Fiscal sustainability and fiscal shocks in a dollarized and oil-exporting country: Ecuador.

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Abstract

This paper investigates the fiscal sustainability of an emerging, dollarized, oil-exporting country: Ecuador. A cointegrated VAR approach is adopted in testing, first, if the intertemporal budget constraint is satisfied in Ecuador and, second, in identifying the permanent and transitory shocks that affect a fiscal policy characterized by inertia and a heavy dependence on oil revenues. Following confirmation that the debt-GDP ratio does not place the Ecuadorian budget under any pressure, we reformulate the model and identify two forces that push the fiscal system out of equilibrium, namely, economic activity and oil revenues implemented in the government budget. We argue that Ecuador needs to recover control of its monetary policy so as to promote the diversification of its economy and in order that non-oil tax revenues can replace oil revenues as a pushing force. Finally, we calculate the quarterly elasticities of tax revenues with respect to Ecuador's GDP and that of eight Eurozone countries. We illustrate graphically how the Eurozone countries with lower and non-cyclic elasticities suffer debt problems after the crisis. This finding emphasizes the pressing need for Ecuador to strengthen the connection between its tax revenues and output, and also suggests that the convergence of these elasticities in the Eurozone might contribute to the success of an eventually future fiscal union.

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I Introduction

Compared to the large body of empirical literature analysing the effects of monetary policy, economic research examining fiscal policy has been much scarcer until recently. The discussions centred on the Balanced Budget Amendment in the US, the deficit limits of the Growth and Stability Pact of the EMU, and the possibility of having independent institutions running fiscal policy all involve arguments that consider fiscal policy an effective tool for stabilizing business cycle fluctuations and debt-GDP ratios.

Ecuador is a particularly interesting country to study in this context. The fact that it relies on its fiscal policy to counteract both external and internal shocks should, it is assumed, result in the failure of current budget constraints. However, on the contrary, as Figure 1 in Annex II shows, Ecuador has not had to cut its expenditure and, moreover, reports a falling debt-GDP ratio, two unlikely achievements for its European counterparts immersed in the current economic crisis.

Figure 1 describes the pronounced decline that Ecuadorian debt-GDP ratio experienced since 2000. On the peak of a devastating economic crisis the country was forced to default on its Brady bonds ($6.604 million of the total debt) in the summer of 1999. The restructuring process, officially in August 2000, resulted in a reduction of close to 40 percent in the face value of the tendered bonds. After this event, Ecuador focused its fiscal policy on debt reduction. Through the Organic Law on Fiscal Responsibility, Stabilization and Transparency[1], in 2002, was created the Stabilization Fund for Social and Productive Investment and Debt Reduction (FEIREP) as a special trust fund, managed by the Central Bank. The FEIREP funds earmarked 70 percent for debt-buyback operations; 20 percent to stabilize oil revenues and for emergency spending, and 10 percent for education and health spending. The Fund was replaced in 2005 by the Special Account of the Productive and Social Reactivation, Development of Science and Technology and the Fiscal Stabilization (CEREPS). The 70 percent earmarking to debt reduction was reduced to 35 percent[2]. The debt-GDP ratio fell from 86 percent by end-2000 to about 34 percent by end-2006. However, this targeted debt reduction policy carried out by the government caused the revalorization of its international bonds, becoming the debt buyback even more onerous. This fact was the basis of the debt repudiation rhetoric of the president Correa[3]. In December 2008 the debt-GDP ratio achieved a value around 23 percent. The public external debt was the least burdensome it had been in over three decades. Nevertheless, Ecuador decided to default again, making clear its “unwillingness to pay” rather than its “inability to pay”[4].

Most studies in the literature have examined the effects of fiscal policy on macroeconomic variables in order to provide robust stylized facts regarding the effects of fiscal policy shocks. The discrepancies that exist, it is argued, result from the different methodologies adopted to analyse these shocks (see Caldara and Kamps, 2008).

[1] See the third title of the original version of the Organic Law on Fiscal Responsibility, Stabilization and Transparency published in the Ecuadorian Official Registry on June 4, 2002.
[2] See Cueva (2008) for a more extensive description about the FEIREP and CEREPS funds.
[3] See Correa (2005).
[4] The most controversial default was that made in 2008. President Rafael Correa justified the country’s moratorium on the basis that Ecuador’s foreign debt obligations were “immoral,” “illegal” and “illegitimate”. Ecuador stopped payments on 3.2 billion, confined to two of the country’s sovereign bonds: the one maturing in 2012 and another due in 2030, both born out of an earlier sovereign default that took place in August 1999 and accounting for nearly one-third of the external public debt in 2008. Between April and November 2009, the government repurchased the two bonds against cash at a steep discount of 65-70 percent on their face value. See Moodys (2009), Salmon (2009), Das, Papaioannou and Trebesch (2012), Porzecanski (2012), Feibelman (2010) and Díaz-Cassou et al. (2008) in order to go in depth on the Ecuadorian defaults over the last decade.

Irrespective however of the identification approach selected, all the studies concur that positive government spending shocks have persistent positive output, inflation and short term interest rate effects[5].

The same holds for tax shocks. There is a degree of consensus in articles using the sign-restrictions approach (Mountford and Uhlig, 2009) or a narrative approach (Romer and Romer, 2010) that unanticipated tax increases have strongly negative output effects. However, conflicting results are obtained when using the structural VAR approach, so that while Blanchard and Perotti's (2002) findings coincide with the aforementioned studies, Perotti (2002) suggests that output – as well as the inflation and short term interest rate – are unaffected[6].

Recently, these models have been extended to satisfy the government budget constraint[7]. Since the fiscal variables of different countries react distinctly to macroeconomic variable shocks, such analyses should shed some light on how best to harmonize fiscal policies in monetary unions. Favero et al. (2011) identify the existence of heterogeneities between countries due to different fiscal reaction functions, different degrees of openness, and different debt dynamics. They also highlight the importance of including feedback between fiscal and macroeconomic variables in VAR models, since this conditions the reactions of both variable types to fiscal shocks.

Bohn (1998) adds to the debate about fiscal sustainability by demonstrating that rejections of low-order difference-stationarity and cointegration are consistent with the intertemporal budget constraint and he suggests that error-correction-type policy reactions are a promising alternative for understanding debt and deficit problems[8]. He also estimates a positive response of primary surpluses to the debt-GDP ratio, suggesting the sustainability of US fiscal policy for the sample period 1916-1995. Other empirical studies adopting the same line include Bohn (2005, 2007) for the US; Collignon (2012) for Europe; Fincke and Greiner (2012) for selected countries in the euro area; and, Kia (2008) who undertakes the analysis for two emerging countries (Iran and Turkey).

Few studies to date have examined Ecuador's fiscal policy. Cueva (2008) and Almeida et al. (2005) report that the legal framework is cumbersome regarding the distribution and earmarking of oil and tax revenues, creating large rigidities in fiscal management. They describe a "rigid budget characterised by inertia" that offers just eight percentage points to counteract unpredictable shocks[9]. Other articles examining issues of debt sustainability include López-Calix (2003) and Tinsley (2003), who adopt standard approaches to sustainability; Barnhill and Kopits (2003) who, in developing a Value-at-Risk approach, find that the volatility of sovereign spreads and of oil prices constitute major sources of risk for Ecuador's public sector; and Alvarado et al. (2004), who calculate debt threshold sensitivities for different assumptions regarding revenue volatility and

[5] In the case of government spending, Perotti (2008) reports that both private consumption and real wages significantly and persistently increase in response to a positive spending shock, while employment does not react. Mountford and Uhlig (2009) find that the response of private consumption is close to zero and statistically insignificant, while Ramey (2011) reports a negative response to such a shock. Burnside et al. (2004) provide evidence that the real wage persistently and significantly falls while employment persistently and significantly increases.

[6] It should be stressed that all these studies were undertaken using a very similar US sample period. Mountford and Uhlig (2009) and Romer and Romer (2010) simply extend the sample period first studied in Blanchard and Perotti (2002) which ran from 1947:1 to 1997:4.

[7] For instance, Favero and Giavazzi (2007) estimate a fiscal VAR applying two approaches: structural VAR and a narrative approach. They include debt and the stock-flow identity linking debt and deficits, and report more sizeable effects of fiscal policy on output in the narrative approach than in the standard structural VARs.

[8] This article contradicts other studies, including Trehan and Walsh (1988, 1991) and Ahmed and Rogers (1995), basically because the unit root regressions ignore variables such as the level of temporary government spending GVAR, and the business cycle indicator YVAR.

[9] The composition of public expenditure is as follows: 26 per cent for wages, 10 per cent for current transfers, 8 per cent for transfers to regional governments (*gobiernos seccionales*), 3 per cent for investment projects, 10 per cent for interest payments and 32 per cent for amortizations, among other expenditures.

expenditure adjustments. They emphasize that uncertainty in government tax revenues and the inflexibility in its non-interest expenditure leave Ecuador vulnerable to fiscal crises in the future.

Several factors hinder the management of fiscal policies and debt levels in emerging countries: a limited capacity to raise taxes due to an underdeveloped fiscal system; a volatile tax base; liquidity problems derived from a sudden stop in capital flows or "debt intolerance" that accounts for the lower credit ratings of emerging countries; and finally, high liability dollarization and "original sin"[10]. Only this last factor does not apply to Ecuador given that the dollar has replaced the local currency, the *sucre*. However, Mejía et al. (2006) claim that dollarization reforms have limited the diapason of fiscal instruments available to governments, and they warn of the dangers of dependency on oil revenues as a source of instability in a balanced budget.

This article has two aims: first, to determine if Ecuadorian fiscal policy satisfies the intertemporal budget constraint and, second, to determine the main push factors and forces of adjustment (permanent and transitory shocks) interacting in the long run equilibrium. The remainder of this article is organized as follows. Section II briefly describes the theoretical approach of the intertemporal budget constraint extended to oil-exporting countries. Section III presents the econometric methodology. Section IV explains the empirical results. Section V examines the policy implications based on an examination of elasticities of tax revenues with respect to Ecuador's GDP and that of eight Eurozone countries. Finally, section VI summarizes the conclusions that can be drawn from the article.

II The Theoretical Model

An increasing debt-GDP ratio depends on the economic environment $(r_t - g_t)d_{t-1}$, and on the primary surplus. If the interest rate r_t exceeds the growth rate g_t, then the debt-GDP ratio d_t will increase indefinitely unless there is a primary surplus which can offset the rising debt service.

The paths of public debt implied by the sequences of primary surplus s_t and economic environment $(r_t - g_t)$ are:

$$d_{t+n} = \left(\prod_{k=0}^{n}[1+(r-g)_{t+k}]d_{t-1} - \sum_{j=0}^{n}\left(\prod_{k=j+1}^{n}[1+(r-g)_{t+k}]\right) s_{t+j}\right) \quad (1)$$

Assuming the economic environment as given and constant, the accumulation of debt over several periods t=1…n:

$$d_{t+n} = (1+r-g)^n d_t - \sum_{j=0}^{n}(1+r-g)^{n-j} s_{t+j} \quad (2)$$

If we divide by $(1+r-g)^n$ and arrange terms:

$$\frac{1}{(1+r-g)^{t+n}} d_{t+n} = d_t - \sum_{j=1}^{n}\frac{s_{t+j}}{(1+r-g)^j} \quad (3)$$

[10] Many studies examine these issues in depth; see, for example, Alvarado (2004), Reinhart, Rogoff and Savastano (2003), Mendoza (2003), Galindo and Izquierdo (2003).

Assuming that the transversality condition holds[11], fiscal policy will satisfy the intertemporal budget constraint (IBC) because it is on a path whereby the present value of expected future primary surpluses equals the initial debt:

$$d_t = E\left(\sum_{j=0}^{\infty}\frac{s_{t+j}}{(1+r-g)^j}\right) \quad (4)$$

Equation (4) states that debt sustainability requires a variation in the primary budget surplus. A surplus is needed when the growth rate falls below the rate of return on government bonds. Thus, whether fiscal policy is sustainable or not depends on the sign of the fiscal policy reaction with respect to the target: if an increase in debt is followed by an increase in primary surpluses, debt is sustainable. In the long run, the debt-GDP ratio is required to converge on an equilibrium position that is determined by the nominal growth rate, target reference values and adjustment coefficients[12].

In order to explain the sustainability of oil-producing countries, Kia (2008) extends Barro's (1979, 1986) tax smoothing model by introducing energy revenues. In Barro's approach, the base of real taxable income is a deterministic variable $y_{t,}$ a fixed fraction of real GDP that generally depends on the path of tax rates. Kia (2008) assumes GDP to be a function of the country's energy income.

Let τ_t be the average tax rate and $\tau_t y_t$ the real tax revenues. The total government revenues of an oil-producing country are, therefore, the sum of $\tau_t y_t$ and EN_t, the oil revenues derived from the exports of the natural resource. The government budget constraint, Equation (4), with constant real interest rate, r, and in a situation in which the country has energy income is:

$$d_t = E\left(\sum_{j=0}^{\infty}\frac{(\tau y_{t+j} + EN_{t+j}) - (Gov_{t+j} + rd_{t+j-1})}{(1+r-g)^j}\right)$$

where the primary surplus S_{t+j} is now different from that in Equation (4) given the inclusion of EN_{t+j}[13].

In line with Kia (2008), we have to make several assumptions for empirical purposes. First, we assume that real government expenditure, Gov_t and the real tax base y_t can be expected to fluctuate around the common rate of the growth of the economy g. Second, the expected present value of energy income is also its current value. This means that all economic agents expect energy revenues

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[11] The initial debt equals the expected present value of future primary surpluses if and only if discounted future debt converges to zero (Bohn, 2005).

[12] Collignon (2012) adopting the fiscal reaction function $\Delta s_t = \alpha(def_t - z_1) + \beta(debt_t - z_2)$ relates the deficit and debt ratios with the primary surplus. z_1 and z_2 are the target reference values for the deficit and debt ratios respectively under the Stability and Growth Pact; α and β are the adjustment speed coefficients by which governments respond to the deviation from the deficit and debt ratio reference values, respectively.

[13] Alvarado (2004) points out the main problem of this given that it assumes that increasing resource exploitation to pay the debt does not affect sustainability. It is assumed that oil reserves have the same return as the government's other financial assets and liabilities.

not to change over the remaining life of the oil reserves[14]. Third, the oil reserves are expected to last forever. This assumption, however, is unsustainable based on OPEP's Annual Statistical Bulletin which states that Ecuador has about 8,235 million barrels of proven reserves and an exportable trend of 334 thousand barrels per day in 2011, that is, seventy per cent of its production. We thus simplify the model, including the fact that interest rates and price levels are kept constant, as we are analyzing a dollarized country[15].

If we resolve empirically that in the long run oil revenues, as opposed to non-oil tax revenues, are pushing away from the steady state, we can assume that this intertemporal budget constraint is not sustainable, given that oil revenues will dry up, unless the country diversifies its economy and substitutes the volatile oil sector with others that are more sustainable over time.

III Data and Econometric Methodology

The study of the dynamic response of macroeconomic variables to shifts in fiscal policy is usually carried out by estimating a vector autoregressive (VAR) model of the form:

$$X_t = \sum_{i=1}^{k} \prod_i X_{t-i} + e_t$$

Where X_t includes the minimum set of variables required for the VAR analysis, i.e., government spending net of interest, net tax revenues, output, inflation and interest rate (Perotti, 2002). Here, we extend this set to include the debt level, as Bohn (1998) has shown that the feedback obtained from the debt to tax and government spending ratios is statistically significant and economically relevant. The importance of monitoring debt dynamics when analysing fiscal policy has also been stressed by Romer and Romer (2010), Favero and Giavazzi (2007) and Favero et al. (2011)[16]. This result has clear implications for countries with fixed exchange rate regimes, including pegged or monetary union regimes.

We use monthly data from the Central Bank of Ecuador and from the Agency of Energy, covering the period 2000:1 to 2012:7. The fiscal variables are the log of government expenditure net of interest $lgov_t$, the log of non-oil tax revenues $lrev_t$ and the log of oil revenues $lorev_t$. For the first model we use the sum of these last two figures to obtain the log of total fiscal revenues: $ltrev_t$. The remaining variables are the log of the Economic Activity Index (EAI) represented by $leai_t$ and the

[14] Where t = m when the country's energy resources are exhausted, and I_t the information available at time t, including the state of the economy:

$$EN_t = E\left[\int_0^m EN_t e^{-rt} dt \mid I_t\right]$$

[15] We reject the null hypothesis of non-stationarity for Ecuadorian inflation.

[16] Romer and Romer (2010) claim that the effect of a US tax shock on output depends on whether the change in taxes is motivated by the government's desire to stabilize the debt or not. Favero and Gavazzi (2007) also find that interest rates depend on future monetary policy and the risk premium, both variables being affected by the debt dynamics. Hence, the absence of an effect of fiscal shocks on the long-term interest rates, a frequent outcome in VAR-based research that omits debt level, is due to a misspecification.

log of the external and internal debt-GDP ratio $ldebt\_gdp_t$. The EAI variable was chosen instead of GDP because Ecuador was dollarized in 2000:1 and GDP is only reported annually or quarterly; thus, in order to be able to use the highest number possible of observations from the dollarized period we include the EAI which is reported monthly.

Hence, the first model we estimate comprises the following vector of endogenous variables: $X_t = [ltrev_t, lgov_t, leai_t, ldebt\_gdp_t]$[17]. We include neither the interest rate nor inflation, since both are constant throughout the sample period.[18]

IV Empirical Results

We start with the CVAR specification. We first estimate the unrestricted VAR(k) model with different lag lengths k using general-to-specific testing and information criteria to determine a lag length with no autocorrelated error terms. With k=4, the model presents neither autocorrelation nor ARCH effects. However, normality is strongly rejected. The univariate tests show that normality is rejected due to the non-normality in the debt-GDP ratio variable: two outliers produce skewed residuals and generate excess kurtosis. The outliers are associated with two key moments in Ecuador's history when, as mentioned, its external debt was restructured: August 2000 and June 2009[19]. However, even when the first restructuring took place in August 2000, it was not until January 2001 that the total debt-GDP ratio illustrated the break level. We, therefore, introduce two unrestricted shift dummies: 2001:01 and 2009:06, that have the value 1 if *t* refers to any of those dates but is zero otherwise.

All our statistical tests are now acceptable. The univariate tests of normality only reveal some kurtosis in the residues of the debt-GDP variable but no skewness (which can be considered more serious than kurtosis)[20]. Thus, our model is well-specified and the empirical results are reliable.

Given that we have four trending variables, we allow for trends in the levels and a non-zero mean of the cointegration relations. Likewise, we allow for a trend in the cointegration relations, since the trends in the levels do not cancel out in the cointegration relations. After testing the non-stationarity of the variables, we calculate the trace test statistics (Johansen, 1996), one including both seasonal and permanent dummies, and a second without dummies as a sensitivity analysis. Both tests determine the existence of one cointegration relation; thus, three common stochastic trends are pushing the system out of equilibrium.

Once the CVAR model is restricted to r=1 and has passed a number of diagnostic tests for parameter constancy, including the log-likelihood test or recursively calculated trace test statistics[21],

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[17] Unlike Favero and Giavazzi (2007), we include the debt-GDP ratio among the endogenous variables, in order to capture the rich dynamics of fiscal aggregates in the cointegrated VAR. As the government debt is an accumulation of budget deficits, if we include the debt-GDP ratio we do not include the interest payments.

[18] The empirical application is carried out using CATS software, in line with Juselius (2006), who argues the advantages of employing the cointegrated VAR approach over others (cf. Hoover et. al (2007); Juselius, 2009). See Annex I to a brief explanation.

[19] The total external debt ratio was reduced from 106 per cent GDP at the end of 1999 to around 98 per cent in 2000 (Quispe-Agnoli, 2006). In June 2009 the Correa government defaulted on \$3.2 billion of foreign public debt, and then completed a buyback of 91 percent of the defaulted bonds (Sandoval, 2009).

[20] Simulation studies have shown that valid statistical inference is sensitive to the violation of some of the assumptions, including parameter non-constancy, autocorrelated residuals (the higher, the worse) and skewed residuals, while quite robust to others, such as excess kurtosis and residual heteroscedasticity.

[21] Interestingly the test of constancy is rejected if the oil revenues variable is included in the model, confirming the volatility of revenues of this type. All tests are available upon request.

we test the long-run exclusion and weak exogeneity hypotheses. These have been tested with a likelihood ratio test procedure described in Johansen (1996), Johansen and Juselius (1990) and Juselius (2006). If we accept the null hypothesis of the test of long run exclusion, i.e. a zero row restriction on β, the variable is not needed in the cointegration relations. Testing whether a variable is weakly exogenous is equivalent to test a zero row in α. When accepted it defines a common driving trend in the system since this variable does not adjust to the long run relations.

We check that the debt level variable can be excluded from the cointegration relation and the weak exogeneity test points to the variables that are pushing the system out of equilibrium, namely, the EAI and the government expenditure. Annex III presents the main tables (Table 1 and Table 2) related to these results.

These results can be read in more than one way; thus, it might be that Ecuador's debt-GDP ratio does not place the government under any pressure, or it might be that its intertemporal budget constraint cannot be described by cointegration relations if the debt is decreasing during most of the sample period while government expenditure rises[22], unless government revenues offset the difference. However, the revenue variable adjusts to the cointegration relation; it is not a variable pushing the system out of equilibrium. The variable which does present this condition is government expenditure, and this might confirm its inertial nature as described elsewhere or it might correspond to other forces not included in the model.

In order to determine the actual exogenous forces that make government expenditure a weak exogenous variable we estimate the following CVAR: $X_t = \left[lrev_t, lgov_t, leai_t, lorev_t \right]$. We divide total revenue between its oil and non-oil sources and exclude the debt-GDP ratio, since here again this variable can be excluded from the new model.

From the previous model we retain the lag number and the deterministic terms, but we change the permanent dummy variables to 2005:4 and 2006:10 in order to avoid problems of skewness in the EAI and the oil revenue variable, respectively. We determine the rank with and without dummies and decide for r=2 without dummies (See Table 3). The exogeneity tests show the two possible common stochastic trends: economic activity and oil revenues (See Table 4).

The Table 5 shows the residual correlations. The government expenses variable is related to both oil and non-oil tax revenues; and non-oil tax revenues are related to economic activity, oil revenues and government spending. Therefore, we need the structural MA representation, which requires structural and uncorrelated residues in order to interpret the empirical shocks adequately.

It can be derived from Annex I that if multiplying by a B matrix, then we add p*p additional parameters to the cointegrated VAR. This being the case, we need to impose exactly the same number of restrictions on the model's parameters to achieve a just-identification scheme. Since we have four variables, the B matrix adds 16 new coefficients. The assumption that u~IN (0,I) implies ((p*(p+1)/2) = 10) ten restrictions on B (four unit coefficients on the diagonal elements and six zero restrictions on the off-diagonal elements).

Four additional restrictions ((p-r)*r =4) are necessary to separate transitory from permanent shocks, and two more restrictions are required to achieve a just-identified structural MA model. The latter are essential because there are two possible sequences of the transitory shocks and two possible sequences of the permanent shocks. A single specification can be obtained by imposing one

[22] Ray and Kozameh (2012) and the World Bank (2005) provide further details about the expansive programs addressed at reducing poverty levels and raising education levels.

exclusion restriction on the common trend and one exclusion restriction on the transitory impulse response.

The impulse response functions are calculated with the following structurally identified MA model:

$$\begin{bmatrix} lrev_t \\ lgov_t \\ leai_t \\ lorev_t \end{bmatrix} = \begin{bmatrix} 0 & 0 & * & * \\ 0 & 0 & * & * \\ 0 & 0 & * & 0 \\ 0 & 0 & * & * \end{bmatrix} \begin{bmatrix} \sum_{i=t}^{t} u_{s1,i} \\ \sum_{i=t}^{t} u_{s2,i} \\ \sum_{i=t}^{t} u_{l1,i} \\ \sum_{i=t}^{t} u_{l2,i} \end{bmatrix} + \begin{bmatrix} * & 0 & * & * \\ * & * & * & * \\ * & * & * & * \\ * & * & * & * \end{bmatrix} \begin{bmatrix} u_{s1,t} \\ u_{s2,t} \\ u_{l1,t} \\ u_{l2,t} \end{bmatrix} + C_1 B^{-1} \begin{bmatrix} u_{s1,t-1} \\ u_{s2,t-1} \\ u_{l1,t-1} \\ u_{2l,t-1} \end{bmatrix}$$

The one exclusion restriction on the permanent shocks is defined by assuming that only supply shocks can affect economic activity in the long run; thus, oil revenues do not impact on production, as proxied by the $leai_t$ variable. The one exclusion restriction on the transitory shocks is defined by assuming "sticky" taxes, so tax revenues do not react immediately to a government expenditure shock.

The estimated matrix B normalized at the largest coefficient in each row in Table 7, defines how the orthogonalized permanent and transitory shocks are associated with the estimated CVAR residuals. Recovering the last two rows and substituting in the equation: $u_t = Be_t$ we obtain the combinations which make up the permanent shocks:

$$u_{l,1} = B'_{l,1} e_t = 0.103 e_{lrev,t} - 0.11 e_{\lg ov,t} + e_{leai,t} + 0.135 e_{lorev,t}$$

$$u_{l,2t} = B'_{l,2} e_t = 0.233 e_{lrev,t} - 0.961 e_{\lg ov,t} + e_{leia,t} - 0.381 e_{lorev,t}$$

It appears that both the first and the second permanent shocks are given primarily by shocks to the economic activity. The results suggest that oil revenue shocks have less influence, which can be considered a favourable outcome given the finite nature of oil reserves. The importance of the government spending shock is worth noting in the second permanent shock. This is in line with reports elsewhere that are critical of the rigid nature of Ecuador's public budget. Table 6 and Figure 7 in Annex III describe the dynamic impulse response functions after 23 periods for each of the system's variables resulting from a one standard deviation shock. We are able to verify that all the transitory shocks have a zero long-run impact on the four variables, whereas all permanent shocks have a non-zero impact, except for the identifying zero impact of economy activity. From this we can infer that oil revenues depend on both government demands and economic activity shocks, and that Ecuador needs to develop its fiscal system so as to ensure that tax revenues constitute not only the most important shock but also the most highly affected variable.

V Policy implications based on elasticities

Having completed the fiscal sustainability exercise based on a CVAR, we chose to conduct a further experiment based on fiscal revenues elasticities. Given that the debt-GDP ratio had not put the Ecuadorian government under pressure over the last decade, we sought to show, by drawing comparisons with the situation in Europe, the consequences of a fiscal policy that fails to stabilize tax revenues. In so doing we follow Eichengreen and Wyplosz (1998), who analyzed whether the Stability and Growth Pact would favour the sustainability of member countries.

We construct the elasticity of government revenue with respect to GDP (erevgdp), which measures the contribution of one unit of product to budget revenues, i.e., the degree of connection between economic growth and government revenues. Countries with a low degree of connection are expected to present the worst debt problems[23]. In order to calculate the elasticities for the Eurozone countries we use the quarterly Eurostat data based on government statistics. To calculate the Ecuador elasticities we employ the monthly data (converted to quarterly revenues) used in the CVAR models described above. We employ an initial elasticity for total revenue including oil revenue and a second for tax revenue only.

Figure 2 shows two groups of countries: group A comprises three countries (Austria, France and Germany) with debt-GDP ratios under 100 percentage points in 2011Q4 together with Belgium, which exceeded this limit in 2012; while group B comprises three countries (Greece, Ireland and Portugal) with debt-GDP ratios over 100 percentage points together with Spain, which while it presents a debt-GDP ratio similar to those in group A, suffers major credit problems as a result of the collapse of its banking sector and high levels of unemployment[24]. The various graphs show the connection between GDP and the country's budgets: those in group A present cyclic or stationary elasticities; those in group B present non-stationary elasticity, with the exception of Spain. In the case of Ecuador, even when its oil revenues are included, the relationship between revenues and output is poor; when they are excluded, the relationship deteriorates further.

Finally, Figures 4 and 5 relate country debt-GDP ratios with deficit-GDP ratios. If we compare these with Figure 2 we realize that Belgium is the country with the highest debt-GDP ratio both before and after the crisis. Yet, differences emerge in the case of all the other countries: Belgium is the country with the lowest degree of connection between its GDP and government revenues; Austria and Germany present negative elasticities of revenues with respect to GDP, but their elasticities rise no higher than |-20|; while in Greece, Ireland and Portugal they are around |-40|, |-75| and |-500|, respectively.

In the case of the group B countries, Greece records the highest debt-GDP ratio before and after 2007. It would seem that the large negative elasticity of revenues with respect to GDP (|-40|) accounts for the high debt-GDP ratio in this country. Ireland has the second highest debt-GDP ratio reaching 100 percentage points. It is worth noting that Ireland has greater deficits but less debt than Greece. It is comprehensive since it has a larger positive elasticity of revenues with respect to GDP, which allowed several surplus events before the crisis. Spain not also accumulated surplus but presents a stationary elasticity of revenues with respect to GDP, a key difference that might save it from entering into an even deeper crisis.

23 Annex II includes all the figures and tables relevant to this section. The analysis has been completed for all the Eurozone countries with the same results and is available upon request.

24 See the Eurostat report of debt-GDP ratio at http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/2-23072012-AP/EN/2-23072012-AP-EN.PDF.

The above analysis can also be applied to the Ecuadorian economy. First, Ecuador does not present a stationary elasticity of tax revenues with respect to GDP (See Fig. 4), even when we include the oil revenues (See Fig. 3), which means that Ecuador does not have a cyclic source of revenues that can cover overall government spending. Unfortunately, Ecuador is following the same path as those countries in group B above. Ecuador needs to diversify both its economy and tax system in order to strength the connection between the two and so as to face any future fiscal crises.

VI Conclusions

This article seeks to clarify whether fiscal sustainability is possible in Ecuador taking into account that it is a dollarized country and one that is strongly dependent on oil revenues, which are particularly volatile because of price fluctuations. We estimate the cointegrated VAR with the variables from the intertemporal budget constraint and confirm previous findings that characterize Ecuadorian government expenditure in terms of its inertia and heavy dependence on oil revenues. We verify that Ecuador does not have a debt problem as the debt-GDP ratio can be excluded from the cointegration relation. We show that the debt-GDP ratio falls as long as government spending rises; therefore, we conclude that government expenditure is not tied to debt. In addition, this allows the Ecuadorian government to keep expenditure high as it does not increase the debt-GDP ratio.

However, it would seem that given its non-diversified economy, Ecuador is vulnerable to future debt problems. If we compare the total government expenditure of the Eurozone countries and their revenue behaviour since becoming part of the EMU, Ecuador seems likely to suffer similar debt problems in the future. From calculations of the quarterly elasticity of tax revenues with respect to GDP, it can be seen that countries with high elasticities are the ones with the smallest debt problems today. However, Ecuador presents patterns of behaviour that adhere closely to those presented by economies with low tax revenues elasticities. But by diversifying its economy, and by basing it on a lasting, renewable sector, this elasticity should be raised, as eventually fiscal sustainability will depend on these stable, more profitable sectors.

The fact that Ecuador is a dollarized country means that it has relinquished control over both its interest rates and exchange rates, the latter being fundamental in failing sectors other than the oil sector. As such, Ecuador needs to rethink its exchange rate regime, and if a monetary union is among the alternatives open to it, it is our belief that within the framework of such a union the convergence of these tax revenues elasticities might be a key factor in its achieving a successful fiscal union so as to avoid any "non-odious and legitimate" debt crises that might end up being restructured.

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Annex I. Econometric Model: Cointegrated VAR

Following Engle and Granger (1987), Johansen and Juselius (1990; 1992) extend the VAR model by applying the concepts of cointegration and error correction to analyse long run relations among non stationary variables. This extension is referred to as cointegrated VAR.

Consider the *p*- dimensional VAR (*k*):

$$X_t = \sum_{i=1}^{k} \prod_i X_{t-i} + \phi D_t + e_t \qquad (1)$$

Where X_t is a p*1 vector of endogenous variables with t=1,2..T; $\prod_i$ is p*p matrices of parameters to be estimated with i=1,2…k; D_t is a vector of deterministic terms as a constant, trend or dummy variables. Finally, e_t is a p*1 vector of error terms which follow a Gaussian distribution: e_t ~ iid with N(0,Ω). The residual covariance matrix (Ω) is a p*p matrix containing the information about contemporaneous effects. And *k* is the number of lags necessary to have an appropriate model (no autocorrelation, no ARCH effects and normalized errors).

This *p*- dimensional VAR (*k*) can be re-written in the Vector Error Correction Model (VECM) form:

$$\Delta X_t = \Pi X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Phi D_t + e_t \qquad (2)$$

Where,

$\Pi = \sum_{i=1}^{k} \prod_i - I_p$ represents the long run effects and $\Gamma_i = -\sum_{j=i+1}^{k} \prod_j$ the short run effects, with i= 1, …,k-1 and e_t ~ iid N(0,Ω).

We have that ΔX_t and ΔX_{t-i} are stationary because they perform first difference processes to get rid of the just one unit root that the level variables contain. Since a stationary process cannot be equal to a non-stationary process, the estimation results can only make sense if $\prod_i$ defines stationary linear combinations of the variables (Juselius, 2006). $\prod_i$ can be written $\prod_i$ = αβ', where α and β'are p*r matrices, r ≤ p. Thus, under the I(1) hypothesis, the cointegrated VAR model is given by:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \cdots + \Gamma_{k-1} \Delta X_{t-k+1} + \alpha\beta' X_{t-1} + \Phi D_t + e_t \qquad (3)$$

where $\beta' X_{t-1}$ is an r*1 vector of stationary cointegration relations. Under the hypothesis that $X_t \sim I(1)$ all stochastic components are stationary in model (3) and the system is now logically consistent.

Cointegration exists when two or more variables share common stochastic and deterministic trends, they move together in the long run, and therefore they can be interpreted as long-run economic steady-state relations.

$\beta' X_{t-1} = \beta_0$ describes a system in equilibrium where there is no economic adjustment force to change the system to a new position. When exogenous shocks affect the system, and $\beta' X_{t-1} - \beta_0 \neq 0$, the adjustment term α , pull the process back towards the long run equilibrium. If r=1 there is a unique stationary relation. If r>1 only the cointegration space $\left(\prod_i = \alpha\beta'\right)$, and not the cointegration parameters (α and β), is estimated consistently. We have to resolve an identification problem.

The VECM expressed as a function of the innovations of the system shows which common stochastic trends are responsible for the non-stationarity of the process.

$$X_t = C \sum_{i=1}^{t} (e_i + \Phi D_t) + C^*(L)(e_t + \Phi D_t) + X_0 \qquad t=1,2,\ldots,T$$

Where,

$$C = \beta_\perp (\alpha_\perp' \Gamma \beta_\perp)^{-1} \alpha_\perp' \qquad \text{or} \qquad C = \beta_\perp^* \alpha_\perp'$$

Where,

$$\beta_\perp^* = \beta_\perp (\alpha_\perp' \Gamma \beta_\perp)^{-1}$$

The idea is to determine which variables are simply adjusting to a long run equilibrium equation i.e. significant alphas (α) in order to identify which ones are simply pushing the system (insignificant alphas, therefore can be zero in the VECM).

Knowing that $\alpha_\perp' \alpha = 0$, a zero row in alpha corresponds to a unit vector in $\alpha_\perp$, we say that this variable is long-run weakly exogenous implying that its cumulated residuals can be considered a common stochastic trend, then $\alpha_\perp' \sum_{i=1}^{t} e_i$ is understood as an estimation of the p - r common stochastic trends.

This does not imply that the variable itself is a common trend. For this we need the rows of the Γ_i matrices associated with the weakly exogenous variable to be zero. Given $X_t \sim I(1)$ this is essentially the condition of strong exogeneity, under which the equation for a strongly exogenous variable $X_{j,t}$ becomes $\Delta x_{j,t} = e_{j,t}$, in this case $x_{j,t} = \sum_{i=1}^{t} e_{j,i}$: the common stochastic trend coincides with the variable itself, and then, $x_{j,t}$ will have a unit row vector in the C matrix.

Similar to α and β, we can transform $\beta^{*}_{\perp}$ and $\alpha^{/}_{\perp}$ by a non-singular (p-r)*(p-r) matrix Q without changing the value of the likelihood function:

$$C^{c} = \beta^{*}_{\perp} Q Q^{-1} \alpha^{/}_{\perp} = \beta^{*c}_{\perp} (\alpha^{c}_{\perp})^{/}$$

Additional restrictions on $\beta^{*}_{\perp}$ and $\alpha_{\perp}$ do constrain the likelihood function making possible the over identifying restrictions on $\alpha_{\perp}$ and $\beta_{\perp}$ which can be expressed as testable restrictions on α and β. In our case, with r=2 and $X^{'}_{t} = [g_{t}, t_{t}, y_{t}, d_{t-1}]$ we test the weak exogeneity of debt level and economic activity in the following manner:

$$\alpha = \begin{pmatrix} * & * \\ * & * \\ 0 & 0 \\ 0 & 0 \end{pmatrix} \qquad \alpha_{\perp} = \begin{pmatrix} 0 & 0 \\ 0 & 0 \\ 1 & 0 \\ 0 & 1 \end{pmatrix}$$

With a C matrix:

$$C^{c} = \begin{pmatrix} 0 & 0 & * & * \\ 0 & 0 & * & * \\ 0 & 0 & * & * \\ 0 & 0 & * & * \end{pmatrix}$$

Even when the unrestricted C matrix gives very useful information about the effects of the stochastic driving forces in the VECM, and the restricted C^{c} can be used to check the robustness of the analysis, the challenge is to recover the structural shocks in order to interpret the results empirically[25]. This means that we have to obtain the empirical shocks from a structural MA model, i.e. the structural C^{c} matrix[26].

By premultiplying (2) with a non-singular p*p matrix B we obtain the VECM with simultaneous effect:

$$B\Delta X_{t} = B_{1}\Delta X_{t-1} + b\beta^{/} X_{t-1} + B\,\Phi D_{t} + u_{t}$$

[25] A column of insignificant coefficients means that the empirical shocks of the corresponding variable have only temporary effects on the variables of the system, while a column of significant coefficients means permanent effects. The rows in C matrix inform us about the weights with which each variable is influenced by any of the cumulated empirical shocks.

[26] Juselius (2006) points out that omitted relevant variables generate correlated *p* residuals in VAR, a feature that is not assumed to be present in the structural VAR model, where the orthogonality of structural VAR errors is based on an assumption that the model contains all the relevant variables. This is the main reason why the labelling of empirical residuals as structural shocks is often misleading.

Where $B_1 = B\Gamma_1$, $b = B\alpha$ and $u_t = Be_t$.

The B matrix defines how the structural shocks u_t are associated with the VECM residuals.

The structural MA representation of the CVAR:

$$X_t = \tilde{C}\sum_{i=1}^{t} u_i + \tilde{C}^{*} u_t + X_0$$

Where $\tilde{C} = C B^{-1}$ and $\tilde{C}^{*} = C^{*}(L)B^{-1}$

Making a distinction between orthogonalized permanent and transitory shocks, we can find a B matrix to fulfil the following assumptions:

1. A distinction between r transitory and p − r permanent shocks is made, i.e. $u_t = (u_s, u_p)$
2. The transitory shocks have no long-run impact on the variables of the system whereas the permanent shocks have such effects on at least one variable in the system.
3. $E(u_t u_t') = I_P$, i.e. all 'structural' shocks are linearly independent.

Annex II. Figures

Fig.1. Total government expenditures and Debt/GDP ratio in Ecuador.

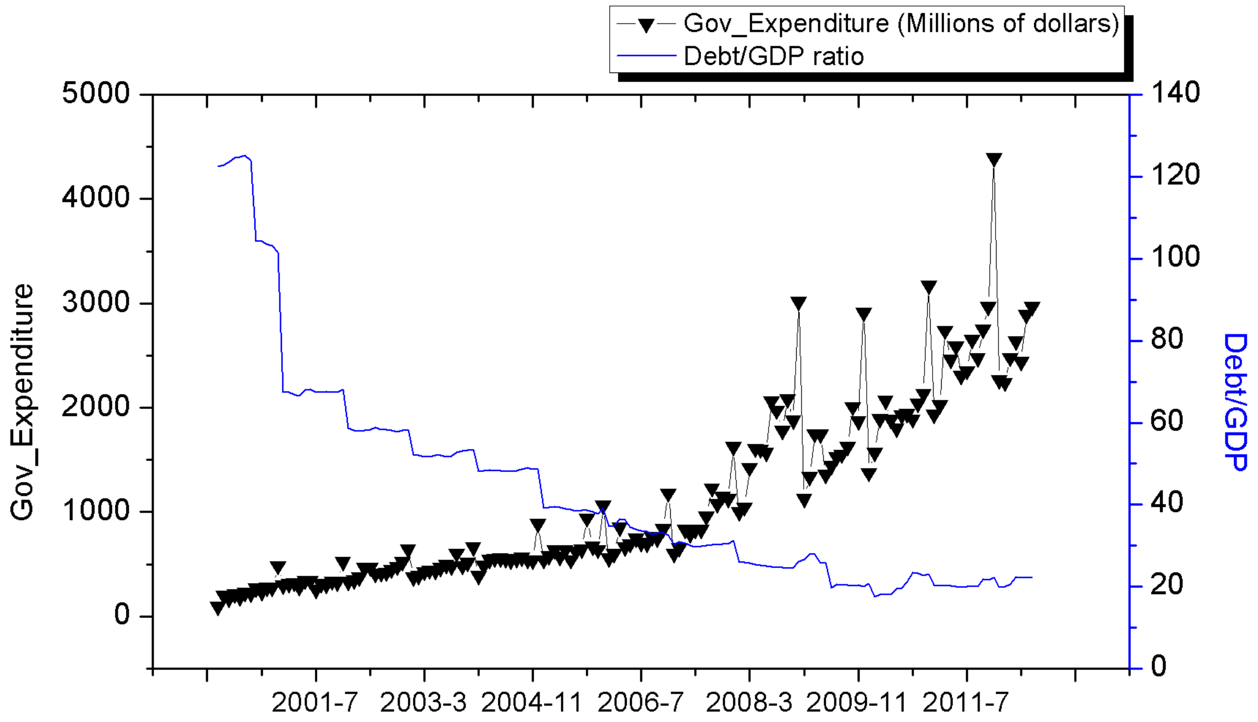
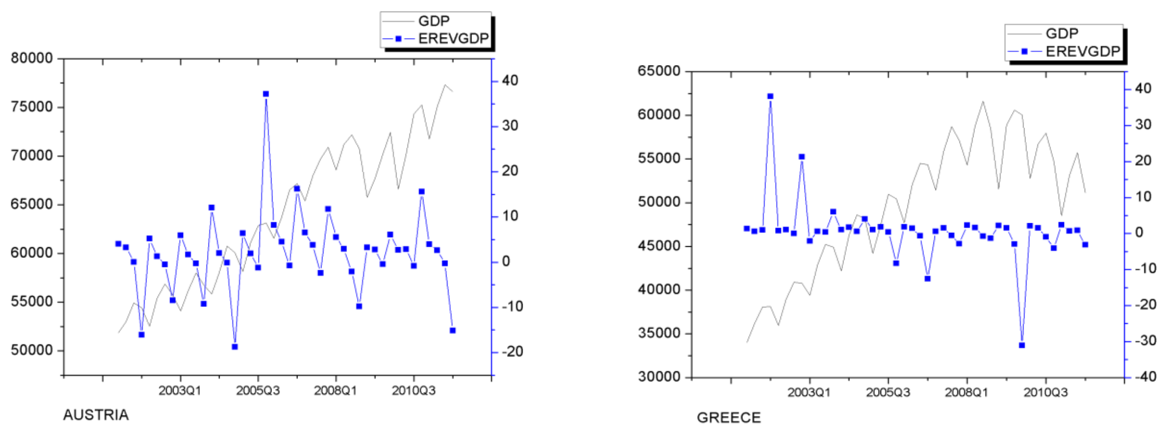


Fig.1. Own Construction with the Central Bank of Ecuador data. The government expenditures are inclusive interest payments showing how Ecuador can diminish its Debt/GDP ratio without abandoning its rising expenditures trend.

Fig. 2. Relation between the Elasticity of Revenues respect GDP vs GDP of countries



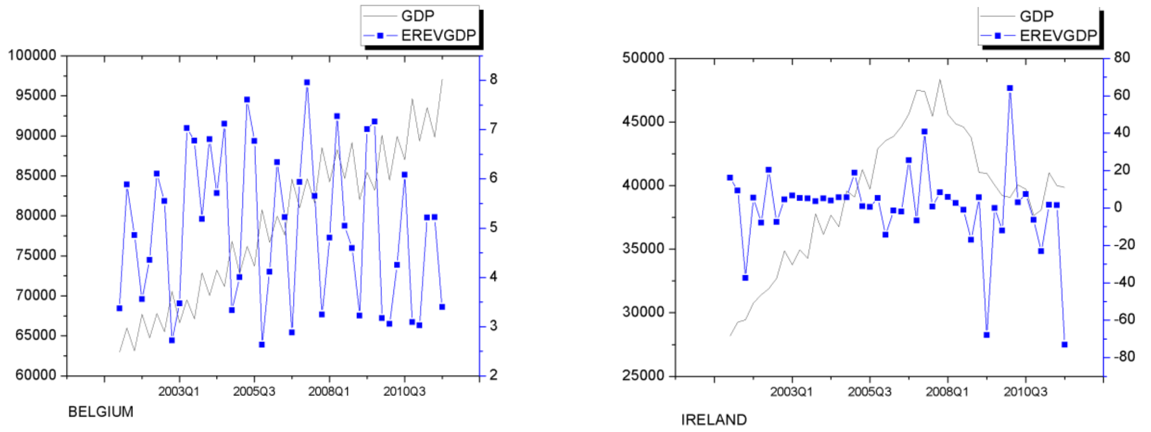


Fig. 2. Relation between the Elasticity of Revenues respect GDP vs GDP of countries (Continuation).

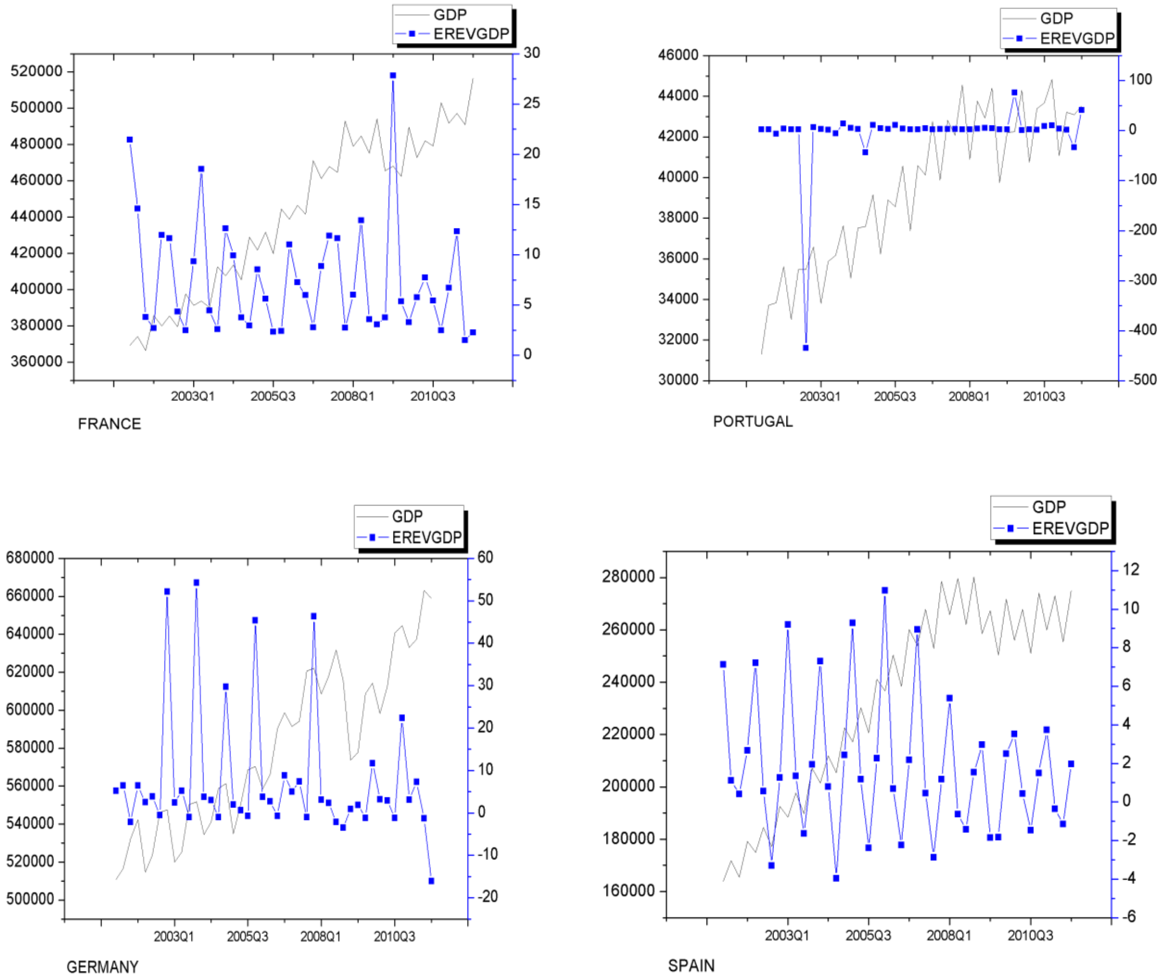


Fig. 3 Relation between the elasticity of revenues respect GDP vs GDP in Ecuador including oil revenues.

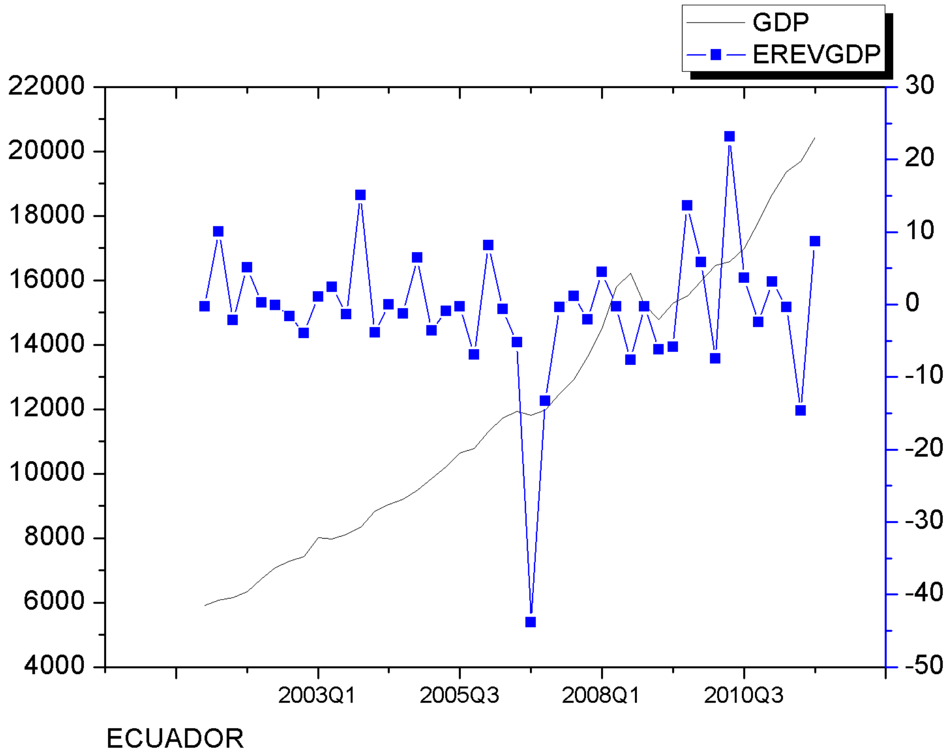


Fig. 4 Relation between the elasticity of revenues respect GDP vs GDP in Ecuador excluding oil revenues.

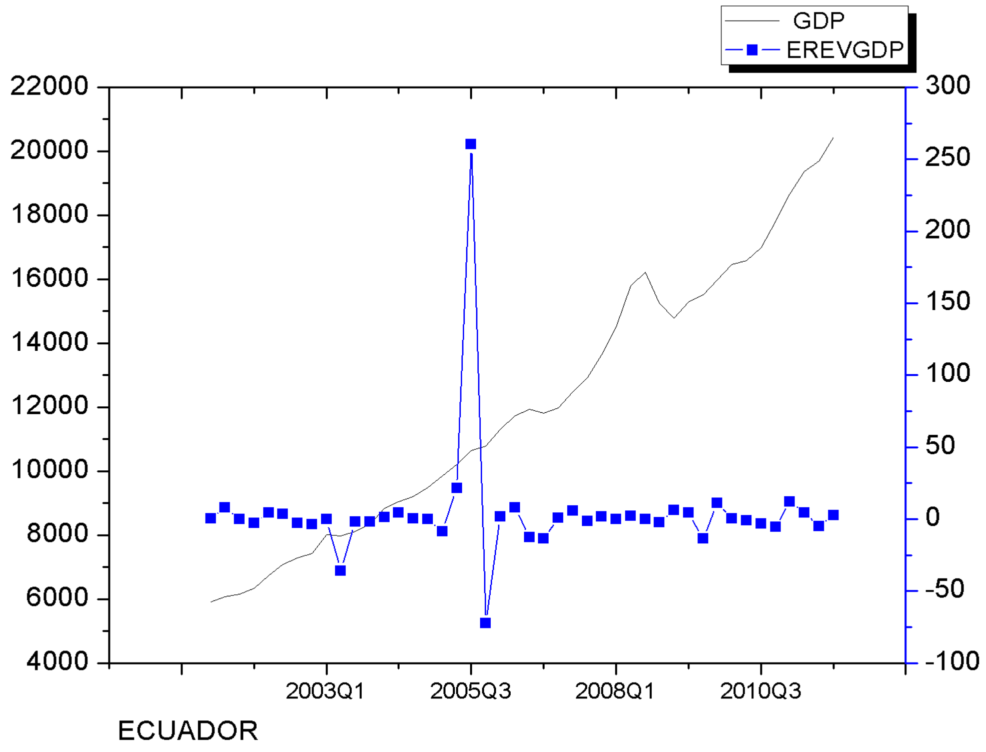
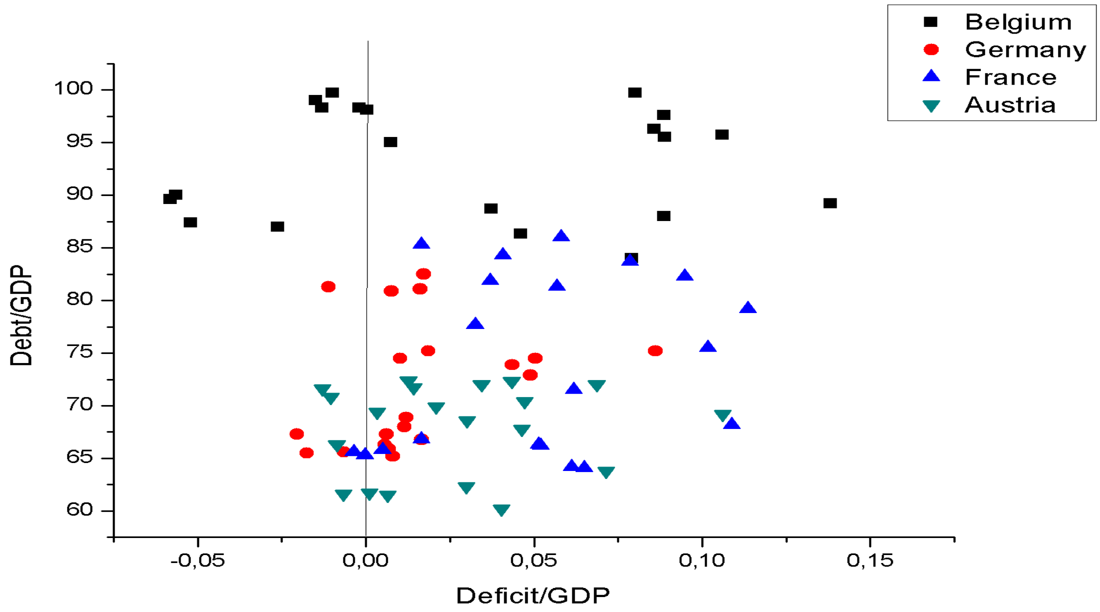


Fig. 5 Debt/GDP v.s. Deficit/GDP for countries during the period 2007-2011.



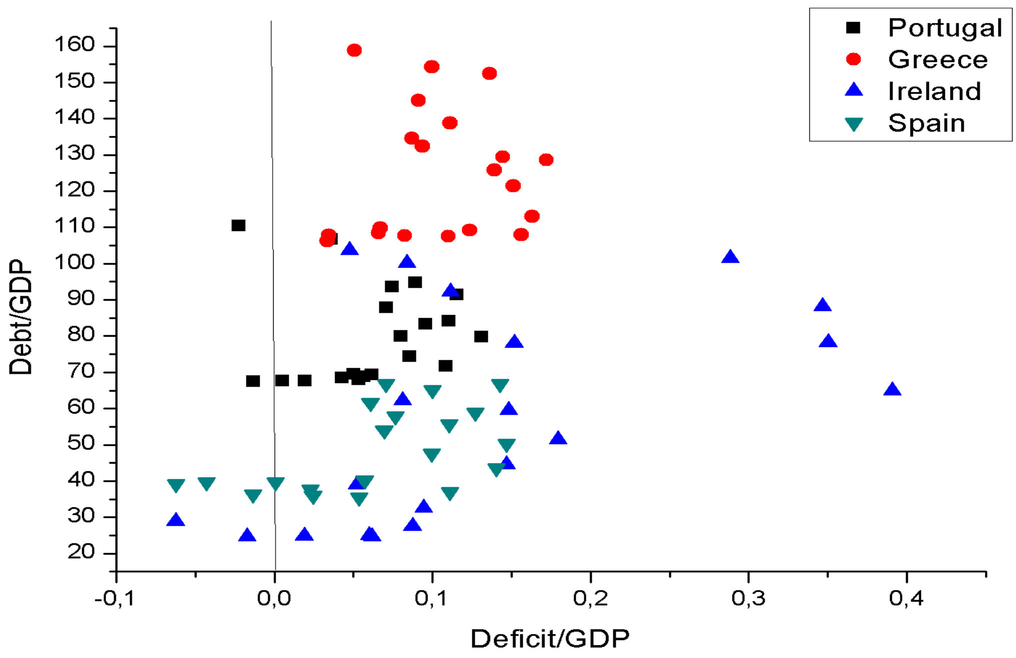
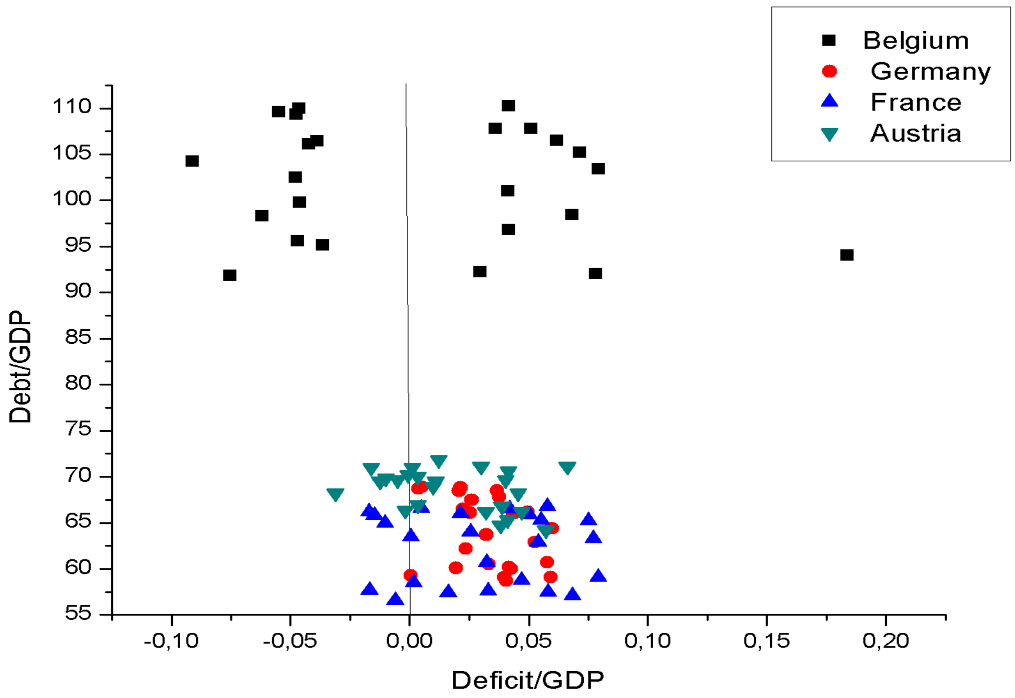
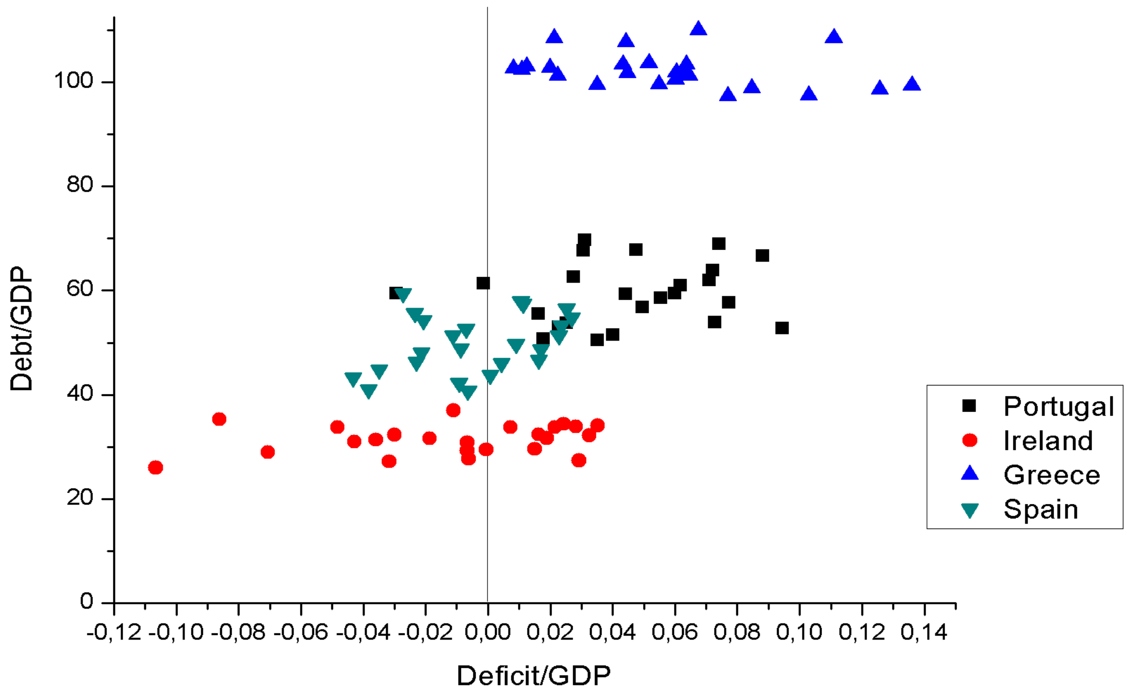


Fig. 6 Debt/GDP v.s. Deficit/GDP for countries during the period 2001-2006.





Annex III. Empirical Results

Table. 1 Results of the I (1) analysis for the first model.

With permanent and seasonal dummies								Excluding all sort of dummies							
p-r	r	Eig.. Value	Trace	Trace*	Frac95	p	p*	p-r	r	Eig. Value	Trace	Trace*	Frac95	p	p*
4	0	0.273	82.67	78.18	63.659	0.000	0.002	4	0	0.301	92.2	87.68	63.659	0.000	0.000
3	1	0.131	35.85	34.09	42.770	0.214	0.289	3	1	0.137	39.7	38.11	42.770	0.100	0.140
2	2	0.064	15.28	14.24	25.731	0.558	0.642	2	2	0.067	18.1	17.47	25.731	0.343	0.388
1	3	0.037	5.613	4.521	12.448	0.521	0.670	1	3	0.053	7.95	7.491	12.448	0.263	0.305

(*) Corresponds to the Bartlett corrected trace test.

Table. 2 Results of testing restrictions on beta and alpha for the first model.

Test of exclusion (restrictions on beta)								Test of weak exogeneity (restrictions on alpha)						
r	DGF	5% C.V.	lexp	lrev	leai	Ldebt_gdp	trend	r	DGF	5% C.V.	lexp	lrev	leai	Ldebt_gdp
1	1	3.84	15.709 [0.000]	26.062 [0.000]	10.856 [0.001]	3.107 [0.078]	0.031 [0.86]	1	1	3.84	0.235 [0.628]	20.248 [0.000]	3.200 [0.074]	0.996 [0.318]
2	2	5.99	22.961 [0.000]	33.603 [0.000]	17.227 [0.000]	5.488 [0.064]	8.688 [0.013]	2	2	5.99	4.450 [0.108]	28.577 [0.000]	8.460 [0.015]	8.137 [0.017]
3	3	7.81	24.054 [0.000]	37.598 [0.000]	19.969 [0.000]	6.194 [0.103]	12.261 [0.007]	3	3	7.81	4.628 [0.201]	31.513 [0.000]	12.350 [0.006]	11.563 [0.009]

LR test, Chi-square(r), p-values in brackets.

Table. 3 Results of the I (1) analysis for the second model.

With permanent and seasonal dummies								Excluding all sort of dummies							
p-r	r	Eig.. Value	Trace	Trace*	Frac95	p	p*	p-r	r	Eig. Value	Trace	Trace*	Frac95	p	p*
4	0	0.308	96.99	92.07	63.659	0.000	0.002	4	0	0.341	113.17	108.456	63.659	0.000	0.000
3	1	0.152	42.89	41.50	42.770	0.049	0.067	3	1	0.166	51.862	50.389	42.770	0.004	0.006
2	2	0.088	18.58	17.54	25.731	0.312	0.383	2	2	0.105	25.213	24.035	25.731	0.058	0.082
1	3	0.034	5.018	4.733	12.448	0.601	0.640	1	3	0.059	8.872	8.484	12.448	0.193	0.221

(*) Corresponds to the Bartlett corrected trace test.

Table. 4 Results of testing restrictions on beta and alpha for the second model.

Test of exclusion (restrictions on beta)								Test of weak exogeneity (restrictions on alpha)						
r	DGF	5% C.V.	lrev	lgov	leai	lorev	trend	r	DGF	5% C.V.	lrev	lgov	leai	lorev
1	1	3.84	28.177 [0.000]	25.457 [0.000]	15.384 [0.000]	11.085 [0.001]	0.030 [0.863]	1	1	3.84	13.057 [0.000]	4.017 [0.045]	5.300 [0.021]	3.152 [0.076]
2	2	5.99	38.515 [0.000]	35.433 [0.000]	15.402 [0.000]	20.339 [0.000]	1.898 [0.387]	2	2	5.99	22.829 [0.000]	14.217 [0.001]	6.111 [0.047]	5.504 [0.064]
3	3	7.81	46.776 [0.000]	38.276 [0.000]	22.590 [0.000]	26.470 [0.000]	9.734 [0.021]	3	3	7.81	31.320 [0.000]	15.881 [0.001]	13.060 [0.005]	8.685 [0.034]

Table 5. Residual S.E. and Cross- Correlations for the second model

	lrev	lgov	leai	lorev
Residual S.E.	0.02922825	0.05619247	0.02272652	0.12829084
Lrev	1.000			
Lgov	0.883	1.000		
Leai	0.708	0.294	1.000	
lorev	0.959	0.980	0.478	1.000

Fig. 7 The impulse response functions for the two permanent shocks and transitory shocks.

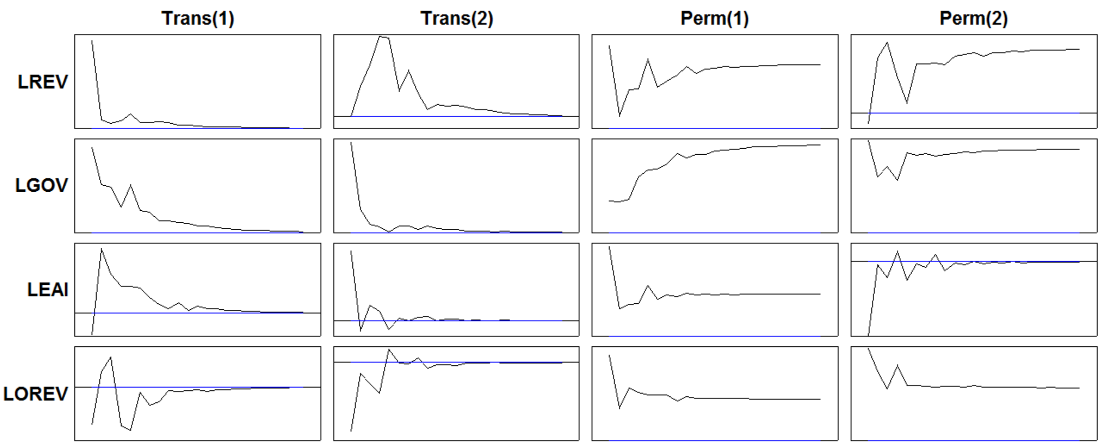


Table 6 Impact after 23 periods

	Trans(1)	Trans(2)	Perm(1)	Perm(2)
LREV	0.034	0.023	2.054	2.037
LGOV	0.034	0.021	1.637	5.348
LEAI	0.007	0.004	2.270	-0.007
LOREV	-0.040	-0.028	6.156	11.295

Table 7 B normalized matrix [U(t)=B*EPS(t)]

	EPS(1)	EPS(2)	EPS(3)	EPS(4)
Trans(1)	1.000	0.069	-0.437	-0.046
Trans(2)	-0.388	1.000	0.707	-0.232
Perm(1)	0.103	-0.110	1.000	0.135
Perm(2)	0.233	-0.961	1.000	-0.381