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THE ACCOMMODATION HYPOTHESIS IN GREECE. A TRI-VARIATE GRANGER-CAUSALITY APPROACH

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Abstract

This paper with title "The Accommodation Hypothesis in Greece. A tri-variate Granger-Causality Approach" investigates empirically the causal relationship between money growth, budget deficits and inflation in Greece employing a tri-variate error-correction model. The causal relationship between money, deficits and inflation is explored using three alternative definitions for money: high-powered, M1 and M2 definitions of money stock. The results support the accommodation hypothesis and provide evidence that deficits are inflationary when monetized. (JEL E58).

1. Introduction

Large budget deficits —according to the popular view— contribute to excessive money growth, high interest rates and inflation. A number of theoretical alternative hypotheses, regarding the relationship between budget deficit and money growth, has been developed. First, is the accommodation hypothesis; large deficits pull upwards interest rates and thus cause the monetary authorities to monetize the debt in order to keep interest rates stable. Second, is the reverse hypothesis that money growth causes budget deficits (Barro, 1979); excessive money growth, results in inflation which causes the government to increase nominal deficits, in order to keep up with the rate of inflation. Third, is the assumption that there may exist two-way causality between deficit and money

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growth. These feedback effects appear either directly or indirectly through the channel of interest rates and inflation. Such a consideration implies that, studies where either money or deficit is treated as an exogenous variable are subject to simultaneous-equation bias. Finally, there is the assumption that there is no causal relationship between budget deficits and money growth; any observed correlation may be spurious due to their correlation with a third variable(s).

The literature concerning the empirical analysis of the relationship between money growth and deficits, can be broadly classified into three categories: a) studies based on the estimation of a single reaction function of the central bank (Niskanen, 1978; Hamburger ans Zwick, 1981; Allen and Smith, 1983; King and Plosser, 1985; Joines, 1985; Grier and Neiman, 1987; Koluri and Giannaros, 1987); b) studies where the reaction function of the central bank is estimated within a system of equations (Button, 1971; Levy, 1981; Dornbush and Fisher, 1981; Demopoulos, Katsimbris and Miller, 1987; Turnovsky and Wohar, 1987; Landon and Reid, 1990; Burdekin and Wohar, 1990) and c) causality studies (Dwyer, 1982 and 1985; Ahking and Miller, 1985; McMillin, 1986; Protopapadakis and Siegel, 1987; Barnhart and Darrat, 1988 and 1989;).

The reported results from all those empirical studies are rather mixed. For example, Akhtar and Wilford (1979), Hamburger and Zwick (1981), Levy (1981), McMillin (1986), report that deficits Granger-cause money growth. On the other hand, Niskanen (1978), Dwyer (1985), Joines (1985), Koluri and Giannaros (1987), Barnhart and Darrat (1988, 1989) and Landon and Reid (1990) conclude that money growth does not appear to be determined by deficit financing. In the studies of Barro (1979) and Bradley and Potter (1986), the evidence is that money growth causes deficit increases. Other studies, conclude that the investigated relationship becomes either significant or insignificant, depending on the subperiod examined (Turnovsky and Wohar, 1987; McMillin, 1986; Landon and Reid, 1990) and on the exchange rate regime (Demopoulos, Katsimbris and Miller, 1987).

This paper investigates empirically the causal relationship between money growth, budget deficits and inflation in Greece for the period 1958-1990, employing a tri-variate error-correction model and using three alternative definitions for money; i.e. high-powered, Ml and M2 definitions of money stock. The results suggest that the variables under investigation are cointegrated and that there exists a two-way causal relationship between budget deficits, and high-powered money and Ml. Furthermore, there is also one-way causal effects running from M2 to deficits. Inflation is found to be Granger-caused by money growth, that is, deficits are inflationary in Greece when monetized.

The remainder of the paper is organized as follows: Section II, outlines the cointegration and error-correction techniques. Section III presents the data and the empirical findings. And section IV presents a brief summary with concluding remarks.

2. Cointegration and Error-Correction Methodology

The concept of causality, outlined by Granger (1969), has been broadly used in Economics. A variable X causes another variable Y, if past changes in X help to explain current changes in Y with past changes in Y. The reverse causality can be tested with Y and X interchanged. All testable hypotheses are:

i) Y Granger-causes X, ii) X Granger-causes Y, iii) Y and X Granger-cause each other, iv) neither variable Granger-causes the other.

The empirical investigation of causality, employs the following general multi-variate autoregressive model, adjusted for three variables:

$$\Delta Y_t = \alpha_0 + \sum_{s=1}^{m} \alpha_{1s}\,\Delta Y_{t-s} + \sum_{s=0}^{n} \alpha_{2s}\,\Delta X_{t-s} + \sum_{s=0}^{k} \alpha_{3s}\,\Delta Z_{t-s} + e_t \qquad (1)$$

where Δ is the first-difference operator, ΔY, ΔX and ΔZ are stationary time series and e_t is a white noise error term, distributed with zero mean and constant variance. The null hypothesis that X (Z) does not Granger-cause Y is rejected if the coefficients $\alpha_{2s}(\alpha_{3s})$ in equation (1) are jointly significant, based on an F-test.

In order to identify the optimal lag-length of equation (1), we employ Hsiao's (1981) methodology as extended by Ahking and Miller (1985). All estimations use Ordinary Least Squares (OLS).

The general multi-variate autoregressive model of equation (1) is appropriate for testing Granger-causality only if the variables are not cointegrated.

Cointegration means, that, two or more variables have a long-run equilibrium relationship. That is, two or more variables are cointegrated if there is one or more, stationary, linear combinations among them, even though these variables, individually, are non-stationary in levels.

Granger, (1985, 1986), and Engle and Granger (1987), suggest a test of causality, based on cointegration and error-correction models. Since cointegrated variables share common trends, they must also exhibit Granger-causality in at least one direction.

The error correction equation of model (1) is of the following form.

$$\Delta Y_t = \alpha_0 + \sum_{s=1}^{m} \alpha_{1s} \Delta Y_{t-s} + \sum_{s=0}^{n} \alpha_{2s} \Delta X_{t-s} + \sum_{s=0}^{k} \alpha_{3s} \Delta Z_{t-s} + \lambda \mu_{t-1} + e_t \quad (2)$$

where X_t, Y_t, Z_t are the first-differenced stationary, cointegrated time series and μ_{t-1} is the lagged value of the error term of the following cointegration regression

$$Y_t = c_1 + c_2 X_t + c_3 Z_3 + \mu_t \quad (3)$$

where μ_t, is integrated of I (0) order.

The error-correction model is differentiated from the standard Granger-causality approach, since, including μ_{t-1}, an additional channel is introduced through which Granger-causality can emerge.

3. Data and Empirical Findings

The empirical analysis[1] uses annual data[2] for the period 1958 to 1990. We have examined the dynamic interactions between money and deficit in a tri-variate system, consisting of the Consumer's Price Index (PC), as a measure of the general price level, the Central Government Budget Deficit (DEF) and three alternative proxies for the money series; high-powered money (HM), the narrow Ml definition of money (Ml) and the M2 definition of money (M2). All data series are in natural logarithms.

In order to remove any deterministic non-stationarity in the system along with troublesome outliers and regime shifts that occured over the sample period, we keep into the analysis a constant term in all the equations and we incorporate two properly specified dummy variables[3], as well as a linear time trend variable. Thus, DUMP takes account of the residuals outliers in the price level eqaution, DUMD takes account of the outliers in the deficit equation and T takes account of the linear time trend.

Our research, proceeds in two stages[4]. First, we test for cointegration between deficit, price level and the three alternative measures of the money variable. Next, if cointegration is detected, the error-correction model of equation (2) is estimated; on the other hand, for the variables which are not cointegrated we estimate equation (2) after deleting the lagged error-correction term.

3.1. Cointegration Tests

Since cointegration requires non-stationary data-series of the same order of integration, we first test for stationarity using the Dickey-Fuller (DF) and augmented Dickey-Fuller (ADF) tests. The results, presented in table (2), suggest that all variables are non-stationary in levels whereas they are stationary in first differences, at the 5-percent level of significance.

Having determined that the series are first-differenced stationary, that is they are integrated of order (1), we proceed to test for cointegration. We applied ordinary least squares (OLS) on model (3) and examine the residuals for stationarity. If the residuals are stationary then the series in the OLS regression are cointegrated, which means that there exists a stable long-run relationship between them. The findings are presented in table (3). Reported DF tests reject the null hypothesis for non-stationary residuals at the 5-percent level of significance and thus the evidence suggests cointegration between the three examined variables. Next, we proceed to detect the directions of the causal effects.

3.2. VAR and Error-Correction Modeling

Since deficit, price level and money series are cointegrated, we examine the directions of the causal effects within an error-correction framework. We employ three-equations systems, where each system incorporates one of the three alternative money proxies, thus allowing us to treat each variable as endogenous.

The autoregressive lags for all the variables have been determined optimally, in a previous stage, using the Final Prediction Error (FPE) Criterion and following Hsiao's methodology as extended by Ahking and Miller. The FPE values have been calculated for lag lengths varying from 1 to 4 years and are reported in table (1).

The final specification of the three-variate autoregressive models given by equation (2), incorporates two dummy variables denoted by DUMP and DUMD as well as a. linear time trend variable T. Dummies and trend variable are properly defined to remove non-stationarities in the system.

Furthermore, the current values of the endogenous variables included in the error-correction models allow to examine for contemporaneous relationships among the variables. Estimation results are based on Seemingly Unrelated

Regressions (SUR). Granger-Causality inferences are derived using X^2-statistic to test the null hypothesis that particular terms are excluded. Inferences concerning contemporaneous causality as well as Granger-Causality emerging through the lagged error-correction term are based on t-tests of the null hypothesis that the respective coefficients are statistically zero. Tables (4), (5) and (6) present the results of the tested hypotheses while each table refers to one of the three equation-systems we estimated in order to examine all different proxies for the money variable.

The evidence from table (4), concerning the causal relationships between high-powered money, price level and budget deficit, during the period 1958-1990, supports the following inferences: budget deficit is caused instantaneously by inflation while causal effects emerge as well through the significant error-correction term of the first equation.

It is widely accepted that the relationship between budget deficit and money growth is best addressed by examining high-powered money. If the Central Bank monetizes the deficit, it expands high-power money which has to be highly correlated with Ml if the money multiplier is stable.

Although based on the above thoughts, we expected to find a causal relationship running from deficit to high-powered money, results revealed lack of causality in any direction between the two variables[6]. Thus, in order to obtain further insight, we checked for a structural break during the employed sample. From 1986, Treasury Bills and Treasury Bonds become the main source of financing deficits. This, together with interest rates deregulation contitute a radical change for the Greek Banking System and thus 1986 may be considered as a breaking-date and has to be used to check the structural stability of the estimated equations. The very limited number of observations after 1986, makes impossible the use of the widely known Chow test for structural stability. Thus we re-estimate the system of equations using data from 1958 to 1986. The results concerning the relationships between the examined variables in the period 1958 to 1986 are presented in table (4) together with the results concerning the whole sample, that is, from 1958 to 1990.

Based on the new findings, we conclude the existence of a two-way causality between high-powered money growth and budget deficits while high-powered money Granger-causes inflation.

Table (5) presents the results concerning the second equation-system with Ml as the appropriate money variable. The outcome supports the existence of a two-way causality between deficit and Ml growth, as well as instantaneous feedback effects between Ml growth and inflation. The above inferences hold for both sample periods, 1985-1986 and 1958-1990.

The findings from the third equation-system are reported in Table (6) and concern the causal relationships between price level, budget deficit and the M2 measure of money. The results indicate, for both samples, uni-directional causality running from M2 and inflation to deficits while between M2 growth and inflation exist feedback effects.

In sum, considering all the money proxies used and comparing the results from the three estimated systems in both sample periods, yields the following, theoretically consistent inferences. First, there is a stable long-run relationship between deficit, price level and money, no matter the employed definition for money. Second, two-way causal effects are detected between deficit, and high-powered money and Ml while a one-way causal relationship runs from M2 to deficit. Third, all definitions of money growth cause inflation to increase. And fourth, 1986 has been correctly used to check for a structural change since it revealed that high-powered money used to be significantly Granger-caused by deficits till 1986.

4. Concluding Remarks

This paper examines the causal relationship in the Granger sense, between budget deficits, inflation and money growth, with special reference to the case of Greece, employing a tri-variate error-correction model. Money is measured using three alternative definitions: high-powered money, Ml and M2 definitions of money stock. The findings support the existence of a stable long-run relationship between the investigated variables and the causal effects are found to be addressed as follows: A two-way causal relationship exists between deficit, and high-powered money and Ml, as well as a uni-directional causal relationship running from M2 to deficit. Last, money growth is found to Granger-cause inflation.

Therefore, our analysis supports the accommodation hypothesis for Greece and provides evidence that deficits are inflationary if they are monetized. Finally, the above findings reveal the interdependence of monetary and fiscal policy in Greece.

Appendix

TABLE 1
Dickey-Fuller Unit Root Tests

	Levels	First Diff.	Levels	First Diff.
Vars	Without trend		With trend	
DEF	0,7	-7,8***	-1,85	-8,48***
CP	6,43	-1,42	-0,21	-3,58 **
HM	0,6	-5,79***	-1,24	-5,86***
M1	2,26	-4,73***	-0,38	-5,32***
M2	0,91	-4,62***	-0,8	-4,7***

NOTES:

i) Dickey-Fuller (DF) and angmented Dickey-Fuller (ADF) tests are based, respectively, on the following regressions:

$$\Delta X_i = \alpha + \beta X_{i-1} + e_i \quad (1)$$

and

$$\Delta X_i = \alpha + \beta X_{i-1} + \sum_{k=1}^{s} \gamma_i \Delta X_{i-k} + e_i \quad (2)$$

where Δ is the first-difference operator and e_i is a stationary random error. The null hypothesis is that X_i is a non-stationary series and it is rejected when β is significantly negative. Regression (2) is estimated only in case the errors from equation (1) are found to be serially correlated.

ii) *** means significant at 1%
** means significant at 5%
* means significant at 10%

TABLE 2

The optimal lag order and the FPE's of the controlled variable

Controlled Variable		First Manipulated Variable		Second Manipulated Variable		FPE x 10^3
ΔDEF	(2)	—		—		66,232
ΔCP	(1)	—		—		1,002
ΔHM	(1)	—		—		5,917
ΔM1	(1)	—		—		1,601
ΔM2	(1)	—		—		1,259
ΔDEF	(2)	ΔCP	(1)	—		54,819
ΔDEF	(2)	ΔHM	(1)	—		52,610
ΔDEF	(2)	ΔHM	(1)	ΔCP	(1)	49,543
ΔDEF	(2)	ΔM1	(1)	—		63,746
ΔDEF	(2)	ΔCP	(1)	ΔM1	(1)	57,729
ΔDEF	(2)	ΔM2	(1)	—		59,407
ΔDEF	(2)	ΔCP	(1)	ΔM2	(1)	54,165
ΔCP	(1)	ΔDEF	(1)	—		1.047
ΔCP	(1)	ΔHM	(1)	—		1,036
ΔCP	(1)	ΔHM	(1)	ΔDEF	(1)	1,090
ΔCP	(1)	ΔM1	(1)	—		0,982
ΔCP	(1)	ΔM1	(1)	ΔDEF	(1)	1,043
ΔCP	(1)	ΔM2	(2)	—		0,931
ΔCP	(1)	ΔM2	(2)	ΔDEF	(1)	0,989
ΔHM	(1)	ΔCP	(1)	—		4,799
ΔHM	(1)	ΔDEF	(1)	—		6,250
ΔHM	(1)	ΔCP	(1)	ΔDEF	(1)	5,112
ΔM1	(1)	ΔCP	(1)	—		1,679
ΔM1	(1)	ΔDEF	(1)	—		1,692
ΔM1	(1)	ΔCP	(1)	ΔDEF	(1)	1,774
ΔM2	(1)	ΔCP	(1)	—		1,044
ΔM2	(1)	ΔDEF	(1)	—		1,341
ΔM2	(1)	ΔCP	(1)	ΔDEF	(1)	1,112

NOTES:

i) The number in parenthesis indicates the order of lags of each variable. Variables has been searched over four lagged values. FPE is the minimum lagged value.

ii) We use the following notation:

HM = The log of the high-powered money

M1 = the log of the narrow (M1) definition of money

M2 = the log of the M2 definition of money

DEF = the log of Central Government Budget Deficit

CP = the log of the Consumer's Price Index

Δ = the first difference operator

TABLE 3

Cointegrating Regressions

Dependent Variable	DEF	CP	HM	M1	M2	Constant	R^{-2}	DW	DF
DEF	—	0,585	1,079	—	—	-3,866	0,992	1,827	-5,697***
DEF	—	0,742	—	1,027	—	-4,135	0,992	1,765	-5,340***
DEF	—	0,704	—	—	0,895	-4,261	0,993	1,879	-5,84***
CP	0,643	—	-0,276	—	—	2,455	0,962	0,71	-3,80**
CP	0,744	—	—	-0,450	—	2,980	0,967	1,019	-4,376**
CP	0,777	—	—	—	-0,427	3,181	0,967	1,093	-4,758**
HM	0,751	-0,175	—	—	—	2,971	0,988	1,517	-4,28***
M1	0,794	-0,347	—	—	—	3,399	0,986	1,437	-4,1**
M2	0,934	-0,403	—	—	—	4,120	0,988	1,554	-4,40**

NOTES:

i) The DF and ADF values are based respectively on the following regressions

$$\Delta\mu_t = \rho\mu_{t-1} + e_t \qquad (1)$$

and

$$\Delta\mu_t = \rho\mu_{t-1} + \sum_{i=1}^{k} \Delta\mu_{t-1} + e_t \qquad (2)$$

where μ_t is the error from the cointegration regression. The null-hypothesis of non-stationarity is rejected when p is significantly negative. Regression (2) is estimated only if the errors from equation (1) are found serially correlated.

ii) *** means significant at 1%

** means significant at 51

* means significant at 10%

TABLE 4

Equation System I (Money measure= High-Powered Money)

Dependent variable	Hypothesis tested	X^2-stat		t-stat	
		1958-1990	1958-1986	1958-1990	1958-1986
ΔDEF	$\alpha_{20} = \alpha_{21} = 0$	1,5313	1,125		
	$\alpha_{20} = 0$			1,3847	1,695*
	$\alpha_{30} = \alpha_{31} = 0$	2,3915	2,615*		
	$\alpha_{30} = 0$			2,1083	2,235**
	$\lambda_1 = 0$			3,7275***	3,52***
ΔHM	$\beta_{20} = \beta_{21} = 0$	0,7685	0,377		
	$\beta_{20} = 0$			0,91	1,109
	$\beta_{30} = \beta_{31} = 0$	0,2686	0,031		
	$\beta_{30} = 0$			0,9392	1,953**
	$\lambda_2 = 0$			1,228	1,443
ΔCP	$\gamma_{20} = \gamma_{21} = 0$	2,3399	4,068**		
	$\gamma_{20} = 0$			2,039**	2,064**
	$\gamma_{30} = \gamma_{31} = 0$	0,008	0,073		
	$\gamma_{30} = 0$			0,668	1,499
	$\lambda_3 = 0$			0,7946	0,913

NOTES:

i) The equations of System I have the following specification:

$$\Delta DEF_t = \alpha_o + \sum_{s=1}^{2} \alpha_{1s}\, \Delta DEF_{t-s} + \sum_{s=0}^{1} \alpha_{2s}\, \Delta HM_{t-s} + \sum_{s=0}^{1} \alpha_{3s}\, \Delta CP_{t-s} + \alpha_4\, DUMD_t + \lambda_1 \mu_{t-1} + e_{1t}$$

$$\Delta HM_t = \beta_0 + \beta_{11}\, \Delta HM_{t-1} + \sum_{s=0}^{1} \beta_{2s}\, \Delta CP_{t-s} + \sum_{s=0}^{1} \beta_{3s}\, \Delta DEF_{t-s} + \lambda_2 \mu_{t-1} + e_{2t}$$

$$\Delta CP_t = \gamma_0 + \gamma_{11}\, \Delta CP_{t-1} + \sum_{s=0}^{1} \gamma_{2s}\, \Delta HM_{t-s} + \sum_{s=0}^{1} \gamma_{3s}\, \Delta DEF_{t-s} + \gamma_4\, DUMP + \gamma_5 T_4 + \lambda_3 \mu_{t-1} + e_{3t}$$

All estimations use SURE (Seemingly Unrelated Regression Estimation)

ii) *** means significant at 1%

** means significant at 5%

* means significant at 10%

TABLE 5

Equation System II (Money measure= M1)

Dependent variable	Hypothesis tested	X^2-stat		t-stat	
		1958-1990	1958-1986	1958-1990	1958-1986
	$\alpha_{20} = \alpha_{21} = 0$	2,576*	2,817*		
ΔDEF	$\alpha_{20} = 0$			2,5891**	2,794***
	$\alpha_{30} = \alpha_{31} = 0$	5,885***	4,145**		
	$\alpha_{30} = 0$			3,2831***	3,2835***
	$\lambda_1 = 0$			4,1543***	4,472***
	$\beta_{20} = \beta_{21} = 0$	0,9183	0,05		
ΔM1	$\beta_{20} = 0$			2,8574***	2,221**
	$\beta_{30} = \beta_{31} = 0$	0,4128	0,327		
	$\beta_{30} = 0$			2,61***	1,91**
	$\lambda_2 = 0$			2,5737**	2,066**
	$\gamma_{20} = \gamma_{21} = 0$	1,7925	2,405		
ΔCP	$\gamma_{20} = 0$			2,9437***	3,003***
	$\gamma_{30} = \gamma_{31} = 0$	0,2101	0,004		
	$\gamma_{30} = 0$			0,8978	1,23
	$\lambda_3 = 0$			0,8669	0,824

NOTES:

i) The equations of System II have the following specification:

$$\Delta DEF_t = \alpha_o + \sum_{s=1}^{2} \alpha_{1s}\, \Delta DEF_{t-s} + \sum_{s=0}^{1} \alpha_{2s}\, \Delta M1_{t-s} + \sum_{s=0}^{1} \alpha_{3s}\, \Delta CP_{t-s} + \alpha_4\, DUMD_t + \lambda_1 \mu_{t-1} + e_{1t}$$

$$\Delta M1_t = \beta_0 + \beta_{11}\, \Delta M1_{t-1} + \sum_{s=0}^{1} \beta_{2s}\, \Delta CP_{t-s} + \sum_{s=0}^{1} \beta_{3s}\, \Delta DEF_{t-s} + \beta_4 T + \lambda_2 \mu_{t-1} + e_{2t}$$

$$\Delta CP_t = \gamma_0 + \gamma_{11}\, \Delta CP_{t-1} + \sum_{s=0}^{1} \gamma_{2s}\, \Delta HM_{t-s} + \sum_{s=0}^{1} \gamma_{3s}\, \Delta DEF_{t-s} + \gamma_4\, DUMP + \gamma_5 T_4 + \lambda_3 \mu_{t-1} + e_{3t}$$

All estimations use SURE (Seemingly Unrelated Regression Estimation)

ii) *** means significant at 1%

** means significant at 5%

* means significant at 10%

TABLE 6

Equation System III (Money measure= M2)

Dependent variable	Hypothesis tested	X^2-stat		t-stat	
		1958-1990	1958-1986	1958-1990	1958-1986
	$\alpha_{20} = \alpha_{21} = 0$	2,911*	3,300*		
ΔDEF	$\alpha_{20} = 0$			1,4919	0,180
	$\alpha_{30} = \alpha_{31} = 0$	2,461*	3,697**		
	$\alpha_{30} = 0$			2,7037***	3,138***
	$\lambda_1 = 0$			4,6870***	4,992***
	$\beta_{20} = \beta_{21} = 0$	4,9854**	3,967**		
ΔHM	$\beta_{20} = 0$			0,2434	0,654
	$\beta_{30} = \beta_{31} = 0$	0,6428	0,0007		
	$\beta_{30} = 0$			1,33	1,066
	$\lambda_2 = 0$			0,227	0,19
	$\gamma_{20} = \gamma_{21} = 0$	17,8828***	22,174***		
ΔCP	$\gamma_{20} = 0$			0,6432	0,7639
	$\gamma_{30} = \gamma_{31} = 0$	0,0207	0,1537		
	$\gamma_{30} = 0$			0,8617	0,553
	$\lambda_3 = 0$			1,268	0,072

NOTES:

i) **The equations of System III have the following specification:**

$$\Delta DEF_t = \alpha_o + \sum_{s=1}^{2} \alpha_{1s}\, \Delta DEF_{t-s} + \sum_{s=0}^{1} \alpha_{2s}\, \Delta M2_{t-s} + \sum_{s=0}^{1} \alpha_{3s}\, \Delta CP_{t-s} + \alpha_4\, DUMD_t + \lambda_1 \mu_{t-1} + e_{1t}$$

$$\Delta M2_t = \beta_0 + \beta_{11}\, \Delta M2_{t-1} + \sum_{s=0}^{1} \beta_{2s}\, \Delta CP_{t-s} + \sum_{s=0}^{1} \beta_{3s}\, \Delta DEF_{t-s} + \beta_4 T + \lambda_2 \mu_{t-1} + e_{2t}$$

$$\Delta CP_t = \gamma_0 + \gamma_{11}\, \Delta CP_{t-1} + \sum_{s=0}^{2} \gamma_{2s}\, \Delta M2_{t-s} + \sum_{s=0}^{1} \gamma_{3s}\, \Delta DEF_{t-s} + \gamma_4\, DUMP + \gamma_5 T_4 + \lambda_3 \mu_{t-1} + e_{3t}$$

All estimations use SURE (Seemingly Unrelated Regression Estimation)

ii) ***** means significant at 1%**

**** means significant at 5%**

*** means significant at 10%**

Footnotes

1. We employ MICRO-TSP ver. 7 0b in all empirical analysis.

2. Data are taken from the International Monetary Fund's *International Financial Statistics, 1990, YEARBOOK,* as follows:
i) Budget Deficit or Surplus, line (80), ii) Consumer Prices, line (64). iii) High-powered money, line (14), iv) Narrow (M1) definition of money, line (34), v) M2 definition of money, by adding lines (34) and (35).

3. Dummy variable DUMP, has been introduced to absorb the effect of the oil crisis on domestic price level. The dummy variable takes the value 1 in 1974 and 1980 and 0 in other years. Dummy variable DUMD has been introduced to absorb the effect of the excess public expenditure in order to finance political parties at general election years in Greece after 1974. The dummy variable takes the value 1 in 1974, 1977, 1981, 1985, 1989 and 1990 and 0 in other years.

4. In the multivariate case the Engle and Granger two-step procedure has been criticized for not providing a framework to deal with the existence of more than one cointegrating vector. Equation (2) implicitly assumes one unique cointegrating vector; each cointegrating vector, however, requires its own error-correction term. Johansen (1988) provides a maximum likelihood cointegration test in the multivariate case (see also Johansen and Juselius, 1990).

5. The FPE is defined as the asymptotic mean square prediction error and is determined from the relation

$$FPE_y(m, n) = \frac{T+m+n+1}{T-m-n-1} \cdot \sum_{t=1}^{T} (Y_t - \hat{Y}_t)^2 / T$$

where T is the number of observations, and m, n are the orders of lags of the examined variables. The right hand side of the above relation, consists of two terms; the first term measures the estimation error while the second measures the modelling error.

6. A referee pointed out that in most of the empirical studies no causal relationship was found between high-powered money and deficits in countries with an independent central bank. Since central bank in Greece is controlled by the Government, high-powered money is the main policy instrument and thus it has to reflect the pressure for covering budget deficits.

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