"Has There Been a Shift in the Greek Money Demand Function?"

By Daniel Himarios, Arlington

I.

In a recent paper in this Journal, *Panayotopoulos* (1984) criticizes my 1983 paper (*Himarios,* 1983) on two counts. First, he questions the incorporation of a dummy variable in the demand for $M1$ for 1967. He argues that if a dummy variable is to be included for 1967 it should also be included for 1974. Second, Panayotopoulos claims that my earlier results cannot be accepted on the grounds that the demand for $M1$ has been unstable and thus the data cannot be pooled. The purpose of this note is to account for these two criticisms. I argue that the introduction of a dummy variable for 1967 is justified and necessary while no such correction is necessary for 1974. On the second and more important issue, formal stability tests indicate that the demand for $M1$ has been statistically stable over the period 1956 - 1981. Thus, estimating a single equation is the appropriate and most efficient strategy.

II. The Estimated Money-Demand Function

The form and properties of the equation to be tested have been discussed in detail in another paper (*Himarios,* 1986). With all variables in logarithms the model to be estimated is:

$$(m-p)^*_t = \alpha + \beta y_t + \gamma r_t$$

$$(m-p)_t - (m-p)_{t-1} = \theta\left[(m-p)^*_t - (m-p)_{t-1}\right] + \varepsilon_t,$$

where the error term, ε_t, is assumed to be spherical. Money ($M1$) and income are expressed in per capita terms and the rest of the symbols have the conventional meanings. This partial adjustment model was chosen over the alternative permanent income model after tests indicated that the latter was not supported by the data. Estimating the model over the period 1956 - 1981 yielded the following results:

DOI https://doi.org/10.3790/ccm.20.1.106 | Generated on 2025-02-23 12:23:20

$$\hat{m}_t = -0.401 - 0.087\,D + 0.537\,y_t - 0.131\,r_t + 0.574\,m_{t-1} \tag{1}$$
$$(4.026) \quad (3.326) \quad (4.434) \quad (5.209) \quad (7.067)$$

$$\bar{R}^2 = 0.998 \quad D.W. = 2.168 \quad d-h = -0.554 \quad S.E. = 0.0308$$

D, is a dummy variable for the constant, taking the value 1 in 1967 and 0 elsewhere, introduced on a priori considerations to capture the effects of the military coup. Longer lags in y and r did not generate any superior specifications to the one presented.

The residuals of the equation conform to the theoretical expectations. Neither the *D. W.* nor *Durbin's h*-statistic $(d-h)$ reveal any problem of serial correlation. In addition, a visual examination of the residuals and application of Durbin's alternative to the h-test confirm that the residuals are non-autocorrelated (see *Himarios* (1986) for details). Non-autocorrelation in the residuals is necessary for the applicability of the tests to be performed below.

Before we proceed with stability tests, it is necessary to determine whether the dummy variable for 1967 should be included in the estimated equation. Excluding the dummy variable yields the following results:

$$\hat{m}_t = -0.291 + 0.423\,y_t - 0.135\,r_t + 0.672\,\hat{m}_{t-1} \tag{2}$$
$$(1.752) \quad (2.620) \quad (4.574) \quad (6.226)$$

$$\bar{R}^2 = 0.996 \quad D.W. = 2.332 \quad d-h = -1.833 \quad S.E. = 0.035$$

Comparing (1) and (2), it is immediately apparent that (2) is inferior. Excluding the dummy has several negative effects: First, the constant is not estimated precisely. Second, the speed of adjustment is much slower. Third, both the *D. W.* and $d-h$ statistic indicate the presence of autocorrelation. Fourth, the standard error (*S. E.*) of the regression is higher and finally, equation (2) consistently overpredicts the demand for $M1$. Apart from these considerations, the dummy is justified on purely statistical grounds. The residual for 1967 is 2.5 the size of *S. E.* Is a dummy necessary also for 1974, as *Panayotopoulos* claims? The answer is definitely no. The residual for 1974 is only 0.0137 the size of S. E. and, as a result, introduction of a dummy for 1974 is not justified.

III. Testing for Stability

In order to test whether the parameters of this relationship changed significantly, in a statistical sense, over the period 1956 - 1981 we will utilize three tests.[1] It is well-known that the power of each test varies, depending on the kind of instability exhibited by a certain relationship and the one that the test was mainly designed to detect. The *Chow* test is powerful in detecting a large or moderate discrete jump that takes place at the point where we split the sample. The second test, an extension of the Chow test, allows one to detect more than on discrete jumps and, further, to gain insight into which parameter(s) is (are) responsible for the jump. The third test is designed to detect a gradual drift in one or more of the parameters. A brief description is provided before each test is applied.

1. The Chow Test

Panayotopoulos claims that a shift occured in 1964 and again in 1973 and therefore the data cannot be pooled. He bases his conclusions on a visual examination of the results in his table 2, where the coefficients appear to be different for the subsamples. Indeed, the coefficents appear to be different in our estimation as well. But as is well known this does not necessarily mean that the coefficients are unstable. Performing a *Chow* test for the two subsamples (1964 - 1972 and 1973 - 1981) yields F-statistics of 0.453 and 0.897 respectively which do not allow us to reject the hypothesis of stability. Had Panayotopoulos performed the Chow tests, he would have reached exactly the same conclusions. The apparently differing estimates may be the result of multicollinearity in the regressors given the very small number of degrees of freedom available in each subsample (*Maddala,* 1977, p. 199). In short, then, Panayotopoulos' arguments do not stand when a formal Chow test is performed. This conclusion is reinforced by the two additional stability tests performed below.

2. The "stabilogram" test

This test, due to *Ashley* (1984)[2], is designed to detect parameter instability without making any assumptions about the form that it may take. Thus it eliminates the need for separate tests against outliers, discrete jumps or deterministic drift, etc. The test makes use of zero-one dummy variables in a very simple but very fundamental way. Consider the model

---

[1] The reader should note all tests are as asymptotically exact due to the presence of the lagged dependent variable.

[2] The basis of the test, of course, dates back to *Gujarati*'s (1970) article.

$$y_t = \sum_{l=L}^{k} \beta_l x_{tl} + u_t \qquad t = 1, \ldots, N \tag{3.1}$$

where all the classical least-squares assumptions apply.

In the simplest form the test is applied to one coefficient at a time. The first step is to partition the sample period into r approximately equal subperiods of about $i = \frac{N}{r}$ observations each. (In practice *Ashley* finds that $i = 5$ performs well.) Then r dummy variables, $D_t^{(1)}, \ldots, D_t^{(r)}$, are defined such that $D_t^{(1)}$ is one only in the first period; $D_t^{(2)}$ is one only in the second subperiod and so on. Ordinary least squares regression is then applied to

$$y_t = \sum_{l=1}^{k-1} \beta_l x_{tl} + \sum_{j=1}^{r} \gamma_j D_t^{(j)} x_{tk} + u_t \qquad t = 1, \ldots, N \tag{3.2}$$

The sequence of parameter estimates, $\hat{\gamma}_1, \ldots, \hat{\gamma}_r$, is the stabilogram of order i for the k^{th} coefficient, or STAB (i, k). Since each of these estimated coefficients is an estimator of β_k from a different subperiod, a picture of how β_k varies over time can be easily obtained by plotting $\hat{\gamma}_j$ or a confidence interval around it versus j. The null hypothesis or stable coefficients then the correspond to the $r - 1$ linear restrictions $\gamma_1 = \gamma_2 = \ldots = \gamma_r$. The appropriate test statistic is

$$\text{STAB} = \frac{(\text{RSS} - \text{URSS}) / (r - 1)}{\text{URSS} / (N - k - r + 1)}$$

which is distributed $F(r - 1, N - k - r + 1)$ under the null hypothesis. RSS is the sum of squared residual from (3.1) and URSS is the sum of squared residuals from (3.2).

The results of applying this test for $i = 5$ are shown below:

Stabilogram Test Results on Coefficients in Equation 1
for Sample Period 1956 - 1981

Coefficient	*RSS*	*URSS*	*F*
y_t	0.0115267	0.0077675	1.815
r_t	0.0115267	0.0063894	3.014
$m1_{t-1}$	0.0115267	0.0073544	2.126

None of the stabilogram tests is significant at the 5 percent significance level, so the null hypothesis of stable coefficients cannot be rejected. Notice, however, that the alternative for the interest rate is barely rejected and the stabilogram graph in figure 2 indicates some dedree of variation for the different periods. The question of a possible shift in this coefficient is addressed by the next test.

3. *The Farley-Hinich Test*

This test due to *Farley* and *Hinich* (1970) is designed to detect a gradual drift in one or more of the parameters. Each of the coefficients that is suspected of instability is modeled as a linear function of time, e.g.

$$\beta_j = \beta_j + \delta_i t \qquad t = 1, 2, \ldots, T$$

For the simple model

$$y_t = \beta_0 + \beta_1 x_t + \varepsilon_t \tag{4.1}$$

where ε_t satisfies all the OLS assumptions, the Farley-Hinich test consists of expanding (4.1) to

$$y_t = \beta_0 + \beta_1 x_t + \delta_1 (t\, x_t) + \varepsilon_t \tag{4.2}$$

and testing the significance of δ_1. The model can be easily extended to the multivariate case where the set of coefficients of the newly created variables is jointly tested for significance from zero.

The results of this test applied on each coefficient one at a time are shown in table 1. None of the $\delta_j\,(t_j\, x_{j\,t})$ terms is significantly different from zero and the null hypothesis of no drift cannot be rejected.

All the statistical tests indicate that the demand for money has been historically stable. But the desirability of this stability relates to predictability rather than mere constancy of the parameters. Predictions of the real money demand (or velocity) for a one year period should be reasonable accurate. Table 2 presents one-year ahead ex-post static forecasts for the period 1975 - 1980. The forecasting performance of the equation is quite satisfactory. The RMSE is always smaller than the standard error of the regression and the percent errors are within reasonable bounds. Further, all χ^2 tests for parameter instability are insignificant.

*Table 1**: **The Farley-Hinich Test**

	C	DUM	$\log y_t$	$\log (t\, y_t)$	$\log r_t$	$\log (t\, y_t)$	$\log m_{t-1}$	$\log (t\, m_{t-1})$	$\bar{R}^2$	D.W./$d-h$	S.E.
1	− 0.546	0.084	0.530	− 0.005	− 0.116		0.557		0.998	2.094	0.030
	(1.705)	(3.037)	(4.299)	(0.476)	(2.88)		(3.574)			− 0.666	
2	− 0.385	0.086	0.535		− 0.127	− 0.000	0.584		0.998	2.168	0.031
	(3.049)	(3.194)	(4.303)		(4.034)	(0.221)	(6.201)			− 0.537	
3	− 0.483	0.087	0.528		− 0.131		0.542	− 0.001	0.998	2.130	0.030
	(1.708)	(3.218)	(4.163)		(5.127)		(4.108)	(0.308)		− 0.485	

* Ordinary least squares estimates. Numbers in parentheses are absolute values of t-statistics. $d-h$ is *Durbin*'s h-statistic for the detection of autocorrelation in the presence of a lagged dependent variable.

Table 2: **One-Year-Ahead Post-Sample Predictions***

Year	Actual	Predicted	% Error	RMSE	χ_1^2 Stability Test**
1975	− 1.936	− 1.948	− .66	0.0128	.22
1976	− 1.892	− 1.887	.22	0.0050	.04
1977	− 1.868	− 1.845	1.26	0.0235	.84
1978	− 1.799	− 1.834	− 1.92	0.0346	1.88
1979	− 1.816	− 1.798	.99	0.0180	.49
1980	− 1.861	− 1.836	1.37	0.0255	1.03

* Actual and predicted values are natural logarithms of real per capita money balances.

** This is an asymptotically valid χ^2 test of post-sample parameter stability with x degrees of freedom, where x is the number of observations retained for the post-sample test. At the 5% significance level $\chi_1^2 = 3.84$.

IV. Conclusions

This note has shown that

(1) The function for the demand for $M1$ shifted temporarily upwards in Greece in 1967. Estimation of the equation without taking account of this shift leads to inefficient estimates and biased predictions.

(2) In spite of the temporary shift, the relationship has overall remained statistically stable on the period 1956 - 81. Formal statistical tests do not support Panayotopoulos' claims that the function has been highly unstable.[3]

On the basis of this evidence, it is clear that the procedures followed in my previous paper are the proper ones.

[3] It should be mentioned that when the relationship is estimated without the correction for the shift in the constant, it appears unstable in all tests. We believe, however, that the relationship should be tested after the correction has been made since the uncertainty created by the 1967 coup could be predicted to increase the demand for money, ceteris paribus.

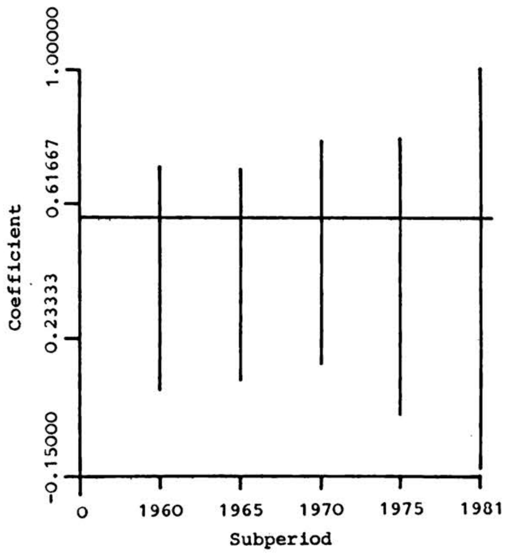

Figure 1: Stabilogram on the $1ny_t$ coefficient.

Note: The vertical lines represent a five percent confidence interval around the value of the coefficient for each subperiod. The horizontal line is the value of the coefficient for the entire period.

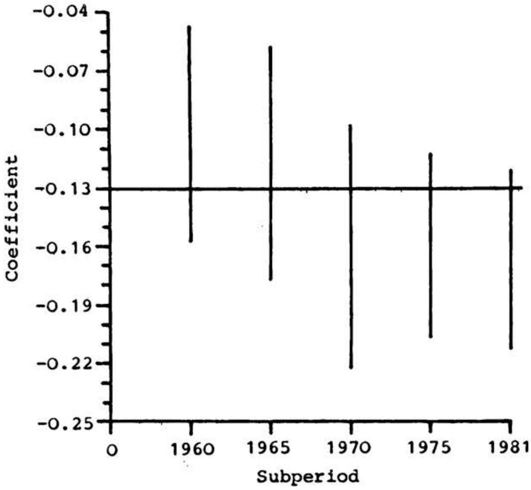

Figure 2: Stabilogram on the $1nr_t$ coefficient.

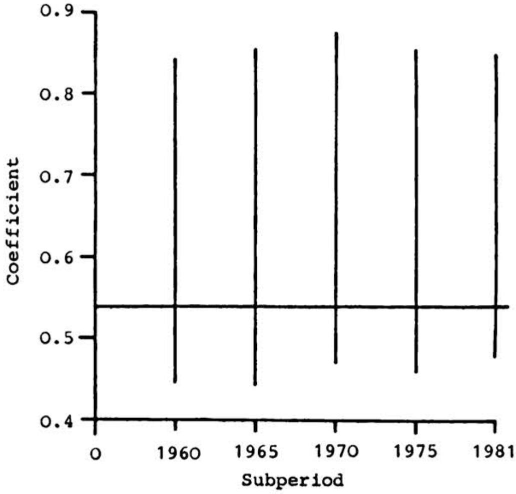

Figure 3: Stabilogram on the $1nm_{t-1}$ coefficient.

References

Ashley, R.: "A Simple Test for Regression Parameter Instability", Economic Inquiry, April 1984. – *Farley,* J. V. and M. J. *Hinich:* "A Test for a Shifting Slope Coefficient in a Linear Model", Journal of the American Statistical Association, 65 (September, 1970). – *Gujarati,* D.: "Use of Dummy Variables in Testing for Equality Between Sets of Coefficients in Two Linear Regressions", American Statistician (February, 1970). – *Himarios,* D.: "Administered Interest Rates and the Demand for Money in Greece under Rational Expectations", Weltwirtschaftliches Archiv, Band 122, Heft 1, 1986. – *Himarios,* D.: "Inflationary Expectations and the Demand for Money: The Greek Experience – A Comment and Some Different Results", Kredit und Kapital, 1983/Heft 2. – *Panayotopoulos,* D.: "Inflationary Expectations and the Demand for Money: The Greek Experience: 'A Comment and Some Different Results' – A Rejoinder", Kredit und Kapital, 1984/Heft 2.

Zusammenfassung

Gab es eine Verschiebung in der griechischen Geldnachfragefunktion?

Kürzlich hat in dieser Zeitschrift *Panayotopoulos* (1984) meinen Aufsatz (*Himarios,* 1983) in zwei Punkten kritisiert. Erstens stellt er die Einführung einer Dummy-Variablen für das Jahr 1967 in die Nachfragefunktion für $M1$ in Frage. Wenn für 1967 eine Dummy-Variable berücksichtigt werden muß, so argumentiert er, dann auch für 1974. Zweitens behauptet Panayotopoulos, daß meine früheren Ergebnisse nicht akzeptiert werden können, weil die Nachfrage nach $M1$ instabil gewesen sei und daher die Daten

nicht gepoolt werden können. Zweck des Artikels ist es, diese beiden Kritikpunkte zu behandeln. Ich zeige, daß die Einführung einer Dummy-Variablen für 1967 berechtigt und notwendig ist, während für 1974 eine solche Korrektur nicht erforderlich ist. Was den zweiten und wichtigeren Punkt angeht, so ergeben formale Stabilitätstest, daß die Nachfrage nach $M1$ über den Zeitraum 1956 - 1981 statistisch stabil geblieben ist. Die Schätzung einer einzelnen Gleichung ist daher das angemessene und effizienteste Verfahren.

Summary

"Has There Been a Shift in the Greek Money Demand Function?"

In a recent paper in this Journal, *Panayotopoulos* (1984) criticizes my 1983 paper (*Himarios,* 1983) on two counts. First, he questions the incorporation of a dummy variable in the demand for $M1$ for 1967. He argues that is a dummy variable is to be included for 1967 it should also be included for 1974. Second, Panayotopoulos claims that my earlier results cannot be accepted on the grounds that the demand for $M1$ has been unstable and thus the data cannot be pooled. The purpose of this note is to account for these two criticisms. I argue that the introduction of a dummy variable for 1967 is justified and necessary while no such correction is necessary for 1974. On the second and more important issue, formal stability tests indicate that the demand for $M1$ has been statistically stable over the period 1956 - 1981. Thus, estimating a single equation is the appropiate and most efficient strategy.

Résumé

La fonction de demande monétaire de la Grèce s'est-elle déplacée?

Dans un article publié récemment dans cette revue, *Panayotopoulos* (1984) critique mon exposé de 1983 (*Himarios,* 83) sur deux points. Il met tout d'abord en question l'incorporation d'une variable correctrive (dummy variable) dans le demande de $M1$ pour 1967. A son avis, si une telle variable doit être introduite pour 1967, elle devrait aussi l'être pour 1974. En deuxième lieu, Panayotopoulos dit que mes résultats antérieurs ne peuvent pas être acceptés car la demande de $M1$ a été instable et que les données ne peuvent donc pas être mises en commun. Je souhaite ici répondre à ces deux critiques. A mon avis, l'introduction d'une telle variable corrective pour 1963 est justifiée et nécessaire, sans l'être pour 1974. Sur l'autre point, des tests de stabilité formels indiquent que la demand de $M1$ a été statistiquement stable de 1956 à 1981. C'est pourquoi, en estimant une seule équation, j'ai choisi la stratégie appropriée et la plus efficace.