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GOVERNMENT SOLVENCY OR JUST PSEUDO-SUSTAINABILITY?
A LONG-RUN MULTICOINTEGRATION APPROACH FOR SPAIN

Regina Escario, María Dolores Gadea, Marcela Sabaté

Applied Economics Department
University of Zaragoza

ABSTRACT

The concept of multicointegration allows to test the sustainability of public finances by assessing dynamic equilibrium relationships between flow and stock variables. This paper focus on the very long-run Spanish case, characterized by the more or less intensive use of monetization to offset the recurrent deficits. The results support that *seigniorage* allowed the governments to guarantee –even artificially– a *pseudo*-sustainability for their budgetary path. Besides, the possibility of there being a structural break during the period is also taken into account.

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* Corresponding Author: Regina Escario (rescario@unizar.es)
Dpto. Estructura e Historia Económica y Economía Pública
Facultad Cc. Económicas y Empresariales
Gran Vía 4, 50005
Zaragoza – Spain
tel.: 976 76 1783
fax: 976 76 1840

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1. INTRODUCTION

Initially, economic literature tackled the topic of government solvency by testing the fulfilment of the Intertemporal Budget Constraint (IBC), that is, whether the current level of debt equals the present discounted value of primary surpluses [see Sargent and Wallace (1981), King and Plosser (1985)]. Empirical tests on sustainability, however, offered mixed results, usually depending on the particular specification of the transversality condition. As Bajo-Rubio *et al.* (2007) summarized, several procedures to test for the IBC have been proposed in the literature. Hamilton and Flavin (1986) and Wilcox (1989) focused on the univariate properties of the public deficit and debt; Trehan and Walsh (1988, 1991), Haug (1991) and Smith and Zin (1991) on the presence of a long-run linear cointegration relationship between government revenues and expenditures. Later, most influential work in this field emphasized that structural breaks must be accounted for while testing the IBC. The occurrence of structural breaks in this cointegrating relationship was examined by Hakkio and Rush (1991), who assumed the break point as exogenously given; and by Haug (1995), Quintos (1995), Camarero *et al.* (1998), Makrydakis *et al.* (1999), Martin (2000) and Escario (2005), where the break point was endogenously derived. Recent studies on the IBC increasingly show evidence of non-linear fiscal adjustments. This new approach to sustainability has been explored, among others, by Bohn (1998), Arestis *et al.* (2004), Bajo-Rubio *et al.* (2004, 2006) and Arghyrou and Luintel (2007). In their first paper, Bajo-Rubio *et al.* (2004) allowed the deficit dynamics to be different depending on whether the change in the deficit was below or above an endogenously estimated limit through a threshold autoregressive (TAR) model. In their second paper (2006), they analyzed the presence of threshold cointegration [a concept first developed by Balke and Fomby (1997)] between public

spending and revenues, applying the LM (Lagrange multiplier) test for the presence of a threshold effect on a vector error correction model (VECM) of Hansen and Seo (2002). Threshold cointegration follows a particular error-correction adjustment: the cointegration relationship does not hold inside a certain range, but holds if the system gets ‘too far’ from equilibrium; that is, cointegration only holds if the system exceeds a certain threshold (the ‘trigger point’, according to Bertola and Drazen (1993)). Finally, Arghyrou and Luintel (2007) employ a Dynamic OLS (ordinary least squares) or GLS (generalized least squares) estimators of the cointegrating vector, proven to perform better for small samples. They make use of the strong and weak senses of sustainability in Quintos (1995)¹, account for structural breaks and allow for the non-linearity of fiscal adjustment².

Although the procedures described above are the most used in the literature, we must remark that Bohn (2007) has recently published a harsh critique describing all of them as “*assessing sustainability as a mechanical exercise*” of testing IBC conditions (unit root and cointegration conditions), leaving aside economic thinking. For him, error correction-type policy reaction functions are more promising for understanding deficit problems. Our approach will try to take this recommendation into consideration by adding the VECM, where the error correction terms allow us to describe the fiscal policy reaction to a determined debt situation.

This paper will deal with sustainability from a rather new perspective: that developed by using the concept of multicointegration between series [Granger and Lee

¹ These concepts are explained in footnote 12.

² Their application to Greece, Ireland, Italy and the Netherlands shows that the fiscal path of these countries went through multiple shifts, their government finances satisfied the IBC, and the fiscal disequilibria adjusted non-linearly. They also found a clear positive Maastricht effect on the IBC of all these countries.

(1989, 1990), Haldrup (1994), Engsted *et al.* (1997)], which permits the treatment of sustainability in a more sophisticated and broader way, and also permits us to consider a structural break. The advantage of using multicointegration techniques is that certain sustainability criteria that are independent of whether the environment is stochastic or not and, thus, valid for any state of nature (not only when the economic growth rate is greater than the interest rate on public debt) can be derived [Leachman *et al.* (2005)]. Moreover, according to the work of Engsted and Johansen (1997), multicointegration between series must be tested for compulsorily because, if the tests are carried out taking only standard cointegration into account, the usual estimation proceedings, hypothesis testing and predictions would not be valid and their interpretation misleading.

Multicointegration is a deeper form of cointegration, in which a complex equilibrium is maintained between two coexisting equilibrium forces. The existence of multicointegration between integrated of order one series allows us to analyze a dynamic equilibrium relationship between them, considering both a first cointegration relation between the original flow variables (in this case public spending and revenues) and a second level relation between a stock variable (the accumulated residual of the initial flow variables, that is, public debt or wealth) and one or both of the original variables.

The case of Spain is particularly interesting because its government frequently had to deal with fiscal imbalances that were partly financed via monetization mechanisms (the so-called *seigniorage* or monetary base growth generated by the public sector). This financing strategy was used more or less intensively, characterizing the Spanish policy model as one of clear *fiscal dominance* [Sabaté *et al.* (2006), Escario (2006)] –

that is, a model where monetary policy was permanently subordinated to fiscal requirements.

This paper will analyze Spanish budgetary series through multicointegration techniques under a very long-run approach (1857-2000). In this way, we will be able to, firstly, unravel the financial consequences of the Spanish budgetary policy in terms of its contribution to the consolidation of the fiscal dominance regime. More specifically, we will test the role of *seigniorage* as a support of fiscal sustainability. Secondly, this paper includes a pioneer application of multicointegration: we will take into account the possibility of there being a structural break during the period –quite plausible given its length and the fundamental transformations of the Spanish financial markets. This is a direct application of the recent work of Carrión-i-Silvestre and Berenguer (2007), who develop the theoretical models and tabulate the critical values that allow the structural break testing.

The paper is organised as follows. The second section provides a brief description of the concept and methodology of multicointegration, focusing on its application to government solvency conditions. The third section is dedicated to outlining the long-run Spanish budgetary background, highlighting the frequent use of monetization as a means of financing public imbalances. In the fourth section, a double analysis is carried out to assess the quantitative impact that *seigniorage* could, even indirectly, exert on the Spanish budget path sustainability conditions. As we will explain, the double analysis is based on the two alternative definitions of revenues that we will consider. Finally, some concluding remarks will be sketched in the last section. In the Appendix, we indicate the sources used in the reconstruction of the long-run data base.

2. THEORETICAL BACKGROUND: THE CONCEPT OF MULTICOINTEGRATION AND THE GOVERNMENT SOLVENCY CRITERION

The research line of this paper is focused on a relatively recent econometric methodology based on the concept of multicointegration. It will allow us to consider, in a single analysis, the study of the relationships both between flow variables and between flow and stock variables. The concept of multicointegration was developed by Engsted, Gonzalo and Haldrup (1997), Haldrup (1998) and Leachman and Francis (2002) based on the following idea: two integrated of order one series X_t and Y_t are cointegrated if there is a linear relation between them $Z_t = Y_t - \beta X_t$ that is stationary. At the same time, the series that results from the accumulation of the residuals of the previous relation, $S_t = \sum_{j=1}^t Z_j$ (a stock variable, integrated of order two, by definition), can itself be cointegrated with the initial variables X_t and/or Y_t , that is, it may be that the relation $I_t = Y_t - \gamma S_t$ and/or $I_t' = X_t - \delta S_t$ is also stationary $-I(0)$. If this is the case, we can state that there are two cointegration levels between X_t and Y_t , that is, that both $I(1)$ series are multicointegrated (Granger and Lee 1989, 1990)³. Engsted and Johansen (1997) advise that multicointegration must be considered empirically given that, if it exists, traditional econometric procedures would be misspecified.

In practice, multicointegration analysis can be tackled in two different ways. Although, in principle, Granger and Lee (1990) suggested carrying out a double test for cointegration (first between X_t and Y_t , and then between S_t and X_t and/or Y_t), later on

³ Multicointegration is a special form of cointegration $I(2)$. In a bivariate system $I(1)$, it implies that there are at least two cointegrating vectors between the variables, that is, there is a polynomial cointegration between the two variables of the system that tie them together by means of two equilibrating forces, through a complex flow-stock equilibrium that goes further than the traditional equilibrium relationship of simple cointegrated systems.

Engsted *et al.* (1997) proved the greater robustness of a test applied on a single equation (one-step test), capable of jointly estimating the parameters of the model:

$$\sum_{i=1}^t Y_i = \alpha_0 + \alpha_1 t + \alpha_2 t^2 + K_0 \sum_{i=1}^t X_i + K_1 \Delta \sum_{i=1}^t X_i + \nu_t \quad [1]$$

This expression integrates into a single equation the I(1) flow variables [$\Delta \sum_{i=1}^t X_i = X_t$] and the I(2) stock variables [their accumulated $\sum_{i=1}^t Y_i$ and $\sum_{i=1}^t X_i$], in such a way that the regressors accompanying parameters (K_0, K_1) represent the first and second level cointegration relationships, respectively, that is: between the flow variables, on one hand, and between flow and stock variables, on the other. The equation can distinguish between three different models, depending on the definition of the deterministic component –whether it includes or not a linear or both linear and quadratic trends, as well as the intercept term α_0 (model 1: without trend, model 2: with linear trend $\alpha_1 t$, model 3: with both linear and quadratic trends $\alpha_1 t + \alpha_2 t^2$).

The test is carried out on the residual term ν_t in [1] to find out if it is a stationary process –I(0). If it is, the null hypothesis (non-stationarity) is rejected, that is, the non-existence of multicointegration between the variables is rejected⁴. Anyway, whether we manage to confirm multicointegration or just first level cointegration (between the flow variables), we can rewrite the relationship as a VECM [Johansen (1992, 1995), Leachman *et al.* (2005)]. In this form, the analysis of the parameters accompanying the error correction terms gives information on the short-run adjustment dynamics, that is, on the fiscal variables' reaction to temporary deviations from the long-run equilibrium relationships.

⁴ Critical values to test the null hypothesis of the non-stationarity of the residuals are tabulated in Haldrup (1994) for the case of the model without trends and in Engsted *et al.* (1997) for the cases of the model with linear or linear and quadratic trends.

The system of equations, in a general form, is as follows:

$$\begin{cases} \Delta X = c(1) + c(2).EC1_{t-1} + c(3).EC2_{t-1} + c(4).\Delta X_{t-1} + c(5).\Delta Y_{t-1} \\ \Delta Y = c(1) + c(2).EC1_{t-1} + c(3).EC2_{t-1} + c(4).\Delta X_{t-1} + c(5).\Delta Y_{t-1} \end{cases} \quad [2]$$

where $EC1$ is the lagged residual from the first cointegration relation (between X_t and Y_t). If we do have multicointegration, the $EC2$ term must be added to the traditional VECM, the $EC2$ being the lagged residual from the second level cointegration relation.

Lastly, if we deal with very long-run series, the possibility of there being a structural break should be considered. This was theoretically studied by Carrión-i-Silvestre and Berenguer (2007), developing eight versions of the model [1] that allow the inclusion of a break in each of the components and also tabulating the critical values to carry out the test. The first five models propose potential breaks not affecting the cointegrating vectors: whereas 1, 2, and 3 are the cases already explained in equation [1], models 4 and 5 consider that structural changes only affect the deterministic component (level or slope shifts). The second way in which the structural break can enter into the model is through the stochastic part. Model 6 considers changes both in the deterministic component and in the first level cointegration relation, but not in the second level one. Model 7 controls for changes affecting both the deterministic component and the second level cointegration relation, but not the first level one. Finally, model 8 is the most general specification, allowing for breaks in every parameter of the model.

This paper will consider public revenues and spending (including interest debt burden) as the flow variables supposedly cointegrated and, thus, deficit or surplus is the residual variable. The accumulation of the latter is the stock variable, the public debt or the national savings, that could again be cointegrated with the revenues and/or

spending. If this last cointegration also holds, the econometric properties that characterize these two multicointegrated series allow us to determine a fiscal process sustainability criterion that improves the one traditionally derived from the fulfilment of the IBC [Sargent and Wallace (1981), King and Plosser (1985)]. As Leachman *et al.* (2005) recently argued, multicointegration analysis is especially useful to develop this criterion, given that it is independent of the country's economic performance, being also valid for 'bad' states of nature (when economic growth falls below the real debt interest rate). Following Leachman *et al.* (2005), if there is multicointegration between spending and revenues, we will be able to assess whether a country's fiscal behaviour is coherent with sustainable budgetary policies. This will depend on the values of the parameters of the relation: we will conclude whether the public finance path is sustainable or not by estimating the coefficients K_0 and K_I in equation [1].

If Y_i represents spending and X_i revenues, and we confirm that they both have a unit root, there might be multicointegration between them. This will occur if they are cointegrated (their residual –budgetary path– is stationary) and if the debt or wealth (depending on a government running a majority of deficit or surpluses) is also cointegrated with the initial spending and/or revenues. As we remarked previously, both levels of cointegration can be simultaneously checked in a single-step procedure, testing the ν_t stationarity in [1]. Once empirically proven that X_i and Y_i are multicointegrated, we can interpret the parameters. In the first place, K_0 represents the relation between the

flow variables spending and revenues⁵. Thus, on average, if $K_0 > I$, we can say that deficits have outpaced surpluses and, if $K_0 < I$, surpluses have outpaced deficits.

But the results of parameter estimations not only give information on the predominance of deficits or surpluses during the period, but also on how the fiscal policy has reacted to the accumulation of debt or wealth: whether spending or revenues have increased or decreased when there was debt or wealth growth, that is, whether the government answer was suitable for the budgetary dynamics. Focusing on the parameter K_I in [1]⁶, which represents the equilibrium relationship between the flow and stock variables, the following sustainability criterion can be established:

- If $K_0 > I$, we will have had a majority of deficits: so, sustainability will require $K_I > 0$ –a positive relation between the revenues and the expected debt value. Thus, revenues rise to accommodate increasing levels of debt.
- On the other hand, if $K_0 < I$, surpluses will have been predominant, and sustainability will require $K_I < 0$, that is, a negative relation between revenues and savings. Thus, revenues fall to accommodate increasing levels of wealth.

Moreover, if the revenues and spending series are multicointegrated, or even if they are just cointegrated at the first level, the model can be expressed through a Vector AutoReggressive system that includes error correction terms (EC terms). The estimation of the EC parameters allows us to describe the fiscal variables' reaction when there are temporary deviations from the long-run equilibrium relationships (only one –between

⁵ It can be demonstrated that K_0 is a super-super-consistent estimator of the first cointegration coefficient (relation between the flow variables: spending-revenues) that converges at a rate $O_p(T^2)$ to its true value [Engsted *et al.* (1997)].

⁶ It can be demonstrated that K_I is a super-consistent estimator of the second cointegration coefficient (flow-stock relation between revenues and debt or wealth) that converges at a rate $O_p(T^1)$ to its true value [Engsted *et al.* (1997)].

the flow variables- in the case of standard cointegration; and two if there is multicointegration –between the stock and flow variables). Estimating $c(2)$ and $c(3)$ in [2] in the two equations, we will be able to analyse whether the revenues, the spending or both have been sensitive to disequilibria or not: that is, how the fiscal variables have been adjusted (upwardly or downwardly), and both the intensity and the speed of the adjustment process.

Finally, our empirical work will try to advance a step further in the application of multicointegration methodologies by considering the case of there being a structural break during the period. Carrión-i-Silvestre and Berenguer (2007)'s procedure allows us to test for the existence of a break as well as its location, thus making it possible to divide the sample into subperiods.

3. HISTORICAL BACKGROUND. THE LONG-RUN SPANISH CASE:

DEFICITS AND *SEIGNIORAGE*

Given that the present analysis is going to focus on the Spanish case, and that there is no previous study on Spanish government solvency spanning such a long-run period, we think it necessary to sketch the historical budgetary background. We can broadly follow the Spanish budget path dynamics between 1857 and 2000 in Graph 1, where the preponderance of deficits over surpluses is clearly highlighted. In chronological order, the first noteworthy imbalances took place around *La Gloriosa* Revolution (1868), years of considerable political and social unrest. Although lower in absolute value, public budgets continued in the red until the first decade of the XXth Century⁷, when the reorganization of the public finances imposed by Fernández

⁷ During the last years of the XIXth Century, the Cuban Wars and the following conflict against the U.S. (1896-98) generated great expenditures for Spanish governments. Nevertheless, given that

Villaverde managed to obtain surpluses and restrain government's access to the Treasury. After that brief stage passed, the deficits reappeared and became the norm again. They gradually increased throughout a period of rising instability, until the Civil War broke out. Military spending during the conflict was undoubtedly substantial, but data are not available for those years (1936-1939)⁸. Postwar consequences are clearly visible during the darkest period of the Franco's autarky (the forties), again in the form of considerable deficits. The fact that, during the fifties and sixties, there were no big imbalances can be explained because of the impossibility of knowing the real deficit figures since, during those years, much government spending was diverted from the official public budget via *Organismos Autónomos* (public entities created *ad hoc* with the aim of stimulating strategic sectors' activity). From the seventies onwards, the deficits rocketed due to a conjunction of factors of great importance: the political transition to democracy, the oil crises and, mainly, the belated but accelerated creation and expansion of the Welfare State. Not until the end of the period did concern about inflation and the wish to fulfil the Maastricht requirements to enter the EMU (restrictions on deficit and public debt) compel the authorities to tackle a deficit-restraining process. After the unavoidable relapse caused by the 91-93 economic crisis, the government immersed itself in the so-called *new stability culture*. Helped by a favourable situation, decreasing interest rates and a firm commitment to spending cuts (captured in the Growth and Stability Pact in Europe, and the even stricter Budget Stability General Law in Spain), by the end of the century equilibrium of the public finances was finally achieved.

they were not officially registered [Sabaté *et al.* (2006), Escario (2006)], we have not represented those years' deficits in Graph 1.

⁸ Interpolation techniques [Tramo-Seats –Gómez and Maravall (1996)] undervalue real spending during the Civil War, so we ignored those years' important deficits in Graph 1.

Graph 1 also shows the dynamics of the monetary base growth created by the public sector⁹. This is essential in the study of Spanish budgetary policy, because the governments tended to finance their fiscal imbalances through monetization mechanisms (*seigniorage*)¹⁰. Accordingly, an inverse relation between deficit and *seigniorage* can be observed in the graph because, when public finances were in the red, monetary expansion was generally more evident (especially, during years with big extraordinary spending –the wars: 1896-98 and 1936-39). This led us to consider a complementary hypothesis to test: whether *seigniorage* played an essential role in achieving sustainability in Spain.

Therefore, in the next section we will carry out the empirical analysis twice: firstly, considering the standard definition of revenues and, afterwards, enlarging it with the *seigniorage* component. We will be able to study to what extent the recurrent

⁹ In line with other studies, such as those of Friedman and Schwartz (1963), Cagan (1965), Fratianni and Spinelli (1997) and Martín Aceña (1985, 1988), we can understand the monetary base as consisting of the contributions of the public, private and external sectors. Gadea *et al.* (2008) quantified the public sector contribution to the monetary base growth in Spain between 1874 and 1998 as nearly 22% of the whole (almost 36% when including both the monetization and the pledgeable debt issuance revenues between 1917 and 1959 in the public sector's contribution).

¹⁰ Following King and Plosser (1985, p. 149-150), "*the process of creating external (fiat) money provides governments with a flow of revenue, frequently termed seigniorage*". These authors compile a summary of six alternative *seigniorage* measures:

- the traditional measure, the one used in our paper, which is simply the change in the external money stock (sum of currency and reserve deposit accounts) as a percentage of GNP (it represents the percentage of GNP that could be purchased with current money creation);
- the product of the nominal interest rate with the percentage of GNP represented by external money;
- in the case of the US, the Federal Reserve System's total earnings, principally nominal interest on the FRS's portfolio, measured as a percentage of GNP;
- in the case of the US, the FRS's net interest earnings (subtracting out the costs of operating the central bank) as a percentage of GNP;
- in the case of the US, the FRS's transfers to the US Treasury as a percentage of GNP;
- in the case of the US, the change in the high powered (external) money stock plus the real interest on the central bank's portfolio, net of operating costs.

reliance on monetization was necessary to achieve budget sustainability, thus supporting the *fiscal dominance* regime¹¹.

Graph 2 shows the deviations between the budget series depending on whether we consider *seigniorage* as part of the public revenues or not. We can observe how, indeed, except for the already remarked first decade of the XXth Century and the last stage (from the nineteen-eighties onwards, when price contention commitment required a progressive end to direct monetization), the deficit including *seigniorage* revenues was, in general, lower than the 'traditional' (or official) one.

Results of previous studies for the case of Spain are hardly comparable with this paper because none of them covers such a lengthy period. Most of them emerged after the late nineties, motivated by the outstanding fiscal consolidation that Spain had just accomplished. Analyses for this final part of our period detect the efforts made to recover control of the deficit path, confirming its increasing sustainability.

Following the approach of Quintos (1995)¹², Camarero *et al.* (1998) were the first to test Spanish fiscal policy sustainability, covering the years 1964-1996. By estimating a long-run relation between spending and revenues, they found that both series were cointegrated ($\beta=0.86$) when considering the possibility of a structural break during the period. Although it finally turned out to be non-significant, these authors coincided with the 1964-1998 analysis of De Castro and Hernández de Cos (2002) in its location (between the years 1987-88), as well as in labelling sustainability as weak. Both studies

¹¹ Understood as the monetary policy subordination to fiscal policy [Sabaté *et al.* (2006), Escario (2006)].

¹² Quintos (1995) states that the IBC transversality condition (and thus, sustainability) holds if spending and revenues are $I(1)$ and their regression is defined by a vector $(1, -\beta)$ such that $0 < \beta \leq 1$. If both series are also cointegrated, or if they are not cointegrated but $\beta=1$, sustainability holds in the strong sense. If they are not cointegrated but $0 < \beta < 1$, sustainability is also guaranteed, but only in the weak sense.

pointed towards not a sudden but a gradual turn in the late eighties-early nineties in Spain, probably motivated by the beginning of a period defined by a greater effort towards fiscal consolidation. Also following the methodology of Quintos (1995), but adding the distinction between different kinds of spending¹³, Escario (2005) also covered the period 1964-1998. She agreed that deficit was only weakly sustainable during those years, but highlighted the different behaviour of social expenditures: the break located in 1987 for total spending did not appear for this subseries, which were still immersed in an expansionary process.

Considering the possibility of non-linearities in the behaviour of the fiscal authorities, Bajo-Rubio *et al.* (2004) made use of a threshold autoregressive (TAR) model for the budget deficit series during the years 1964-2001. They expected to find a mean-reverting dynamic behaviour of the budget deficit once a certain limit is reached, which was endogenously derived. The results showed that fiscal stabilizations were only undertaken when the ratio of the budget deficit to GDP showed an increase of more than 1.9% between the previous year and the sixth year before. They also found evidence of delays in the adoption of fiscal adjustment programs, because the reaction did not occur until 7 years later. Bajo-Rubio *et al.* (2006) also studied the possible presence of threshold cointegration between public spending and revenues for the period 1964-2003. In this case, they found that the authorities only took restraining measures when the budget deficit exceeded a specific limit (5.3% of GDP), with the

¹³ Escario (2005) disaggregated the total public spending into three main lines: *general expenditures*, *social expenditures* and *economic expenditures*. In this way, she was able to distinguish between their behaviour and their repercussion on deficit sustainability.

main consolidation effort taking place at the end of the first half of the eighties and the period 1993-95¹⁴.

4. EMPIRICAL APPLICATION

The variables and nomenclature we are going to work with are the following:

- Public revenues (as percentage of GDP): *revy1*
- *Seigniorage* amplified public revenues (that is, enlarged with the monetary base growth due to the public sector), as percentage of GDP: *revy2*
- Public spending as percentage of GDP (including interest debt burden): *spendy*
- * when required, we use the accumulated variables of the original series, respectively named: *revy1_ac*, *revy2_ac* and *spendy_ac*.

Table 1 presents the results of the unit root and stationarity tests carried out on the three series. The battery of tests applied (the null hypothesis in the ADF, PP and MZ_t-GLS tests is non-stationarity; the null in the KPSS is stationarity) allows us to draw clear conclusions: all series are I(1), that is, they have a unit root, and so it is possible to find cointegration relations between them if their corresponding residuals are proven stationary.

Nevertheless, as we are initially interested in analysing multicointegration, we directly estimate the single equation [1], or its following specific application to our case in the alternative versions with revenues (*revy*) equal to *revy1* and *revy2*:

$$spendy_ac = \mu + \delta.time + \theta.time^2 + \beta.revy_ac + \gamma.revy \quad [3]$$

¹⁴ In agreement with Escario (2006)'s results.

We consider the three possible models which depend on the definition of the deterministic component. The multi-DF test (Dickey-Fuller test for multicointegration) checks the null hypothesis of non-stationarity on the residual of equation [3] (v_t in [1]), and the best model is selected by the AIC criterion.

We can highlight the following results from the figures in Table 2: while the best model with standard revenues turns out to be the third one (with linear and quadratic trends), the AIC criterion selects the second (with a linear trend) from among the ones that consider the enlarged revenues. Focusing on those two models (in bold) and comparing the Dickey-Fuller statistics with the critical values at the 5 and 10% levels of significance, we conclude that we reject multicointegration between spending and standard revenues, but not between spending and the amplified revenues.

In model 2 with *revy2*, the estimation of the parameter that represents the first level cointegration relationship between the flow variables is $\beta = 1.09 > 1$ and highly significant. Thus, we can corroborate a slight predominance of deficits in the long run even after including the extra revenues from *seigniorage*. Deficits are logically greater, $\beta = 1.23$, in model 3 with *revy1*. Analysing the parameter that represents the second level cointegration relation, we observe $\gamma = 0.64 > 0$. In this case, despite the deficit persistence, we can label the budgetary path as sustainable, since the political reaction was coherent (raising revenues as public debt increased). We can add that, if we considered the ordinary revenues, and focusing on model 2 with *revy1* (which does not reject multicointegration –AIC values between 2 and 3 are almost the same–), the budgetary path would not be sustainable, given that $\beta > 1$ and $\gamma < 0$ (though γ is not significant). Facing even greater deficits, the fiscal reaction would not be sustainable,

given that increasing levels of debt would be followed by falling revenues. These results can be understood as proof of the importance of *seigniorage* as a –more or less adequate- guarantee of public finance sustainability in the long-run Spanish case.

Nevertheless, the length of the period (144 years) advises considering the possible existence of structural breaks in the relation. This is what we address in Table 3.

The inclusion of a break in equation [3] (Notes to Table 3) gives us interesting results. The AIC criterion focuses the study on the eighth model, the most general, whether we consider the revenues variable as *revy1* or as *revy2*. With *revy1* we cannot reject non-multicointegration nor are the defining parameters significant. This might indicate that the paths of spending and revenues are independent of each other.

With *revy2*, however, we do detect multicointegration, given that the multi-DF test does not reject the null hypothesis. The testing methodology locates the break in 1933, so we can distinguish two subperiods approximately corresponding to the ones before and after the Civil War. Looking at the parameters of the relation, it can be stated that, for the first subperiod, $\beta = -0.81 < 1$ and $\gamma = 0.92 > 0$, indicating surpluses on average but not a coherent fiscal reaction because enlarged revenues rose while wealth increased. In the second subperiod, the parameter values of $\beta = 1.22 > 1$ and $\gamma = -0.40 < 0$ (adding $\beta_1 + \beta_2$, $\gamma_1 + \gamma_2$) indicate that deficits outpaced surpluses (more than for the whole period: $1.22 > 1.14$) and sustainability did not hold, as revenues –even amplified- fell when public debt grew.

Summing up, in Table 2 we concluded that we had sustainable deficits for the whole period with enlarged revenues and now, in Table 3, we conclude that deficits are not sustainable for the second subperiod. Therefore, from 1934 on, (higher) deficits

were predominant, but fiscal reaction was no longer adequate: sustainability cannot be guaranteed even including *seigniorage*. A possible explanation for the non-sustainability of the budgetary deficit path during the second subperiod is that, especially from the 80s onwards, new deficit financing mechanisms emerged: monetization was substituted by a massive issue of debt in the form of other liquid assets (OLA), but the present analysis does not include the potential positive effect of the OLA on sustainability.

In any case, the analysis is useful to reveal 1933 as the break point, indicating a possible behavioural change around that year. To decide the specification of the VECMs, we need to know whether we have at least a first level cointegration relation in the cases where we did not find multicointegration. As we remarked, the EC terms will help us to know the short-run adjustment dynamics of the fiscal variables when there were deviations from the long-run equilibrium relationships (first or first and second level ones). This is shown in Tables 4, 5 and 6.

Table 4 estimates by Ordinary Least Squares the relation between spending and revenues, the latter considered both as standard and enlarged. R^2 values confirm the suspicion that it is quite difficult, or simply impossible, to model any relation between spending and revenues for the pre-war subperiod. In the same way, the representative coefficient of the relation, $c(2)$, is non-significant between 1857 and 1933. We are able, nevertheless, to draw a relation both for the whole period and the second subperiod: considering the standard revenues, the relation tended to end in deficit (higher for 1934-2000); but the deficit becomes surplus if we add the *seigniorage* (higher for 1857-2000).

But Table 5 shows that only the residuals derived from the whole-period relationship can be considered stationary. Thus, there is a first-level cointegration relation only for the whole period (a steady relation between spending and revenues, either standard or amplified). For the whole period we also confirmed a second level cointegration relation, so in Table 6, in agreement with these results, we will estimate the VECMs with their corresponding EC terms (one or two) where $revy = revy1$ and $revy2$, alternatively:

$$\begin{cases} \Delta spendy = c(1) + c(2).EC1_{t-1} + c(3).EC2_{t-1} + c(4).\Delta spendy_{t-1} + c(5).\Delta revy_{t-1} \\ \Delta revy = c(1) + c(2).EC1_{t-1} + c(3).EC2_{t-1} + c(4).\Delta spendy_{t-1} + c(5).\Delta revy_{t-1} \end{cases} \quad [4]$$

Lastly, Table 6 leads us to highlight the following. In these VECMs, the only important parameter that is highly significant is the one beside the first error correction term in the equations on revenues ($\Delta revy$). In a strict sense, $c(2)$ positive and significant in the equation on $\Delta revy$ implies that changes in revenues increase in response to deviations from the flow equilibrium relation. So, we can state that revenues were the only fiscal variable sensitive to the situation, upwardly adjusted in the short run as a reaction to imbalances in the spending-revenue relationship. It can also be observed that when we enlarge the revenues by adding the monetization, the fiscal reaction rises both in intensity and significance, indicating a higher adjustment speed of *seigniorage*. This highlights again that *seigniorage* played an essential role in supporting sustainability.

Regarding the parameter beside the second error correction term, a slightly negative $c(3)$ in the equation on $\Delta revy$ would imply (if it were significant, and it nearly is) that changes in revenues would fall quite slowly when there were deviations from the debt-revenues long-run equilibrium relation (the stock-flow one).

As regards the equations on $\Delta spendy$, we can compare the cases with the standard and amplified revenues. A ‘correct’ behaviour of spending is deduced from the sign of $c(2)$: it would react negatively (decreasing) when there were deviations from the flow equilibrium. In any case, though significance rises in the case of $revy2$, it still does not reach the minimum standard levels.

Summing up, these results allow us to support empirically that, given that spending followed independent dynamics, the Spanish authorities only made use of revenues to react when there were fiscal imbalances, enhancing the effect with the help of *seigniorage*. So we could say that, in some way, monetization allowed the governments to guarantee –even artificially– a *pseudo*-sustainability for their budgetary path.

5. CONCLUSIONS

The following conclusions can be derived from the empirical results obtained for the very long-run Spanish case. Considering the period as a whole, and the usual definition of public revenues, no evidence of multicointegration between spending and revenues is found. However, there is a clear first level cointegration relation between the two variables, characterized by a persistent deficit. On the other hand, taking the *seigniorage* into account, the results change drastically: multicointegration is not rejected between spending and the enlarged revenues, implying the presence of steady cointegration relations both at the first and second levels –that is, there are flow and flow-stock equilibria in the long run. Moreover, though the relation between spending and enlarged revenues is still characterized by deficits, they are lower and the budgetary policy answer appears to be coherent: amplified revenues rose to accommodate public

debt growth. Therefore, it is proven that *seigniorage* played an essential role in achieving the sustainability of the deficit path, since other kinds of measures –more unpopular ones- that could have tried to guarantee that aim, such as undertaking a necessary reform of the obsolete tax system to increase revenues or restrain expenditures, were repeatedly postponed. In fact, including the extra financial support of *seigniorage*, the first level cointegration relation –individually considered- even shows a slight surplus.

Coherently with these results, expressing the relation as a VECM, it can be stated that while public spending had independent dynamics, the revenues (and particularly the amplified revenues) were the variable which tended to be adjusted upwardly when there were temporary deviations from the long-run equilibrium relationship.

If the possibility of structural changes during the period is considered, the test on the null hypothesis of non-multicointegration would only be significantly rejected in the case of the amplified revenues, the break being located around the beginning of the Civil War. Nevertheless, though multicointegration is again defined by a majority of deficits, fiscal reaction can no longer be labelled as coherent. The estimation of the corresponding parameters reveals that, as public debt grew, revenues decreased. That is, from the nineteen-thirties till the year 2000, sustainability of the budget path does not hold even when including the extraordinary contribution of *seigniorage*.

This result could be interpreted as pointing to the progressive loss of weight of monetization as a means to finance fiscal imbalances. With respect to the history of this second subperiod, it is worth remembering the successive efforts to restrain direct monetization, which were particularly firm in 1984 and 1989. Moreover, especially

from the eighties onwards, the governments found new mechanisms to finance their increasing fiscal requirements, namely, the massive issuance of debt in the form of the so-called Other Liquid Assets (OLA) that emerged strongly during the late but rapid Spanish financial development. Not taking into account the financial support that governments obtained with these new liquid bonds (*Pagarés, Letras*, etc.) in the definition of public revenues could explain why the multicointegration test considers the deficit path unsustainable for the second subperiod.

On the whole, our results reveal that budgetary sustainability in the long-run Spanish case depended, to a great extent, on *seigniorage*. Although public finances tended to result in deficit, monetization managed to adjust the imbalances, giving a certain coherence to the fiscal policy reaction (increasing revenues). After the thirties, the deficit problem became more evident: its high growth and the progressive reduction of monetization do not allow us, under this approach, to characterize the budgetary path as sustainable.

APPENDIX: DATA SOURCES

The data series were obtained mainly from the *Estadísticas Históricas de España*, vols. I and II (Carreras and Tafunell (eds.), 2006). Data availability was the selection criterion for the length of the period, since we wished to cover the longest possible interval. The spending series was reconstructed as the sum of “Obligaciones totales del Estado reconocidas y liquidadas” (Chart 12.13, p. 925), “Gasto total extraordinario (1926-1953)” (Chart 12.19, p. 947) and “Gasto total por atrasos de la guerra (1940-1946)” (Chart 12.20, p. 947). Revenues were obtained as the “Derechos reconocidos y liquidados totales” (Chapter 12.9, p. 912) minus the “Producto de la negociación de la

Deuda del Estado y del Tesoro” (Chapter 12.12, p. 922). In order to obtain the amplified revenues, the *seigniorage* component was added (in differences, since it is a stock variable). This series was the most difficult to calculate, finally being reconstructed from several sources. We made use of the Bank of Spain balances based on Anes (1974a, c). We also added the silver coin (1876-1900), also available in Anes (1974b), so as to homogenize the data with the sources of the following period. For the subperiods 1900-1935 and 1940-1962, we used the figures from Martín Aceña (1985) and Martín Aceña (1988), respectively. For the next subperiod, 1962-1981, we used information from different Bank of Spain *Informes* (issues 1976, 1982). Finally, the last subperiod 1982-2000 was covered by several Bank of Spain’s *Boletines Estadísticos* (Statistical Bulletins). All the series were expressed in percentages of GDP, also proceeding from the *Estadísticas Históricas de España*.

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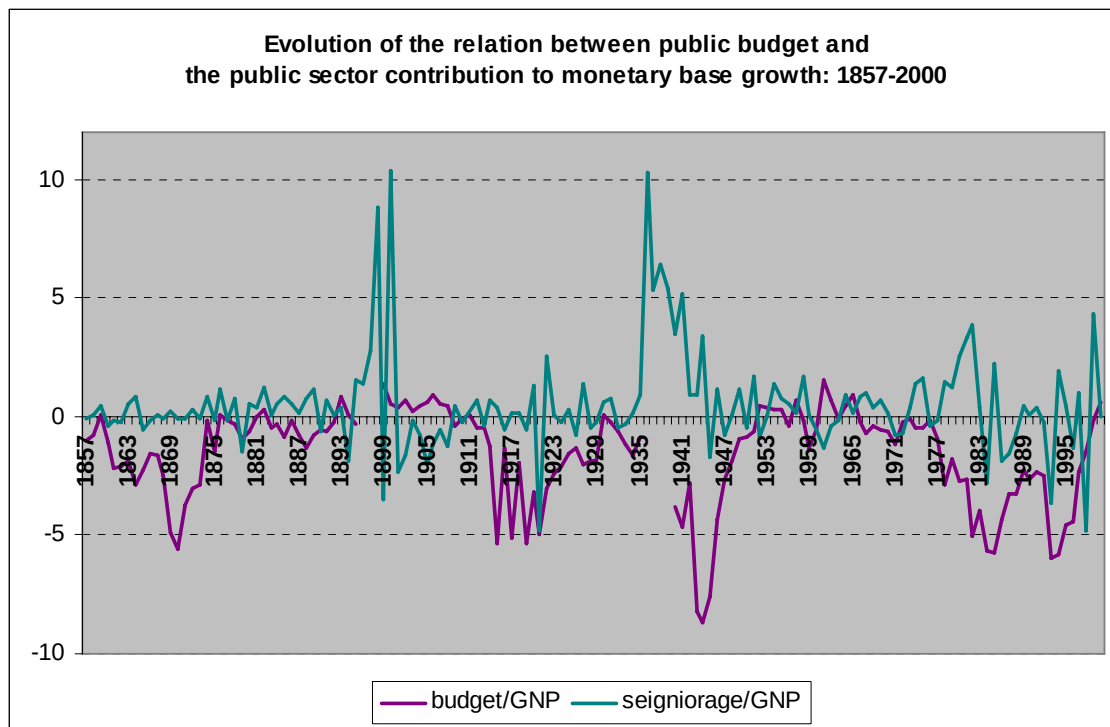
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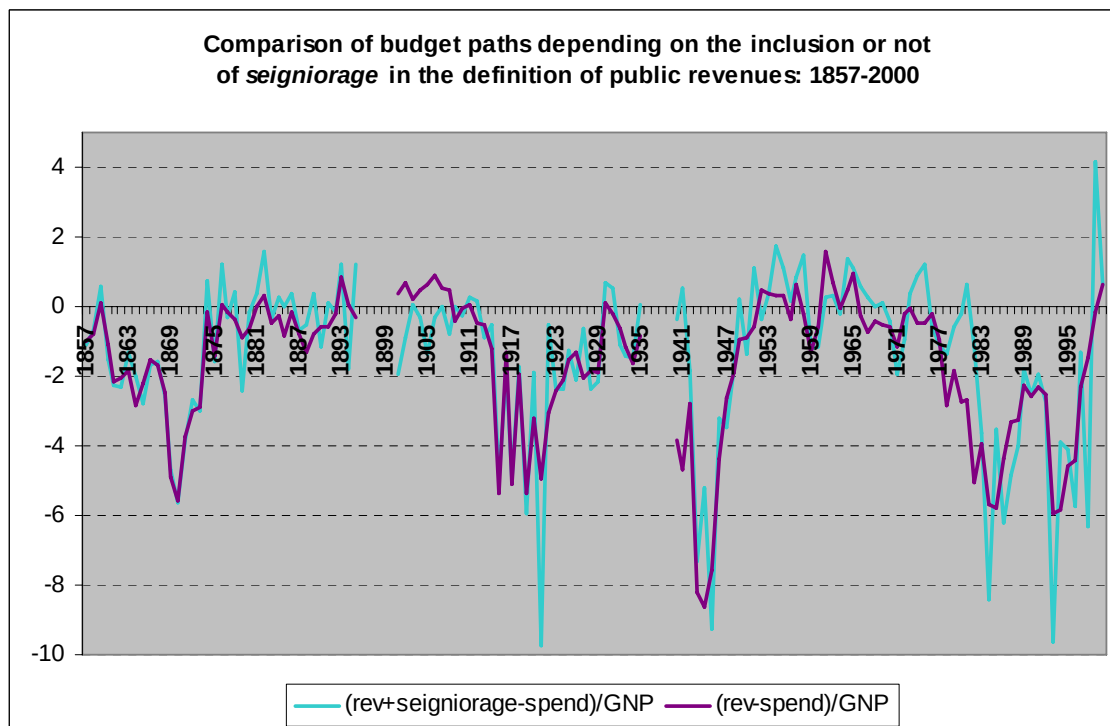
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FIGURES:

GRAPH 1



GRAPH 2



TABLES:**TABLE 1. UNIT ROOT AND STATIONARITY TESTS**

Intercept and trend	ADF	PP	MZ _t -GLS	KPSS
<i>revy1</i>	-2.04	-2.00	-1.95	0.20*
<i>revy2</i>	-2.16	-3.94*	-2.20	0.15*
<i>spendy</i>	-2.33	-2.02	-2.18	0.19*
Intercept	ADF	PP	MZ _t -GLS	KPSS
<i>revy1</i>	-0.74	-0.42	-0.31	0.90**
<i>revy2</i>	-0.93	-2.65	-0.65	0.87**
<i>spendy</i>	-1.25	-0.86	-0.84	0.83**

Notes: ** Significant at 1% and * significant at 5%. Critical values of ADF and PP tests are tabulated in McKinnon (1996). The number of lags of the ADF and MZ_t-GLS tests was selected depending on the SBIC criterion. The Barlett window was used as kernel estimator in the PP test.

TABLE 2. MULTICOINTEGRATION WITHOUT STRUCTURAL BREAKS

<i>revy = revy1</i>	Model 1	Model 2	Model 3
μ	4.17 (0.046)	13.00 (0.001)	11.51 (0.005)
δ		-0.60 (0.011)	-0.92 (0.002)
θ			-0.02 (0.090)
β	1.11 (0.000)	1.17 (0.000)	1.23 (0.000)
γ	0.52 (0.035)	-0.14 (0.685)	-0.30 (0.404)
multi-DF test	-2.97	-4.03	-3.04
5% critical value	-3.89	-4.26	-4.64
10% critical value	-3.55	-3.94	-4.32
AIC	537.93	535.63	535.13
<i>revy = revy2</i>	Model 1	Model 2	Model 3
μ	9.04 (0.001)	15.23 (0.001)	13.17 (0.005)
δ		-0.48 (0.073)	-0.80 (0.027)
θ			-0.02 (0.184)
β	1.04 (0.000)	1.09 (0.000)	1.14 (0.000)
γ	0.94 (0.001)	0.64 (0.048)	0.57 (0.087)
multi-DF test	-3.24	-4.02	-4.08
5% critical value	-3.89	-4.26	-4.64
10% critical value	-3.55	-3.94	-4.32
AIC	582.91	582.25	582.33

Notes: p-values in parentheses.

Based on the equation: $spendy_ac = \mu + \delta.time + \theta.time^2 + \beta.revy_ac + \gamma.revy$

TABLE 3. *MULTICOINTEGRATION ALLOWING FOR ONE STRUCTURAL BREAK*

<i>revy</i> = <i>revy1</i>	Model 4	Model 5	Model 6	Model 7	Model 8
μ_1	14.69 (0.000)	2.70 (0.431)	1.72 (0.938)	1.72 (0.938)	15.58 (0.316)
μ_2	6.24 (0.057)	-16.16 (0.000)	12.68 (0.566)	12.68 (0.566)	-667.88 (0.000)
δ_1	-1.10 (0.001)	-0.85 (0.001)	-0.66 (0.962)	-0.66 (0.962)	13.05 (0.001)
δ_2	-0.32 (0.047)	1.85 (0.000)	-0.02 (0.999)	-0.02 (0.999)	-12.44 (0.002)
θ		-0.02 (0.000)			-0.01 (0.000)
β_1	1.22 (0.000)	1.30 (0.000)	-0.02 (0.999)	1.18 (0.000)	-0.30 (0.520)
β_2			0 (1.000)		-1.59 (0.001)
γ_1	-0.28 (0.458)	0.22 (0.444)	-0.19 (0.601)	-0.19 (0.601)	-1.70 (0.355)
γ_2				0 (1.000)	1.90 (0.308)
break point	1935	1906	1859	1859	1902
multi-DF test	-4.48	-4.65	-4.39	-4.39	-5.07
5% c.v.	-5.90	-6.23	-6.13	-6.23	-6.38
10% c.v.	-5.59	-5.90	-5.80	-5.88	-6.06
AIC	533.77	501.26	537.04	537.04	491.65
<i>revy</i> = <i>revy2</i>	Model 4	Model 5	Model 6	Model 7	Model 8
μ_1	18.62 (0.000)	-2.53 (0.902)	1.97 (0.627)	35.68 (0.965)	2.19 (0.650)
μ_2	-14.24 (0.012)	23.25 (0.261)	-935.40 (0.000)	-33.76 (0.978)	-1439.38 (0.000)
δ_1	-0.91 (0.027)	-1.63 (0.863)	14.59 (0.000)	3.54 (0.973)	16.30 (0.000)
δ_2	-0.06 (0.794)	0.82 (0.931)	-17.03 (0.000)	-4.20 (0.968)	-21.34 (0.000)
θ		-0.00 (0.500)			0.01 (0.000)
β_1	1.14 (0.000)	1.13 (0.000)	-0.54 (0.004)	1.10 (0.000)	-0.81 (0.000)
β_2			1.77 (0.000)		2.03 (0.000)
γ_1	0.43 (0.915)	0.57 (0.080)	0.34 (0.183)	-4.87 (0.966)	0.92 (0.036)
γ_2				5.47 (0.962)	-1.32 (0.009)
break point	1944	1860	1915	1860	1933
multi-DF test	-4.59	-4.63	-5.07	-4.58	-7.02
5% c.v.	-5.90	-6.23	-6.13	-6.23	-6.38
10% c.v.	-5.59	-5.90	-5.80	-5.88	-6.06
AIC	581.02	581.04	543.93	581.28	510.18

Notes: p-values in parentheses.

5% and 10% critical values are tabulated in Carrión-i-Silvestre and Berenguer (2007). They have been considered for a sample size of $n=100$, given that we have a size of 144 and the following tabulation was for $n=250$. Anyway, the results of the tests are the same.

Based on the equation: $spendy_ac = \mu_1 + \mu_2.dum + \delta_1.time + \delta_2.time.dum + \theta.time^2 + \beta_1.revy_ac + \beta_2.revy_ac.dum + \gamma_1.revy + \gamma_2.revy.dum$; where *dum* is a dummy variable of value zero in the subperiod preceding the break and one for the next.

TABLE 4. *OLS ESTIMATION OF THE RELATIONSHIPS*

$spendy = c(1) + c(2). revy1$	$c(1)$	$c(2)$	R^2
1857-1933	7*	0.36	0.07
1934-2000	0.45	1.09**	0.88
1857-2000	0.58	1.07**	0.88
$spendy = c(1) + c(2). revy2$	$c(1)$	$c(2)$	R^2
1857-1933	9.98*	0.02	0.001
1934-2000	1.63	0.95**	0.72
1857-2000	2.21*	0.90**	0.73

Notes: ** Significant at 1%, * significant at 5%.

TABLE 5. *UNIT ROOTS AND STATIONARITY TESTS
(ENGLE&GRANGER COINTEGRATION TEST ON THE RESIDUALS)*

$revy1$ equation residual	DF
No intercept, no trend	
1857-1933	-1.80
1934-2000	-2.73
1857-2000	-4.42**
$revy2$ equation residual	DF
No intercept, no trend	
1857-1933	-0.09
1934-2000	-2.56
1857-2000	-4.60**

Notes: Based on the residuals of the equations: $spendy = c(1) + c(2). revy1$ and $spendy = c(1) + c(2). revy2$.

** Significant at 1%, * significant at 5%.

ADF-tests critical values are derived from McKinnon (1991). The ADF-test number of lags was selected according to the SBIC criterion.

TABLE 6. *ERROR CORRECTION MODELS*

With $revy = revy1$		$c(1)$	$c(2)$	$c(3)$	$c(4)$	$c(5)$	R^2
1857-2000	$\Delta spendy$	0.14	-0.07 (0.38)		-0.20*	0.12	0.039
	$\Delta revy$	0.14	0.14** (0.04)		-0.08	0.04	0.032
With $revy = revy2$		$c(1)$	$c(2)$	$c(3)$	$c(4)$	$c(5)$	R^2
1857-2000	$\Delta spendy$	0.14	-0.072 (0.20)	-0.006	-0.122	0.002	0.040
	$\Delta revy$	0.19	0.23*** (0.006)	-0.07 (0.125)	0.16	-0.43***	0.349

Notes: Based on the systems of equations VECM:

$$\begin{cases} \Delta spendy = c(1) + c(2).EC1_{t-1} + c(3).EC2_{t-1} + c(4).\Delta spendy_{t-1} + c(5).\Delta revy_{t-1} \\ \Delta revy = c(1) + c(2).EC1_{t-1} + c(3).EC2_{t-1} + c(4).\Delta spendy_{t-1} + c(5).\Delta revy_{t-1} \end{cases}$$

where $revy = revy1$ and $revy2$, alternatively; $EC1$ is the residual from the first cointegrating relationship (spending and revenues) and $EC2$ is the residual from the second cointegrating relationship (revenues and debt).

* Significant at 10%, ** significant at 5% and *** significant at 1%; p-values in parentheses.

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