working paper
2020-08

Exchange-Rate Policy in a Dollarized Economy: Implications for Growth and Employment in Bolivia

Martin Cicowiez
Carlos Gustavo Machicado
Beatriz Muriel
Alejandro Herrera Jiménez
Alejandra Goytia

February 2020

pep
partnership for economic policy

PAGE
policy analysis on growth and employment

Exchange-Rate Policy in a Dollarized Economy: Implications for Growth and Employment in Bolivia

Abstract

We analyzed the impact of currency devaluation on the Bolivian economy, employing a dynamic and extended version of the PEP 1-1 standard model to simulate effects impact on both the main macroeconomic aggregates and the financial stocks and flows of economic agents. We built a new Financial Social Accounting Matrix for the year 2014 and calibrated the model to it. Besides simulating a devaluation of the nominal exchange rate, we also analyzed a policy-response scenario, an external-shock scenario, and a gradual-devaluation scenario. In the policy-response scenario, devaluation was accompanied by a reduction in government expenses (fiscal adjustment); in the external-shock scenario, devaluation came with an increase in the export price of gas (main export commodity); and, in the gradual-devaluation scenario, the exchange-rate policy relaxed gradually. The external-shock scenario dominated the other scenarios in terms of higher average growth and less average unemployment. The fiscal-adjustment scenario, however, dominated in terms of inflation, though it implied an inflationary shock in 2020.

JEL: C68, E61, O24, O54.

Keywords: Foreign exchange policy, macroeconomic policy, CGE modelling, Bolivia

Authors

Martin Cicowiez
Economist, Ph.D., CEDLAS
Universidad Nacional de la Plata
Argentina
martin@depeco.econo.unlp.edu.ar

Beatriz Muriel
Economist, Ph.D., INESAD
La Paz, Bolivia
bmuriel@inesad.edu.bo

Alejandra Goytia
Economist, B.A., INESAD
La Paz,-Bolivia
agoytiarios@gmail.com

Carlos Gustavo Machicado S.
Economist, Ph.D., INESAD
La Paz, Bolivia
cmachicado@inesad.edu.bo

Alejandro Herrera Jiménez
Economist, M.Sc., INESAD
La Paz, Bolivia
pr_alehjbol@hotmail.com

Acknowledgements

This research work was carried out with financial and scientific support from the Partnership for Economic Policy (PEP) (www.pep-net.org) with funding from the Department for International Development (DFID) of the United Kingdom (or UK Aid) and the Government of Canada through the International Development Research Center (IDRC). The authors are grateful to Bernard Decaluwé for technical support and guidance.

Table of Contents

List of tables

List of figures

List of abbreviations

GDP	Gross Domestic Product
MDRI	Multilateral Debt Relief Initiative
NFPS	Non-Financial Public Sector
SAM	Social Accounting Matrix
F-SAM	Financial Social Accounting Matrix
PEP	Partnership for Economic Poverty
GAMS	General Algebraic Modelling System
LDC	Less Developed Countries
LCU	Local Currency Units
FCU	Foreign Currency Units
BAU	Business as Usual

I. Introduction

Bolivia's modern economic history starts in 1952, after the economic reforms that followed the National Revolution. In the sixty-seven years since then, two periods have been marked by the most rapid growth: 1958-1978 and 2006-2018. In both periods, real GDP grew by around 5%. Bolivia adopted a fixed exchange rate from 1960 to 1978, which covered the entire Bretton Woods experience (1960-1971). The nominal exchange rate devalued in 1972 but then once again remained fixed from 1973 to 1978. According to Kehoe, Machicado, and Perez-Cajias (2019), in July 1978 a balance-of-payments crisis began of the sort analyzed by Krugman (1979). The government had no option other than to devalue in 1979 because net international reserves were falling. In fact, net international reserves as a share of GDP had begun falling in 1978 and, by 1979, already represented a negative share of GDP. Because reserves fell continuously and abruptly, the balance of payment crisis was inevitable.

Since November 2011, Bolivia has adopted a fixed exchange rate—a de facto rate because the central bank never affirmed that the crawling-peg policy of mini-devaluations, in effect since 1986, had been abandoned. The change in external economic conditions from 2006 onward allowed appreciation of the nominal exchange rate through November 2011, at which point the central bank intervened to fix its value. Subsequently, Bolivia managed to accumulate international reserves without precedent. In 2012, net international reserves reached 51% of GDP, a situation explained by the current account surplus that Bolivia has experienced since 2004 and the forgiveness of almost all of its external debt under the Multilateral Debt Relief Initiative (hereafter, MDRI) in 2005.

These fortuitous external economic conditions seemed to come to an end, however: the commercial balance surplus ended in 2014 and, in the 2015-2018 period, Bolivia's deficit was, on average, 6.41% of GDP. In addition, net international reserves had fallen from 51.8% in 2012 to 22.4% in 2018. Even though external debt as a share of GDP had been growing, it represented only 25.5% of GDP by December 2018, a sustainable level according to the standard threshold of 50% of GDP. An examination of the sources of financing of the Non-Financial Public Sector (hereafter, NFPS), however, makes clear that 70% of deficit in that sector was financed with internal debt, and the main debtors were public enterprises that had received credit, mainly from the central bank.

The combination of an increasing fiscal deficit with a current account deficit (twin deficits) and falling international reserves were reminiscent of the policies of the 1970s that led to the balance of payments crisis. Specifically, these included external debt accumulation and the drop in international reserves as a consequence of the fixed exchange rate. We therefore analyzed the potential impact on the main macroeconomic and financial variables in the Bolivian economy of abandoning this fixed exchange-rate policy.

To perform this simulation, we extended the standard PEP 1-1 model to include financial agents (private banks and the central bank) and financial transactions among households, firms, government, financial agents, and the rest of the world. The model was dynamic and was calibrated to a new 2014 Financial Social Account Matrix (hereafter, F-SAM) that included financial flows.[1] Dollarization was included in the model in terms of deposit dollarization (by which commercial banks offered deposits in local and foreign currency units). Revalorization effects were also included in the stocks of financial agents, according to which changes in the nominal exchange rate changed the value of agents' financial wealth.

Four different scenarios were simulated: (1) devaluation scenario only; (2) devaluation accompanied by a fiscal-adjustment scenario; (3) devaluation accompanied by an improvement-in-the-terms-of-trade scenario, and (4) a gradual-devaluation scenario. The magnitude of the simulated changes was hypothetical in order to study potential effects. Given our ability to control the magnitude of effects, however, we found that the fiscal-adjustment scenario was the best of all.

II. Literature review

According to Thissen (1999), different CGE models have been used to analyze the consequences of macroeconomic policy choices and the allocation of resources in

[1] We could certainly have used PEP-1-t as our starting point, but the other improvements we introduced to the PEP 1-1 GAMS code made such an alternative less cost-effective.

developing as well as in developed countries. However, most of these models were real models and did not take into account the financial markets, so they were not suitable to analyze World Bank/IMF (International Monetary Fund) stabilization and adjustment programs. In particular, most of these models ignored the direct link between financial variables and aggregate supply. This link has been very important because, according to Decaluwé and Nsengiyumva (1994), firms in financially repressed economies depend largely on bank credit to finance part or all of their working capital.

In general, several approaches to constructing real-financial CGE models exist; all, however, are based on a common theoretical structure. The inclusion of the financial side adds assets/liabilities markets to the real side in which commercial banks and the central bank are the indispensable financial agents. The portfolio behavior for each agent, regarding assets and liabilities choices, differs according to the assumptions employed in the models, but, in all cases, total assets = total liabilities + net financial wealth (Bourguignon, Branson & De Melo, 1989; Fargeix & Sadoulet, 1990; Rosenzweig & Taylor, 1990; Lewis, 1991; Telli, Voyvoda & Yeldan, 2003; Yeldan, 1997; Naastepad, 2001, 2003; Agénor et al., 2006; Simorangkir & Adamanti, 2012; Dixon, Rimmer & Roos, 2014; Liu et al. 2015; and Giesecke, Dixon & Rimmer, 2017).

Debowicz (2010) reviewed a set of sixteen real-financial CGE models that focused on equilibrium mechanisms in different markets, structural features, and the channels by which the performance of the financial side of the economy affected the real side. The models were classified according to their closures regarding factors of production, products, asset markets, loanable funds market (saving-investment), fiscal, and rest of the world. Most real-financial CGE models are country-specific and vary according to the financial agents and variables that are included. For instance, the "maquette" model (Bourguignon, Branson & De Melo, 1989) integrated commercial banks and the central bank into an aggregate monetary survey in order to avoid modelling details of the process of creating inside money. The transmission channels that are highlighted determine the set of agents and accounts (assets and liabilities) to be included.

Real-financial CGE models are also classified according to the inclusion of financial flows and/or stocks. Robinson (1991) considered that real-financial CGE models were usually denominated in flows rather than stocks because agents presumably did not restructure their complete portfolios every period, and adjustments in asset holdings were made at the margin. Thissen (1999) stated that failing to consider financial stocks did not correspond to Tobin's basic framework of financial general equilibrium modelling (1969) because important effects, such as portfolio restructuring, wealth effects, and interest payments, could not be modeled adequately.

According to Thissen and Lensink (2001), an analysis of the impact of currency devaluation in the framework of a real-financial CGE model was important because supply-side and demand-side effects, as well as feedback effects among different sectors, needed to be considered. Papers that have addressed the issue of devaluation explicitly include Rozenweig and Taylor (1990); Lemelin (2017); Schweickert, Thiele, and Wiebelt (2005); Ahmad (2013); and Pauw, Dorosh, and Mazunda (2013). All of these modeled exchange-rate devaluation exogenously. Yeldan (1998); Dixon, Rimmer & Roos (2014); and Acharya (2014) modeled currency devaluation endogenously.

The use of real-financial CGE models in Bolivia began with Jemio (1993), who developed a neo-structuralist real-financial CGE model to analyze external shocks, macroeconomic adjustment, and stabilization policies in Bolivia between 1970 and 1989. This model was novel in the sense that it presented a better approach for analyzing the impact of external shocks on short-term macroeconomic equilibrium and long-term economic growth in LDCs than did existing neo-orthodox and structuralist models (Jemio, 2001). Based on this model, Jemio and Wiebelt (2002) constructed a recursive-dynamic real-financial CGE model to address the question of whether and how policymakers could cushion the short-term effects of adverse external shocks.

Papers based on Jemio's model that have analyzed topics such as poverty, climate change, foreign aid, and labor issues have included Andersen and Faris (2002); Thiele and Wiebelt (2003); Andersen and Evia (2003); Lay, Thiele, and Wiebelt (2004, 2005, 2008a, and 2008b); Andersen et al. (2006); Wiebelt (2004); Nunnenkamp, Schweickert, and Wiebelt (2007); Klasen (2006); Aliaga et al. (2007); Aliaga and Villegas (2011); Aguilar and Aliaga (2009, 2010);and Villegas et al. (2010). Some of these analyses were also linked to micro-simulations.

Schweickert, Thiele, and Wiebelt (2005) employed a real-financial CGE model to simulate the macroeconomic and distributional effects of exchange-rate policy in a highly dollarized economy like Bolivia's; it remains one of the most cited papers in this area. They captured the major links between devaluation and dollarization by constructing a model that explicitly incorporated financial portfolio balances. The model was calibrated using Thiele and Piazolo's (2003) real-financial Social Accounting Matrix (hereafter, SAM) for 1997. This 1997 F-SAM captured many distributional features of the Bolivian economy obtained from the 1997 Input-Output Table and 1997-1999 household surveys.

Other CGE models used in Bolivia but not based on Jemio's model have included Tellería et al. (in press) and Tellería and Ludena (2015), who employed the GTAP model (real side and recursive CGE model); Jimenez (2007), who employed the MAMS model; Canavire-Bacarreza and Mariscal (2010), who employed the MACEPES model developed by Cicowiez and Sánchez (2009); and Cicowiez and Machicado (2011) and Morales et al. (2016), who used the PEP 1.1 model. All of these were real-side models only.

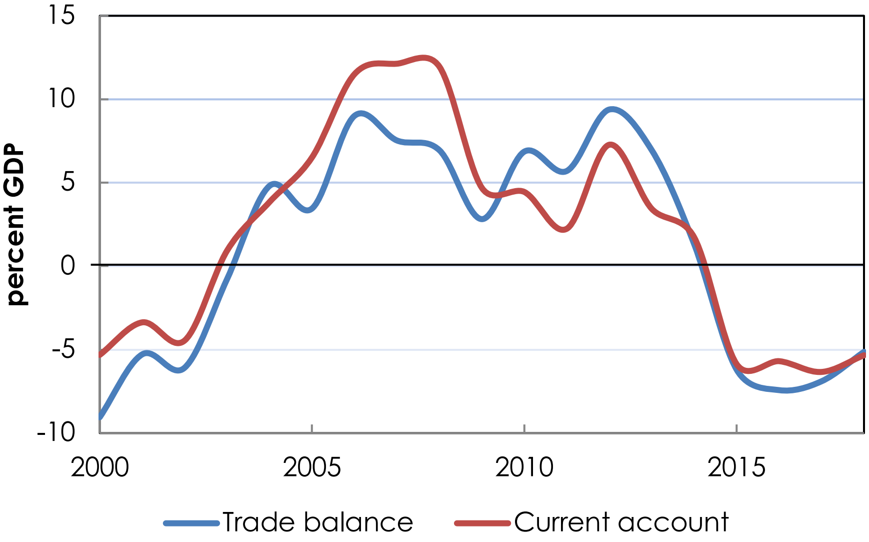
Our contribution to the real-financial CGE literature includes (a) developing a new model and dataset for Bolivia, (b) considering the portfolio choice for household deposits in commercial banks denominated in domestic or foreign currency, and (c) introducing an independent investment function that has been absent in all previous real-financial models applied to the Bolivian economy.

III. Economic context

During 2000-2018, the Bolivian economy went from recession (2000-2003) to expansion and bonanza (2004-2013) and, lately, to slowdown (2014-2018). Between 2000 and 2003, the country experienced macroeconomic problems that exacerbated sociopolitical conflicts; these ended with the election, in 2005, of Evo Morales (the first indigenous president). The economy began to recover in 2004, principally because of the rise of international prices of Bolivia's main exports (natural gas and minerals). This context was favored by increased taxes on these commodities beginning in 2005, in addition to strong debt relief through the

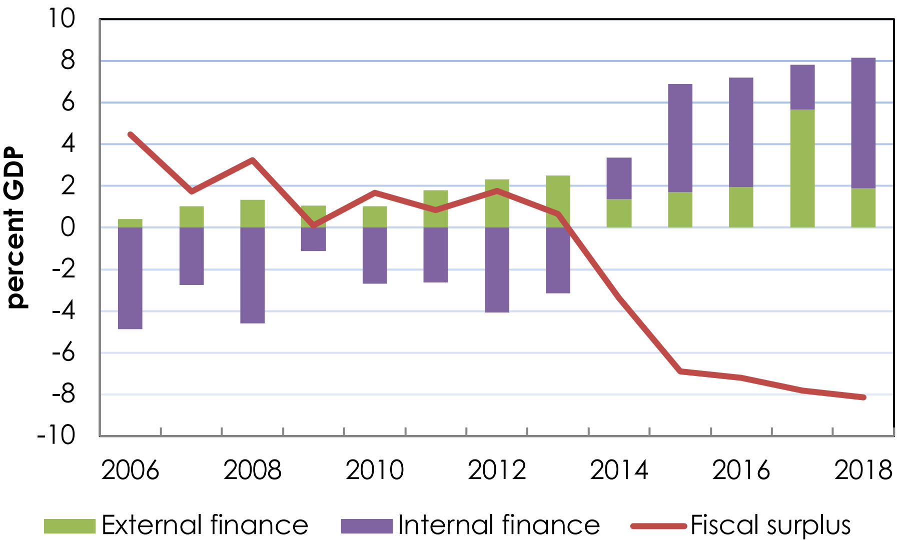
MDRI program,[2] which allowed high economic growth between 2006 and 2014 (at an average rate of 5.1%). However, during more recent years, exports have begun to fall given the drop in prices of export commodities and lower gas production. Figures 1 and 2 show the external and fiscal balances that followed this economic performance.

Figure 1: Trade Balance and Current Account



Source: World Development Indicators.

Figure 2: Non-Financial Public Sector Balance



Source: Ministry of Economy and Public Finance.

Bolivia experienced a trade balance and current account surplus between 2004 and 2014,

[2] The Multilateral Debt Relief Initiative (MDRI) provided 100% relief on eligible debt from three multilateral institutions to a group of low-income countries that were eligible based on their progress toward halving poverty by 2015, one of the UN's Millennium Development Goals.

which reached its highest values in 2012 (9.38% of GDP) and in 2007 (12.13% of GDP). However, deficits occurred in both balances beginning in 2015, at which point levels were similar to those observed in 2000 (5.3%).

The NFPS balance became positive in 2006 (4.47% of GDP) and remained so until 2013. During these years, the fiscal surplus allowed the NFPS to display negative internal financing, meaning that it was accumulating deposits. The NFPS balance has been negative since 2014, however, growing steadily from 3.36% of GDP in 2014 to 8.14% of GDP in 2018. Besides the drop in commodities exports, this scenario is also explained by the increase in public investments as a counter-cyclical policy. Since 2014, this deficit has been covered by both internal and external financing.

The large current account surpluses, experienced since 2004, generated both a nominal exchange rate appreciation and an international reserves accumulation. In 2005, the nominal exchange rate reached a value of 8.08 bolivianos/USD, and it appreciated until November 2011, when the central bank adopted a de facto fixed exchange-rate policy which continues to the present (6.96 bolivianos/USD).[3] In addition, net international reserves increased from 12.0% of GDP in 2003 to 51.8% of GDP in 2012. Since then, reserves have fallen, reaching the same percentage of GDP in 2017 as in 2006.

It is clear that a fixed exchange rate regime allowed inflation to be controlled because it was precisely anchored to the exchange rate. Low inflation (4.43% on average between 2012 and 2017) contributed to maintaining economic stability that favored growth and employment. In addition, the fixed nominal exchange rate caused an appreciation of the real exchange rate which affected exports negatively but favored imports, particularly those of intermediate inputs. The negative impact on exports was offset by a reduction in costs through imports. This compensation effect was especially visible in the manufacturing sector, whose production structure had not changed in recent years.

The main concern on the real side of the economy, then, with the abandonment of the fixed nominal exchange rate, was that inflation could adversely affect growth and employment. On the monetary side, the main concern was the reversal of "bolivianization" or the increase in dollarization, which affected negatively monetary policy because, as was argued, monetary policy had less freedom in a dollarized economy.

[3] Previously, the exchange rate was managed under the crawling-peg regime.

IV. Data

Our dynamic real-financial CGE model was calibrated to economic data that reflected the conditions of the Bolivian economy in 2014. The main sources of information for the construction of the real sphere of the F-SAM were the Input-Output Table and the integrated economic Table for Bolivia, both constructed by the National Institute of Statistics. The Input-Output Table provided information on production, intermediate consumption, final demand (i.e., households and government consumption), exports, value added, and taxes on activities and commodities. The integrated economic table presented information about production, income, expenses, and financing of transactions among agents.

In building the real sphere, we followed the procedure proposed by Reinert and Roland-Holst (1997). That process had a top-down structure that entailed these steps: (i) construction of an aggregate SAM (hereafter, macro-SAM), (ii) disaggregation of the macro-SAM into a matrix with a relatively large breakdown by sector (hereafter, micro-SAM), and (iii) balancing of the micro-SAM to make it suitable for the calibration of the real sphere of the PEP 1-1 model.

Table 1 shows the accounts in the F-SAM. The productive sector was split in thirteen activities and commodities: two primary, three manufacturing, and eight services. This sector-based disaggregation allowed us to isolate the main productive sectors in Bolivia. The SAM identified three factors of production: labor, capital, and a natural resource factor used in agriculture and mining.4 Institutional accounts included households, firms, government, rest of the world, commercial banks, and the central bank. Tax accounts were disaggregated into four as shown in the table. Lastly, the SAM identified savings, private and public investment, and stock change accounts.

[4] The mining sector included mining and hydrocarbons.

Table 1: F-SAM 2014 Accounts

Sectors (13)	Sectors (13) - cont.	Institutions (6)	Taxes (4)
Primary	**Services**	**Households**	**Commodity taxes**
Agriculture	Construction	Firms	Activity taxes
Mining	Commerce	Government	Tariffs
	Electricity, gas and water	Rest of the world	Income taxes
Manufacturing	Restaurants and hotels	Commercial banks	**Savings/Investment (4)**
Food	Transport	Central bank	Savings
Textiles and leather	Public administration	**Factors (3)**	Investment
Other manufacturing	Domestic services	Labor	Private Investment
	Other services	Capital	Public Investment
		Natural resources	Stock change

Source: Authors' calculations.

Table A.1 in Appendix A presents the structure of the F-SAM, and Table A.2 shows the estimated macro-SAM. The Bolivian GDP reached 2.280 billion bolivianos in 2014 (see Table 2). In 2014, household and government consumption was 62.9% and 14.7% of GDP, respectively. Fixed investment represented 21% of GDP, while imports surpassed exports by 0.13 percentage points. As shown in Table 2, the model fairly well simulated national account ratios for the years 2015-2019, which means that the model was capable of emulating the baseline scenario.

Table 2: Bolivia's GDP, 2014-2019 (in billions of bolivianos)

			Baseline scenario					
Percentage of GDP		**LCU (2014)**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Household consumption	Model	1435	62.94%	59.97%	58.30%	57.15%	55.87%	54.57%
	Data		62.94%	68.42%	68.91%	67.65%	67.01%	n.d.
Fixed Investment	Model	480	21.03%	21.69%	21.88%	22.12%	22.42%	22.68%
	Data		21.03%	20.28%	21.06%	22.22%	20.60%	n.d.
Government consumption	Model	335	14.71%	15.34%	15.33%	15.60%	16.02%	16.32%
	Data		14.71%	17.50%	17.46%	17.02%	17.53%	n.d.
Exports	Model	875	38.38%	39.55%	40.73%	41.15%	41.48%	41.98%
	Data		38.38%	30.87%	24.49%	24.90%	25.99%	n.d.
Imports	Model	878	-38.51%	-38.04%	-37.80%	-37.60%	-37.36%	-37.13%
	Data		-38.51%	-37.06%	-31.91%	-31.80%	-31.12%	n.d.
GDP at market prices	Model	2280	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	Data		100.00%	100.00%	100.00%	100.00%	100.00%	n.d.

Source: Bolivia F-SAM (2014). LCU=Local Currency Units.

Table 3: Bolivia's Production Structure, 2014-2019 (in percent)

	Baseline scenario					
Sector	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Agriculture	12.0%	11.7%	11.8%	11.6%	11.3%	11.1%
Minerals	26.7%	27.5%	28.1%	28.4%	28.8%	29.1%
Food	10.9%	10.9%	11.0%	11.0%	10.9%	10.8%
Textiles and leather	1.1%	1.1%	1.1%	1.1%	1.1%	1.1%
Manufacturing	8.9%	9.0%	9.2%	9.3%	9.3%	9.4%
Electricity, gas and water	4.5%	4.6%	4.6%	4.6%	4.6%	4.6%
Construction	4.5%	4.6%	4.7%	4.7%	4.8%	4.8%
Commerce	12.7%	12.6%	12.7%	12.7%	12.6%	12.5%
Transport	13.0%	12.8%	13.0%	12.9%	12.7%	12.6%
Services	21.8%	21.6%	21.8%	21.6%	21.3%	21.2%
Restaurant and hotels	3.7%	3.7%	3.7%	3.7%	3.6%	3.6%
Domestic services	0.4%	0.4%	0.4%	0.4%	0.4%	0.4%
Public administration	12.0%	12.3%	12.4%	12.5%	12.6%	12.7%

Source: Bolivia SAM 2014

Bolivia's production and trade structure is reflected in Tables 3 and 4, respectively. Table 4 shows the share of the tradable sectors in total exports and imports. While mining products (particularly gas) represented a significant share of export revenue (around 71.3%), their share in total value added was, on average, 28.1%. Services also represented an important share of total value added (21.5%, on average). Commerce and transport represented 12.6% and 12.8%, on average. The large share of mining exports in total exports showed a structural and historical failure of the Bolivian economy: its exports were concentrated in one product (gas). This is, of course, a weakness, because the main source of foreign exchange was the export of this natural resource. Far below came food exports, which represented, on average, 10.5% of GDP. On the other side, imports were largely concentrated in the manufacturing sector (74.5% of GDP) and were driven mainly by an over-valued real exchange rate.

Table 4: Bolivia's Trade Structure, 2014-2019 (in percent)

	Exports						Imports					
Sector	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Agriculture	3.0%	2.9%	2.9%	2.8%	2.7%	2.5%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%
Minerals	71.3%	71.4%	70.9%	71.1%	71.5%	71.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Food	10.2%	10.4%	10.6%	10.6%	10.6%	10.5%	5.7%	5.4%	5.3%	5.2%	5.1%	5.0%
Textiles and eather	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	3.2%	3.2%	3.2%	3.1%	3.1%	3.1%
Manufacturing	6.1%	6.1%	6.2%	6.2%	6.2%	6.2%	73.1%	73.9%	74.6%	74.8%	75.1%	75.4%
Transport	3.7%	3.6%	3.7%	3.6%	3.6%	3.5%	6.3%	6.1%	6.0%	5.9%	5.9%	5.8%
Services	1.7%	1.7%	1.8%	1.7%	1.7%	1.7%	7.1%	6.9%	6.7%	6.6%	6.6%	6.5%
Restaurant and hotels	2.7%	2.6%	2.7%	2.7%	2.6%	2.6%	3.1%	3.0%	2.9%	2.9%	2.8%	2.8%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: Bolivia SAM 2014

Because there were changes in transfers, and interest flows had been incorporated in the real part of the F-SAM, the savings of each agent (previously obtained from the integrated economic table), were computed as residuals in the macro-SAM. The savings for each agent corresponded to the change in their net financial wealth. Household savings represented 13% of GDP. Firm savings were negative and represented 5% of GDP. Government savings represented 10% of GDP and were mainly used to finance public investments (60% of total investment).

There was neither protocol nor good practices to follow in building the financial part of an F-SAM; therefore, to the extent possible we tried to maintain the balance between stocks of assets and liabilities of the central bank and the commercial banks, which were those that were available and represented the monetary sector of the economy.5 In addition, to compute financial flows between agents, we took the consistency between uses and sources of financial flows into account. Financial flows were computed as the difference between stocks at the end and at the beginning of 2014, the latter corresponding to existing stocks at the end of 2013.

Financial assets and liabilities by economic agent are shown in Appendix B. Household assets were liquidity, deposits in Local Currency Units (hereafter, LCU) and deposits in Foreign Currency Units (hereafter, FCU). This reflected the bi-monetary condition of the Bolivian economy, in which bolivianos and US dollars can be used interchangeably in transactions. In 2006, FCU deposits represented 20.3%, while LCU deposits represented only 7.3%. In 2017, deposits in bolivianos represented 53.3% while deposits in dollars represented only 8.3%. This change in the composition, observed since 2010, was a consequence of the nominal appreciation that the boliviano experienced since 2006. This was the so called "bolivianization"—the opposite of dollarization.6

The balance sheets of firms showed that private investment was financed with loans from commercial banks and from the rest of the world. In fact, the main asset of commercial banks was the credit extended to the private sector, which had grown constantly since 2008: from 23.7% of GDP to 54.2% of GDP in 2017. Banks also hold bonds from the government and, on the liabilities side, can contract debt with the rest of the world. In fact, this is net foreign debt. The main assets of the central bank are foreign reserves, which grew steadily until 2012 when they reached 51% of GDP, a record for the Bolivian economy. This accumulation of reserves is explained by the trade-balance surplus that the economy experienced between 2004 and 2014 and also by the forgiveness of public external debt under the MDRI program in 2005.

Another important asset of the central bank is credit to the public sector which increased from 10.6% of GDP in 2013 to 17.9% of GDP in 2017. This increase is explained by the growth of the NFPS deficit from 2013 onward, following a fiscal surplus between 2006 and 2013. The NFPS deficit mainly involved public enterprises, many of which had

[5] There are other financial institutions in the Bolivian economy, including specialized banks, but private or commercial banks represent 90% of the financial system.

[6] Dollarization, measured as the share of dollar deposits over total deposits, fell from 92% in 2000 to 13% in 2017.

received significant credit from the central bank. Liquidity and required reserves were liabilities of the central bank.

The last balance sheet belonged to the rest of the world, for which it was assumed that only companies, commercial banks, and the government could contract foreign debt. The amount of external debt contracted by private banks came from the external liabilities account in the balance sheet of the commercial banks. The external debt data of companies and the government came from the central bank's medium- and long-term external public debt statistics. This means that external government debt corresponded to the general government and the external debt of the companies corresponded to public companies.

Table 5: Financial Stocks, 2014-2019 (percent of GDP)

			Baseline scenario					
Percentage of GDP		**LCU (2014)**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Credit to firms by commercial bank	Model	90623	39.75%	41.11%	41.73%	42.15%	42.66%	43.09%
	Data		39.75%	47.10%	53.10%	54.20%	n.d.	n.d.
Credit to domestic agents by RoW	Model	-557	-0.24%	-0.26%	-0.27%	-0.28%	-0.30%	-0.31%
	Data		-	-	-	-	-	-
Deposits in FCU	Model	21152	9.28%	8.76%	8.12%	7.93%	7.78%	7.56%
	Data		9.28%	9.90%	9.30%	8.30%	n.d.	n.d.
Deposits in LCU	Model	94640	41.51%	41.16%	40.28%	39.06%	37.89%	36.80%
	Data		41.51%	51.50%	52.50%	53.30%	n.d.	n.d.
Foreign Reserves	Model	103745	45.50%	44.90%	43.75%	42.47%	41.27%	40.15%
	Data		45.50%	39.30%	29.50%	27.20%	n.d.	n.d.
Government Bonds	Model	23773	10.43%	10.78%	10.95%	11.06%	11.19%	11.30%
	Data		-	-	-	-	-	-
Supply of money	Model	41372	18.15%	18.20%	18.04%	17.55%	17.08%	16.71%
	Data		18.15%	18.80%	18.40%	17.90%	n.d.	n.d.
Required reserves in LCU	Model	14066	6.17%	5.82%	5.40%	5.28%	5.17%	5.02%
	Data		6.00%	9.59%	6.82%	n.d.	n.d.	n.d.
Required reserves in FCU	Model	11357	4.98%	4.94%	4.83%	4.69%	4.55%	4.42%
	Data		4.74%	6.06%	6.26%	n.d.	n.d.	n.d.

Source: The 2014 Bolivian SAM and Instituto Nacional de Estadísticas (National Institute of Statistics)

Table 5 shows that the model was fairly well able to reproduce the main financial ratios for the baseline years. The model displayed a less strong drop in foreign reserves and a smaller share of LCU deposits in GDP. Notice also that credit to domestic agents was negative. This means that domestic agents were creditors instead of debtors with the rest of the world.

Once stocks were defined for all the variables that were part of the financial sphere of the 2013 and 2014 F-SAM, flows were calculated as the difference between stocks in both years. In order to maintain consistency between the net wealth of each of the agents and their savings from the real part, however, some variables were calculated as residuals. This was also done to preserve the general balance of the financial part, in which, once all assets and liabilities accounts had been equalized, the result would necessarily be the savings-investment balance (lower right corner of Table A.2).

V. Methodology

We developed a real-financial CGE model, which integrated the real side of the economy, using a modified version of the standard PEP-1-1 (v.2.1) CGE model adapted to include dynamics, with the financial side of the economy expressed in the capital accounts of each agent.

5.1 The Real Side of the Economy

The standard PEP-1-1 (v.2.1) CGE model (Decaluwé et al., 2013) is a static and real model. To add a financial side to this model, we needed to introduce certain dynamics. We therefore followed Cicowiez (2019) who, in turn, had followed Dervis, De Melo, and Robinson (1982) in introducing dynamics to the PEP-1-1 model.[7] According to the authors, new capital was allocated among sectors. In the set of equations shown below, we present the dynamics of the model and, specifically, the mechanisms we used to assign investment among sectors in each period. We distinguished private from public capital stocks, which was particularly relevant to simulations of increases in public infrastructure investment.

[7] Although the PEP-1-t model exists as a dynamic version of the PEP-1-1 model, we introduced other dynamics in modelling the financial side because of the importance of investment and differences in the growth rates of variables.

For domestic non-governmental institutions, investment in each period increased the capital stock available in the next period. We then needed to determine how new capital would be distributed among industries. In our model, for private investment (i.e., households and/or enterprises), we assumed that new capital was distributed among activities based on differences in capital rates of return. Thus, sectors with a relatively higher (lower) capital rate of return received a relatively larger (smaller) share of new capital. For the government, investment was determined as: (1) a policy variable (i.e., exogenously) or (2) a residual to balance the government budget.

Equation 1 computes the average capital rate of return as the ratio between total capital income and total capital stock. Equation 2 computes the share of each activity in the new capital stock, following the explanation on the previous paragraph. The κ parameter, which varies between zero and one, measures the degree of capital mobility among productive sectors. When κ is zero, investment is distributed among sectors only based on the initial share of each sector in the total capital stock. When κ is positive, investment is distributed among sectors, based also on relative capital returns. Finally, Equation 3 shows how capital stocks are updated by sector (private and public).

$$RAVG_{k,t} = \frac{\sum_{j \in J} R_{k,j,t} \cdot KD_{k,j,t}}{\sum_{j \in K} KD_{k,j,t}} \qquad k \in K,\ t \in T \tag{1}$$

$$QINVDESTA_{k,j,t} = GFCF_t^{REAL} \cdot \frac{KD_{k,j,t}}{\sum_{jj \in J} KD_{k,jj,t}} \left[1 + \kappa \left(\frac{R_{k,j,t}}{RAVG_{k,t}} - 1\right)\right] \qquad k \in KCAP,\ j \in J,\ t \in T \tag{2}$$

$$KD_{k,j,t} = KD_{k,j,t-1}(1 - deprat_k) + QINVDESTA_{k,j,t-1} \qquad k \in KCAP,\ j \in J,\ t \in T \tag{3}$$

where

$RAVG_{k,t}$: average capital rent

$QINVDESTA_{k,j,t}$: investment by destination

κ: capital mobility parameter

$deprat_k$: capital depreciation rate

Notice that, in this approach, the fundamental innovation was the definition of investment and physical capital accumulation. In this dynamic version of the model, specific mechanisms allocated the new physical capital between sectors or activities but also according to the type of agent (private vs. public physical capital). Investment for private physical capital by domestic non-governmental agents (e.g., firms) was distributed among sectors according to differences in their returns. That is, those sectors with high (low) returns to private physical capital received a greater (lesser) proportion of new physical capital or investment. In contrast, the new public physical capital was defined as a policy variable that adjusted the budget balance of the public sector.

The accumulation of physical capital, for both government and nongovernment agents, followed a standard accumulation rule: new physical capital was considered by destination (i.e., sector) as well as by the depreciation of the stock of capital up to the previous period. While the real side of the model considered investment demand (by sector) and investment expenditure (by type of agent), the financial side of the model only incorporated the latter.

In addition, in the real-side of the model, we introduced differences in wages by industry at equilibrium: each activity paid an activity-specific wage that was the product of the economy-wide wage and an activity-specific wage (distortion) term. We also considered endogenous unemployment via an extended wage curve. The PEP Standard Model assumes full employment of the labor force. Specifically, we added Equation 4 to the model as well as the endogenous variable UERAT (unemployment rate). The value of the $\eta_l^{w,uerat}$ parameter (i.e., the wage curve elasticity) was set at -0.1 based on international evidence documented in Blanchflower and Oswald (2005). Naturally, the equilibrium condition for labor market was adjusted accordingly (see Equation 5).

$$W_{l,t} = (1 + wgrw_l)W_{l,t-1} \cdot (1 + INFL_t)^{\eta_l^{w,infl}} \cdot (1 + INFL_{t-1})^{\left(1-\eta_l^{w,infl}\right)} \cdot \left(\frac{UERAT_{l,t-1}}{ueratbar_l}\right)^{\eta_l^{w,uerat}} \quad (4)$$

$$LS_{l,t}\left(1 - UERAT_{l,t}\right) = \sum_{j \in J} LD_{l,j,t} \quad (5)$$

where

$UERAT_{l,t}$: unemployment rate for type l labor

$\eta_l^{w,infl}$: elasticity of wage with respect to current inflation rate

$\eta_l^{w,uerat}$: elasticity of wage with respect to unemployment rate

Some modifications were also introduced in exports, the current account, the government, tax rates, and household savings (see Appendix C for details).

5.2 The Financial Side of the Economy

We followed the macroeconomic financial CGE modelling framework of Agénor, Izquierdo, and Fofack (2003); Schweickert, Thiele, and Wiebelt (2005); and Debowicz (2010) to formulate the financial side of the economy. Under this framework, we included the relevant financial variables and parameters according to the empirical regularities of the Bolivian economy; which we highlighted in constructing the F-SAM.

Based on the dynamic modelling of the real side of the economy as well as the intermediation role of financial agents, we initially assumed that financial resources came from: i) deposits of households (LCU and FCU) and ii) the financial capital that the rest of the world provided to local agents as liabilities. Subsequently, commercial banks and the central bank would transfer these financial resources in the form of credit extended to companies, public debt, and foreign loans to commercial banks.

Capital accounts imply the inclusion of assets, both in flows and stocks, an additional dynamic in the model. In this regard, each agent generated a net financial wealth or a net worth that reflected the savings of the period (determined on the real side) plus a revaluation of assets for those agents that held assets expressed in FCU. The financing requirement, expressed in the demand for loans to domestic financial institutions and to the rest of the world, came from firms and from the government who sought to finance private and public investment endogenously once they had spent their own financial resources (i.e., net worth differential or savings).

Households

Each type of household $\mathrm{h} \in \mathrm{H}$ allocates its financial resources in three available assets at time t: liquidity or cash ($\mathrm{H}_{\mathrm{h,t}}$), domestic deposits in LCU ($\mathrm{DD}_{\mathrm{h,t}}^{\mathrm{LC}}$), and domestic deposits in FCU ($\mathrm{DD}_{\mathrm{h,t}}^{\mathrm{FC}}$), as defined in Equation 6. The sum of these assets should be equivalent to the net financial wealth of the household at the same time t ($\mathrm{WT}_{\mathrm{h,t}}$), which is a financial constraint for each household.

The endogenous determination of the demand for assets by households is defined according to the following rules and assumptions. Equation 7 defines the money demand or cash holdings by households. For this, we adopted the cash-in-advance assumption (Feltenstein & Shah, 1995): an exogenous proportion $\alpha_{\mathrm{h,t}}^{\mathrm{mon}} \in (0,1)$ of the current level of consumption ($\mathrm{CTH_{h,t}}$), which comes from the real side of the model. Once money demand was determined, the remaining proportion of household budgets was allocated between the two types of deposits. Because the rate of return on liquidity was zero, the choice between LCU deposits vs. FCU deposits was defined by the relative rate of return of each alternative, as established in Equation [8]. This relative relationship of interest rates considered the interest rate of deposits in LCU ($\overline{\mathrm{intrat}}_t^{\mathrm{deplc}}$), adjusted by expected inflation(π_t^e), and deposits in FCU ($\overline{\mathrm{intrat}}_t^{\mathrm{depfc}}$), both rates determined exogenously. Following Fargeix and Sadoulet (1990), we also include the effect of an expected devaluation ($\mathrm{dev^e}$) on household portfolio decisions, considering that devaluation favored deposits in FCU. $\alpha_{h,t}^{dep}$ and η_h^{dep} are a scale parameter and elasticity respectively.8

$$WT_{h,t} = H_{h,t} + DD_{h,t}^{LC} + e_t \cdot DD_{h,t}^{FC} \tag{6}$$

$$H_{h,t} = \alpha_{h,t}^{mon} \cdot CTH_{h,t} \tag{7}$$

$$\frac{DD_{h,t}^{LC}}{e_t \cdot DD_{h,t}^{FC}} = \alpha_{h,t}^{dep} \left(\frac{\left(1 + intrat_t^{deplc}\right) \cdot (1 + \pi_t^e)^{-1}}{\left(1 + intrat_t^{depfc}\right) \cdot (1 + dev^e)} \right)^{\eta_h^{dep}} \tag{8}$$

$$WT_{h,t} = WT_{h,t-1} + SH_{h,t} + (e_t - e_{t-1}) \cdot (DD_{h,t-1}^{FC}) \tag{9}$$

$$YINT_{h,pb,t} = \overline{intrat}_t^{deplc} \cdot DD_{h,t-1}^{FC} \cdot intratdist_{1h,pb} + \overline{intrat}_t^{depfc} \cdot DD_{h,t}^{LC} \cdot e_t \cdot intratdist_{2h,pb} \tag{10}$$

$$YH_{h,t} = YHL_{h,t} + YHK_{h,t} + +YHTR_{h,t} + \sum_{ag \in AG} YINT_{h,ag,t} \tag{11}$$

A household's net financial wealth at time t is defined in Equation 9, which includes the wealth of the previous period ($\mathrm{WT_{h,t-1}}$), household savings ($\mathrm{SH_{h,t}}$), and the revaluation of domestic deposits in FCU taking into account a potential variation in the nominal exchange rate (e_t). The financial revenue of the household comes from its flow of interest as defined in Equation 10, which includes interest paid on the stock of deposits until the previous period according to the two denominations of currency, both paid by the commercial bank. The flow of interest that the household received for its deposits redefined its income equation. Subsequently, Equation 11 includes the interest that the household received as part of its current income.

Because the dynamics of the financial side required the expression of each asset in

[8] Expected inflation and devaluation equations are explained below.

both flow and stock terms, Equations 12-14 establish deposit flows in both currencies and liquidity holdings by households.

$$\Delta DD_{h,t}^{LC} = DD_{h,t}^{LC} - DD_{h,t-1}^{LC} \quad (12)$$

$$\Delta DD_{h,t}^{FC} = DD_{h,t}^{FC} - DD_{h,t-1}^{FC} \quad (13)$$

$$\Delta H_{h,t} = H_{h,t} - H_{h,t-1} \quad (14)$$

Firms

The objective of each firm $f \in F$ was to finance its investment at time t. Firm f had three available sources of funding for this (expressed in flow terms): its current level of savings ($SF_{f,t}$), the acquisition of domestic loans from commercial banks ($\Delta DL_{f,t}$), and the acquisition of foreign loans from the rest of the world ($\Delta FL_{f,t}$). The sum of these flows of liabilities must be equivalent to funding required for investment purposes (Investf,t), as defined in Equation 15 (Agénor, Izquierdo & Fofack, 2003). At the aggregate level, the sum of the investment flow of each firm is equivalent to gross fixed capital formation ($GFCF_t$) and the change in the inventories value ($VSTK_{i,t}$), as shown in Equation 16.[9]

The model allowed us to distinguish access to foreign credit by sectors. Thus, the constraint on foreign borrowing by firms would reflect limited access to foreign credit for private firms as a whole without taking into account which sector was borrowing. Consequently, only two sources of financing were to be determined endogenously.

Because firms assumed the role of net borrowers in our scheme, the flow of interest to them was strictly negative, reflecting the payment of interest on domestic loans ($YINT_{pb,f,t}$) as shown in in Equations 17.[10] The interest payment due on credit acquired by firms with domestic agents was debited from their current savings as shown in Equation 18, which redefined savings established in the real part.

$$SF_{f,t} + \Delta DL_{f,t} + \Delta FL_{f,t} \cdot e_t = INVEST_{f,t} \quad (15)$$

$$\sum_{f \in F} INVEST_{f,t} = GFCF_t + \sum_{i \in I} PC_{i,t} \cdot VSTK_{i,t} \quad (16)$$

$$YINT_{pb,f,t} = \overline{intrat}_t^{credpb} \cdot DL_{f,t-1} \cdot e_t \cdot intratdist_{pb,f} \quad (17)$$

---

[9] Equation 11 does not define *INVEST* for more than one firm; for more than one firm, our model would need adjustment.

[10] $intrat_t^{credpb}$ is the interest rate and $intratdist_{pb,f}$ is a necessary adjustment to calibrate the model from an average interest rate applied to several credits/debits. Without this factor, the macro-SAM could not be made compatible with the assumption that the same rate applied to several transactions.

$$SF_{f,t} = YDF_{f,t} - \sum_{ag \in AG} TR_{ag,f,t} - \sum_{ag \in AG} YINT_{ag,f,t} \qquad (18)$$

Commercial Banks

The capital account of commercial banks is defined in Equation 19, in which the left hand side included: the commercial bank's savings at time t, which in turn is defined in Equation 20 as the net result of both the transfers received from other agents and the flow of interests; the total sum of domestic deposits (according to currency and the both expressed in LCU through the nominal exchange rate); and the total amount of loans that the commercial bank acquired from the rest of the world ($FL_{pb,t}$). On the right hand side of Equation 19 are the assets of commercial banks: the loans granted to the firms, the reserve (legal) requirements by currencies deposited in the central bank (RR_t^{LC} and RR_t^{FC}), and the bonds issued by the government (B_t).

Reserve requirements were defined as an exogenous share of the total sum of domestic deposits according to the type of currency, as reflected in Equations 21 and 22. The demand for loans by firms was an endogenous decision according to level of investment, as detailed above. Consequently, the supply of loans by commercial banks would satisfy such demand. The demand for government bonds by commercial banks was the residual of the difference between total assets minus previously determined liabilities (i.e., loans to firms and required reserves). On the side of liabilities, Equation 19 also states that the level of loans that commercial banks acquired from the rest of the world depended upon the demand for loans by the firms. Commercial banks satisfy this demand by first using the remainder of domestic deposits and, once this source is exhausted, using external financing.

In each period, commercial banks paid interest to the rest of the world for loans acquired, as Equation 23 shows. Finally, both Equations 24 and 25 state the flow of reserve requirements as the difference in stocks between time t and $t-1$.

$$\begin{aligned} SPB_t &+ \sum_{h \in H} \Delta DD_{h,t}^{FC} \cdot e_t + \sum_{h \in H} \Delta DD_{h,t}^{LC} + \Delta FL_{pb,t} \cdot e_t \\ &= \sum_{f \in F} \Delta DL_{f,t} + \Delta RR_t^{LC} + \Delta RR_t^{FC} \cdot e_t + \Delta B_{pb,t} \end{aligned} \qquad (19)$$

$$SPB_t = \sum_{ag \in AG} TR_{pb,ag,t} + \sum_{ag \in AG} YINT_{pb,ag,t} - \sum_{ag \in AG} TR_{ag,pb,t} - \sum_{ag \in AG} YINT_{ag,pb,t} \qquad (20)$$

$$RR_t^{LC} = req_{LC,t} \cdot \left(\sum_{\text{h} \in \text{H}} DD_{h,t}^{LC} \right) \quad (21)$$

$$RR_t^{FC} = req_{FC,t} \cdot \left(e_t \cdot \sum_{h \in H} DD_{h,t}^{FC} \right) \quad (22)$$

$$YINT_{row,agd,t} = \overline{intrat}_t^{credrow} \cdot FL_{agd,t-1} \cdot e_t \cdot intratdist_{row,agd} \quad (23)$$

$$\Delta RR_t^{LC} = RR_t^{LC} - RR_{t-1}^{LC} \quad (24)$$

$$\Delta RR_t^{FC} = RR_t^{FC} - RR_{t-1}^{FC} \quad (25)$$

Central Bank

Equation 26 establishes the balance of the capital account of the central bank. This balance included: the central bank's savings (SCB_t) which, in turn, are defined as the net result of transfers and interest payments by other agents to the central bank as in Equation 27, plus the total flow of money holdings in the hands of households ($\Delta \text{H}_{\text{h,t}}$); and the flows of reserve requirements in LCU and FCU ($\Delta \text{RR}_\text{t}^{\text{LC}}, \Delta \text{RR}_\text{t}^{\text{FC}}$), both expressed in LCU using the nominal exchange rate. The previous sum should equal the flow of government bonds held by the central bank ($\Delta \text{B}_{\text{CB,t}}$) plus the flow of foreign reserves ($\Delta \text{FF}_\text{t}$), both expressed in LCU. Under the assumption that the money supply (MB_t) was endogenously adjusted to match the demand for money ($\sum \text{H}_{\text{h,t}}$), Equation 28 states that the supply of money equals the total sum of the liquidity stock held by households (money market equilibrium condition).

Because the central bank managed the portfolio of foreign reserves, the flow of foreign reserves was determined by the variation in the stock of those reserves, as defined in Equation 29. Equation 30 shows the flow of interest received by the central bank as the result of the profitability of the portfolio of foreign reserve stock, accumulated up to period $\text{t} - 1$.

$$SCB_t + \sum_{h \in H} \Delta H_{h,t} + \Delta RR_t^{LC} + \Delta RR_t^{FC} \cdot e_t = \Delta B_{CB,t} + \Delta FF_t \cdot e_t \quad (26)$$

$$SCB_t = \sum_{\text{ag}} TR_{cb,ag,t} + \sum_{\text{ag}} YINT_{cb,ag,t} - \sum_{\text{ag}} TR_{ag,cb,t} - \sum_{\text{ag}} YINT_{ag,cb,t} \quad (27)$$

$$MB_t = \sum_{\text{h} \in \text{H}} H_{h,t} \quad (28)$$

$$\Delta FF_t = FF_t - FF_{t-1} \quad (29)$$

$$YINT_{cb,row,t} = \overline{intrat}_t^{fres} \cdot FF_{t-1} \cdot e_t \cdot intratdist_{cb,row} \quad (30)$$

Government

The financial objective of the government was to finance its level of (public) investment. The government had three available sources of funding for this purpose: its own level of savings at time t (SG_t), the acquisition of internal debt with domestic financial institutions (commercial banks and central bank) via the issuance of bonds ($B_{ag,t}$), and the acquisition of foreign debt with the rest of the world ($FL_{gov,t}$). The equivalence between the level of public investment and the total of the mentioned liabilities is established in Equation 31. Because the government pays interest on domestic bonds and foreign debt, it was necessary to broaden the definition of government savings of the real sector of the model, which we show in Equation 32.

Internal and external government debt was defined exogenously, and the issuance of bonds financed the fiscal deficit once the sources of debt with the central bank and the rest of the world had been exhausted, as can be deduced from the government capital account in Equation 31. Equation 33 defines foreign government debt in flow terms as the difference between stocks in t and $t-1$.The government's borrowing position meant that its flow of interest was negative, implying payment for interest on domestic debt and external debt as well as payments for bond profitability, as shown in Equation 34.

$$SG_t + \sum_{ag\in AGD} \Delta B_{ag,t} + \Delta FL_{gov,t} \cdot e_t = \sum_{i\in I} PC_{i,t} \cdot QINVG_{i,t} \quad (31)$$

$$SG_t = YG_t - \sum_{ag\in AGNG} TR_{ag,gov,t} - G_t - \sum_{ag\in AG} YINT_{ag,gov,t} \quad (32)$$

$$\Delta FL_{ag,t} = FL_{ag,t} - FL_{ag,t-1} \quad (33)$$

$$YINT_{agd,gov,t} = \overline{intrat}_t^{gbond} \cdot B_{agd,t-1} \cdot intratdist_{agd,gov} \quad (34)$$

Rest of the World

The financial accounts of the rest of the world were defined according to the financial decisions of domestic agents in each period as a consequence of financing requirements. For the rest of the world, the balance in the capital account is defined by Equation 35 as the equivalence between: external savings (negative of the current account balance: $SROW_t$) plus the flow of foreign reserves (ΔFF_t). The sum of those flows should equal the sum of the flows of the credit granted to the government ($FL_{gov,t}$), the commercial bank ($FL_{pb,t}$), and firms ($FL_{f,t}$).

The lender position of the rest of the world meant that domestic agents (government, commercial banks, and firms) paid interest on foreign debt, while the central bank received a flow of interest for foreign reserves from the rest of the world. The existence of this net flow of interest required us to redefine the expression of savings from the rest of the world, including the aforementioned interest payments, as shown in Equation 36.

$$SROW_t + \Delta FF_t \cdot e_t = \Delta FL_{gov,t} \cdot e_t + \Delta FL_{pb,t} \cdot e_t + \sum_{f \in F} \Delta FL_{f,t} \cdot e_t \quad (35)$$

$$SROW_t = YROW_t - \sum_{i \in I} PE_{i,t}^{FOB} \cdot EXD_{i,t} - \sum_{ag \in AGD} TR_{ag,row,t} - \sum_{ag \in AGD} YINT_{ag,row,t} + \sum_{ag \in AGD} YINT_{gov,ag,t} \quad (36)$$

Inflation, Expected Devaluation, and Wages

We included three equations on inflation, expected inflation, and expected devaluation. As mentioned regarding household portfolio decisions, the expected devaluation played a role in the choice between LCU and FCU deposits. Equation 37 expresses the inflation rate in the model (π_t) purely as the percentage variation of the consumer price index (PIXCON, defined in the real part). The formation of expectations was fundamental in both portfolio and investment decisions. Expectations of inflation (π_t^e) were formed adaptively including both the inflation rates in the previous period and the current period, as in Equation 38. As for expectations of devaluation (dev_t^e), we assumed agents do not expect any real devaluation or revaluation, so expected devaluation was equal to expected inflation, as defined in Equation 39.

$$\pi_t = \frac{PIXCON}{PIXCON_{t-1}} - 1 \quad (37)$$

$$\pi_t^e = \gamma_\pi \cdot \pi_t + (1 - \gamma_\pi) \cdot \pi_{t-1} \quad (38)$$

$$dev_t^e = \pi_t^e \quad (39)$$

Interest Rate

We considered the interest rate that banks charged on credit $\overline{intrat}_t^{credpb}$ to be endogenously determined by Equation 40, in which pr corresponds to a premium. This finance premium was constant and equal to the initial (calibrated) finance premium.

$$\overline{intrat}_t^{credpb} = \overline{intrat}_t^{deplc} \cdot pr_t \quad (40)$$

$$pr_t = \frac{intrato^{credpb}}{intrato^{deplc}} \quad (41)$$

Independent Investment Function

Finally, we introduced an independent investment function

$$IKRAT_t = \frac{GFCF_t^{REAL}}{\sum_{k,j\in K,J} KD_{k,j,t}}$$

$$IKRAT_t = \left(\frac{GDP\_BP_t^{REAL}}{GDP\_BP_{t-1}^{REAL}}\right)^{\Omega^{rgdpfc}} (1+\pi_t)^{\Omega^{infl}} \left(1+RAVG_{a,t}\right)^{\Omega^{ravg}} \left(1+INRAT_t^{credpb}\right)^{\Omega^{intrat}} \quad (42)$$

where

$IKRAT_t$: investment-to-capital ratio

$\Omega^{rgdpfc} > 0$; $\Omega^{infl} < 0$: $\Omega^{intrat} < 0$; $\Omega^{ravg} > 0$

Closure Rule

In this model, we needed to specify a clearing mechanism for the capital account of each institution. Specifically, we needed to determine how savings, borrowing/lending, and investment balanced for households, enterprises, government, commercial banks, central bank, and rest of the world:[11]

- households: exogenous savings rate with portfolio choice for money, deposits in LCU, and deposits in FCU;
- enterprises: independent investment function, exogenous borrowing from rest of the world, and capital account clears through borrowing from commercial banks;
- government: capital account clears through changes in borrowing from central bank;
- commercial banks: borrowing from rest of the world and lending to government were exogenous, the interest rate on household deposits was endogenous, and the capital account clears through changes in household deposits brought about by changes in the interest rate;
- central bank: money supply endogenously adjusts to equal money demand, nominal exchange rate was exogenous, and capital account clears through changes in foreign reserves;
- rest of the world: current account clears through changes in real exchange rate.

[11] The much simpler PEP 1-1 model includes a single savings-investment balance for the whole modeled economy.

VI. Application and Results

We used the modified PEP 1.1 v.2.1 model to perform counterfactual simulations. Four sets of scenarios were considered. In the first, we simulated a nominal devaluation intended to analyze its impact on real and financial variables of the Bolivian economy; in the second, we assessed the impact of a policy response to the devaluation; in the third, we simulated devaluation with a change in international conditions; and, in the fourth, we simulated a gradual devaluation.

6.1 Nominal Devaluation Scenario

We simulated a 15% devaluation of the nominal exchange rate (scenario dev). Since 2011, the nominal exchange rate has been 6.96 bolivianos per USD; therefore, a 15% devaluation means that the nominal exchange rate increased up to 8 bolivianos per USD. This was the value of the nominal exchange rate in force in 2004 (end of period). Table 6 presents the simulation results on real macro indicators.

Table 6: Real Macro Indicators (Percent Change with Respect to the Baseline Scenario, Devaluation Scenario)

NATIONAL ACCOUNTS (% change)	Base LCU	2020	2021	2022	2023	2024	2025
Household consumption	1418.11	10.55%	6.37%	3.38%	4.30%	5.69%	5.92%
Fixed investment	589.31	11.99%	14.39%	15.71%	14.67%	14.33%	14.71%
Government consumption	424.11	8.65%	17.87%	11.90%	9.11%	10.57%	11.48%
Exports	1091.13	3.65%	-0.91%	1.94%	3.74%	3.25%	2.95%
Imports	964.86	-1.89%	-4.03%	-4.02%	-3.48%	-3.15%	-2.99%
GDP market price	2598.92	13.61%	12.06%	11.42%	12.00%	12.54%	12.74%
Net indirect taxes	321.92	13.48%	10.48%	10.50%	11.37%	11.78%	11.90%
GDP factor cost	2244.02	13.63%	12.30%	11.55%	12.08%	12.64%	12.86%
PRICE INDICES (100=base)							
Consumer price index	0.97	11.58%	14.33%	11.59%	10.66%	11.47%	11.86%
Domestic price index	1.10	11.53%	14.11%	11.48%	10.59%	11.37%	11.76%

Terms of trade	0.88	-0.08%	-0.30%	-0.08%	-0.01%	-0.08%	-0.11%
World price index	1.05	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Real exchange rate	1.03	3.62%	0.10%	3.06%	4.25%	3.40%	2.94%
FISCAL ACCOUNTS (% change)							
Government savings	241.90	28.91 %	-0.89%	14.71 %	25.76 %	23.69 %	22.15 %
Total government income	875.57	14.63 %	11.91 %	12.36 %	13.38 %	13.69 %	13.79 %
Government consumption	414.35	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Government investment	243.54	-2.55%	-1.91%	3.72%	3.08%	1.65%	1.98%
Transfers to households	112.50	11.58 %	14.33 %	11.59 %	10.66 %	11.47 %	11.86 %
EXTERNAL ACCOUNTS (% change)							
Current Account Balance	136.67	61.69 %	38.03 %	56.04 %	61.03 %	53.04 %	48.36 %

Source: CGE simulation.

As can be seen, a nominal devaluation had a positive effect on all national account variables. GDP at market price and at factor cost improved in 2020 by 13.61% and 13.63%, respectively, with respect to the BAU scenario. This improvement was smaller in 2021 and 2022, but then started to increase again. By 2025, the difference with respect to the BAU was 12.74% for GDP at market prices. Economic growth positively affected household consumption and investment and government consumption. These variables also showed a U-shaped trajectory between 2021 and 2023.

Businessmen and entrepreneurs always ask for nominal devaluations when there is a fixed exchange rate regime, arguing that their exports are expensive compared to those of other countries and believing that a nominal devaluation can help them recover competitiveness. The results displayed in Table 6 show that there was a positive effect on exports in 2020. Exports increased by 3.65% with respect to the BAU but, in 2021, exports decreased by 0.91%, thought they recovered in subsequent years. The cause was the fact that competitiveness was related to the real exchange rate and not to the nominal exchange rate. As can be seen, the real exchange rate increased by 3.62% in 2020 (real depreciation), but then increased by only 0.1% in 2021. The real exchange almost did not change in 2021 because the change in domestic prices represented by the consumer price index was 14.33%, which was very similar to the 15% change in the nominal exchange rate. In subsequent years, changes in domestic prices were lower. Therefore, we observed real depreciation again and, in turn, an increase in exports with respect to the BAU.

Notice that imports decreased with respect to the BAU in all years. It was no surprise that imports fell when there was a depreciation of the real exchange rate. Imports also fell because of a drop in the terms of trade with respect to the BAU (larger in 2021). This meant that import prices increased, negatively affecting imports.

Regarding fiscal accounts, we observed a large increase in government savings (28.91%) in 2020. In this modified version of the PEP 1-1 model, investment was not solely savings-driven; therefore, government investment fell, even though government savings increased. But government investments only fell in 2020 and 2021. In other years, public investment increased because government savings also increased. Government income increased in 2020 with respect to BAU but then decreased the following year, recovering again in subsequent years. The reason was a progressive decrease in revenues from import and export taxes in 2021 but a recovery in export taxes in subsequent years.

The last row of Table 6 shows that nominal devaluation had a positive effect on current account balance. The current account surplus increased by 61.7% in 2020 with respect to the BAU and keeps growing at an increasing rate until 2022.

Table 7: Financial Stocks Results (Percent Change with Respect to the Baseline Scenario, Devaluation Scenario)

STOCK (% change)	Base LCU	2020	2021	2022	2023	2024	2025
Credit to firms by commercial bank	111979.10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Credit to domestic agents by RoW	12951.51	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Deposits in FCU	19635.48	-4.95%	-3.50%	-12.22%	-14.35%	-12.58%	-11.97%
Deposits in LCU	95634.13	0.39%	0.12%	0.74%	0.79%	0.48%	0.26%
Foreign reserves	104354.01	0.00%	0.06%	0.10%	0.17%	0.26%	0.34%
Government bonds	32187.93	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Supply of money	43425.11	1.79%	1.66%	4.73%	5.69%	5.43%	5.55%
Required reserves in LCU	11476.09	0.39%	0.12%	0.74%	0.79%	0.48%	0.26%
Required reserves in FCU	13057.59	-4.95%	-3.50%	-12.22%	-14.35%	-12.58%	-11.97%

Source: CGE simulation.

Table 7 shows the evolution of financial variables (in stocks) after nominal devaluation in 2020. Nominal devaluation had the desired effect on foreign reserves, which increased with respect to the BAU but only starting in 2021. On the other hand, FCU deposits decreased while deposits in LCU increased. As deposits in FCU fell, required reserves fell correspondingly.

6.2 Policy-Response Scenario

In our policy-response scenario, nominal devaluation was accompanied by a fiscal adjustment. According to Alesina et al. (2017), fiscal adjustments based on spending cuts have usually been less detrimental to growth than are those based on taxes. We explored whether this was the case for the Bolivian economy. In this scenario (dev+gcon), a 15% devaluation was accompanied by a 15% reduction in government expenditures. Table 8 shows the simulation results.

Table 8: Real Macro Indicators
(Percent Change with Respect to the Baseline Scenario, Devaluation Scenario + gcon)

NATIONAL ACCOUNTS (% change)	Base LCU	2020	2021	2022	2023	2024	2025
Household consumption	1418.11	10.17%	4.42%	2.75%	4.16%	4.85%	4.62%
Fixed investment	589.31	11.34%	13.65%	13.86%	12.86%	12.88%	13.24%
Government consumption	424.11	-7.95%	-6.59%	-11.56%	-11.99%	-10.75%	-10.83%
Exports	1091.13	3.92%	3.07%	6.62%	7.32%	6.66%	6.86%
Imports	964.86	-2.93%	-4.78%	-4.42%	-3.98%	-3.86%	-3.76%
GDP market price	2598.92	11.09%	9.18%	9.33%	9.98%	10.17%	10.21%
Net indirect taxes	321.92	12.50%	10.07%	10.66%	11.36%	11.49%	11.59%
GDP factor cost	2244.02	10.87%	9.03%	9.10%	9.75%	9.96%	9.99%
PRICE INDICES (100=base)							
Consumer price index	0.97	11.13%	10.72%	8.15%	8.19%	8.90%	8.84%
Domestic price index	1.10	10.99%	10.55%	8.12%	8.16%	8.86%	8.83%
Terms of trade	0.88	-0.03%	0.00%	0.19%	0.18%	0.11%	0.11%
World price index	1.05	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Real exchange rate	1.03	4.06%	4.09%	7.13%	7.21%	6.37%	6.43%
FISCAL ACCOUNTS (% change)							
Government savings	241.90	57.84%	50.85%	69.10%	75.81%	76.03%	80.75%
Total government income	875.57	14.14%	12.37%	13.40%	14.17%	14.27%	14.45%
Government consumption	414.35	-15.00%	-15.00%	-15.00%	-15.00%	-15.00%	-15.00%
Government investment	243.54	-3.57%	0.58%	4.01%	2.19%	1.44%	2.20%
Transfers to households	112.50	11.13%	10.72%	8.15%	8.19%	8.90%	8.84%
EXTERNAL ACCOUNTS (% change)							
Current Account Balance	136.67	71.33%	72.99%	90.73%	86.63%	77.22%	74.44%

Source: CGE simulation.

One of the main effects that stand out by comparing Table 8 with Table 6 is that the effect on inflation was smaller after a nominal devaluation. While the average variation in the consumer price index was 11.9% (Table 6), it was only 9.3% in Table 8. This was an important result because it showed how fiscal policy helped monetary policy accomplish price stabilization. Second, the current account balance displayed a larger increase with respect to the BAU. This meant that the nominal devaluation had a stronger effect on the current account balance.

The larger improvement in the current account balance was the result of a larger depreciation of the real exchange rate, which was explained by a larger increase in nominal exchange rate than in domestic prices. Moreover, a permanent increase in exports also took place (an average increase of 5.7% with respect to the BAU). As expected, the decrease in imports was also larger in this policy-response scenario; a permanent recovery of the terms of trade beginning in 2022 was also observed.

The cut in government consumption generated a larger increase in government savings; however, government investment fell in 2020. Therefore, the rise in fixed investment had to be explained by an increase in private investment, leading to a crowding-in effect. GDP grew, on average, by 3.5% between 2020 and 2025 and, although this was the same rate of growth as under the dev scenario, it did not have the same volatility, as shown in Figure 3.

Table 9: Financial Stocks Results (Percent Change with Respect to the Baseline Scenario, Devaluation Scenario + gcon)

STOCK (% change)	Base LCU	2020	2021	2022	2023	2024	2025
Credit to firms by commercial bank	111979.10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Credit to domestic agents by RoW	12951.51	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Deposits in FCU	19635.48	-5.22%	-5.46%	-13.77%	-13.59%	-11.83%	-11.94%
Deposits in LCU	95634.13	0.48%	0.43%	1.10%	1.02%	0.79%	0.72%
Foreign reserves	104354.01	0.00%	0.08%	0.17%	0.30%	0.44%	0.57%
Government bonds	32187.93	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Supply of money	43425.11	1.73%	1.96%	4.73%	4.80%	4.39%	4.55%
Required reserves in LCU	11476.09	0.48%	0.43%	1.10%	1.02%	0.79%	0.72%
Required reserves in FCU	13057.59	-5.22%	-5.46%	-13.77%	-13.59%	-11.83%	-11.94%

Source: CGE simulation.

Regarding financial variables, Table 9 shows that the effects of this policy-response scenario simulation were the same as in the devaluation-only scenario; only the magnitudes of impact changed. There was a drop in deposits in FCU and an increase in deposits in LCU. The supply of money increased, which was explained by an increase in consumption. Foreign reserves increased on average by 0.26%.

6.3 External-Shock Scenario

The third scenario combined a 15% devaluation of the nominal exchange rate with a recovery in the terms of trade, specifically a 15% increase in the export price of gas, the main export commodity of the Bolivian economy (dev+pwegas). This scenario was intended to analyze the impact of a nominal devaluation in the context of improvement in commodity prices on international markets. This was precisely the result the government was hoping for so that no adjustment in public spending would be necessary. Table 10 shows the impact on real macro variables.

Table 10: Real Macro Indicators (Percent Change with Respect to the Baseline Scenario, Devaluation Scenario + pwegas)

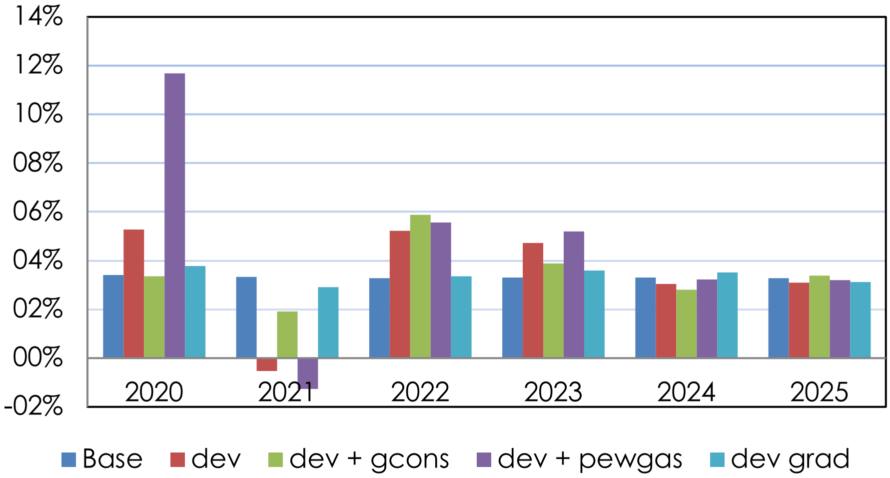
NATIONAL ACCOUNT (% change)	Base LCU	2020	2021	2022	2023	2024	2025
Household consumption	1418.11	11.01%	7.46%	4.12%	5.21%	7.10%	7.68%
Fixed investment	589.31	14.08%	16.64%	18.54%	17.57%	17.27%	17.87%
Government consumption	424.11	9.02%	21.15%	14.82%	11.47%	13.23%	14.60%
Exports	1091.13	6.92%	1.38%	4.79%	7.43%	7.35%	7.33%
Imports	964.86	-0.52%	-2.64%	-2.47%	-1.65%	-1.03%	-0.62%
GDP market price	2598.92	21.09%	19.84%	19.51%	20.61%	21.67%	22.33%
Net indirect taxes	321.92	16.78%	13.65%	13.76%	14.93%	15.62%	15.97%
GDP factor cost	2244.02	21.79%	20.83%	20.41%	21.49%	22.61%	23.31%
PRICE INDICES (100=base)							
Consumer price index	0.97	12.10%	16.10%	13.26%	12.24%	13.31%	14.01%
Domestic price index	1.10	13.94%	17.72%	15.00%	14.00%	15.04%	15.73%
Terms of trade	0.88	1.15%	0.99%	1.20%	1.24%	1.16%	1.12%
World price index	1.05	1.11%	1.11%	1.11%	1.11%	1.11%	1.11%
Real exchange rate	1.03	1.61%	-3.06%	-0.14%	1.17%	0.14%	-0.56%
FISCAL ACCOUNTS (% change)							
Government Savings	241.90	69.20%	33.30%	53.09%	69.96%	71.01%	72.13%
Total government income	875.57	25.74%	22.84%	23.88%	25.71%	26.60%	27.19%
Government consumption	414.35	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Government investment	243.54	-1.10%	-1.62%	5.17%	4.85%	3.29%	3.70%
Transfers to households	112.50	12.10%	16.10%	13.26%	12.24%	13.31%	14.01%
EXTERNAL ACCOUNTS (% change)							
Current Account Balance	136.67251	170.29%	127.60%	143.22%	147.54%	136.06%	128.22%

Source: CGE simulation.

This scenario was very similar to the dev scenario in terms of the effect on exports. Exports increased by 6.9% in 2020 but then increased by only 1.4% in 2021. In this scenario, inflation increased more, in particular in 2021. The variation in the CPI was 16.1%, which was larger than the devaluation. Therefore, we observed a real exchange appreciation of -3.06%. Even though the real exchange rate appreciated, exports, fueled by the higher price of gas, increased. Real exchange appreciation continued in 2022.

The government's bet was fulfilled in this scenario, but only in the short run, as seen in the following figure. The economy was capable of growth of 11.7% in 2020, while in the BAU it grew at only 3.4%. In 2021, however, the economy decreased by -1.3%. Nevertheless, when we added the rates of growth in the years 2020 and 2021, we found that the dev+pewgas scenario was still better in terms of growth: the accumulated rate of growth was 10.4% but was half that (5.3%) in the dev+gcons scenario.

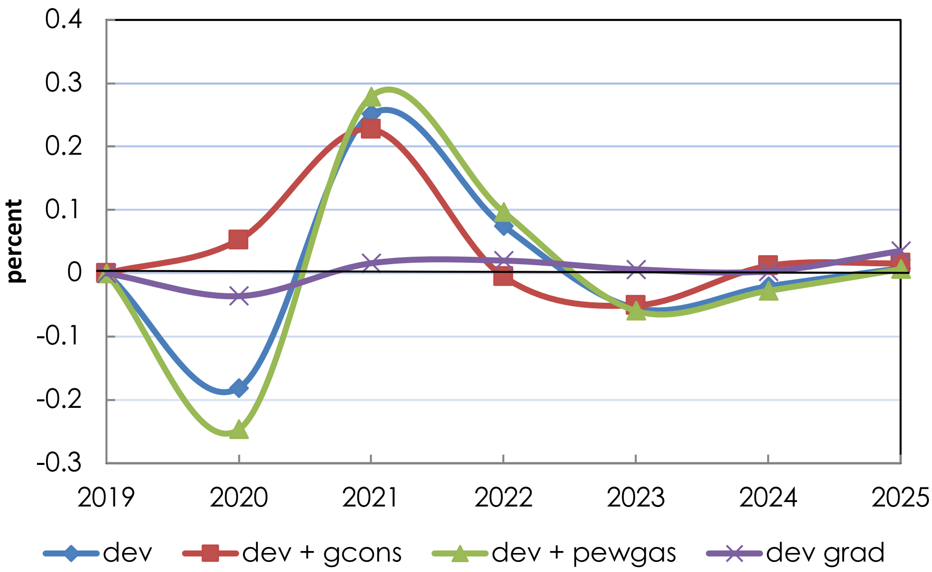
Figure 3: GDP Growth



Source: CGE simulation.

Figure 4 presents the evolution of the unemployment rate for the period 2019-2025 under the four scenarios analyzed. It can be seen that the third scenario (dev+pewgas) displayed the larger decrease in the unemployment rate in 2020. This can be explained by the large increase observed in the rate of growth in 2020. Although the drop in the rate of growth in 2021 was larger than the fall under the dev scenario, the overshooting effect was not as large as in that scenario. By the year 2025, this was the scenario with the smallest increase in the unemployment rate (0.6%)

Figure 4: Unemployment Rate (Deviation from BAU, in Percent)



Source: CGE simulation.

Our results under Scenario 3 followed the same trend in financial variables that appeared in other scenarios. We observed a large increase in the supply of money at the expense of a reduction of deposits in FCU. This was a balance-sheet effect. Foreign reserves increased with respect to the BAU scenario but at a higher rate, which meant they increased not only by the nominal increase in LCU value but also by an increase in the amount of foreign exchange that, itself, was the result of an increase in the value of exports. Foreign reserves increased on average by 0.5% while, in the dev scenario, they increased by only 0.15% with respect to the BAU.

6.4 Gradual-Devaluation Scenario

As a fourth scenario, we simulated a gradual devaluation of the nominal exchange rate. That is, we simulated a 3% initial change in the nominal exchange rate in 2020 and then increased that change by 3% each year until we reached a 15% devaluation rate in 2024 and held that rate thereafter. Table 11 shows the main results of these devaluations on macroeconomic variables. Considering our three simulated scenarios, what became apparent was that, in general, gradual devaluation reflected an intermediate scenario between constant-devaluation and the combined fiscal-adjustment/price-increase scenarios. In other words, this fourth scenario moved the least from BAU.

Domestic components of aggregate demand—that is, household consumption, private investment, and government consumption—deviated positively and increasingly from the baseline scenario. Gradual devaluation also seemed to incentivize exports gradually because, with a 3% devaluation, exports were not significantly different from the baseline scenario (0.76%), although they increased by 2.47% with respect to the BAU when devaluation was at its peak in 2024. On the other hand, imports moved much further from the baseline scenario, exceeding export behavior in absolute terms. As a consequence, the current account balance in this scenario was positive for the simulated periods because exports were boosted following the gradual adjustment. It could be argued that the volume of imports exerted a downward pressure as the result of improvement in the terms of trade. Therefore, the devaluation achieved its two objectives—i.e., it incentivized exports and discouraged imports, but it did so gradually and slowly. As a net result of the response of the components of aggregate demand under this scenario, the GDP moved positively and gradually from the baseline scenario, exponentially during the first years and then decreasing after 2024.

Table 11: Real Macro Indicators (Percent Change with Respect to the Baseline Scenario, Gradual Devaluation Scenario)

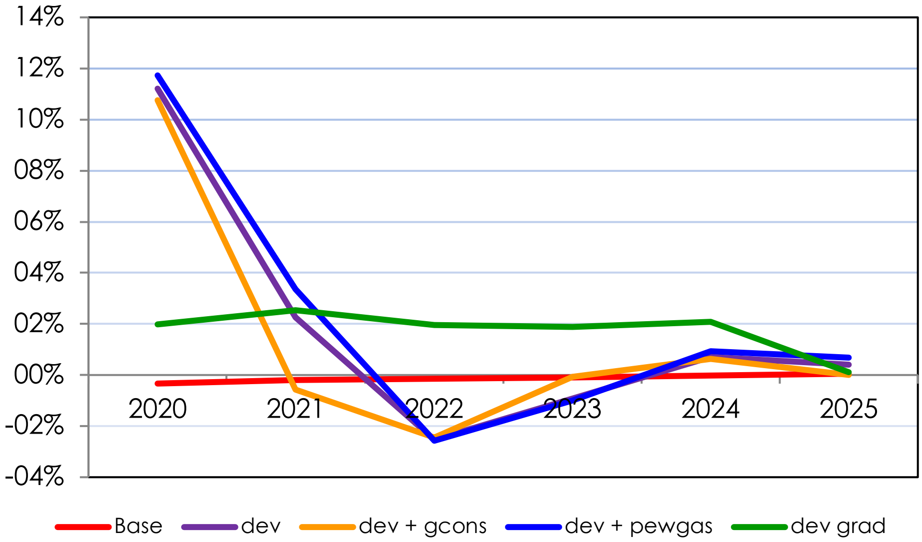
NATIONAL ACCOUNTS (% change)	Base LCU	Shock: gradual devaluation 2020	2021	2022	2023	2024	2025
Household consumption	1418.11	2.11%	3.33%	3.92%	4.80%	5.88%	5.04%
Fixed investment	589.31	2.40%	5.26%	8.36%	11.25%	14.13%	14.70%
Government consumption	424.11	1.76%	5.14%	7.23%	9.01%	11.16%	11.74%
Exports	1091.13	0.76%	0.61%	1.15%	1.89%	2.47%	2.35%
Imports	964.86	-0.43%	-1.30%	-2.11%	-2.75%	-3.28%	-3.44%
GDP market price	2598.92	2.70%	5.09%	7.37%	9.80%	12.34%	12.23%
Net indirect taxes	321.92	2.68%	4.78%	6.90%	9.20%	11.57%	11.33%
GDP factor cost	2244.02	2.71%	5.14%	7.44%	9.89%	12.44%	12.36%
PRICE INDICES (100=base)							
Consumer price index	0.97	2.33%	5.13%	7.33%	9.45%	11.75%	11.82%
Domestic price index	1.10	2.32%	5.08%	7.25%	9.37%	11.66%	11.72%
Terms of trade	0.88	-6.98%	-5.43%	-3.60%	-1.83%	-0.16%	-0.20%
World price index	1.05	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Real exchange rate	1.03	0.77%	0.86%	1.62%	2.46%	3.07%	2.92%
FISCAL ACCOUNTS (% change)							
Government savings	241.90	5.65%	6.08%	9.92%	15.41%	20.39%	18.84%
Total government income	875.57	2.91%	5.31%	7.82%	10.53%	13.30%	13.18%
Government consumption	414.35	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Government investment	243.54	-0.56%	-0.91%	-0.05%	0.50%	0.83%	1.74%
Transfers to households	112.50	2.33%	5.13%	7.33%	9.45%	11.75%	11.82%
EXTERNAL ACCOUNTS (% change)							
Current Account Balance	136.67	11.96%	19.18%	30.17%	40.59%	49.00%	47.25%

Source: Authors' calculations.

On the fiscal side, we observed a progressive increase in government savings with an initial 5.6% in 2020. Government investment initially fell between 2020 and 2022 and then increased because government savings also increased. Government income increased in 2020 with respect to gradual annual increase in BAU. Regarding the response of financial stocks to a gradual devaluation, household deposits in foreign currency decreased progressively until they deviated 11% from the baseline scenario in 2025. Conversely, gradual devaluation favored deposits in local currency very slightly; as a consequence, required reserves in LCU also increased quite modestly while those expressed in FCU decreased. Due to the slight increase in deposits in LCU, the money supply responded positively. The table also shows that international reserves did not improve significantly, considering that, in 2025, they moved only 0.2% positively from baseline.

One of the main reasons to consider gradual devaluation is the idea of softening the inflationary effects that other shock policies could generate. Figure 5 shows that such an approach was correct: gradual devaluation prevented the large increases in the inflation rate observed in 2020 and kept the inflation rate at an average of 1.8% between 2020 and 2025. Note also that, even though we observed negative inflation rates in 2022 under the three shock scenarios, by 2025 the inflation rate converged to match the baseline scenario. The best scenario in 2025, however, was fiscal adjustment because the inflation rate reached a value of 0.

Figure 5: Inflation Rate



Source: CGE simulation.

VII. Conclusions and Policy Implications

Over the last twenty years Bolivia has gone from a period of crisis (1998-2003) to a period of bonanza (2004-2013) and is currently in a period of economic deceleration with characteristics very similar to those that prevailed during the 1970s before the balance of payments crisis in 1978—that is, twin deficits, increased external debt, low inflation anchored to a regime of fixed exchange rates, and a sustained decline in foreign reserves. This context led us to ask whether the exchange rate should be made more flexible to avoid a drop in reserves and, therefore, a potential crisis in balance of payments.

We answered this question by employing a real-financial CGE model calibrated for a 2014 Bolivian F-SAM. First, we simulated a 15% devaluation of the nominal exchange rate. The results showed a U-shaped effect on all national account variables—that is, there was a positive effect in 2020, which weakened in 2021 and then recovered in subsequent years. In other words, devaluation had only a transitory effect with respect to the BAU. On the other hand, if policymakers' fear was that devaluation would cause inflation and appreciation (rather than depreciation) in the real exchange rate, our results showed that this would not be the case. The real exchange rate depreciated in 2020 and, to a lesser extent, in 2021. This meant that exports increased in 2020 and decreased by -0.9% in 2021.

These unsatisfactory results led us to analyze a policy-response scenario, in which devaluation was accompanied by a reduction in public spending of the same magnitude (15%). The results were better because the change in the CPI was smaller. This allowed continuous real depreciation and a continuous increase in exports, with a corresponding large recovery of the current account deficit. We also observed that the economy grew by 3.4%, 1.9%, and 5.9% in the years 2020, 2021, and 2022. The only negative aspect of this scenario was its strong impact on unemployment in 2020. This was explained by the high concentration of employment in the public sector, which was abruptly reduced.

We analyzed a third scenario in which devaluation was accompanied by an increase in the price of gas, which remains Bolivia's main export commodity. We observed strong growth volatility. The economy grew by 12% in 2020, but then it decreased by 1.3% in 2021. In terms of accumulated growth, this was certainly the best scenario, but not in terms of stability because the inflation rate soared to 11.7% in 2020. In this scenario, public investment fell less with respect to the BAU than it did in the fiscal-adjustment scenario, which can be explained by a larger increase in government savings which, in turn, increased because government income increased through export taxes.

Finally, we simulated a gradual-devaluation scenario, increasing devaluation 3% per year until reaching a rate of 15% in 2024. In comparison with the three previous scenarios, the gradual-devaluation scenario moved least from the status quo or baseline scenario. The components of aggregate demand gradually but slowly increased, and devaluation slowly favored exports on account of imports. This scenario is recommended if the government hopes to avoid a jump in the inflation rate in 2020 and wants to distribute the effects of inflation smoothly across the years. This does not mean that inflation could not be controlled in the other shock scenarios, however. By 2025, all scenarios reached low levels of inflation; the best of these was the fiscal-adjustment scenario in which no inflation occurred.

It is clear that the policy-response scenario and the external-shock scenario dominated the devaluation scenario only. Given that the external-shock scenario was uncertain, therefore, and considering that Bolivia will probably reduce gas production in the coming years, we recommend following the devaluation scenario accompanied with a fiscal adjustment. In addition, this is the best scenario in terms of the inflation rate; the average inflation rate between 2020 and 2025 was 1.4% under this scenario, while it was 1.8% under the gradual-devaluation scenario.

Because our real-financial CGE model did not allow us to examine welfare impacts and, in particular, distributional impacts, future studies should add a microsimulation framework to the model. This would, of course, imply disaggregating households, including the informal sector (which is large in Bolivia), disaggregating labor factors, or proposing job categories. Because households were not disaggregated and poverty indicators were not introduced into the model, we have not addressed the specific topic of poverty. Nevertheless, this model contributes to macroeconomic analysis in Bolivia because it provides a new real-financial CGE model, different from those of Jemio (1993 and 2001). In fact, ours is also the first real-financial model of the family of PEP models.

References

Acharya, S. (2014). Trade Liberalisation in Fixed and Flexible Exchange Rate Regimes: A CGE Analysis for Nepal. Journal of Economic Policy Reform, 17(2), 129-148.

Agénor, P. R., Izquierdo, A., and Fofack, H. (2003). The Integrated Macroeconomic Model for Poverty Analysis: A Quantitative Macroeconomic Framework for the Analysis of Poverty Reduction Strategies. Policy Research Working Paper No. WPS 3092. Washington, DC: World Bank. .

Agénor, P-R., Tarp Jensen, H., Verghis, M., and Yeldan, E. (2006). Disinflation, Fiscal Sustainability, and Labor Market Adjustment in Turkey. Policy Research Working Paper No. WPS 3804.Washington, DC: World Bank.

Aguilar, T. and Aliaga, J. (2009). The Climate Change Effects on the Agricultural Sector of Bolivia. Revista Latinoamericana de Desarrollo Económico, 12, 7-30.

Aguilar, T. and Aliaga, J. (2010). Bolivia en el Contexto de la Crisis Económica Internacional. Revista Latinoamericana de Desarrollo Económico, 13, 91-116.

Ahmad El Talla, A. H. (2013). Devaluation and Output Growth in Palestine: Evidence from a CGE Model. European Journal of Business and Economics, 8(4), 26-31.

Alesina, A., Barbiero, O., Favero, C., Giavazzi, F., and Paradisi, M. (2017). The Effects of Fiscal Consolidations: Theory and Evidence. NBER Working Paper 23385. Cambridge, MA: National Bureau of Economic Research.

Aliaga, J. and Villegas, H. (2011). Poverty, Indigence and Public Investment in Bolivia: A Simulation Analysis. Documento de Trabajo 5/2011. La Paz, Bolivia: Universidad Católica Boliviana/Instituto de Investigaciones Socioeconómicas (IISEC).

Aliaga, J., Trivéz, F. J.., Ramos. R., and Sanchez J. (2007). Shocks Externos y Escenarios de Política Macroeconómica en Bolivia. In P. Moyano, N. Somarriba, J. Fernádez, and J. L. Rojo, Eds., Anales de Economía Aplicada 2007. Valladolid, España: Asociación Internacional de Economía Aplicada, 87-111.

Andersen, L. E. and Evia, J. L. (2003). The Effectiveness of Foreign Aid in Bolivia: Final Report. No. 10/03. La Paz, Bolivia: Universidad Católica Boliviana/Instituto de Investigaciones Socioeconómicas (IISEC).

Andersen, L. E. and Faris, R. (2002). Natural Gas and Income Distribution in Bolivia (Vol. 1). La Paz, Bolivia: Universidad Católica Boliviana/Instituto de Investigaciones Socioeconómicas (IISEC) Universidad Católica Boliviana.

Andersen, L. E., Caro, J., Faris R., and Medinaceli, M. (2006). Natural Gas and Inequality in Bolivia after Nationalization (No. 05/2006). La Paz, Bolivia: Institute for Advanced Development Studies (INESAD).

Blanchflower, D. and Oswald, A. (2005). The Wage Curve Reloaded. NBER Working Paper No. 11338. Cambridge, MA: National Bureau of Economic Research.

Bourguignon, F., Branson, H. W., and De Melo, J. (1989). Macroeconomic Adjustment and Income Distribution: A Macro-Micro Simulation Model. Research Programme on Adjustment Programmes and Equitable Growth Working Paper No. 1. Paris, France: Organisation for Economic Co-Operation and Development Centre.

Canavire-Bacarreza, G. and Mariscal, M. (2010). Implicaciones de la Política Macroeconómica, los Choques Externos y los Sistemas de Protección Social en la

Pobreza, la Desigualdad y la Vulnerabilidad en América Latina y el Caribe: Bolivia. La Paz, Bolivia: Unidad de Análisis en Políticas Socioeconómicas (UDAPE).

Cicowiez, M. and Sánchez, M.V. (2009). Modelo de Análisis de Choques Exógenos y de Protección Económica y Social. Unpublished manuscript.

Cicowiez, M. and Machicado, C.G. (2011). Effects of the Global Financial and Economic Crisis on the Bolivian Economy: A CGE Approach. CEDLAS Documentos de Trabajo. La Plata, Argentina: Universidad Nacional de la Plata/Centro de Estudios Distributivos, Laborales y Sociales (CEDLAS).

Cicowiez, M. (2019). Extensions to PEP-1-1 V2.1. Unpublished manuscript.

Debowicz, D. (2010). Modelling Trade and Financial Liberalization Effects for Argentina. Doctoral dissertation, University of Sussex.

Decaluwé, B. and Nsengiyumva, F. (1994). Policy Impact under Credit Rationing: A Real and Financial CGE of Rwanda. Journal of African Economies, 3(2), 262-308.

Decaluwé, B., Robichaud, V., Lemelin, A., and Maisonnave, H. (2013). PEP-1-1: The PEP Standard Single Country, Static CGE Model. Version 2.1. Quebec City, Quebec, Canada: Laval University/Partnership for Economic Policy (PEP).

Dervis, K., De Melo, J., and Robinson, S. (1982). General Equilibrium Models for Development Policy. Washington, DC: The International Bank for Reconstruction and Development/The World Bank.

Dixon, P., Rimmer, M., and Roos, L. (2014). Adding Financial Flows to a CGE Model of PNG. Centre of Policy Studies Working Paper No. G-242. Melbourne, Australia: Victoria University.

Fargeix, A. and Sadoulet, E. (1990). A Financial Computable General Equilibrium Model for the Analysis of Equator's Stabilization Programs. OECD Working Paper No.10. Paris, France: Organisation for Economic Co-Operation and Development (OECD).

Feltenstein, A. and Shah, A. (1995). General Equilibrium Effects of Investment Incentives in Mexico. Journal of Development Economics, 46(2), 253-269.

Giesecke, J. A., Dixon, P., and Rimmer, M. (2017). The Economy-Wide Impacts of a Rise in the Capital Adequacy Ratios of Australian Banks. Economic Record, 93, 16-37.

Jemio, L. C. (1993). Micro-and Macroeconomic Adjustment in Bolivia (1970-89): A Neostructuralist Analysis of External Shocks, Adjustment and Stabilization Policies. The Hague: The Institute of Social Studies.

Jemio, L. C. (2001). Simulation of External Shocks and Policies With the CGE Model for Bolivia. In Luis Carlos Jemio, Ed., Debt, Crisis and Reform in Bolivia. UK: Palgrave MacMillan in association with the Institute of Social Studies, 311-369.

Jemio, L. C. and Wiebelt, M. (2002). Macroeconomic Impacts of External Shocks and Anti-Shock Policies in Bolivia: A CGE Analysis. Kiel Working Paper No. 1100. Kiel, Germany: Kiel Institute for World Economics.

Jimenez, W. (2007). Bolivia Export Promotion and Its Effects on Growth, Employment and Poverty. In R. Vos, E. Ganuza, S. Morley, and S. Robinson, Eds., Who Gains from Free Trade: Export-Led Growth, Inequality and Poverty in Latin America. New York, NY: Rutledge Studies in Development Economics, 150-183.

Kehoe, T., Machicado, C.G., and Perez-Cajias, J. (2019). The Monetary and Fiscal History of Bolivia, 1960-2017. NBER Working Paper No. 25523. Cambridge, MA: National Bureau of Economic Research.

Klasen, S. (2006). Macroeconomic Policy and Pro-Poor Growth in Bolivia. IAI Discussion Paper 143. Goettingen, Germany: Ibero-America Institute for Economic Research.

Krugman, P. (1979). A Model of Balance-of-Payment Crises. Journal of Money, Credit and Banking, 11(3), 311-325.

Lay, J., Thiele, R., and Wiebelt, M. (2004). Pro-Poor Growth in Bolivia: Accounting for External Shocks and Policy Reforms. Kiel, Germany: Institut für Weltwirtschaft an der Universitat Kiel.

Lay, J., Thiele, R., and Wiebelt, M. Wiebelt, M. (2008a). Resource Booms, Inequality, and Poverty: The Case of Gas in Bolivia. Review of Income and Wealth, 54(3), 407-437.

Lay, J., Thiele, R., and Wiebelt, M. Wiebelt, M. (2008b). Shocks, Policy Reforms and Pro-Poor Growth in Bolivia: A Simulation Analysis. Review of Development Economics, 12(1), 37-56.

Lewis, J. D. (1991). Financial Repression and Liberalization in a General Equilibrium Model with Financial Markets. Journal of Policy Modelling, 14(2), 135-166.

Lemelin, A. (2017). Current Account Balances, Exchange Rates, and Fundamental Properties of Walrasian CGE World Models: A Pedagogical Exposition. Journal of Global Economic Analysis, 2(1), 215-324.

Liu, J-Y., Lin, S-M., Xia, Y., Fan, Y., and Wu, J. (2015). A Financial CGE Model Analysis: Oil Price Shocks and Monetary Policy Responses in China. Economic Modelling, 51, 534-543.

Morales, R., Gomez, E., Cueto, M., Parisaca, E., and Illanes, J. (2016). The Impact of Wage Policy on Informality and Growth. Unpublished manuscript.

Naastepad, C. W. M. (2001). The Macro-Economic Effects of Directed Credit Policies: A Real-Financial CGE Evaluation for India. Development and Change, 32, 477-506.

Naastepad, C. W. M. (2003). Restoring Macroeconomic Stability through Fiscal Adjustment: A Real-Financial CGE Analysis for India. Review of Development Economics, 7(3), 445-461.

Nunnenkamp, P., Schweickert, R., and Wiebelt, M., M. (2007). Distributional Effects of FDI: How the Interaction of FDI and Economic Policy Affects Poor Households in Bolivia, Development Policy Review, 25(4), 429-450.

Pauw, K., Dorosh, P., and Mazunda, J. (2013). Exchange Rate Policy and Devaluation in Malawi. IFPRI Discussion Paper 01253.Washington, DC: (International Food Policy Research Institute.

Reinert, K. A. and Roland-Holst, D. W. (1997). Social Accounting Matrices. In J. F. Francois and K. A. Reinert, Eds., Applied Methods for Trade Policy Analysis: A Handbook. Cambridge, MA: Cambridge University Press, 94-121.

Robinson, S. (1991). Macroeconomics, Financial Variables, and Computable General Equilibrium Models. World Development, 19, 1509-1525.

Rosenzweig, J. A. and Taylor, L. (1990). Devaluation, Capital Flows, and Crowding-Out: A CGE Model with Portfolio Choice for Thailand. In L. Taylor, Ed., Socially Relevant Policy Analysis: Structuralist Computable General Equilibrium Models for the Developing World. Cambridge, MA: MIT Press, 302-332.

Schweickert, R., Thiele, R., and Wiebelt, M. (2005). Macroeconomic and Distributional Effects of Devaluation in a Dollarized Economy: A CGE Analysis for Bolivia (No. 120). Goettingen, Germany: Goettingen University/Ibero-America Institute for Economic Research.

Simorangkir, I and Adamanti, J. (2012). Financial Computable General Equilibrium (FCGE) Model: Exploring Real-Financial Linkage on Indonesian Economy During Financial Crisis. Paper presented at the BSP International Research Conference on Contemporary Challenges to Monetary Policy, 28-29 February 2012, Manila, The Philippines.

Tellería, R. and Ludena, C. (2015). Bolivia-European Union Trade Agreement: Is It an Option for the Morales Administration? Latin American Research Review, 50(3), 24-45.

Tellería, R., Ludena, C. E., Shankar, B., and Bennett, R. (2008). Would a Free Trade Agreement Between Bolivia and the United States Prove Beneficial to Bolivian Households? Unpublished manuscript. Available at https://pdfs.semanticscholar.org/5a1c/f225768e91751021aaceab4df011fb91ebc0.pdf .

Telli, C., Voyvoda, E., and Yeldan, E. (2003). Macroeconomics of Twin-Targeting in Turkey: Analytics of a Financial Computable General Equilibrium Model. International Review of Applied Economics, 22(2), 227-242.

Thiele, R. and Wiebelt, M. (2003). Attacking Poverty in Bolivia—Past Evidence and Future Prospects: Lessons from a CGE Analysis. Documento de Trabajo No 6/2003. La Paz, Bolivia: Universidad Católica Boliviana/Instituto de Investigaciones Socioeconómicas (IISEC).

Thiele, R. and Piazolo, D. (2003). A Social Accounting Matrix for Bolivia Featuring Formal and Informal Activities. Cuadernos de Economía, 40(120), 285-318.

Thissen, M. (1999). Financial CGE Models Two Decades of Research. Unpublished manuscript.

Thissen, M. and Lensink, R. (2001). Macroeconomic Effects of a Currency Devaluation in Egypt: An Analysis with a Computable General Equilibrium Model with Financial Markets and Forward-Looking Expectations. Journal of Policy Modelling, 23, 411-419.

Tobin, J. (1969). A General Equilibrium Approach to Monetary Theory. Journal of Money, Credit and Banking, 1(1), 15-29.

Villegas, H., Aguilar, T., Vargas, J., and Montaño, C. (2010). Inversión Pública y Pobreza en Bolivia. Documento de Trabajo No. 08/2010. La Paz, Bolivia: Universidad Católica Boliviana/Instituto de Investigaciones Socioeconómicas (IISEC).

Wiebelt, M. (2004). GEM-PIA: A Real-Financial General Equilibrium Model for Poverty Impact Analysis Technical Description. Kiel Working Paper No. 1230. Kiel, Germany: Kiel Institute for the World Economy.

Yeldan, E. (1997). Financial Liberalisation and Fiscal Repression in Turkey: Policy Analysis in a CGE Model with Financial Markets. Journal of Policy Modelling, 19(1),79-117.

Yeldan, E. (1998). On Structural Sources of the 1994 Turkish Crisis: A CGE Modelling Analysis. International Review of Applied Economics, 12(3), 387-414.

Appendices

Appendix A: The Real Financial Social Accounting Matrix (F-SAM)

Table A.1: The Structure of the F-SAM

		CURRENT ACCOUNTS											CAPITAL ACCOUNTS							
		Activities	Commodities	Factors of production	Households	Enterprises	Government	Private banks	Central bank	Rest of the world	Taxes	Interests	Households	Enterprises	Government	Private banks	Central bank	Rest of the world	Investment	Total
CURRENT ACCOUNTS	Activities		Domestic supply																	Total revenue
	Commodities	Intermediate demand			Household consumption		Government consumption			Exports									Investment	Total demand
	Factors of production	Value added																		Factor income
	Households			Wages		Transfers	Transfers			Transfers		Interests received from deposits on banks								Household income
	Enterprises			Profits			Transfers			Transfers										Firms' incomes
	Government									Transfers	Tax receipts									Government revenues
	Private banks			Profits								Interests received from loans								Banks' revenues
	Central bank			Profits																Cantral bank's revenues
	Rest of the world		Imports		Transfers	Transfers	Transfers					Interests received from extrnal debt								Payments to RoW
	Taxes		Import tariffs & indirect taxes		Direct taxes	Direct taxes		Direct taxes												Tax payments
	Interests					Interests paid on bank loans and external debt	Interests paid on bonds, credit from cantral bank and external debt	Interests paid on external debt		Interests paid on international reserves										Interest payments
CAPITAL ACCOUNTS	Households				Household savings															Househols' liabilities
	Enterprises					Firms´ savings										Credit to firms		Firm's foreign debt		Firm´s liabilities
	Government						Government savings									Government bonds	Credit to public sector	Government's foreign debt		Government's liabilities
	Private banks							Banks' savings					Deposits on banks					Banks' foreign debt		Banks' liabilities
	Central bank								Central banks´savings				Cash holdings							Central bank´s liabilities
	Rest of the world									Foreign savings							Gross international reserves			RoW liabilities
	Investment													Private investment	Public investment					Total investment
	Total	Total cost	Total supply	Factor income	Households' outlays	Firms' outlays	Government's outlays	Banks´outlays	Central bank's outlays	Payments from RoW	Total taxes	Total interests	Housholds' assets	Firm´s assets	Government's assets	Banks' assets	Central bank´s assets	RoW assets	Total investment	

Table A.2: F-SAM for Bolivia 2014 (Millions of Bolivianos)

	act	com	f-lab-asal	f-cap	hhd	firm	pb	cb	gov	row	tax-act	sub-act	cssoc	tax-imp	tax-vat	ax-com	tax-dir	int-hhd	int-firm	int-pb	int-cb	int-gov	int-row	cap-hhd	cap-firm	cap-pb	dep-lcu	dep-fcu	cap-cb	rr-lcu	rr-fcu	cap-gov	cap-row	invng	invg	dstk	total
act		351019.02																																			351019
com	180,013				143499.69				33532.6	98709.82																								19542.46	28297.38	117.99	503713
f-lab-as	59651.0969									139.7823																											59791
f-cap	114156.949																																				114157
hhd			59,717.71		0	107,318	683		11,250	5,196								1882.55																			186046
firm				115,909.92	21	796	304		4,912	2,325																											124268
pb				-1016.72	268	297	0	0	34	0										7830.01																	7412.4
cb				-736.25			0	0	24	0											1193.37																481.54
gov					-1,950	132	61	44	0	0	901.63	-3704	5310.83	2943.92	18631.69	35422	18236.2																				76029
row		95696.286	73.1653682		7,104	3,081	683	495	0	0													248.85														107380
tax-act	901.629007																																				901.63
sub-act	-3703.504																																				-3704
cssoc					531.08	4,779.75																															5310.8
tax-imp		2943.9188																																			2943.9
tax-vat		18631.693																																			18632
tax-com		35421.876																																			35422
tax-dir					5176.30	12671.70	388.20																														18236
int-hhd							1882.55																														1882.6
int-firm																																					0
int-pb						7808.34			21.67																												7830
int-cb									1037.52	155.85																											1193.4
int-gov																																					0
int-row						15.65	5.34		227.87																												248.85
cap-hhd					31396.4																																31396
cap-firm						-12630.8																				22215							10076				19660
cap-pb							3405.45																				25757	1269					-7272				23160
dep-lcu																								25757													25757
dep-fcu																								1269													1269.4
cap-cb								-57.15																4371						3091	844						8248.3
rr-lcu																										3091											3090.8
rr-fcu																										844											844.15
cap-gov									24989.29																	-2991			3494				2804				28297
cap-row										854.56																			4754								5608.4
invng																									19542												19542
invg																																28297.4					28297
dstk																									118												117.99
total	351019.02	503712.79	59790.8791	114156.9489	186045.82	124267.81	7412.42	481.5437	76028.92	107380.4	901.63	-3704	5310.83	2943.92	18631.69	35422	18236.2	1882.555	0	7830.007	1193.371	0	248.8509	31396.4	19660.4	23160	25756.5	1269.4	8248.3	3091	844.1	28297.4	5608.4	19542.46	28297.38	117.99	

Appendix B: Accumulated Balances of Financial Agents (flow terms)

HOUSEHOLDS	
ASSETS	LIABILITIES
Liquidity ($\Delta H_{h,t}$)	Household's savings ($SH_{h,t}$)
Domestic deposits in LCU ($\Delta DD_{h,t}^{LC}$)	
Domestic deposits in FCU ($e_t \cdot \Delta DD_{h,t}^{FC}$)	
FIRMS	
ASSETS	LIABILITIES
Private investment ($INVEST_{f,t}$)	Loans from commercial bank ($\Delta DL_{f,t}$)
	Loans from the rest of the world ($e_t \cdot \Delta FL_{f,t}$)
	Firm's savings (SF_t)
COMMERCIAL BANKS	
ASSETS	LIABILITIES
Treasury bonds ($\Delta B_{pb,t}$)	Domestic Deposits of households in LCU (ΔDD_t^{LC})
Loans to firms ($\Delta DL_{f,t}$)	Domestic Deposits of households in FCU (ΔDD_t^{FC})
Required reserves in LCU (ΔRR_t^{LC})	Net Foreign Debt ($e_t \cdot \Delta FL_{pb,t}$)
Required reserves in FCU ($e_t \cdot \Delta RR_t^{FC}$)	Commercial bank's savings (SPB_t)
CENTRAL BANK	
ASSETS	LIABILITIES
Treasury bonds ($\Delta B_{cb,t}$)	Liquidity (ΔH_t)
Foreign reserves ($e_t \cdot \Delta FF_t$)	Required reserves of commercial bank in LCU (ΔRR_t^{LC})
	Required reserves of commercial bank in FCU ($e_t \cdot \Delta RR_t^{FC}$)
	Central bank's savings (SCB_t)
GOVERNMENT	
ASSETS	LIABILITIES
Public investment ($\sum_{i \in I} \mathrm{PC}_{i,t} \cdot \mathrm{QINVG}_{i,t}$)	Bonds to commercial banks and central bank ($\Delta B_{agd,t}$)
	Foreign Debt ($e_t \cdot \Delta FL_{gov,t}$)
	Government's savings (SG_t)
REST OF THE WORLD ASSETS	LIABILITIES
Loans to domestic firms ($e_t \cdot \Delta FL_{f,t}$)	Foreign Reserves of Central Bank ($e_t \cdot \Delta FF_t$)
Loans to commercial bank ($e_t \cdot \Delta FL_{pb,t}$)	Rest of the world's savings ($SROW_t$)
Foreign Debt of government ($e_t \cdot \Delta FL_{gov,t}$)	

Appendix C: Technical Appendix

C.1 Calibration

Real Side

The different types of transfers shown in Table A.2 were identified from the integrated economic table and include business income withdrawal, interest, dividends, rent, profit sharing, insurance premiums and indemnities, social benefits, and current transfers. Unfortunately, the integrated economic table aggregated information for households and companies and for the financial sector; according to Thiele and Piazolo (2003), then, 70% of them were assigned to households and the rest to firms. The financial sector was split between commercial banks (58%) and the central bank (42%), using the central bank's share in the monetary accounts.

This somewhat ad-hoc way of splitting agents generated inconsistencies in the real part of the F-SAM. Some assumptions were therefore incorporated to maintain consistency with the national accounts. For instance, labor income was entirely allocated to households, while capital income was entirely allocated to firms. These represented 26% and 51% of GDP, respectively. This means that households received their income indirectly from the capital factor as transfers from the firms. Consequently, firm transfers to households represented 47% of GDP, which was a fairly high percentage compared to other types of transfers.

Also noteworthy were transfers made by the government to households. These were basically conditional transfers, which were applied for several years in the Bolivian economy and were successful in reducing poverty levels. These transfers amounted to 11,250 million bolivianos, which was 5% of GDP. Government transfers to companies amounted to 4,912 million bolivianos (2.1% of GDP) and were mainly transfers from the general government to public companies.

Using Employment by Sector

The PEP-1-1 model assumes that all sectors pay the same wage. In the extended PEP-1-1, the analyst can complement the SAM with data on number of workers by sectors. To do so, the remuneration to labor type l paid by the activity j is computed as

$$W_{l,t} \cdot wdist_{l,j,t}(1 + ttiw_{l,j,t})$$

where $wdist_{l,j}$ is a "distortion" factor applied for labor type l in industry j that allows modelling cases in which the factor remuneration differs across activities. In other words, each activity pays an activity-specific wage that is the product of the economy-wide wage and an activity-specific wage (distortion) term. To calibrate $\mathrm{wdist}_{l,j}$, the model dataset must provide physical labor quantities. In implementing this extension, the following Equations of the original model were modified.

$$YHL_{h,t} = \sum_{l \in L} \lambda_{h,l}^{WL} \sum_{j \in J} W_{l,t} \cdot wdist_{l,j,t} \cdot LD_{l,j,t}$$

$$TIW_{l,j,t} = ttiw_{l,j,t} \cdot W_{l,t} \cdot wdist_{l,j,t} \cdot LD_{l,j,t}$$

$$YROW_t = e \sum_{i \in I} PWM_{i,t} \cdot IM_{i,t} + \sum_{k \in K} \lambda_{row,k}^{RK} \sum_{j \in J} R_{k,j,t} \cdot KD_{k,j,t} + \sum_{l \in L} \lambda_{row,l}^{WL} \sum_{j \in J} W_{l,t} \cdot wdist_{l,j} \cdot LD_{k,j,t} + \sum_{agd \in AGD} TR_{row,agd,t}$$

$$WTI_{l,j,t} = W_{l,t} \cdot wdist_{l,j,t}(1 + ttiw_{l,j,t})$$

$$GDP\_IB_t = \sum_{l,j \in L,J} W_{l,t} \cdot wdist_{l,j,t} \cdot LD_{l,j,t} + \sum_{k,j \in K,J} RK_{k,j,t} \cdot KD_{l,j,t} + TPRODN_t + TPRCTS_t$$

C.2 Extensions to the PEP-1-1 v2.1 CGE Model: Real Side

Here, we present the modifications introduced to the single-country static PEP model PEP-1-1 v2.1. (See Cicowiez, 2019, for a detailed explanation of this model).

Exports

In the PEP 1-1 Standard Model, the world demand for exports of product i is defined in the following equation (see Equation 62 in Decaluwé et al., 2013):

$$EXD_i = EXD_i^O \left(\frac{e \cdot PWX_i}{PE_i^{FOB}} \right)^{\sigma_i^{XD}}$$

In case $\sigma_i^{XD} = \infty$, this equation is simplified as

$$PE_i^{FOB} = e \cdot PWX_i$$

which represents the "pure" form of the small-country hypothesis: producers can always sell as much as they want in the world market at the (exogenous) current price,$\mathrm{PWX_i}$. In our simulations, we assumed $\sigma_i^{XD} = \infty$. Hence, the domestic (FOB) price of exports was defined as

$$PE_{i,t}^{FOB} = e_t \cdot PWX_{i,t}$$

Current Account: Balance of Payments

Equation RW1 defines the current account balance in foreign currency. Equations W2 and RW3 define the index for domestic producer prices and the real exchange rate, respectively. As shown, variables CAB_FCU and REXR are used to select the macroeconomic closure rule for the model.

RW1 $$\mathrm{CAB_t^{FCU}} = \frac{\mathrm{CAB_t}}{\mathrm{e_t}} \quad \mathrm{t \in T}$$

RW2 $$\mathrm{DPI_t} = \sum_{\mathrm{i \in I}} \mathrm{dwts_i \cdot PL_{i,t}} \quad \mathrm{t \in T}$$

RW3 $$\mathrm{REXR_t} = \frac{\mathrm{e}}{\mathrm{DPI_t}} \quad \mathrm{t \in T}$$

where

$\mathrm{CAB_t^{FCU}}$: current account balance in foreign currency units

$\mathrm{DPI_t}$: index for domestic producer prices (PL-based)

$\mathrm{REXR_t}$: real exchange rate

$\mathrm{dwts_i}$: domestic sales price weights

Government

In the PEP 1-1 Standard Model, government consumption of commodity i is determined by this equation (see Equation 55 in Decaluwé et al., 2013):

$$PC_i \cdot CG_i = \gamma_i^{GVT} \cdot G$$

where G (current government expenditures on goods and services) is fixed and equal to its initial value (i.e., $\mathrm{G = G^O}$). As an alternative, we modified government behavior assuming that real government spending could be exogenous (i.e., all the $\mathrm{CG_i}$ variables) while G was endogenous. Specifically, we dropped the previous equation from the model and added Equations G1 and G2. In addition, we included Equation G3 to define real government savings as the ratio between nominal government savings and the GDP deflator.

$$CG_{i,t} = cgbar_{i,t} \cdot CGADJ_t \quad i \in I, \; t \in T \qquad \text{(G1)}$$

$$G_t = \sum_{i \in I} PC_{i,t} \cdot CG_{i,t} \quad t \in T \qquad \text{(G2)}$$

$$SG_t^{REAL} = \frac{SG_t}{PIXGDP_t} \quad t \in T \qquad \text{(G3)}$$

where

$CGADJ_t$: adjustment factor for CG

$cgbar_{i,t}$: base-year CG(i)

SG_t^{REAL}: real government savings

Tax Rates

By default in PEP-1-1, the government can clear its budget by adjusting savings (variable SG) or current expenditures on goods and services (variable G). Thus, we added Equations T1 and T2 to allow for changes in household income or commodity tax rates to clear government budget.

$$TTDH1_{h,t} = ttdh1bar_{h,t} \cdot TTDHADJ_t \quad h \in H, \; t \in T \qquad \text{(T1)}$$

$$TTIC_{i,t} = tticbar_{i,t} \cdot TTICADJ_t \quad i \in I, \; t \in T \qquad \text{(T2)}$$

where

$TTDHADJ_t$: adjustment factor for $TTDH1_{h,t}$

$TTICADJ_t$: adjustment factor for $TTIC_{i,t}$

$ttdh1bar_{h,t}$: exogenous (base-year) $TTDH1_{h,t}$

$tticbar_{i,t}$: exogenous (base-year) $TTIC_{i,t}$

Household Savings

By default, PEP-1-1 assumes that investment is savings-driven. In other words, the marginal propensities to save for non-government institutions are fixed while investment clears the savings-investment balance. In contrast, our model allowed the opposite assumption. To that end, Equation SH defines households' marginal propensity to save. Its structure is the same as that of Equations T1 and T2 for tax rates and G1 for government consumption. In fact, whether MPSADJ is flexible depends upon the closure rule for the savings-investment balance.

$$\text{SH} \quad sh1_{h,t} = sh1bar_{h,t} \cdot MPSADJ_t \quad \begin{matrix} h \in H \\ t \in T \end{matrix}$$

where

$\mathrm{MPSADJ_t}$: savings rate scaling factor

$\mathrm{sh1bar_{h,t}}$: exogenous (base-year)