PUBLIC DEFICIT MONETIZATION IN GREECE: EVIDENCE USING STRUCTURAL VAR MODELING

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1. Introduction

There has been extensive evidence in the relevant literature that budget deficits contribute to excessive money growth, high interest rates, and inflation. The hypotheses which attempt to explain - theoretically - the proposed interactions among the above series, and particularly, those between deficits and inflation are summarized, first, by the Keynesian view, according to which, budget deficits stimulate aggregate demand and, thus, have serious inflationary repercussions in the economy, and second, by the accommodation hypothesis, according to which, once large budget deficits push interest rates upwards, the monetary authorities react and monetize the deficit, thus resulting in higher inflation (Friedman, 1968). One step ahead, Sargent and Wallace (1981) argue that persistent budget deficits will force the central bank to monetize the debt either in the current period or in future periods depending upon the degree of independence between monetary and fiscal authorities.

Furthermore, Miller (1983) argues that deficits are inflationary irrespective of whether they are monetized or not. In particular, inflationary conditions could be made worse through, i) monetary accommodation, ii) crowding out, which tends to reduce the real capital stock in the economy resulting in a lower growth rate of output, and thus, with a given money supply to increase prices, and iii) excessive issuing of government bonds, since in essense, they constitute a substantial part of money supply.

A third theoretical attempt to explain the relationships among deficits, money and inflation is related to the reverse hypothesis, according to

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which, it is money growth that seems to cause budget deficits (Barro, 1979). In particular, excessive money growth results in higher inflation, which forces the government to increase budget deficits in order to keep up with the inflation increase. In addition, the related "fiscal divident hypothesis" argues that within a progressive tax system inflation tends to push tax payers to higher income tax brackets resulting in further changes and adjustments in budget deficits.

The literature concerning the empirical verification of the aforementioned hypotheses reports rather mixed results. Akhtar and Wilford (1979), Hamburger and Zwick (1981), Levy (1981), McMillin (1986), and Grier and Neiman (1987) conclude that deficits seem to cause higher money growth and inflation. By contrast, Barro (1979) and Brandley and Potter (1986) present evidence that it is money growth which causes budget deficits to increase. Niskanen (1978), Dwyer (1985), Joines (1985), King and Plosser (1985), Koluri and Giannaros (1987), Protopapadakis and Siegel (1987), Barnhart and Darrat (1988, 1989), Landon and Reid (1990), and Karras (1994) report results which demonstrate that deficits do not seem to contribute significantly to higher money growth and inflation. Finally, Turnovsky and Wohar (1987), and Demopoulos et al. (1987), argue that the empirical results depend upon the subperiod examined as well as the exchange rate regime.

The aim of this paper is to investigate the relationship among budget deficits, money and inflation in Greece over the period 1976:1-1987:4. Dogas (1992) reports evidence that budget deficits have exerted substantial influence on inflation. Furthermore, Karassavoglou and Katrakilidis (1993), using Cointegration and Error-Correction techniques, support the existence of a systematic long-run relationship among deficits, money and inflation, while they detect feedback effects in the short-run. Hondroyiannis and Papapetrou (1993), via a bivariate VAR model and annual data, report bi-directional causal effects between deficits and inflation. Finally, Karras (1994) concludes the lack of significant causal effects running from deficits to money, inflation and real output.

The methodology utilized in this paper is that of multivariate Structural Vector Autoregressive (SVAR) analysis. In particular, we employ the Granger-causality methodology in conjunction with variance decompositions and impulse response functions from a structural VAR model where contemporaneous long-run restrictions have been imposed. The analysis uses quarterly data running from 1974:1 to 1987:4.

The rest of the paper is organized as follows: Section 2 reviews briefly the Greek experience, in terms of fiscal history. Section 3 presents

methodological issues employed in this paper, while section 4 reports the empirical results. Finally, section 5 provides some concluding remarks.

2. The Greek experience

Since mid 70s the Greek economy has been characterized by a substantial increase in budget expenses which have not been matched by a simultaneous increase in budget revenues. The implementation of such a fiscal policy resulted in a large increase in budget deficits. Thus, large budget deficits, in conjunction with stagflation conditions which hit the economy at that period, had as a consequence the significant increase in budget deficits as a percentage of GNP. Table 1 demonstrates the size of budget deficits as a percentage of GNP; according to the figures reported in Table 1, the budget deficit as a percentage of GNP was only 2.9% in 1980, while it grew up to 20.4% in 1990.

Table 1 - Budget deficit as a percentage of GNP in Greece over the period 1976:1-1990:1

Year	*Budget deficit (%)*
1976	3.2
1977	2.5
1978	2.8
1979	2.5
1980	2.9
1981	10.9
1982	7.6
1983	8.1
1984	9.9
1985	13.5
1986	10.7
1987	12.3
1988	15.3
1989	18.4
1990	20.4

Source: Bank of Greece, various publications of the Economic Report of the Governor.

Since the monetary deregulation process has been set off, the monetary authorities have adopted as their major objective the achievement and maintenance of price stability. The main aim of monetary policy is to diminish the high Greek inflation rate within the framework provided for in the Maastricht Treaty. A country intending to join a monetary union and whose monetary authorities have a reputation of pursuing inflationary policies will find it difficult to shed that reputation without a long and costly process of disinflation. Only by implementing a highly consistent monetary policy can monetary authorities gain credibility.

Table 2 - Sources of finance for public sector deficits (%)

Year	*T-notes and bonds held by banks and other credit institutions*	*T-notes and bonds held by individuals and corporations*	*Loans from special credit institutions*	*Central bank*
1976	48.2	0.0	16.4	21.7
1977	41.8	0.0	8.2	35.4
1978	44.4	0.0	12.4	20.7
1979	38.2	0.0	12.5	44.6
1980	30.8	0.0	18.6	26.3
1981	14.8	0.0	16.7	54.3
1982	13.3	0.0	19.7	49.0
1983	54.9	0.0	16.6	-6.1
1984	33.2	0.0	21.7	16.2
1985	40.5	1.1	11.8	14.0
1986	28.8	2.7	30.7	9.4
1987	36.1	20.1	28.3	6.6
1988	47.3	31.2	19.4	-1.4
1989	44.1	16.6	15.3	10.5
1990	16.1	43.1	13.7	15.0

Source: Taken from Alexakis and Apergis (1994), p. 86.

There exist two adverse consequences stemming from the presence of the excessive public deficits: first, the crowding-out effect for the private sector, and second, their monetization which, in turn, deteriorates inflation and inflationary expectations. In terms of the Greek experience, a substantial part of large fiscal deficits was financed by the banking sector,

primarily, through the monetization process as well as the commercial banks' obligatory investments in low-yielding Treasury-bills. Therefore, in seeking mechanisms to strengthen control over budget imbalances, consideration was given by the central bank to the discipline exerted by private credit markets. These had been made more effective through measures designed to increase the public sector's dependence on market financing (see Table 2), while the cost of credit should be made more sensitive to the current and prospective size of budget imbalances. In 1983, the finance of the public sector began to take place at a far higher interest rate cost compared to that of previous years. In general, such measures include strict limitations on monetary financing and bailouts of fiscal deficits and eventually lead to financing via government bond issues, an action that not only mobilizes unused savings but also contributes significantly to an appropriate check in the rate of money supply increase.

It has been argued that well-functioning capital markets should prevent excessive borrowing. Well-informed investors in a liberalized capital market impose discipline by raising the interest rates at which they are willing to lend, and by eventually cutting off lending to governments with unsustainable debt accumulation. For the present time and under the commitments of the Maastricht agreement, deficit finance, via the monetization process, is extremely prohibited.

3. Methodology

The structural VAR approach is a modification of the "atheoretical" VAR approach proposed by Sims (1980). Sims' suggestion was based on the orthogonalization of VAR innovations in such a way that the involved variables were ordered in a manner reflecting their contemporaneous causality relationships. However, this particular way of ordering was criticized as "atheoretical" by Cooley and Leroy (1985). Therefore, a new approach was developed which imposes explicit theoretical restrictions on a random VAR ordering (Bernanke, 1986, Blanchard, 1989, Apergis, 1994, and Apergis and Karfakis, 1994).

Let

$$X_t = \sum_{j=0}^{n} B_j X_{t-j} + w_t \qquad (1)$$

with

$$E[w_t w'_{t-s}] = \Omega, \text{ if } t = s$$
$$= 0, \text{ if } t \neq s, \text{ (with } \Omega \text{ to be a diagonal matrix)}$$

be a structural model which connects the vector of endogenous variables, denoted by X, with the vector of economic disturbances w (structural shocks). B is a coefficient square matrix. The VAR model for X has the form:

$$X_t = \sum_{j=1}^{n} A_j X_{t-j} + u_t \tag{2}$$

with

$$E[u_t u'_{t-s}] = \Sigma, \text{ if } t = s$$
$$= 0, \text{ if } t \neq s$$

and

$$A_j = (I - B_0)^{-1} B_j \tag{3}$$

The estimation of the elements of the square matrix B_0 - which depicts the structural parameters on the contemporaneous variables - is based on the following model which allows us to recover the structural shocks w:

$$u = B_0 u + w \tag{4}$$

In our case, u and w denote, respectively, 4x4 vectors of variables and structural shocks. B_0 is a 4x4 coefficient matrix. To estimate (4) we allocate the restrictions in such a way that the following model is specified:

$$u^D = w^D \tag{5}$$
$$u^B = \varphi_1 u^D + w^B \tag{6}$$
$$u^P = \varphi_2 u^B + \varphi_3 u^D + \varphi_4 u^Y + w^P \tag{7}$$
$$u^Y = \varphi_5 u^P + w^Y \tag{8}$$

The definitions of the involved variables are reported in the next

section. Equation (5) is the fiscal policy rule which is assumed to be exogenous. Equation (6) indicates that base money is only affected by the size of the deficit. Fiscal policies affect the implementation of monetary policy due to the presence of an intertemporal budget constraint for the government. In particular, government attempts to minimize a loss function subject to various constraints. One such constraint is the financing of government deficit. In addition, the monetization of the deficit depends on the degree of independence of the Central Bank (Sargent and Wallace, 1981; Grier and Neiman, 1987). In the case of Greece and for the period 1974-1987, the central bank was kept under the full control of the government. According to the Economic Theory money tends to respond to output and price cycles. However, in the Greek case, and at least over the period concerned, monetary policy was never used to stabilize output and prices (Alexakis and Apergis, 1994) and a policy of qualitative and quantitative regulations was heavily implemented (see also section 2). The monetary authorities' major objective had been only the issuing of money for budget financing purposes. Equation (7) demonstrates the behaviour of aggregate demand, while equation (8) depicts aggregate supply. To estimate the contemporaneous model, the method of moments (GMM) or the instrumental variables estimator method can be used. For the purposes of this paper the former method, proposed by Bernanke (1986), has been adopted.

4. The data and empirical results

4.1. The data

This paper is focused on the Greek economy. The sample uses quarterly data and covers the period from 1974:1 to 1987:4[1]. The variables involved are: base money (B), real output (Y), proxied by the index of industrial production, the price level (P), measured by the consumer price index, and the budget deficit (D), measured by the ratio of deficit over GDP. All series are used in logarithms except the ratio of deficit and were obtained from various publications of OECD Main Economic Indicators and the Monthly Bulletin of the Bank of Greece.

1. The sample period ends to 1987:4, since in this year the deregulation prosses in the monetary sector was set off and thereafter deficits monetization was disbanded. The period before 1974 was characterized by a virtually balanced public budget.

4.2. Integration analysis

A common fact in the empirical analysis is that many macroeconomic series are characterized by nonstationarities, implying that the classical t and F-tests are not appropriate (Fuller, 1976), since they may lead to invalid results. Thus, as it is required in standard econometric analysis, the series under consideration are examined, first, for unit root nonstationarity employing the methods developed in Phillips (1987), Phillips and Perron (1988) and Perron (1988).

Testing for a unit root in a time series, requires the computation of one of the three OLS regressions presented below.

$$y(t) = \alpha y(t-1) + u_1(t) \quad (9)$$

$$y(t) = \mu^* + \alpha^* y(t-1) + u_2(t) \quad (10)$$

$$y(t) = \tilde{\mu} + \tilde{\beta}(t-T/2) + \tilde{\alpha} y(t-1) + u_3(t) \quad (11)$$

In model (9) the adjusted t-Statistic $Z(t_\alpha)$ is used to test the null hypothesis of a unit root, i.e. H_0:α=1 against the stationary alternative α< 1. If the equation includes a constant (model 10), we calculate the $Z(t_{\alpha^*})$ and the joint statistic $Z(\Phi_1)$ to test the null H_0:$(\alpha^*, \mu^*)=(1, 0)$ against the alternative $(\alpha^*, \mu^*)\neq(1, 0)$. Further, if the equation includes a constant and a trend (model 11), $Z(t_{\tilde{\alpha}})$ and the joint statistics $Z(\Phi_2)$ and $Z(\Phi_3)$ are used. In particular, $Z(\Phi_2)$ tests the null H_0: $(\tilde{\alpha}, \tilde{\beta}, \tilde{\mu})=(1, 0, 0)$ while $Z(\Phi_3)$ tests the null H_0:$(\tilde{\alpha}, \tilde{\beta}, \tilde{\mu})=(1, 0, \mu)$.

Table 3 reports the results based on Phillips-Perron $Z(t_\alpha)$, $Z(\Phi_1)$, $Z(\Phi_2)$ and $Z(\Phi_3)$ statistics while inferences are extracted following the strategy suggested in Perron(1988, pp. 316-317). Thus, the hypothesis of a unit root in levels was not rejected for base money, prices and output, at the 5% level of significance, while for the deficit variable the evidence supports an I(0) process. When first differences were used, unit-root nonstationarity was rejected in all cases.

4.3. Short-run dynamics

In case where all time series are nonstationary of the same order of integration, the long–run relationship between them is examined within the context of multivariate cointegration (Johansen,1989; Johansen and Juselius, 1990). Since, in our study the deficit variable is found stationary, the estimation of a classical vector autoregressive (VAR) system

specification is the appropriate methodology to examine the information content of the variables concerned. Thus, our VAR approach includes base money, prices and output. As it concerns the deficit variable, it is included in level form because of its stationary characteristics as well as because this is the most common form used in the international empirical literature.

Table 3 - Phillips-Perron tests for unit roots

Variable	$Z(t_{\alpha}*)$	$Z(t_{a})$	$Z(\Phi_1)$	$Z(\Phi_2)$	$Z(\Phi_3)$
		Levels (4 Lags)			
B	-0.082	-2.953	15.211	8.773	4.187
D	-6.195	-7.985	18.598	19.936	30.719
P	-0.293	-2.863	127.349	56.812	3.964
Y	-3.224	-3.849	6.214	5.242	7.372
		First differences (4 lags)			
ΔB	-8.271	-8.265	32.147	20.728	32.115
ΔD	-15.389	-15.265	110.177	70.594	109.898
ΔP	-8.264	-8.284	32.455	21.167	32.609
ΔY	-14.770	-15.986	107.414	79.568	122.159

Note:
Phillips-Perron values of the $Z(t_{\alpha})$ test statistic were calculated with a lag length equal to 4. The critical values for $Z(t_{\alpha}*)$, $Z(t_{\alpha})$, $Z(\Phi_1)$, $Z(\Phi_2)$, $Z(\Phi_3)$ at the 5% level and n=50 are -2.93, -3.50, 4.86, 5.13 and 6.73, respectively. [From Fuller (1976), p.373, and Dickey and Fuller (1981), p.1063].

Next, Sims (1980) Likelihood Ratio (LR) test was adopted to specify the optimal lag length of the variables involved in the VAR. Furthermore, the selected optimal lag structure was checked for the presence of serial correlation in the residuals. The LR test statistic suggested the adoption of a 8–lag VAR[2] which was employed to investigate for Granger–causal effects between the series concerned[3]. Then, the concept of causality was considered by using F–tests for block exogeneity so that to examine whether the lag structure of an excluded variable adds to the explanatory power of the estimated equation.

2. The LR value of the 8-lag vs 7-lag model was calculated $X^2(16)=27.94$ (0.032)

3. Buiter (1984 and 1986), has argued that such tests are uninformative about the presence, absence, degree or kind of policy (in)effectiveness.

Table 4 - Granger-causality tests and diagnostics

Dep. var.	*Hypotheses tested*	*F-statistic*	*p-values*
	Lagged ΔB do not Granger-cause D	1.02	0.46
D	Lagged ΔP do not Granger-cause D	2.07	0.11
	Lagged ΔY do not Granger-cause D	1.21	0.35
	Lagged D do not Granger-cause ΔB	3.46	0.02
ΔB	Lagged ΔP do not Granger-cause ΔB	2.28	0.08
	Lagged ΔY do not Granger-cause ΔB	2.35	0.07
	Lagged D do not Granger-cause ΔP	1.99	0.12
ΔP	Lagged ΔB do not Granger-cause ΔP	0.65	0.71
	Lagged ΔY do not Granger-cause ΔP	1.69	0.18
	Lagged D do not Granger-cause ΔY	0.66	0.71
ΔY	Lagged ΔP do not Granger-cause ΔY	2.89	0.03
	Lagged ΔB do not Granger-cause ΔY	1.05	0.44

Diagnostic Tests (LM version)

Deficit equation
SC: Q(18)=17.93(0.45) NO:X^2(2)=0.35(0.83) HE:X^2(1)=0.04 (0.83)
ARCH:X^2(4)=0.89(0.92)

Money equation
SC: Q(18)=19.55(0.35) NO:X^2(2)=2.54(0.63) HE:X^2(1)=0.06(0.80)
ARCH:X^2(4)=4.27(0.37)

Inflation Equation
SC: Q(18)=9.92(0.93) NO:X^2(2)=3.29(0.51) HE:X^2(1)=0.21(0.64)
ARCH:X^2(4)=0.24(0.90)

Output equation
SC: Q(18)=22.26(0.22) NO:X^2(2)=1.12(0.57) HE:X^2(1)=0.08(0.77)
ARCH:X^2(4)=3.98(0.40)

Table 4 presents the F–values of the Granger–causality tests performed in the 4–variable VAR system. The results suggest the existence of one-way causal effects running from deficit, prices and output to money supply and from prices to output. Thus, the evidence obtained for the Greek case supports the "accommodation hypothesis" while budget deficit and inflation seem uncorrelated. Diagnostics of the estimated equations, reported at the same table, indicate the absence of serial correlation (SC), deviations from normality (NO), heteroscedasticity (HE), and autoregressive conditional heteroscedasticity (ARCH) at the 5% level of significance. Furthermore CUSUM and CUSUMSQ TESTS, based on recursive residuals, reveal lack of instability in the parameter estimates.

Since our results have been obtained using a rather small sample and data of low frequency and given that the adopted methodology is unable to detect contemporaneous effects among the examined variables we proceed our investigation in the next section employing SVAR modeling so as to support the robustness of our inferences.

4.4. Contemporaneous model estimates and variance decompositions

Table 5 reports the estimates of matrix B_0. These estimates show how various shocks affect contemporaneously the economic system described by the model (5)-(8). All the estimates are statistically significant.

The variance decompositions are reported in Table 6. The table presents the percentage of the variance of the k-quarter ahead forecast error of the variables that is attributable to each of the shocks for k = 1, 4, 8, 20. In other words, the percentages are reported for only four horizons which, according to Blanchard and Watson (1986), could be interpreted as the short-run (1 quarter ahead), the medium-run (4 or 8 quarters ahead), and the long-run (20 quarters ahead).

According to the results of Table 6, trends in output and public deficit seem to explain rather extensively the variance in money supply during the period under study. For example, in the short and medium-run, output innovations explain 25-35 percent of the variance in money supply, while another significant percentage (10-20 percent) of this variance is explained by public deficitcs. In the long-run public deficits and output, each explain roughly a 25 percent of the variance in money supply. Regarding inflation, the results indicate that it is influenced primarily by real shocks (output explains a 80 percent of the variance in prices in the short-run and 50-60 percent in the medium-run) and to a lesser, but significant degree by fiscal

policy (e.g., deficits explain the 32 percent of the variance for the same time horizons). In the long-run the results suggest that monetary and fiscal shocks can explain a significant percentage of the variation in prices (e.g. money innovations explain about 53 percent of prices innovations while another 27 percent is explained by the public deficits).

Table 5 - Estimates of the contemporaneous model

$$u^D = w^D$$

$$u^B = \underset{(0.042)^*}{0.111}\ u^D$$

$$u^P = \underset{(0.82)^*}{4.299}\ u^B + \underset{(1.31)^*}{0.285}\ u^D - \underset{(0.0051)^*}{0.316}\ u^Y$$

$$u^Y = \underset{(1.519)^*}{4.349}\ u^P$$

Notes: 1) * indicates significance at 5%.
2) Figures in parentheses denote standard errors.

Table 6 - Variance decompositions

I. Money

	% of variance of error due to innovations in			
	Money	*Inflation*	*Deficit*	*Income*
Forecast horizon				
1	98.71	0.00	1.29	0.00
4	49.16	5.36	9.99	35.49
8	37.84	16.98	19.97	25.21
20	32.75	17.07	25.16	25.03

II. Inflation

	% of variance of error due to innovations in			
	Money	*Inflation*	*Deficit*	*Income*
Forecast horizon				
1	0.02	15.75	4.11	80.12
4	0.92	6.49	32.47	60.12
8	15.94	2.88	32.62	48.57
20	52.76	2.80	26.79	17.63

Overall, the variance decomposition indicate that-at least, over the period of inference-the public deficit in Greece was monetized, while the deficit itself was responsible along with monetary policy for the inflationary trends in the economy.

4.5. Impulse response functions

Figures 1 and 2 plot impulse response functions - the 1 to 25 quarter response of the level of prices to deficit shocks and of the level of money to deficit shocks, respectively. The overall patterns are as expected; deficit shocks tend to increase prices as well as monetary aggregates.

5. Concluding remarks

This paper has investigated the relationships among budget deficits, money and inflation in Greece, using a structural VAR model in conjunction with Granger-causality tests. When quarterly data over the period 1974:1-1987:4 was used, the results provided significant evidence that budget deficits are monetized and that these deficits were inflationary.

Under the above finding and considering that the remaining obstacles to a fully liberalized monetary and financial sector should be eliminated, Greek monetary policy will come into line with its counterpart in other EC countries. The progress in the Convergence Plan for Greece, currently implemented under the Maastricht agreements, is expected to enhance the effectiveness of monetary policy implementation in the context of price stabilization targets and in the upcoming monetary unification in the EC.

Fig. 1 - Price responses to deficit shocks

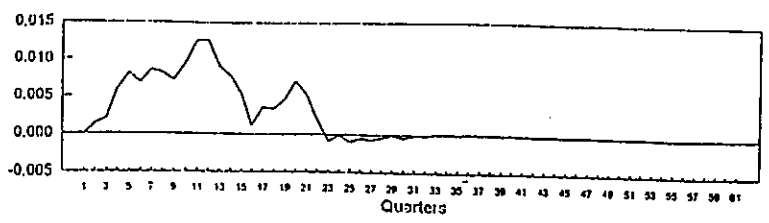
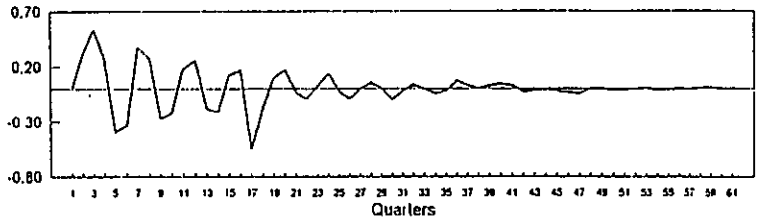


Fig. 2 - Money responses to deficit shocks



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Abstract

This paper uses the structural VAR approach in conjunction with Granger-causality tests to investigate the dynamic relationships among budget deficits, money and inflation in Greece. The results support the deficit-monetization hypothesis as well as that deficits contribute to the inflationary trends of the economy.

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