Is the budget deficit sustainable when fiscal policy is nonlinear? The case of Spain, 1964-2001*

Oscar Bajo-Rubio†

Departamento de Economía y Empresa,
Universidad de Castilla-La Mancha, 13071 Ciudad Real (Spain)

Carmen Díaz-Roldán

Departamento de Economía y Empresa,
Universidad de Castilla-La Mancha, 13071 Ciudad Real (Spain)

Vicente Esteve

Departament d'Economia Aplicada II,
Universitat de València, 46071 Valencia (Spain)

March 2003

Abstract

In this paper we re-examine the long-run sustainability of budget deficits, when fiscal policy is conducted as a nonlinear process. Our empirical methodology makes use of recent developments on threshold cointegration that consider the possibility of a nonlinear relationship between government revenues and expenditures. The analysis is applied to the case of Spain, a country that has recently accomplished an important fiscal consolidation. Overall, our results suggest the presence of significant nonlinear effects in Spanish fiscal policy, so that fiscal authorities would cut deficits only if they are 'large', and assuring their long-run sustainability.

Keywords: Fiscal policy, Sustainability, Threshold cointegration, Nonlinearity.

JEL classification: E62, H62.

*The authors acknowledge financial support from the Spanish Ministry of Science and Technology, through the projects SEC2002-01892 (O. Bajo-Rubio and C. Díaz-Roldán) and SEC2002-03651 (V. Esteve), as well as from the Valencian Council of Education and Science, through the project GV01-127 (V. Esteve).

†Corresponding author: Oscar Bajo-Rubio, Departamento de Economía y Empresa, Universidad de Castilla-La Mancha, 13071 Ciudad Real (Spain). Tel.: +34-926-295300, ext. 3580; fax: +34-926-295211. E-mail: oscar.bajo@uclm.es.

1 Introduction

The formation of the Economic and Monetary Union (EMU) by 12 member countries of the European Union (EU) means that fiscal policy becomes the main instrument of stabilization policies available to their national authorities. As a consequence, issues related with fiscal policy have gained a growing interest in last years, in both academic and policy circles. In particular, the long-run sustainability of budget deficits has become a matter of great concern. On the one hand, sustainability issues would mean in themselves a limit to the flexibility of fiscal policy as a stabilization tool; on the other hand, EMU might lead to relax fiscal discipline, so increasing the risks of default and bailout. In turn, all this was reflected in the Treaty of Maastricht, which defined budgetary rules that countries had to satisfy in order to enter EMU, later enforced in the clauses of the Pact for Stability and Growth (De Grauwe, 2000).

The traditional approach to analyze the sustainability of budget deficits has tested whether the government's intertemporal budget constraint (IBC) holds, that is, whether the current level of debt equals the present discounted value of primary surpluses. Empirical tests on sustainability, however, are still inconclusive due to differences in the econometric methodology, the particular specification of the transversality condition, and the sample period used.

Several procedures to test for the IBC have been proposed in the literature, which focus on the univariate properties of the government deficit and debt (Hamilton and Flavin, 1986; Wilcox, 1989), and on the presence of a long-run, lineal, cointegration relationship between government revenues and expenditures (Trehan and Walsh, 1988, 1991; Haug, 1991; Smith and Zin, 1991). Further on, the eventual occurrence of structural breaks in this cointegrating relationship has been examined by Hakkio and Rush (1991), who assumed the breakpoint as exogenously given; and by Haug (1995), Quintos (1995), Camarero, Esteve and Tamarit (1998), Makrydakis, Tsavalis and Balfoussias (1999), and Martin (2000), where the breakpoint was endogenously derived.

However, and unlike the above quoted papers, which assumed a linear relationship between government revenues and expenditures, several recent studies have suggested the possibility that fiscal policy may have non-linear effects, in the sense that both the size and the sign of the response of macroeconomic variables to fiscal policy actions could be different depending on the way and the initial conditions in which such policy actions are implemented; see, e.g., Giavazzi, Jappelli and Pagano (2000), and the references therein. More specifically, fiscal authorities would cut deficits only when they are very large, in order to meet the IBC (Bertola and Drazen, 1993).

The empirical literature on fiscal sustainability has only recently begun to incorporate these new developments. Cipollini (2001) introduced a regime

shift in the adjustment towards a linear long-run (cointegrating) relationship between total government revenues and expenditures for the UK, using a smooth transition error correction model to test for nonlinearities or asymmetries in the adjustment process. More recently, Bajo, Díaz and Esteve (2003) have found strong evidence on nonlinearities in the Spanish budget deficit using a threshold autoregressive model, so that the deficit dynamics would be different depending on whether its change is below or above an endogenously estimated threshold; in particular, a mean-reverting dynamic behaviour of the budget deficit should be expected once such threshold is reached.

The objective of this paper is to provide some additional evidence on the sustainability of budget deficits, when fiscal policy is conducted as a nonlinear process. To this end, we make use of recent developments on threshold cointegration that consider the possibility of a nonlinear relationship between government revenues and expenditures. Our approach should be relevant for a number of EU countries that have faced problems of fiscal sustainability during the 1980s and 1990s. In particular, we analyze the case of Spain, a country traditionally experiencing high budget deficits, which has accomplished an important fiscal consolidation in last years that has allowed her to be able to participate in EMU since the outset.

The rest of the paper is organized as follows. First, our empirical methodology is outlined in Section 2. Next, the tests on threshold cointegration between Spanish government revenues and expenditures are performed in Section 3. Finally, the main conclusions are summarized in Section 4.

2 Methodology

The concept of threshold cointegration was introduced by Balke and Fomby (1997) as a feasible way to combine nonlinearity and cointegration. As is well known, systems in which variables are cointegrated can be characterized by an error correction model (ECM), which describes how the variables respond to deviations from the equilibrium. In this way, the ECM can be characterized as the adjustment process through which the long-run equilibrium is maintained. The traditional approach, however, assumes that such a tendency to move towards the long-run equilibrium is present every time period.

Balke and Fomby (1997) stress the possibility that this movement towards the long-run equilibrium might not occur in every time period, due to the presence of some adjustment costs on the side of economic agents. In other words, there could be a discontinuous adjustment to equilibrium so that, only when the deviation from the equilibrium exceeds a critical threshold, the benefits of adjustment are higher than the costs, and economic agents move the system back to equilibrium. Threshold cointegration

characterizes this discrete adjustment as follows: the cointegrating relationship does not hold inside a certain range, but holds if the system gets 'too far' from the equilibrium; i.e., cointegration would hold only if the system exceeds a certain threshold.

This type of discrete adjustment could be particularly useful to describe the behaviour of fiscal authorities. More specifically, fiscal authorities would intervene by cutting budget deficits only when these are 'too large', in order to meet the IBC. The concept of threshold cointegration would capture the possibility of a nonlinear relationship between government revenues and expenditures, so that a mean-reverting dynamic behaviour of the budget deficit (or a cointegrating relationship between government revenues and expenditures) should be expected only when a certain threshold is reached.

When testing for threshold cointegration, Balke and Fomby (1997) propose applying several univariate tests previously developed in the literature, to the known cointegrating residual (i.e., the error-correction term). Lo and Zivot (2001) extend their approach to a multivariate threshold cointegration model with a known cointegrating vector, using Tsay's (1998) and multivariate extensions of Hansen's (1996) tests. More recently, Hansen and Seo (2002) contribute further to this literature by examining the case of a unknown cointegration vector. In particular, these authors propose a vector error-correction model (VECM) with one cointegrating vector and a threshold effect based on the error-correction term, and develop a Lagrange multiplier (LM) test for the presence of a threshold effect. This will be the approach followed in this paper.

Hansen and Seo (2002) consider a two-regime threshold cointegration model, or a nonlinear VECM of order $l+1$, such as:

$$\Delta x_t = \begin{cases} A_1' X_{t-1}(\beta) + u_t & \text{if } w_{t-1}(\beta) \leq \gamma \\ A_2' X_{t-1}(\beta) + u_t & \text{if } w_{t-1}(\beta) > \gamma \end{cases} \tag{1}$$

with

$$X_{t-1}(\beta) = \begin{pmatrix} 1 \\ w_{t-1}(\beta) \\ \Delta x_{t-1} \\ \Delta x_{t-2} \\ \vdots \\ \Delta x_{t-l} \end{pmatrix}$$

where x_t is a p-dimensional $I(1)$ time series which is cointegrated with one $p \times 1$ cointegrating vector β, $w_t(\beta) = \beta' x_t$ is the $I(0)$ error-correction term, u_t is an error term, A_1 and A_2 are coefficient matrices that describe the dynamics in each of the regimes, and γ is the threshold parameter.

As can be seen, the threshold model (1) has two regimes, defined by the value of the error-correction term. As long as deviations from the equilib-

rium are lower or equal than the threshold, there is no tendency for the variables x_t to revert to an equilibrium (i.e., the variables would not be cointegrated); on the contrary, if deviations from the equilibrium are greater than the threshold, there is a tendency for the variables x_t to move towards some equilibrium (i.e., the variables would be cointegrated).

Next, Hansen and Seo (2002) propose two heteroskedastic-consistent LM test statistics for the null hypothesis of linear cointegration (i.e., there is no threshold effect), against the alternative of threshold cointegration (i.e., model (1)). The first test would be used when the true cointegrating vector is known a priori, and is denoted as:

$$\sup LM^{0} = \sup_{\gamma L \leq \gamma \leq \gamma U} LM(\beta_0, \gamma) \tag{2}$$

where β_0 is the known value of β (in the case analyzed below, $\beta_0 = 1$); whereas the second test would be used when the true cointegrating vector is unknown, and is denoted as:

$$\sup LM = \sup_{\gamma L \leq \gamma \leq \gamma U} LM(\tilde{\beta}, \gamma) \tag{3}$$

where $\tilde{\beta}$ is the null estimate of β. In both tests, $[\gamma_L, \gamma_U]$ is the search region set so that γ_L is the π_0 percentile of $\widetilde{w}_{t-1}$, and γ_U is the $(1-\pi_0)$ percentile; Andrews (1993) suggests setting π_0 between 0.05 and 0.15. Finally, Hansen and Seo (2002) develop two bootstrap methods to calculate asymptotic critical values and p-values.

3 Results

In this section, we re-examine the issue of sustainability of the Spanish budget deficit using the new approach of Hansen and Seo (2002), described in the last section. We use data on Spanish total government revenues, and total (i.e., inclusive of debt interest) government expenditures, both of them as a ratio to GDP, and denoted by rev_t and gr_t, respectively. The data are annual, cover the years 1964 to 2001, and come from the Spanish National Institute of Statistics. The evolution of the two series is shown in Figure 1.

As a first step of the analysis, we have tested for the order of integration of the two series. To this end, we have used a modified version of the Phillips and Perron (1988) tests proposed by Ng and Perron (2001), which try to solve the main problems present in the conventional tests for unit roots. Table 1 shows the results of the three tests, $\bar{M}Z_{\alpha}^{GLS}$, $\bar{M}Z_{t}^{GLS}$, and ADF^{GLS}. As shown in the table, the null hypothesis of nonstationarity for the two series in levels cannot be rejected, independently of the test; and the presence of two unit roots is clearly rejected at the usual significance levels. Accordingly, both series would be I(1).

Next, we have applied the tests of threshold cointegration proposed by Hansen and Seo (2002), namely, $\sup LM^0$ (for a given $\beta = 1$) and $\sup LM$ (for an estimated β). In both cases, the p-values are calculated using a parametric bootstrap method (with 5,000 simulation replications), as proposed by Hansen and Seo (2002). To select the lag length of the VAR, we have used the AIC and BIC criteria, both of them leading to $l = 1$; we also report the results for $l = 2$ for the sake of comparison. The results of the tests are reported in Table 2.

Threshold cointegration would only appear (at the 1% level) when $l = 1$, and β is fixed at unity, so that the null hypothesis of linear cointegration would be strongly rejected. The estimated threshold is $\hat{\gamma} = -5.30$, with the error-correction term defined as $w_t = rev_t - gr_t$. Hence, the first regime would occur when government expenditures are more than 5.30 percentage points above revenues, as a ratio to GDP; in other words, when the government deficit as a ratio to GDP is above 5.30%. This would be the relatively unusual regime, including only 13% of the observations (in particular, the years 1982, 1984, 1985, 1993, and 1995). In turn, the second or usual regime (with 87% of the observations) would occur when the government deficit as a ratio to GDP is below 5.30%.

The estimated two-regime threshold VAR is (heteroskedasticity-consistent standard errors in parentheses):

$$\Delta rev_t = \begin{cases} \underset{(3.11)}{13.04} + \underset{(0.50)}{1.41}\, w_{t-1} + \underset{(0.70)}{2.32}\, \Delta rev_{t-1} - \underset{(0.87)}{3.29}\, \Delta gr_{t-1} + u_{1t}, & w_{t-1} \leq -5.30 \\ \\ \underset{(0.22)}{0.43} - \underset{(0.09)}{0.04}\, w_{t-1} - \underset{(0.26)}{0.19}\, \Delta rev_{t-1} + \underset{(0.10)}{0.32}\, \Delta gr_{t-1} + u_{2t}, & w_{t-1} > -5.30 \end{cases}$$

$$\Delta gr_t = \begin{cases} \underset{(2.04)}{22.04} + \underset{(0.33)}{2.85}\, w_{t-1} + \underset{(0.46)}{3.10}\, \Delta rev_{t-1} - \underset{(0.57)}{4.26}\, \Delta gr_{t-1} + u_{1t}, & w_{t-1} \leq -5.30 \\ \\ \underset{(0.23)}{0.41} - \underset{(0.07)}{0.007}\, w_{t-1} - \underset{(0.26)}{0.17}\, \Delta rev_{t-1} + \underset{(0.17)}{0.70}\, \Delta gr_{t-1} + u_{2t}, & w_{t-1} > -5.30 \end{cases}$$

where significant error-correction effects (estimated at 1.41 and 2.85, respectively) appear only in the first regime, i.e., when either government expenditures are well above revenues or government deficit is relatively high. On the contrary, in the second regime error-correction effects and dynamics are minimal, both in terms of significance and size of the coefficients.

Figure 2 plots the error-correction effect, i.e. the estimated response of government revenues and expenditures to the discrepancy between them (i.e., to the size of the government deficit) in the previous period, holding the other variables constant. As can be seen, for a 'small' deficit (i.e., lower than 5.30% of GDP), the response of both revenues and expenditures would be nearly zero. However, if the deficit was 'large' (i.e., greater than 5.30% of GDP), both revenues and expenditures would decrease sharply with the size

of the deficit. And, since the response of expenditures would be larger than that of revenues (notice that the estimated error-correction term is twice for expenditures than for revenues), government deficit would fall accordingly.

Overall, the above evidence, taken together with that from a previous paper (Bajo, Díaz and Esteve, 2003), suggests that Spanish fiscal policy would have shown significant nonlinear effects. In particular, the outstanding fiscal consolidation experienced in recent years would have occur only once the budget deficit exceeded a certain threshold and became 'too large'. As a consequence, budget deficits would have shown a mean-reverting dynamic behaviour after such threshold was reached, which in turn would assure their long-run sustainability.

4 Conclusions

This paper has re-examined the long-run sustainability of budget deficits, when fiscal policy is conducted as a nonlinear process. The empirical methodology has made use of Hansen and Seo's (2002) recent contribution, based on a threshold cointegration model that considers the possibility of a nonlinear relationship between government revenues and expenditures. Our analysis should be relevant for a number of EU countries that have faced problems of fiscal sustainability in last years, and has been applied to the case of Spain, a country traditionally experiencing high budget deficits, which has recently accomplished an important fiscal consolidation.

According to our results, the null hypothesis of linear cointegration would be strongly rejected in favour of a two-regime threshold cointegration model, with the threshold parameter estimated at -5.30. In particular, if the budget deficit was 'small' (i.e., lower than 5.30% of GDP), the response of both revenues and expenditures would be nearly zero. However, if the deficit was 'large' (i.e., greater than 5.30% of GDP), both revenues and expenditures would experience a substantial decrease, but stronger for the latter, so that the budget deficit would fall accordingly.

In the end, these results would suggest the presence of significant nonlinear effects in Spanish fiscal policy. This in turn would support the theoretical insights put forward by Bertola and Drazen (1993) and other authors, who conclude that fiscal authorities would cut deficits only if they are large enough, which would allow to assure their sustainability in the long run.

References

[1] Andrews, D.W.K. (1993): "Tests for parameter instability and structural change with unknown change point", Econometrica, 61, 821-856.

[2] Bajo-Rubio, O., Díaz-Roldán, C. and Esteve, V. (2003): "Searching for threshold effects in the evolution of budget deficits: An application to the Spanish case", Working Paper, Fundación Centro de Estudios Andaluces, forthcoming.

[3] Balke, N.S. and Fomby, T.B. (1997): "Threshold cointegration", International Economic Review, 38, 627-645.

[4] Bertola, G. and Drazen, A. (1993): "Trigger points and budget cuts: Explaining the effects of fiscal austerity", American Economic Review, 83, 11-26.

[5] Camarero, M., Esteve, V. and Tamarit, C.R. (1998): "Cambio de régimen y sostenibilidad a largo plazo de la política fiscal: El caso de España", Working Paper WP-EC 98-15, Instituto Valenciano de Investigaciones Económicas.

[6] Cipollini, A. (2001): "Testing for government intertemporal solvency: A smooth transition error correction model approach", The Manchester School, 69, 643-655.

[7] De Grauwe, P. (2000): Economics of Monetary Union (4th edition), Oxford University Press, Oxford.

[8] Giavazzi, F., Jappelli, T. and Pagano, M. (2000): "Searching for nonlinear effects of fiscal policy: Evidence from industrial and developing countries", European Economic Review, 44, 1259-1289.

[9] Hakkio, C.S. and Rush, M. (1991): "Is the budget deficit 'too large'?", Economic Inquiry, 29, 429-445.

[10] Hamilton, J.D. and Flavin, M.A. (1986): "On the limitations of government borrowing: A framework for empirical testing", American Economic Review, 76, 808-819.

[11] Hansen, B.E. (1996): "Inference when a nuisance parameter is not identified under the null hypothesis", Econometrica, 64, 413-430.

[12] Hansen, B.E. and Seo, B. (2002): "Testing for two-regime threshold cointegration in vector error-correction models", Journal of Econometrics, 110, 293-318.

[13] Haug, A.A. (1991): "Cointegration and government borrowing constraints: Evidence for the U.S.", Journal of Business and Economic Statistics, 9, 97-101.

[14] Haug, A.A. (1995): "Has the federal deficit policy changed in recent years?", Economic Inquiry, 33, 104-118.

[15] Lo, M. and Zivot, E. (2001): "Threshold cointegration and nonlinear adjustment to the law of one price", Macroeconomic Dynamics, 5, 533-576.

[16] Makrydakis, S., Tsavalis, E. and Balfoussias, A. (1999): "Policy regime changes and the long-run sustainability of fiscal policy: An application to Greece", Economic Modelling, 16, 71-86.

[17] Martin, G. (2000): "US deficit sustainability: A new approach based on multiple endogenous breaks", Journal of Applied Econometrics, 15, 83-105.

[18] Ng, S. and Perron, P. (2001): "Lag length selection and the construction of unit root tests with good size and power", Econometrica, 69, 1529-1554.

[19] Perron, P. and Ng, S. (1996): "Useful modifications to some unit root tests with dependent errors and their local asymptotic properties", Review of Economics Studies, 63, 435-465.

[20] Phillips, P.C.B. and Perron, P. (1988): "Testing for a unit root in time series regression", Biometrika, 75, 335-346.

[21] Quintos, C.E. (1995): "Sustainability of the deficit process with structural shifts", Journal of Business and Economic Statistics, 13, 409-417.

[22] Smith, G.W. and Zin, S.E. (1991): "Persistent deficits and the market value of government debt", Journal of Applied Econometrics, 6, 31-44.

[23] Trehan, B. and Walsh, C.E. (1988): "Common trends, the government's budget balance, and revenue smoothing", Journal of Economic Dynamics and Control, 12, 425-444.

[24] Trehan, B. and Walsh, C.E. (1991): "Testing intertemporal budget constraints: Theory and applications to U.S. federal budget and current account deficits", Journal of Money, Credit, and Banking, 23, 206-223.

[25] Tsay, R.S. (1998): "Testing and modeling multivariate threshold models", Journal of the American Statistical Association, 93, 1188-1198.

[26] Wilcox, D.W. (1989): "The sustainability of government deficits: Implications of the present-value borrowing constraint", Journal of Money, Credit, and Banking, 21, 291-306.

Table 1
Ng-Perron tests of unit roots

I(2) vs. I(1)	Case: $p = 0, \bar{c} = -7.0$		
Variable	$\bar{M}Z_{\alpha}^{GLS}$	$\bar{M}Z_{t}^{GLS}$	ADF^{GLS}
Δrev_t	-17.9***	-2.99***	-6.12***
Δgr_t	-15.8***	-2.79***	-4.14***
I(1) vs. I(0)	Case: $p = 1, \bar{c} = -13.5$		
Variable	$\bar{M}Z_{\alpha}^{GLS}$	$\bar{M}Z_{t}^{GLS}$	ADF^{GLS}
rev_t	-3.16	-1.07	-1.13
gr_t	-0.48	-0.20	-0.20

Notes:

[a] *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively. The critical values are taken from Ng and Perron (2001), Table 1.

[b] The autoregressive truncation lag, k, has been selected using the $MAIC$ information criterion, as proposed by Perron and Ng (1996).

Table 2
Hansen-Seo tests of threshold cointegration

	$\sup LM^0$		$\sup LM$	
	$l=1$	$l=2$	$l=1$	$l=2$
Test statistic value	341.9	20.3	6.51	14.5
Calculated p-values	0.021***	0.567	0.490	0.186
Threshold parameter	-5.30	-5.30	1.87	2.54
Estimate of the cointegrating vector	1.00	1.00	0.87	0.80

Notes:
[a] *, **, and *** denote significance at the 10%, 5% and 1% levels, respectively.

Figure 1

Spanish government revenues and expenditures (ratio to GDP), 1964-2001

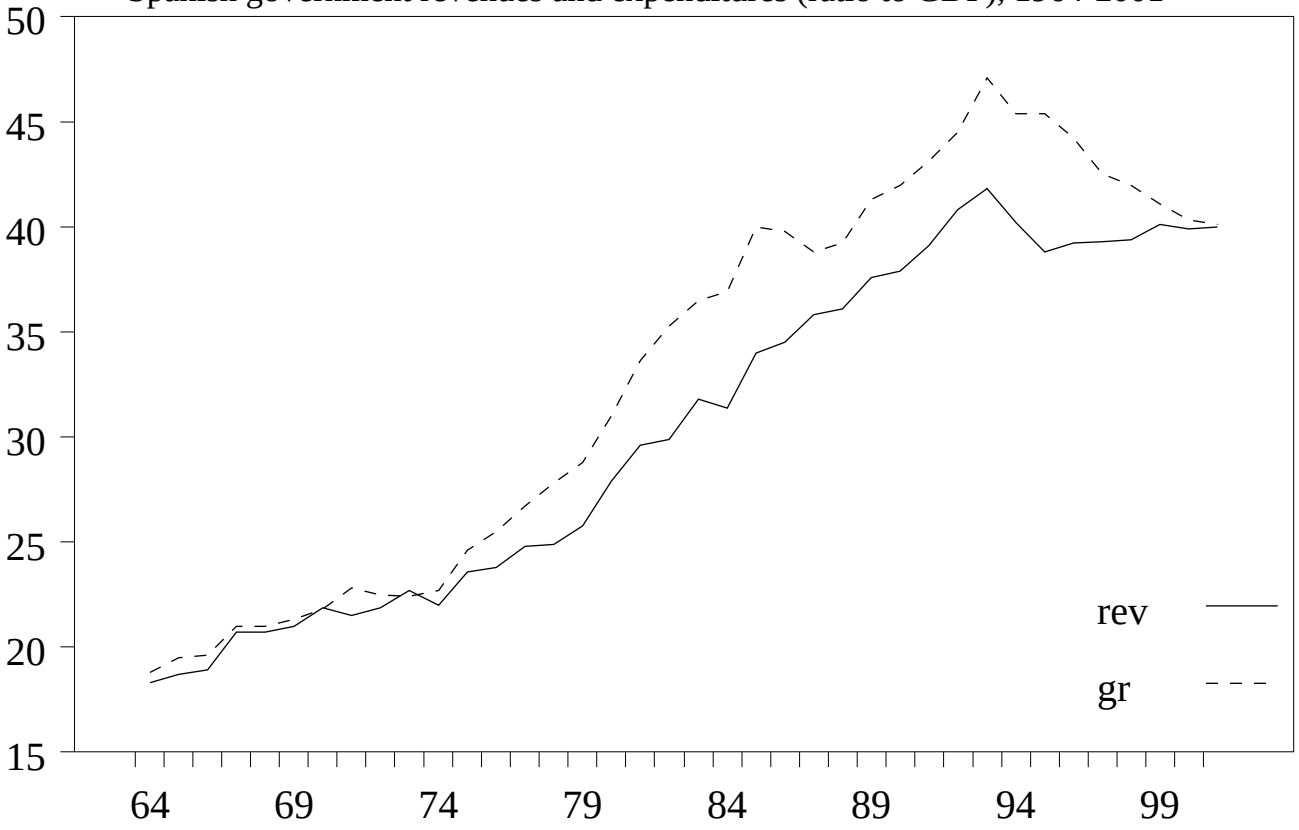

Figure 2
Tax Revenues and Expenditure Response to Error-Correction