Which directions drive to fiscal sustainability? The Spanish regional case*

Josep Lluís Carrion-i-Silvestre†
University of Barcelona

March 9, 2015

Abstract

The fiscal deficit of the Spanish Autonomous Communities (AC) is investigated using non-stationary panel data analysis. The analysis investigates the presence of short-run and long-run relationships between the primary surplus and the debt of the Spanish regions, focusing on the direction of the causality.

JEL Classification: E62, H62, C12, C22

Keywords: Fiscal deficit, non-stationary panel data, fiscal dominant, monetary dominant

1 Introduction

The sustainability of government fiscal policy is a major issue especially in the current context where the developed economies are facing the effects of the global crisis. Efforts to contain public spending and streamlining the provision of public goods is an objective of the present governments trying to reactivate the economies in an environment where there is a difficulty in finding funding and liquidity. Borrowers monitor governments accounts when deciding where to locate their investment and loans. In this scenario, Spain is a case of relevant interest, given the adjustment procedures that have been implemented to reduce the level of debt and the pressure of the fiscal deficit of the Spanish economy. The interest is also given by the fact that since the beginning of the democratic period in 1978 Spain started a process of competences transference towards the Spanish regions (Autonomous Communities, ACs), which involves

*The author acknowledges the financial support from the IEA2011 grant from the Institut d'Estudis Autonòmics, Department of Institutional Relations and Participation of the Government of Catalonia, and from the Spanish Ministerio de Ciencia e Innovación under grant ECO2011-30260-C03-03.

†AQR-IREA research group. Department of Econometrics, Statistics and Spanish Economy, University of Barcelona, Av. Diagonal, 690. 08034 Barcelona. Tel: 934024598 Fax: 934021821, Email: carrion@ub.edu

transference of some taxes and the provision of public services – security, health and education, essentially. This fiscal decentralized situation has led the central government to monitor the ACs when trying to reduce the excessive deficit and debt levels of the Spanish economy.

The aim of this paper is to analyze the sustainability of the fiscal policy of the ACs as a whole focusing on the relationship between the primary surplus and the debt of the ACs. The information available to conduct the study covers the period 1984-2012, thus defining series on fiscal variables in a relative short time period.[1] This suggests that the analysis of the fiscal deficit sustainability should be based on the use of panel data techniques to combine the information of both temporal and cross-section dimensions when conducting statistical inference. The analysis should also take into account that the fiscal variables that we are using show a high degree of persistence, i.e., they can be I(1) nonstationary variables. Complied with this, econometric techniques that consider this feature should be applied, if meaningful conclusions are to be obtained. The paper discusses the different alternatives that exist in the literature when specifying models that will allow assessing the sustainability of fiscal deficit, and the (necessary and sufficient) conditions that must be checked.

The paper is structured as follows. Section 2 develops the empirical model that relates the debt and the fiscal deficit, discussing the conditions of fiscal sustainability. Section 3 details the database. Section 4 details the econometric methodology and the results of its application. Finally, Section 5 concludes.

2 The debt and fiscal sustainability

The literature that focuses on fiscal sustainability bases the analysis on the assessment of the intertemporal budget constraint (IBC). Basically, it requires the definition of the budget constraint that faces the goverments every time period, and define the equilibrium condition that the present value of government debt (B_t) equals the present value of future budget surpluses,

$$B_t = \sum_{j=0}^{\infty} \left(\frac{1}{(1+i)} \right)^{j+1} E_t \left(R_{t+j+1} - EXP_{t+j+1} \right), \tag{1}$$

where $E_t(\cdot)$ denotes the conditional expectation on the information set available at time t, R_t represents the revenues, and $EXP_t = GE_t + (i_t - i) B_{t-1}$, with GE_t the actual expenditure excluding interest payments, i_t denotes the real interest rate and i the expected value of the real interest rate. The equilibrium condition given in (1) can be expressed in terms of the GDP, giving

$$\frac{B_t}{P_t y_t} = \sum_{j=0}^{\infty} \left(\frac{(1+g)}{(1+i)} \right)^{j+1} E_t \left(s_{t+j+1} \right), \tag{2}$$

[1] It should be bear in mind that the Spanish ACs territorial organization was implemented in 1984 so there is no previous information concerning this level of government.

with P_t the price level, y_t the real GDP, g the growth of the real GDP and $s_t = (R_t - EXP_t)/y_t$ the primary surplus over GDP ratio. From (2) it is evident that the equilibrium condition might be satisfied because either B_t or P_t adjust. This feature links the fiscal deficit sustainability with the fiscal theory of the price level (FTPL), which was developed in Leeper (1991), Sims (1994), Woodford (1994, 1995, 2001), and Cochrane (2001, 2005), among others. The traditional macroeconomic analysis assumes taht the fiscal authorities set the primary surplus to ensure the fiscal sustainability and the monetary authorities set the prices, i.e., they control the inflation as a macroeconomic target. This situation gives rise to the Ricardian or monetary dominant (MD) regime. On the other hand, the FTPL argues that the fiscal authorities might be able to set the primary surplus according to an arbitrary process, not necessarily compatible with the solvency. In this case, the equilibrium condition in (2) will be satisfied through the price level, and the monetary authorities might be able only to control the timing of the inflation. This situation is known as the non-Ricardina or fiscal dominant (FD) regime. This distinction between MD and FD regimes is important for subsequent analysis.

There are two broad groups of contributions in the literature that addresses the fiscal sustainability from an empirical point of view. First, an important branch of contributions focus on the presence of a cointegration relationship between the revenues (R_t) and the government expenditure (G_t) – where $G_t = GE_t + i_t B_{t-1}$, with GE_t being the actual expenditure excluding interest payments. Hakkio and Rush (1991) postulate that if the total revenues and total expenditures are I(1) non-stationary variables that define the cointegration relationship:

$$R_t = \mu + \beta G_t + u_t, \tag{3}$$

with $0 < \beta \leq 1$, then the condition that prevents a Ponzi game situation is satisfied. In this model the value of β in (3) determines the degree of sustainability. Thus, $0 < \beta < 1$ associates to weak sustainability, whereas $\beta = 1$ defines the sustainability in the strict sense (or strong sustainability). In economic terms, sustainability in the weak sense corresponds to a situation where the government reacts to the increase in public debt, but this correction is not equal to the growth of the public expenditure. In this case, an unsteady growing deficit and an increase in public debt can be observed. Consequently, Hakkio and Rush (1991) argue that a cointegration relationship between R_t and G_t would be necessary for a strict interpretation of the sustainability of the deficit – see also Trehan and Walsh (1988, 1991), Hakkio and Rush (1991), Haug (1991), Quintos (1995) and Martin (2000) for further contributions. However, Quintos (1995) indicates that $0 < \beta \leq 1$ in (3) would be a necessary and sufficient condition for the fiscal deficit sustainability, and the cointegration relationship between R_t and G_t – regardless of whether or not the cointegration vector is imposed – would only be a sufficient condition for fiscal deficit sustainability.

The second branch of the literature bases on Bohn (1998), who proposed to estimate a fiscal rule in order to assess the sustainability of the fiscal policy of the government. Basically, Bohn (1998) suggests checking whether there exists a corrective response by the government to increases of the public debt. The focus is set on the response from the primary surplus – non-financial revenues less non-financial expenditures (excluding interest payments on debt) – to changes in the level of the public debt. The model suggested in Bohn (1998) for the U.S. economy takes the form:

$$s_t = \mu + \rho b_t^* + \alpha z_t + \varepsilon_t, \tag{4}$$

where the primary surplus over the real GDP is given by $s_t = (R_t - EXP_t)/y_t$, $b_t^* = B_t^*/y_t$ the level of debt in the economy at the beginning of period t over the real GDP – it can be approximated by the level of debt in the period $t-1$ – and, finally, z_t is a vector of explanatory variables that capture the economic cycle.[2] The sufficient condition for sustainability requires $\rho > 0$ in equation (4) so that the government would be taking corrective actions – reducing the level of expenditures (excluding interest on debt) and/or increasing the tax revenues – in order to offset the changes in the level of debt. Bohn (1998) mentions that it is possible to proceed in two different ways. First, if the primary surplus and debt are I(1) non-stationary variables, one might consider the relationship:

$$S_t = \mu + \rho B_t^* + v_t, \tag{5}$$

and test for the presence of cointegration between S_t and B_t^*. If cointegration holds, that would mean that $v_t = \alpha Z_t + \varepsilon_t$ is an I(0) stationary process, so that, according to Bohn (1998), it would not be necessary to explicitly model the effect of the economic cycle on the primary surplus in order to obtain a consistent estimate of ρ. Second, if the variable primary surplus and debt are I(0) stationary variables, then equation (4) should be estimated with the inclusion of the cyclical determinants of the fiscal surplus to ensure a consistent estimate of ρ.

The approximation of Bohn (1998) to assess the fiscal sustainability defines the so-called backward-looking approach, where it is expected a positive response of the primary surplus to the debt of the economy. The literature has also proposed the so-called forward-looking approach in Canzoneri, Cumby and Diba (2001), where it is expected that a change in the primary surplus causes a positive reaction of the future debt – see Bajo-Rubio, Díaz-Roldán and Esteve (2009, 2014) for further details. As pointed out in in Canzoneri, Cumby and Diba (2001), both the backward-looking and the forward-looking approaches might be behind the existence of a (statistical significant) positive relationship between the primary surplus and the debt, so that it is not possible to distinguish between them from the mere estimation of (4).

The sign of ρ in equation (4) provides an additional interpretation about the interaction between monetary and fiscal policies, and its relation to the price level determination of the economies. As pointed out in Bajo-Rubio, Díaz-Roldán and Esteve (2014), in a backward-looking approach an estimate $\rho > 0$

[2] As for the explanatory variables (Z_t), Bohn (1998) uses the variables GVAR and YVAR in Barro (1986), which aim to capture the temporary government spending and cyclical variations of the output of the economy, respectively.

would indicate the prevalence of a MD regime, where the monetary authority is expected to set the price level without constraint, whereas fiscal authority would adjust, so that the budget surplus path would be endogenous. On the contrary, $\rho \leq 0$ would indicate the prevalence of a FD regime, which assumes that fiscal authorities are able to set primary surpluses that follow an arbitrary process, not necessarily compatible with solvency. In this case, the budget surplus would be exogenous, and the endogenous adjustment of the price level would be required to achieve fiscal solvency.

In order to disentangle between the backward-looking and forward-looking approaches, and between the MD and FD regimes, it would be necessary to characterize whether the primary surplus and the debt are endogenous or exogenous. The approach that is adopted in this paper bases on cointegration and Granger causality analyses.

3 Data and descriptive analysis

The main source of information used in this paper is the Spanish Ministry of Economy and Finance, which provides consolidated revenues and expenditures, settled by chapters, for the seventeen Spanish ACs regions for the period 1984-2012. From the breakdown in which the data is available, the non-financial revenues and expenditures of the ACs can be obtained, which allows to compute the deficit and primary surplus of the Spanish ACs.[3] The debt of the Spanish ACs has been obtained from various issues of the Monthly Bulletin of the Bank of Spain. The GDP deflator of each AC is obtained from the BDMORES database and the Regional Accounting of the Spanish national statistical institute (INE).

Figure 1 presents the primary surplus over the GDP for the seventeen Spanish ACs. As can be seen, there is a common behavior along the analyzed period, with values that move around zero, and a clear deterioration at the end of the sample. Figure 2 depicts the debt over the GDP for the seventeen Spanish ACs. This ratio experiences a moderate steady increase up to 2007. Consistent with the behavior of the primary surplus, the debt increases at the end of the sample. Therefore, two features arise from this initial analysis, i.e., the presence of comovements across the Spanish ACs –they seems to follow a similar pattern– and between the primary surplus and the debt.

[3] One could think of removing the two Spanish AC foral regions that have a funding system different from the other ACs, which give them greater autonomy in their decision of raising and spending. However, these ACs also face the same conditions as the rest of the ACs when assessing whether the fiscal policy is sustainable or not, and therefore we have decided to keep them in the sample.

4 Panel data integration and cointegration analyses

Macroeconomic variables are usually characterized by high persistence, which makes that many macroeconomic variables are characterized as non-stationary stochastic processes that are governed by stochastic trends, i.e., integrated processes $I(d)$ with $d > 0$. This is a relevant issue, since the estimation of models involving non-stationary time series can lead to spurious relationships. The parameter estimates from a spurious relationship are inconsistent and the test statistics that are usually computed to validate the estimated model can lead to think that we are facing a causal relationship with economic meaning, when in fact the variables are not related.

Previous analyses in the literature have characterized the fiscal variables involved in the model specification described above as I(1) non-stationary processes, although it is possible that relationships among I(1) variables lead to consistent estimates of the parameters if the variables generate a cointegration relationship. In this paper the order of integration and cointegration analyses are performed using panel data techniques. The advantage of taking into account the statistical information coming from both the temporal and cross-section dimensions is the improvement of the statistical inference, provided that panel data unit root and cointegration test statistics are supposed to be more powerful than the ones based on the individual information. However, non-stationary panel data techniques can lead to misleading conclusions if the presence of cross-section dependence among the units of the panel data sets is not taken into account. The first generation of non-stationary panel data techniques assumed the independence among the units of the panel data sets, an assumption that, if not satisfied, will introduce a bias to conclude in favor of the stationarity of the panel data – see Banerjee, Marcellino and Osbat (2004, 2005). Although it is now a common practice to apply panel data unit root and stationarity test statistics that account for cross-section dependence, few studies test whether such dependence exist. Further, the application of these cross-section dependence test statistics can give some hints on the type of cross-section dependence that is present.

4.1 Panel data cross-section dependence

This section computes the test statistics in Pesaran (2004, 2014) – henceforth, denoted as WCD and WCD_{LM} statistics – and the statistic in Ng (2006) – denoted as the svr statistic – which test the null hypothesis of cross-section independence against the alternative hypothesis of cross-section dependence using pair-wise Pearson's correlation coefficients. Further, the application of the test statistic in Ng (2006) is interesting because it provides information about the degree of dependence. Thus, Ng (2006) proposes to define a group of small (S) correlation coefficients and a group of large (L) correlation coefficients, where ϑ denotes the proportion of correlation coefficients in the S group. Once the sample of correlation coefficients has been split, the null hypothesis of no correlation in both sub-samples can be tested. If ϑ is large, this will indicate that the dependence is pervasive.

Table 1 presents the results of calculating the WCD, WCD_{LM} and svr statistics for each panel data. The qualitative conclusion that can be drawn is that the WCD test clearly rejects the null hypothesis of no correlation – this conclusion is supported by the WCD_{LM} test statistic. The large values of these statistics can be taken as an indication that strong cross-section dependence is affecting the units of the panel data. This can be confirmed computing the degree of cross-section dependence in Bailey et al. (2012). As can be seen, the point estimate $\mathring{\delta}$ is close to one for the two variables for which it can be computed, and the 90% confidence interval defined by $(\mathring{\delta}_L, \mathring{\delta}_U)$ does not exclude the value of one – the value of one indicates the existence of strong cross-section dependence.

The svr statistic in Ng (2006) shows that the null hypothesis of no correlation can be rejected at the 5% significance level for the whole sample of correlations for both variables – see the p-values associated to the $svr(S)$ statistic. It can also be rejected for the large sample of correlations when the deterministic specification includes a constant. When focusing on the small group of correlations, the null hypothesis of no correlation is rejected for the primary surplus, but not for the debt. If a time trend is used as the deterministic specification when analysing the debt, the null hypothesis of no correlation is rejected for the small sample of correlations, where it is not rejected for the large one. In all cases, the L group is largely more numerous than the S one, which indicates that, in case where there is cross-section dependence, it will be of a strong nature – see Ng (2006). When all correlations are considered, the null hypothesis of cross-section independence is clearly rejected for all variables. This feature requires the use of panel data unit root and cointegration test statistics that accommodate the presence of cross-section dependence in the analysis.

4.2 Panel data order of integration analysis

Provided the conclusions obtained above, panel data unit root test statistics that incorporate unobservable common factors to capture the cross-section dependence are computed. Bai and Ng (2004), Moon and Perron (2004) and Pesaran (2007) are three of the proposals available in the literature that include the use of common factors when testing the order of integration. The framework of Bai and Ng (2004) is more general than the other proposals, and assumes that a given observable generic variable $y_{i,t}$ – i.e., primary surplus over GDP or debt over GDP ratios – can be decomposed into a deterministic component, a common component and an idiosyncratic component, so that this technique can determine the source of the non-stationarity that is present on the observable variable. It is possible that the non-stationarity of the observed variables $(y_{i,t})$ is the result of the presence of I(1) common factors (F_t) – or a combination of I(0) and I(1) common factors – which would imply that the panel data set is non-stationary and that the source of non-stationarity is a common cause for all the units in the panel. In this case, it should be concluded that there are global permanent shocks affecting the whole panel. It could also be the possible that the source of non-stationarity of the panel is idiosyncratic – i.e., the idiosyncratic disturbance terms are I(1) non-stationary processes – a fact that implies that shocks that affect only each time series have a permanent character.[4]

Table 2 provides the results of the two test statistics proposed in Pesaran (2007) – denoted as CIPS and CIPS* – for different valuesof the order of the autoregressive correction (p) that is used when estimating the ADF auxiliary regression equations. In general, the results lead to the non-rejection of the null hypothesis of panel data unit root at the 5% significance level for all variables and deterministic specifications that are considered when $p > 1$. Therefore, we can conclude that there is evidence that the variables that we consider are I(1) non-stationarity processes. Table 2 also includes the results of the test statistics proposed by Moon and Perron (2004) – denoted by t_a and t_b. Interestingly, the conclusions that can be drawn from the use of these statistics contradicts the results from Pesaran's (2007) tests. Thus, regardless of the number of common factors (r) that is used, both test statistics reject the null hypothesis of unit root at the 5% significance level.[5] Consequently, the evidence obtained from these two test approaches is not conclusive.

The evidence obtained with Pesaran and Moon-Perron test statistics may be biased because of the assumption that the dynamic of the common factors is the same as the one driving the idiosyncratic disturbance term. This limitation is overcome by the proposal in Bai and Ng (2004), which analyses the order of integration of the common factors and the idiosyncratic disturbance terms in a separate way. Table 2 reports the test statistics in Bai and Ng (2004). The conclusion obtained from these statistics is that all variables present of symptoms of being I(1) non-stationary stochastic processes, as in all cases the presence of I(1) non-stationary common factors is detected, i.e., $\hat{r}_1 > 0$.[6] Therefore and regardless of the stochastic properties of the idiosyncratic disturbance terms, all variables are I(1) non-stationary panel data sets.

4.3 Panel data cointegration

The panel data unit root test statistics that have been applied in the previous section indicate that the variables involved in our model are I(1) non-stationary

[4] As noted by Bai and Ng (2009), the proposals in Moon and Perron (2004) and Pesaran (2007) control the presence of cross-section dependence allowing for common factors, although the common factors and idiosyncratic shocks are restricted to have the same order of integration. Therefore, it is not possible to cover situations in which one component (e.g., the common factors) is I(0) and the other component (for example, the idiosyncratic shocks) is I(1), and vice versa. In practical terms, the test statistics in Moon and Perron (2004) and Pesaran (2007) turn out to be statistical procedures to make inference only on the idiosyncratic shocks, where the dynamics of both the idiosyncratic and the common components are restricted to be the same.

[5] The use of the different information criteria in Bai and Ng (2002) always lead to select the maximum number of common factors that is specified.

[6] As above, the use of different information criteria to estimate the number of common factors always lead to chose the maximum number of common factors that is specified.

variables. The use of these variables in levels may lead to obtain wrong conclusions as a spurious relationship might appear. In this regard, it is necessary to test whether the relationship posed by the model that analyzes the fiscal deficit sustainability is a long-run relationship (an equilibrium relationship with economic meaning) or not (a spurious relationship). This section computes the panel cointegration test statistics in Banerjee and Carrion-i-Silvestre (2011, 2014), Westerlund (2008) and Bai and Carrion-i-Silvestre (2013), since these proposals account for the presence of cross-section dependence among the units of the panel data through the specification of an approximate common factor model.[7]

This paper analyzes the sustainability of fiscal policy following Bohn (1998), which bases on the estimation of the fiscal rule given by:

$$S_t = \mu + \rho B_t^* + v_t. \tag{6}$$

In order to estimate (6), Bohn (1998) considers that the level of debt at the beginning of period t is proxied by the level of debt in the period $t-1$. The analysis of these two approaches is conducted in a separate way.

Table 3 shows that the procedure of Banerjee and Carrion-i-Silvestre (2015) detects the presence of an I(1) non-stationary common factor ($\hat{r}_1 = 3$) that drives the cross-section dependence of the panel data model.[8] As for the panel cointegration, the ADF test applied to the idiosyncratic disturbance terms lead to reject the null hypothesis of no panel cointegration at the 5% significance level. Consequently, there is evidence for a long-term relationship (cointegration) between the primary surplus and the debt once the cross-section dependence has been taken into account. This conclusion is also achieved with the application of the $CADFp$ test statistic, delivering a parameter estimate of $\hat{\rho} = 0.0857$ in (6). The DH test statistics of Westerlund (2008) lead to the same conclusion since the null hypothesis of no cointegration is rejected regardless of the number of common factors that is specified and the degree of heterogeneity that is assumed for the autoregressive coefficient of the model in which the test statistic base. Finally, the application of the test statistic in Bai and Carrion-i-Silvestre (2013) reinforces the presence of a cointegration relationship between the primary surplus and the debt, although the number of estimated common factors increases compared to the one that is obtained using the Banerjee and Carrion-i-Silvestre

[7] It is worth mentioning that there are some important features that share and distinguish these proposals. First, one important difference concerns to the order of integration of the common factors, since Westerlund (2008) considers that all common factors are I(0) stationary common factors, whereas the other approaches assume that there might be a combination of I(0) and I(1) common factors as in Bai and Ng (2004). Second, Bai and Carrion-i-Silvestre (2013) considers the most general case where the common factors might both affect the dependent variable and the stochastic regressors, whereas the other proposals assume that the common factors and the stochastic regressors are orthogonal. Finally, in Banerjee and Carrion-i-Silvestre (2011) the effect of the unobserved common factors is taken into account as in Pesaran (2006), who uses cross-section averages to proxy the common factors. The other proposals estimate the common factors using principal components as in Bai and Ng (2004).

[8] The total number of common factors is denoted by r. The number of I(1) non-stationary common factors is denoted by r_1 whereas the number of I(0) stationary common factors is r_0, so that $r = r_0 + r_1$.

(2015) approach – see Table ??. In this case, the estimated ρ parameter in (6) is $\hat{\rho} = 0.09$, a value that is close to the previous estimate and is in accordance with the sufficient condition of fiscal sustainability in Bohn (1998).

4.4 Estimation of the panel cointegration relationship

This section presents the estimated cointegrating relationships of the two approaches that are used to determine the sustainability of the fiscal policy of the Spanish ACs. Due to the presence of cross-section dependence, the procedures for estimating the cointegrating relationships that are used are the ones proposed in Bai, Kao and Ng (2009) and Kapetanios, Pesaran and Yamagata (2011). The approach of Bai, Kao and Ng (2009) estimates the cointegration vector using procedures that render consistent and efficient estimates of the parameters – Continuous Updated Fully-Modified (CUP-FM) and Continuous Updated Bias Corrected (CUP-BC) estimators – considering the presence of I(0) and/or I(1) common factors.[9] The strategy in Kapetanios, Pesaran and Yamagata (2011) bases on the CCE approach in Pesaran (2006).[10]

Table ?? reports the results of the estimates for the two models and the three estimators. As can be seen, all parameter estimates are positive and statistical significant – the CCE-based estimate is statistical significant at the 10% level of significance. The coefficients that have been estimated using the CCE and the CUP-BC estimation procedures are pretty similar – around 0.08 – whereas the CUP-FM estimate is slightly smaller. According to these estimates, the sufficient condition of sustainability advocated by Bohn (1998) is met.

5 Conclusions

The paper analyzes the sustainability of the deficit of the Spanish ACs in the period 1984-2012 using the primary surplus and the debt. A first set of results clearly shows that the variables involved in the analysis share the characteristics of being I(1) non-stationary variables and being affected by the presence strong cross-section dependence. The cross-section dependence has been captured through the use of parsimonious common factor models, which are able to account for global stochastic trends. This just makes it clear that the system of financing of the ACs and the competences that they have undertaken are driven by the same legal framework that brings up this strong (pervasive) cross-section dependence.

[9] Given the efficiency property of these estimators, inference on the estimated parameters can be performed – in the limit the estimated parameters are distributed according to a normal distribution.

[10] These authors show that under panel cointegration, the pooled CCE estimator is a consistent estimator of the cointegration vector, which is asymptotically distributed as a normal distribution. There is an important feature that distinguish both proposals. Thus, whereas Kapetanios, Pesaran and Yamagata (2011) assume that the stochastic regressors are weakly exogenous, Bai, Kao and Ng (2009) specify a more general framework where the stochastic regressors might be endogenous.

A second important result has been to evidence how the deficit of the Spanish ACs as a whole is sustainable in the long-run. The paper has shown that the fiscal rule that relates the primary surplus and debt levels at the beginning of the period defines a cointegration relationship, with a parameter of interest that is statistical significant and positive. According to Bohn (1998), this implies that the fiscal deficit of the ACs in Spain is sustainable for the analyzed period.

References

[1] BAI, J. and CARRION-I-SILVESTRE, J.L. (2013) Testing panel cointegration with unobservable dynamic common factors that are correlated with the regressors, *Econometrics Journal* 16, 222-249.

[2] BAI, J., KAO, C. and NG, S. (2009) Panel cointegration with global stochastic trends, *Journal of Econometrics* 149, 82-99.

[3] BAI, J. and NG, S. (2004) A PANIC attack on unit roots and cointegration, *Econometrica* 72, 1127-1177.

[4] BAJO-RUBIO, O., DÍAZ-ROLDÁN, C. and ESTEVE, V. (2009) Deficit sustainability and inflation in EMU: an analysis from the fiscal theory of the price level, *European Journal of Political Economy* 25, 525-539.

[5] BAJO-RUBIO, O., DÍAZ-ROLDÁN, C. and ESTEVE, V. (2014) Deficit sustainability, and monetary versus fiscal dominance: the case of Spain, 1850-2000, *Journal of Politicy Modeling* 36, 924-937.

[6] BANERJEE, A. and CARRION-I-SILVESTRE, J. L. (2011) Testing for panel cointegration using common correlated effects estimators. Working paper, Universitat de Barcelona.

[7] BANERJEE, A. and CARRION-I-SILVESTRE, J. L. (2015) Cointegration in panel data with breaks and cross-Section dependence, *Journal of Applied Econometrics* 30, 1-23.

[8] BANERJEE, A., MARCELLINO, M. and OSBAT, C. (2004) Some cautions on the use of panel methods for integrated series of macro-economic data, *Econometrics Journal* 7, 322-340.

[9] BANERJEE, A., MARCELLINO, M. and OSBAT, C. (2005) Testing for PPP: should we use panel methods?, *Empirical Economics* 30, 77-91.

[10] BARRO, R. (1986) U.S. deficits since World War I, *Scandinavian Journal of Economics* 88, 195-222.

[11] BOHN, H. (1998) The behavior of U.S. public debt and deficits, *The Quarterly Journal of Economics* 13, 949-963.

[12] CANZONERI, M. B., CUMBY, R. E. and DIBA, B. T. (2001) Is the price level determined by the needs of fiscal solvency?, *American Economic Review* 91, 1221-1238.

[13] COCHRANE, J. H. (2001) Long-term debt and optimal policy in the fiscal theory of the price level, *Econometrica* 69, 69-116.

[14] COCHRANE, J. H. (2005) Money as stock, *Journal of Monetary Economics* 52, 501-528.

[15] HAKKIO, C. and RUSH, M. (1991) Is the budget deficit too large?, *Economic Inquiry* 24, 429-445.

[16] HAMILTON, J. and FLAVIN, M. (1986) On the limitations of government borrowing: A framework for empirical testing, *American Economic Review* 76, 808-816.

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

[18] KAPETANIOS, G., PESARAN, M. H. and YAMAGATA, T. (2011) Panels with nonstationary multifactor error structures, *Journal of Econometrics* 160, 326-348.

[19] LEEPER, E. M. (1991) Equilibria under 'active' and 'passive' monetary and fiscal policies, *Journal of Monetary Economics* 27, 129-147.

[20] MARTIN, G. (2000) U.S. deficit sustainability: A new approach based on multiple endogeneous breaks, *Journal of Applied Econometrics* 15, 83-105.

[21] MOON, H. R. and PERRON, B. (2004) Testing for unit root in panels with dynamic factors, *Journal of Econometrics* 122, 81-126.

[22] NG, S. (2006) Testing cross-section correlation in panel data using spacings, *Journal of Business and Economic Statistics* 24, 12-23.

[23] PESARAN, M. H. (2004) General diagnostic tests for cross section dependence in panels. CESifo Working Papers. No. 1233.

[24] PESARAN, M. H. (2006) Estimation and inference in large heterogeneous panels with a multi- factor error structure, *Econometrica* 74, 967-1012.

[25] PESARAN, M. H. (2007) A simple panel unit root test in the presence of cross section dependence, *Journal of Applied Econometrics* 22, 265-312.

[26] PESARAN, M. H. (2014) Testing weak cross-sectional dependence in large panels, *Econometric Reviews*, forthcoming.

[27] QUINTOS, C. E. (1995) Sustainability of the deficit process with structural shifts, *Journal of Business & Economic Statistics* 13, 409-418.

[28] SIMS, C. A. (1994) A simple model for study of the determination of the price level and the interaction of monetary and fiscal policy, *Economic Theory* 4, 381-399.

[29] TREHAN, B. and WALSH, C. (1988) Common trends, the government budget constraint, and revenue smoothing, *Journal of Economic Dynamics and Control* 12, 425-444.

[30] TREHAN, B. and WALSH, C. (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.

[31] WESTERLUND, J. (2008) Panel cointegration tests of the Fisher effect, *Journal of Applied Econometrics* 23, 193-233.

[32] WOODFORD, M. (1994) Monetary policy and price level determinacy in a cash-in-advance economy, *Economic Theory* 4, 345-380.

[33] WOODFORD, M. (1995) Price-level determinacy without control of a monetary aggregate, *Carnegie-Rochester Conference Series on Public Policy* 43, 1-46.

[34] WOODFORD, M. (2001) Fiscal requirements for price stability, *Journal of Money, Credit, and Banking* 33, 669-728.

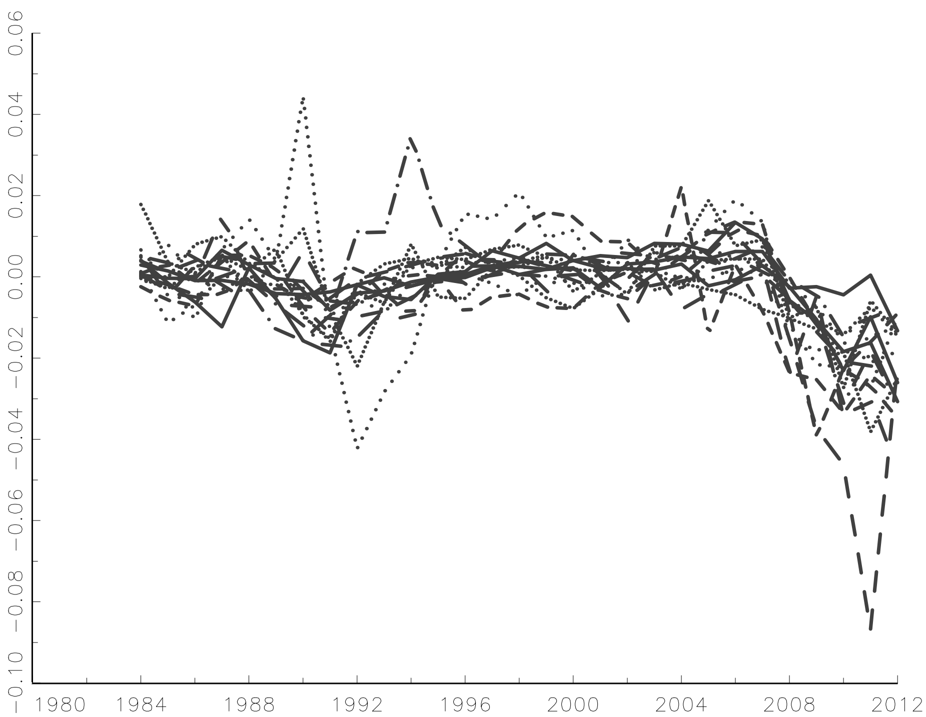

Figure 1: Primary surplus over GDP ratio

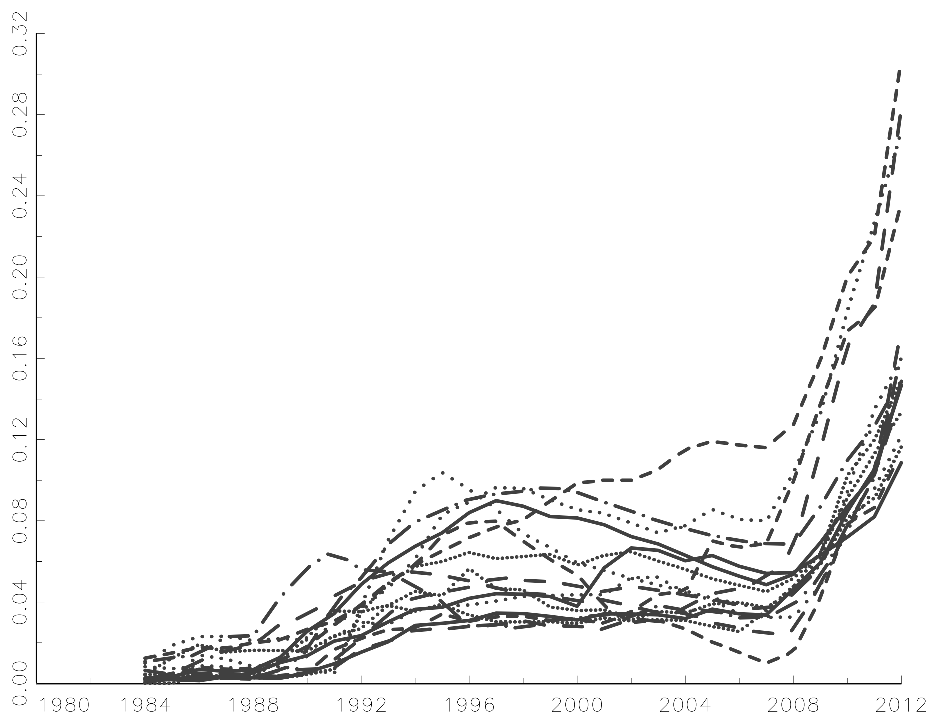

Figure 2: Debt over GDP ratio

Table 1: Cross-section dependence

		Ng (2006)							Pesaran (2004, 2013)		Bailey et al. (2012)		
		Whole sample		Small sample		Large sample							
		$svr(W)$	p-value	$svr(S)$	p-value	$svr(L)$	p-value	η	WCD_{LM}	WCD	$\mathring{\delta}$	$\mathring{\delta}_L$	$\mathring{\delta}_U$
Primary surplus	Constant	3.935	0.000	2.029	0.021	4.663	0.000	0.096	23.970	19.459	0.950	0.844	1.055
Debt	Constant	3.228	0.001	0.845	0.199	6.677	0.000	0.096	39.048	24.666	0.958	0.767	1.148
	Trend	3.017	0.001	1.844	0.033	0.666	0.253	0.096	38.155	23.755	-		

Table 2: Panel data unit root tests

Pesaran (2007)

	Primary surplus		Debt		Debt	
	Constant		Constant		Trend	
p	CIPS	CIPS*	CIPS	CIPS*	CIPS	CIPS*
0	-3.714**	-3.714**	-3.714**	-3.714**	-4.449**	-4.208**
1	-2.362**	-2.362**	-2.362**	-2.362**	-2.977**	-2.977**
2	-2.223	-2.223	-2.223	-2.223	-2.739	-2.739
3	-1.866	-1.866	-1.866	-1.866	-2.167	-2.115
4	-1.838	-1.838	-1.838	-1.838	-2.098	-2.098
5	-1.760	-1.760	-1.760	-1.760	-2.137	-2.137

Moon and Perron (2004)

	Primary surplus		Debt		Debt	
	Constant		Constant		Trend	
r	t_a	t_b	t_a	t_b	t_a	t_b
1	-17.483**	-6.015**	-17.483**	-6.015**	-3.860**	-3.401**
2	-20.856**	-7.088**	-20.856**	-7.088**	-6.714**	-5.751**
3	-23.710**	-8.449**	-23.710**	-8.449**	-9.161**	-8.129**
4	-25.036**	-9.183**	-25.036**	-9.183**	-9.867**	-8.872**
5	-24.693**	-8.796**	-24.693**	-8.796**	-8.032**	-7.042**
6	-24.561**	-8.520**	-24.561**	-8.520**	-8.871**	-7.624**

Bai and Ng (2004)

	Primary surplus		Debt		Debt	
	Constant		Constant		Trend	
	Test	p-value	Test	p-value	Test	p-value
ADF idiosyncratic	-7.084**	0.000	-1.227	0.110	-1.361	0.087

	Test	$(\hat{r}, \hat{r}_1)$	Test	$(\hat{r}, \hat{r}_1)$	Test	$(\hat{r}, \hat{r}_1)$
MQ (no par.)	-26.168	$(6, 6)$	-26.354	$(6, 6)$	-24.008	$(6, 6)$
MQ (par.)	-26.432	$(6, 6)$	-26.094	$(6, 6)$	-26.043	$(6, 6)$

** denotes rejection of the null hypothesis of unit root at the 5% level of significance. The Moon-Perron test statistics distribute according to a standard nomal distribution in the limit.

Table 3: Bai and Carrion-i-Silvestre (2013) panel cointegration test statistics

	ADF-idio	p-value	$\hat{r}$	$\hat{r}_1^P$	$\hat{r}_1^{NP}$
BCS (2015)	-2.551	0.005	3	3	3
	$CADFp$	$\hat{\rho}$			
BCS (2011)	-3.871	0.0857			
		Test	p-value	$\hat{r}$	$\hat{\rho}$
BCS (2013)	MSB_ξ	-2.377	0.009	8	0.090
	P_m	4.341	0.000		
	P	69.800	0.000		
Westerlund (2008)	DH_g	p-value	DH_p	p-value	r
	7.939	0.000	20.452	0.000	1
	7.680	0.000	18.812	0.000	2
	14.421	0.000	14.282	0.000	3
	11.789	0.000	11.209	0.000	4
	8.545	0.000	7.111	0.000	5
	8.571	0.000	8.690	0.000	6

BCS (2011, 2015) refers to Banerjee and Carrion-i-Silvestre (2011. 2015), and BCS (2013) refers to Bai and Carrion-i-Silvestre (2013).

Table 4: Panel data cointegrating vector estimates

	CCE	CUP-FM	CUP-BC	$\hat{r}$
ρ	0.086	0.069	0.089	1
t-ratio ($\rho = 0$)	1.817	5.861	7.274	