_t)$ equations suggesting no variable alone can be interpreted as the unidirectional forcing variable for the long-run evolution of the other. This clearly contradicts with the QTM postulation that money is the sole forcing variable. Contrary to the QTM, the evidence is consistent with an endogenous money hypothesis. The long-run adjustments of money and income to a disequilibrium, however, are relatively slow as suggested by the magnitude of the ec_{t-1} coefficients. The magnitude of the short-run monetary accommodation, i.e. the adjustment of money to prices (0.81), is much higher than the adjustment of prices to money (0.49).

[INSERT TABLE 2 ABOUT HERE]

Table 2 presents also the ARDL results for $(p_t | m_t)$ and $(m_t | p_t)$ equations. For $(p_t | m_t)$, the ARDL (4,2) model selected by SBC (Eq. 2c) is essentially the same with the results reported by Table 3 of Karfakis (2002). However, this equation alone cannot be interpreted as sufficient evidence supporting the QTM that money is the sole forcing variable. Equation 2d specified under the maintained hypothesis that price level is the forcing variable $(p_t | m_t)$ provides a contrary evidence. According to (2d), the levels equilibrium between m and p is achieved through long-run monetary accommodation. The magnitude of the adjustment coefficients in the conditional m and p equations suggests that the speeds of both long-run monetary and price adjustments are slow. Similar to the money-income case, the short-run contemporaneous monetary accommodation of prices is strong.

Contrary to the findings of Karfakis (2002), the results from the ARDL approach provide no valid empirical support to the QTM. Consistent with an endogenous money hypothesis, money and nominal income (and prices) appear to be jointly determined. However, this result itself may also suggest that applying the ARDL approach under the maintained conditioning hypothesis may indeed be misleading due to a possible simultaneity bias. A solution might be estimating the systems by an instrumental variable method and testing the validity of the maintained conditioning hypothesis. In the absence of the asymptotic theory and the corresponding CV bounds, such solution may not be without problems at the moment. An alternative may be employing the Johansen (1988, 1992) procedure which does not impose a priori conditioning restrictions on the variable space.

Table 3 reports the results of the Johansen procedure applied to the bivariate systems $z_{1t}= (m_t, y_t)$ and $z_{2t}= (m_t, p_t)$ with the VAR length k = 4. The trace eigenvalue (λ_{trace}) statistics suggest the presence of a single cointegrating vector for each of the systems. According to the long-run exclusion tests (Q_E), none of the variables can be excluded from the long-run relationships.

The cointegration relation for the first system $z_{1t}= (m_t, y_t)$,

$$m_t = 0.972y_t$$

is essentially the same with the levels relationship from the ARDL method. The LR test that the income coefficient is unity yielded 1.61 ($\sim \chi^2(1)$, p = 0.21) implying that the velocity is I(0). The significance of the adjustment coefficients in both the Δm_t and Δy_t equations suggests the rejection of the weak exogeneity (Johansen (1992)) of money and income for the parameters of the long-run relationship. Thus, contrary to the QTM postulation, the stationary velocity is the outcome of the adjustments of both money and income to velocity shocks.

[INSERT TABLE 3 ABOUT HERE]

The long-run relationship for the money-price system,

$$m_t = 1.10p_t$$

is consistent with the ARDL results. The LR test for the unitary price coefficient yielded 1.41 (~ $\chi^2(1)$, p = 0.24) implying that real money is I(0). The weak exogeneity nulls for money and prices are rejected as the equilibrium correction term is significant in the corresponding equations. The endogeneity of money is not consistent with the basic postulate of the QTM.

III. CONCLUSION

We re-examined the validity of the QTM for the Greek annual data considered by Karfakis (2002) using both the ARDL bounds and Johansen procedures. Contrary to Karfakis (2002), the results strongly reject the exogeneity of money in a velocity variable system, which is indeed the *sine quo non* of the QTM. Consistent with an endogenous money hypothesis, money and nominal income (or prices) appear to be jointly determined.

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Table 1. Statistics for the VAR Lag Order Selection

	$z_{1t} = (m_t, y_t)$			$z_{2t} = (m_t, p_t)$		
k	*AIC*	*SBC*	*LR*	*AIC*	*SBC*	*LR*
5	151.2	129.5		157.7	136.0	
4	153.7	135.6	$\chi^2(4) = 2.95$ [0.33]	160.1	142.0	$\chi^2(4) = 3.13$ [0.53]
3	146.9	132.5	$\chi^2(8) = 24.5$ [0.00]	155.7	141.2	$\chi^2(8) = 20.03$ [0.01]
2	145.3	134.4	$\chi^2(12) = 35.9$ [0.00]	153.7	142.9	$\chi^2(12) = 31.9$ [0.00]
1	145.3	134.4	$\chi^2(16) = 35.9$ [0.00]	153.7	142.9	$\chi^2(16) = 31.9$ [0.00]

Notes: See Pesaran and Pesaran (1997) for the statistics, p-values in the brackets.

Table 2. Money, Nominal Income and Prices: Conditional EC Models

Eq. (Cond.)	**2a (y_t| m_t)**	**2b (m_t| y_t)**	**2c (p_t| m_t)**	**2d (m_t| p_t)**
Dep. Var.	Δy_t	Δm_t	Δp_t	Δm_t
Regressors	***Coef. (s.e)***	***Coef. (s.e)***	***Coef. (s.e)***	***Coef. (s.e)***
Δm_t	0.491 (0.97)**		0.390 (0.08)**	
Δm_{t-1}		-0.196 (0.109)*	0.252 (0.08)**	-0.376 (0.118)**
Δm_{t-2}		-0.157 (0.112)		-0.181 (0.114)
Δm_{t-3}		-0.286 (0.106)**		-0.341 (0.107)**
Δy_t		0.810 (0.128)**		
Δy_{t-1}	0.148 (0.088)*			
Δy_{t-2}	0.171 (0.09)*			
Δy_{t-3}	0.311 (0.09)**			
Δp_t				0.951 (0.139)**
Δp_{t-1}			0.201 (0.098)**	
Δp_{t-2}			0.198 (0.096)**	
Δp_{t-3}			0.182 (0.096)*	
ec_{t-1}	-0.091 (0.024)**	-0.136 (0.029)**	-0.054 (0.012)**	-0.071 (0.013)**
Diagnostics				
R^2	0.779	0.607	0.880	0.608
s.e	0.03	0.04	0.03	0.04
$\chi^2_{SC}(1)$	0.01 [0.91]	0.08 [0.78]	1.75 [0.19]	3.61 [0.06]
$\chi^2_{FF}(1)$	1.37 [0.24]	0.47 [0.49]	0.21 [0.64]	1.69 [0.19]
$\chi^2_{N}(2)$	0.32 [0.85]	1.43 [0.49]	1.08 [0.58]	0.15 [0.93]
$\chi^2_{H}(1)$	2.70 [0.11]	0.04 [0.85]	1.83 [0.18]	0.38 [0.54]
Long-run equilibrium	y_t= 1.65 + 1.98m_t (0.22)** (0.03)**	m_t= -0.55 + 0.96y_t (0.34) (0.02)**	p_t= -2.23 + 0.797m_t (0.07)** (1.01)**	m_t= 4.91 + 1.06p_t (0.07)** (0.07)**

Notes: * and ** denote the significance at the 10 and 5 %, respectively. Equilibrium correction (ec) terms are the residuals from the corresponding long-run equilibrium equations. R^2 is the squared correlation coefficient, s.e is the standard error, $\chi^2_{SC}(1)$, $\chi^2_{FF}(1)$, $\chi^2_{N}(2)$, $\chi^2_{H}(1)$ denote χ^2 tests for the lack of residual autocorrelation, functional form mis-specification, non-normality and heteroscedasticity, respectively with p-values given in [.]. For these tests see Pesaran and Pesaran (1997, Ch. 18).

Table 3. Johansen Cointegration Analysis

System	m1, y		m1, p	
Eigenvalues (λ)	0.484	0.044	0.531	0.96
Hypotheses	r = 0	r ≤ 1	r = 0	r ≤ 1
λ_{trace}	32.50**	2.05	39.48**	4.63
95 % fractiles	17.9	8.1	17.9	8.1
Standardized eigenvectors β				
	m1	**y**	**m1**	**p**
β_1	1.000	-0.972	1.000	-1.104
β_2	-0.684	1.000	0.290	1.000
Standardized adjustment coefficients α				
Equation	**Δm1**	**Δy**	**Δm1**	**Δp**
α_1	-0.103 (-3.30)**	0.052 (2.01)**	-0.05 (-3.61)**	0.026 (2.66)**
α_2	-0.017 (-1.25)	-0.015 (-1.38)	-0.021 (-1.91)	-0.016 (-2.05)
LR tests for long-run exclusion: $Q_E \sim \chi^2(1)$				
Variable	**m1**	**y**	**m1**	**p**
	26.7**	24.8**	29.1**	22.1**

Note: The critical values for λ_{trace} are from Osterwald-Lenum (1992).
** Indicates significance at the 5 % level.