DEFICIT SUSTAINABILITY AND INFLATION IN EMU: AN ANALYSIS FROM THE FISCAL THEORY OF THE PRICE LEVEL*

Oscar Bajo-Rubio
(Universidad de Castilla-La Mancha and Instituto de Estudios Fiscales)

Carmen Díaz-Roldán
(Universidad de Castilla-La Mancha)

Vicente Esteve
(Universidad de Valencia)

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Abstract

Price determination theory typically focuses on the role of monetary policy, while the role of fiscal policy is usually neglected. From a different point of view, the Fiscal Theory of the Price Level takes into account monetary and fiscal policy interactions and assumes that fiscal policy may determine the price level, even if monetary authorities pursue an inflation targeting strategy. In this paper we try to test empirically whether the time path of the government budget in EMU countries would have affected price level determination. Our results point to the sustainability of fiscal policy in all the EMU countries but Finland, although no firm conclusions can be drawn about the prevalence of either monetary or fiscal dominance.

Keywords: Fiscal Theory of the Price Level, monetary and fiscal dominance, central bank independence, fiscal solvency, inflation.

JEL Classification: E62, H62, O52.

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1. Introduction

The traditional view on price determination focuses on the role of monetary policy, usually neglecting the role of fiscal policy. Most analyses assume that the monetary authority is expected to set its control variable without facing any constraint, so that prices are determined by money supply and demand, in a conventional way. As a counterpart, the fiscal authority sets primary surpluses in order to assure fiscal solvency, for any path the price level could take. This scenario is refereed in the literature as the Ricardian or “monetary dominant” (MD) regime, and works as follows: monetary policy would be “active”, being price determination its nominal anchor; whereas fiscal policy would adjust according to a Ricardian rule in a “passive” way, so that the budget surplus path would be endogenous.

However, a new approach has emerged in the 1990s, which allows fiscal policy to set primary surpluses to follow an arbitrary process, not necessarily compatible with solvency. Therefore, the budget surplus path would be exogenous, and the endogenous adjustment of the price level would be required in order to achieve fiscal solvency. In this context, fiscal policy becomes “active”, with budget surpluses turning to be the nominal anchor; whereas monetary policy becomes “passive” and can only control the timing of inflation. This is the so-called non-Ricardian or “fiscal dominant” (FD) regime, and the literature developed on these assumptions is known as the Fiscal Theory of the Price Level (FTPL). The FTPL builds on the contributions of, among others, Leeper (1991), Sims (1994), Woodford (1994, 1995, 2001), and Cochrane (1998, 2001, 2005). This literature has been surveyed in Kocherlakota and Phelan (1999), Carlstrom and Fuerst (2000), or Christiano and Fitzgerald (2000); some critical appraisals can be found, e.g., in Buiter (1998, 2001, 2002), McCallum (2001, 2003), and McCallum and Nelson (2005).

But the role of fiscal policy in stabilization goes beyond the interactions between monetary and fiscal policies. Traditional macroeconomic analysis has mainly focused on the effectiveness of policy instruments depending on the exchange rate regime. More recently, the debate has turned to issues related to policy coordination, as well as the potential problems that could arise in monetary unions. Accordingly, some literature has emerged more recently on the implications of FTPL on inflation targeting in open economies and, in particular, for the case of monetary unions; see, e.g., Sims (1997), Woodford (1997), Bergin (2000), Canzoneri, Cumby and Diba (2002), and Ballabriga and Martínez-Mongay (2003).

This theory could be of particular interest for monetary unions since it might contribute to explain the different evolution of the price level across the member countries. Regarding the case of the European Union (EU), the fiscal limitations imposed to the member countries by the Maastricht Treaty, and later on by the Pact for Stability and Growth, should be interpreted as a way to assure a Ricardian regime. In this line, Woodford (1998, 2001) shows that a central bank committed to maintaining price stability cannot be indifferent as to how fiscal policy is determined.

In this paper, we will try to analyze to which extent the empirical evidence would support the assumptions of the FTPL, for the case of the EU countries participating in the Economic and Monetary Union (EMU). More specifically, we will try to investigate how fiscal sustainability is achieved: through the endogenous adjustment of the primary budget surplus (MD regime), or through the endogenous adjustment of the price level (FD regime).

So far, the empirical evidence regarding the FTPL is not too abundant. The first contributions, both of them for the case of the US economy, were those of Bohn (1998) and Canzoneri, Cumby and Diba (2001), who pioneered the two main approaches employed to test for the FTPL, namely, the so-called *backward-looking* and *forward-looking* approaches, respectively. So, Bohn (1998) obtains, by means of econometric techniques, a positive response of the primary surplus-to-GDP ratio to the (lagged) debt-to-GDP ratio. In turn, making use of VAR analysis, Canzoneri, Cumby and Diba (2001) find that a positive innovation in the primary surplus would cause a fall in debt. Accordingly, the results of both studies would not support the existence of fiscal dominance. The methodology of Canzoneri *et al.* was also applied by other authors. Komulainen and Pirttilä (2002) examine the influence of fiscal deficits on inflation for several transition economies, concluding that a FD regime cannot be always identified. However, for the case of Brazil, Tanner and Ramos (2003) find that some periods of fiscal dominance could be documented.

There are also some contributions that analyze the case of the EU. The first one was by Mélitz (2000), who shows that fiscal policy would have responded in a stabilizing manner to changes in the debt-to-GDP ratio for the EU-15 countries. Later on, Ballabriga and Martínez-Mongay (2003) estimate monetary and fiscal rules for the euro area, and conclude that the MD regime would have prevailed in these countries throughout the years before the formation of EMU (1979-1998). In a further contribution, Ballabriga and Martínez-Mongay (2005) re-examine fiscal rules extending the period of analysis until 2002, and considering the possibility of structural change; their main finding was that the sustainability of public finances would have prevailed in most EMU countries even before the Pact for Stability and Growth.

Afonso (2005) analyzes the relationship between the primary budget surplus and government debt, as percentages to GDP, using panel data for the EU countries over the period 1970-2003. His results give support to the Ricardian regime hypothesis throughout the sample period, as well as before and after both the Maastricht Treaty and the setting of the Pact for Stability and Growth. Finally, Creel and Le Bihan (2006) confirm for France, Germany, Italy and the UK, both using the primary surplus and its two separate components (cyclical and structural), the conclusions of Canzoneri, Cumby and Diba (2001), so that a MD regime would also apply to the experience of these countries.

In our empirical approach we will try to perform a systematic analysis of the relation between primary surplus and debt for the case of EMU countries, in the line of Bohn (1998). Additionally, this approach will provide us with an indirect test on the solvency of public finances in EMU countries. More specifically, we will start by estimating cointegration relationships between primary surplus and debt (both as ratios to GDP), on a country-to-country basis, for the EMU members over the period 1970-2005. However, since this method might not be able to fully distinguish between a FD and a MD regime (see below), we will try to avoid this problem by performing Granger-causality tests between primary surplus and debt. Finally, we will test for the eventual presence of structural breaks in the estimated relationships.

The paper is organized as follows. The underlying theoretical framework is briefly described in section 2, the methodology and empirical results are presented in section 3, and the main conclusions are summarized in section 4.

2. Theoretical background: The interactions between monetary and fiscal policies

In general terms, the FTPL states that concerns about fiscal solvency can condition the policy of the central bank, even when the latter has been granted legal independence. An antecedent of this claim can be found in Sargent and Wallace's (1981) contribution, where the interaction of fiscal and monetary variables in the financing of deficits, through taxes and seigniorage, was already analyzed. In this way, in some cases monetary policy should "accommodate" the path of expenditures and revenues chosen by the government, in order to guarantee fiscal solvency. The FTPL develops this idea, stating that policies considered *a priori* inconsistent can in fact co-exist in equilibrium, but at the cost of generating price instability.

The arguments can be presented using the intertemporal, or present-value, government budget constraint, written in terms of GDP shares:

$$b_t = \sum_{j=0}^{\infty} \left(\frac{1+x}{1+r} \right)^{j+1} E_t s_{t+j+1} + \lim_{j \to \infty} \left(\frac{1+x}{1+r} \right)^{j+1} E_t b_{t+j+1} \qquad (1)$$

where b and s denote, respectively, the public debt and primary surplus, both as ratios to GDP; E is the expectations operator; and x and r stand, respectively, for the rate of growth of real GDP and the real interest rate, both assumed to be constant for simplicity. The condition for fiscal sustainability is:

$$\lim_{j \to \infty} \left(\frac{1+x}{1+r} \right)^{j+1} E_t b_{t+j+1} = 0 \qquad (2)$$

or, equivalently:

$$b_t = \sum_{j=0}^{\infty} \left(\frac{1+x}{1+r} \right)^{j+1} E_t s_{t+j+1} \qquad (3)$$

i.e., solvency requires that the government must run expected future budget surpluses equal, in present-value terms, to the current value of its outstanding debt.

According to the conventional approach (identified as the Ricardian or MD regime), the price level would be determined in the money market, following the quantity theory of money, and the primary surplus would adjust endogenously to satisfy the present-value budget constraint. In terms of equation (3), s would be set to meet a given b, independently of the price level. The interdependence between monetary and fiscal policy can still appear in the following way (see Sargent and Wallace, 1981): assume that, in equation (3), seigniorage is allowed, so that b would denote all the government's liabilities, and s include the seigniorage revenue. Hence, if b is given and the government wants to reduce the primary surplus, seigniorage must be increased keeping the total s constant, leading to a higher inflation. In this way, the requirements of fiscal solvency can mean a limit to the options open to the central bank. The corollary of this argument would be the now standard recommendation of granting independence to the central bank, which should assign a high priority to inflation, and strictly commit to understandable and publicized rules when conducting monetary policy. As a consequence, seigniorage eventually has disappeared as a source of budget deficit financing in advanced countries.

The theoretical and empirical literature on monetary policy regimes characterized by Taylor-type rules (Taylor, 1993), shows the contribution of these rules to achieve both price and output stability. However, several studies [e.g., Ballabriga and Martínez-Mongay (2003), Jonung and Larch (2004), or Larch and Salto (2005)] conclude that monetary policy rules are not sufficient to guarantee price stability. Consequently, it has been argued that a rule for fiscal policy would be a useful tool, through commitments to satisfy the government's solvency condition, and the introduction of budget targets or even of deficit rules.

On the other hand, the FTPL assumes that fiscal policy may determine the price level even if monetary authorities pursue an inflation targeting strategy. This theory would hold in the non-Ricardian regime or FD regime, where the primary surplus is set exogenously by the government, regardless of the level of public debt. In this framework, the price level would adjust in order to assure the fulfillment of the intertemporal budget constraint. And the main implication for fiscal policy would be that government solvency turns to be a sufficient condition for price stability.

In terms of equation (3), we can write this equation as:

$$\frac{B_t}{P_t y_t} = \sum_{j=0}^{\infty} \left(\frac{1+x}{1+r} \right)^{j+1} E_t s_{t+j+1} \qquad (3')$$

where *B*, *P*, and *y* denote, respectively, the nominal value of public debt, the price level, and real GDP. Then, given *B*, *y*, and *s*, *P* would "jump" to satisfy (3'). In other words, if the market believes the government's commitment when setting *s*, a value of *P* will be set so that *B* was not excessive and (3') could be satisfied.

The presence of interactions between monetary and fiscal policy opens the possibility of jointly allowing for rules for monetary as well as for fiscal policy. In terms of the game theory approach, the solution would be given by the leader-follower model. Carlstrom and Fuerst (2000) show the restrictions that government budget may place on monetary policy. Whether monetary or fiscal policy determines prices involves an assumption about which policymaker will move first, the central bank or the fiscal authority.

3. Empirical methodology and results

The empirical literature has usually employed two approaches to test for the FTPL:

(i) The *backward-looking* approach (e.g., Bohn, 1998), which would imply that, in a Ricardian regime, an increase in the previous level of debt would result in a larger primary surplus today; i.e., $\Delta b_{t-1} \rightarrow \Delta s_t$.

(ii) The *forward-looking* approach (e.g., Canzoneri, Cumby and Diba, 2001), which would imply that, in a Ricardian regime, a larger primary surplus today would lead to a reduction in the future level of debt; i.e., $\Delta s_t \rightarrow \nabla b_{t+1}$.

In this paper, we will follow the first approach, by estimating cointegration relationships between the primary surplus and the (lagged) level of debt, both as ratios to GDP:

$$s_t = \alpha + \beta b_{t-1} + v_t \qquad (4)$$

with being *v* an error term. Here, an estimated $\beta > 0$ would indicate the prevalence of a MD regime, and an estimated $\beta \leq 0$ the prevalence of a FD regime. Notice that a positive and significant estimated coefficient in that regression would be a sufficient condition for solvency, indicating that the government satisfies its present-value budget constraint. In other words, testing whether $\beta > 0$ or $\beta \leq 0$ would provide an indirect test for fiscal solvency.

A problem with this approach, however, is that a positive estimate of β is strictly compatible with the presence of both a MD and a FD regime. That is, in a MD regime we would observe that an increase in debt in period *t* would lead to a larger primary surplus *ex-post*; i.e.: $\Delta b_t \rightarrow \Delta s_{t+1}$, which implies an estimated $\beta > 0$. However, in a FD regime, a decrease in the expected primary surplus would lead to a fall in the current debt ratio, through a price increase; i.e.: $\nabla E_t s_{t+1} \rightarrow \nabla b_t$, which also implies an estimated $\beta > 0$. For that reason, the cointegration analysis will be complemented with Granger-causality tests between primary surplus and debt. Finally, we will test for the eventual presence of structural breaks in the estimated relationships.

We use data on primary (i.e., excluding interest payments) budget surplus, and general government consolidated gross debt, both of them as percentages of GDP, for the EMU member countries. The data cover the period 1970 through 2005 (except for France, the Netherlands, and Portugal, where they are available from 1977, 1975, and 1973 on, respectively), and come from the official annual data base of the Directorate General for Economic and Financial Affairs of the European Commission.

As a first step of the analysis, we investigate the time series properties of the surplus and debt series using the tests of Ng and Perron (2001). The results are shown in Table 1, so that the null hypothesis of non stationarity cannot be rejected at the 5% level for the two series in all cases, independently of the test. Accordingly, both series would be concluded to be I(1).

Since the result for the German primary surplus is unclear (strictly, the ADF^{GLS} test would reject the null of a unit root at the 5% significance level), we have also applied to this variable the test proposed by Perron and Vogelsang (1992a) of a unit root against the alternative of stationarity with structural changes. As can been seen in Table 2, the null hypothesis of a unit root cannot be rejected at the 5% level for the two models considered, so the German primary surplus series would be also concluded to be I(1).

Once analyzed the order of integration of the series, we are in position to estimate the parameter β in equation (4). The estimation is made using the method of Dynamic Ordinary Least Squares (DOLS) of Stock and Watson (1993), following the methodology proposed by Shin (1994). This method has the advantage of providing a robust correction to the possible presence of endogeneity in the explanatory variables, as well as of serial correlation in the error terms of the OLS estimation. Hence, we first estimate a long-run dynamic equation including leads and lags of the (first difference of the) explanatory variable in equation (4):

$$s_t = \alpha + \beta b_{t-1} + \sum_{j=-q}^{q} \varphi_j \Delta b_{t-1-j} + v_t \qquad (5)$$

and then perform Shin's (1994) test from the calculation of C_μ, a LM statistic from the DOLS residuals which tests for deterministic cointegration (i.e., when no trend is present in the regression).

The results of the estimation of equation (5) for each country, in terms of the coefficient β and the statistic C_μ, appear in Table 3. Two main results can be obtained from the table. First, since none of the cointegration statistics are significant at the conventional levels, the null of deterministic cointegration is not rejected in all cases. And, second, the estimates of β are always positive and significantly different from zero at least at the 5% level (10% for Portugal); the only exception would be Finland, where the estimated coefficient is negative, but not significantly different from zero. Therefore, a preliminary conclusion would emerge: except for Finland, where the opposite would happen, fiscal policy would have been sustainable in all the EMU countries, and a Ricardian or MD regime would have prevailed.

However, as noticed before, in equilibrium the fiscal solvency condition holds in both regimes, and a positive estimate of β can be found both in a Ricardian and in a non-Ricardian regime. A possible way of trying to distinguish between the two regimes would be performing Granger-causality tests.

According to Granger (1988), if X_t and Y_t are cointegrated I(1) variables, they are generated by an error correction model. If we denote the error correction as Z_t, then either ΔX_t or ΔY_t (or both) must be caused by Z_{t-1}, which is itself a function of X_{t-1} and Y_{t-1}. Hence, if there is cointegration between a pair of variables, there must be causality between them in at least one direction, in order to provide these variables with enough dynamics to reach the equilibrium. So, if Z_t is not used, the model will be misspecified and, in some cases, causality will not be detected.

On the other hand, Sims, Stock and Watson (1990) show that this problem only appears when both series are cointegrated. If the two I(1) series X_t and Y_t are cointegrated, the relevant regression is the following:

$$X_t = \alpha_0 + \delta_1 X_{t-1} + \gamma_1 \left(X_{t-1} - \beta Y_{t-1} \right) + \sum_{i=1}^{m} \alpha_{1i} \Delta X_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta Y_{t-i} + \varepsilon_t \qquad (6)$$

with an analogous representation holding for Y_t as dependent variable. Then, to testing for Granger-causality, the null hypotheses would be: (i) $\gamma_1 = 0$, for the absence of long-run causality; and (ii) $\alpha_{2i} = 0$, for the absence of short-run causality. And the standard F test can be used to test for Granger-causality in the short and in the long run.

The results of the Granger-causality test for the variables primary budget surplus and government gross debt are presented in Table 4. We report F statistics on the null hypotheses $\gamma_1 = 0$ and $\alpha_{2i} = 0$, from the estimation of equation (6) with s_t and b_{t-1} alternatively as dependent variables, and including up to three lags of the first difference of each of these variables. As can be seen, no long-run Granger-causality was found in any of the cases analyzed. In turn, bilateral short-run Granger-causality was found for Belgium, Germany, Greece, Spain, Ireland, Italy, Austria, and Portugal; whereas short-run Granger-causality just from primary surplus to debt appears for the Netherlands and Finland, and no short-run Granger-causality was found in any sense for France.

Therefore, the results from the Granger-causality tests do not allow us to ascertain whether fiscal solvency in EMU would have followed from a MD or a FD regime. Only in the case of the Netherlands some evidence on a FD regime might appear, whereas the previous results for Finland would be confirmed.

Next, we examine the possibility of instabilities in the cointegration relationship between primary surplus and debt. In this way, we extend the previous analysis in order to address whether the estimated relationship is stable over time, or it exhibits instead some structural break, allowing the instability to occur at an unknown date. To do so, we use the tests for parameter instability in cointegration relationships suggested by Hansen (1992). This author proposes some tests of parameter instability based on the "fully modified" estimator of Phillips and Hansen (1990), through the *SupF*, *MeanF*, and L_c test statistics. All of them have the same null hypothesis (i.e., stability of the regression parameters), but differ in the alternative, since the *SupF* test captures changes in regimes, and the *MeanF* and L_c tests capture gradual shifts over time.

In Table 5 we report the results from Hansen's instability tests. As can be seen, the relationship between the primary budget surplus and government gross debt would seem to be clearly stable only for Germany and Greece, whereas some signs of instability would be detected in the rest of cases. The sequence of *F* statistics for structural change, along with 5% critical values for its largest value (*SupF*), its average value (*MeanF*), and for a fixed known breakpoint, are displayed in Figure 1. In particular, the sequence of the *F* statistic reaches the 5% critical value associated with the *SupF* test before 1983 and after 1996 for Belgium, before 1981 for Spain, between 1988 and 1993 for France, after 1997 for Ireland, after 2000 for Italy, after 2001 for the Netherlands, after 1992 for Austria, and over almost all the period for Finland.

4. Conclusions

In this paper, we have tried to analyze whether the empirical evidence would support the assumptions of the FTPL, for the case of the EMU countries over the period 1970-2005. To that end, we estimated solvency equations for each country, by regressing the primary budget surplus on the (lagged) government gross debt, both as ratios to GDP. In particular, a positive and significant estimated coefficient in that regression would be a sufficient condition for solvency, indicating that the government satisfies its present-value budget constraint. Our results showed that deterministic cointegration prevailed in all cases, and, with the only exception of Finland, the estimated regression coefficient was always positive and significantly different from zero. Therefore, fiscal policy would have been sustainable over the whole period in all the EMU countries but Finland, indicating the prevalence of a Ricardian or MD regime.

However, in equilibrium, the fiscal solvency condition holds under both the MD and FD regimes; and the difference between them would come from how fiscal sustainability is achieved, i.e., through the endogenous adjustment of the primary budget surplus in the MD case, or through the endogenous adjustment of the price level in the FD case. For that reason, in order to distinguish between the two regimes, we next performed Granger-causality tests between primary surplus and debt, but the results from the tests did not allow us to achieve any firm conclusion about the prevalence of either a MD or a FD regime. Finally, we also tested for the eventual presence of structural breaks in the estimated long-run relationships, finding some evidence of instability in most cases, with the main exceptions of Germany and Greece.

To conclude, despite the fact we have not found clear evidence supporting the FTPL in the EMU case, it should be recalled the important role to be played by fiscal policy in EMU as the main instrument available to individual countries when dealing with asymmetric shocks. Notice also that the new scenario given by EMU and the Pact for Stability and Growth should strengthen the response of the primary surplus to debt, in order to keep the budget not far from equilibrium, and guarantee the long-run solvency of fiscal policy (European Central Bank, 2004). Our findings, however, would point to an ease in last years, of the fiscal stance in some countries that exhibit fiscal solvency over the whole period; this would be the case of Austria, Belgium, Ireland, Italy, and the Netherlands. Finally, it is still possible that fiscal authorities could behave in a non linear fashion, so that fiscal solvency might hold in some periods, but not in others. In this sense, an extension of the analysis in this paper could make use of the methodology applied in Bajo-Rubio, Díaz-Roldán and Esteve (2006), where significant nonlinear effects were found for Spanish fiscal policy, assuring notwithstanding its long-run sustainability.

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Table 1
Ng-Perron tests for unit roots

A) Government gross debt

	$\overline{M}Z_{\alpha}^{GLS}$	$\overline{M}Z_{t}^{GLS}$	ADF^{GLS}
Belgium	0.29	0.20	0.16
Germany	–6.82	–1.83	–2.08
Greece	–2.32	–0.94	–1.13
Spain	–0.62	–0.27	–0.29
France	–4.20	–1.44	–1.74
Ireland	–0.21	–0.16	–0.39
Italy	–0.26	–0.12	–0.19
Netherlands	–0.38	–0.28	–0.54
Austria	–0.77	–0.33	–0.35
Portugal	–2.29	–1.03	–1.41
Finland	–3.25	–1.24	–1.42

B) Primary budget surplus

	$\overline{M}Z_{\alpha}^{GLS}$	$\overline{M}Z_{t}^{GLS}$	ADF^{GLS}
Belgium	–5.00	–1.52	–1.91
Germany	–12.92	–2.52	–3.41
Greece	–5.57	–1.66	–1.95
Spain	–4.60	–1.48	–1.78
France	–9.55	–2.18	–2.69
Ireland	–5.12	–1.50	–1.72
Italy	–5.65	–1.61	–2.04
Netherlands	–8.72	–2.04	–2.40
Austria	–9.20	–2.14	–2.65
Portugal	–6.41	–1.77	–2.15
Finland	–7.78	–1.97	–2.27

Notes:

(i) Only the ADF^{GLS} statistic for the German primary budget surplus is significant at the 5% level. The critical values are taken from Ng and Perron (2001), Table 1.

(ii) The autoregressive truncation lag has been selected using the modified Akaike information criterion, as proposed by Perron and Ng (1996).

Table 2
Perron-Vogelsang tests for unit roots with structural changes, for the German primary budget surplus

Model	T_b	k	$\hat{\delta}$	$\hat{\theta}$	$\hat{\alpha}$	$t_{\hat{\alpha}}$
IOM	1982	3	–1.01 (–0.80)	2.19 (3.65)	0.54	–4.60
AOM	1978	3	–	0.86 (1.52)	–0.12	–4.07

Notes:
(i) None of the $t_{\hat{\alpha}}$ statistics are significant at the conventional levels. The critical values are taken from Perron and Vogelsang (1992b), Table 1 (AOM model) and Table 2 (IOM model), for $T = 50$.
(ii) t-statistics in parentheses.
(iii) The estimated models are, first, the innovational outlier model (IOM):

$$y_t = \mu + \theta DU_t + \delta D(T_b)_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-1} + e_t$$

where $DU_t = 1$ if $t > T_b$ and 0 otherwise, $D(T_b)_t = 1$ if $t = T_b + 1$ and 0 otherwise; and, second, the additive outlier model (AOM):

$$y_t = \mu + \theta DU_t + \tilde{y}_t$$

where $\tilde{y}_t = \sum_{i=0}^{k} \omega_i D(T_b)_{t-i} + \alpha \tilde{y}_{t-1} + \sum_{i=1}^{k} c_i \Delta \tilde{y}_{t-i} + e_t$.

Table 3
Estimation of long-run relationships: Stock-Watson-Shin cointegration tests

	β	$\bar{R}^2$	C_μ
Belgium	0.07 (0.003)	0.98	0.126
Germany	0.14 (0.006)	0.88	0.109
Greece	0.06 (0.03)	0.92	0.112
Spain	0.06 (0.003)	0.92	0.159
France	0.07 (0.005)	0.99	0.216
Ireland	0.10 (0.007)	0.95	0.180
Italy	0.15 (0.004)	0.98	0.155
Netherlands	0.08 (0.03)	0.84	0.232
Austria	0.02 (0.005)	0.91	0.129
Portugal	0.11 (0.06)	0.86	0.173
Finland	–0.09 (0.08)	0.96	0.115

Notes:

(i) None of the C_μ statistics are significant at the conventional levels. The critical values are taken from Shin (1994), Table 1, for $m = 1$.

(ii) Standard errors in parentheses, adjusted for long-run variance. The long-run variance of the cointegrating regression residuals was estimated using the Bartlett window with $l = 5 \approx INT(T^{1/2})$, as proposed in Newey and West (1987).

(iii) The number of leads and lags selected was $q = 3 \approx INT(T^{1/3})$, as proposed in Stock and Watson (1993).

Table 4
Sims-Stock-Watson tests for Granger-causality

	H_0	$s_t \rightarrow b_{t-1}$	$b_{t-1} \rightarrow s_t$
Belgium	$\gamma_1 = 0$	0.864	0.054
	$\alpha_{2i} = 0$	3.629**	12.09***
Germany	$\gamma_1 = 0$	0.569	0.001
	$\alpha_{2i} = 0$	3.684**	8.96***
Greece	$\gamma_1 = 0$	0.023	0.001
	$\alpha_{2i} = 0$	6.200**	5.818**
Spain	$\gamma_1 = 0$	1.418	0.165
	$\alpha_{2i} = 0$	5.673**	4.734**
France	$\gamma_1 = 0$	0.005	0.001
	$\alpha_{2i} = 0$	1.406	0.002
Ireland	$\gamma_1 = 0$	0.001	0.375
	$\alpha_{2i} = 0$	5.683**	2.581*
Italy	$\gamma_1 = 0$	1.387	0.241
	$\alpha_{2i} = 0$	3.894*	2.660*
Netherlands	$\gamma_1 = 0$	1.738	0.010
	$\alpha_{2i} = 0$	7.599**	0.085
Austria	$\gamma_1 = 0$	0.312	0.051
	$\alpha_{2i} = 0$	6.127**	6.875***
Portugal	$\gamma_1 = 0$	1.048	0.053
	$\alpha_{2i} = 0$	7.848**	3.837**
Finland	$\gamma_1 = 0$	0.428	0.038
	$\alpha_{2i} = 0$	3.689**	0.083

Notes:

(i) The reported values are *F*-statistics on the null hypotheses $\gamma_1 = 0$ and $\alpha_{2i} = 0$, from the estimation of equation (6) in the text using s_t and b_{t-1} alternatively as dependent variables.

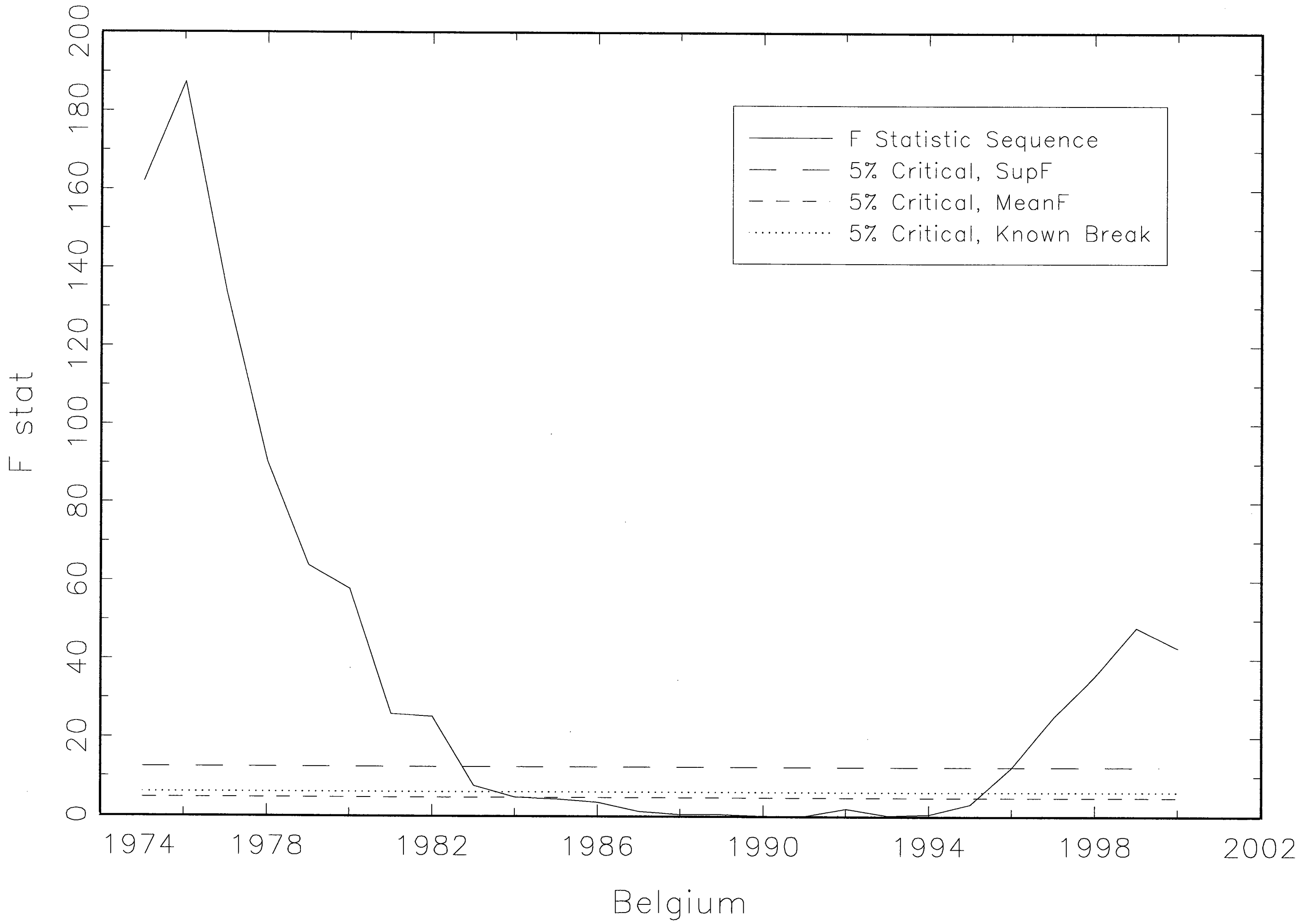
(ii) *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 5
Hansen tests for parameter instability

	L_c	*MeanF*	*SupF*
Belgium	0.48 (0.04)	36.0 (0.01)	187.3 (0.01)
Germany	0.15 (0.20)	1.83 (0.20)	4.77 (0.20)
Greece	0.19 (0.20)	1.80 (0.20)	11.10 (0.10)
Spain	0.33 (0.11)	23.58 (0.01)	147.4 (0.01)
France	0.81 (0.01)	9.74 (0.01)	28.72 (0.01)
Ireland	0.35 (0.10)	6.86 (0.01)	66.09 (0.01)
Italy	0.35 (0.10)	5.05 (0.03)	18.07 (0.01)
Netherlands	0.17 (0.20)	3.22 (0.14)	14.49 (0.02)
Austria	0.19 (0.20)	8.73 (0.01)	39.00 (0.01)
Portugal	0.52 (0.03)	5.30 (0.03)	11.89 (0.07)
Finland	0.397 (0.07)	43.02 (0.01)	144.9 (0.01)

Notes:
(i) Probability of parameter instability in parentheses.
(ii) According to Hansen (1992), a relation is said to be stable if the estimated probability is greater or equal than 20%.

Figure 1. Hansen instability tests



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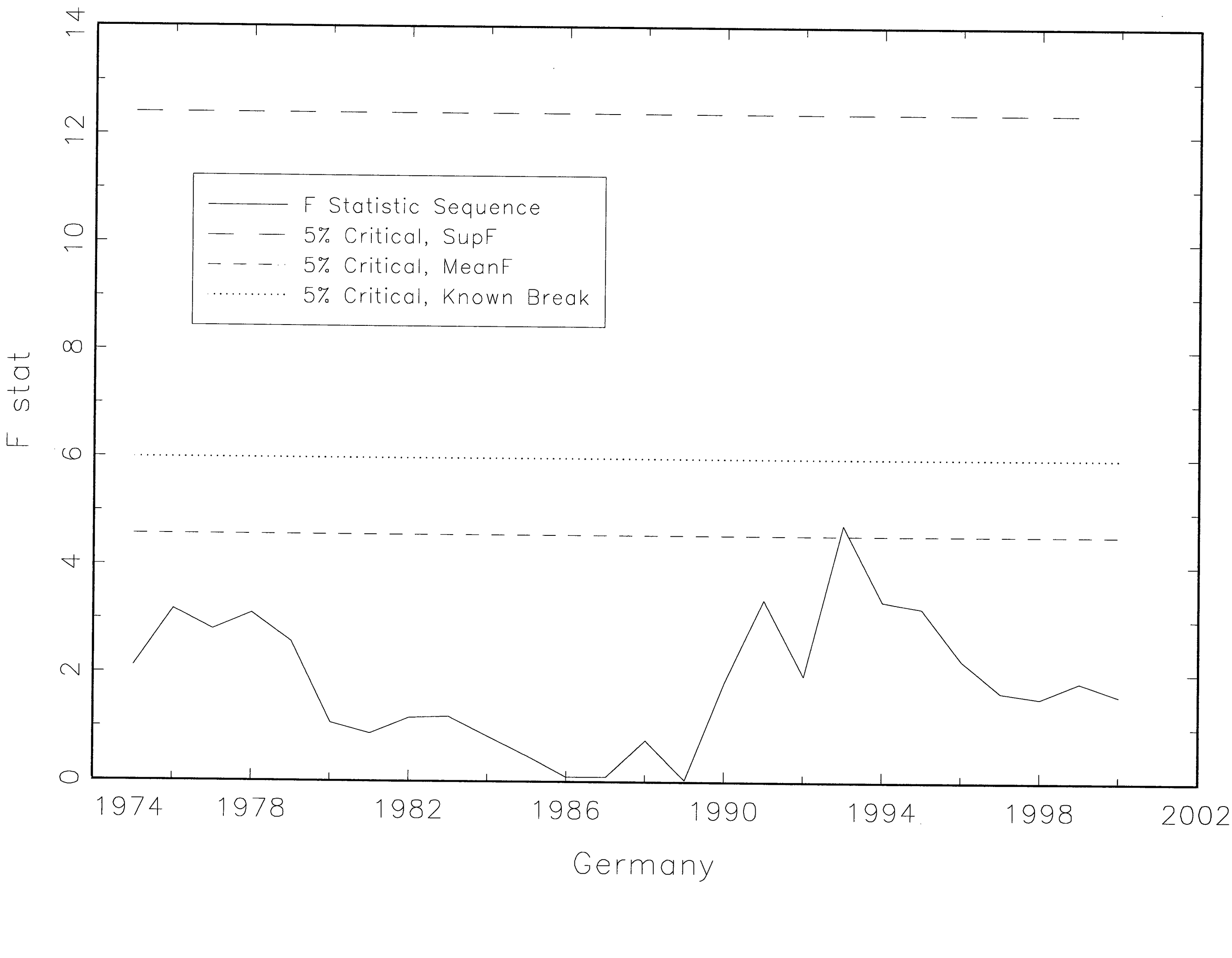

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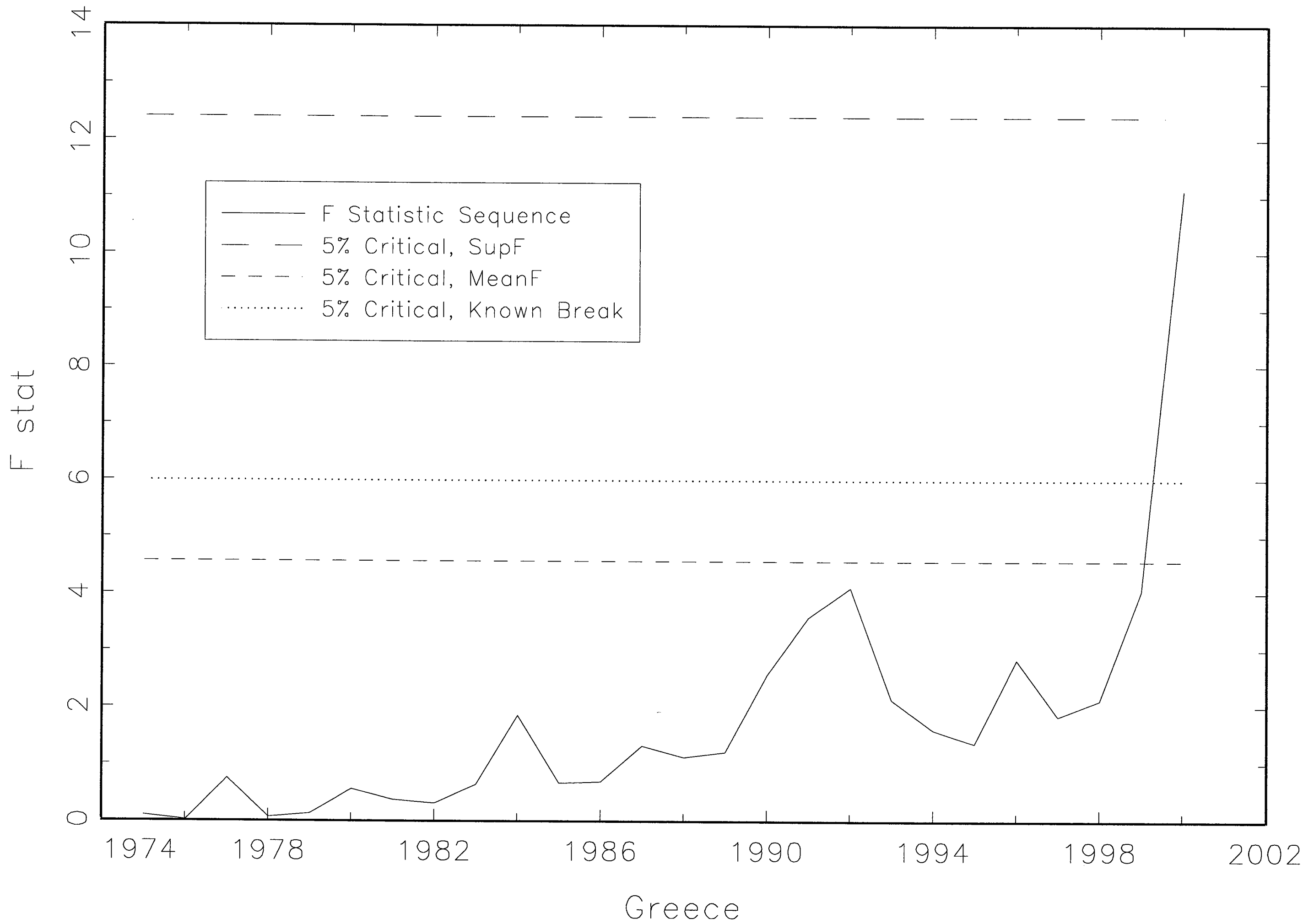

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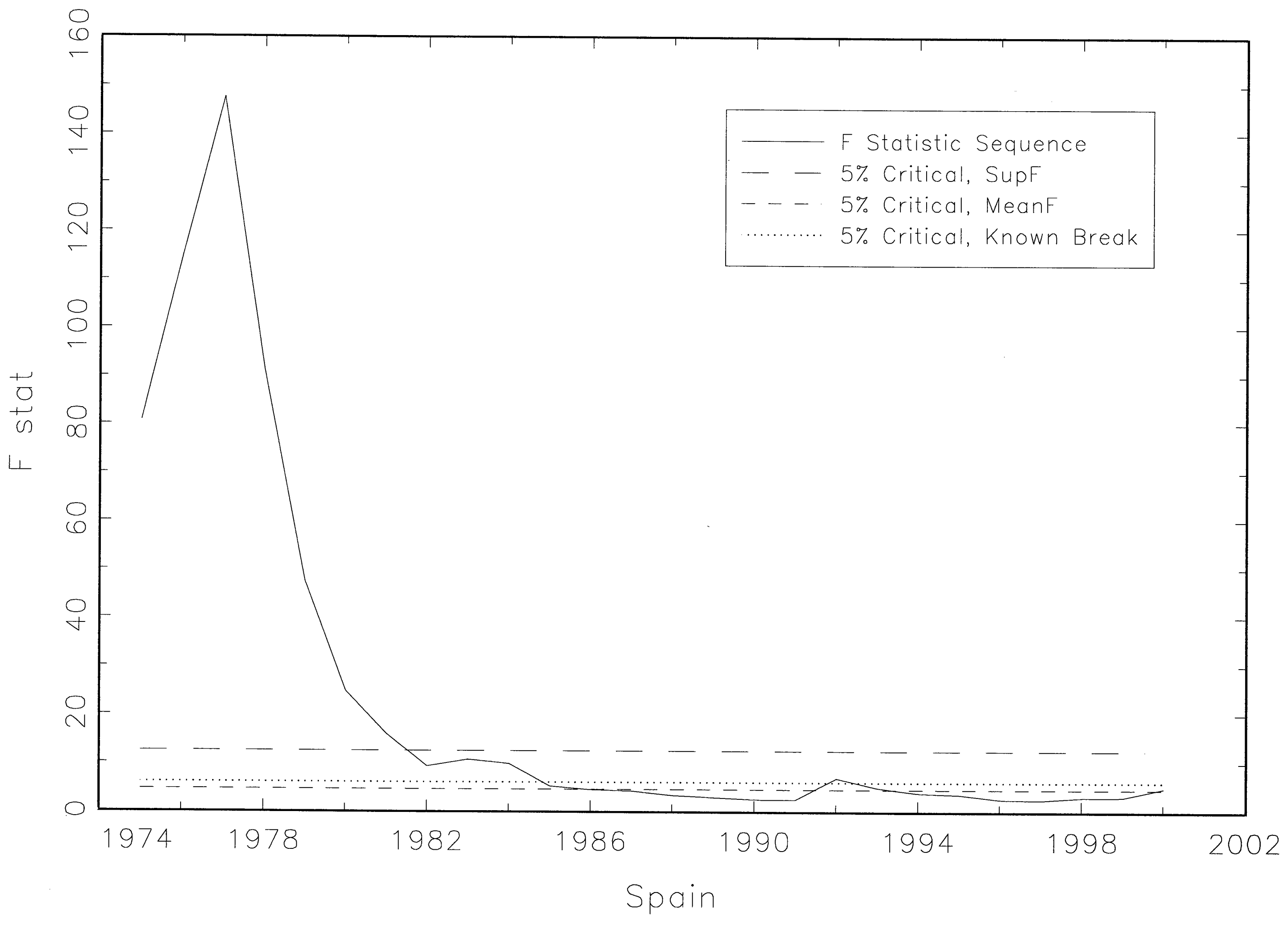

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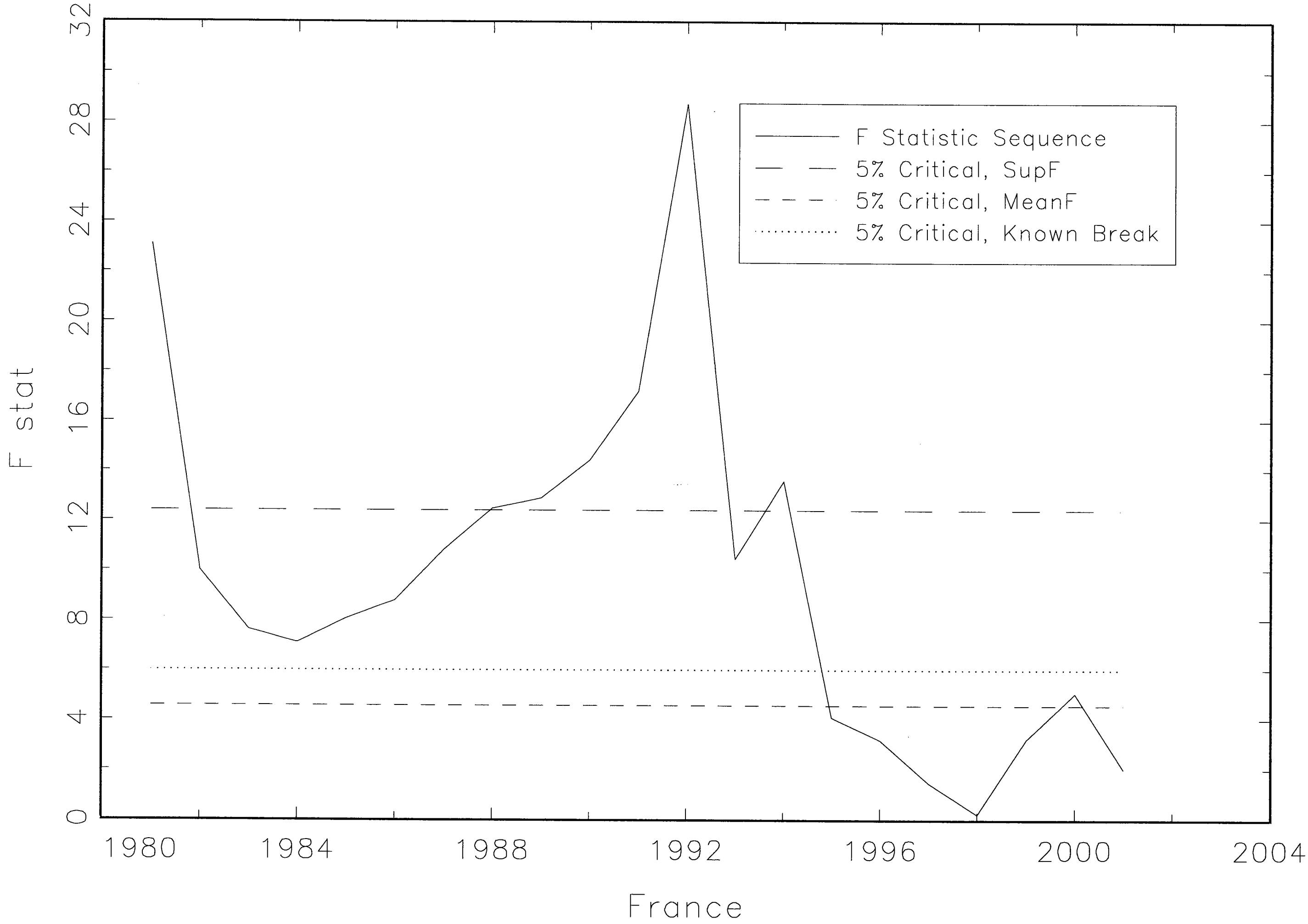

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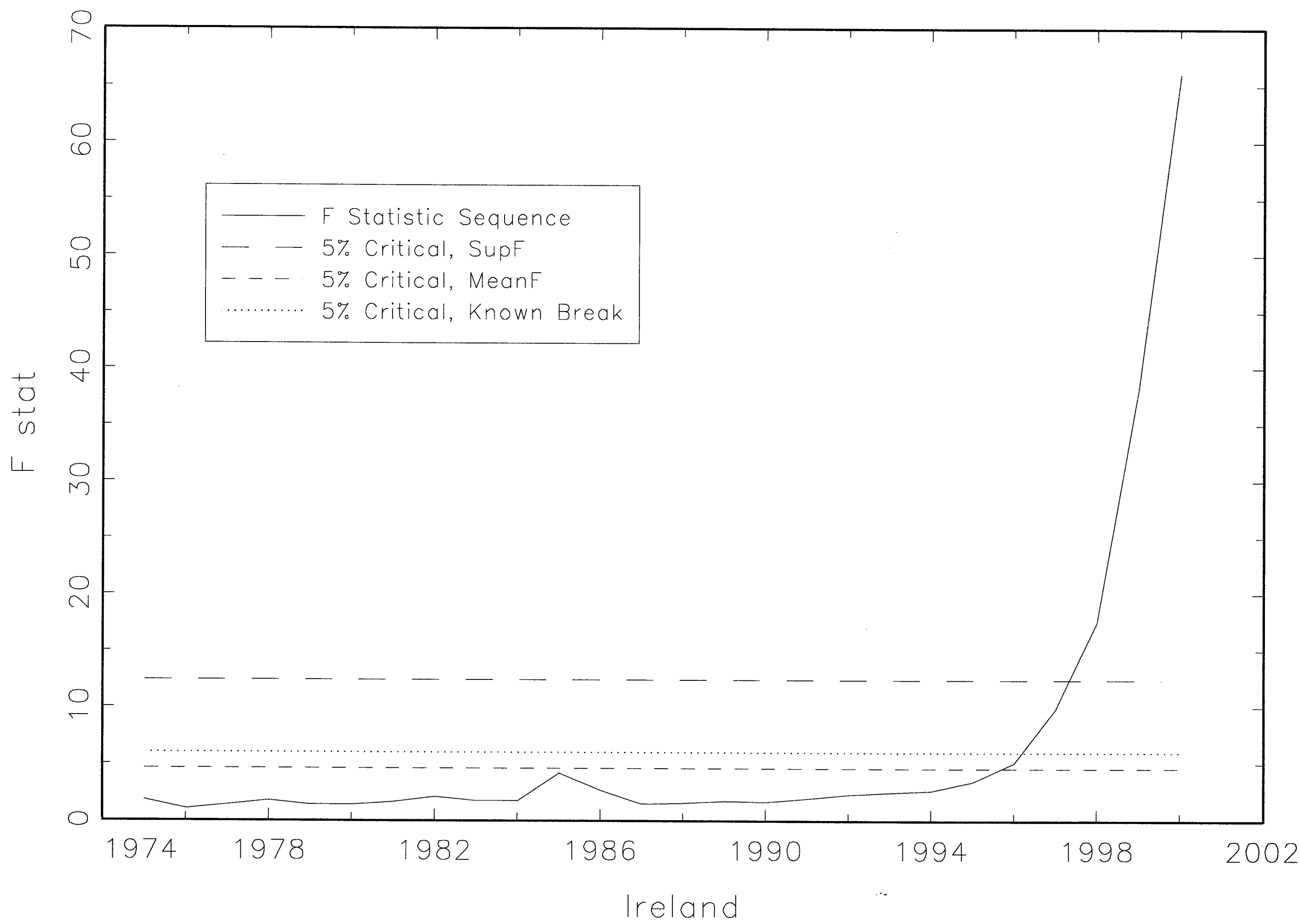

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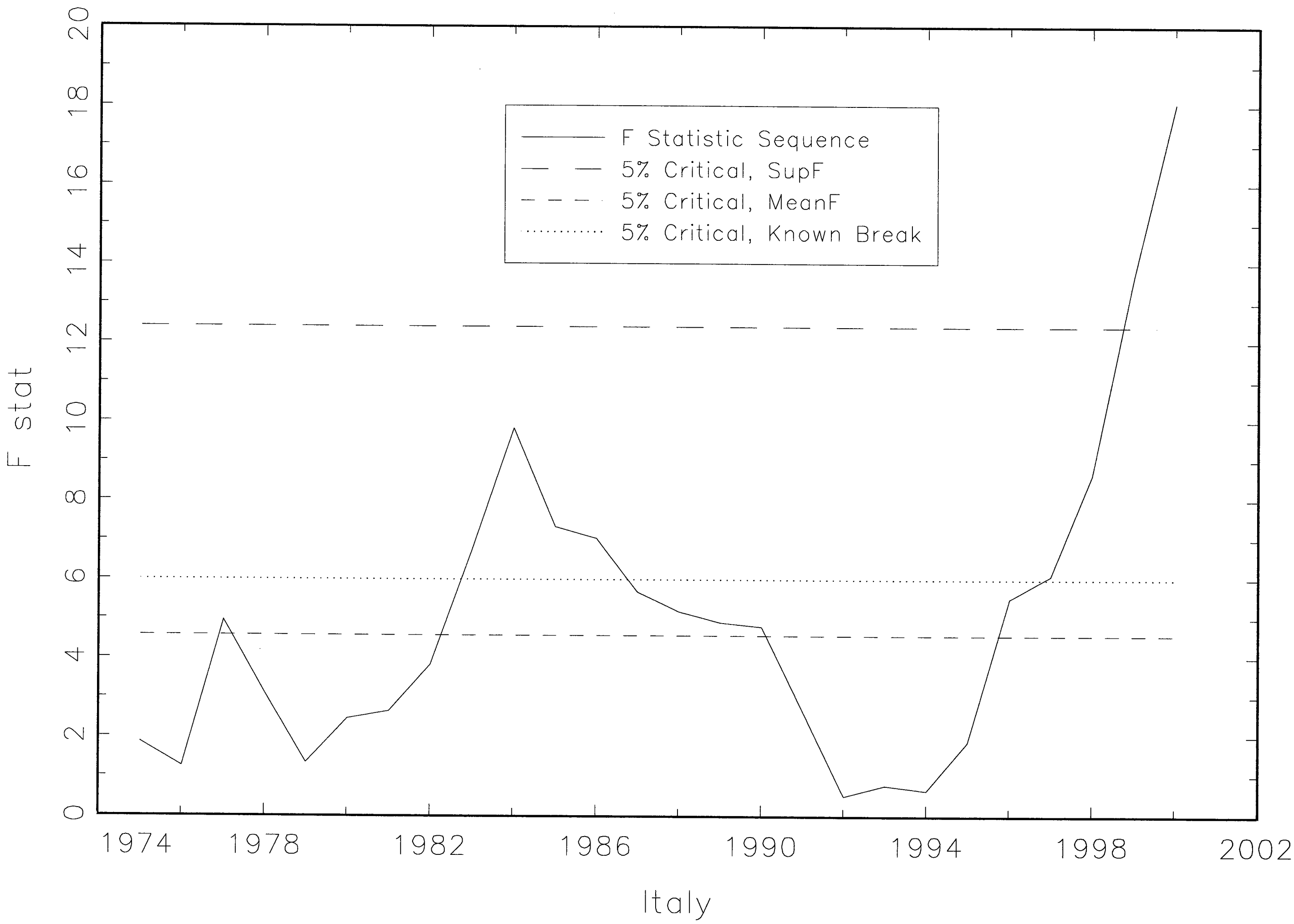

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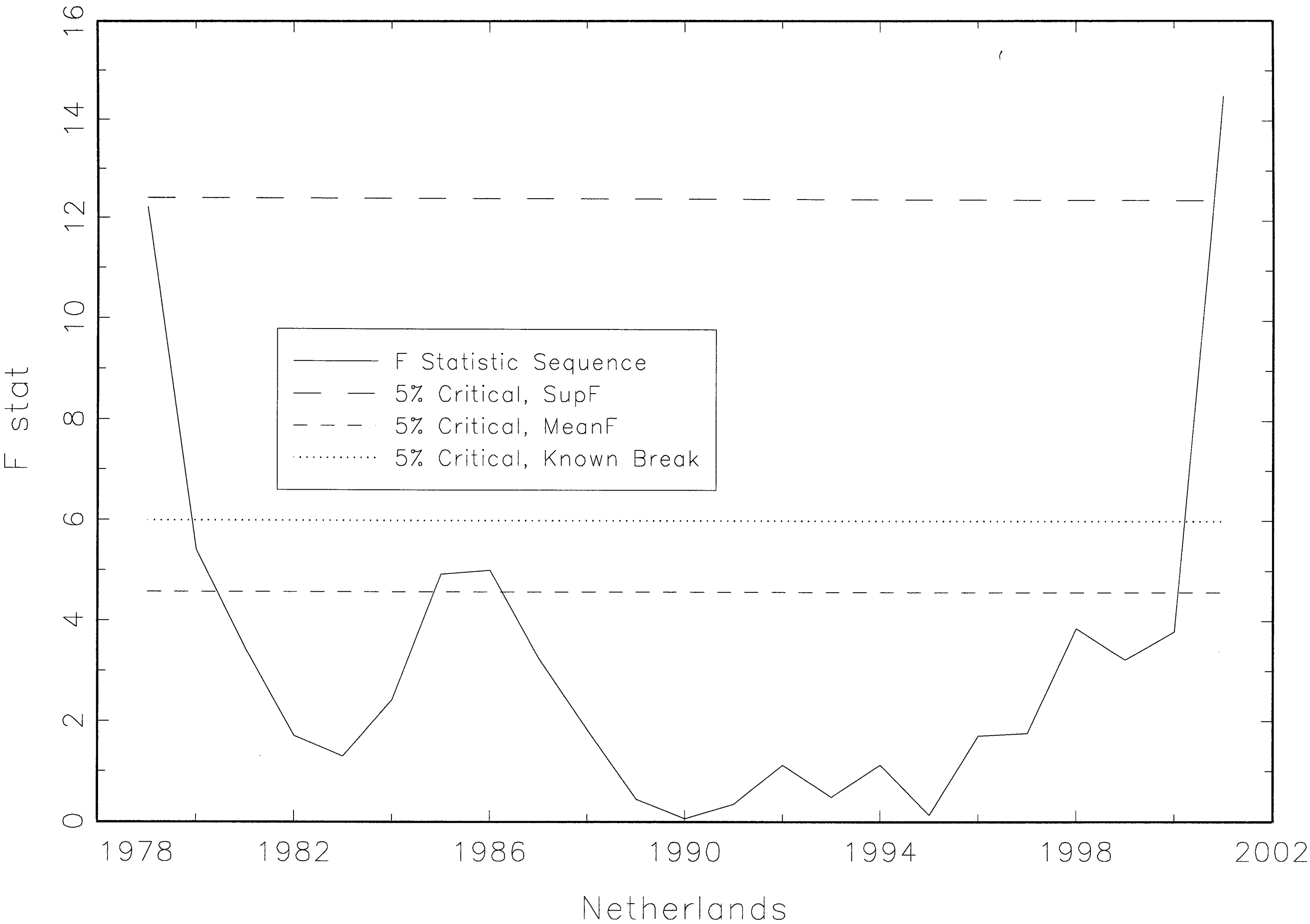

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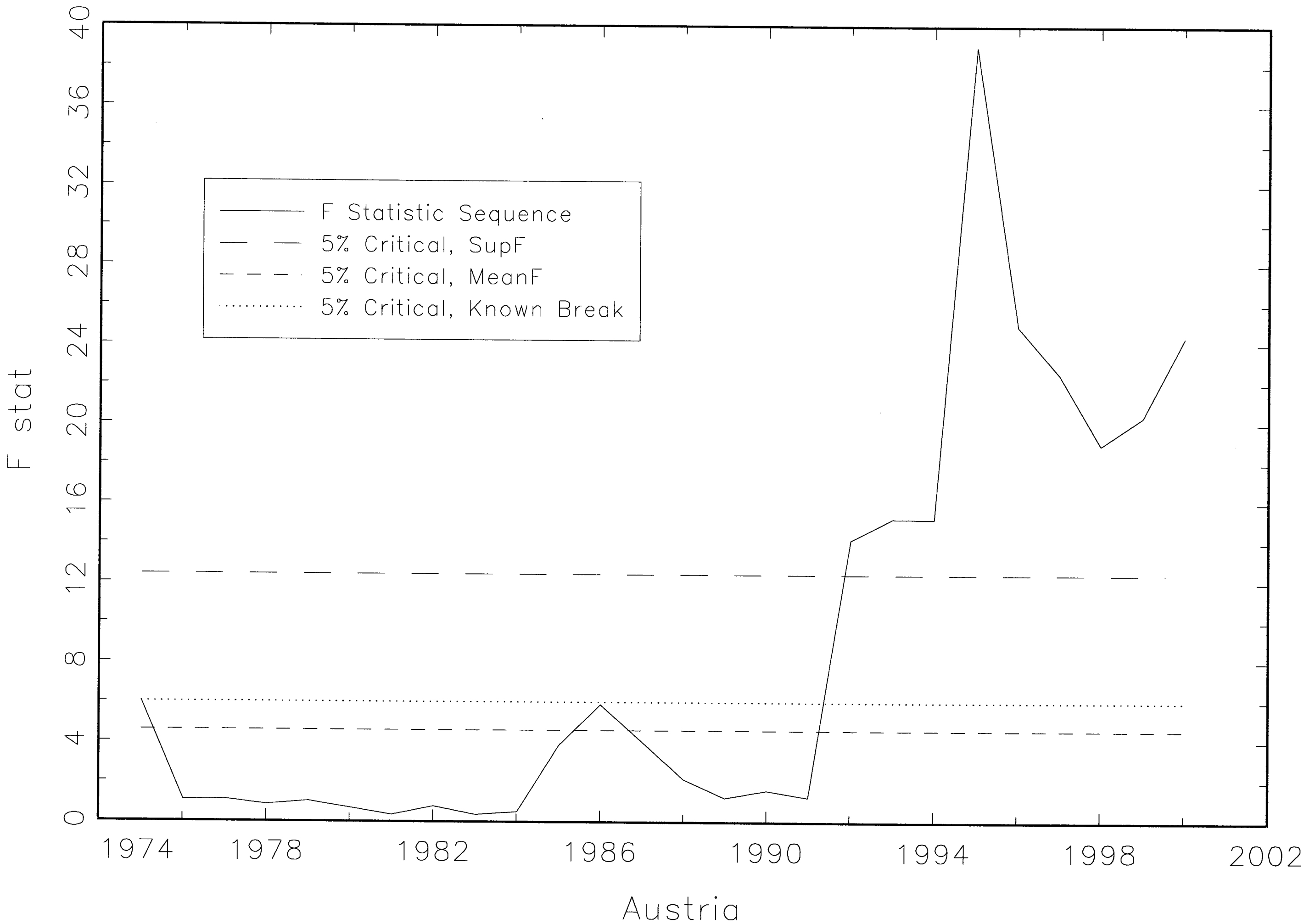

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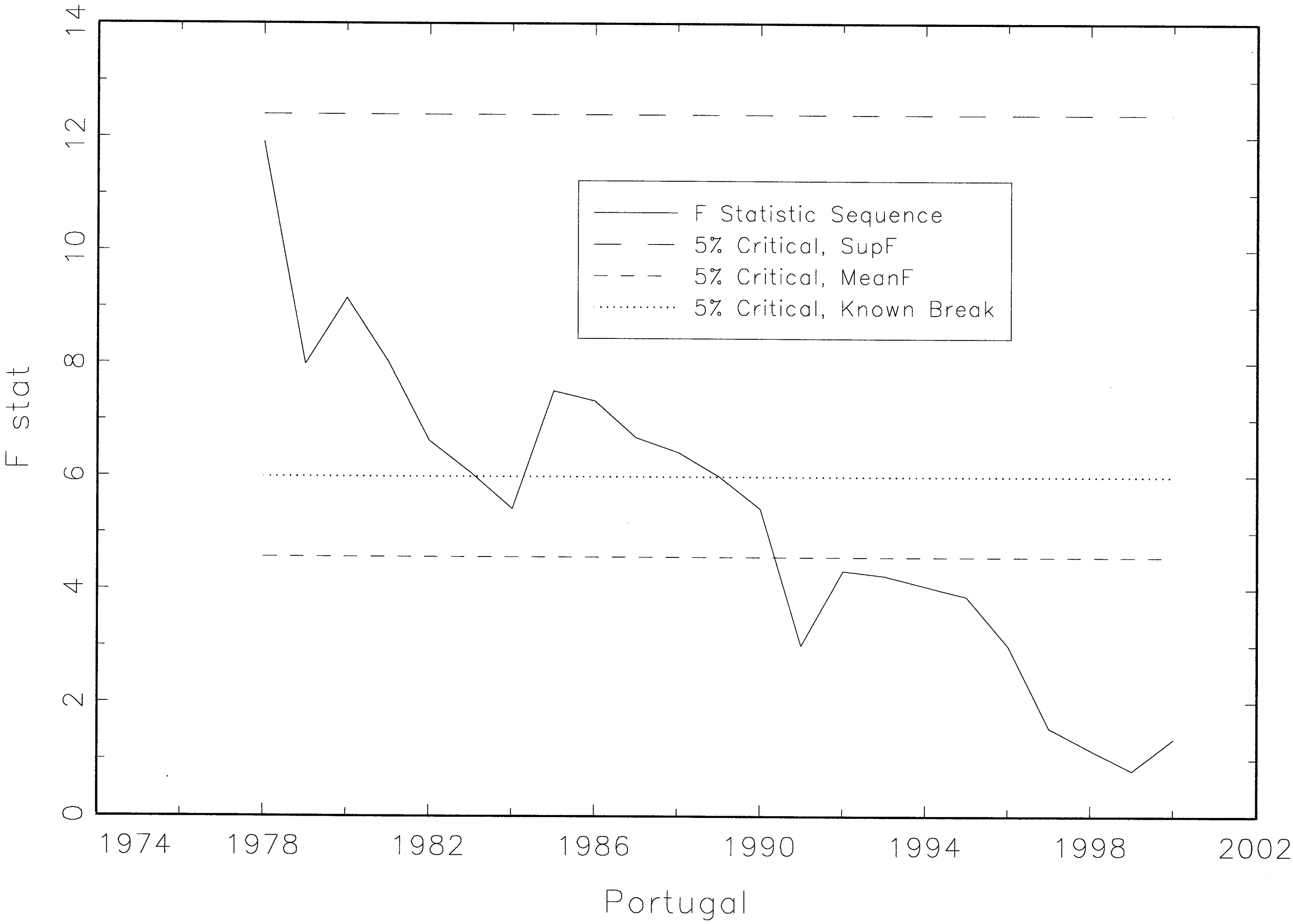

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