Modeling the economic effects of a natural resource boom in general equilibrium: The Bolivian case

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Abstract

The Bolivian government has seen the project of exporting natural gas to the United States as a hope to relieve the critical economic situation of the country. To take into account the effects of this project, direct and indirect effects must be considered. This study aims to measure the impact of an expansion of the natural gas sector in Bolivia using a CGE model, focusing on the effects on other activity sectors and on wage levels. The particularities of this work are: a) Labor in the SAM has been disaggregated using a household survey. b) To introduce the shock, capital has been split in natural resources and other capital for the oil and gas sector. c) A labor market distortion for unskilled labor is considered, fixing its wage in the formal sector, and leaving it free to vary in the informal sector. Results show Dutch Disease effects, a migration of unskilled workers from formal to informal sector, and changes in factor revenues suggesting an increase of inequality.

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Chapter 1

Introduction

With a GDP per capita of around US$ 883 (INE, 2002) and social indicators similar to Sub-Saharan Africa countries, Bolivia is one of the poorest countries in Latin America. About two-thirds of the Bolivian population is poor, with low levels of education, health and nutrition. The average schooling completed is less than seven years, infant mortality stands at 69 per thousand live births, and 10 percent of the children under five are malnourished (World Bank, 2003).

The Bolivian government has seen the project of exporting of natural gas to the United States as a hope to relieve the critical economic situation the country goes through. The country holds Latin America's second-largest reserves of natural gas (...) The IMF estimates that Bolivia's oil and gas sector could add an average 1% to GDP growth over the next five years, if projects to market the gas materialise (The Economist, Sept. 11, 2003).

Since Bolivia itself uses little gas, it can send most of it elsewhere. At present, though, its only big customer is Brazil; and Petrobras, a Brazilian oil firm, has just announced a huge gas find there. Bolivia therefore needs to look further afield. Three companies calling themselves Pacific LNG (RepsolYPF, British Gas and PanAmerican Energy) have long wanted to sell the gas to Californian power plants. Pacific LNG believes the project, which involves spending US$3.1 billion to build pipelines and a coastal terminal, is economical only if the gas goes through a Chilean port, most probably Platillos (The Economist, Sept. 11 2003).

Nevertheless, many Bolivian sectors are not only against the idea to export natural gas through Chile, because of an old resentment of Bolivians toward Chile, but also against the idea itself of exporting this natural resource. Protests about this issue became the trigger for last month's confrontations (in October 2003) between the government, police and army, against marchers from several parts of the country who went to La Paz to "declare war" on a range of government policies. The result: more than 100 deaths and the resignation of the President. The new president has agreed to review the project taking

into account its benefits and problems. This process will be carried out in consultation with the civil society, economic advisors, while the Bolivian people wait for the government decision.

To take into account the effects of exporting natural gas to the United States is not an easy task. Direct and indirect effects have to be considered since the latter can be as important as the former, and this has been the motivation for the present work. This study aims to measure the impact of an expansion of the natural gas sector in Bolivia using a computable general equilibrium (CGE) model. The paper focuses on the effects of an increase in the reserves of the natural resource on other production sectors and on wage levels.

Previous studies modeling the economic effects of a natural resource boom in general equilibrium have been done. We can mention for example those made by Andersen and Faris (2002a and 2002b)where they focus on income distribution effects, and on the benefits of a stabilization fund in reducing volatility due to natural gas exports.

Three features distinguish this work from others. First, labor in the social accounting matrix (SAM) has been disaggregated using the Living Standard Measurement Survey (LSMS). The coherence between the SAM and the household survey allows the possibility of linking the CGE model with microeconometric models (for an example of this line of research, see Bourguignon et al., 2003). Second, capital has been split in natural resources and other capital for the oil and gas sector. This division will enable us to introduce the shock in the model since it assumes an increase of natural gas resources. Finally, the study considers a labor market distortion for unskilled labor, fixing wages for this type of labor in the formal sector, and leaving them to vary freely in the informal sector.

The rest of the document is organized as follow: chapter two describes briefly some particularities of the country's economy such as exports structure and informal economy; chapter three presents the social accounting matrix (SAM) used in this study and the CGE model. Chapter four introduces the shocks and measures the main changes in the economy. Chapter five concludes.

Chapter 2

Exports and Informal Economy in Bolivia

Bolivia is one of the poorest countries in Latin America, and the poorest in South America. Bolivia is landlocked, its access to the sea was lost in a war against Chile in the late 19th century, and its poorly developed communications infrastructure limits its access to export markets. Besides, Bolivia´s exports are mainly concentrated in natural resources, leaving far behind other type of exports. Exporting natural gas to the United States may increase Bolivia´s exports dependence on natural resources.

We also want to mention another important feature of Bolivia, which is the importance of the informal economy sector in the country. The informal sector in Bolivia is probably as big as the formal sector, and if we want to focus on changes on wage levels, we consider of relevant importance to distinguish in the model the informal sector from the formal sector.

This chapter gives a small description of both characteristics of Bolivia mentioned above: Its exports structure and its informal economy.

2.1 Exports structure

Gas exports have risen in the last years from 5.1% of total exports in 1998, to 21.9% in 2002, becoming the main export commodity of the country, followed by soja (14.9%) and zinc (9.3%)(Central Bank of Bolivia, 2003).

Natural resources account for more than one half of total exports; this has always been the case since the "tin age" in the early 20th century, and even before. If Bolivia is rich in natural resources, how can we explain its poor economic performance?

According to Gylfason (2001), it has been the rule that countries rich in natural

Table 1: Exports in 2002 (in current Dollars)

	million US$	%
Natural gas	263.8	21.9
Soja	179.4	14.9
Zinc	111.3	9.3
Other natural resources	313.6	26.0
Other exports	334.9	27.9

*Source:*Banco Central de Bolivia.

resources underperform economically compared to countries poor in natural resources. Four main channels of transmission from abundant natural resources to stunted economic development are discussed: (a) the Dutch disease, (b) rent seeking, (c)overconfidence, and (d) neglect of education. Since the last three channels are difficult to model, the present study focuses on Dutch Disease.

The term "Dutch Disease" has its origin in the experience undergone by the Netherlands three decades ago. In the nineteen sixties, big natural gas discoveries took place in the Netherlands. This "blessing" turned out to become a malediction. The natural gas industry had adverse effects on Dutch manufacturing, essentially because of the appreciation of the Dutch real exchange rate (Corden, 1984). By the late seventies and early eighties, the oil and natural gas prices fell, and the Dutch economy suffered more than the others, because of its dependence on natural gas.

Dutch disease can be defined as "The harmful consequences for a national economy of discovering natural resources, specially the decline in traditional industries brought about by the rapid growth and prosperity of a new industry... The successful new industry has high exports, creating a foreign exchange surplus and raising the country's exchange rate with the consequence that other industries of the economy become internationally uncompetitive..." Rutherford (Dictionary of Economics, 1992).

In the case of Bolivia, we can imagine that an expansion of the gas sector might entail Dutch disease effects, harming other export sectors such as mining and soja, following an appreciation of the real exchange rate, and also increasing imports.

2.2 Informal market in Bolivia

The existence of an informal market, also known as informal sector or underground activities, is an important phenomenon in Latin America. The definition of the informal sector has always been a motive of debate. Conceptually, a simple definition of this phenomenon can be offered: Underground activities are those that have legal ends but employ illicit means. That is to say, they are activities that do not intrinsically have a criminal content, but must be carried

out illicitly, even though they are licit and desirable activities for the country. (Ghersi, 1997). A more exhaustive definition, adopted by the International Labor Organization, can found in the *Fifteenth International Conference of Labor Statisticians* (ILO, 1993).

Estimations of the size of the informal sector in Bolivia vary from one author to the other because of the weak frontier between formal and informal sector. According to Morales (2000), the informal sector contributed to 20% of GDP in 1995, and two thirds of urban labor work in the informal economy. Some characteristics of workers in informal sector compared to workers in formal sector are: lower wages compared to those in formal sector, low schooling levels and more important presence of women.

According to J.L. Ortiz (In Jiménez et al, 2002), the urban informal sector includes a great share of the population whose labor supply is not absorbed by the modern production sector (formal sector), and who is forced to work in informal activities in order to earn a subsistence income. This lack of labor demand in formal sector might arise, as several authors argue, because of the existence of a minimum wage in this sector.

For the Bolivian case, we have attempted to verify if wages in informal sector are lower than those in formal sector for identical workers. Applying a standard Mincer regression equation (Heckman et al., 2001), with dummy variables to control for personal characteristics other than schooling and experience, we have measured wage differences between urban workers in the formal sector and in the informal sector. The description of the SAM in chapter 3 details the characteristics of workers in informal economy.

The modified Mincer equation used for our estimations is:

$$log(w) = \alpha_0 + \rho_s s + \beta_0 x + \beta_1 x^2 + \gamma_0 h_i + \gamma_1 f_f + \gamma_2 f_i + \epsilon$$

where $log(w)$ is the *log* of the observed income, s is the years of schooling, x is defined as the age minus years of schooling minus 6, a proxy to experience; and h_i, f_f and f_i are dummy variables taking the value of 1 respectively if the observed person is a man working in the informal sector, a woman working in the formal sector or a woman working in the informal sector. Thus, the reference is a man working in the formal sector.

Results applying an OLS standard regression show that the informal sector remunerates labor with lower wages, compared to the formal sector, for both sexes. Following this result, and the importance of the informal sector in Bolivia, we can imagine that economy shocks may have impacts in this sector, especially in its size and its wage level. The gas sector belongs enterally to the formal sector of the economy. It is capital intensive, and the labor employed is mainly skilled. Through the simulations we will try to answer how the gas exports to the United States may affect the informal sector, mainly in its factor remuneration and its size, and if this changes suggest any change in the poverty

Table 2: Estimated Parameters for the Modified Mincer Equation (OLS)

Parameter	Estimated Value	t-statistic	P-value
α_0	0.7152	7.9383	[.000]
ρ_s	0.0381	5.1826	[.000]
β_0	0.0320	8.1237	[.000]
β_1	-0.0005	-8.4322	[.000]
γ_0	-0.3509	-3.3307	[.001]
γ_1	-0.2667	-10.4509	[.000]
γ_2	-0.5309	-6.4338	[.000]

Adjusted R-squared = 0.1

and inequality levels.

In this study, wage difference between the formal and informal sector will be modeled through the introduction of a minimum wage in the formal sector, which is described in the next chapter.

Chapter 3

The CGE Model and the Bolivian SAM

This chapter describes the main features and the structure of the CGE model, which includes a distortion in the unskilled urban labor marked. As mentioned before, we suppose existence of a minimal wage in the formal sector, which limits the demand for this type of labor. A short description of the SAM used to calibrate the model is also included in this chapter.

3.1 The CGE model

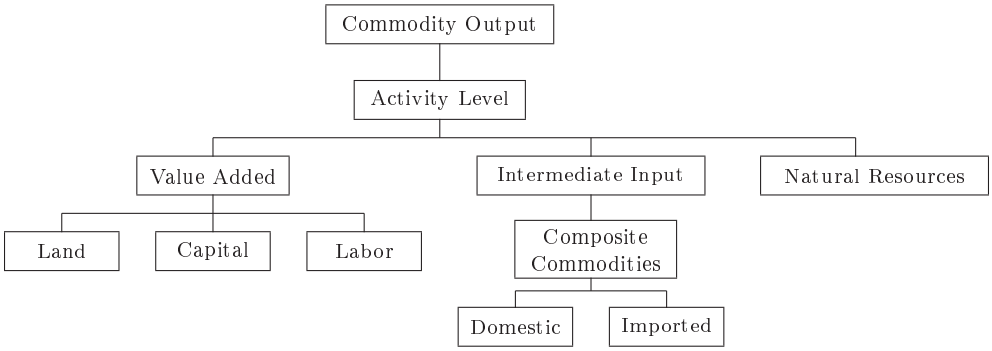
The CGE model explains all of the payments recorded in the SAM (see the SAM structure in Appendix A.3). The model therefore follows the SAM disaggregation of factors, activities, commodities and institutions. It is written as a set of simultaneous equations, linear or non-linear. These equations define the behavior of the different actors which can follow simple rules captured by simple coefficients, ad valorem tax rates for instance, or optimality conditions as in the case of utility maximization for consumption decisions. The equations also include a set of constraints that have to be satisfied by the system as a whole. These constraints cover markets and macroeconomic aggregates.

The CGE model used in this work is based on a standard one made by Lofgren, Harris and Robinson (2002), hereafter LHR, at the International Food Policy Research Institute, with some changes to fit better the Bolivian economy, as the existence of an informal economy sector. Its main characteristics are described below and equations are included in the annexes.

3.1.1 Activities, production and factor markets

Each producer, representative of a production sector, is assumed to maximize profits subject to a production technology. The production function has a nested structure, as illustrated in figure 1. At the top level, the activity level is function of primary factors and aggregate intermediate input. The Value-added and aggregate intermediate input are, in turn, functions of primary factors and disaggregated intermediate inputs, respectively. Finally, disaggregated intermediate inputs can be imported or domestic.

Figure 1: Nested production function



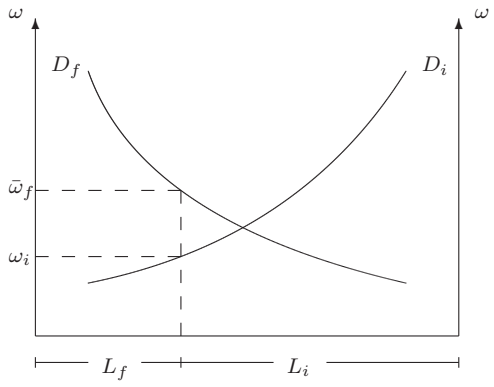
At the top level, the technology is specified by a Leontief function of value-added and aggregate intermediate input quantities for all sectors, except the oil and gas one. For this sector natural fossil resources, specific to this activity, are included in the Leontief technology function. See equation A.11, A.12 and A.13 in annexe. This means that both value-added and intermediate inputs, and fossil resources for the oil and gas sector, are used in fixed proportions.

Value-added is specified by a CES function of the primary factors which are labor, capital, and land A.14. There are four types of labor: skilled, unskilled in formal sector, unskilled in informal sector, and rural. The first three types of labor are supposed to operate only in the urban sector. To determine factor demand, marginal productivity of each factor equalizes its price A.15.

Since we model the difference in wages between unskilled urban formal labor and unskilled urban informal labor, we will have to introduce a labor market imperfection for this kind of labor. As mentioned before, wage differences between formal and informal sector for an identical type of labor, may arise from of the existence of a minimal wage, fixed by law, in the formal sector. This labor market distortion is illustrated in figure 2, where $\bar{\omega}_f$ is the minimal wage fixed by law for the formal sector, L_f is the demanded labor in the formal sector given the minimal wage, and ω_i is the equilibrium wage from the intersection of the informal labor demand and the residual labor supply L_i. D_f and D_i are demands for unskilled labor in the formal and in the informal

economy respectively. We will introduce in the model the hypothesis of a labor market distortion caused by a fixed minimal wage. Thus wages for unskilled urban formal labor will be fixed at the observed level A.16.

Figure 2: Supply and demand for unskilled labor



Except in some cases, all factors are free to move across activities. Restrictions are made for the land, which is specific to the agricultural activities, and for natural resources, specific to the oil and gas sector. Unskilled labor can also move between the formal sector and the informal sector.

Aggregate intermediate input demand for each activity is a Leontief function of disaggregated intermediate inputs, thus all intermediate inputs are used in fixed proportions in all activities A.17.

Commodity production must match commodity total demand for each activity. Commodity total demand is its marketed quantity, which is either consumed, exported or used for investment, and its production is defined as the activity level times fixed yields of commodity produced by each activity A.18.

Figure 3 on next page gives a schematic representation of flows of marketed commodities which are modeled as follows:

Aggregate marketed production of each commodity is composed of the marketed production of the commodity of each activity in a CES aggregation function. The optimal quantity of the commodity from each activity source is inversely related to the activity-specific price A.19 and A.20.

Marketed commodities are either exported or sold in domestic market. The model will assume imperfect transformation between these two destinations. A constant elasticity of transformation (CET) will be introduced to represent this hypothesis A.21. Optimal mix between exports and domestic sales comes from the first order condition for maximization of producer revenues given the two prices and subject to the CET function A.22.

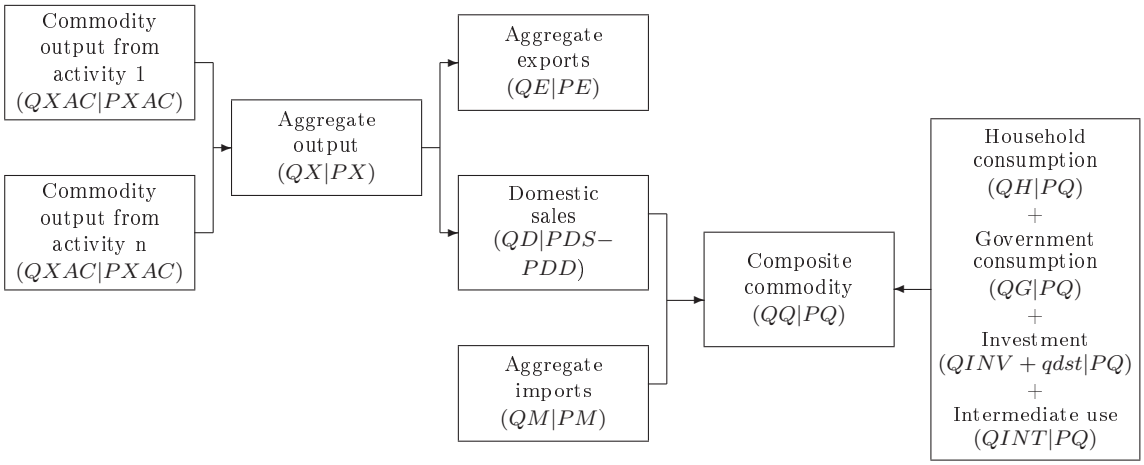
Whenever a commodity is only domestically sold or exported, but not both, the aggregate marketed domestic output equalizes respectively the domestic sold

or the exported quantity and no CET function is used for these commodities A.23.

Composite commodities that are supplied domestically are composed of those produced in the country and those imported. Imperfect substitutability between both sources is captured by a CES aggregation function of them. This is also called an Armington function A.24. The optimal mix between imports and domestic output is defined by the first order condition for minimization of the cost given the two prices A.25.

The Armington function is replaced by the equalization of composite supply and domestically produced or imported commodities for commodities that have either imports or domestic sales of domestic output but not both. A.26.

Figure 3: Flows of marketed commodities



3.1.2 Institutions

Total income of each factor is defined by the sum of activity payments to factors A.27. This income goes to domestic institutions in fixed shares after payment of direct factor taxes, imputed bank services (see SAM description in next section) and transfers to the rest of the world. The latter are fixed in foreign currency and transformed into domestic currency by multiplying by the exchange rate A.28. Domestic institutions are households, enterprises and the government.

Non-government institutions total income is the sum of its income from factors, net transfers from other domestic non-government institutions, net transfers from government (indexed to the CPI), and net transfers from the rest of the world. A.29. Transfers between domestic non-government institutions are paid

as fixed shares of the total institutional incomes net of direct taxes and savings A.30.

Households' consumption is obtained from maximization of their utility function, in this case the Stone and Geary function, subject to a consumption expenditure constraint. The resulting first order conditions are referred to as linear expenditure system (LES) functions since spending on individual commodities is a linear function of total consumption spending A.31. For each commodity, household consumption is equal to the sum of a fixed subsistence consumption plus a residual consumption. Residual consumptions are in fixed proportions of total consumption spending minus all subsistence consumptions. Since estimation of subsistence consumptions is not possible using one household consumption survey, because of under-identification, an alternative and widely-used method using a *Frisch* parameter is applied (Dervis, de Melo and Robinson, 1982). This parameter is the elasticity of the marginal utility of income with respect to income.

Total consumption spending of households is defined as the income that remains after direct taxes, savings, and transfers to other domestic non-government institutions A.32.

Imputed bank service income is defined as a fixed proportion of the capital revenue, which is paid to financial services commodity A.33 and A.34;

Fixed investment demand is defined as the base-year quantity multiplied by an adjustment factor A.35, which at equilibrium equalizes investments to savings.

Government consumption demand is also defined as the base-year quantity multiplied by an adjustment factor which is exogenous and hence, the quantity of government consumption is fixed A.36.

Total government revenue is the sum of revenues from taxes, royalties from natural resources, factors and transfers from the rest of the world; and government spending is the sum of government spending on consumption and transfers A.37. Government expenditure is the sum of its consumption and transfers A.38.

3.1.3 Prices

As already mentioned, commodities of different origins and destinations (exports, imports, and domestic outputs used domestically) are assumed to be imperfect substitutes. This makes the price system of the model rich. The price block consists of equations in which endogenous model prices are linked to other prices and to non-price model variables.

First we have the import price, measured in local currency units (LCU), which is the price paid by domestic users for imported commodities, exclusive of the sales tax. This price is the world price of each imported commodity, in foreign

currency, converted in LCU by the exchange rate and considering the import tariff. World price of the commodities is considered as fixed, which holds for the case of a small country such as Bolivia A.1.

The export price in LCU is the price received by domestic producers when they sell their output in foreign markets. This equation is similar in structure to the import price definition, but in this case, there are no export taxes to alter prices A.2.

In the reference model, domestic output that is used domestically has different prices in the presence of transaction costs. The Bolivian SAM does not include these costs, then prices paid by demanders and those received by suppliers are the same A.3.

Total domestic spending on a commodity at domestic demander prices, *absorption*, exclusive of the sales tax, is expressed as the sum of spending on domestic output and imports at the demand prices, excluding the commodity sales tax A.4.

Marketed output value at producers prices for each domestically produced commodity, is stated as the sum of the values of domestic sales and exports, valued at the prices received by the suppliers A.5.

The return from selling the output of the activity, *the gross revenue per activity unit*, is defined as the sum over all commodities of the fixed yields per activity unit multiplied by activity-specific commodity prices, allowing activities to produce multiple commodities A.6.

The activity-specific aggregate intermediate input price shows the cost of disaggregated intermediate inputs per unit of aggregate intermediate input. It depends on composite commodity prices and intermediate input coefficients, which show the quantity of input commodity per unit of aggregate intermediate input A.7.

For all activities, total revenue net of taxes is distributed among value-added and intermediate inputs, except for the oil and gas sector where distribution includes the natural resource revenue (royalties) A.8.

Finally, consumer price index (CPI), and producer price index for domestically marketed output (DPI), are defined as a pounded mean of the commodity prices A.9 and A.10. Weights are the parts of consumption, respectively production, of each commodity in total consumption, respectively production. Since the model is homogeneous of degree zero in prices, one of these indexes must be set as *numéraire*. For this work, the CPI will be the *numéraire*.

3.1.4 Constraints

There are several conditions that variables must satisfy, such as macroeconomic equilibrium condition. This section enounces the constraints of the model.

First, equality between the total quantity demanded and the total quantity supplied for each factor must be satisfied A.39. We specially focus on the unskilled urban labor case. For this factor, it is the sum of unskilled labor in the formal sector and the unskilled labor in the informal sector that must match the total unskilled labor supply (see figure 4) A.40.

Another condition that must be satisfied is the equality between quantities supplied and demanded of the composite commodity. The demand side includes endogenous terms and a new exogenous term for stock changes A.41.

Equality between the country's spending and its earning of foreign exchange is imposed in the current-account balance equation, expressed in foreign currency. In our model, foreign savings will be fixed, and real exchange rate will serve the role of equilibrating variable to the current-account balance. This means that deficit is also fixedA.42.

Next, we have government balance imposing equality between current government revenue and the sum of current government expenditures and savings, which can be negative, interpreted as government deficit A.43.

Direct tax rates of domestic non-government institutions are fixed as well as domestic non-government institutions saving rates A.44 and A.45.

Savings-investment balance states that total savings and total investment have to be equal. Total savings is composed of domestic non-government institutions savings, government savings and the rest of the world savings. Total investment is the sum of the values of fixed investment and stock changes A.46.

3.1.5 Model closure

The CGE model includes three macroeconomic balances: the government balance, the external balance and the savings-investment balance. The choice of the model closure has to reflect the political behavior of the country, or the expected policies for the future.

For the savings-investment balance, we introduce in the model a neo-classical closure. It means the closure is savings-driven. All non-government savings rates are fixed. The quantity of each commodity in the investment bundle is multiplied by a flexible scalar to ensure that the investment cost equals the savings value.

For the government balance, the closure used is that government savings is a flexible residual, whereas all tax rates are fixed. Since one of the government goals is to reduce its deficit, this choice seems to be the appropriate one.

For the external balance, which is expressed in foreign currency, the closure is that the real exchange rate is flexible, while foreign savings are fixed. Given that all other items, as transfers between the rest of the world and domestic institutions, are fixed in the external balance, the trade balance is also fixed.

Thus, if foreign savings are below the exogenous level, a depreciation of the real exchange rate would correct this situation by simultaneously reducing spending on imports and increasing earnings from exports. The last because of an increase in export quantities at fixed world prices.

3.1.6 Elasticities

Five different types of elasticities are introduced in the model: the Armington substitution elasticities, the factor substitution elasticities, the transformation elasticities, the income elasticities of demand and the output aggregation elasticity for each commodity. These elasticities are included in annex A.2.

For the Armington hypothesis of imperfect substitution between national and imported commodities, a CES function has been specified. The trade elasticities for this specification have been obtained from Dimaranan (2002).

Another group of elasticities are the factor substitution elasticities. As mentioned before, primary factors of production are assumed to substitute for one another according to constant elasticities of substitution. Like trade elasticities, these have been taken from the SALTER model. CET substitution elasticities between exported and domestically marketed output are the third group of elasticities considered in the model. These elasticities have been taken from the Andersen and Faris CGE model (Andersen and Faris, 2002a).

Income elasticities of demand have been also taken from the Dimanaran et al. (2002). Since no estimation of these elasticities have been made for Bolivia, elasticities for other countries of the region such as Colombia, Peru, Argentina, and Chile have been taken as proxies.

For the output aggregation elasticities, no suggested values have been found for the country. An arbitrary value of 4 has been assigned to this elasticity for all commodities, taken from the LHR model.

Finally, the Frisch parameter used to determinate subsistence consumptions has been set at -2. In fact there is no Frisch parameter estimation for Bolivia, and the -2 value has been taken from the LHR model for poor countries. There are also estimations that for countries with per-capita GDP of about $500 correspond a Frisch parameter that ranges from -5.0 to -1.6. (Dervis et al. 1982).

3.2 The Bolivian SAM

Although a lot of work has been done in the SAM for its use in the model, we will be brief in this section and describe only the most important particularities of the matrix and its modifications.

The Social Accounting Matrix (SAM) of Bolivia was developed by CIESS -

ECONOMETRICA, for the year 2000 using national accounts. The original matrix was modified for later calibration of the CGE model. These changes are described below, and the structure of the SAM is in the appendix.

The original SAM presented 36 activities and 36 commodities. Imputed bank services, the services borrowers purchase from banks in order to obtain a loan (interests), had to be removed and treated as final consumption. Since distribution of these services among activities is not available, it is not possible to consider them as an activity input; hence the modified SAM is composed of 35 activities and 35 commodities.

Commercial margins, the service from moving commodities from producers to demanders is treated as an intermediate input and not as a payment from commodities as represented in the original SAM.

Capital has been disaggregated in three different kinds of capital: Land, natural resources and physical capital, hereafter just called capital. This is important since the first two are specific for agricultural and oil and gas sectors, respectively. For non-industrial agriculture and coca activities, the totality of capital revenue is attributed to land revenue; while for industrial agriculture, shares of land and capital in total capital have been obtained from the Hertel and Tsigas (2002) estimations (1991). These shares are 53% for land and 47% for capital.

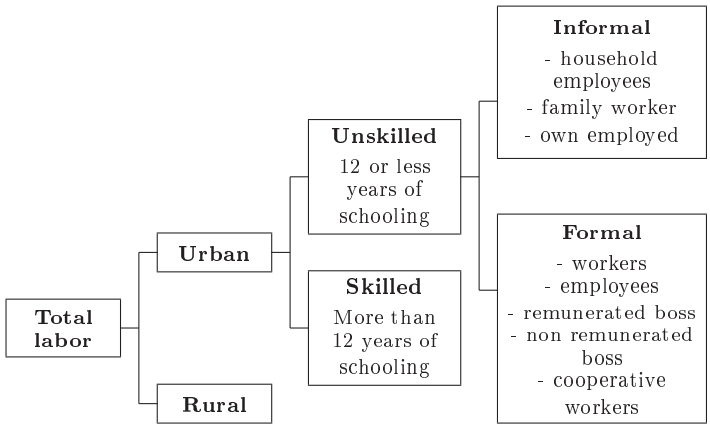
The value imputed to natural resources in the matrix is given by the royalties paid to the government for their exploitation. These royalties are 18% of a price negotiated between the Bolivian government and the enterprise that holds the right to exploit and commercialise the natural resource. An approximated value has been calculated using data of gas exports from the Bolivian Statistics Institute (INE,2003). The calculated value is 511 millions of Bolivianos, about 27.4% of the capital revenue for 2000.

Labor has been also disaggregated, using the MECOVI household survey, in: (a) rural, (b) skilled urban, (c) unskilled urbans in formal market and (d) unskilled urbans in informal markets. The criteria used for the disaggregation is illustrated in figure 4.

Only one representative household is considered. It's clear that this is very restrictive, but the lack of detailed information of flows from other institutions to the different households has forced to consider only one type of representative household.

Stock changes are especially high for the oil and gas sector. If we try to find long run equilibrium, such stock accumulation would create an important distortion; thus, stock exchange has been added to exports. The justification of this can be found in the particularity of this commodity. Natural gas is mainly exported, and the big contract that Bolivia has signed with Brazil to sell 7.1 trillion of cubic feet (TCF) from 1999 to 2019 has motivated the country to stock natural gas in order to respect the contract. Once oil and gas stock are

Figure 4. Labor disaggregation



moved to exports.

Finally, flows from institutions to the same institutions have been eliminated.

Chapter 4

Simulations and Results

This chapter describes the scenario capturing the expansion of the natural gas and the results obtained.

We will simulate the impact of an expansion of the oil and gas sector. The split of capital in natural resources and other capital for this sector is crucial to introduce the shock. To expand the oil and gas sector, we'll assume an increase of the natural resource supply. Since natural resources is in the Leontief function at the top of the technology nest, all increases of natural resources will expand the sector in the same proportion. This specification is consistent with the hypothesis that oil and gas sector expands only if the exploitation of the natural resources increases.

The 2000 SAM was constructed using the exports quantities for that year: 2116 millions of cubic meters. Once the stock changes moved to exports, as described in the SAM section, the new gas exports value corresponds to a volume of 10270 millions of cubic meters, which is approximately the contracted annual exports of natural gas for the next 16 years. (Andersen et al, 2002 a.)

The project to export this natural resource to the United States considers exports of 30 millions of cubic meters every day, or 10950 millions of cubic meters every year. This represents an increase of more than 100% of the current exports. Such an enormous change introduced at once in the model could entail incomprehensible results. So, we prefer to make several simulation introducing in each one increasing shocks of natural resources expansion.

Since high stock accumulation can be the origin of biases in simulations, they are reduced to zero before the shock is introduced in the model. Once stock changes are eliminated, using the model, new values are measured and considered as *base values*.

In a second step, shocks are introduced and results of five simulations, Sim1 to Sim5, are presented below, representing increases of 5%, 10%, 40%, 70% and 100% of the natural resource respectively.

Table 3: Aggregate Results (Percentage Change with respect to the *base* simulation)

Natural Resource Increase	sim1 5%	sim2 10%	sim3 40%	sim4 70%	sim5 100%
GDP	0.2	0.3	1.2	2.1	2.9
Private consumption	0.1	0.2	0.8	1.4	2.2
Investment	0.1	0.2	1.1	1.3	-0.6
Government income	0.1	0.2	1.0	1.3	0.4
Exports	0.0	0.1	0.5	1.1	2.2
Oil and gas	5.3	10.5	42.1	73.6	105.1
Mining	-5.9	-11.7	-44.0	-67.8	-80.1
Food products	-0.3	-0.7	-4.7	-15.6	-35.5
Base metals	-8.3	-16.5	-61.6	-90.0	-97.3
Industrialized agriculture	-0.3	-0.6	-3.4	-10.1	-23.4
Textiles	-0.4	-0.7	-3.8	-10.8	-23.1
Factor prices					
skilled	0.3	0.6	2.5	4.5	6.8
unskilled formal	0.0	0.0	0.0	0.0	0.0
unskilled informal	0.0	0.0	-0.1	0.2	1.1
rural	-0.2	-0.4	-1.6	-2.4	-2.5
capital	0.1	0.2	0.6	1.5	3.2
land	0.0	-0.1	-1.0	-4.3	-10.7
natural resource (gas, oil)	-0.5	-1.0	-4.9	-14.3	-33.6
Change in demand for unskilled labor					
formal sector	-0.2	-0.3	-1.4	-2.0	-1.9
informal sector	0.2	0.4	1.6	2.3	2.2
Real exchange rate	-0.0	-0.0	-0.3	-1.1	-2.9

Results show that, in spite of large increase in gas exports, overall exports increases very little (2.2%). This is because almost all other exports decrease. Exports structure in the base scenario and in the five simulations are shown in the table below. As we can see, oil and gas exports increases from 31% in the *base* simulation to a little more than 62% of total exports, while the share in total exports of other commodities decrease. In particular mining drops to one fifth of its participation in total exports. This shows us one booming sector and several lagged sectors, and a formalized explanation of this phenomenon can be found in Corden (1984).

The real exchange rate decreases, hence national currency appreciates in real terms. Both changes, decreases in other exports and local currency appreciation, suggest Dutch disease effects.

GDP increases almost 3% and Investment drops 0.6% for the last simulation. For the first four simulations investment increases though very little. It is important to recall some implicit hypothesis of model. First of all, it is a static model, hence it doesn't consider factor accumulation following investments.

Table 4: Exports Structure (In Percentage of Total Exports)

	base	sim1	sim2	sim3	sim4	sim5
Oil and gas	30.9	32.6	34.2	43.8	53.1	62.1
Mining	15.6	14.7	13.8	8.7	5.0	3.0
Food products	14.7	14.6	14.6	13.9	12.3	9.3
Base metals	7.3	6.7	6.1	2.8	0.7	0.2
Industrialized agriculture	4.8	4.8	4.8	4.6	4.3	3.6
Textiles	3.3	3.3	3.3	3.2	2.9	2.5

Besides, the demand for capital in the natural gas sector is supplied by the existent capital in the economy. Since we assume in the model that factors are free to move across activities, capital intensive sectors can be expected to shrink following capital absorption of the oil and gas sector. Changes in activity levels of all sectors are included in annexe A.4, and the intensities of factors in the activity in annexe A.5.

An alternative scenario would be to consider an exogenous (international) capital inflow in the economy to compensate the increasing capital demand of the sector. Since gas resources are mainly in foreign enterprises hands, this scenario would match better the reality. For now we will stay in the former scenario of no exogenous capital inflows which might match better a short run impact.

Changes in Government income depend on the level of the natural resource increase shock. For the first four shocks government income increases with the size of the shock, and then it decreases for the last simulation. A possible explanation is that since most other sectors activities shrink, tax incomes also shrink.

Factor price changes are also important: While skilled labor, unskilled informal labor and capital incomes increase, rural labor and land income decrease. Since a hypothesis of minimal wage for unskilled formal labor is assumed, wages for this type of labor remain unchanged in terms of the CPI. Results show that skilled labor and capital owners are the ones who experience higher income increases, 6.8% and 3.2% respectively. On the other hand, income of rural labor and land owners fall, -2.5% and -10.7% respectively. This suggests an increase of inequality, but further analysis should be done to measure the changes in income distribution.

Finally, migration of unskilled labor from formal sector to informal sector is also observed among the results. This reflects that indirect effects of shocks are more important than direct effects. In fact we can expect that an increase in the gas sector, which works only in the formal economy, generates a bigger demand for labor. However, the contraction of other formal labor intensive sectors, and the expansion of some informal labor intensive sectors, such as transport and housing services have larger effects on unskilled labor migration.

Chapter 5

Conclusions

This study has applied a CGE model to illustrate the changes that may arise following an increase of a natural resource. It shows that several side effects are likely to happen if Bolivia decides to export natural gas to the United States. Three major effects besides the expansion of the oil and gas sector have been observed: (a) most other sectors contract following the natural gas boom, (b)natural gas crowds out the other exports, and (c) there are important changes in wage, and considering their sign and magnitude, they suggest an increase in inequality.

To export natural gas could be a solution to relief the government deficit, but it is clear that side effects can by harmful. Other side effects not considered by the model could be: (a) rent seeking behavior, (b) false sense of security and (c) poor investment in human capital, which could be very harmful for the country (Gylfason, 2001). An efficient public management is a condition in order to avoid these possible side effects.

We must mention that the static nature of the model and its restrictive hypothesis don't allow us to use results as forecasting values. However, it is rather a good instrument which helps us to have a better view of the country's overall economy, and to reveal direct and indirect effects that a specific shock may generate in Bolivia's economy. The model can also be useful to compare alternative scenarios. For instance, new projects for natural gas utilisation have arisen after last month's political and social problems; most of them suggesting local utilisation of the resource in industries.

To exit a bit from the macroeconomic panorama, this model can be linked to a microeconometric model to expand the analysis to a household level (Bourguignon et al. 2003). This is possible since the SAM has been disaggregated using a household survey. As we have mentioned, results suggest an increase of income inequality. Its magnitude can be calculated through the link of the CGE model to a microeconometric model; which can be a next step of the present study.

Appendix

A.1 CEG Model equations

A.1.1 Sets, parameters and variables

Sets

A	Activities
C	Commodities
F	Factors
UNSK	Unskilled labor, UNSK $\subset$ F
INSD	Institutions domestique
INSDNG	Domestic non-government institutions, INSDNG $\subset$ INSD

Parameters

$cwts_c$	weight of commodity c in the *CPI*
$dwts_c$	weight of commodity c in the producer price index *(DPI)*
ica_{ca}	quantity of c as intermediate input per unit of activity a
$inta_c$	quantity of aggregate intermediate input per activity unit
iva_a	quantity of value-added per activity unit
$\overline{mps}_i$	base savings rate for domestic institutions i
pwe_c	export price (foreign currency)
pwm_c	import price (foreign currency)
$qdst_c$	quantity of stock change
$\overline{qg}_c$	base-year quantity of government demand
$\overline{qinv}_c$	base-year quantity of private investment demand
$shif_{if}$	share for domestic institution i in income of factor f
$shii_{ii'}$	share of net income of institution i' to institution i
ta_a	tax rate for activity a
tf_f	direct tax rate for factor f
$\overline{tins}_i$	exogenous direct tax rate for domestic institution i
tm_c	import tariff rate
tq_c	rate of sales tax
$trnsfr_{if}$	transfer from factor f to institution i

$trnsfr_{ii'}$	transfer of institution i' (government, rest of the world) to institution i
α_c^{ac}	shift parameter for domestic commodity aggregation function
α_a^{va}	shift parameter for domestic commodity aggregation function
α_c^q	Armington function shift parameter
α_c^t	CET function shift parameter
β_{ch}	marginal share of consumption spending on commodity c for household h
γ_{ch}	subsistence consumption of commodity c for household h
δ_{ac}^{ac}	share parameter for domestic commodity aggregation function
δ_c^q	Armington function share parameter
δ_c^t	CET function share parameter
δ_{fa}^{va}	CES value-added function share parameter for factor f in activity a
$\theta_a c$	yield of output c per unit of activity a
ρ_a^{va}	CES value-added function exponent
ρ_a^{ac}	domestic commodity aggregation function exponent
ρ_c^q	Armington function exponent
ρ_c^t	CET function exponent

Exogenous variables

$\overline{CPI}$	consumer price index
$\overline{FSAV}$	foreign savings in foreign currency units *(FCU)*
$\overline{GADJ}$	government consumption adjustment factor
MPS	marginal propensity to save for domestic non-government institutions
$\overline{QFS}_f$	quantity supplied of factor f
$TINS_i$	direct tax rate for institution i

Endogenous variables

DPI	producer price index for domestically marketed output
EG	government expenditures
EH_h	consumption spending for houshold
EXR	exchange rate (local currency units, LCU, per unit of FCU
$GSAV$	government savings
$IADJ$	investment adjustment factor
PA_a	output price of activity a
PDD_c	demand price for commodity produced and sold domestically
PDS_c	supply price for commodity produced and sold domestically
PE_c	export price in LCU
$PINTA_a$	aggregate intermediate input price for activity a
PM_c	import price in LCU
PQ_c	composite commodity price
PVA_a	value-added price (factor income per unit of activity)
PX_c	aggregate producer price for commodity
$PXAC_{ac}$	producer price of commodity c for activity a
QA_a	quantity (level) of activity
QD_c	quantity sold domestically of domestic output

QE_c	quantity of exports
QF_{fa}	quantity demanded of factor f from activity a
QG_c	government consumption demand for commodity
QH_{ch}	quantity consumed of commodity c by household h
$QINTA_a$	quantity of aggregate intermediate input
$QINT_{ca}$	quantity of commodity c as intermediate input to activity a
$QINV_c$	quantity of investment demand for commodity
QM_c	quantity of imports of commodity
QQ_c	quantity of goods supplied to domestic market (composite supply)
QVA_a	quantity of (aggregate) value-added
QX_c	aggregated marketed quantity of domestic output of commodity
$QXAC_{ac}$	quantity of marketed output of commodity c from activity a
$TRII_{ii'}$	transfers from institution i' to i (both in *INSDNG*
WF_f	average price of factor f
YF_f	income of factor f
YG	government revenue
YI_i	income of domestic non-government institution
YIF_{if}	income to domestic institution i from factor f

A.1.2 Price block

Import Price

$$PM_c = pwm_c \cdot (1 + tm_c) \cdot EXR \tag{A.1}$$

Export Price

$$PE_c = pwe_c \cdot EXR \tag{A.2}$$

Demand Price of domestic non-traded goods

$$PDD_c = PDS_c \tag{A.3}$$

Absorption

$$PQ_c \cdot (1 - tq_c) \cdot QQ_c = PDD_c \cdot QD_c + PM_c \cdot QM_c \tag{A.4}$$

Marketed output value

$$PX_c \cdot QX_c = PDS_c \cdot QD_c + PE_c \cdot QE_c \tag{A.5}$$

Activity price

$$PA_a = \sum_{c \in C} PXAC_{ac} \cdot \theta_{ac} \tag{A.6}$$

Aggregate intermediate input price

$$PINTA_a = \sum_{c \in C} PQ_c \cdot ica_{ca} \tag{A.7}$$

Activity revenue and costs

$$\begin{aligned} PA_a \cdot (1 - ta_a) \cdot QA_a &= PVA_a \cdot QVA_a \\ &+ PFR_a \cdot QFRO_a + PINTA_a \cdot QINTA_a \end{aligned} \tag{A.8}$$

$QFR0_a = 0 \; \forall a \neq$ oil and gas

Consumer price index

$$\overline{CPI} = \sum_{c \in C} PQ_c \cdot cwts_c \tag{A.9}$$

Producer price index for nontraded market output

$$DPI = \sum_{c \in C} PDS_c \cdot dwts_c \tag{A.10}$$

A.1.3 Production and trade block

Leontief technology: Demand of aggregate value-added

$$QVA_a = iva_a \cdot QA_a \tag{A.11}$$

Leontief technology: Demand of aggregate intermediate input

$$QINTA_a = inta_a \cdot QA_a \tag{A.12}$$

Leontief technology: Demand for natural resource

$$QFRO_a = ifr_a \cdot QA_a \tag{A.13}$$

Value-added and factor demands

$$QVA_a = \alpha_a^{va} \cdot \left(\sum_{f \in F} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-\frac{1}{\rho_a^{va}}} \tag{A.14}$$

Factor demand

$$WF_f = PVA_a \cdot QVA_a \cdot \left(\sum_{f \in F^t} \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}} \right)^{-1} \cdot \delta_{fa}^{va} \cdot QF_{fa}^{-\rho_a^{va}-1} \tag{A.15}$$

Unskilled labor wage level

$$WF_f = minwage \tag{A.16}$$

f = unskilled urban labor in formal sector

Disaggregated intermediate input demand

$$QINT_{ca} = ica_{ca} \cdot QINTA_a \tag{A.17}$$

Commodity production and allocation

$$QXAC_{ac} = \theta_{ac} \cdot QA_a \tag{A.18}$$

Output aggregation function

$$QX_c = \alpha_c^{ac} \cdot \left(\sum_{a \in A'} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-\frac{1}{\rho_c^{ac}}} \tag{A.19}$$

First-order condition for output aggregation function

$$PXAC_{ac} = PX_c \cdot QX_c \cdot \left(\sum_{a \in A'} \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}} \right)^{-1} \cdot \delta_{ac}^{ac} \cdot QXAC_{ac}^{-\rho_c^{ac}-1} \tag{A.20}$$

Ouput transformation (CET) function

$$QX_c = \alpha_c^t \cdot \left(\delta_c^t \cdot QE_c^{\rho_c^t} + (1 - \delta_c^t) \cdot QD_c^{\rho_c^t} \right)^{\frac{1}{\rho_c^t}} \tag{A.21}$$

Export-domestic supply ratio

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PDS_c} \cdot \frac{1 - \delta_c^t}{\delta_c^t} \right)^{\frac{1}{\rho_c^t - 1}} \tag{A.22}$$

Output transformation for non-exported or only exported, but not both commodities

$$QX_c = QD_c + QE_c \tag{A.23}$$

Composite supply (Armington) function

$$QQ_c = \alpha_c^q \cdot \left(\delta_c^q \cdot QM_c^{-\rho_c^q} + (1 - \delta_c^q) \cdot QD_c^{-\rho_c^q} \right)^{-\frac{1}{\rho_c^q}} \tag{A.24}$$

Import-domestic demand ratio

$$\frac{QM_c}{QD_c} = \left(\frac{PDD_c}{PM_c} \cdot \frac{\delta_c^q}{1-\delta_c^q}\right)^{\frac{1}{1+\rho_c^q}} \tag{A.25}$$

Composite supply for non-imported outputs and nonproduced imports

$$QQ_c = QD_c + QM_c \tag{A.26}$$

A.1.4 Institution block

Factor income

$$YF_f = \sum_{a \in A} WF_f \cdot QF_{f\ a} \tag{A.27}$$

Institutional factor incomes

$$YIF_{i\ f} = shif_{i\ f}\left[YF_f - trnsfr_{row\ f} \cdot EXR - YBS\right] \tag{A.28}$$

Income of domestics, nongovernement institutions

$$\begin{aligned} YI_i = &\sum_{f \in F} YIF_{i\ f} + \sum_{i' \in INSDNG'} TRII_{i\ i'} \\ &+ trnsfr_{i\ gov} \cdot \overline{CPI} + trnsfr_{i\ row} \cdot EXR \end{aligned} \tag{A.29}$$

Intra-institutional tranfers

$$TRII_{i\ i'} = shii_{i\ i'} \cdot (1 - MPS_{i'}) \cdot (1 - TINS_{i'}) \cdot YIh \tag{A.30}$$

Household consumption demand for marketed commodities

$$PQ_c \cdot QH_{c\ h} = PQ_c \cdot \gamma_{c\ h} + \beta_{c\ h} \cdot \left(EH_h - \sum_{c' \in C} PQ_{c'} \cdot \gamma^m_{c'\ h}\right) \tag{A.31}$$

Household consumption expenditure

$$\begin{aligned} EH_h = &\left(1 - \sum_{i \in INSDNG} shii_{i\ h}\right) \\ &\cdot (1 - MPS_h) \cdot (1 - TINS_h) \cdot YI_h \end{aligned} \tag{A.32}$$

Imputed bank services income

$$YBS = tibs \cdot YF_{capital} \tag{A.33}$$

Payment of bank services to financial services

$$QBS_c = YBS/PQ_c \tag{A.34}$$

c =financial services

Investment demand

$$QINV_c = IADJ \cdot \overline{qinv_c} \tag{A.35}$$

Government consumption demand

$$QGc = \overline{GADJ} \cdot \overline{qg_c} \tag{A.36}$$

Government revenue

$$\begin{aligned} YG = & \sum_{i \in INSDNG} TINS_i \cdot YI_i + \sum_{f \in F} tf_f \cdot YF_f \\ & + \sum_{a \in A} ta_a \cdot PA_a \cdot QA_a + \sum_{c \in CM} tm_c \cdot pwm_c \cdot QM_c \cdot EXR \\ & + \sum_{c \in C} tq_c \cdot PQ_c \cdot QG_c + \overline{QFR} \cdot PFR + trnsfr_{gov\ row} \cdot EXR \end{aligned} \tag{A.37}$$

Government expenditures

$$EG = \sum_{c \in C} PQ_c \cdot QG_c + \sum_{i \in INSDNG} trnsfr_{i\ gov} \cdot \overline{CPI} \tag{A.38}$$

A.1.5 Constraints

Factor Market (skilled labor, rural labor and capital)

$$\sum_{a \in A} QF_{f\ a} = \overline{QFS}_f \tag{A.39}$$

Unskilled Labor Market

$$\sum_{unsk} \sum_{a \in A} QF_{unsk\ a} = \overline{QFS}_{unsk} \tag{A.40}$$

Composite commodity markets

$$\begin{aligned} QQ_c = & \sum_{a \in A} QINT_{c\ a} + \sum_{h \in H} QH_{c\ h} + QG_c \\ & + QINV_c + qdst_c + QT_c \end{aligned} \tag{A.41}$$

Current account balance for rest of the world (in foreign currency)

$$\sum_c pwm_c \cdot QM_c + \sum_{f \in F} trnsfr_{row\ f} = \sum_{c \in CE} pwe_c \cdot QE_c + \sum_{i \in INSD} trnsfr_{i\ row} + \overline{FSAV} \tag{A.42}$$

Government balance

$$YG = EG + GSAV \tag{A.43}$$

Direct institutional tax rates

$$TINS_i = \overline{tins_i} \tag{A.44}$$

Institutional savings rates

$$MPS_i = \overline{mps_i} \tag{A.45}$$

Saving-Investment Balance

$$\sum_{i \in INSDNG} MPS_i \cdot (1 + TINS_i) \cdot YI_i + GSAV + EXR \cdot \overline{FSAV} = \sum_{c \in C} PQ_c \cdot QINV_c + \sum_{c \in C} PQ_c \cdot qdst_c \tag{A.46}$$

A.2 Elasticities

Commodities Activities	Commodities elasticities				Activities elasticities
	σ_q	σ_t	ϵ	τ	σ_a
Non-industrialized agriculture	2.2	4	0.21	4	0.24
Industrialized agriculture	2.2	4	0.58	4	0.24
Coca	2.2	4	0.21	4	0.24
Livestock production	2.8	4	0.21	4	0.24
Timber hunting and fishing	2.8	4	0.21	4	0.20
Oil and natural gas	2.8	2	1	4	0.20
Mining	2.8	4	1	4	0.20
Meat and processed meat	2.2	4	0.57	4	1.12
Dairy products	2.2	4	0.56	4	1.12
Baking and grain mill products	2.2	4	0.21	4	0.24
Sugar and confiture	2.2	4	0.58	4	1.12
Food products	2.2	4	0.58	4	1.12
Beverages	3.1	4	0.89	4	1.12
Processed Tabacco	3.1	4	0.89	4	1.12
Textiles	2.2	4	0.84	4	1.26
Wood and wood products	2.8	4	1.21	4	1.26
Paper and paper products	1.8	4	1.21	4	1.26
Chemical products	1.9	4	1.21	4	1.26
Processed oil products	1.9	4	1.21	4	1.26
Non-metallic minerals products	2.8	4	1.21	4	1.26
Base metals	2.8	4	1.21	4	1.26
Machinery and equipment	2.8	4	1.21	4	1.26
Other manufactures	2.8	4	1.21	4	1.26
Electricity gas and water	2.8	4	1.01	4	1.26
Construction	1.9	4	1	4	1.40
Trade	1.9	4	1.20	4	1.68
Transport and storage	1.9	4	1.20	4	1.68
Communications	1.9	4	1.24	4	1.26
Financial services	1.9	4	1.24	4	1.26
Company services	1.9	4	1.24	4	1.26
Property	1.9	4	1.24	4	1.26
Local, social and personal services	1.9	4	1.24	4	1.26
Restaurants and hotels	1.9	4	1.24	4	1.26
Domestic services	1.9	4	1.24	4	1.26
Public sector	1.9	4	1.24	4	1.26

where σ_q are the substitution elasticities between domestic and imported commodities; σ_t are the elasticities of transformation between domestic marketed and exported commodities; ϵ are the expenditure elasticities; τ are the aggregation elasticities of each commodity; and σ_a are the factor substitution elasticity for each activity.

A.3 Bolivian Social Accounting Matrix structure

The Bolivian Social Accounting Matrix used in the model is composed of:

35 Activities and 35 Commodities

1. Non-industrialized agriculture
2. Industrialized agriculture
3. Coca
4. Livestock production
5. Timber hunting and fishing
6. Oil and natural gas
7. Mining
8. Meat and processed meat
9. Dairy products
10. Baking and grain mill products
11. Sugar and confiture
12. Food products
13. Beverages
14. Processed Tabacco
15. Textiles
16. Wood and wood products
17. Paper and paper products
18. Chemical products
19. Processed oil products
20. Non-metallic minerals products
21. Base metals
22. Machinery and equipment
23. Other manufactures
24. Electricity gas and water
25. Construction
26. Trade
27. Transport and storage
28. Communications
29. Financial services
30. Company services
31. Property
32. Local, social and personal services
33. Restaurants and hotels
34. Domestic services
35. Public sector

7 Production factors

1. Skilled labor
2. Unskilled labor in formal sector
3. Unskilled labor in informal sector
4. Rural labor
5. Capital
6. Land
7. Natural resources

3 Domestic institutions

1. Households 2. Enterprises 3. Government

Imputed bank services

Savings and Investment

Rest of the world

Its structure is represented in the table of the next page.

Social Accounting Matrix (SAM) for Bolivia

	Expenditures										
Receipts	**Activities**	**Commodities**	**Factors**	**Natural Resources (NR)**	**Households**	**Enterprises**	**Government**	**Bank Services**	**Savings Investment**	**Rest of the World (ROW)**	**Total**
Activites		Marketed output			Home-consumed output						Activity income (gross output)
Commodities	Intermediate inputs	Transaction costs			Private consumption		Government consumption	Bank Services absortion	Investment	Exports	Demand
Factors	Value-added									Factor income from ROW	Factor income
NR	NR income										NR income
Household			Factor income to households		Interhousehold transfers	Surplus to households	Transfers to households			Transfer to households from ROW	Household income
Enterprises			Factor income to enterprises				Transfers to enterprises			Transfers to enterprises from ROW	Household income
Government	Producer taxes, value-added tax	Sales taxes, tariffs, export taxes	Factor income to government factor taxes	Royalties	Transfers to government, direct	Surplus to government, direct enterprise taxes				Transfer to government from ROW	Government income
Bank Services			Imputed Bank Services								Imputed Bank Services
Savings-Investment					Household savings	Enterprise savings	Government savings			Foreign savings	Savings
Rest of the World (ROW)		Imports	Factor income to ROW			Surplus to ROW	Government transfers to ROW				Foreing exchange outflow
Total	Activity	Supply expenditures	Factor expenditures	Royalties	Household expenditures	Enterprise expenditures	Government expenditures	Bank Services	Investment	Foreign exchange inflow	

A.4 Changes in level of domestic activity

Percentage Change with respect to the *base* simulation

Activites	SIM1	SIM2	SIM3	SIM4	SIM5
Non-industrialized agriculture	0.000	0.001	0.005	0.014	0.032
Industrialized agriculture	-0.002	-0.005	-0.030	-0.098	-0.227
Coca	0.001	0.001	0.005	0.013	0.027
Livestock production	0.000	0.001	0.003	0.002	-0.003
Timber hunting and fishing	-0.003	-0.006	-0.026	-0.052	-0.086
Oil and natural gas	0.050	0.100	0.400	0.700	1.000
Mining	-0.058	-0.115	-0.431	-0.658	-0.765
Meat and processed meat	0.001	0.001	0.004	0.006	0.006
Dairy products	0.000	0.001	0.001	-0.002	-0.010
Baking and grain mill products	0.000	0.000	0.001	0.001	-0.002
Sugar and confiture	0.000	0.001	0.000	-0.007	-0.026
Food products	-0.003	-0.006	-0.041	-0.139	-0.318
Beverages	0.001	0.002	0.006	0.007	0.006
Processed Tabacco	0.000	0.001	0.002	-0.002	-0.013
Textiles	-0.001	-0.002	-0.013	-0.042	-0.096
Wood and wood products	-0.002	-0.004	-0.020	-0.051	-0.100
Paper and paper products	-0.001	-0.002	-0.010	-0.026	-0.055
Chemical products	-0.003	-0.005	-0.024	-0.053	-0.097
Processed oil products	0.015	0.029	0.110	0.180	0.238
Non-metallic minerals products	0.001	0.003	0.009	0.004	-0.025
Base metals	-0.081	-0.161	-0.605	-0.888	-0.963
Machinery and equipment	0.000	-0.001	-0.007	-0.026	-0.068
Other manufactures	-0.021	-0.042	-0.185	-0.403	-0.614
Electricity gas and water	0.000	0.000	-0.002	-0.002	0.000
Construction	0.002	0.004	0.015	0.020	0.005
Trade	0.000	0.000	-0.001	-0.011	-0.031
Transport and storage	0.004	0.008	0.029	0.043	0.049
Communications	-0.001	-0.003	-0.012	-0.029	-0.057
Financial services	-0.001	-0.001	-0.005	-0.008	-0.011
Company services	0.003	0.005	0.020	0.029	0.028
Property	0.001	0.002	0.007	0.011	0.013
Local, social and personal services	0.001	0.002	0.008	0.013	0.017
Restaurants and hotels	0.001	0.002	0.007	0.011	0.012
Domestic services	0.001	0.003	0.011	0.019	0.026
Public sector	0.000	0.000	0.000	0.000	0.001

A.5 Factor intensities in activities before shock

Activites	SKILL	UNSK-F	UNSK-I	RURAL	CAP.	LAND	N.RES.
Non-industrialized agriculture	0.001	0.003	0.015	0.094		0.887	
Industrialized agriculture	0.062	0.017		0.082	0.381	0.458	
Coca	0.015	0.015	0.022	0.349		0.599	
Livestock production	0.016	0.005	0.014	0.102	0.863		
Timber hunting and fishing	0.032	0.009	0.002	0.044	0.913		
Oil and natural gas	0.223	0.008		0.001	0.555		0.213
Mining	0.075	0.084	0.011	0.059	0.770		
Meat and processed meat	0.090	0.116	0.017		0.777		
Dairy products	0.480	0.234	0.009		0.278		
Baking and grain mill products	0.125	0.065	0.151	0.029	0.631		
Sugar and confiture	0.317	0.067		0.126	0.490		
Food products	0.141	0.054	0.042	0.015	0.748		
Beverages	0.259	0.108	0.010	0.006	0.617		
Processed Tabacco		0.100	0.007		0.893		
Textiles	0.264	0.194	0.089	0.019	0.434		
Wood and wood products	0.079	0.310	0.028	0.097	0.486		
Paper and paper products	0.212	0.214	0.003		0.571		
Chemical products	0.231	0.124		0.008	0.637		
Processed oil products	0.076				0.924		
Non-metallic minerals products	0.156	0.136	0.066	0.030	0.612		
Base metals	0.393	0.159			0.448		
Machinery and equipment	0.137	0.230	0.109	0.018	0.506		
Other manufactures	0.184	0.124	0.027	0.071	0.595		
Electricity gas and water	0.189	0.018		0.006	0.786		
Construction	0.201	0.137	0.128	0.028	0.546		
Trade	0.131	0.040		0.019	0.681		
Transport and storage	0.253	0.090	0.131	0.045	0.481		
Communications	0.456	0.028		0.001	0.516		
Financial services	0.555	0.014			0.431		
Company services	0.304	0.018	0.005	0.002	0.671		
Property					1.000		
Local, social and personal services	0.409	0.064	0.059	0.013	0.456		
Restaurants and hotels	0.100	0.074	0.166	0.026	0.634		
Domestic services	0.070		0.859	0.072			
Public sector	0.801	0.084		0.115			

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