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OIL & DEBT WINDSFALL AND FISCAL DYNAMICS IN BOLIVIA

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Abstract

During 2004-06 Bolivia experienced a five-fold increase in oil revenues due to tax/ contractual innovations, higher prices and larger volumes at the same time that a multi-lateral debt reduction initiative trimmed roughly one third of the public external debt. The political economy setting of this environment entails a new hydrocarbons law that automatically decentralize expenditure to local governments and nationalization of the oil industry. We model fiscal dynamics in Bolivia in an stochastic framework and find that the new status-quo will generate double reversions of primary surplus and a public debt path that may fall short of being pleasant in the presence of unfettered fiscal spending and/ or decline in international energy prices and gas demand from its neighbors. Even though it is difficult to assess the underlying fiscal policy reaction function to future development in Bolivia, we conclude that governance of the process of allocations and distribution of the oil rent is essential to the short to medium term sustainability of the new Bolivian model.

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1 Introduction

Bolivia's public finances struggled in the late 90's, after a series of shocks, including recession and debt default by Argentina (one of its large neighbors), which translated into lower domestic growth and highlighted the structural fiscal imbalance created by the pensions reform undertaken in 1996. In 2002, the worst year for Bolivia's public finances and the beginning of a newly elected government set for collision, the country posted a fiscal deficit of 8.8% of GDP. While the imbalance was mainly due to pensions deficit, which explained 5% of GDP, the country still had a 1.3% of GDP primary deficit excluding pensions, which made it necessary to implement actions to tackle deficiencies in revenues, follow a stringent expenditure policy and find structural remedies to limit the hole resulting from the pension system. Most of the analysis on fiscal sustainability at that time turned the eyes into the effects of the HIPC initiative in Bolivia and its requirements, the estimation of possible revenues that could accrue from newly discovered hydrocarbons fields and the required corrections in the structural pensions deficit. While Bolivia, with a total public debt above 70% at that time, did not had a solvency problem given the large share of multilateral and bilateral public debt issued in concessional terms (which reduced the NPV of the public debt) there were sustainability concerns associated with the observed fiscal gap, the corresponding fast growth of domestic public debt (driven by market interest rates) which was dangerously increasing to more than 20% of GDP and the prospects for graduation from concessional sources in the future.

This situation changed dramatically in 2005 as the political crisis, named the "gas war", waged by a new left wing broad coalition including indigenous groups, peasants and urban poors alike, pressed for major changes in the taxation of hydrocarbons production. Within a few months, Bolivia faced a strong change in public finances resulting from increases in the price of exports of natural gas, which doubled between mid 2004 and the end of 2005, a sharp increase in hydrocarbon taxes and higher exports volumes demanded by energy-troubled Argentina. The compounded fiscal impact of all these developments amounted to almost 7% of GDP and was enough to move Bolivia from the red, at the very same time that a new global multilateral debt reduction initiative was announced by the IMF and the World Bank which would allow Bolivia to write off 100% its (public) debt with these institutions (equivalent to 21% of GDP). As in many other revolutionary settings, these changes came with other innovations for public finances that ranged from pressures to redistribute hydrocarbons rents in a decentralized fashion, to demands for greater regional autonomy and lower levels of governments, that suggest a lagged response in expenditures as the new authorities in departments take control and demands for public spending materialize. More recently, and after the coalition took office after a landslide electoral victory, additional changes ensued, including oil nationalization and a sweeping breach of existing contractual rights (with possible extensions to non oil sectors) and calls for a referendum to reform the constitution.

In this paper we model fiscal sustainability in this fluid scenario in a manner that can be conceptually divided into two stages.[1] In the first stage we estimate a deterministic baseline scenario that computes the primary result and the trajectory of the public debt departing from the conventional steady state approach in the sense that we model the dynamic behavior of the determinants of the public debt to GDP ratio. Given the non trivial aspects concerning revenue and spending dynamics resulting from the recent political and fiscal innovations, we make a thorough effort to estimate both critical elements of hydrocarbons revenues as well as other fiscal and macro variables. The main objective of the paper, however, is to move beyond a deterministic setup by modeling the stochastic elements present both in fiscal income and expenditure as well as in other financial and macro-economic variables which influence the path of public debt. Hence, in the second stage we model uncertainty within a simple framework that separates between fundamental and policy variables and allows for explicit treatment of the risk embedded in the joint distribution of the stochastic variables. This framework allows us to simulate a distribution, also called a "fan chart", for the trajectory of public debt.

The paper belongs to the sub-field of fiscal sustainability analysis, which has undergone significant changes both in analytical and applied formats in recent years. Analytical approaches have been concerned with modeling risk and its appropriate evaluation for debt sustainability assessment and policy response, questioning the conclusions drawn from conventional deterministic steady-state evaluations that do not account for dynamics, risk, or the possible policy responses to fundamental shocks. At the same time, IFI's and practitioners alike have been concerned with a better modeling of fiscal and debt trajectories that are at the same time more amenable and relevant for practical evaluation and policy dialogue.[2] Analytical approaches have been particularly interested in modeling stochastic structures from a pure financial perspective[3], modeling endogenous variables such as the real exchange rate and/or policy reaction functions to fundamental shocks.[4] More applied or hands-on blueprints, such as extensions to the IMF template, have been interested in obtaining confidence intervals from reduced-form econometric models and in establishing practical criteria for sustainability assessment.[5] Our chosen methodological approach for Bolivia is more close to this second strand because it starts from a conventional deterministic approach which is extended to account for risk in fundamental and policy variables, employing a non-parametric modeling of risk that is more appropriate given data limitations and policy structural breaks.

The rest of the paper proceeds as follows. In section 2 we briefly present the basic accounting framework. In section 3 we discuss the fiscal, macro–economic, and financial

[1] We say concenptually, since, as it will become clear in section 4 when we discuss how we model uncertainty, the two stages are actually computed simultaneously.

[2] Burnside (2004) provides a clear and thorough presentation and critical review of some recent contributions and depicts the tension between analytical proposals and the problems for empirical implementation in true economies with data limitations and many unobservables.

[3] See for example Barnhill and Kopits (2004) and Xu and Ghezzi (2003).

[4] See for example Oviedo and Mendoza (2004a, 2004b) and Alvarado, Izquierdo and Panizza (2004).

[5] See IMF (2002, 2003) and Celasun, Debrun and Ostry (2006).

assumptions which allow us to estimate a baseline trajectory for the public debt to GDP ratio up to 2015. In section 4 we explain our modeling approach concerning risk, obtain the stochastic path of fundamental variables and the debt to GDP ratio, and simulate several relevant shocks. Section 5 draws conclusions from our exercise, its implications for fiscal policy in Bolivia and also discusses analytical extensions.

2 Definitions and Basic Framework

In nominal terms, public debt evolves according to:

$$D_t - D_{t-1} = D_{t-1} i_t - SP_t - BL_t \tag{1}$$

where D_t is debt at the end of period t, i_t is the average interest rate on debt, PS_t is the primary surplus, BL_t is the below the line surplus and all variables are expressed in current Bolivian pesos. The adjective "average" refers to the fact that interest rate which is relevant in order to determine the evolution of debt between two periods is not a marginal interest rate (corresponding to debt issued the period before) but an average interest rate which takes into account all debt issued up to period t.

We can rewrite (1) as:

$$d_t - d_{t-1} = d_{t-1} r_t - sp_t - bl_t \tag{2}$$

where lower case variables represent the corresponding (nominal) upper case variable expressed in terms of the nominal GDP and r_t is the adjusted average real interest, where "adjusted" means that it takes into account GDP growth and the evolution of the real exchange rate.[6]

Specifically,

$$r_t \equiv \frac{(1+\hat{e}_t)\left(1+r_t^{us\$}\right)}{1+g_t} - 1 \tag{3}$$

where:

$$\hat{e}_t = \frac{(1+\varepsilon_t)\left(1+\pi^{PPI}\right)}{1+\pi^{Def}} - 1 \qquad \text{and} \qquad r_t^{us\$} = \frac{1+i_t^{us\$}}{1+\pi_t^{PPI}} - 1$$

represent, respectively, the rate of devaluation of the real exchange rate and the real dollar interest rate during period t; ε_t is the rate of devaluation of the nominal exchange rate, π_t^{Def} is the inflation of the GDP deflator, g_t is the growth of real GDP, $i_t^{us\$}$ is the average nominal interest rate expressed in dollar terms, and π_t^{PPI} the rate of inflation implicit in the US' Producer Price Index which proxies international inflation.

[6] Our expressions (2) and (3) correspond to the special case assumed in IMF (2002) and (Ley (2004)) where all debt is external (in dollars) and the variation of the real exchange rate is given in real terms (using the GDP deflator).

Expressions (2) and (3) conveniently summarize the factors which determine public debt evolution: automatic debt creation, (the first term on the right hand side of the former equation) and the primary surplus together with the below the line items. In turn, automatic debt creation can be decomposed into four components as the following expression shows:

$$d_{t-1}r_t \equiv d_{t-1}r_t^{us\$} + d_{t-1}\hat{e}_t + d_{t-1}\left[(1+g_t)^{-1} - 1\right] + EI_t \tag{4}$$

where the four right hand side terms represent the real interest rate effect, the real depreciation effect, the growth effect and a fourth effect which results from the interaction of the first three components.

Given the assumptions regarding fiscal policy and the macro-economic/financial conditions which will be made later on, it is possible to determine the evolution of the debt to GDP ratio. Specifically, iterating forward equation (2),

$$d_t = d_0 \prod_{s=1}^{t} (1 + r_s) - \sum_{s=1}^{t} (sp_s + bl_s) \prod_{j=s+1}^{t} (1 + r_j) \tag{5}$$

Intuitively, future public debt, d_t, is the sum of two components. The first one is the future value of present debt d_0, discounted t periods using the adjusted real interest rate. The second term is the sum of the future values of the primary result and the below the line result from period 1 to period t.

3 Calibration of the Baseline Scenario

In this section we calculate the path of the public debt to GDP ratio using equation (5). In order to do so, we posit a policy baseline scenario which represents the most likely policy scenario given the current state of policy and make assumptions regarding the (trend) behavior of fundamental variables.

3.1 Baseline Assumptions

In order to simulate the evolution of the debt to GDP ratio, it is necessary to make assumptions about the macro–economic/financial conditions and fiscal policy. To keep the discussion short, in this section we will emphasize the assumptions regarding fiscal policy (and oil prices which are a central component of government revenues).[7]

[7] A more detailed description of the baseline assumptions (by end-2005) is presented in Navajas, Bour and Catena (2006). In this paper we have introduced some modifications concerning the evolution of hydrocarbons prices and quantities, and of primary spending, that we find more relevant given recent developments.

3.1.1 Fiscal Assumptions

The evolution of the primary surplus not only includes explicit assumptions about government revenues and expenditures but also takes into account the evolution of the fiscal accounts up to 2006 as well as fiscal policy measures which have been recently adopted. For most items in the primary balance, we assumed an exogenous non–stochastic trend in terms of GDP which takes into account the historical behavior and the medium term projections in IMF (2005).[8] However, given the significance of the developments in the hydrocarbon sector which took place in 2005, we modify the path of government revenues, salaries, investment and transfers to account for these developments. Table 1 summarizes the fiscal assumptions in the baseline scenario.

Hydrocarbon Revenues: Counter-reform, Tax Hike and Revenue Sharing The most significant innovation to Bolivia's fiscal dynamics in 2005 was generated by the hydrocarbon sector where several developments took place which led to a significant windfall for public finances. Amidst the political pressure to introduce deep changes in hydrocarbons policy, exerted by a fast growing opposition, which gave rise to several political maneuvers by the government of President Mesa, including a referendum in July 2004 and a submission of a new law, the Congress eventually took control and passed a new law (No.3058 which replaced the previous Hydrocarbons' law No.1869) in May 2005. The big bang, was the introduction of a new tax, the Impuesto Directo a los Hidrocarburos (IDH), which amounted to setting a new royalty that doubled up the effective average tax rate levied on the value of hydrocarbon production. In addition, hydrocarbon export contracts prices, which due to contractual arrangements follow oil prices with a lag, also (roughly) doubled in 2005. Finally, export volumes also increased due to greater natural gas sales to Argentina (facing a serious shortage since mid 2004), that recovered after six years of being negligible. As far as revenue sharing was concerned, the reform gave rise to significant changes in the way hydrocarbons are shared between the central government and other jurisdictions, creating demands for redistributions that could operate in the medium term restraining the ability of the Treasury to appropriate the ongoing windfall. In fact, the new law was a combo package presented to the executive with the new IDH tax earmarked to several stakeholders.

Because the evolution of hydrocarbon tax collection and sharing is central in the estimations of fiscal performance and sustainability of Bolivia, in this subsection we explain, on the one hand, the procedure employed to estimate medium term hydrocarbon prices and quantities along with the implied path of hydrocarbons revenues and, on the other, the assumptions regarding the evolution of expenditures that would automatically

[8] Hence, the behavior of these items in terms of GDP was strictly non–stochastic and exogenous in the sense that they were not functions of other exogenous variables and where not influenced by government policy either. The path of these variables relative to GDP is exactly the one explained in Navajas et al. (2006).

follow from the redistribution of revenues, as the proceeds are allocated to different stakeholders.

Hydrocarbons Prices. Bolivia has a dual hydrocarbon price system which distinguishes between external and domestic prices. Prices of oil exports are normally quoted slightly below WTI prices due to quality and transport cost considerations, while the government sets domestic oil prices significantly below external prices. In the case of natural gas, average exports prices have been driven by the main export contract (to Brazil, called "Gas Sales Agreement") which sets a lagged, partial adjustment motion that depends on the evolution of three types of fuels that are quoted in the Platts Oilgram Report, while domestic prices are set significantly below export prices.

Finally other hydrocarbons such as LPG evolve in a similar manner and do not have a significant internal or domestic use. Both external and domestic hydrocarbon products are subject to the same tax treatment (royalties and IDH) so the differences in revenues come only from price setting (and of course volumes). Measurement and auditing of wellhead prices (export prices at a given geographical point less transport prices) on which taxation is levied is performed by the Ministry of Hydrocarbons which also supplies projected values to the Treasury for budget planning purposes.

For 2004 and 2005 we have employed the actual values reported by the Ministry of Hydrocarbons and the Treasury, and set initial external prices for crude oil, natural gas and LPG. In 2006 we assume there is a renegotiation of the price level of natural gas exports which increases from 3.25 to 4.75 dollars per million of BTU (a % 46% increase) starting in 2007.[9] Beyond these initial conditions we employed the price of NYNEX traded WTI future contracts as a proxy for future fuel oil prices up to 2011 that under normal contractual arrangement should determine natural gas export prices. For 2012-15 we assumed that the WTI price stays constant in nominal dollar terms. Thus, we use a sequence of oil prices as a proxy for the sequence of fuel oil prices and use the contractual arrangement to calculate natural gas export prices. For domestic prices we are more conservative (given the new political status quo which was built on the demand of cheap natural gas for Bolivians) and assume that natural gas prices stay constant at the level set in the 2006 budget. For crude oil we assume that domestic prices grow at the same rate as external crude oil prices and that these two oil prices maintain a constant ratio.

Hydrocarbons Production. Regarding quantities, we assume a baseline statu-quo scenario in which production stagnates for natural gas and oil. Natural gas production increases moves very slowly, from about 32 million m^3 per day in 2005 to 38

[9] We are introducing this increase in export gas prices into the baseline scenario given that renegotiations have actually started in may 2006. Although the format of the final agreement is not clear, we can anticipate with some confidence that there will be an upward adjustment of the current price. We assume this increase happens once-and-for-all in 2007.

million in 2015 as a result of marginally increasing sales to Brazil, Argentina and domestic markets. Crude oil production stays barely constant at 18 million barrels a year while LPG production declines. Alternatives to this statu-quo, which are also consistent with contractual renegotiations with neighbors and with investment climate, are considered later on.

Revenue Sharing and Fiscal Savings. As stated before, although Law 3058 and the increase in oil prices both led to an important increase in oil related revenues, also came with a earmarked treatment which automatically transfers of the additional revenues to Provinces (Departamentos), Municipalities (Alcaldias) and other stakeholders such as Universities, Indigenous Groups and an open list which may include additional stakeholders in the future. Insofar as these stakeholders do not save the additional revenues, this interacts with fiscal sustainability by direct and indirect ways, namely weakening the visible improvement in the government's financial position in 2005-06 and also exerting pressure (for appreciation of the Bolivian peso) on the real exchange rate. This is so because under the old law, the central government received a 38% royalty over hydrocarbon fields discovered before its enactment (which represented about 23% of total production in 2004) and a 6% of newly discovered fields, while the provinces received a 12% royalty over all fields, so that the effective overall tax rate on the value of hydrocarbons production was 25%[10], with the effective tax rate accruing to the Central Government being 13%. The change (towards a generalized tax burden of 50% on the value of production for all fields, made out of a royalty of 18 plus an IDH of 32%) in Law 3058 leaves the central government receiving a 6% royalty over all fields and a 26% share of the newly created IDH, while the Provinces maintained the 12% royalty over all fields and get along with the other stakeholders the 74% of the IDH tax. These other jurisdictions and stakeholders, namely provinces, municipalities, universities and the "Indian Development Fund" (FDI), get 44%, 20%, 5% and 5% of the IDH receipts. Hence, although the overall tax rate on hydrocarbons doubled to 50%, the effective tax rate on Hydrocarbons production value accruing to the Treasury in the steady state (i.e. when all the funds are properly distributed) would only increase from 13% to 14%. Table 2 compares how hydrocarbon revenues were shared by the different stakeholders under the new and the old law.[11]

In this new statu-quo, we assume that only the Central Government saves 100% of the additional oil revenue. However, given the centralized provision of education and health expenditures in Bolivia, we assume the Central Government is automatically forced to spend 20% of the 44% share of the Provinces in the IDH in the form of wages and 55% in

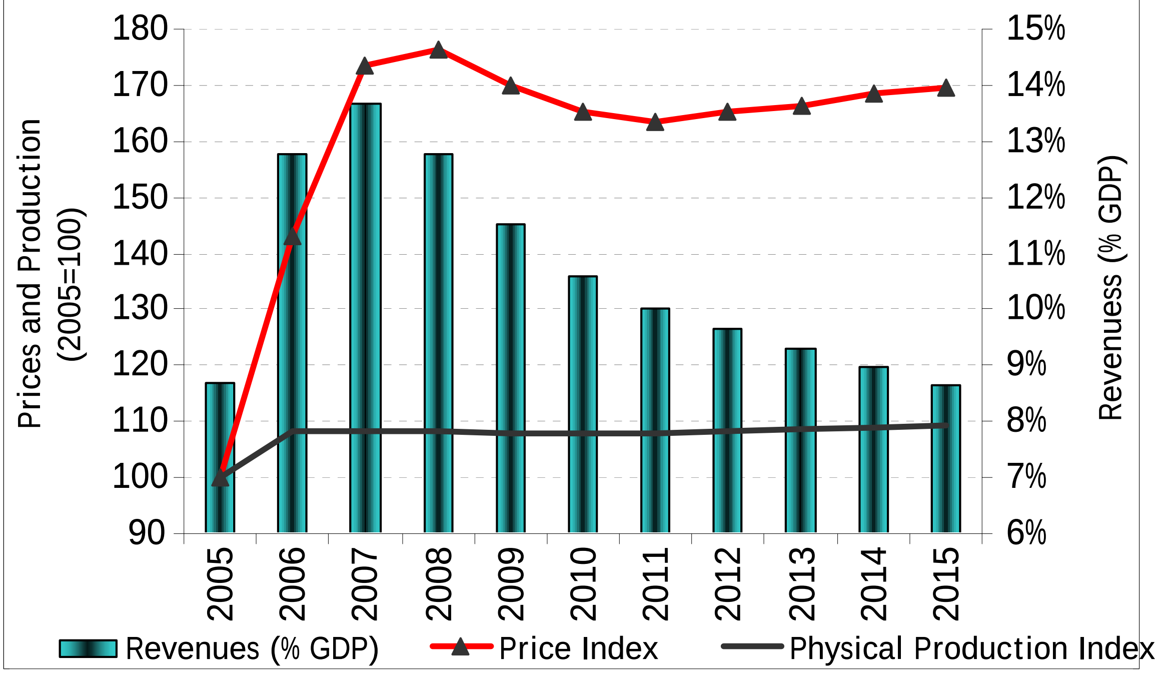
[10] 23% of production taxed at 50% (38% accruing to the Treasury and 12% to the Provinces) and the remaining 77% taxed at 18% (6% to the Treasury and 12% to the Provinces).

[11] In addition, the effect on the central government finances depend on the way these stakeholders spend the additional revenues generated by the new tax code and increased hydrocarbon production and prices.

the form of investment, so that the provinces only save 25% of the newly created claims. Instead, we assume that the municipalities, universities and the FDI fund spend all the IDH revenues. In summary, for each additional dollar generated by the IDH, the public sector ends up saving 0.37 cents, while spending 0.38 in additional investment, 0.20 in additional wages and 0.05 in additional transfers (to the FDI fund).

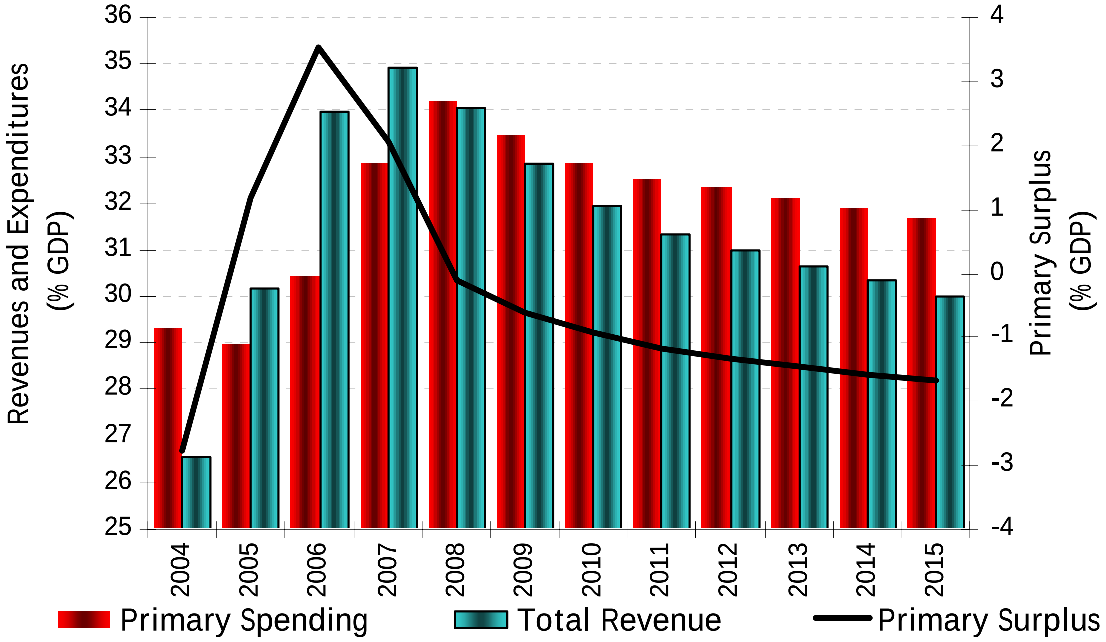
Hydrocarbons Revenues. Graph 1 shows the results our assumptions regarding production, prices and hydrocarbon tax policy. Initially, the price of hydrocarbon adjusts because of the renegotiation of the natural gas price export level with Argentina and Brazil (assumed to happen during 2006). From 2007 to 2010, prices decrease since we assume oil prices decrease (consistent with oil future prices) and the fact that according to contractual adjustment clauses, natural gas export prices lag behind oil prices. From 2008 forward, (nominal) oil prices roughly stay constant because we assume that oil prices stay constant. Hydrocarbon production increases up to 2007, as the quantity of natural gas exports to Argentina and Brazil increases but then stays constant. In terms of GDP, oil revenues increase from 5% in 2004 (not shown) to 13.7% in 2007. From then onwards they decrease since the rate of growth in real GDP outpaces the rate of growth of hydrocarbon revenues measured at constant prices, reaching 8.7% in 2015.

Graph 1:
Hydrocarbons: Production, Prices and Revenues



Primary Surplus Graph 2 shows the evolution of revenues, primary spending and primary surplus resulting from our baseline assumptions regarding oil prices and quantities, the real exchange rate and real GDP. During 2005 and 2006, income grows significantly as a percentage of GDP mostly due to the natural gas price renegotiation and the new tax scheme. From 2007 onwards it declines because the decline in (dollar) oil prices, the appreciation of the real exchange rate and the increase in real GDP. Spending on the other hand, increases at a lower rate than revenues as the increases in oil revenue are distributed across stakeholders. Consequently, the primary surplus peaks from a 2.5% deficit in 2004 to a 3.8% surplus in 2006 and diminishes to a 1.4% deficit at the end of the projection period, averaging a 0.9% deficit through the period projection period. Table 1 shows the components of the primary surplus in terms of GDP.

Graph 2:
Evolution of the Primary Surplus



3.1.2 Macro–Economic and Financial Assumptions

Table 3 summarizes the Macro–economic and Financial Assumptions.

Macro–Economic Conditions In line with private consensus for Bolivia, we assume that during 2005 and 2006 Bolivia grows at a 4% rate.[12] In the long run (2012 forward)

[12] See BCB (2006b).

we assumed a growth rate of 3.1%, consistent with the rate observed in the last two decades and growth exercises.[13] During 2007 to 2009 we assumed that growth gradually converges to its long run path.

In order to project the evolution of the real exchange rate we considered its historical evolution. Roughly, we can distinguish two stationary regimes: an appreciated real exchange rate regime and a depreciated regime. The first regime took place from the year 1985 to 2000 and the second regime the rest of the interval. In the baseline scenario we assumed that the real exchange rate steadily appreciates 10% from 2006 to 2012, towards its 1980–2005 average and stays constant for the rest of the simulation period.

Finally, with respect international inflation which was proxied by the US PPI, we followed FIEL (2005) from 2005 to 2007. From that point forward we assumed it slowly converges to 2% (slightly below its 1980–2003 average of 1.77%).

Financial Conditions According to the setup presented in Section 2, we need to obtain the average interest rate i_t. Specifically, we calculate i_t as a weighted average: $i_t = s_t i_t^N + (1 - s_t)\, i_t^X$ where i^N is the average interest rate on internal debt i_t^X and the average interest rate on external debt and the s_t is the share of internal debt in total debt.[14] In turn both average interest rates (i_t^X and i_t^n) depend on the amount of debt issued in previous periods and the marginal interest rate on new debt in the corresponding currency. Period 0 (i.e. the year 2005) average interest rates where calculated using actual data.[15] With respect to internal marginal debt, we assumed that the current average maturity is maintained and that i_t^N is calculated as:

$$i_t^N = i_t^l + \sigma$$

where i_t^l is the libo interest rate and σ is a constant spread (set at 380 b.p.). The profile of the libo rate was calculated using the implicit one period ahead in libo swaps.[16] We assumed interest rate parity condition with regards to internal debt issued in domestic currency. Regarding external debt we assumed that it is issued with a time to maturity of 8 years at a rate of 150 b.p.[17]

[13] See, for example, Mercado, Leitón and Medinaceli (2005) and López Murphy (2005).

[14] Recall that we assume that all debt is issued in dollar terms.

[15] The temporal profile of historical domestic debt was calculated using information provided by Salcedo Gutierrez (2004) and SPVS (2006). The temporal profile of external debt owed to the IMF, IADB and World Bank was calculated using public information available in the respective weg pages. The temporal profile of other external debt was proxied using information provided in BCB (2006a).

[16] See Appendix D in Navajas et al. (2006) for further details.

[17] These figures represent the time to maturity and spread over libor of bolivian external debt by end 2005 respectively.

3.1.3 Multilateral Debt Reduction Initiative

By the year 2001, Bolivia had become eligible for debt forgiveness according to the HIPC ("Heavily Indebted Poor Countries") II initiative, a debt reduction mechanism that involves the IMF and the International Development Association (IDA) of the World Bank.[18] In 2005, however, a more comprehensive debt reduction strategy, the MDRI (Multilateral debt reduction initiative) which allows for 100 percent debt relief was adopted by these institutions. The baseline scenario takes into account the effect on Bolivian debt of the MDRI which will lower Bolivian national debt by 2,000 million dollars (21% of GDP) by the end of 2006.

3.2 Evolution of the debt to GDP ratio: Baseline Results

Graph 3 shows the evolution of the debt to GDP ratio as well as the interest payments as percentage of GDP. As a result of the strong primary surplus projected from 2005 to 2007, (2.5% of GDP), high rate of growth during this period (4% per year), real exchange rate appreciation (1% per year) and the MDRI initiative, debt diminishes from 78% in 2004 to 38% in 2007. From then onwards, the decline of the primary surplus, the decline in the rate of growth and the stabilization of the real exchange rate implies that the debt to GDP ratio increases by 1.8% from 2008 to 2015. It is worth noting that interest payments as a share of GDP decline initially, following the decline in debt, but then increase from 2008 onwards. This result is not surprising because multilateral debt is cheap compared to voluntary debt. Hence, as time passes marginal debt is issued at a higher interest rate which eventually leads to an increase in interest payments.

[18] And the African Development Fund (AfDF) in the case of African countries.

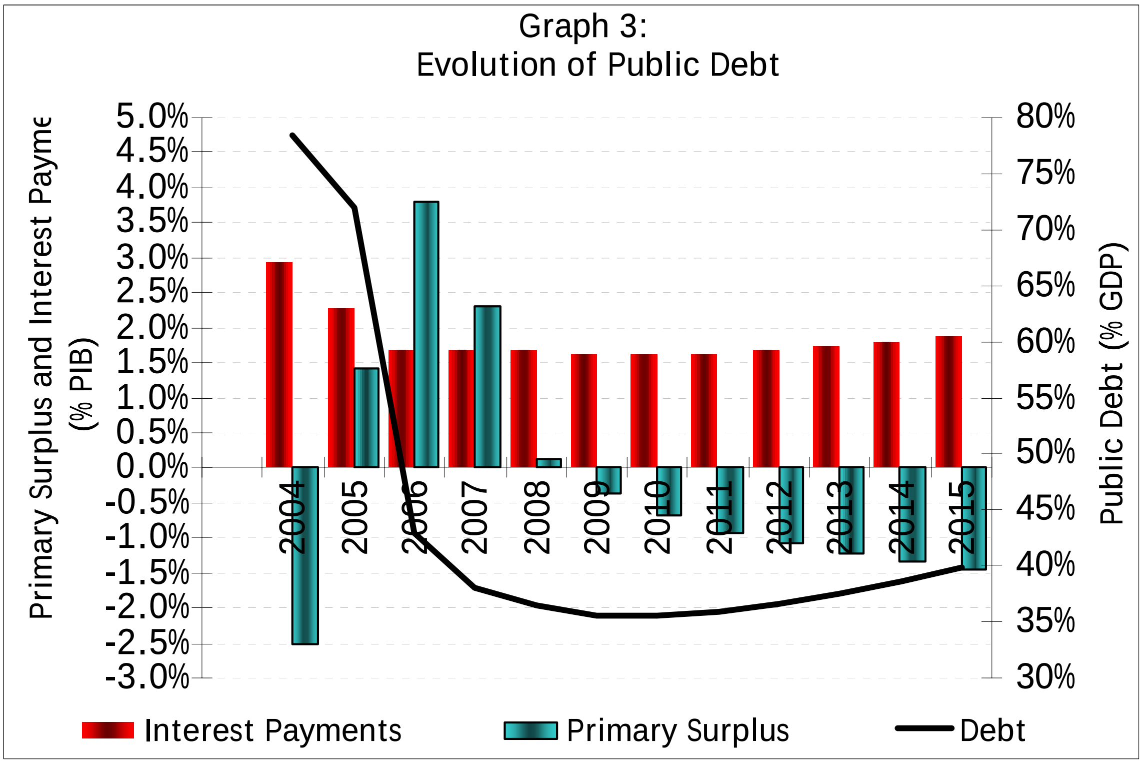


Table 4 decomposes yearly declines in the public debt to GDP ratio in three components: primary deficit, automatic debt creation and debt forgiveness (HIPC II for IADB and MDRI for WB and IMF). According to our simulations, the debt to GDP ratio declines to 40% in 2015, a 39 percentage point reduction relative to 2005. This reduction is almost entirely explained by a 17% debt destruction caused by automatic debt reduction (resulting from a combination of real interest rate, growth and real exchange rate) and a 25% decline due to debt forgiveness.[19] In turn, the above mentioned 17% automatic debt destruction can be decomposed (according to equation 4) into three components: the real interest rate effect that contributes a 4% increase for the whole period, real GDP growth which contributes to 17% decline and, real exchange rate appreciation which contributes to a 5% decline.

It worth emphasizing that due to the double reversion of the primary surplus Bolivia averages a 1% deficit during 20005-2015, which has a neglible effect on the debt to GDP ratio. This result highlights the need for fiscal discipline in the wake of an oil and debt windfall.

[19]The total primary result for the whole period is negligible.

4 Modeling Risk: Fundamental vs. Policy Variables

In this section, we extend our analysis to account for uncertainty. We proceed as follows. First we explain the conceptual framework we employ to deal with risk. Second, we discuss how this conceptual framework is implemented. Finally we discuss how the basic results in section 3 are modified once risk is taken into consideration.

According to our methodology, the path of the debt to GDP ratio is subject to policy shocks and fundamental shocks. In this section we will compare the relevant importance of the two types of shocks. Before we do so, however, we discuss the manner in which shocks to fundamental variables were modelled.

4.1 Exogenous Shocks vis-a-vis Policy Scenarios

As discussed in the introduction, one of the main areas in sustainability analysis which needs improvement center around the role of risk. In order to model risk we discuss two types of shocks: exogenous shocks and policy shocks which correspond to fundamental and strategic uncertainty. The former results from shocks to the fundamentals and the latter corresponds to uncertainty regarding the actions of the players in the game. In Celasun et al. (2006) the former is modelled using a vector autoregression approach which captures the stochastic properties of the exogenous variables (including the covariance matrix among the latter variables), while strategic uncertainty is modelled using reaction functions obtained employing panel techniques. In our case, the lack of a sufficiently long quarterly data set on GDP and the GDP deflator (necessary to calculate the real exchange rate) and the possible presence of structural breaks make it difficult to estimate a vector autoregression with sufficient precision. In the case of strategic uncertainty we lack sufficient data to estimate the reaction of policy variables to shocks in the exogenous variables a là Celasun et al. (2006). Instead, we model fundamental uncertainty (e.g. oil prices, growth, real exchange rates,etc.) through a non parametric approach and address strategic uncertainty by considering different policy scenarios (e.g. changes in government spending policy and in natural gas exports).

As we will see next, our methodology implies that for each set of assumptions or scenarios regarding policy variables it is possible to obtain a distribution for the path of the debt to GDP ratio given the stochastic properties of the fundamental variables. In the next sub-section we explain how we can obtain a distribution for the path of the debt to GDP ratio for a given scenario of policy variable.

4.2 Modeling Fundamental Variables Risk

In line with equation (2) we can write the difference equation which governs the path of the public debt in terms of GDP as:

$$d_t = (1 + r_t)\, d_{t-1} - sp_t - bl_t = G\left(d_{t-1}, X_{t-1}, Y_{t-1}\right),$$

X is a (row) vector of fundamental variables and Y is a (row) vector of policy variables. Denote by n^X the number of fundamental variables.

Iterating the above equation forward, we can rewrite equation (5) as:

$$\begin{aligned} d_t &= d_0 \prod_{s=1}^{t} (1 + r_s) - \sum_{s=1}^{t} (sp_s + bl_s) \prod_{j=s+1}^{t} (1 + r_j) &\quad (6) \\ &= J \left({}_0\mathbf{X}_t, {}_0\mathbf{Y}_t \right) &\quad (7) \end{aligned}$$

where ${}_s\mathbf{X}_t \equiv \{X_i\}_{i=s}^{t}$ and ${}_s\mathbf{Y}_t \equiv \{Y_i\}_{i=s}^{t}$ are sequences of vectors which represent, respectively, the path of the fundamental (or exogenous) and policy variables from period s to period t. Normalize to $t = 0$ the start of the simulation window and let the $U(X)$ denote the first period for which information regarding each of the variables in X is available.

Furthermore, define the normal score of random variable z as:

$$n_\Phi (z) = \Phi^{-1} (F (z))$$

where Φ^{-1} is the inverse of the *c.d.f* of the standard normal distribution and F is *c.d.f.* of variable x. This allows us to define the Spearman correlation coefficient between random variables w and z as the correlation between the corresponding normal scores:

$$\rho (y, z) \equiv Corr \left(n_\Phi (w), n_\Phi (z) \right)$$

Given this setup, in order to simulate the path of d_t for a given policy scenario (i.e. for a given path ${}_0\mathbf{Y}_t$), it is necessary to obtain a distribution for the path of the fundamental variables, ${}_0\mathbf{X}_t$. This non–parametric procedure involves three stages:

1. Calculation of the joint empirical distribution of the deviations of the fundamental variables,
2. Simulating non–independent paths for each of the fundamental variables, and,
3. Simulating a distribution for the path of the debt to GDP ratio.

In Section 4.3 we explain in detail the treatment which was applied to each of the fundamental variables (oil prices, growth, real exchange rate and libo rate). In this section, to explain the procedure we will assume that all fundamental variables are modelled as absolute deviations of the variable from their HP trend, although the procedure can be easily adapted to cover situations in which fundamental variables are modelled in a different manner.

The first stage involves calculating the marginal empirical distribution of the deviation (absolute or percentage, depending on the case) of each variable with respect to its trend (given by the HP filter) using historical data (i.e. from $t = S(X)$ to $t = 0$) and calculating the (historical) Spearman rank correlation matrix between the deviations of the variables subject to fundamental shocks.[20]

Specifically, let $\Delta H\left(X_t\right)$ denote the difference between the value of vector X_t and the value of the HP trend corresponding to X in period t given the historical information regarding the variables in vector X (i.e. given $_{U(X)}X_{-1}$). In this stage we would first calculate the marginal empirical distribution of $\Delta H\left(X\right)$ and the Spearman correlation matrix among the normal scores of the random variable $\Delta H\left(X\right)$, denoted by $\mathbf{\Sigma}$. It is important to note that in order to obtain the marginal empirical distribution in $\Delta H\left(X\right)$ we do not impose normality. Rather, we assume that the observed frequency distribution represents the actual distribution of the variables in $\Delta H\left(X\right)$. Denote by $G^i\left(\cdot\right)$ the marginal distribution function of fundamental variable i, where $i = 1, ..., n^X$ and define the vector valued function $\mathbf{G} \equiv \left(G^1, ..., G^{n^X}\right)'$.

The second stage involves two steps.[21] First, for each $t \geq 0$ and for each fundamental variables we take D independent draws from the standard normal distribution. These draws can be grouped together in the $D \times n^X$ matrix $\widetilde{\mathbf{Z}}_t$ where columns denote fundamental variables and rows denote draws. This implies that the correlation matrix among the vectors in $\widetilde{\mathbf{Z}}_t \times \mathbf{\Sigma}$ equals $\mathbf{\Sigma}$ since $\widetilde{\mathbf{Z}}_t$ is composed of standard normal draws. Hence, the marginal distribution of each of the vectors in $\mathbf{G}^{-1}\left[\Phi\left(\mathbf{\Sigma}\widetilde{\mathbf{Z}}_t\right)\right]$ is the same as that of $\Delta H\left(Z\right)$ and by the definition of normal scores, the matrix $\mathbf{G}^{-1}\left[\Phi\left(\mathbf{\Sigma}\widetilde{\mathbf{Z}}_t\right)\right]$ has Spearman rank correlation equal to $\mathbf{\Sigma}$ as desired.[22] In the second step, we combine the deterministic trend of the fundamental variables, which we might denote by the matrix $\mathbf{X}_t^d = \left(X_t^{1,b}, ..., X_t^{n^X,b}\right)$, and the simulations produced in the first step to produce simulations for the fundamental variables themselves:

$$\widetilde{\mathbf{X}}_t \equiv \left(X_t^1, ..., X_t^{n^X}\right) = \mathbf{I}X_t^d + G^{-1}\left[\Phi\left(\mathbf{\Sigma}\widetilde{\mathbf{Z}}_t\right)\right]$$

where $\mathbf{I}$ is a matrix which is conformable with $\mathbf{X}_t^d$ and with ones as elements.

In the third stage we feed the simulations of the fundamental variables (i.e. $\widetilde{\mathbf{X}}_0, ..., \widetilde{\mathbf{X}}_T$) and the path of the policy variables, $_0\mathbf{Y}_T$, into equation (6) to obtain simulated paths for the debt to GDP ratio. With these paths it is possible to derive a distribution for the path of d_t. In addition, averaging out across simulations, it is possible to obtain a "mean" path for each of the fundamental variables and for the debt to GDP ratio.

[20] The spearman rank correlation between the random variables x and y calculates the correlation between the normal scores of variables x and y.

[21] Simulations were actually done by employing the @risk simulation software. Here we are merely describing how the program runs the simulation.

[22] Where $\mathbf{G}^{-1}$ denotes the inverse of function $\mathbf{G}$.

4.3 Stochastic Behavior of Fundamental Variables

In section 3 we described the trend behavior of fundamental variables. In this section we will discuss our modelling assumptions regarding the distribution of the deviations of fundamental variables along their trend.

We model five fundamental variables: the price of hydrocarbons, the rate of GDP growth, the real exchange rate, the libo rate and international inflation (i.e. the USA's PPI). Although the philosophy employed to model the fundamental variables is the same, we did not follow the same procedure for each one. Consequently, we discuss the modelling assumptions in further detail.

a) Growth Rate of GDP, PPI inflation and 6 month libo rate

GDP growth was modelled as explained in Section 4.2. Specifically in the first stage we detrended growth of GDP using an HP filter to obtain the distribution of the residuals (i.e. the difference between value of the variable and its detrended value). More, explicitly,

$$\Delta H\left(g_t\right) \equiv g_t - g_t^H$$

where g is the growth rate of GDP and the superscript H denotes the HP filter. In order to simulate GDP growth we took draws from the observed historical distribution of $\Delta H g_t$.

The libo rate and PPI inflation were modelled in exactly the same way:

$$\begin{aligned} \Delta H\left(l_t\right) &\equiv l_t - l_t^H \\ \Delta H\left(\pi_t^*\right) &\equiv \pi_t^* - \pi_t^{*H} \end{aligned}$$

where l and π^* are the 180 libo rate and PPI inflation. Again in order to simulate these distributions we took draws from the corresponding detrended series.

b) Real Exchange Rate

Since economic theory suggests that the real exchange rate should be an stationary variable, we did not model the devaluation of the real exchange rate but the level of the real exchange rate. Specifically, we modeled the percentage deviation from HP trend rather than the absolute difference.

$$\Delta H\left(e_t\right) \equiv \frac{e_t - e_t^H}{e_t^H}$$

c) Hydrocarbon revenues

Government receipt from tax i to levied on hydrocarbon j in year t depends on three factors: the dollar price of hydrocarbon j at time t, $P_{j,t}$, the quantity produced of hydrocarbon $Q_{j,t}$ and tax i's rate charged on hydrocarbon j at time t, $\tau_{t,i,j}$. We assumed that both $Q_{j,t}$ and $\tau_{t,i,j}$ were policy variables and that $P_{j,t}$ is a fundamental variable (and thus subject to random shock).

In order to estimate the value of hydrocarbon production it would be necessary, in principle, to evaluate the stochastic properties of five prices (domestic and external natural gas prices, domestic and external oil prices and external LPG). However, the fact that the export price of natural gas is linked to the international price of fuel oil due to contractual arrangements and that the prices of the different types of internationally traded hydrocarbon products are closely linked together since it is possible to arbitrage among them, implies that it is sufficient to model the price of WTI oil. The paths of the other prices can be them simulated as functions of the price of WTI oil.

The stochastic behavior of the WTI was modelled differently than the rest of the fundamentals variables. In the first stage, we calculated the percentage deviation of the monthly WTI price with respect to its HP trend (from 1985:1 to 2005:5) instead of calculating the absolute annual deviation.

$$\Delta H\left(WTI\right)_t \equiv \frac{WTI_t - WTI_t^H}{WTI_t^H}$$

where WTI is the price.

In addition we modeled the percentage deviation with an ARMA(1,1) process:

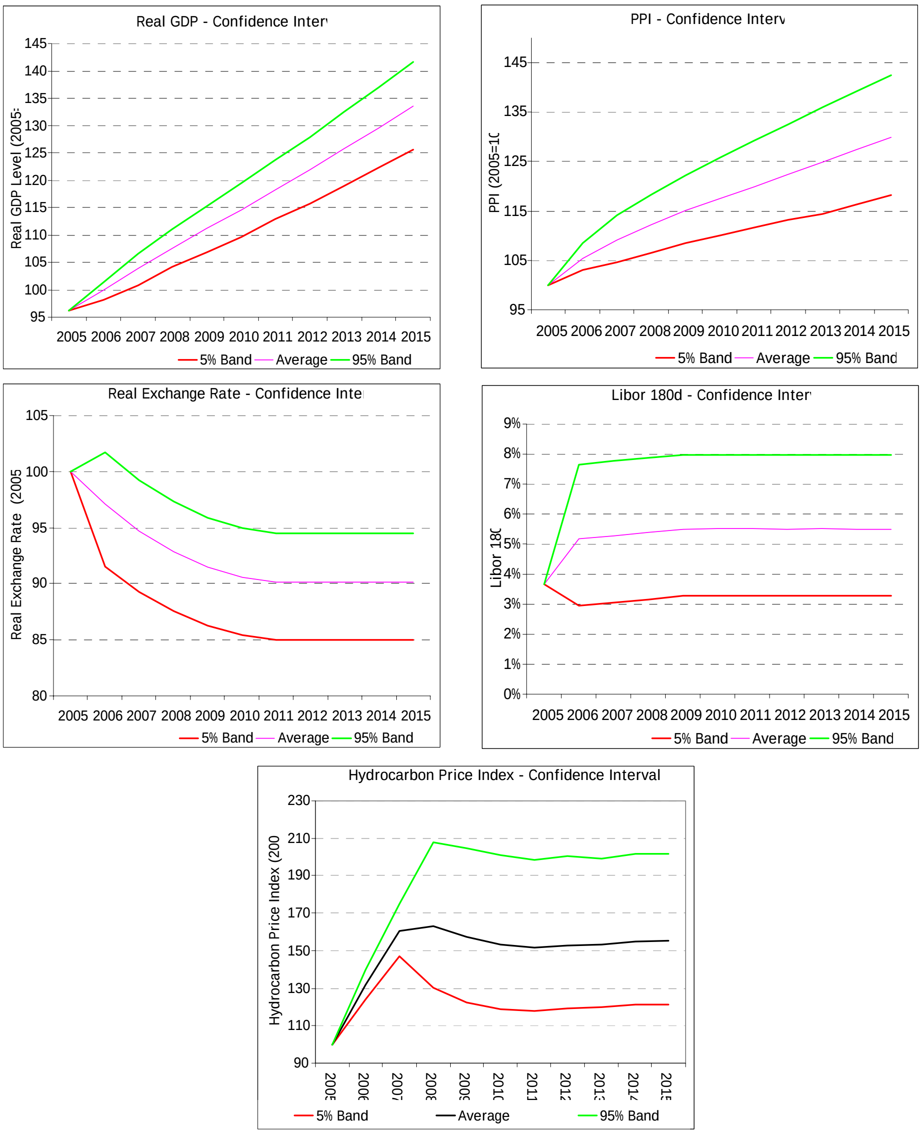
$$\begin{aligned} \Delta H\left(WTI\right)_t &= c + \alpha_{MA} \Delta H\left(WTI\right)_{t-1} + \varepsilon_t \\ \varepsilon_t &= \alpha_{AR} \varepsilon_t + \nu_t \end{aligned} \tag{8}$$

where ν_t is i.i.d normal.

Hence, in the simulations we do not take draws of (percentage) deviations directly (like with the other variables) but take draws from a normal distribution (i.e. we take draws from (8)) and use the estimated ARMA process to create draws for the percentage deviations around the monthly average trend, $\Delta H\left(WTI\right)_t$. The second and third stage proceeds as in the rest of the variables except that we need to average up the original monthly simulations to obtain annual simulations as in the rest of the variables.

In order to simulate the fundamental variables, we took 10,000 draws for each disturbance term. Graph 4 shows the mean evolution of the fundamental variables as well as a 90% confidence interval around the "mean" of the path of these variables.

Graph 4
Fundamental Variables 90% Confidence Intervals



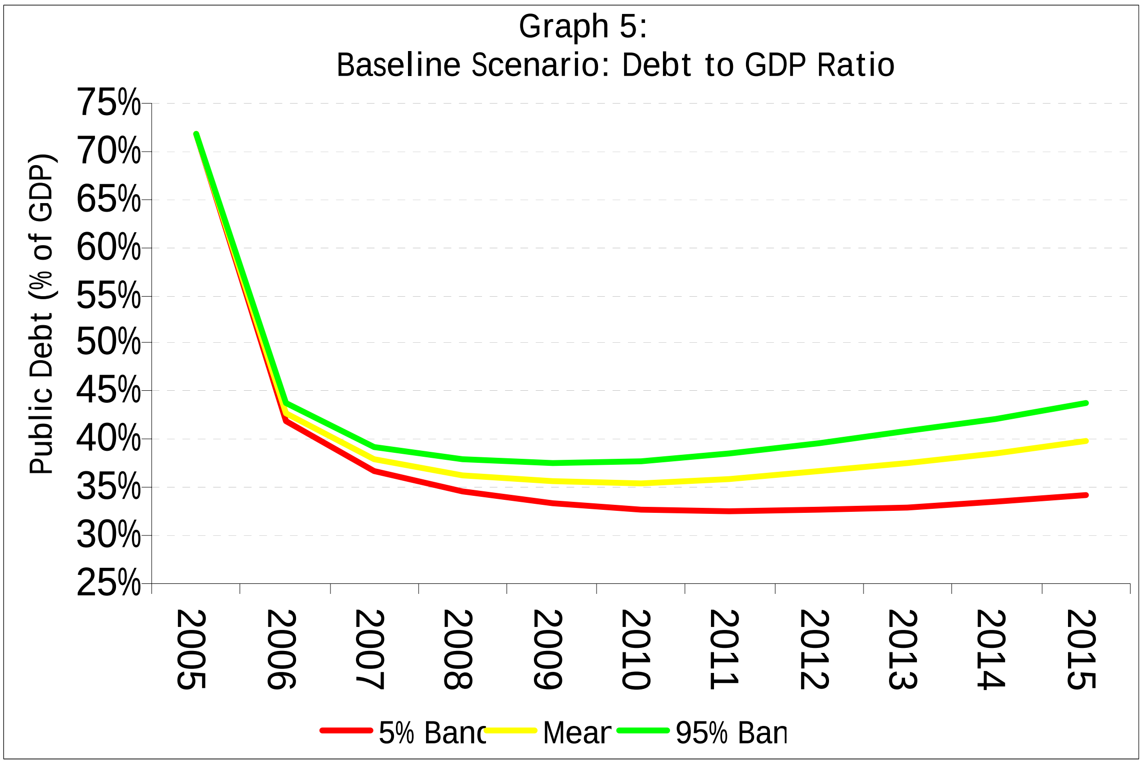
In the next section we discuss the stochastic properties of the debt to GDP ratio in the baseline scenario.

4.4 Baseline Results: Confidence Intervals for the Evolution of Debt

Graph 5 shows the mean evolution of the debt to GDP ratio in the baseline scenario as well as a 90% confidence interval around the median value of the path of the debt to

GDP ratio. Although the mean debt to GDP ratio is 39%, there is a 5% probability that this ratio exceeds 45% in the year 2015.

Most of variation of the debt to GDP ratio across states of nature is due to the volatility of oil revenues. Graph 5 shows 90% confidence intervals for the paths of the fundamental variables while Table 5 shows some summary measures of the volatility of the fundamental variables in the year 2015. We employ two measures of volatility. The first is the coefficient of variation (the ratio of the standard deviation to the mean value). However, since the distributions are not necessarily symmetric, we also compared the 5% and 95% percentile values with respect to the mean value. It can be seen that the path of the price (index) of hydrocarbons is much more volatile than real GDP, real exchange rate, and the PPI index independently of how volatility is measured.[23]



This can be confirmed by performing two experiments. In the first one, shown in Table 6, Panel A, we simulate pure "oil" shocks. Specifically, we simulate a distribution of paths of the debt to GDP ratio assuming that all fundamental variables with the exception of oil prices are deterministic. In Panel B, we simulate pure "non–oil" shocks by assuming that the price of oil is a fundamental deterministic variable. Comparing the last columns of both panels, it is clear that most of the volatility of the debt to GDP

[23] Although the 180 day libo rate is much more volatile than the latter, it has marginal effect on the path of the debt to GDP ratio because only a fraction of Bolivian debt is issued at market interest rates.

ratio results from the volatility of oil prices since both volatility measures are lower in the case of pure oil shocks.

4.5 Alternative Policy Scenarios

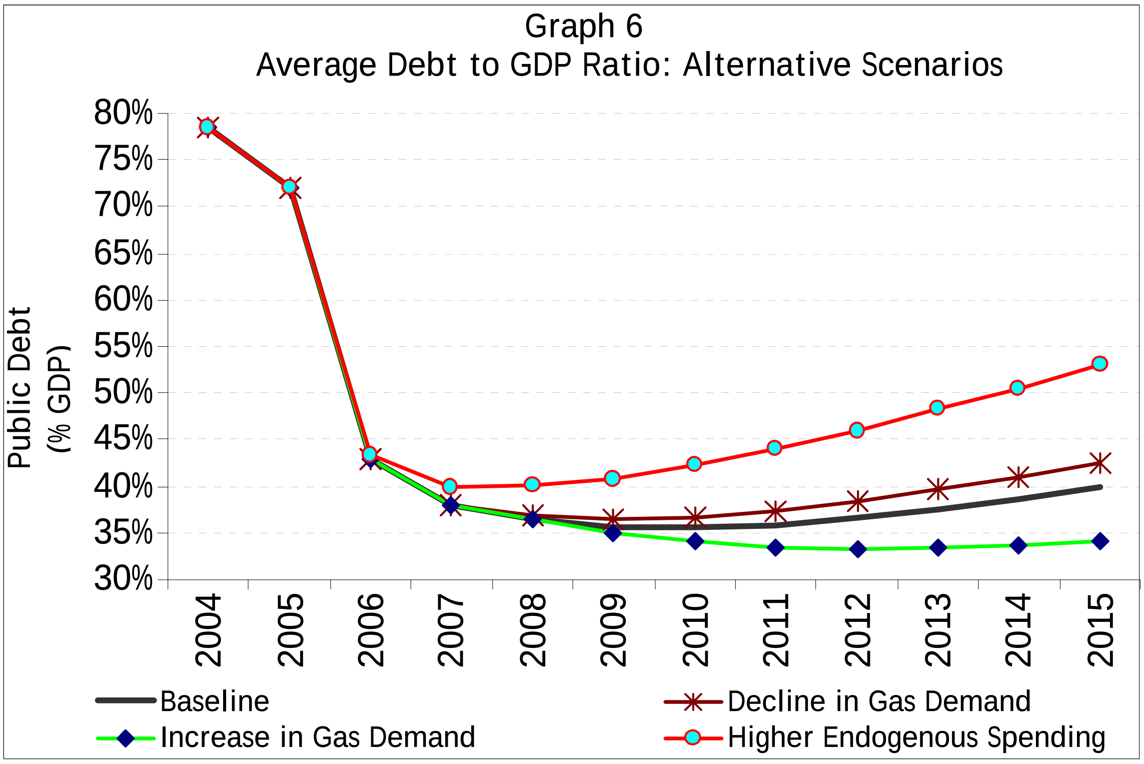
In this section we considered alternative policy scenarios which, according to our judgement, are the most likely significant departures from the statu–quo assumed in the baseline scenario.[24] Table 7 summarizes the results of the policy shocks.

Graph 6 shows the effect on the debt to GDP ratio of the two most likely policy shocks to debt sustainability. A decline in natural gas exports to Argentina and Brazil resulting from a renegotiation of natural gas prices would lead to a 42% debt to GDP ratio in 2015 and would lead to an unsustainable path starting in 2009.[25] However, as graph 6 suggests, the most significant and problematic downside risk to fiscal sustainability stems from higher government spending. A less conservative fiscal stance in the sense that the Provinces spend all the IDH revenue and the Central Government saves only 60% of the former tax so that the consolidated public sector only saves 15% of the revenues generated by the latter tax (compared to a 40% in the baseline scenario) leads to a 53% mean debt to GDP ratio in 2015, and leads to an unsustainable mean path starting in 2008. On the other hand, an increase in natural gas sales to Argentina (with the construction of a pipeline in the Argentina's northwest) would lead to a knife edge trajectory with debt reaching 34% debt to GDP ratio in 2015.[26]

[24] Given the recent change in the political situation in Bolivia and (strategic) uncertainty regarding the governments policy the situation is very fluid.

[25] Specifically, we suppose that due to a renegotiation of the price of bolivian gas exported to Brazil, the former price increases by 1.5 dollar/Billion BTU starting in the year 2007. As result, bolivian gas exports decline to 20 million m^3 (from 35 million m^3 in the baseline scenario) as Brazil marginally sustitutes away from bolivian natural gas.

[26] Specifically, we suppose bolivian gas sales to Argentina increase to 14.1 million m^3 (from 6.6 million m^3 in the baseline scenario) in 2009 and to 21.6 million m^3 in 2010 and subsequent years.



5 Conclusion

It is clear at this stage that Bolivia has experienced rapid changes that have created very interesting dynamics in its public finances so that sustainability issues are much too complex to analyze employing simple deterministic steady state analysis. Instead, we have developed a methodology that distinguishes between fundamental shocks and policy shocks, introducing uncertainty in a dynamic context. The lack of sufficiently long historical data and the high probability that recent political developments may lead to further structural breaks in fiscal policy precludes the estimation of policy reaction function in the lines of Celsun et al (2006). Rather, we have modeled policy shocks as alternative policy scenarios which, according to our judgement, are the most likely significant departures from the statu-quo assumed in the baseline scenario.

We have made an effort to calibrate the most likely evolution of the primary surplus and of the public debt after oil and debt windfalls and policy innovations. Our simulations suggest that even after taking into account the magnitude of the increase in hydrocarbon revenue and the MDRI, the endogenous spending effect, which generates a double reversion of the primary surplus, puts the public debt to GDP ratio on an sustainable trajectory with debt reaching around 34% of GDP by 2015. Furthermore, significant risks are present, given that Bolivia is a “natural gas” rather than an oil country and that the political economy movie of the natural gas rent allocation is just about to begin. In the first place, we estimate a 5% probability that "oil price shocks" alone might lead a 44% GDP ratio in 2015. Most importantly, problems in the control of expenditures with an increase in the marginal propensity to spend out of IDH revenues to 75% (up from 60% in our estimated baseline) on the part of Provinces, Municipalities and other stakeholders might substantially revert the descending debt trajectory as early as 2008, with the debt to GDP ratio reaching 53% in 2015.

Hence, although it is difficult to asses the underlying fiscal policy reaction function to future developments in Bolivia, we conclude that governance of the process of allocation and distribution of the oil rent is essential to the sustainability in the new Bolivian political scenario despite the clouds over capital accumulation and sustained growth. Our numbers suggest that the evolution of the primary surplus is an almost-sufficient statistic for debt sustainability and that the ability of the new government to manage an oil rent boom, and to govern the allocation process to stakeholders, is a crucial ingredient.

Finally, we believe that in order to improve the modeling strategy, further research should aim to endogeneize the real exchange rate, given the potential for real exchange rate appreciation due to additional government spending and to model the new saving-investment configuration in Bolivia and its effects on growth.

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Table 1

Baseline Scenario: Projected Primary Surplus												
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
NFPS Revenue	26.5	30.2	34.0	34.9	34.1	32.9	31.9	31.3	31.0	30.6	30.3	30.0
Taxes	20.5	24.5	28.3	29.2	28.3	27.0	26.1	25.5	25.2	24.8	24.5	24.2
Excise Taxes	*14.5*	*14.8*	*14.5*	*14.5*	*14.5*	*14.5*	*14.5*	*14.5*	*14.5*	*14.5*	*14.5*	*14.5*
Customs duties	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Mining Royalties	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Hydrocarbon Taxes	5.0	8.7	12.8	13.7	12.8	11.5	10.6	10.0	9.7	9.3	9.0	8.7
IEHD	1.6	2.2	2.5	2.3	2.2	2.0	1.9	1.9	1.9	1.8	1.8	1.8
Royalties	3.4	2.9	3.7	4.1	3.8	3.4	3.1	2.9	2.8	2.7	2.6	2.5
IDH	-	3.5	6.6	7.3	6.8	6.1	5.6	5.2	5.0	4.8	4.6	4.4
Current Transfers	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Operating Result Public Enterpr	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Other Income	4.8	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
NFPS Primary Expenditure	29.3	29.0	30.4	32.9	34.2	33.5	32.9	32.5	32.3	32.1	31.9	31.7
Current Expenditures	20.2	20.1	20.6	21.4	21.8	21.5	21.2	21.0	20.9	20.8	20.7	20.5
Wages	9.0	8.8	9.2	9.8	10.2	9.9	9.7	9.6	9.5	9.5	9.4	9.4
Goods and Services	2.0	1.9	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Transfers	1.9	1.8	1.9	2.1	2.2	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Social Security Expenditures	4.6	4.5	4.5	4.4	4.4	4.3	4.3	4.2	4.2	4.1	4.0	3.9
Other Current Expenditures	2.6	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Investment	9.1	8.9	9.8	11.5	12.4	12.0	11.7	11.5	11.4	11.3	11.2	11.1
NFPS Primary Surplus	(2.8)	1.2	3.5	2.1	(0.1)	(0.6)	(0.9)	(1.2)	(1.3)	(1.5)	(1.6)	(1.7)
BCB Primary Result	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Overall Primary Surplus	(2.5)	1.4	3.8	2.3	0.1	(0.4)	(0.7)	(0.9)	(1.1)	(1.2)	(1.3)	(1.4)

Table 2

Sharing of Hidrocarbon Revenues						
	Old Law					
	Stakeholder Take					Total
	TGN	Provinces	Municipalities	Universities	FDI	Take
New Fields (77% of Total Productio	6.0%	12.0%	-	-	-	18.0%
Old Fields (23% Total Production)	38.0%	12.0%	-	-	-	50.0%
Average Take across Fields	13.4%	12.0%	-	-	-	25.4%
	New Law					
	Stakeholder Take					Total
	TGN	Provinces	Municipalities	Universities	FDI	Take
Royalties	6.0%	12.0%	-	-	-	18.0%
IDH	8.3%	14.1%	6.4%	1.6%	1.6%	32.0%
Total Take	14.3%	26.1%	6.4%	1.6%	1.6%	50.0%
	New vs. Old Law					
Increase in Take	1.0%	14.1%	6.4%	1.6%	1.6%	24.6%

Table 3

Baseline Scenario: Macro-Economic and Financial Assumptions Assumptions												
Year	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Real GDP Growth		4.0%	4.1%	3.9%	3.6%	3.4%	3.1%	3.1%	3.1%	3.1%	3.1%	3.1%
RER devaluation		0.3%	-2.9%	-2.4%	-2.0%	-1.5%	-1.0%	-0.5%	0.0%	0.0%	0.0%	0.0%
Libo rate		3.7%	5.2%	5.3%	5.4%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%
4 yr risk free rate		5.2%	5.4%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%	5.5%
Marginal Internal interest rate		9.0%	9.2%	9.3%	9.3%	9.3%	9.3%	9.3%	9.3%	9.3%	9.3%	9.3%
PPI Inflation		5.6%	5.5%	3.5%	2.8%	2.5%	2.3%	2.0%	2.0%	2.0%	2.0%	2.0%
Marginal Internal Real Interest rate		3.2%	3.6%	5.6%	6.3%	6.7%	6.9%	7.2%	7.2%	7.2%	7.2%	7.2%
Share of IFI's in total Financing		71.9%	71.9%	53.2%	53.2%	53.2%	53.2%	53.2%	53.2%	53.2%	53.2%	53.2%

Table 4

Baseline Scenario: Projected Public Sector Debt												
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Public Debt												
Level	78.4%	72.0%	42.9%	38.1%	36.4%	35.6%	35.5%	35.9%	36.6%	37.5%	38.6%	39.8%
Change		-6.4%	-29.1%	-4.8%	-1.7%	-0.8%	-0.1%	0.4%	0.7%	0.9%	1.1%	1.2%
Above the line result												
Primary Surplus	-2.5%	1.4%	3.8%	2.3%	0.1%	-0.4%	-0.7%	-0.9%	-1.1%	-1.2%	-1.3%	-1.4%
Interest Payments	2.9%	2.3%	1.7%	1.7%	1.7%	1.6%	1.6%	1.6%	1.7%	1.7%	1.8%	1.9%
Overall Deficit	-5.4%	-0.9%	2.1%	0.6%	-1.6%	-2.0%	-2.3%	-2.6%	-2.7%	-2.9%	-3.1%	-3.3%
Debt Decrease Decomposicion												
Primary Deficit		-1.4%	-3.8%	-2.3%	-0.1%	0.4%	0.7%	0.9%	1.1%	1.2%	1.3%	1.4%
Automatic Debt Creation		-4.6%	-6.7%	-2.3%	-1.3%	-0.9%	-0.5%	-0.3%	-0.1%	-0.1%	0.0%	0.0%
Average Dollar Real Interest Rate		-1.8%	-2.0%	0.3%	0.7%	0.8%	0.9%	1.0%	1.0%	1.1%	1.1%	1.2%
Growth		-3.2%	-3.0%	-1.7%	-1.4%	-1.2%	-1.1%	-1.1%	-1.1%	-1.1%	-1.2%	-1.2%
Real Exchange Rate		0.2%	-2.1%	-1.0%	-0.7%	-0.5%	-0.3%	-0.2%	0.0%	0.0%	0.0%	0.0%
HIPC II (BID) + MDRI (WB & IMF)		-0.5%	-18.6%	-0.2%	-0.2%	-0.2%	-0.2%	-0.3%	-0.2%	-0.2%	-0.2%	-0.2%
Nominal Average Interest Rate		3.2%	2.6%	4.3%	4.8%	4.8%	4.8%	4.8%	4.9%	4.9%	5.0%	5.1%
Real Average Interest Rate		-2.3%	-2.7%	0.8%	1.9%	2.2%	2.5%	2.8%	2.8%	2.9%	3.0%	3.1%
Effective Average Interest Rate		-5.8%	-9.3%	-5.3%	-3.5%	-2.5%	-1.5%	-0.8%	-0.3%	-0.2%	-0.1%	0.0%

Table 5

Volatility Measures: Year 2015 values						
	Real GDP (Level)	WPI (Level)	RER (Level)	Libor 180d	Hydrocarbon Price Index	Debt to GDP Ratio
Average Value	133.5	129.9	90.2	5.5%	155.2	39.5%
Standard Deviation	5.0	7.6	3.4	1.5%	25.0	3.5%
5% Percentile	125.9	118.0	85.0	3.3%	121.3	33.6%
95% Percentile	141.5	143.1	94.5	8.0%	202.3	45.0%
Coefficient of Variation[a]	3.7%	5.9%	3.7%	26.6%	16.1%	8.8%
5% Percentile vs. Average[b]	-5.7%	-9.1%	-5.7%	-2.2%	-21.9%	-5.9%
95% Percentile vs. Average[b]	5.9%	10.1%	4.8%	2.5%	30.3%	5.5%

[a]Measured as the ratio of the standard deviation to the average value for Real GDP, WPI, RER, the hydrocarbon price index and the debt to GDP ratio.

[b]Measured as the percentage difference between the percentile value and the average value for Real GDP, WPI, RER, hydrocarbon price index and the debt to GDP ratio and as the absolute difference between the percentile value and the average value for the 180 libo rate.

Table 6

Panel A

Volatility Measures: "Pure" Oil Shocks

	Real GDP (Level)	WPI (Level)	RER (Level)	Libor 180d	Hydrocarbon Price Index	Debt to GDP Ratio
Average Value	133.5	129.9	90.2	5.5%	155.2	39.4%
Standard Deviation	0.0	0.0	0.0	0.0%	25.0	2.9%
5% Percentile	133.5	129.9	90.2	5.5%	121.3	34.2%
95% Percentile	133.5	129.9	90.2	5.5%	202.3	43.8%
Coefficient of Variation[a]	0.0%	0.0%	0.0%	0.0%	16.1%	7.4%
5% Percentile vs. Average[b]	0.0%	0.0%	0.0%	0.0%	-21.9%	-5.2%
95% Percentile vs. Average[b]	0.0%	0.0%	0.0%	0.0%	30.3%	4.3%

Panel B

Volatility Measures: Non Oil Shocks

	Real GDP (Level)	WPI (Level)	RER (Level)	Libor 180d	Hydrocarbon Price Index	Debt to GDP Ratio
Average Value	133.5	129.9	90.2	5.5%	155.2	39.9%
Standard Deviation	5.0	7.6	3.4	1.5%	0.0	1.9%
5% Percentile	125.9	118.0	85.0	3.3%	155.2	36.9%
95% Percentile	141.5	143.1	94.5	8.0%	155.2	43.1%
Coefficient of Variation[a]	3.7%	5.9%	3.7%	26.6%	0.0%	4.8%
5% Percentile vs. Average[b]	-5.7%	-9.1%	-5.7%	-2.2%	0.0%	-3.0%
95% Percentile vs. Average[b]	5.9%	10.1%	4.8%	2.5%	0.0%	3.2%

[a]Measured as the ratio of the standard deviation to the average value for Real GDP, WPI, RER, the hydrocarbon price index and the debt to GDP ratio.

[b]Measured as the percentage difference between the percentile value and the average value for Real GDP, WPI, RER, hydrocarbon price index and the debt to GDP ratio and as the absolute difference between the percentile value and the average value for the 180 libo rate.

Table 7

Alternative Policy Scenarios: Year 2015 values				
		Alternative Scenarios		
Debt to GDP Ratio	Baseline Scenario	Higher IDH Spending	Decline in Gas Sales	Increase in Gas Demand
Average Value	39.5%	53.0%	42.3%	33.7%
Standard Deviation	3.5%	2.7%	2.9%	4.2%
5% Percentile	33.6%	48.6%	37.6%	26.7%
95% Percentile	45.0%	57.6%	47.0%	40.1%
Coefficient of Variation[a]	8.8%	5.2%	6.7%	12.5%
5% Percentile vs. Average[b]	-5.9%	-4.4%	-4.7%	-7.0%
95% Percentile vs. Average[b]	5.5%	4.6%	4.7%	6.4%