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Searching for threshold effects in the evolution of budget deficits: an application to the Spanish case

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Abstract

In this paper, we use recent developments on threshold autoregressive (TAR) models that allow us to derive endogenously threshold effects in the evolution of the Spanish budget deficit. Specifically, a mean-reverting dynamic behaviour of the budget deficit should be expected once such threshold is reached.

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1. Introduction

Several recent studies have suggested the possibility that fiscal policy may have nonlinear 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 et al. \(2000\)](#), and the references therein.

A possible reason for such nonlinear effects has been pointed out in an important paper by [Bertola and Drazen \(1993\)](#). Specifically, these authors argue that significant cuts in government spending take place only when the ratio of government spending to output hits a trigger point, which implies that abrupt changes in fiscal policy should not be observed frequently.

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In this paper, we use recent developments on threshold autoregressive (TAR) models that allow us to derive endogenously threshold effects in the evolution of the budget deficit. In this way, a mean-reverting dynamic behaviour of the budget deficit should be expected once such threshold is reached. In the empirical application, we use data for Spain, a country traditionally experiencing high budget deficits, which has accomplished an important fiscal consolidation in last years. Such efforts were necessary to satisfy the requirements set in the Treaty of Maastricht, in order to be able to participate in the Economic and Monetary Union (EMU) launched in Europe after 1999.

The econometric methodology is outlined in Section 2, the empirical results are presented in Section 3, and the main conclusions are summarized in Section 4.

2. Econometric methodology

Recent work by Hansen (2000) and Caner and Hansen (2001) presents some new results on the TAR model introduced by Tong (1978). In particular, they develop new tests for threshold effects, estimate the threshold parameter, and construct asymptotic confidence intervals for the threshold parameter.

More specifically, consider a two-regime TAR (k) model with an autoregressive unit root, and two θ_1 and θ_2 :

$$\Delta y_t = \theta_1' x_{t-1} 1_{\{Z_{t-1} < \lambda\}} + \theta_2' x_{t-1} 1_{\{Z_{t-1} \geq \lambda\}} + e_t \quad (1)$$

for $t=1, \dots, T$, where $x_{t-1} = (y_{t-1} r_t' \Delta y_{t-1} \dots \Delta y_{t-k})'$, $1_{\{\cdot\}}$ is the indicator function, e_t is an iid error, $Z_{t-1} = y_{t-1} - y_{t-m}$ for some $m \geq 1$ is the threshold variable, r_t is a vector of deterministic components including an intercept and possibly a linear timetrend, and $k \geq 1$ is the autoregressive order. The threshold parameter, λ , is unknown and represents the level of the variable y_t that triggers a “regime change”.

Since Eq. (1) is a regression equation (although nonlinear in parameters), least squares (LS) would be an appropriate method of estimation. Caner and Hansen (2001) show that, under the auxiliary assumption that e_t is $N(0, \sigma^2)$, LS is equivalent to maximum likelihood, in which case, the estimates can be used to conduct inference on the parameters of Eq. (1) using standard Wald test statistics.

The main question in model (1) is whether or not there is a threshold effect. In order to test the null hypothesis of linearity (i.e., no threshold effect and $\theta_1 = \theta_2$), against the alternative of threshold effect (i.e., the process is nonlinear), Caner and Hansen (2001) propose a standard heteroskedastic-consistent Wald or Lagrange multiplier test, $\sup W_T(\lambda)$, where the threshold point, λ , and the corresponding vectors θ_1 and θ_2 , are estimated by LS. They show that $\sup W_T(\lambda)$ has a nonstandard asymptotic null distribution, which is due partially to the presence of a parameter that is not identified under the null, and partially to the assumption of a nonstationary autoregression. As a result, critical values cannot be tabulated, so that the authors suggest a bootstrap method to compute asymptotic critical values and p -values.

3. Empirical results

In this section, we investigate the possible presence of nonlinearities in fiscal policy, through the estimation of a TAR model for the Spanish total (i.e., inclusive of debt interest) budget surplus, as a ratio

Table 1
TAR models for the Spanish budget surplus

$Z_{t-1} = y_{t-1} - y_{t-m}$								
m	1	2	3	4	5	6	7	8
SSE	8.24	8.32	8.68	13.59	12.82	12.36	7.33	11.39
<i>p</i> -value	0.71	0.60	0.16	0.72	0.21	0.31	0.04	0.92

to GDP. The data are annual, cover the years 1964 to 2001, and come from the Spanish National Institute of Statistics.

As a first step of the analysis, we have tested for the order of integration of that variable. Both the Phillips–Perron test on a unit root (Phillips and Perron, 1988) and the KPSS test on stationarity (Kwiatkowski et al., 1992) suggests that the budget surplus–GDP ratio would be $I(1)$, so we work with the variable in first differences to ensure stationarity.

In the TAR (k) model, the threshold variable is $Z_{t-1} = y_{t-1} - y_{t-m}$ for some integer $m \in [1, M]$ called the delay lag, which is unknown a priori so it has to be estimated. For the threshold variable, we use a long difference for some $m \leq 8$, as suggested by Hansen (1997). The autoregressive order has been selected by way of the minimization of the AIC and BIC, both criteria leading to $k=8$.

Table 1 reports the sum of squared errors (SSE) from the various TAR models from $m=1$ to $m=8$, and the bootstrap-calculated asymptotic *p*-value (using 5000 replications) for the Wald test statistic, $sup W_T(\lambda)$, on the null of linearity against a particular threshold model. Hansen (1997, 2000) suggests to select the delay lag through the minimization of the SSE, so in this case $m=7$.

Next, Table 2 presents the parameter estimates for the TAR model selected. Setting $m=7$, the LS estimate of the threshold parameter (or trigger point) would be -1.90 , with a 95% asymptotic confidence interval $[-1.70, -2.00]$ computed from the adjusted likelihood ratio $LR_n^*(\lambda)$ (see Hansen, 1997). The estimate $\hat{\lambda} = -1.90$ means that the estimated TAR model splits the regression into two regimes, depending on whether, in a particular year, the budget deficit, as a ratio to GDP, has shown an increase of more than 1.9% between the previous year and the 6th year before.

Table 2
TAR estimates for the Spanish budget surplus

Variable	Intercept	Δy_{t-1}	Δy_{t-2}	Δy_{t-3}	Δy_{t-4}	Δy_{t-5}	Δy_{t-6}	Δy_{t-7}	Δy_{t-8}
<i>Regime 1: $y_{t-1} - y_{t-7} \leq -1.90$</i>									
$\hat{\theta}_1$	1.89	0.07	-0.15	-1.57	1.11	1.66	4.10	2.88	-0.54
S.E.	(0.17)	(0.03)	(0.11)	(0.18)	(0.12)	(0.14)	(0.20)	(0.12)	(0.05)
95% confidence interval	[1.54, 2.24]	[0.01, 0.13]	[-0.38, 0.07]	[-1.94, -1.21]	[0.86, 1.36]	[-1.94, -1.38]	[3.71, 4.50]	[2.63, 3.13]	[-0.64, -0.45]
<i>Regime 2: $y_{t-1} - y_{t-7} > -1.90$</i>									
$\hat{\theta}_2$	0.01	0.22	-0.19	0.15	-0.19	-0.05	-0.37	-0.10	0.03
S.E.	(0.15)	(0.16)	(0.14)	(0.17)	(0.13)	(0.16)	(0.25)	(0.20)	(0.19)
95% confidence interval	[-0.27, 0.31]	[-0.09, 0.54]	[-0.48, 0.09]	[-0.17, 0.49]	[-0.47, 0.07]	[-0.37, 0.27]	[-0.87, 0.12]	[-0.50, 0.30]	[-0.35, 0.42]

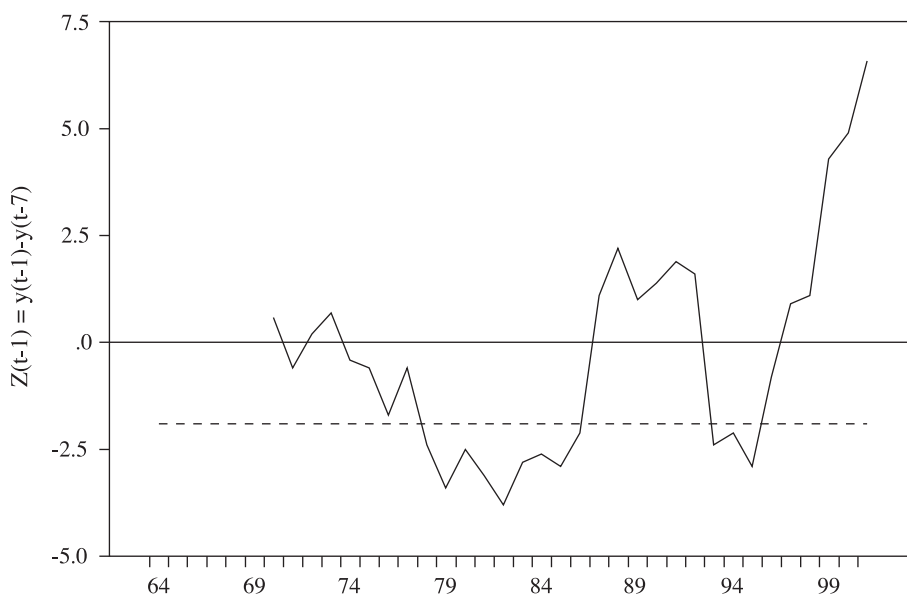


Fig. 1. Threshold regimes for the Spanish budget surplus, 1964–2001.

Fig. 1 depicts the threshold variable, $Z_{t-1} = y_{t-1} - y_{t-7}$, together with the estimated threshold parameter, -1.90 , for the case of the Spanish budget surplus over the period 1964–2001. As can be seen, two trigger points, according to Bertola and Drazen's (1993) model, would appear.

The first one would occur at 1978, the year after the first democratic election in 40 years, and following the Moncloa Agreements among the main political forces that led to a broad stabilization program. The adjustment in the budget deficit took 8 years to be completed. Such a delay could be explained, according to Alesina and Perotti (1999), in terms of the existence of "budget institutions" in the industrialized countries, i.e., all the rules and regulations according to which the budget is prepared, approved and executed, and that would lead to delays when implementing cuts in deficits.

In turn, a second trigger point would emerge at 1993, following the end of the expansionary cycle that began with the Spanish accession to the then European Community in 1986. In this case, however, the adjustment took just 3 years to be completed. This could be justified due to the requirement, established in the Treaty of Maastricht, of a 3% deficit in order to enter EMU, a condition finally satisfied by the Spanish economy.

4. Conclusions

In this paper, we have used recent developments on TAR models that have allowed us to derive endogenously threshold effects in the evolution of the Spanish budget deficit, which could explain changes in the implementation of fiscal policy. Specifically, we should expect a mean-reverting dynamic behaviour of the budget deficit once such threshold is reached, according to the theoretical model of Bertola and Drazen (1993).

Our empirical results showed that significant fiscal stabilizations would occur when, in a particular year, the ratio of the budget deficit to GDP had shown an increase of more than 1.9% between the previous year and the 6th year before, which implies nonlinearities in the dynamic behaviour of the budget deficit. There is also evidence of delays in the adoption of fiscal adjustment programs, since fiscal authorities would react to an undesirable increase in the budget deficit–GDP ratio only after 7 years.

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