Fiscal Sustainability and Economic Growth in Bolivia

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Abstract

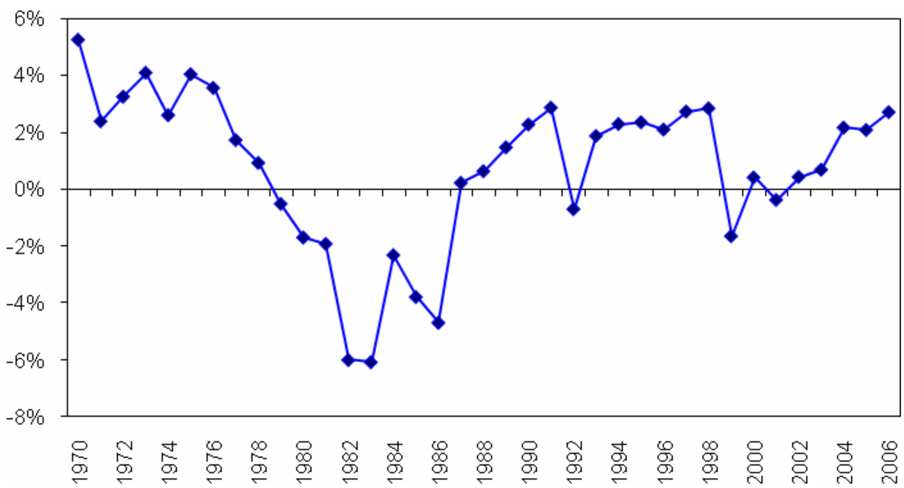
In this paper we analyze the role played by fiscal sustainability shocks on the Bolivian economic growth performance. To do this, we impose restrictions on a VAR for the Bolivian economy that allow us to identify fiscal sustainability shocks. We argue that imposing long run identification restrictions in our structural VAR is a new (applied to fiscal issues) and useful way to identify the macroeconomic impact of shocks on fiscal sustainability. Our results show a significant lost in the level of GDP in the Bolivian economy as a consequence of the sequence of adverse fiscal sustainability shocks this economy has experienced. Although, fiscal sustainability shocks have not permanent effect on Bolivia's economic growth, the fact that adverse fiscal sustainability shocks has occurred during the period studied (in a significant way at least during the late 70s early 80s and at the late 90s early 2000s) have negatively affected Bolivian economic growth. Our results also show that inflation has been affected by fiscal sustainability shocks, especially the adverse shocks experienced during the period from 1977 to 1986, which ended in the hyperinflation in 1985.

We thank Leonardo Ortega and Irene Sierraalta for excellent research assistance. All the errors are responsibility of the authors. Email: jpineda@caf.com and rodolfo.mendez@grupobbva.com.

1. Motivation

During the 60s and mostly of the 70s, Bolivia experienced an important economic growth mainly based in a boom of commodities prices and capital inflows[1]. In per capita terms, as shown in Figure 1, Bolivian growth performance has been disappointing (with a 0.75% average annual growth from 1970 to 2006). The relatively good performance of the 70s (2.78% average annual growth), was reversed by a severe contraction at the beginning of the 80s (4.65% average annual decrease from 1981 to 1985) mostly due to the presence of vulnerabilities in the productive sector (for example the dependency of foreign currency to buy intermediate goods in national firms) (Pinto and Candia, 1986), a very unstable political environment[2], the reversal of the good external conditions, among other negative shocks which made possible the change of the positive situation of the previous years (Morales and Sachs, 1987). Unfortunately, the growth performance after mid 80s has not been strong enough to recover the Bolivian economy (with an average annual growth of 1.36% between 1986 and 2006).

Figure 1: Real GDP per capita Growth (1990=100)



Source: IFS (2007), Cerro and Pineda (2002) and own calculations

[1] Morales and Sachs (1987) shows that Bolivian Real GDP growth was 6.29% (annual average) between 1962-1967 and 5.57% (annual average) between 1967-1972.

[2] In 1978, President Banzer faced pressures for a return to the democratic system. In 1979, General Pereda was called president in a criticized election. This situation promoted a strong political instability causing that brought to power no less than eleven military and civilians between 1978 and 1982. This instability made Bolivia low attractive to foreign investment.

Associated with the Bolivian growth performance described above has been the evolution of the export sector, in particular those commodities whose prices have been high during the two periods of higher growth in Bolivia (the 70s and the 2000s). Table 1 shows the price evolution of the main export commodities for Bolivia. We can notice that since the beginning of the 70s the prices of these commodities experienced a significant growth (especially in tin, the most important export sector in those years). However, during the late 70s and beginning of 80s the Bolivian economy suffered significant negative shocks in its term of trade. Prices of lead, silver and tin fell between 1979-1981 by 25.25%, 24.15% and 2.84%, respectively (annual average). During the next 3 years natural gas and petroleum incorporated into this negative trend experienced since the late 70s, whereas zinc prices continued growing but in a more moderate way.. All those changes in international prices had a negative effect on export performance, in a context of fall in production capability mainly due to inadequate investment policy focused in discovery activities of new mineral deposits, administrative problems in mineral public firms and so on[3]. In Table 2 we show evolution of term of trade of Bolivia.

Table 1: Growth of prices of the main export commodities of Bolivia

Period	Lead	Silver	Tin	Zinc	Natural Gas	Petroleum
1974-78	2,78%	4,34%	11,65%	-6,23%	28,01%	8,97%
1979-81	-25,25%	-24,15%	-2,84%	6,74%	25,64%	18,29%
1982-85	-11,15%	-9,06%	-2,51%	0,21%	-0,27%	-5,15%
1986-00	0,81%	-0,59%	-3,18%	-1,14%	7,76%	5,01%
2001-04	15,71%	14,40%	17,39%	3,75%	22,01%	15,71%
2005-06	32,23%	52,98%	21,93%	129,70%	-36,57%	17,02%

Source: IFM (2007) and own calculations.

[3] BCB (1980) show that production of tin, lead, copper and silver had fallen 23%, 38%, 81% and 5% respectively between 1970 and 1980.

Table 2: Term of trade of more important commodities of Bolivia

Year	TOT	Year	TOT
1970	79,25	1989	138,12
1971	72,64	1990	117,69
1972	71,43	1991	93,32
1973	86,58	1992	120,07
1974	123,24	1993	105,34
1975	115,57	1994	113,23
1976	123,58	1995	117,50
1977	184,17	1996	126,92
1978	244,36	1997	109,24
1979	305,71	1998	96,59
1980	297,27	1999	92,82
1981	205,43	2000	100,00
1982	165,10	2001	76,67
1983	154,78	2002	80,24
1984	157,32	2003	97,36
1985	135,11	2004	124,84
1986	69,91	2005	164,40
1987	82,09	2006	165,74
1988	99,87		

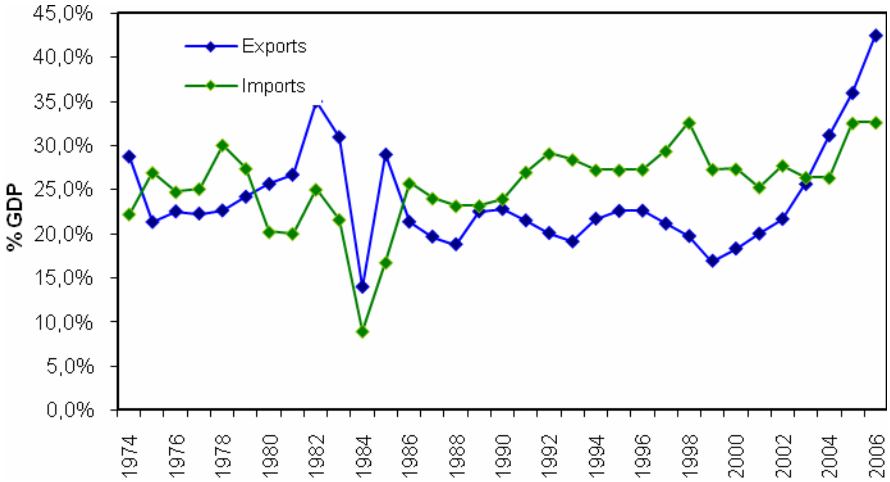
Note: The term of trade presented here are calculated as weighted average of commodity prices with the weight given by its shares in total commodity exports.

Source: IFS (2007), BBVA commodities data base and own calculations

The fall in prices and production capability together limited foreign currency flows, which were necessary to import intermediate goods that were required in productive process of national establishments. In Figure 2 we show the evolution of import and export as percentage of GDP. Since 1979 both exports and imports shares begun to fall suggesting the dependence of import sector to foreign currency generated by export sector. Another external shock that affects the export external performance was the climate phenomenon so called El Niño that caused floods and droughts that affected mainly one of the most important economic sectors, the agrarian production[4].

[4] Also, Morales and Sachs (1987) argue that an overvalued exchange rate during 70s drove investment in the nontradable sectors and induced capital flight, so that there was little basis laid for a more dynamic export sector in the 80s that would be necessary to service the debt accumulated during the 70s.

Figure 2: Evolution of Bolivian exports and imports from 1974 to 2006.



Source: IFS (2007) and own calculations

Those negative shocks affects the international reserves position, which fell 29% between 1979-1981 (annual average) complicating imports activities and debt payments (see Table 3)[5]. This situation was no favourable to economic performance due to foreign debt begun to growth since 1978, especially foreign debt which represented almost total debt (see Figure 3).

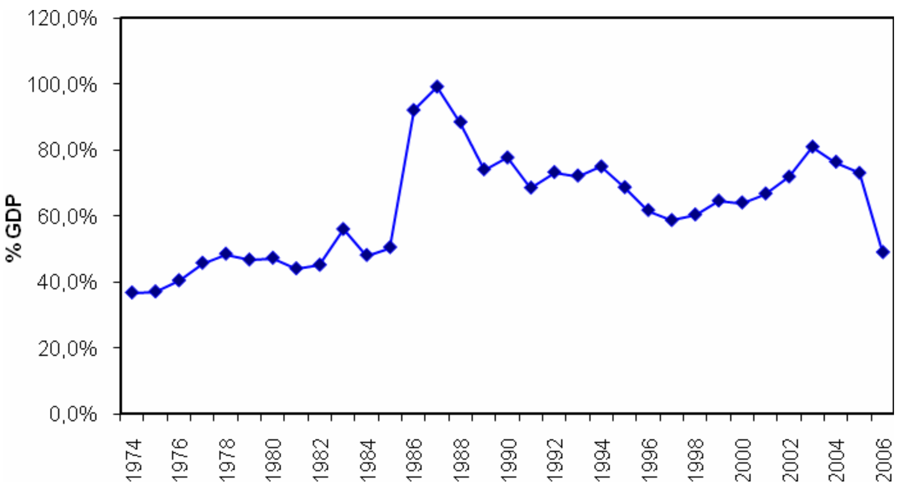
Table 3: Annual growth of total reserves minus gold

Period	Total reserves minus gold
1974-79	0,22%
1979-81	-28,97%
1981-85	17,37%
1985-00	10,22%
2000-04	-1,50%
2004-06	54,89%

Source: IFS (2007)

[5] However, we can see an important recovery since 1981-1985 mainly due to the re-scheduling in debt payments since 1983 (BCB, 1983, Antelo, 2000)

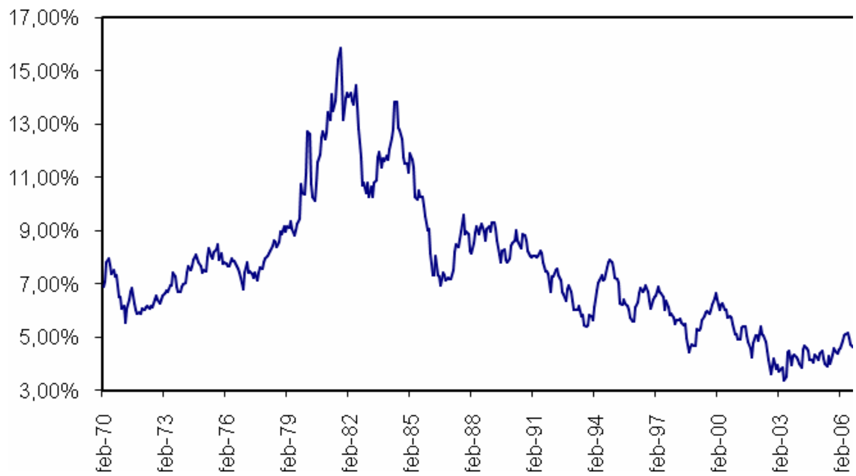
Figure 3: Total debt as percentage of GDP



Source: IFS (2007) and own calculations.

In the end of the 70s, world economy faced a significant increase of international interest rates that raise the cost of debt service in Bolivia. In Figure 4 we can see the increase of international interest rates (proxy by the 10 years US Treasury Yields). This fact and the fall in export commodity prices of Bolivia limited the availability of foreign currency and external financing of government expenditure.

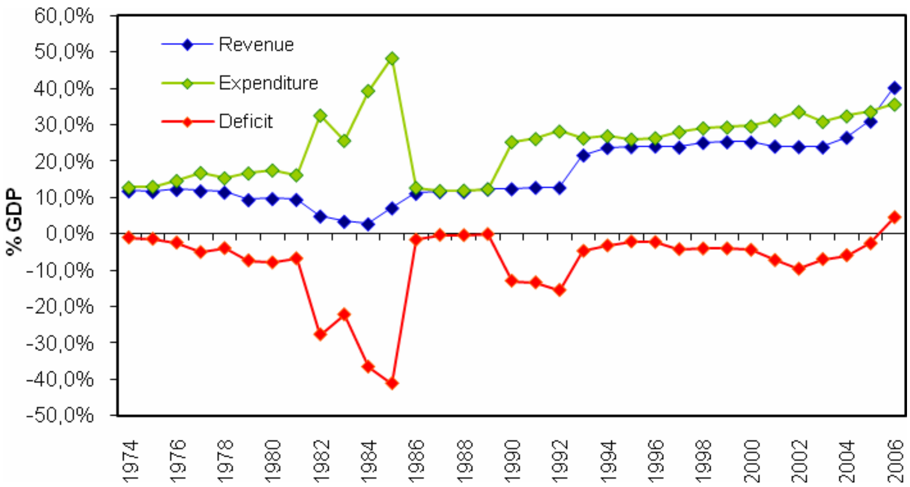
Figure 4: 10 Years US Treasury Yields



Source: Bloomberg (2008)

All those shocks complicated the fiscal situation in Bolivia. In the beginning of 70s Bolivia had a controlled fiscal deficit, with relative stability in revenues and expenditures growth thanks to a good performance of export sector and foreign inflows. Revenues represented on average 11% GDP between 1974-1979, whereas expenditure represented 15% of GDP between 1979-1981. However, government balance was also affected by the negative shocks described above. The fall in Real GDP growth since 1979-1981 affect significantly the dynamics of government finance. During 1979-1981 revenues and expenditures reached 9% and 17% of GDP respectively, while during 1981-1985 reached 4% and 36%, respectively (see Figure 5).

Figure 5: Revenues, expenditure and fiscal deficit as percentage of GDP



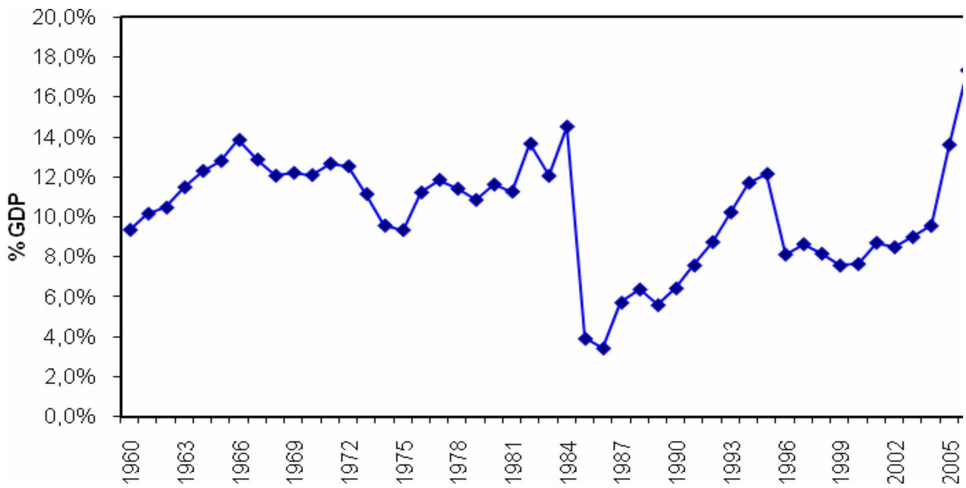
Source: IFS (2007) and own calculations

The growth of the deficit came for two sources. On the one hand, fiscal revenues decreased due to the decrease of the tax base and the negative effects of inflation in the value of total tax collection (Olivera-Tanzi effect). On the other hand, fixed expenditures grew as personal services and debt services. Thus, fiscal deficit increased (as percentage of GDP) during the beginning of the 80s. Sachs (1987) show that given the financial needs between 1982-1985, the resource to seignorage jumped as the net international resource transfer turned negative, whereas the increase of inflation caused the tax system collapse. Also, the high deficit was financed with credits from Central Bank by monetary emissions, provoking inflationary pressures that complicated even more the fiscal situation[6]. In Figure 6, we can notice process of severe contraction on

[6] BCB (1981) and (1982) show that fiscal credit granted by Central Bank of Bolivia to central government was an important source of financing of fiscal deficit which generated more inflationary pressures.

the level of monetization that Bolivia faced since 1982, which simply reflects the effects that the heavy use of the inflation tax generate in the monetary market equilibrium in Bolivia.[7]

Figure 6: Money as percentage of GDP



Source: IFS (2007)

The fiscal deficit was so important that, as Antelo (2000) described, between 1983-1985 government introduced 5 stabilization plans trying to reduce it without any success and with a very low impact in the social and economic conditions. They included policies like price controls (especially on public firms) and exchange rate controls, but they did not take in account the fiscal adjustments that were necessary to overcome the crisis. All those factors described above provoked that Bolivia face a hyperinflation (the inflation rate for 1985 was 11750%) (See Table 4).[8]

[7] In fact, monthly average Senignorage (billions 1980 pesos) increased from 0.232 during 1980-1981 to 0.981 during 1982 to 1984:09, and to 1.334 from 1984:10-1985:06. See Kharas and Pinto (1989).
[8] An important aspect mention in the literature that contributes to the hyperinflation process was the evolution of the black market premium, which increased from 1.29 during 1980-1981 to 2.95 during 1982 to 1984:09, and to 4.53 from 1984:10-1985:06. See Kharas and Pinto (1989).

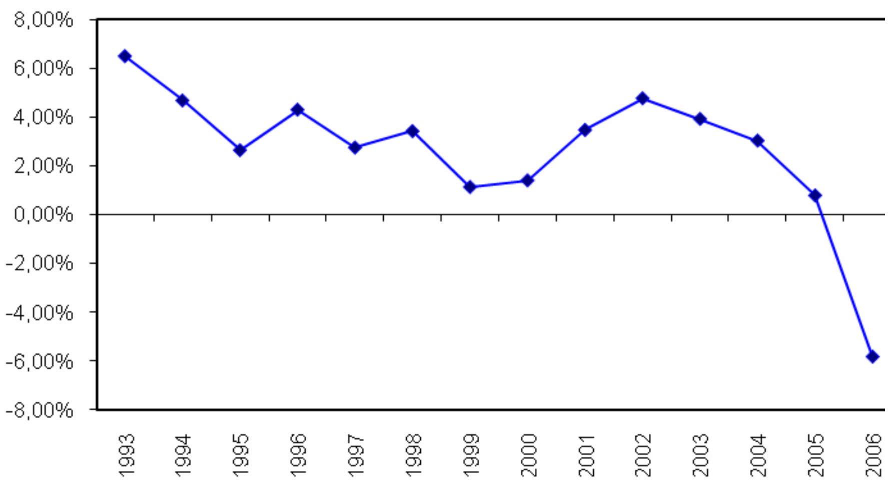
Table 4: Inflation and devaluation in Bolivia

Period	Inflation	Devaluation
1974-78	18,8%	0,0%
1979-81	33,0%	7,5%
1982-85	3357,5%	5416,6%
1986-00	28,7%	9,4%
2001-04	2,6%	6,0%
2005-06	4,8%	-0,4%

Source: IFS (2007)

In August 1985 a new government implant the so called "Nueva Política Económica" that pretended to achieve economic stabilization. This economic plan consisted on an exchanged rate unification, fiscal adjustment and coordination in fiscal and monetary policies. Also, a liberalization process was pushed ahead in goods, credit, capital and labor market, whereas suspended payments in debt with commercial banks was continued. All those measures undertook by NPE plan achieved price stabilization in the next years and the recovery (although mild) of the Bolivian economy. However, fiscal sustainability of Bolivia was not solve at all. In Figure 7, we present Blanchard Index[9] which considers sustainability based on stabilizing the debt-to-GDP ratio. Positive values correspond to a non-sustainable fiscal policy (CAF, 2004).

Figure 7: Blanchard Index of Bolivia



Source: CAF (2007)

[9] In Appendix 1, we compare our results with some of the intuition presented in Blanchard (1990) about the accounting approach to fiscal sustainability.

In Figure 8, we can see how Bolivia still been fiscal vulnerabilities. Only in 2006 Blanchard Index shows a negative value, which implies that no adjustment will be needed for the Bolivian fiscal stance to guarantee a sustainable Debt to GDP ratio. That situation can be partially explain by the HIPC and HIPC II (Heavily Indebted Poor Countries) Initiative which ensure the relief of debt in most heavily indebted countries (including Bolivia), and as we previously discuss to the positive situation on the terms of trade.

The rest of the paper is as follows: in section 2 we discuss some relevant literature. In section 3, we describe our methodological strategy and our data set. In section 4, we present our results, and in section 5 we present some final remarks.

2. Literature Review

Vector autoregressions analyzing the impact of fiscal policy must address the issue of how to identify fiscal policy shocks. This task presents important challenges to researches since it requires distinguishing between the movements in fiscal variables which are caused by fiscal policy shocks from those which are simply the response to other macroeconomic shocks. It also requires an explicit definition of what would be called a fiscal policy shock, and to take into account the fact that most of the time there is a lag between the announcement and the implementation of fiscal policy.

We can find in the literature three type of work that solves this identification problem. In the first group we find papers that try to identify fiscal shocks by making assumptions about the sluggish reaction of some variables to fiscal policy shocks (for example Blanchard and Perotti (2002), Perotti (2002), Fatas and Mihov (2001), Favero (2002), and Galí, López-Salido, and Vallés (2004). This literature uses external information to isolate the components of the VAR innovations in government spending and revenues that represent the automatic responses of these variables to macro variables (such as GDP, inflation and interest rates) from those that are exogenous policy shocks. In particular, as Blanchard and Perotti (2002) say this approach is actually better suited for the study of fiscal policy than for any other policy (in particular monetary policy). The argue that, in contrast to monetary policy, fiscal variables are more exogenous (with respect to output), and that the decision and implementation lags presents in fiscal policy imply that, at high enough frequency, there is little or no discretionary response of fiscal policy to unexpected contemporaneous movements in activity. Thus, they are able to construct estimates of the impact of unexpected movements on fiscal variables.

Other part of the literature follows the methodology developed by Romer and Romer (1989) to study monetary policy. It constructs a dummy variable capturing well identified episodes of significant increases in government spending that can arguably be considered exogenous and unforeseen, mostly because connected to foreign policy events; it then traces the dynamic effects of a shock to this dummy variable in a Vector Autoregression. This methodology tries to solve the identification problem by using information such as the timing of wars, detailed institutional information about the tax system and detailed historical study of policy decisions or elections. Examples of their application to the analysis of the impact of fiscal policy shocks are Blanchard and Perotti (2002), Burnside, Eichenbaum and Fisher (2003) and Eichenbaum and Fisher (2004).

A different approach has been followed by Mountford and Uhlig (2005), who relies more on macroeconomic time series data for shock identification and does not rely on assumptions about the sluggish reaction of some variables to macroeconomic shocks or en the dummy variable approach just described. Indeed it imposes no restrictions on the responses of the key macroeconomic variables of interest (for example GDP, private consumption, private residential and non-residential investment, etc.) to fiscal policy shocks. The approach of this paper thus sharply differentiates it from previous studies and provides an important complementary method of analysis which, being a purely vector autoregressive approach, is automatically systematic and can be universally applied.

Another challenge that the literature of the analysis of the impact of fiscal policy shocks faces is the fact that its impact could have a non-linear nature. In fact, many studies have found that the response of the private sector to fiscal policy may be non-linear, since both the magnitude and the sign of the response appear to change depending on the conditions under which the impulse occurs and on its characteristics.[10] An important element that is related to this non-linear effect is the fiscal policy stance, and how policy shocks interacts with it. For example, if the current fiscal situation is

[10] Other examples of non-linear effects of fiscal policy shocks can be found in Giavazzi and Pagano (1996), who find that private sector behavior following a fiscal impulse depends on the size and persistence of the impulse. While, Alesina and Perotti (1995) and Alesina and Ardagna (1998) find that the composition of the fiscal adjustment plays an important role in explaining its final impact on the economy.

unsustainable, raising net taxes will lower the probability of default and this will raise private consumption due to the positive effect on expected net lifetime income (Giavazzi, Japelli and Pagano, 2000). Also, Romer and Romer (2007) find results where the effect of a U.S. tax shock on output depends on whether the change in taxes is motivated by the government's desire to stabilize the debt, or is unrelated to the stance of fiscal policy. In the case of government consumption shocks, Perotti (1999) shows that the net effect on aggregate consumption is ambiguous and it depends on the debt to GDP ratio.

The incorporation of debt into the analysis stresses the importance of fiscal sustainability in the determination of the impact of fiscal policy shocks in the economy. Recent literature has made this point clear by indicating the potential errors that this omission could bring to the analysis (Giannitsarou and Scott, 2006 and Favero and Giavazzi, 2007). In particular, Favero and Giavazzi (2007)indicates that Vector AutoRegressive models that are typically used to estimate the effects of fiscal shocks on various macroeconomic variables fail to keep track of the debt dynamics that arises following a fiscal shock, and related to this, these models overlook the possibility that taxes and spending might respond to the level of the debt. This omission is particularly surprising given the fact this feedback seems to be a feature of the data, as shown by Bohn (1998), who finds a positive correlation (in a century of U.S. data) between the government surplus-to- GDP ratio and the government debt-to-GDP ratio.[11]

This omission of the literature could also be related with the result found in the literature that the effects of fiscal policy shocks have changed over time. For example, Perotti (2007) finds that the effect on U.S. consumption of an increase in government spending is positive and statistically significant in the 1960's and 1970's, but became insignificant in the 1980's and 1990's. In this regard, Favero and Giavazzi (2007) argue that this difference could be explained by the way U.S. fiscal authorities responded to the accumulation of debt in the two periods.

So far we have seen that the literature of the impact of fiscal policy basically focuses on short run economic fluctuations (working mostly with quarterly data). And this feature of the data has dominated the identification efforts of fiscal policy shocks. Instead, in this paper we are interested on analyzing long run effects of fiscal policy shocks, in particular the role played by the shocks to the fiscal sustainability on the

[11] This is also de the case for the Bolivian case, as we checked for our sample, with a positive correlation of 0.164.

Bolivian economic growth performance. This imposes a different set of challenges, since we have to impose restrictions that could be meaningful to identify fiscal sustainability shocks. We argue that imposing long run identification restrictions in a structural VAR is a very useful way to identify the macroeconomic impact of shocks on fiscal sustainability. In the next section we discuss our structural VAR methodology and our identification strategy.

3. Methodology and data

The Structural Vector Autoregression Approach to Fiscal Sustainability Analysis

We have already stated that our methodology bases on the Structural Vector Autoregression methodology (SVAR) with long-run identification restrictions proposed firstly by Blanchard and Quah (1989) and popularized since then, and that, to our knowledge, this is the first time such approach is applied to the analysis of the effects of changes in the sustainability of fiscal policy in the sense of Blanchard (1990). Now, we give the details of our particular application.

Identification of *sustainability shocks*

Let X_t (3x1) be the vector of values at period t of the following variables, previously transformed to make them stationary and Gaussian: the ratio of total Debt to GDP ratio, (D_t), the GDP (Y_t), and the consumer prices index (P_t). And let Z_t (1x1) be the value at period t of terms of trade -we keep the vector form of Z_t for generality's sake- also previously transformed to get the variables to be stationary and Gaussian.

By the *Wold Theorem* (see Canova (2007, Chapter 4) we know that under mild conditions the time series for the stationary vector of variables X_t can be seen as a realization of a vector moving average (VMA) stochastic process, plus linear deterministic and exogenous components (in part by the terms of trade). Moreover, for whatever representation of this stochastic process, there exists an equivalent form of it with orthogonalized or non-correlated innovations. The latter version is our benchmark structural model for X_t, i.e.:

$$X_t = A + \sum_{i=0}^{+\infty} B_i Z_{t-i} + \sum_{i=0}^{+\infty} C_i \mu_{t-i} \qquad (1)$$

Where the elements of A (3x1), B_i (3x3) and C_i (3x3) for i = 1, 2…, ∞ are parameters, and μ_t is a vector of unobservable uncorrelated random innovations distributed in a Gaussian and independent way, i.e.:

$$\mu_t \sim N[0, I]$$

As usual, these innovations represent the forces external to the system which propel the dynamic of X_t , but what is crucial to notice is that these forces exclude the impact of the terms of trade given the inclusion of this variable as an external component in 1.

The model 1 can be succinctly expressed as:

$$X_t = A + B(L)Z_t + C(L)\mu_t \qquad (2)$$

Where *B(L)* and C*(L)* are matrix polynomials in the lag operator, *L*.

Notice that $C(1)$ is the matrix of the cumulated effect of the innovations on X_t, and, what is more important, the first column of this matrix show the long-run impact of the *fiscal sustainability shocks* on the –untransformed versions- of the Debt ratio, GDP and inflation.

The core of our the methodology lay in the crucial assumption -based on fiscal policy empirical and theoretical literature, partly discussed in section 2- that we can sensibly decompose the innovations that impinge on the time path X_t in two orthogonal or non-correlated groups or categories of innovations who differ just by its effect on the Debt to GDP ratio, namely: the group the innovations which causes long-run or permanent effects on the Debt to GDP ratio –what suppose that such ratio has at least one unit root- and the group of those innovations which don't. We label the former *fiscal sustainability shocks*, and it constitutes our proxy to the unexpected changes in the sustainability of fiscal policy (Blanchard, 1990) whose effects we try to disentangle.

As a matter of mere convention, we place the *fiscal sustainability shocks* in the first row of μ_t, therefore our definition of them implies that the (1, 1) or upper-right element of $C(1)$ must be zero, whereas the rest of elements remain unrestricted, i.e.:

$$\mu_t = \begin{bmatrix} \mu_{sost,t} \\ \mu_{other,t} \\ \mu_{other,t} \end{bmatrix}$$

$$C(1) = \begin{pmatrix} . & . & 0 \\ . & . & . \\ . & . & . \end{pmatrix}$$

This established, all we need in order to estimate *A(L)* from available data in a consistent and efficient way, because after that it is straightforward to get the standard summary statistics of the SVAR innovation-analysis –impulse-response functions, forecast errors variance decomposition, and residual historical decomposition-, and based on them to assess the effect and role played by the *fiscal sustainability shocks* on the historical evolution of X_t and its untransformed version.

<u>Estimating the effect of sustainability shocks</u>

Our starting point is to assume that the stochastic process in 1 satisfies the conditions for *invertibility* (Canova (2007), Chapter 4), which mainly require the stability of the process, so that it can be expressed in a vector autoregression (VAR) form plus deterministic and exogenous components -which can be seen as the reduced or non-structural form of 1-, i.e.:

$$X_t = E + \sum_{i=1}^{+\infty} F_i X_{t-i} + \sum_{i=1}^{+\infty} G_i Z_{t-i} + \varepsilon \qquad (3)$$

Where ε_t is the vector of one-step-ahead forecast errors given the model or reduced form disturbances, which are assume to follow a Gaussian distribution and are possibly contemporaneously, but not serially, correlated, i.e.:

$$\varepsilon_t \sim N[0, \Sigma]$$

The system 3 can compactly be expressed as:

$$X_t = E + F(L)X_t + G(L)Z_t + \varepsilon_t \qquad (4)$$

It is straightforward to obtain "good" estimates for the parameter matrices of 4, namely *E*, *F(L)* and *G(L)* for all *L*, and Σ, and even for the historical time path of ε_t. As a matter of fact, least square estimation equation by equation results in consistent and efficient estimators.

Now, model 4 can be inverted and expressed in the following form,

$$X_t = H + M(L)Z_t + R(L)\varepsilon_t \qquad (5)$$

Where,

$$R(L) = (I - F(L))^{-1}, H = R(L) \times E, M(L) = R(L) \times G(L)$$

And given that 3 is supposed to be the inverted form of 1, for some matrix *Q* must be true that,

$$\varepsilon_t = Q\mu_t$$

Therefore, it is valid to express 5 as a function of μ_t, i.e.,

$$X_t = H + M(L)Z_t + R(L)Q\mu_t \qquad (6)$$

Moreover, relating 5 to 2 should be clear that,

$$R(L)Q = C(L) \qquad (7)$$

And,

$$Q^T Q = \Sigma \qquad (8)$$

This implies that we can obtain an estimate for *C(L)* from our estimate for *R(L)Q*. An estimate of *R(L)* can be computed directly from our estimate of *F(L)*. As for *Q*, it can be computed from estimates of *C(L)* and Σ in the way described in the following paragraphs.

Note that 8 implies,

$$R(L)Q^T \times QR(L)^T = R(L)\Sigma R(L)^T \quad (9)$$

It follows that *R(L)*Q is a factor in the decomposition of $R(L)\Sigma R(L)^{\mathrm{T}}$, and, in particular, $R(1)Q$ is a factor of $R(1)\Sigma R(1)^{\mathrm{T}}$, so we can get that value of *Q* just by multiplying the later factor by $R(1)^{-1}$.

However, this factor is not unique unless we impose enough restrictions on the matrices *R*(1) and/or Σ. This is accomplished by just adding to our initial and crucial restriction on *C*(1) -zero in its upper-right corner-, additional zero restrictions on the remaining elements above the diagonal of *C*(1). By 7, the whole set of zero restrictions on *C*(1) implies that *R*(1)*Q* must be lower triangular, what makes of it the unique Choleski factor of the matrix $R(1)\Sigma R(1)^{\mathrm{T}}$.

In this way we have obtained consistent and efficient estimators of *R(L)* and *Q* conditional on the veracity of the restrictions impose on *C*(1). We rely on theorem 4 of Zha (1999) to guess that the resulting estimates of the effects of the *fiscal sustainability shocks* only depend on our initial restriction on *C*(1) -the zero in the upper-right corner that defines *fiscal sustainability shocks*- and not at all on the additional restrictions, which can be considered just as a mere inconsequential normalization (we have confirmed this guess at least for the alternative triangularizations of *C*(1)).

<u>Data</u>

We are mainly interested here in analyzing the effect of *sustainability shocks* on output under a long-run perspective, because of that we rely on annual data, more precisely on the annual time series for GDP, ratio of Total Debt to GDP, CPI, and terms of trade. For model estimation the availability of total debt statistics restricts the sample to the period 1972-2006.[12]

As explained above, the estimation of the effect of *fiscal sustainability shocks* requires the previous transformation of the variables to make them stationary and, at least approximately, Gaussian. Our transformed variables are: the first difference of the logarithm of total Debt to GDP ratio, the first difference of the logarithm of GDP, and the logarithm of the rate of inflation (where the later computed as the percentage variation of the CPI).

Differencing was applied when it was required to get stationary, i.e., when the variable level was integrated of first order, $I(1)$ according to standard Augmented Dickey Fuller test, which was the case, as required by our methodology, for the Debt to GDP ratio and its logarithmic transformation. It could cause surprise the stationary nature of inflation in the Bolivian case in spite of hyperinflationary period, but the result holds even before the logarithmic transformation (even at 1% significance level). The logarithmic transformation of the inflation tries to overcome the virtual impossibility that the flat-tailed Normal approximation put on the extreme values reached by this variable during the hyperinflationary period. The logarithmic transformation of the Debt to GDP ratio before differencing rules out the high probability the Normal approximation put otherwise on negative values of the ratio as a consequence of its high historical volatility.

We also tested for the absence of cointegration between the undifferenced variables, hypothesis that could not be rejected –otherwise we would be forced to include an error correction terms in 3.

4. Results

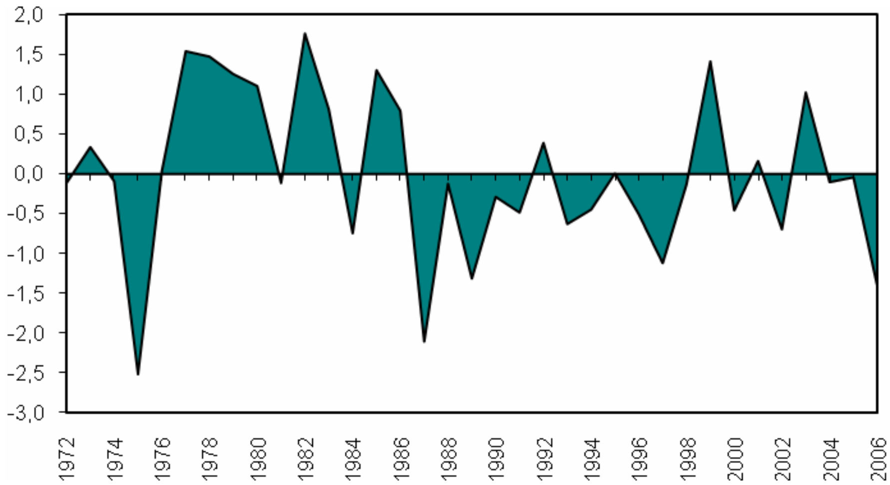
The fiscal sustainability shock

In the following graph we present the evolution of Bolivian fiscal sustainability shocks. As we can see there are 5 periods: period 1 (from 1972 to 1976), period 3 (from

[12] Nominal GDP, real GDP and the GDP deflator between 1970 and 2005 comes from World Development Indicators 2007, whereas 2006 comes from National Statistical Institute of Bolivia (INE). Total debt is the sum of domestic and foreign debt. The source of domestic debt is annual report of Central Bank of Bolivia (BCB), whereas foreign debt comes from Mariscal and Quiroz (2005) (between 1970-1989) and from National Statistical Institute of Bolivia (INE) (between 1990-2006). The Commodity prices comes from IMF (2007) and from BBVA commodities database. We use the main seven export commodities of Bolivia (lead, natural gas, petroleum, silver, soybeans, tin and zinc,) to calculate its term of trade. We use the share of each export value in the total export of those commodities to calculated a weighted average of commodity prices. Export data comes from UNComtrade database.

1987 to 1998) and period 5 (from 2004 to 2006), where Bolivia experienced favorable fiscal sustainability shocks; and period 2 (from 1977 to 1986), period 4 (from 1999 to 2002), where Bolivia experienced adverse fiscal sustainability shocks.

Figure 8: Fiscal sustainability shocks



Source: Own calculations

Variance Decomposition

Table 5: Share of prediction errors explained *by fiscal sustainability shocks*

Year	log(Debt/GDP)	GDP Growth	Log(Inflation)
1	20,0094	75,5172	24,5491
2	20,1476	58,4642	22,8622
3	20,2201	53,0871	23,9745
4	20,3153	50,6089	25,0034
5	20,4065	49,2352	25,7394
6	20,4834	48,3945	26,2453
7	20,5444	47,8490	26,5927
8	20,5911	47,4819	26,8332
9	20,6263	47,2288	27,0013
10	20,6524	47,0515	27,1198
11	20,6717	46,9260	27,2039
12	20,6859	46,8364	27,2640
13	20,6962	46,7722	27,3070
14	20,7037	46,7259	27,3380
15	20,7092	46,6926	27,3603
16	20,7132	46,6684	27,3764
17	20,7161	46,6510	27,3881
18	20,7182	46,6383	27,3965
19	20,7198	46,6291	27,4026
20	20,7209	46,6225	27,4071

Source: Own calculations

As we can see from the previous table, *fiscal sustainability shocks* represent a relatively high share of the explanation of all the variables in our model, especially for the case of GDP growth. Fiscal sustainability shocks could explain in the first year of occurrence more than 75% of the GDP growth variations, and although its explanation power decreases over time, they explain more than 46% of the GDP growth variation after 20 years. These results indicate the importance of this type of shocks in the understanding of the Bolivian growth performance.

Analysis of the impacts of fiscal sustainability shocks

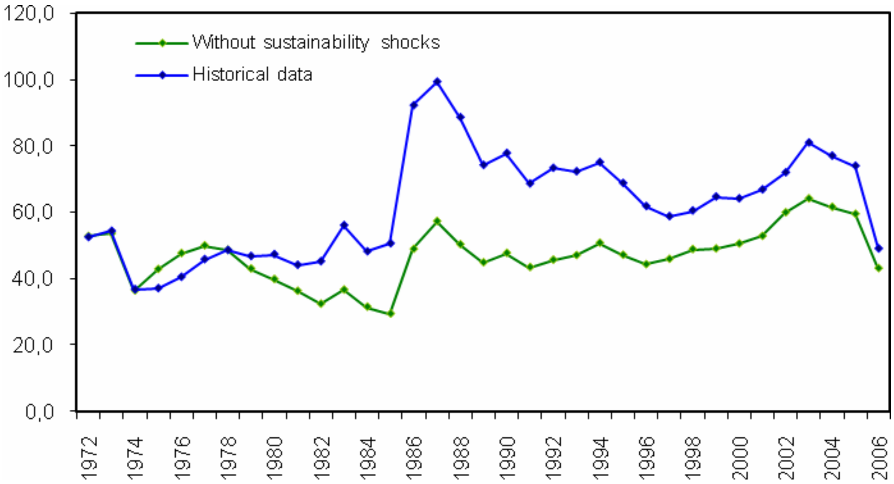
In the following graphs, we present the results of the effects of sustainability fiscal shocks on the evolution of the Bolivian Debt to GDP ratio, GDP and Inflation. The exercises presented consist in the comparison of the historical data with the data that would be implied if Bolivia had not experienced shocks to its fiscal sustainability. Thus, we can attribute the difference of the two series to the effect that fiscal sustainability shocks has had in the Bolivian economy.

<u>GDP/Debt ratio</u>

In the case of the Debt to GDP ratio, the sequence of adverse fiscal sustainability shocks during the period from 1977 to 1986,[13] increased this ratio by more than (43.2 percentage points) with respect to the ratio without these shocks. However, the sequence of positive fiscal sustainability shocks that Bolivia experienced from 1987 to 1998 significantly reduced this gap (to 11.5 percentage points), which was still relatively high. Finally, after some adverse fiscal sustainability shocks from 1999 to 2003, the gap between the historical and the implied Debt to GDP ratio was reduced by the year 2006 to the lowest margin in the last 20 years (just to 5.3 percentage points).

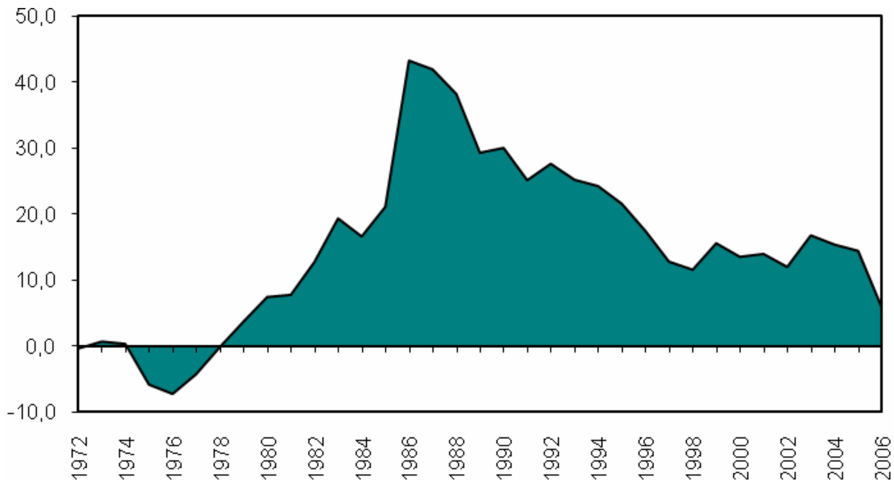
[13] It is important to mention that from 1972 to 1976, this economy experienced some favorable fiscal sustainability shocks, whose effect implies a lower historical value of the Debt to GDP ratio that the one that is implied by the model when shocks to the fiscal sustainability are excluded.

Figure 9: Effects of sustainability shocks on Debt/GDP ratio



Source: Own calculations

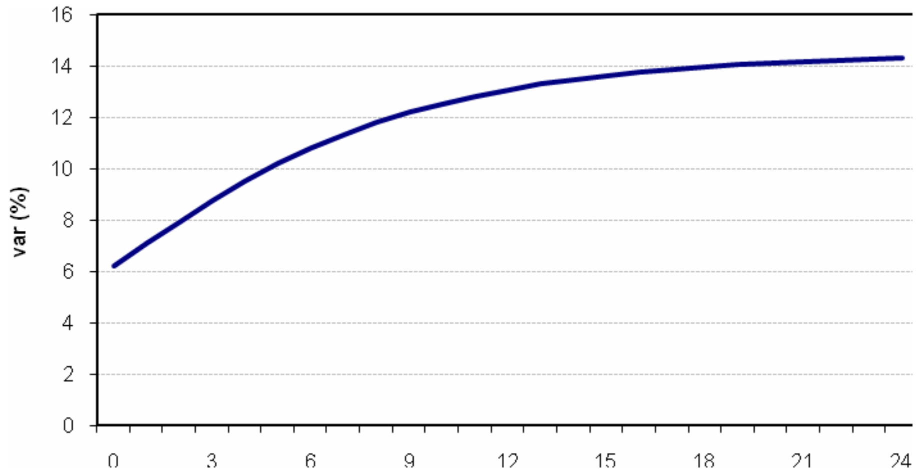
Figure 10: Deviation of Debt/GDP ratio by the effects of sustainability shocks



Source: Own calculations

These results reflects the highly persistent nature of the effect of fiscal sustainability shocks on the Debt to GDP ratio, as can be seen in Figure 11 which represents the impulse response function of the Debt to GDP ratio to a typical fiscal sustainability shocks that generates a permanent increase of more than 14 percentages points in this ratio.

Figure 11: Impulse Response function of Debt/GDP ratio to a typical fiscal sustainability shocks

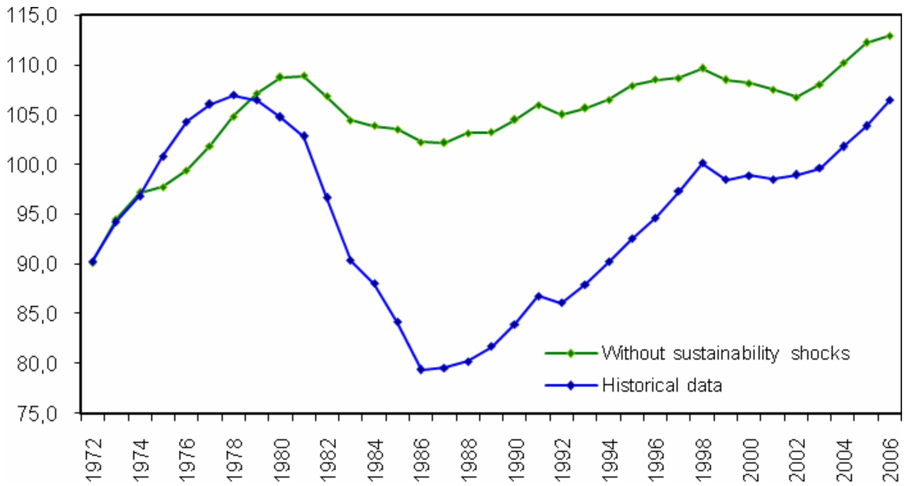


Source: Own calculations

GDP Growth

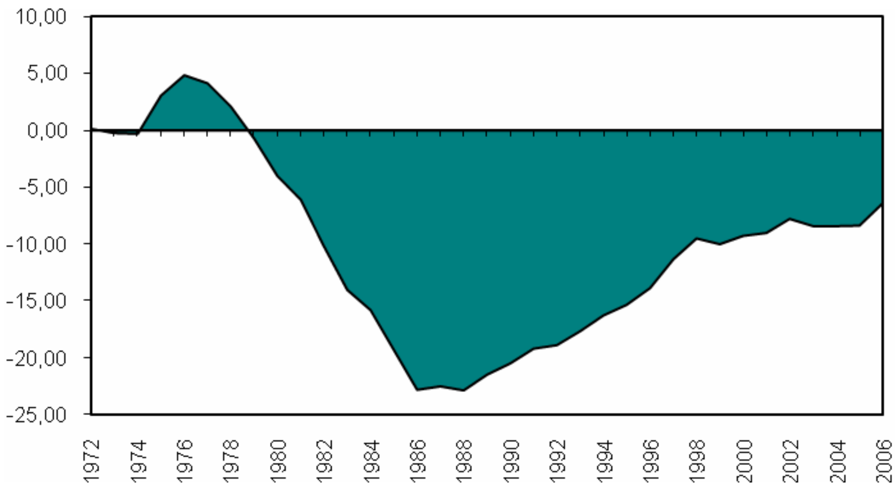
In the case of the GDP, the exercise shows a significant lost in the level of GDP in the Bolivian economy as a consequence of the sequence of adverse fiscal sustainability shocks experienced during the period from 1977 to 1986, generating a 28.8% difference between the historical GDP and the one without fiscal sustainability shocks. Another point to make is the fact that although the gap was substantially close by 1998, after some favorable fiscal sustainability shocks, the gap is still significant (representing more than 9.5%), and the gap was reduced at the end of the sample due to the fact that in this period Bolivia has experienced favorable sustainability fiscal shocks. Finally, if we accumulate the gap over the entire sample and compare it with the level of Bolivia GDP in 2006, the accumulated losses reached more than 330%.

Figure 12: Effects of fiscal sustainability shocks on GDP



Source: Own calculations

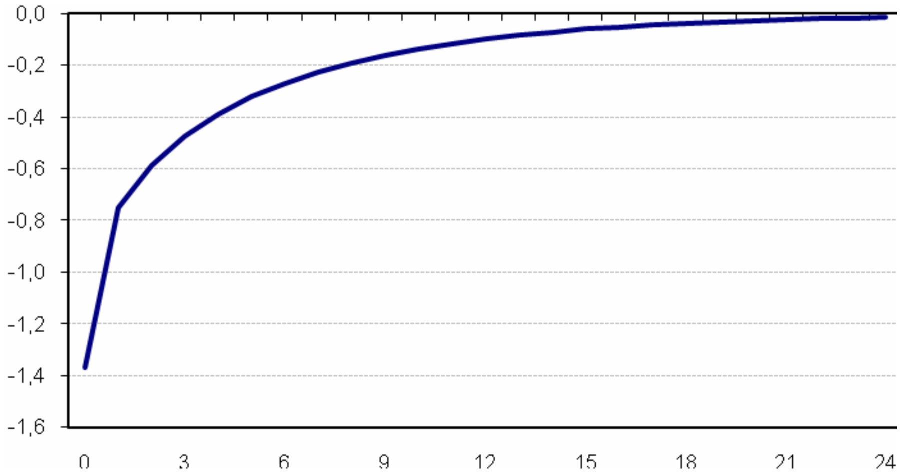
Figure 13: Deviation of GDP by the effects of fiscal sustainability shocks



Source: Own calculations

In order to have a better interpretation of this result, we present in Figure 14 the Impulse Response function of a typical fiscal sustainability shock on the GDP growth. An important result is that fiscal sustainability shocks have a persistent but temporary effect on economic growth (around 12 years). Then, in explaining Bolivian growth performance we can say that even though fiscal sustainability shocks have a negative effect on economic growth for a period of proximally twelve years, the occurrence of these types of shocks in the Bolivian economy has occurred in time close to this period of time. Thus, the situation of recurrent unsustainable fiscal shocks have negatively affected the Bolivia economic growth during the period studied, even though this type of shock dos no appear to have a permanent effect.

Figure 14: Impulse Response function GDP growth to a typical fiscal sustainability shocks



Source: Own calculations

Inflation

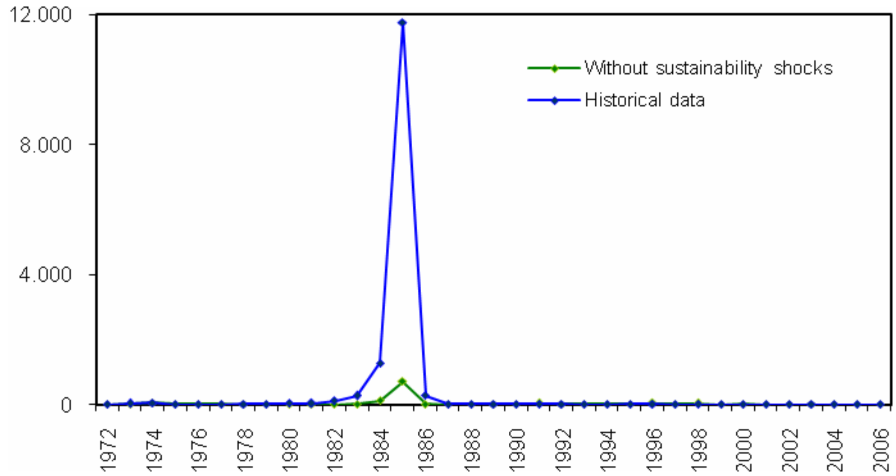
For the case of the inflation, the exercise shows a significant effect of the fiscal sustainability shocks, especially the adverse shocks experienced during the period from 1977 to 1986, which ended in the hyperinflation in 1985. The following graphs show the evolution of the Bolivian historical inflation and the inflation implied by the model after taking out the effects of the shocks of fiscal sustainability. On important feature of our model and our identification strategy is the ability of explaining a very high proportion (94%) of the hyperinflation episode of the Bolivian economy attributing it to a sequence of adverse shocks of its fiscal sustainability that this economy experienced since 1977. In fact, this result is in line with Sargent et. al (2006), who find that the dynamics of inflation in Bolivia are almost entirely driven by the dynamics of seignorage revenue, and that the learning dynamics plays a very limited role.[14]

We also separate the periods previous 1982 and post 1987 in order to have a better representation of the results since the hyperinflation episode distorts the rest of

[14] These authors affirm that "Bolivia is a prime example of the importance of the fiscal determination of hyperinflation".

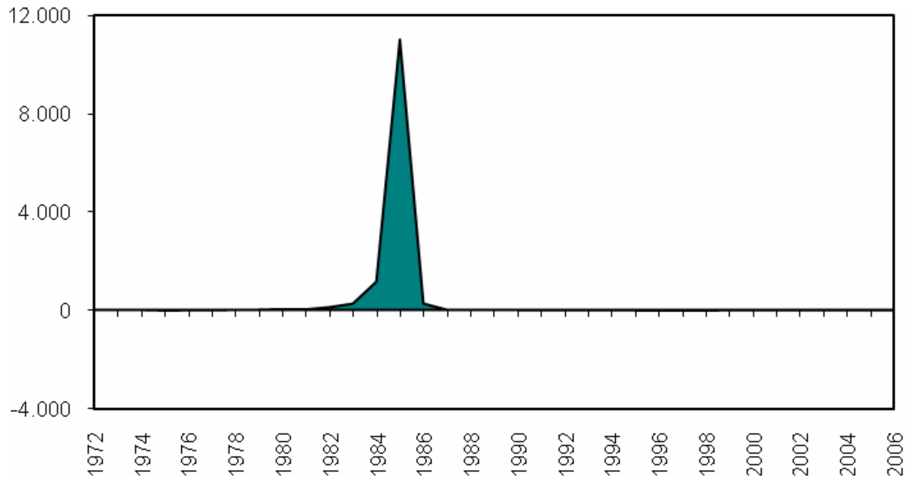
the graph. Results shows that even for periods of relatively moderate inflation, fiscal sustainability shocks play an important role both adverse and favorable ones.

Figure 15: Effects of fiscal sustainability shocks on Inflation



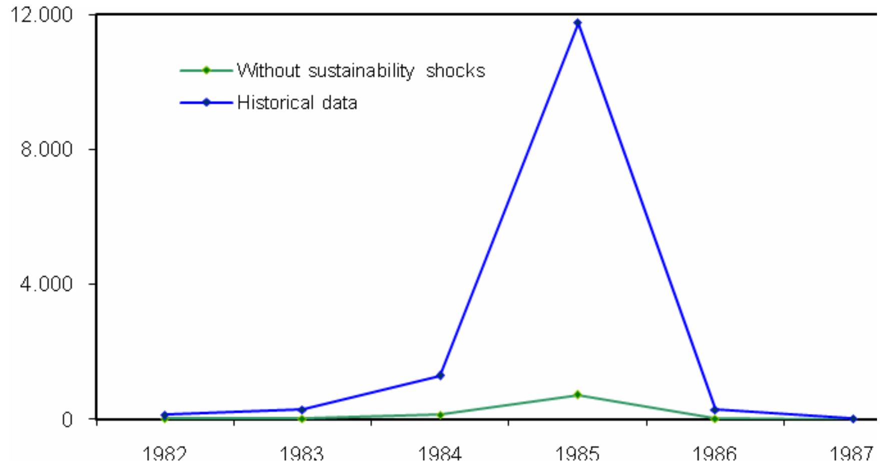
Source: Own calculations

Figure 16: Deviation of Inflation by the effects of fiscal sustainability shocks



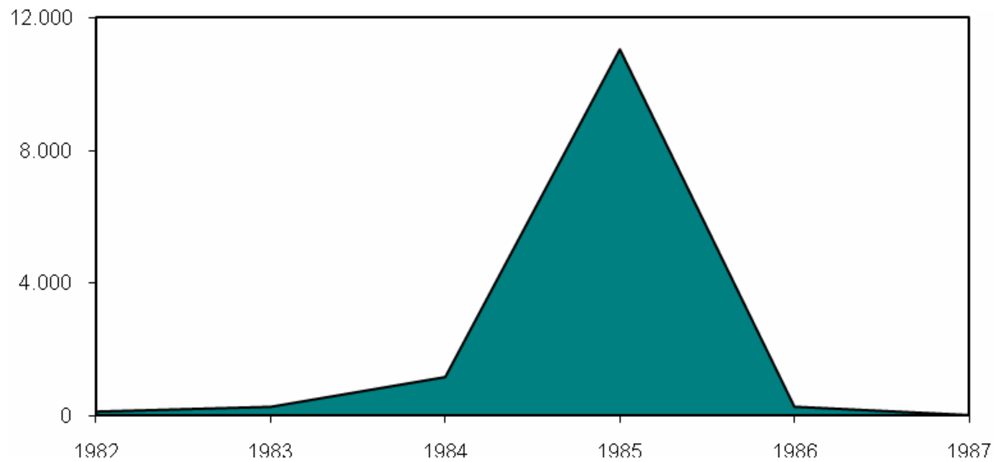
Source: Own calculations

Figure17: Effects of fiscal sustainability shocks on Inflation, 1982-1987



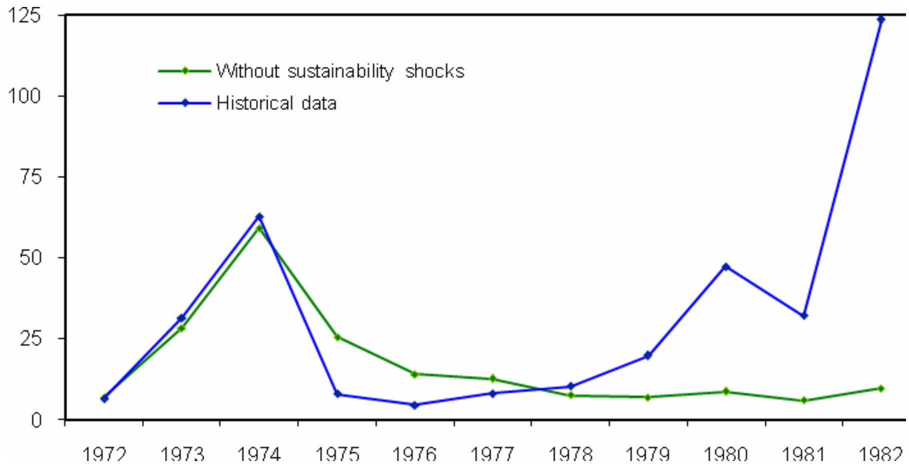
Source: Own calculations

Figure 18: Deviation of Inflation by the effects of fiscal sustainability shocks, 1982-1987



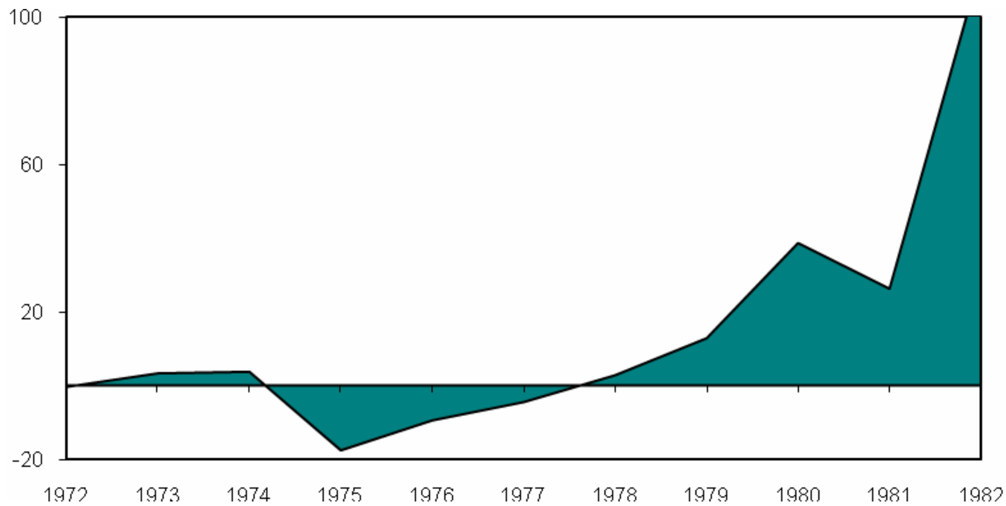
Source: Own calculations

Figure 19: Effects of fiscal sustainability shocks on Inflation, 1972-1982



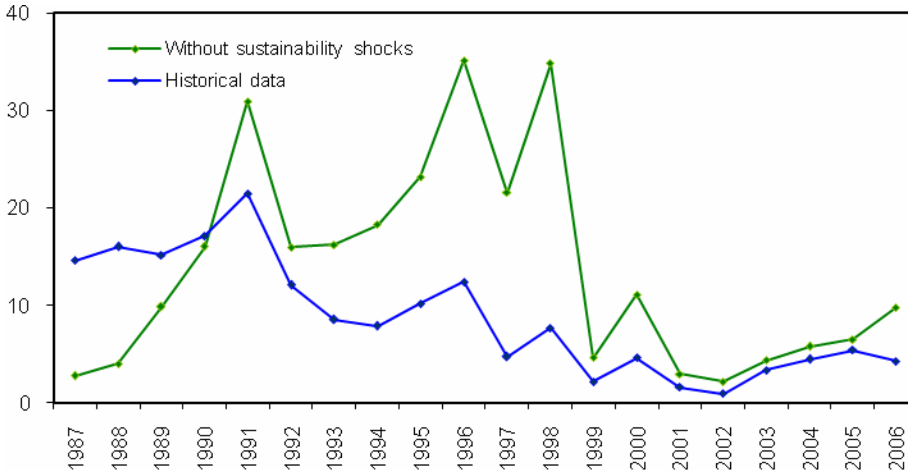
Source: Own calculations

Figure 20: Deviation of Inflation by the effects of fiscal sustainability shocks, 1972-1982



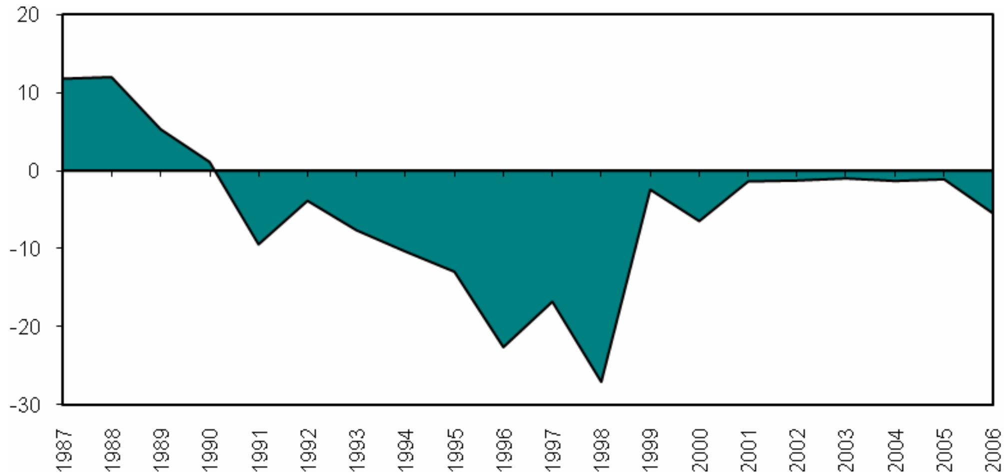
Source: Own calculations

Figure 21: Effects of fiscal sustainability shocks on Inflation, 1987-2006



Source: Own calculations

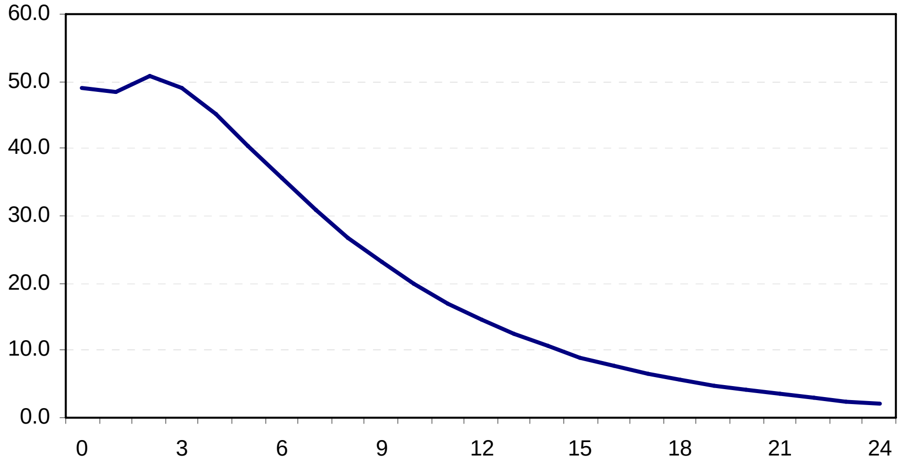
Figure 22: Deviation of Inflation by the effects of fiscal sustainability shocks, 1987-2006



Source: Own calculations

Finally, as can be seen from the impulse response function, shown in Figure 23, the inflationary effects of the fiscal sustainability shocks are also temporal but highly persistent (in fact, their effect is twice more persistence than the effect they have on GDP growth).

Figure 23: Impulse Response function of Inflation to a typical fiscal sustainability shocks



Source: Own calculations

5. Final remarks

In this paper we analyze long run effects of fiscal sustainability shocks, in particular the role played by these shocks on the Bolivian economic growth performance. To do this, we impose restrictions on a VAR for the Bolivian economy that allow us to identify fiscal sustainability shocks. We argue that imposing long run identification restrictions in our structural VAR is a new and useful way to identify the macroeconomic impact of shocks on fiscal sustainability.

Our results show a significant lost in the level of GDP in the Bolivian economy as a consequence of the sequence of adverse fiscal sustainability shocks this economy has experienced. In this regard, an important result is that even though unsustainable fiscal shocks have not permanent effect on Bolivia's economic growth, the fact that this type of shock has occurred during the period studied (in a significant way at least during the late 70s early 80s and at the late 90s early 2000s) negatively affected the Bolivian economic growth. In fact, if we accumulate the output loss due to adverse fiscal sustainability shocks (net of favorable ones) over the entire sample and compare it with the level of Bolivia's GDP in 2006, the accumulated losses represent more than 330%.

Our results also show that inflation has been affected by fiscal sustainability shocks, especially the adverse shocks experienced during the period from 1977 to 1986, which ended in the hyperinflation in 1985. In fact, our model attribute 94% of the inflation level that Bolivia experienced during its hyperinflation episode to the sequence of adverse shocks of its fiscal sustainability that this economy experienced during that period.

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Appendix 1. The arithmetic of budget constraints. Blanchard (1990)

As suggested by Blanchard (1990), the starting point of any discussion of sustainability is the dynamic government budget constraint, which is given by:

$$dB / ds = G + H - T + rB = D + rB \qquad \text{(A.1)}$$

Where B is real debt, G is government spending on goods and services, H is transfers, T is taxes, D is the primary deficit G+H-T, and r is the real interest rate. s denotes time. Rewriting the budget constraint in terms of ratios to GNP (denoted by lower case letters):

$$db / ds = g + h - t + (r - \theta)b = d + (r - \theta)b \qquad \text{(A.2)}$$

Where θ is the rate of growth of GNP. In order to have fiscal sustainability, the dynamic solution to (A.2) requires that the real interest rate exceeds the GNP growth rate, in other words, that r- θ is positive. In this regards, it is important to mention that this condition was not satisfied ex post during several periods for the Bolivian case.

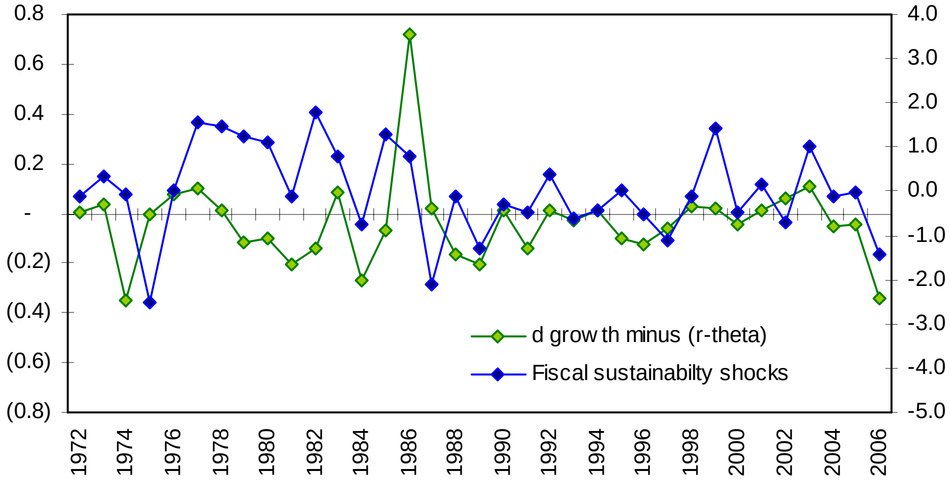
Fiscal policy is a sequence of (g,h,t) and an initial value of b, b_0. As we mention, it is sustainable if real debt does not explode faster than the interest rate, or equivalently if the ratio of real debt to GNP does not explode faster than the excess of the interest rate over growth rate. If it is sustainable, then the following intertemporal budget constraint holds:

$$\int_0^{\infty} \mathrm{d} \exp - (r - \theta) s \mathrm{d}s = -b_0 \qquad (3)$$

Where r and θ are assumed constant for notational simplicity. For fiscal policy to be sustainable, the present value of primary surpluses (-d), discounted at, r- θ, must be equal to the initial level of debt.

Ex post, equation (A.3) will clearly be satisfied, perhaps through adjustment of taxes or spending, perhaps by monetization or repudiation. In order to have a comparison of what would be implied by this accounting approach and by our model, we make a simple comparison of the evolution of our fiscal sustainability shocks and the difference between Debt/GDP growth and (r- θ). As ca be seen from the Figure A.1, the two series move relatively close, in fact the correlation between the two series in 0.26.

Figure A.1: Comparison between the model fiscal sustainability shocks and the conditions for Debt/GDP to be sustainable.



Source: Own calculations