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Export Boom and Economic Performance: Bolivia 2004-2015

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Resumen

El superciclo de altos precios para las materias primas ha tenido impactos profundos en la economía boliviana. En este trabajo hemos investigado las relaciones de los precios de materias primas con los principales indicadores de desempeño macroeconómico. Hemos encontrado relaciones significativas en nuestro análisis estadístico. Una pregunta importante a la que hemos dirigido nuestra atención tiene relación con los efectos de la bonanza exportadora transitoria en la tasa de crecimiento de largo plazo de la economía. También, por la importancia de los eslabonamientos fiscales con los ingresos no anticipados, producidos por la bonanza exportadora, se ha examinado la prociclalidad de los componentes del gasto público, apoyados en un análisis de correlaciones de los componentes cíclicos. Hemos encontrado correlaciones positivas pero débiles.

Con las bonanzas exportadoras, se incrementan tanto el consumo como las tasas de ahorro. Los ahorros se han invertido en reservas internacionales y, en gran medida, en construcción. Encontramos que los precios de las materias primas y el valor agregado per cápita en construcción están co-integrados, lo que sugiere una relación de largo plazo.

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También nos hemos fijado en los eslabonamientos del sector de hidrocarburos con otros sectores de la economía, en términos reales, mediante un análisis insumo-producto. Finalmente, hemos efectuado un conjunto de simulaciones con un modelo pequeño de Equilibrio General Computable, adaptado a las condiciones bolivianas para rastrear los efectos en los precios internos y en cantidades.

Código JEL: C32, C67, C68, E60, E62, F63

Palabras Clave: superciclo de precios, shocks comerciales transitorios, efectos fiscales, prociclalidad, Economía Boliviana.

Abstract

The supercycle of high commodity prices has had profound impacts on the Bolivian economy. We have investigated the relations of commodity prices with the main indicators of macroeconomic performance. We have found significant ties in our statistical analysis. An important question that we address concerns the consequences of the transitory export boom on the long term rate of growth of the economy. Also, given the importance of fiscal linkages with windfall income, we examined the procyclality of public expenditures based on an analysis of correlations of the cyclical components. We find positive but weak correlations.

With export booms, consumption increases but also saving rates. Savings have been invested in foreign assets and, to a large extent, in construction. We find that commodity prices and per capita value added in the construction sector are co-integrated, suggesting a long term relationship. Also we looked into the real linkages of the hydrocarbons sector with other sectors of the economy through an Input-Output analysis. Finally, we have conducted a set of simulations, with a small Computable General Equilibrium Model adapted to the Bolivian conditions, to trace the domestic price and quantity effects of the commodity price increases.

JEL code: C32, C67, C68, E60, E62, F63

Keywords: price supercycle, transitory trade shocks , fiscal effects, procyclality, Bolivian economy.

Introduction

Bolivia has been a main beneficiary of the supercycle of high prices of commodities that went from 2004 and lasted through mid 2014. Its main exports, natural gas, metals and soybeans, in that order, constituted close to 90%of total exports in some years.

Exports propelled by the high prices expanded in value terms in 5.5 times in that period. In turn real GDP grew at a rate close to 5% per year. It is fair to say that the dimensions of the economy changed in a significant way with the export boom. The positive terms-of-trade effect was huge, amounting in some years to about 8% of GDP.

Bolivia adopted *de facto* a fixed exchange rate at the end of 2011 that combined with the export boom produced high surpluses in the current account of the Balance-of-Payments. The stock of foreign international reserves, resulting from the accumulation of the current account surpluses, was large by any standard: close to 50% of GDP in some years.[1]

The export bonanza and its interactions with domestic policies have received considerable attention. In a pioneer analysis Easterly *et al* (1993) found that the rate of growth of GDP was strongly correlated with the terms-of-trade, and less so with domestic policies, although their interaction is important.

More recently, De la Torre *et al* (2016) find that the conventional indicators of the macroeconomy of the South American countries that experienced rises in their export prices follow closely the terms-of- trade. Also, they find that the intensity of the transmission of the windfall depends on the savings rates and on their handling. In general, the export bonanza has not been accompanied by productivity gains in the tradable sector.

Chumacero (2017) focus on the contribution of domestic policies to per capita GDP growth and other socio-economic indicators during the government of Evo Morales, using statistical methods with international comparators. Morales' government largely overlaps our period of export bonanza. Chumacero finds that domestic policies have hurt the benefits of the favorable external shock, instead of enhancing them.

[1] With flexible exchange rates the exchange rate would have appreciated with the boom and the accumulation would have been lower.

Our paper addresses the economic effects of the export boom, both in terms of its macroeconomic impacts and of changes across sectors of production. Also, the policy reactions, mainly of a fiscal nature, to the boom deserve our attention. The paper extends the results of Loza(2017).

Our treatment differs from the studies of the papers cited above in that it does not use international comparisons. Moreover, it relies on high frequency time series, with mostly domestic data. Despite the differences in approaches the conclusions are in many ways similar.

Fiscal variables were a main driver of the performance of the economy. The slack that these variables enjoyed was determined to a large extent by taxes collected on exports. An important question concerns the procyclality (or lack of) of the fiscal variables with the export prices. The non-stationary nature of the variables of concern difficults the analysis. Yet with de-trended variables, which are stationary, we find positive but weak correlations between export prices and the main fiscal expenditure variables. This result has positive and normative implications. With regard to the latter it is often recommended to break the procyclality of public expenditure and commodity prices in order avoid busts in the economy, once the export bonanza comes to an end. Also, we have examined the long run relationships between the trajectory of prices and of fiscal variables. To this end we estimated co-integration models.

The paper goes beyond the macroeconomic effects and we have looked at the sectoral effects. We used three approaches. We have first focused on the effects across sectors using input-output analysis. The aim was to try to detect the real output changes across sectors, brought about by the expansion of hydrocarbons exports in real terms.

Since the price and income effects were deemed to be more important than the expansion of the volume of exports of hydrocarbons we have investigated the composition of output, following the windfall. In particular, the very important growth of the construction sector strikes us and we have looked at its relationship with the export boom and the export prices. The idea is that construction booms, both public and residential, are driven by the increase in savings, explained in turn by export booms. The savings were invested in the most readily available assets, namely real estate, given moreover a closed *de facto* balance-of-payments. The idea comes from Collier et al. (1999).

The Dutch Disease effect is a typical concern when dealing with export booms of a single commodity or even a handful of commodities. The possible ensuing appreciation of the real exchange rate affects negatively the production of tradables, other than those of the leading sector (or sectors). We have tracked the possibility of real appreciation of the exchange rate with a small and simple Computable General Equilibrium Model tailored to Bolivian data. Notice that in this type of exercises, there is no estimation but instead calibration.

Section 1 of the paper gives a summary of the large body of literature on the theory of transitory export windfalls. The main issues receive due attention and are underlined. Section 2 provides a discussion on the main macroeconomic indicators after the boom. This section sets the background to the considerations that follow. Section 3 is devoted to the statistical analysis of the price data and of the other variables of interest. The analysis of correlations, of the cyclical components of the variables of interest, takes up a large part of this section. In Section 4, we focus on the budgetary effects of the export boom, given the centrality of fiscal variables. The procyclality of fiscal expenditures and export prices is a main concern in this section. Section 5 is devoted to the sector effects of the boom. In its first subsection we present the results of our input-output analysis, given the expansion of hydrocarbons exports. In the next subsection we deal with the relationships of the export boom with the construction sector. The latter has a broader scope than constructions used by the export sectors. Last, we present some calibrations, with focus on the export prices, obtained with a simple computable General Equilibrium model. Section 6 concludes.

1. The theory

The impact of the windfall income caused by the unexpected rise in prices of the main commodity exports is not fully unambiguous. On the one hand, the windfall income expands consumption, increases savings that lead to more investment, and expands the volume of exports of commodities. The growth in these components of aggregate demand directly contributes to GDP growth. On the other hand, some production sectors may be negatively affected by the possible overvaluation of the exchange rate caused by the windfall income. Besides, the excessive dependency of exports on a handful of commodities makes the economy very vulnerable to the

vagaries of international prices. The latter are beyond the control of a small economy like Bolivia´s. Also, the sociology of taxation and government expenditure may be affected, insofar that the domestic tax effort weakens and the government embarks itself in expenditures on entitlements and public works that are difficult to dismantle once the boom is over.

The limited impact of the boom on long-term growth is rooted in its transient nature. Also, it must always be kept in mind that the deposits of the exported commodities are exhaustible. This is obvious for hydrocarbons and minerals. It is less obvious for soy beans and related products but nevertheless it occurs, as their production depletes the nutrient content of the soil. Also its production is based on the expansion of the agricultural frontier trough deforestation.

While the focus is on hydrocarbons, minerals and soy, the effect of their exports on other sectors of the economy linked to them also have to be taken into account, however weak they are.[2] More important is the effect of the commodity boom on relative prices and particularly on the real exchange rate. There is the danger of a "Dutch disease.[3]

The export boom, with the important proviso of being well managed, can spark industrialization. However, few countries seem to have benefited, with lasting effects, of this sparkplug. In fact a major obstacle to industrialization and export and product diversification is precisely the overwhelming dependency of exports on a handful of commodities.

The problems derived of this high dependency are, among others:[4]

- High volatility of government revenues.
- Fragility in the public expenditure path, particularly of public investment.
- High rates of exploitation of the natural resources that accelerate their exhaustion, first kicked by high prices but kept on after the fall in export prices, given the need to continue generating income.[5]

[2] Auty (1993) emphasizes the fiscal linkage as the main contribution of the resource sector to the national economy.

[3] The Dutch Disease phenomenon has been studied extensively, See *inter alia* Corden (1985), Neary (1985), Corden and Neary (1982), Mulder(2006).

[4] See, for example, CEDLA (2016).

[5] The clearest illustration of this assertion is given by small-scale mining.

Several authors have posited the question of why economies rich in natural resources exhibit low long-run rates of growth. The main hypothesis of Rodriguez and Sachs (1999) is that these economies live for a while beyond their means. They benefit of the windfall income, but only temporarily. They are unable to sustain their rates o growth. Natural resources have a natural limit, hence the rate of growth of production based on them inexorably declines. In fact, the steady-state rate of growth is zero.

It is not difficult to see that the steady-state rate of growth of an economy highly dependent on the exploitation of natural resources, subject to exhaustion, is zero. There is a physical limit to the continuity of their exploitation. Technical progress in the natural resource firms can delay reaching the zero rate of growth of exhaustible resources but it ultimately it will be hit.

In contrast, in sectors not subject to exhaustion, technical progress (more generally, total factor productivity growth) can sustain the rate of growth of output, despite the declining marginal productivity of capital.

Access to the capital market can also stretch the positive rates of growth of the economy but for most developing countries this access is not unrestricted. Moreover it has been often observed that access to the international capital market is pro-cyclical. Once export revenues start declining the sources of external financing symmetrically dry up.

The transition of the resource rich economies to their steady state is also very interesting. Rodriguez and Sachs (1999) show that the transition to the steady-state level is from above instead of being from below as in any economy not dependent on natural wealth (a normal economy). This means that the short-term rates of growth can be above the corresponding rates that lead to the steady state in a normal economy. Also, this feature explains the consumption and construction booms that are contemporaneous or immediately follow a commodity boom.

The political economy of the management of natural wealth is also complex. Governments are tempted to pay attention only to those sectors generating immediate wealth, while disregarding at the same time public policies for other less attractive sectors. It may happen also that the distribution of the rents generated by natural wealth give rise to acute distributive conflicts among the several claimants. Political conflicts tend to lower the rate of growth of the economy. This is the main idea of the curse of natural resources.

Natural resource wealth is extracted, in difference with wealth generated by industrial processes and others that are produced. Natural resource wealth is often extracted independently of the conditions prevailing in the economy, which is not the case, for instance, for industrial production.[6]

Another important feature is that extraction of natural resources represents the conversion of an asset into cash (or other financial assets).[7] The extraction of the natural resource does not add significantly to the wealth of the nation. The natural resources converted into financial assets can be consumed or invested. If invested, the rate of return has to be commensurable with society's time preference to preserve the net worth of the country.[8]

The fluctuations in the value of the produced natural resource have several consequences.

1. The long-term planning of expenditures becomes very difficult, given the uncertainty associated with the revenues, themselves determined by a price generating process, which may not have reversion to trend.
2. The government's revenues fluctuate with the price of the export commodities and with the delays in tax payments by the companies, either state-owned or private.
3. In some cases the fluctuations in export value cause unwarranted fluctuations in the rates of extraction of the natural wealth.

Fluctuations in fiscal spending occur even if the country has access to the international capital market to smooth them. There will be nevertheless expenditure volatility. As an outcome, the procyclality of expenditures is accentuated, particularly of public expenditure. In years of good prices the public sector expands, while in bad years it contracts although the amount of expansion is rarely

[6] The rents of natural wealth are so huge that they can withstand high levels of taxation and overvaluation of the exchange rate, unless the latter is absurdly overvalued. The dearth of investment in natural resources that happens sometimes is mostly explained by the ambiguity of property rights and the inherent difficulties in arriving to fair contracts. Also, in many countries natural resources are controlled by state owned enterprises. State owned enterprises are generally ill-equipped to undertake exploration, which is costly and where the probability of success is small.

[7] See, e.g. Humphreys et al. (2007).

[8] The popular idea is that the natural wealth should be "sowed" in investments, either real or in financial assets can prolong the effects of the export boom.

countenanced by a contraction of the same order of magnitude. This can be the source of serious macroeconomic disequilibria over time.

Given the high discount rate that governments usually have, there are pressures to spend the tax collections on the exploitation of natural resources as soon as they become effective. Voters are also impatient and they want immediate rewards in terms of their welfare. Moreover, governments have a motivation to spend promptly in order not to leave the benefits to the opposition.[9]

The increase in consumption displaces investment partially. The latter increases but not at a rate that is commensurate with the rate of increase of gross domestic income.[10] Since the windfall accrues on impact mainly to the government coffers, either because of higher tax revenues or profits of the state owned enterprises, public investment, particularly infrastructure construction, receives a big push. Private investment usually responds more timidly and is largely confined to residential construction. Governments betting on the windfall income tend to neglect production and export diversification.

It is difficult for the governments of developing countries to reach good contracts with the multinational enterprises. In a fair contract, both contracting parties should benefit in ways that they find convenient to them regardless of the state of the world. However, when circumstances change, one of the parties may be tempted to renege or renegotiate the original terms of the contract. In all known modalities the problems of dynamic inconsistency arise (Hogan *et al.* 2010). Actually, there is no ideal contract.[11]

Lastly, considerations of environmental issues cannot be absent in a study on the impact of natural resources' use. The fixation with the exploitation of natural resources has been labeled "extractivism" (See e.g Gudynas 2012a and Gudynas 2012b). Extractivism is characterized by:

- Extraction of big volumes from the underground or from extensive agriculture, at the cost of considerable environmental damage.

[9] In Bolivia, to contrast with the situation prevailing in previous governments.

[10] The ratios of investment to GDP may increase but not the ratios to gross domestic income.

[11] Contracts and regulations for natural resources are still a field of experimentation. What some consider the "best international practice" may be a poor guide to fair contracts, as countries willing to attract foreign investment enter into a competitive race of concessions, for instance tax benefits, at the expense of the developing countries.

- The extracted resources are exported to a very significant extent.
- The international trading of the resources depends on international prices, with little influence of producers unless they are very large, and of the dominant presence of large, multinational companies.
- The above features create a high dependency of the countries selling raw materials from buyers. The markets are often "buyers'" markets.
- Even in bilateral contracts prices mimic the international prices. In absence of a "true" market, producers show a preference for this "second best" solution.
- Unequal exchanges loom large in the trade of commodities.

The effects of the export boom can be stretched with adequate policies that, in turn, depend on the institutional strength of the country. Sovereign wealth funds, investment and stabilization funds, international reserves stocks and fiscal rules with ceilings for some expenditure items and, more generally, countercyclical fiscal policies are the types of institutions that contribute to this endeavor.[12]

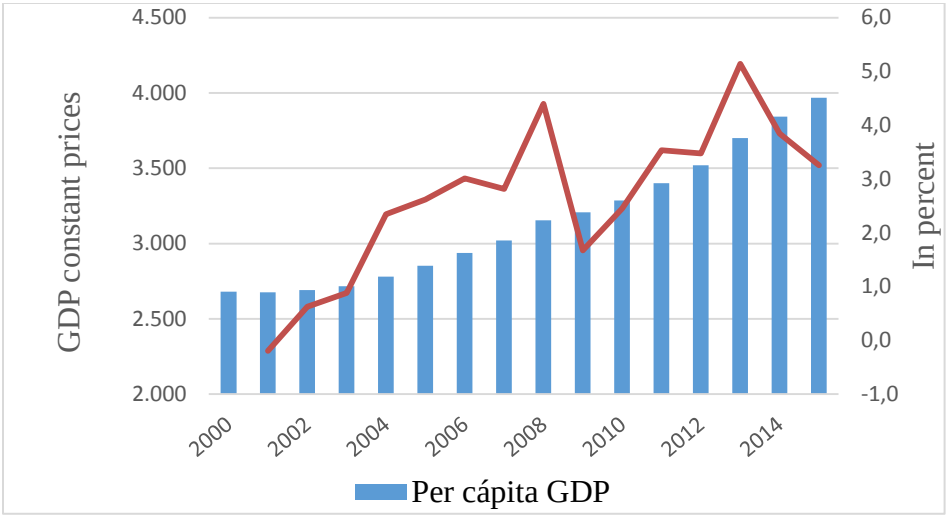
2. Descriptive background: Evolution of macroeconomic indicators

GDP growth

The commodity boom has had as its most salient impact a rise in the rate of growth of per capita GDP (figure 1). The rate slowed after 2014, with the fall in exports, but it is still high. The stock of foreign reserves, accumulated during the boom, has given a new lease to growth after the fall in commodity prices.

[12] However it is to be mentioned, in passing, that international reserves are a weak substitute of sovereign wealth funds and of stabilization funds.

Figure 1. Per capita GDP and annual rates of growth



Source: Authors' elaboration with data of the Bolivian National Institute of Statistics.

The current account of the balance of payments

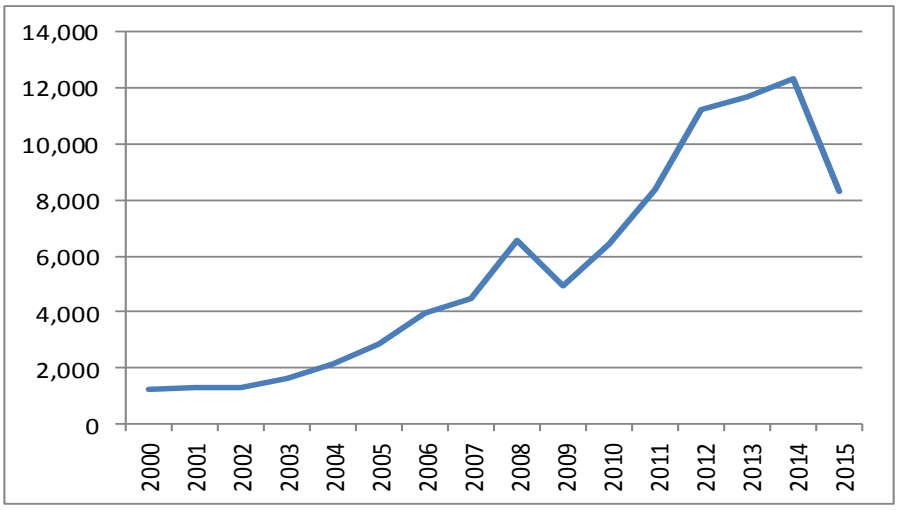
Given that the trade balance is the most important subaccount of the current account of the Balance-of-Payments, our analysis will focus on it. On impact, the high prices for commodities increased exports, at their peak, by a factor of 10 in relation to their level of 2000, as can be observed in figure 2. The high increase of exports is mainly explained, but not only, by the rise of commodity prices as shown in figure 3. Natural gas is the main Bolivian export and its price is linked, with a time lag varying between 3 months and 6 months, to the price of oil.[13] The prices of metals rose the most but they started declining after 2011. The price of soybeans, the main agricultural export, reached its highest level in 2012 where it leveled off until 2014.

After a sharp fall in the first half of 2009, contemporaneous to the international financial crisis, commodity prices started to rise again in the second half of that year.

[13] It is stipulated in the bilateral contracts with Brazil and Argentina that the export price of natural gas adjusts with a lag, to a basket of fuels, whose price depends closely of the oil price. This makes the oil price the main determinant of the export price of natural gas.

They reached a plateau in 2011 and remained there until mid 2014. The price of oil recovered from its slump in 2010 and stayed at high levels until mid 2014.

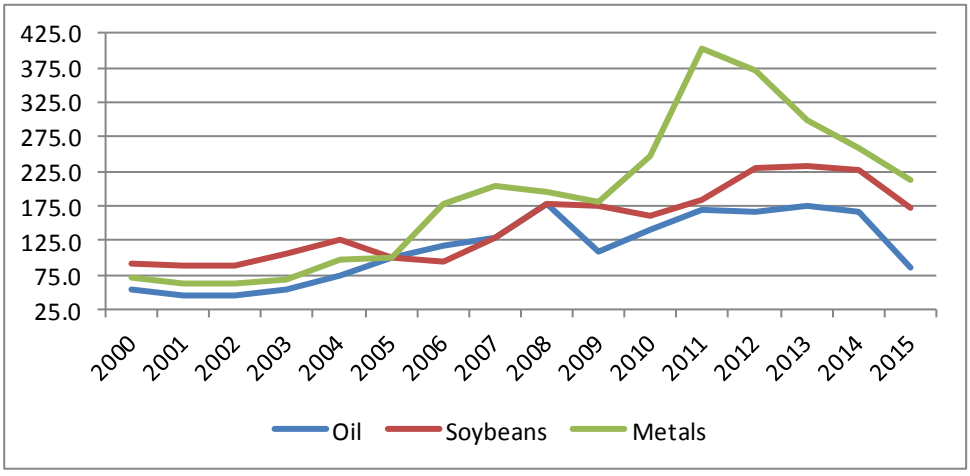
Figure 2. Exports FOB 2000-2015(millions USD)



Source: Authors' elaboration with data of the Bolivian National Institute of Statistics.

It must be added that exports of natural gas were also fueled by high rates of its production in years 2012 and 2013. This increased rate of exploitation depleted more rapidly than expected the existing deposits.

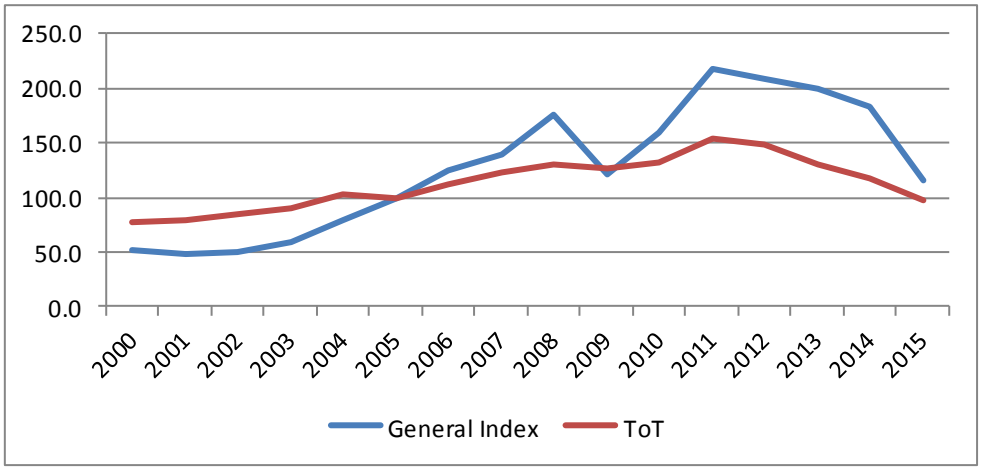
Figure 3. Price indexes for main commodity exports (Base 2005 = 100)



Source: Authors' computations with data of the IMF. Primary commodity prices

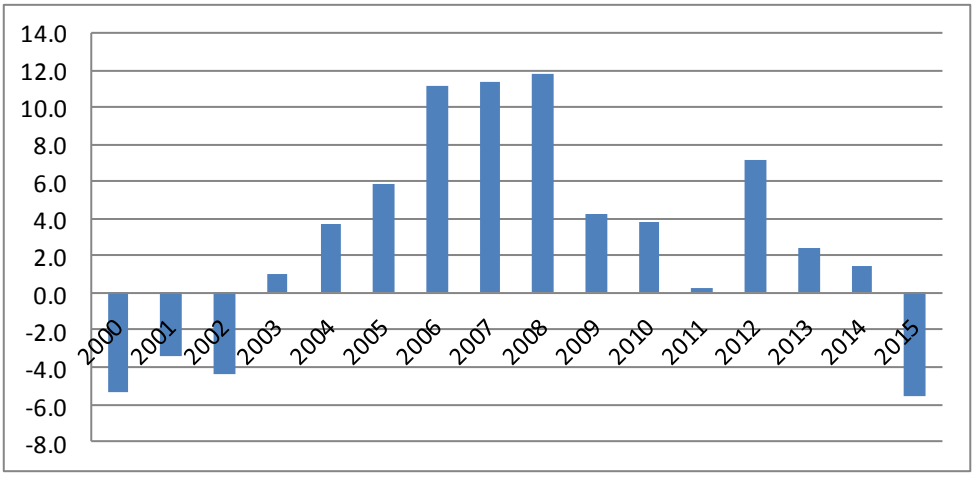
Our export price index of commodities (se Appendix A for details) and the terms-of-trade are closely linked as depicted in figure 4. In our study we have preferred the export price index, because it has advantages of its own: its effects on the macroeconomic variables of interest are more direct than those of the terms-of-trade.

Figure 4. Export price index of commodities and Terms of Trade
Base (2005 =100)



Source: Authors' computations for the export price index; terms-of-trade data from the Economic Commission for Latin America (ECLA)

Figure 5. Current account balance of the BoP (as percent of GDP)

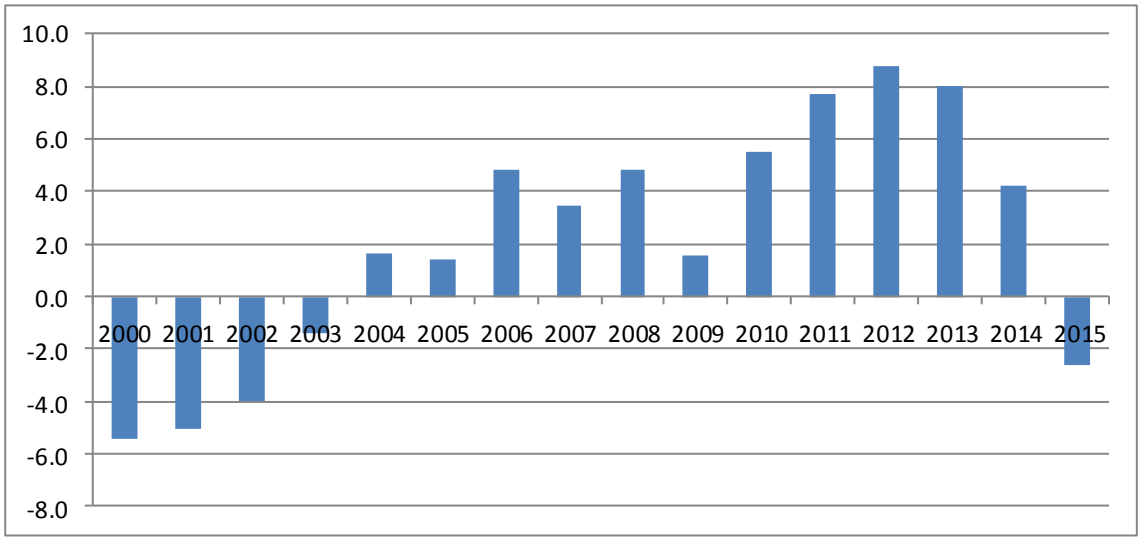


Source: Prepared with data of the IMF World Economic Outlook, April 2017

Note in figure 5 that the current account (and the trade balance, not shown) were in deficit up to 2002. Once the surge in prices happened, the current account exhibited surpluses until 2014. In most years the surpluses were very large, with the exception of the international financial crisis years 2008-2009. Starting in the third quarter of 2014, the prices of the commodities fell again and a deficit in the current account appeared although 2014 still ended with a small surplus.

Gross Domestic Income (GDI) is equal to GDP plus the terms-of-trade effect. The GDI premium over GDP gives a good idea of the implications on output of the price windfall. The premium was a huge over 8% of GDP in years 2012-2013. In other words GDI was 8% higher than output, at market prices, resulting of the effect of international prices (figure 6).

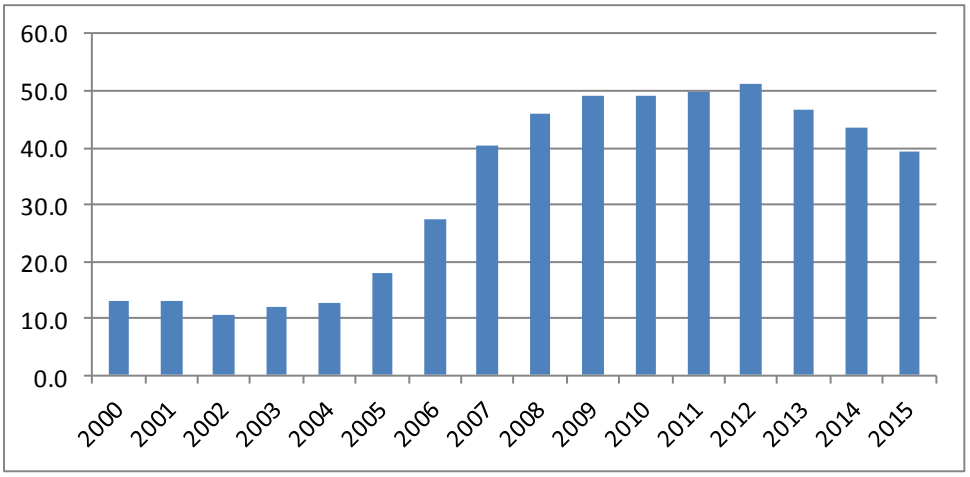
Figure 6. Gross Domestic Income premium over Gross Domestic Product
(In percent)



Source: Authors' elaboration with data of the Bolivian National Institute of Statistics.

Figure 7 shows the large international reserves accumulated from 2004 on. In some years they reached 50% of GDP. They started to decline in 2013 and the pace of reduction accelerated in 2014-2015. Reserve accumulation is mainly explained by the surpluses in the current account of the Balance of Payments.

Figure 7. International reserves as percent of GDP



Source: Authors' elaboration with data of the Bolivian National Institute of Statistics.

3. Analysis of the data on prices

Statistical properties of commodity prices

The statistical properties of the quarterly international prices (in indices with base 2005) used in the study appear in table 1. Note that the prices for all commodities increased on average. The prices of metals, with the exception of zinc, increased more than the prices of oil and soybeans. The price of soybeans increased more than that of oil. Given the weight of hydrocarbons in the export basket, the statistics of the export price index (last column in table 1) track the statistics of the price of oil.

Prices had large fluctuations as indicated by their standard deviations and their coefficients of variation. Also, note the width between the maximum and the minimum prices. The largest fluctuations were those of the prices of precious metals, gold and silver, followed by the price of the semi-precious tin. Price volatility has been regarded traditionally as being a major explanatory factor of the booms and busts in countries highly dependent on exports of commodities.

It is important to note that the export price index is non-stationary.[14]As can be seen in Appendix B, they are I(1), that is, they are integrated of order 1. Non-stationarity difficults the analysis in levels as it may lead to spurious correlations. This is why, when possible, our ensuing analysis is with de-trended series

Table 1. Quarterly price indexes of commodities during the export boom period 2004Q1-2014Q2

Base 2005 =100

	OIL	ZINC	TIN	LEAD	SILVER	GOLD	SOYBEANS	EPI[a)]
Mean	137.4	149.9	222.4	189.0	246.1	225.2	165.0	154.8
Median	136.4	146.4	226.9	204.2	218.6	207.8	162.4	149.7
Maximum	219.6	304.0	404.6	330.4	530.6	386.4	275.1	235.7
Minimum	62.4	71.1	87.3	82.6	85.3	88.3	83.8	72.9
Standard Deviation	39.3	53.9	89.9	66.1	127.3	99.7	52.8	48.0
Coefficient of variation in percent	28.6	36.0	40.4	35.0	51.7	44.3	32.0	31.0
Observations	42	42	42	42	42	42	42	42

Source: Authors' computations with data of IMF(2016) and KITCO(2016)

Note: [a)] EPI = Export price Index

Note that the price of metals started declining in the first quarter of year 2013 and continued their declining trend throughout 2015, as shown in table 2. Silver had the most important decline in prices.

Between 2013Q1 and 2015Q4, the price of the main exports of Bolivia suffered a steep fall (table 2). Prices fell close to 50% on average. The prices of oil and silver fell more than 50% in the period. The prices of other metals had started falling in 2012 but the rate of fall increased between 2013Q1 and 2015Q4. The price of soybeans was relatively more stable: it did not increase by much during the boom years, but symmetrically it did not fall as much during the downturn.

[14] Also, all commodity prices intervening in the computation of the export price index are non-stationary.

Table 2.	Change in the international price of commodities between 2013Q1 and 2015Q4							
Commodity	Oil	Lead	Soybeans	Tin	Zinc	Gold	Silver	EPI[a)]
Price change	-55.5%	-26.6%	-31.0%	-37.3%	-20.6%	-32.3%	-50.9%	-49.9%
	Source: Authors' computations with data of IMF(2016) and KITCO(2016)							
	Note : [a)] EPI = Export Price Index							

Simple correlations

The analysis of correlations is central to our study. Of course correlations do not imply causality but nevertheless they give an idea of the linkages among the variables of interest. Unfortunately most variables, either prices or macroeconomic variables, are not stationary which precludes their use in levels.[15] To avoid spurious correlations the variables have been de-trended with the Hodrick- Preston filter and we have retained the cycle component. Table 3 shows the correlations of prices and some of the more important macroeconomic variables.

Table 3. Simple correlations of macroeconomic variables with prices[a]

	Δ4LNGDP	INV	S	CA	ΔIR	RER	PRICES
D4LNGDP	1						
INV	0.1547	1					
S	-0.0027	-0.7667	1				
CA	0.2710	-0.2908	0.2803	1			
DIR	0.2938	-0.1225	0.1813	0.2976	1		
RER	0.2197	-0.1156	0.0695	0.3215	0.2989	1	
PRICES	0.4677	-0.0262	0.1611	0.3895	0.6003	0.3911	1

Source: Authors' computations

Note: [a]All variables, except Δ4GDP, are de-trended with the Hodrick-Preston filter. Δ4LNGDP is stationary.

Δ4LNGDP = Inter-annual rate of growth

INV = Investment rate

S = Savings rate

CA = Current account of the Balance of Payments as ratio of nominal GDP.

ΔIR = Change in international reserves as ratio of nominal GDP.

[15] All variables, except Δ4lnGDP, which is stationary, are integrated of order 1 (see Appendix B).

RER = Real Exchange rate
Prices = Export Price index of commodity exports

Variable Δ4lnGDP needs explanation. It is computed as the difference between the the log of the current GDP and the log of GDP lagged four quarters. It proxies the rate of growth of GDP between the current quarter and similar quarter in the previous year. Δ4lnGDP has been checked for stationarity. Not unsurprisingly it is.

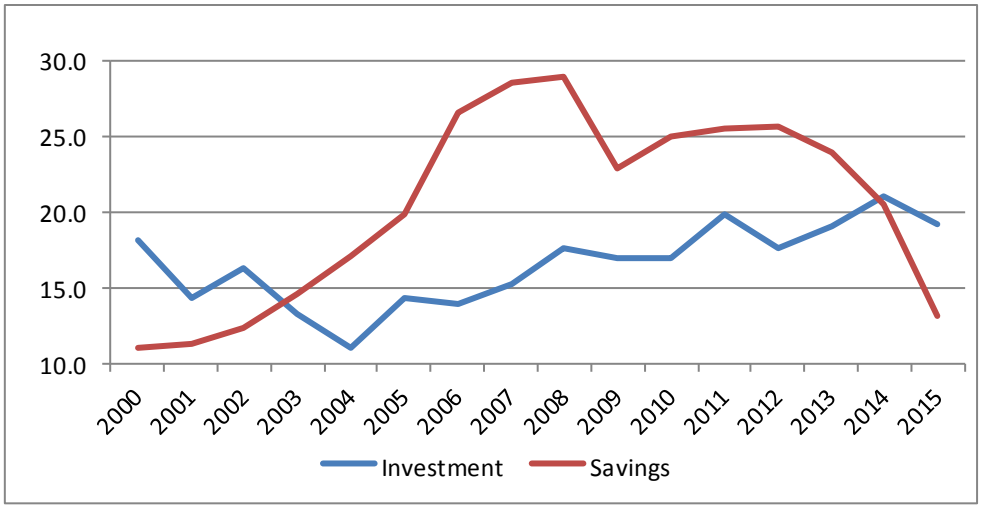
The price index is correlated positively and with relatively large values with the aforementioned rate of growth of GDP, with the current account of the Balance-of-Payments, with changes in international reserves and with the real exchange rate (RER).[16] It is weakly correlated with the savings rate and its correlation with the investment rate, albeit very low, is negative, which is unexpected. The weak correlation of the cyclical component of prices and of the savings rate deserves special attention. This correlation, while positive, is weaker than would have expected, given that the savings rate increased very significantly during the boom period, as can be observed in figure 8.[17] One appealing explanation for this is that the cyclical components captured only the deviations caused by disturbances and imperfect adjustments of consumption and hence savings, to the underlying consumption functions of households maximizing their utility functions.

Investment rates did not follow the pace of the savings rates. A significant proportion of savings was invested in foreign assets (foreign reserves), despite the fact that the yield on real domestic assets was significantly higher.

[16] See the discussion below on the positive correlation of the Export Price Index and the RER.

[17] De la Torre, Filippini,and Ize (2016) emphasize the importance of savings in dealing with booms and busts of commodities.

Figure 8. Investment-Savings, 2000-2015 (as percent of GDP)



Source: Prepared with data of the IMF World Economic Outlook, April 2017

The positive correlation of prices and RER may seem surprising at first sight, given the extent of the real appreciation during the boom period.[18] Actually a negative correlation was expected. When lags of two quarters are considered, the correlations are indeed negative, both for oil prices and for the export price index (-0.2205 and -0.1212 respectively).

4. Fiscal linkages

The fiscal balance

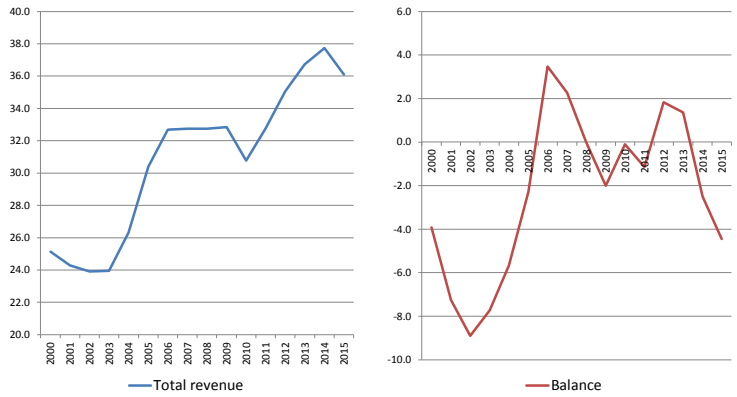
Not unexpectedly, the main beneficiary of the export boom was the government. Coupled with the higher tax rates enacted in Hydrocarbons Law 3058 of 2005 and Nationalisation Decree of 2006, government revenues jumped very significantly.[19] With higher prices of hydrocarbons and higher tax rates, the rate of growth of

[18] The convention of the Central Bank of Bolivia is when the RER index rises indicates depreciation and apreciation the other way around.

[19] To the existing royalty rate of 18% of the value of output at the well, a tax labeled Direct Tax on Hydrocarbons (IDH for its acronyms in Spanish), with similar features to the royalty of 32% was added. Hence the minimum tax rate on output was of 50%. Profits are also taxed, but the tax base is more difficult to gauge, given the multiplicity of deductible charges. The yield of these taxes on profits pales in comparison with IDH and royalties. The government take is of 50% as a minimum.

government revenue, as percent of GDP, jumped from an annual average of 0.9% between 2000-2004 to 2.9% between 2004 and 2015.[20]

Figure 9. Total government revenue and balance as percent of GDP



Source: Authors' elaboration with data of the Central Bank of Bolivia.
Note: Positive balance = surplus ; negative balance = deficit

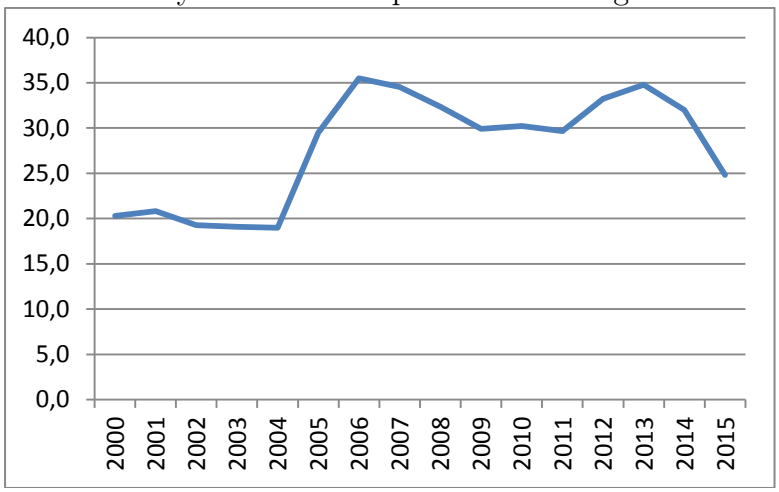
With the jump in oil prices, total revenues passed from about 25% of GDP in the early years of this century to over 36%, even close to 38% as can be observed in the left panel of figure 9. As a consequence, in most years of the boom period 2004-2013 the government had surpluses. The deficit of 2009 and the small deficits of 2010 and 2011 were linked to the fall in export prices due to the sequels of the international financial crisis of 2007-2009.[21]

Taxes on hydrocarbons were in average 22.7% of total government revenue until the third quarter of 2005 (figure 10). From then on these taxes were on average 33.8 % of total revenue until the first half of 2014.

[20] It needs to be mentioned that during the international financial crisis of 2008 the rate of growth of government revenue was negative. This fall represented 2.8 percent of GDP.

[21] It is to be underlined that the fiscal accounts reported in this study relate only to the general government while the accounts of the public enterprises are ignored. A more complete panorama would be given by the consolidated public sector balance, but the interpretation of some of the items is not straightforward. This is the reason why we have stuck with the general government.

Figure 10. Taxes on hydrocarbons as percent of total government revenues



Source: Authors' elaboration with data of the Central Bank of Bolivia

In what follows, computations have been performed with quarterly data, with all fiscal variables stated in percent of GDP. Notice that public expenditures, on a quarterly base, have very marked fluctuations. For instance, in some quarters the rate of growth of total expenditures, as percent of GDP, could be as high as 27.7% while in some other quarters the rate of growth could drop to -19.7%. The variables have been decomposed in trend and cycles using the Hodrick-Preston filter. Figure 11 below depicts the trends.

Restricting the analysis to trends it can be seen in the upper panels of figure 11 that the heightened government revenue allowed a big expansion of public expenditure, both of current expenses as well as public investment.[22] Trends in oil prices and in the export price index can be observed in the lower panels of the same table. Notice that these prices grew until mid 2014.

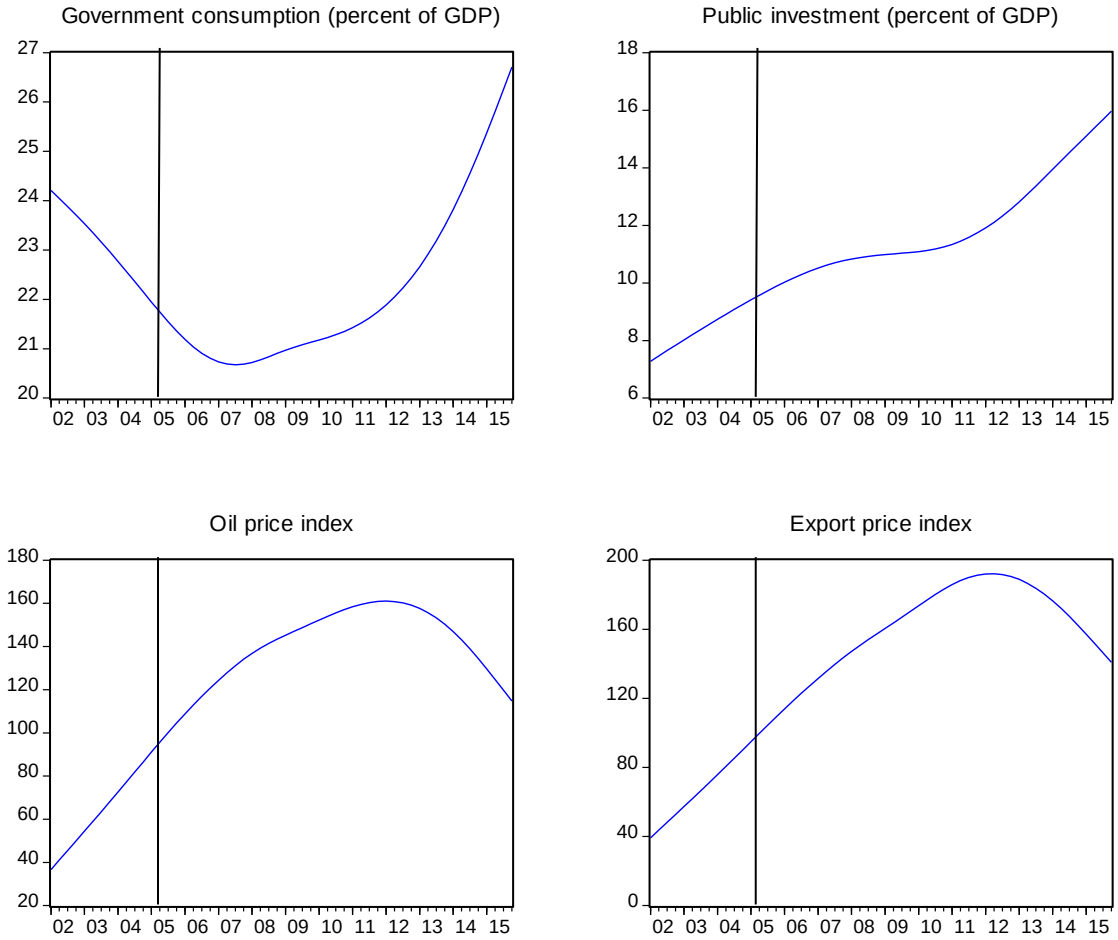
Tables B3 to B5 in Appendix B show that total government expenditure, government consumption and public investment (in logs) are co-integrated with the price index of exports. In other words, there is a long-term relationship between these fiscal variables and export prices.

Up to 2014 there was a close relationship of public expenditures with export prices. The link broke in mid- 2014. The expansive fiscal policy continued,

[22] Government consumption, as percent of GDP, started to rise in 2006, with the ascent of the government of president Evo Morales.

notwithstanding the fall in commodity prices and in government revenue. The ensuing fiscal deficits were financed with the international reserves that had been accumulated during the export boom years and with international debt.[23]

Figure 11. Trends in expenditures and prices, 2002Q1 – 2015Q4



The fiscal variables are not stationary, in fact they are I(1) as shown in table B2 in Appendix B. In order to investigate the procyclality of the fiscal variables and

[23] The government of Bolivia has been reluctant to adjust fiscally. The big, consecutive deficits from 2014 to 2017 and likely to show again in 2018, put at stake the solvency of the government. However, the solvency issues have not impeded access to the international capital market and other foreign loans, particularly from suppliers in China.

the price variables we used the cycle components of the Hodrick-Preston filter, which are stationary. The correlations in table 4 below have been computed with them.

Table 4. Correlations of fiscal variables and prices 2002q1 2015q4[a]

	GC	GK	GT	YH	YC	YT	TCR	OILPRICE(-1)	PRICES(-1)
GC	1								
GK	0.6540	1							
GT	0.9295	0.8869	1						
YH	0.0236	0.0992	0.0628	1					
YC	0.1205	-0.0394	0.0544	0.5821	1				
YT	0.1605	-0.0131	0.0917	0.5713	0.9913	1			
RER	-0.2997	-0.0608	-0.2127	0.0007	-0.0314	-0.0216	1		
OILPRICE(-1)	0.0261	0.1850	0.1061	0.3248	0.1524	0.1401	-0.0478	1	
PRICES(-1)	-0.0268	0.1348	0.0493	0.2982	0.1745	0.1582	0.0470	0.9179	1

Source: Authors' computations

Note: [a]Detrended variables

The variables are:
GC = Government consumption
GK = Government investment
GT = Total government expenditure
YT = Total government revenue
YC = Government current revenue
YH = Government revenue from taxes on hydrocarbons
RER = Real exchange rate
OILPRICE = Price of oil
PRICES = Export price index

It can be noted in table 4 that the tax revenue on hydrocarbons is highly correlated with the oil price and the export price index. On the other hand total government revenue and total expenditure (current government expenditures as well as capital expenditures, i.e., public investment) show only a modest but positive correlation.

The fact that total government revenue and prices are weakly correlated prices would be indicative that the boom did not lead to a lessening in tax effort.[24] Also,

[24] Of course, hydrocarbon exports do not generate taxes only directly. More exports allow more imports and tariff collections. They also increase income and consumption that generate more collections of the Value Added Tax. We have ignored these indirect effects.

there is a weak procyclality of government expenditures.[25] Correlations are lower because expenditures are either bunched in the last quarter or smoothed on a quarterly basis. On a quarterly basis they are disassociated of the path followed by revenues.

Singling out the oil price, the analysis of correlations yields similar results. It is to be recalled that natural gas is the main Bolivian export.

It is interesting to narrow the period of analysis to the boom period 2004Q1-2014Q2. The correlations with both the oil price and the export price index are higher for government consumption and for total expenditure than in the broader period. They are however lower for public investment. It is tempting to conclude that public investment truly had a countercyclical role.[26]

Table 5. Correlations of fiscal variables and prices 2004q1 2014q2[a]

	GC	GK	GT	YH	YC	YT	TCR	OILPRICE(-1)	PRICES(-1)
GC	1								
GK	0.6537	1							
GT	0.9324	0.8830	1						
YH	0.1211	0.0997	0.1227	1					
YC	0.2481	-0.0219	0.1434	0.6222	1				
YT	0.2922	0.0114	0.1866	0.6190	0.9941	1			
TCR	-0.3231	-0.0599	-0.2290	-0.0535	-0.0908	-0.0859	1		
OILPRICE(-1)	0.1213	0.1196	0.1323	0.2418	0.1407	0.1341	-0.1035	1	
PRICES(-1)	0.0434	0.0787	0.0645	0.2119	0.1539	0.1428	0.0107	0.9076	1

Source: Authors' computations

Note: [a]Detrended variables

5. Sector effects

We have followed different approaches to the econometric analysis of the previous sectors to try to gauge the impact of the export boom on the economy. These approaches do not substitute the econometric approach but hopefully serve as complements.

[25] With a similar approach to ours but with different variables and periods Frankel et al (2012) find no cyclality with the fiscal variables.

[26] Officials of the government of Bolivia have systematically claimed that they followed a countercyclical policy with public investment as the main instrument.

The real effects of the commodity boom across sectors

We have attempted to trace the impact of the export commodity boom throughout the economy with the help of a standard input-output analysis. For details and numbers see Appendix C.

Since our focus is on the hydrocarbons exports we assumed that the only demand that increased was that of hydrocarbons, $\Delta f_i = 0$ for all other sectors, where f_i is final demand. Also, in the demand for hydrocarbons we will focus only on the export demand. Between 2005 and 2015 exports of hydrocarbons increased in Bs 14,037.35 millions (at 2012 prices). It is quite obvious that the sectors of crude oil and natural gas will show the biggest output increase induced by the export demand. Also, the expansion of the demand for the exported hydrocarbons affected significantly the production of refined oil products, transportation and storage, services to enterprises, chemical substances and products, in that order. The mining sector also benefitted from the expansion of the hydrocarbons exports. On the other hand effects on other sectors, including the manufacturing sectors, are very small. All in all, the real links of the hydrocarbons sector with other sectors of the economy are weak.

The construction boom

The I–O analysis is limited to the real effects across sectors, ignoring price effects. However it is to be underlined that the price effects were significantly more important than the quantity ones. A case in point is construction (both in infrastructure and residential) that received a big impulse with the windfall income of the export boom. The crucial variable is the increase in savings discussed above. Unfortunately the available quarterly data does not allow us to separate between the public sector savings and the savings of the private sector.[27]With regard to public investment a large fraction went to roads, airports, urban equipment and the like.[28] This gave momentum to the construction sector.

We turn now to the behavior of the private sector. The discussion that follows relies on an application, with some changes, of the theory developed by Collier and

[27] Data distinguishing public savings and private savings as well as public investment and private investment is available only on a yearly basis.

[28] Public investment has been discussed in section 4. Note that a significant fraction of the public sector savings was placed in foreign assets, mainly because of the delays in completing the public sector projects.

Associates (1999) of the construction booms. The private sector saving was invested largely in real state. The extra income produced by the windfall did not go only to consumption but it was also saved by households. It was first saved in the form of cash money and soon after as bank deposits, mostly in savings passbooks and term deposits. Banks were flooded with liquidity and access to mortgages became cheaper and easier. [29]

More important, because loans grew at a slower pace than deposits during most of the boom phase, interest rates on deposits fell very substantially. Bank deposits are in Bolivia, to a significant extent, captive deposits, in the sense that there are few alternatives to them. Investing savings in foreign assets is not a realistic option for most households, even if the capital account of the balance-of-payments is *de jure* completely open, given the lack of information and the small size of the deposits. Moreover after the international financial crisis of 2008-2009 foreign interest rates were only slightly higher than the domestic ones.

Households had only a very limited set of assets in which they could invest: real estate and bank deposits. Given the afore mentioned fall in deposits rates they found in real estate a way to store their wealth, moreover with the expectation of significant capital gains.[30] Since the demand for the existing stock of houses received a big push and their prices increased, investment in residential construction followed. [31]

Investment in real estate provided a way to delay consumption and hence the Dutch Disease effect after the windfall was attenuated. Expectations on the nature of the windfall played an important role. Had the expectations be of a permanent gain most of it would have been consumed. If the expectations were of a windfall of transient nature then most of it would have been saved. It seems that the expectations of the public lied in between, given the uncertainty on price movements and, specially, incomes. Also the windfall relaxed the liquidity constraints that households faced. Hence they hastened their acquisitions of houses that they

[29] Moreover the regulations enacted in the Financial Services law of 2013 that obliged banks and quasi-banks to place loans to housing at regulated interest rates increased mortgage loans very significantly.

[30] An incipient bubble was formed with this perception.

[31] Unfortunately there is no a housing price index in Bolivia that could give a clearer picture of this particular type of asset.

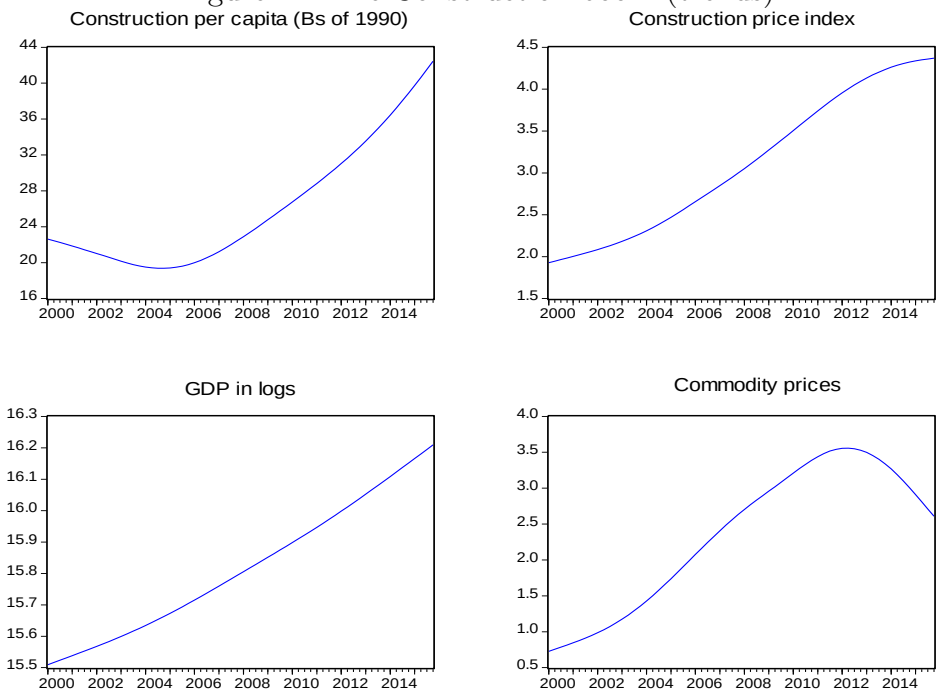
intended to buy but that they couldn't do so because of obstacles in their access to credit. Finally, in owner occupied housing there is an element of consumption that sometimes is overlooked.

The expected rate of return of domestic investments in real estate was higher than in foreign investments. Therefore capital in construction could go a long way in the domestic market, before feeling the pinch of incentives to place it out of the country.

Given the paucity of information on constructed square meters of houses, a value added in construction was used as a proxy. We have considered value added per capita to correct for the effect of population growth in the demand for construction. Figure 12 suggests that construction per capita and commodity prices were positively related during the export boom years of 2004-2013. After 2013 construction continued with its impulse notwithstanding the decline in commodity prices. Commodity prices fell but not GDP, which may explain this. The tests in table B5 in Appendix B show that per capita construction and commodity prices are co-integrated, telling us of long run relationship between the two variables.

The increase in the demand for construction inputs and labor derived from the construction booms was another channel that affected the price of non-tradables. Notice in Figure 12 the close relationship between commodity prices and the construction price index. The tests in table B5 in Appendix B show the co-integration of both prices.

Figure 12. The Construction boom (trends)



A simple computable general equilibrium model (CGEM) and the real exchange rate

We have used a modified version of the simple CGEM of Dervarajan et al. (1977) to evaluate the possible impact of changes in export prices on the economy and, particularly, on the real exchange rate. The model contains 22 equations, with 2 sectors and 3 goods (see Appendix D). The results of the calibrations are shown in table D1. Notice that all values are expressed as proportions of real output.[32] Real output is held constant but its composition in terms of different types of goods is not.

The main modifications are in the tax equation (equation 11 in Appendix D) where the Direct Tax on Hydrocarbons (IDH for the acronyms in Spanish) plus Royalties has been added. IDH and Royalties are output taxes, valued at their international prices. They have loomed large in the fiscal revenues of 2005-2015. In

[32] Real output differs from GDP. Real output is computed at producers´ prices while GDP is computed a market prices. The wedge between them is mainly given by indirect taxes.

the calibrations reported in the Table D2, IDH+Royalties have varied with the different assumptions on the price of exports. To complete the picture on the fiscal revenues a myriad of other taxes under the heading of Other has been added.

An adjustment coefficient "a" varying between 0.45 and 1, has been added to take into account the expansion of imports, following the big growth of exports when export prices move forward. It was observed that imports went well beyond what could be attributed to changes in their price relative to the price of a composite good. The adjustment coefficient varied inversely with the price of exports to capture in the foreign savings equation the fact that when export prices increase imports also increase (equation (8) in table D1 of Appendix D).

Since natural gas is the main export and explains most of the variance in the export price index, we have tried with the model to trace its effects on the endogenous variables with a close attention to taxes and rents on hydrocarbons. We have examined the model varying the price of exports while the other exogenous variables have been kept constant. The value of 2.17 for the export price in table D2 corresponds to the highest price (in indices) observed in the period 2004-2015.

As can be seen in table D1 in Appendix D, a first lesson of our computations with the CGEM is the reduction of exports in real terms with the higher prices for oil. On the other hand, imports increase significantly in real terms. An interpretation of this result is that the country's volume of exports declines because the high prices yield by themselves a high level of income with no need to augment volumes. As important, the sectors unrelated to the booming hydrocarbons sector did not have the right incentives to increase their production or even to limit its reduction. The increase in imports is the expected result of higher income.

The supply of domestic goods augments rather considerably with the increases in the export price. Because of market equilibrium demand adjusts itself to supply. The supply and the demand of the composite good also increase. With the doubling of price of hydrocarbons the supply and demand of domestic goods changes from 0.97 to as high as 1.37.

An important result is the increase in tax revenues for the government that almost double with the export price rise. Higher fiscal revenues are among the main effects of the jumps in prices. This increase is large, as can be observed in table D1. The boost to hydrocarbons tax collections is mainly explained by the rise in prices. However notice that despite the large tax revenues windfall, government savings

improve only slowly. For government savings to become positive the rise in prices has to be very steep: over 100%.

Another important result concerns the behavior of household consumption. With a doubling of prices consumption increase very significantly; it increases even when prices do not rise as much (say 25%).

There is also the expected result of a rise of real investment with the increase in savings, up to a ceiling. Yet the trajectory of investment is not smooth: total investment even decreases when the increase in export prices is modest.

Not unexpectedly, most prices of the domestic economy increase with the export price. It is to be noted the high increase in the price of domestic goods although only a small fraction of the hydrocarbons output is sold locally.[33] The model yields a significant impact of export prices in the economy mostly due to competition of resources in fixed supply between the production of export goods and domestic goods.

The real exchange rate was normalized to 1 before the jump in the price of hydrocarbons. With the price rise the real exchange rate could go as low as 73% of its initial level. That is, the real exchange rate appreciates. This is not unexpected.

6. Conclusions

There is little doubt of the enormous impact that the supercycle of high prices has had in he Bolivian economy. The econometric work points out to the procyclality of many variables with the export prices, as well as the long run relationships among them. However, the correlations between the cyclical components of the export price index and fiscal expenditures while positive are weak. The sector effects of the export boom identified within the frame of the input-output analysis are weak as they were expected, as the backward and forward linkages of the hydrocarbons sector with the other sectors of the economy are non-existent or feeble. The export boom was felt only in sectors in the immediate vicinity of hydrocarbons in the I-O table.

Windfall income had however important sector effects. For instance, it was calculated with a simple Computable General Equilibrium Model that overvaluation

[33] It could be added but this feature is not in the model that the domestic market for hydrocarbons is highly regulated, with administered prices frozen well below the international price.

of the real exchange rate could be substantial. However, this is a result of the calibrations, not of estimations.

The construction boom that Bolivia has experienced in the past years is closely related to the export boom. In fact the variables used to proxy construction and the export price index are co-integrated. This econometric result is underpinned by a discussion of the theory.

From a normative viewpoint, the construction boom, closely related to the export boom, needs the attention of the supervisory bodies. The possibility of the build-up of a bubble is all too present.

The main problem which we have not addressed in the paper is the stretching of the benefits of the bonanza, once it was over. The results of the paper beg some questions on the institutional set up necessary to convert a transitory and exogenous bonanza into a permanent rise of the rate of growth of the economy.

Given the non-stationary nature of the export prices the design of a stabilization fund is far from trivial. Other fiscal rules are also difficult, although not impossible to implement. A first and handy step would be to keep a lid on the non-hydrocarbons deficit.

More attention, not given in the paper, should go to the possibility of greater openness of the Balance of Payments. *Prima facie* there will be significant efficiency gains with more *de facto* openness. Less investment would go to the construction sector.

Appendix A. The data base

The following sources of data are used in what follows:

- International Monetary Fund.- Primary commodity prices
- KITCO.- Historical prices of gold and silver
- Bolivia´s National Institute of Statistics
  - Terms-of-trade
  - National accounts, quarterly and yearly
  - Exports and imports of commodities
- Central Bank of Bolivia
  - Fiscal accounts

We have looked at the behavior of seven commodities that are Bolivia´s main exports. The commodities are: petroleum, lead, tin, zinc, silver, gold and soybeans. Monthly data on prices and quantities is available for the aforementioned commodities. They have been summarized in quarterly and yearly data in some parts of the analysis by simple averaging.

The prices of the above commodities have been considered separately for each of them. Also a representative Laspeyres price index has been constructed. The details of the construction are as follows:

$EPI_t = \sum_{i=1}^{7} w_i I_{it/1990}$ (1)

Where:

EPI_t = Export Price Index for period t.

$I_{it/1990} = \frac{P_{it}}{P_{i/1990}}$ is the price index for commodity i with base year 1990

$w_i = \frac{x_i}{x_{total}}$ is the (fixed) weight for commodity i (i=1… 7)

x_i = export of i in base year 1990

x_{total} = total exports $= \sum_{i=1}^{7} x_i$ in base year 1990.

For some computations the price index in (1) has been re-centered to year 2005

Appendix B. Unit root tests and co-integration

Table B1. Macroeconomic variables and prices. Augmented Dickey-Fuller Test

Null Hypothesis: Variable has a unit root

Variable	In levels		In differences		Order of
	t-statistic	Prob. H_0 *	t-statistic	Prob. H_0 *	Integration
D4LNGDP	-4.3469	0.0009			I(0)
INV	-0.6678	0.8465	-4.1522	0.0017	I(1)
S	-1.8419	0.3572	-34.8240	0.0001	I(1)
CA	-1.7573	0.3978	-7.7163	0.0000	I(1)
DIR	-1.3284	0.6106	-3.0961	0.0324	I(1)
RER	-0.4123	0.8999	-5.5061	0.0000	I(1)
OIL PRICE	-2.2305	0.1980	-6.5398	0.0000	I(1)
PRICES	-1.8252	0.3650	-5.6747	0.0000	I(1)

Source: Authors' computations

Note: *MacKinnon (1996) one-sided p-values.

Where:

L GDP = Inter-annual rate of growth of GDP

INV = Investment rate

S =Savings rate

CA = Current account of the Balance of Payments as ratio of nominal GDP.

IR = Change in international reserves as ratio of nominal GDP.

RER = Real Exchange rate

OILPRICE =Normalized Price of oil

Prices = Export Price index

Table B2. Fiscal variables and prices. Augmented Dickey-Fuller Test

Null Hypothesis: Variable has a unit root

Variable	In levels		In differences		Order of
	t-statistic	Prob. H_0 *	t-statistic	Prob. H_0 *	Integration
GC	-1.3495	0.5997	-12.0565	0.0000	I(1)
GK	-2.1838	0.2145	-4.5409	0.0006	I(1)
GT	-0.3575	0.9085	-19.6166	0.0001	I(1)
YT	-1.6360	0.4573	-8.7210	0.0000	I(1)
YC	-1.4954	0.5281	-8.5116	0.0000	I(1)
YH	-2.3520	0.1600	-8.4648	0.0000	I(1)

Source: Authors' computations

Note: *MacKinnon (1996) one-sided p-values.

GC = Government consumption
GK = Government investment
GT = Total government expenditure
YT = Total government revenue
YC = Government current income
YH = Tax revenue from hydrocarbons

Table B3. Cointegration tests of fiscal variables and commodity prices

Trend assumption: Linear deterministic trend (restricted)

Unrestricted Cointegration Rank Test (Trace)

A. Series: LOG(GT) PRICES				
Hypothesized		Trace	0.0500	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.5281	45.2398	25.8721	0.0001
At most 1	0.0832	4.6879	12.5180	0.6416
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
B. Series: LOG(GC) PRICES				
Hypothesized		Trace	0.0500	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.3897	31.5115	25.8721	0.0089
At most 1	0.0858	4.8419	12.5180	0.6192
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
C. Series: LOG(GK) PRICES				
Hypothesized		Trace	0.0500	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.4604	37.9390	25.8721	0.0010
At most 1	0.0821	4.6284	12.5180	0.6503
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				

Notes:

Sample (adjusted): 2002Q3 2015Q4

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table B4. Cointegration tests of fiscal variables and commodity prices

Trend assumption: Linear deterministic trend (restricted)

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

A.	Series: LOG(GT) PRICES			
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.5281	40.5519	19.3870	0.0000
At most 1	0.0832	4.6879	12.5180	0.6416
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
B.	Series: LOG(GC) PRICES			
Hypothesized		Max-Eigen	0.0500	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.3897	26.6697	19.3870	0.0037
At most 1	0.0858	4.8419	12.5180	0.6192
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
C.	Series: LOG(GK) PRICES			
Hypothesized		Max-Eigen	0.0500	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.4604	33.3107	19.3870	0.0003
At most 1	0.0821	4.6284	12.5180	0.6503
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				

Notes:

Sample (adjusted): 2002Q3 2015Q4

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Table B5. Cointegration tests for the sector of construction

Included observations: 61 after adjustments

Trend assumption: Linear deterministic trend (restricted)

Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

A. Series: PERCAPITA CONSTRUCTION, COMMODITIES PRICES

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.4854	43.2684	25.8721	0.0001
At most 1	0.0440	2.7448	12.5180	0.9054

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

B. Series: CONSTRUCTIONPRICES, COMMODITYPRICES

Hypothesized		Trace	0.0500	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.4051	34.8132	25.8721	0.0030
At most 1	0.0500	3.1289	12.5180	0.8608

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

A. Series: PERCAPITA CONSTRUCTION, PRECIOS CONSTRUCTION

Hypothesized		Max-Eigen	0.0500	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.4854	40.5236	19.3870	0.0000
At most 1	0.0440	2.7448	12.5180	0.9054

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

B. Series: CONSTRUCTIONPRICES, COMMODITYPRICES

Hypothesized		Max-Eigen	0.0500	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.4051	31.6843	19.3870	0.0005
At most 1	0.0500	3.1289	12.5180	0.8608

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

Notes:

Sample (adjusted): 2000Q4 2015Q4

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Appendix C. Basic equations of the Input-Output Analysis[34]

The basic identity for the I-O analysis is

$$Ax + f = x \qquad (1)$$

where x = gross output

f = final demand: consumption of households, government consumption, investment and exports

A = (a_{ij}) is the n x n matrix of domestic output coefficients

a_{ij} = input i / output j

The model can be completed with an import equation.

$$m'x + f_M = M \qquad (2)$$

where m' is the 1 x n vector of coefficients of imported imports, scalars f_M and M are imports of final goods and total imports, respectively. Our focus will be however on equation (1).

x can be solved in (1) as:

$$x = (I - A)^{-1} f$$

Differentiating (3) and assuming A constant, we obtain:

$$\Delta x = (I - A)^{-1} \Delta f$$

Since our focus is on the hydrocarbons exports we will assume $\Delta f = 0$ for all sectors other than hydrocarbons. Also, in the demand for hydrocarbons we will focus only on the export demand. The results of the computations are shown in table C.

[34] Input-output analysis has a long tradition. For a recent account see e.g.Schuschny(2005).

Table C. Changes in sector outputs following an increase in the demand For hydrocarbons exports	
Sectors	Increase in output (millions of Bs of 2012)
Crude oil and natural gas	46,625.7
Refined oil products	7,398.6
Transportation and storage	6,242.8
Services to enterprises	3,254.2
Chemical substances and products	2,504.1
Basic metallic products	1,858.9
Metallic products, machinery and equipment	1,741.2
Minerals	1,537.8
Community , social and personal services	860.0
Electricity, gas and water	852.2
Communications	838.3
Paper and paper products	749.5
Textiles, apparel and leather products	547.4
Products of non-metallic minerals	335.6
Financial services	335.2
Restaurants and hotels	184.8
Beverages	147.7
Miscellaneous manufactured products	140.0
Forestry, hunting and fishing	130.3
Construction	106.9
Miscellaneous food products	101.4
Wood and Wood products	88.9
Agricultural products for industry	84.3
Fresh and elaborated meats	69.1
Non industrial agricultural products	42.7
Cattle products	39.4
Flours and bakery products	23.4
Sugar and sweets	14.4
Dairy products	13.5
Coca	0.1
Note: The increase in the demand for exports of hydrocarbons was assumed to be Bs, 14,037.05	

Appendix D. A simple computable general equilibrium model

Equations of the CGEM 1-2-3

	Real flows		**Nominal flows**
(1)	$\bar{X} = G(E, D^s; \Omega)$	(11)	$T = t^m * R * pw^m * M + t^s * P^q * Q^D + t^y * Y - t^e * R * pw^e * E + P^e * (IDHR) + Other$
(2)	$Q^S = F(M, D^D; \sigma)$	(12)	$Y = P^X * \bar{X} + tr * P^q + re * R$
(3)	$Q^D = C + Z + \bar{G}$	(13)	$S = \bar{s} * Y + R * \bar{B} + S^g$
(4)	$\frac{E}{D^S} = g_2(P^e, P^d)$	(14)	$C * P^t = (1 - \bar{s} - t^y) * Y$
(5)	$\frac{M}{D^D} = f_2(P^m, P^t)$	(15)	$P^m = (1 + t^m) * R * pw^m$
	Equilibrium conditions	(16)	$P^e = (1 + t^e) * R * pw^e$
(6)	$D^D - D^S = 0$	(17)	$P^s = (1 + t^s) * P^q$
(7)	$Q^D - Q^S = 0$	(18)	$P^x = g_1(P^e, P^d)$
(8)	$\bar{B} = (\frac{1}{a}(P^m * M) - P^e * E - ft - re))/R$	(19)	$P^q = f_1(P^m, P^t)$
(9)	$P^t * Z - S = 0$	(20)	$R = 1$
(10)	$T - (1 + a) * (P^q * \bar{G} + tr * P^q) - ft * R - S^g = 0$		**Accounting identities**
		(21)	$P^x * \bar{X} \equiv P^e * E + P^d * D^s$
		(22)	$P^q * Q^s \equiv P^m * M + P^t * D^d$

Endogenous variables

E: Export good
M: Import good
D^S: Supply of domestic good
D^D: Demand of domestic good
Q^S: Supply of composite good
Q^D: Demand of composite good
P^e: Domestic price of export good
P^m: Domestic price of import good
P^d: Producer price of composite good
P^t: Sales price of composite good
P^x: Price of aggregate output
P^q: Price of composite good

Exogenous variables

Pw^m: World price of import good
Pw^e: World price of export good
t^m: Tariff rate
t^e: Export subsidy rate
t^s: Value-added tax
t^y: Direct tax rate
tr: Government transfers
ft: Foreign transfers to government
re: Foreign remittances to private sector
$\bar{S}$: Average savings rate
$\bar{X}$: Aggregate output
$\bar{G}$: Real government demand

R: Exchange rate
T: Tax revenue
S^g: Government saving
Y: Total income
C: Aggregate consumption
S: Agregate savings
Z: Aggregate real investment
IDHR: Direct Tax on Hydrocarbons and Royalties

Source: Slightly modified version of model proposed by Devarajan, Go,Lewis, Robinson and Sinko, P. (1997).

$\bar{B}$: Balance of trade
Ω: Export transformation elasticity
σ: Import substitution elasticicity

Table D1. Calibrations of the simple CGEM 1-2-3

World Price of Exports (we)		**1.00**	**1.25**	**1.50**	**1.75**	**2.00**	**2.17**
Endogenous Variables	Base Year	Current	Current	Current	Current	Current	Current
Export Good (E)	0.43	0.43	0.40	0.38	0.37	0.36	0.36
Import Good (M)	0.40	0.40	0.50	0.59	0.65	0.70	0.72
Supply of Domestic Good (Ds)	0.57	0.57	0.60	0.64	0.66	0.68	0.69
Demand of Domestic Good (Dd)	0.57	0.57	0.60	0.64	0.66	0.68	0.69
Supply of Composite Good (Qs)	0.97	0.97	1.09	1.21	1.28	1.34	1.37
Demand of Composite Good (Qd)	0.97	0.97	1.09	1.21	1.28	1.34	1.37
Tax Revenue (TAX)	0.28	0.28	0.34	0.41	0.46	0.51	0.53
Total Income (Y)	1.01	1.01	1.28	1.57	1.79	2.00	2.13
Aggregate Savings (S)	0.24	-0.02	0.11	0.24	0.31	0.36	0.39
Consumption (Cn)	0.71	0.71	0.78	0.85	0.91	0.96	1.00
Import Price (Pm)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Export Price (Pe)	1.00	1.00	1.25	1.50	1.75	2.00	2.17
Sales Price (Pt)	1.14	1.14	1.32	1.48	1.58	1.66	1.71
Price of Supply (Pq)	1.00	1.00	1.15	1.29	1.38	1.45	1.49
Price of Output (Px)	1.00	1.00	1.26	1.54	1.76	1.96	2.09
Price of Dom. Good (Pd)	1.00	1.00	1.27	1.53	1.70	1.84	1.91
Exchange Rate (Er)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
RER	1.00	1.00	0.89	0.81	0.79	0.79	0.79
Investment (Z)	0.14	0.09	0.14	0.19	0.20	0.20	0.20
Government Savings (Sg)	0.10	-0.16	-0.10	-0.05	0.00	0.03	0.06
Walras Law (Z-S)	-0.09	0.13	0.08	0.04	0.00	-0.03	-0.05
Foreign savings	-0.07	-0.07	-0.05	-0.02	-0.04	-0.07	-0.10
adjustment (a)		1.000	0.750	0.600	0.525	0.475	0.450

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