MACROECONOMIC POLICY CHALLENGES IN LOW INCOME COUNTRIES

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Bolivia: Impact of shocks and poverty policy on household welfare

by

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Contents

Tables

Figures

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Executive Summary

This paper evaluates the short term impacts on poverty of pro-poor expenditure and total social expenditure during the 1999-2002 period of Bolivian economic recession. Observed characteristics of recession are simulated by the combined effects of negative terms of trade shock, reduction in foreign saving flows and low output growth. Evaluation is performed by simulating the impacts of shocks and social expenditures in an environment of low growth: i) on macro aggregates of consumption, income, saving and prices (based on a simple static 1-2-3 model built with 1998 data as the base year), ii) on household income and consumption levels by quintiles and areas, and iii) on consumption based poverty indicators by areas. The following were main results from experiments:

The terms of trade shock had greater negative impact on household income than reduction in foreign saving flows. In contrast, reduction in foreign saving flows had greater negative impact on household consumption than the terms of trade shock. Poverty measured by the head count ratio has been greater from reduction in foreign saving flows then from the terms of trade shock. Poverty measured by the poverty gap and poverty intensity has concentrated in rural areas, being greater from reduction in foreign saving flows then from the terms of trade shock.

Under macroeconomic stability (no shocks and 1998 macro conditions) social expenditure policy for poverty reduction would have had an important positive impact on household income and consumption levels (more so in income than consumption), in reducing the number of poor (more in urban than rural areas), and in reducing poverty gap and poverty intensity (more so in rural areas). However, social expenditure policy does not promote the production of tradables.

The combined positive effects from observed social expenditure policy and effort in an environment of low output growth, did not compensate the combined negative impacts from the experienced terms of trade shock and reduction in foreign saving flows.

These conclusions show that under macroeconomic disequilibrium poverty reduction efforts become policies of poverty containment or safety net programs. Poverty reduction is a long term objective that requires long term commitment for an environment of macroeconomic stability.

I. Introduction

This paper develops a simple static model that connects a small open economy framework to the Bolivian poverty reduction strategy. The main objective is to evaluate the short term impacts on poverty of pro-poor expenditure and total social expenditure more generally, during the 1999-2002 period of economic recession. Secondary objectives are to establish: i) the degree and channels through which external shocks impact poverty reduction efforts; ii) the degree and channels through which stabilization policy complement and/or conflict with poverty reduction efforts; and iii) identify main lines of recommendations for public policy. An implicit objective is to evaluate performance of the market led model, built since 1985, in poverty reduction under shocks and recession.

What are the connections between the macro economy, shocks and poverty reduction? As a consequence of shocks to the economy, the decrease in growth and aggregate consumption, saving and investment, expressed in changes in overall prices, wages and profits, will have an impact on welfare expressed in changes in household income, consumption and overall poverty and its structure. This approach follows the 123PRSP model developed by Devarajan and Go (2003), in the tradition of top-down models – see Bourguignon, Robillard and Robinson (2002).

A starting idea was that poverty reduction is a long term objective that requires a long term commitment for an environment on macroeconomic stability. Poverty reduction efforts and policy will have its full impact in poverty reduction instead of poverty containment only if the macro environment is stable. Moreover, a higher degree of economic instability could generate economic forces that reduce overall welfare with greater impact on poor.

A model of the 1-2-3 type with 1998 as base year is developed for the macroeconomic aspects and the introduction of shocks and pro-poor expenditure policy. Household income, consumption and poverty indicators to evaluate the impact of shocks and expenditure policy are based on 1999 household data. The reason for divergence in base years between the macro model and household data is that the MECOVI survey, designed to study poverty, began in 1999.

Besides this introductory section, the second section describes some key features of recent Bolivian macroeconomic performance in order to identify main shocks experienced during the period of economic recession. Also establish their magnitude as well as the magnitude of poverty reduction effort in terms of expenditure. The third section presents the macro model (static, simple and flexible of the 1-2-3 type) with structure and parameters that best represent the Bolivian economy in 1998. This year is selected as the base year because it is the one just before the beginning of economic recession and because it is the last year of high growth performance accomplished by the market led model that resulted from structural reforms since 1985. That is 1998 represents the accumulated economic conditions and model momentum with which shocks were faced. Based on 1999 household

survey data, the fourth section presents household income and expenditure level and structure, as well as poverty indicators accomplished by the market led model.

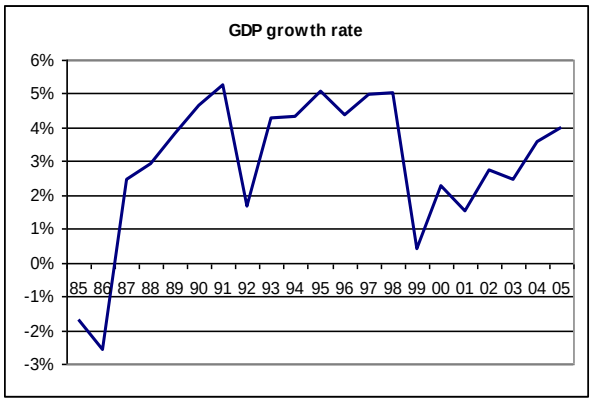
The fifth section connects the macro model to household data through aggregate income and consumption. This connection is used to evaluate the impacts of shocks and poverty reduction policy on household welfare and poverty. First, macroeconomic impacts from shocks and poverty reduction policy are simulated in order to generate changes in aggregate income and consumption. Second, these changes are used together with household data to simulate the effect of shocks and policy on household income and consumption levels by quintiles and areas, and also their effect in terms of changes in poverty indicators by areas. Conclusions and policy implications are presented in the last section.

II. Recent performance of the Bolivian economy

Bolivian efforts for economic development can be summarized in the first structural reform of 1985-89 aimed at stabilization and market liberalization policies, and the second structural reform of 1994-97 based on privatization and regulation policies. Among the most important implications of structural reforms is the construction of a market led growth model where the government's roll is primarily concentrated in social expenditure and regulation. Bolivian efforts in poverty reduction in particular can be summarized in the Bolivian strategy for poverty reduction (PRSP, 2001) originally based on the distribution of HIPC resources, but later amplified to the concept of pro-poor expenditure which began much earlier during the 90's (UDAPE, 2003). Our computations (presented later in detail) show that 41.4% of Bolivian households were poor in 1999, 23.7% in urban areas and 71.5% in rural areas.

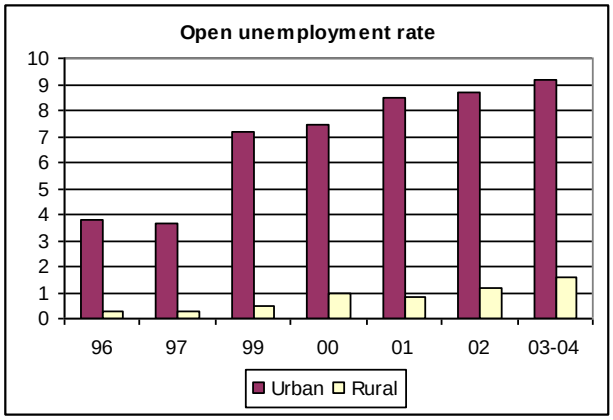
The following figures provide a brief review of performance of the Bolivian economy. Figure 1 shows that structural reforms had a positive impact on economic growth allowing growth rates up to just above 5% until 1998. During this period a common expression was that Bolivia needed much higher growth rates in order to have some significant effect on poverty reduction (UDAPE, 1993).

Figure 1



Source: Bolivian National Institute of Statistics

Figure 2



Source: Bolivian National Institute of Statistics

Then at the beginning of 1999 the economy experienced a sudden stop and entered a period of recession and slow recovery until today[1]. Finally a growth rate of 3.6% in 2004 and 4.0% in 2005 may be the awaited indication that recovery is to stay and speed up. Figure 2 shows that the growth period also had a positive impact in the open unemployment rate which by 1997 was at it lowest level of 3.65% in urban areas and 0.25% in rural areas. From 1999 on, the open unemployment rate has grown continuously even showing a disconnection with initial economic recovery. The reason for this is that economic recovery is largely explained by new oil and natural gas exports, a sector that is not labor intensive. Although government had additional income from oil and gas rents, these have not prevented a fiscal deficit of 9% of GDP by 2002 and could not prevent a contractionary fiscal policy due to a significant net drop in government income, caused by recession, against rigid government expenditures.

As a consequence the impact of growth on poverty is expected to have reversed after 1999. At the same time, greater pro-poor expenditure under the Bolivian Poverty Reduction Strategy (BPRS) and greater social expenditure more generally is expected to have helped with poverty containment. However, one can not help to wonder how the Bolivian economy could have evolved if macroeconomic stability was maintained, together with a 5% growth and current poverty reduction resources. What happened in early 1999 that changed the Bolivian growth path and history? An answer is the accumulation of several events in a moment in time when the key second structural reforms where only beginning to take hold. What were those events?

Foreign direct investment (FDI) in Bolivia has followed a pattern similar to that observed throughout Latin America and the Caribbean (ECLAC, 2004). After reaching its highest level and sudden stop in 1999 (see Figure 3), the following years FDI drops back to its early levels, having a large impact on total investment, particularly by 2003. However, total investment (public and private) reached its highest level in 1998 and its drop in 1999 is explained by the sudden stop of private domestic investment[2].

FDI was expected to diminish as "capitalized" firms fulfilled their investments commitments[3], however it was also expected that these firms would continue investing given an environment of economic stability and market led growth, as well as induce the increase in domestic private investment. These were key assumptions for the consolidation of a private market-led oriented economy in Bolivia. When the time came, the economic environment had deteriorated due to external and internal factors.

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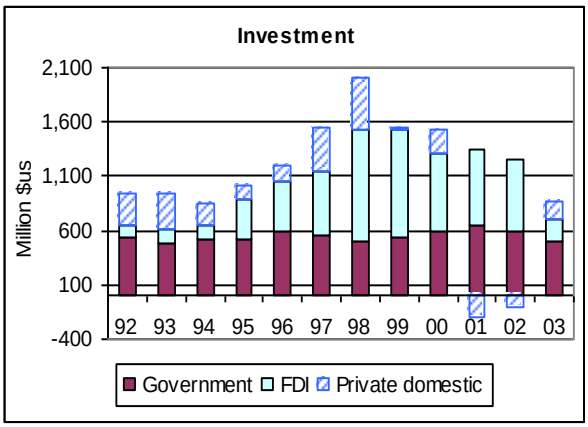
[1] Inflation during the decade was at an average of 7.5% and at an average of 2.5% during the period of recession. The nominal depreciation rate was at an average of 7.1% during the decade and at 6.8% during recession.

[2] Private domestic investment was approximated by subtracting public investment and FDI from the economy's gross fixed capital formation plus inventory variations.

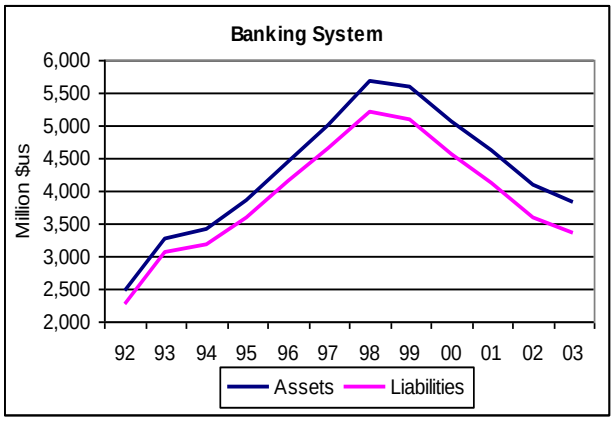
[3] Under traditional privatization the government transfers majority ownership of a state-owned firm to the private sector and has freedom over how to spend the proceeds. Under "capitalization" the government transfers 50% of a company's shares to the investor with the winning bid, who takes over management and commits to invest within a specific time period the amount offered to acquire its 50% in development of the firm.

Figure 3



Source: UDAPE

Figure 4



Source: UDAPE

Contraction in economic activity and aggregate demand can also be observed from the behavior of the banking system (see Figure 4). By 1998 the system reached its highest level of activity, in 1999 it experienced a sudden stop and even decreased, then the following years show a substantial drop in assets (largely loans) and liabilities (largely deposits) toward their early levels. The drop in liabilities is explained by important deposit withdraws due to an environment of higher risk and uncertainty that resulted from economic contraction accompanied by a deteriorated social environment, the latter being a main source of internal shock[4]. Part of those withdrawals may have left the economy as capital flight, an event that has also been observed throughout Latin America during this period.

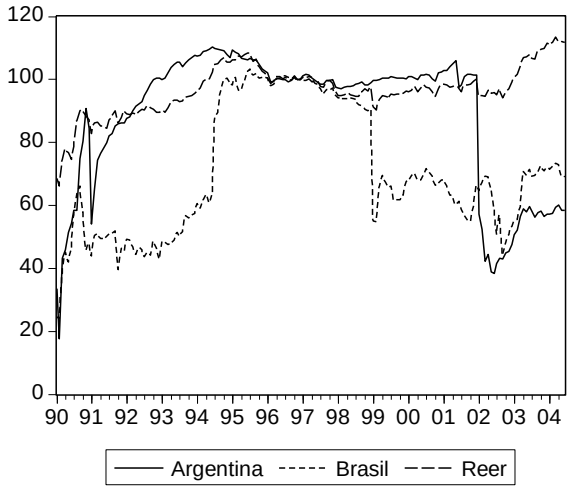
Figure 5 shows the large drop experienced in the bilateral exchange rate with Brazil in 1999 and later in the bilateral exchange rate with Argentina in 2002. However, the multilateral real effective exchange rate (REER) shows that real depreciations in the bilateral exchange rate with other countries, particularly the United States with whom Bolivia has its largest trade, has somewhat helped in compensating those drops.

Figure 6 presents the evolution of the value of exports in million $us in its three global categories. It shows a decreasing tendency in exports of primary minerals and metals, with a drop also in 1999 but its lowest level in 2001. This is explained by the long term decreasing tendency of international prices of Bolivian mineral exports. It also shows 1999 as the year of lowest exports of oil and natural gas. Natural gas exports to Argentina ended in early 1999 and later in the same year began natural gas exports to Brazil. Although non-traditional exports presents a

[4] Social and political instability resulted in changing expectations and the perception of higher risk, although the degree of this correlation has not been established. Some sense of the magnitude of this shock was best expressed by Gamarra (2003): "The threshold moment defined as a significant period in which the essence of political relations changed, probably peaked in the year 2000. The 2002 elections merely capped a longer process that is ongoing and which could culminate a very different Bolivia then the one prior to 2000." Gamarra also identified five overriding and interrelated sources of conflict: "i)…..the end of pacted democracy…..; ii) …..the collapse of Bolivia's so called neoliberal development strategy…..; iii)….. calls for a new land reform and for an end to land reconcentration; iv) increasing public insecurity nationally…..; v) an array of issues related to the coca and cocaine industry."

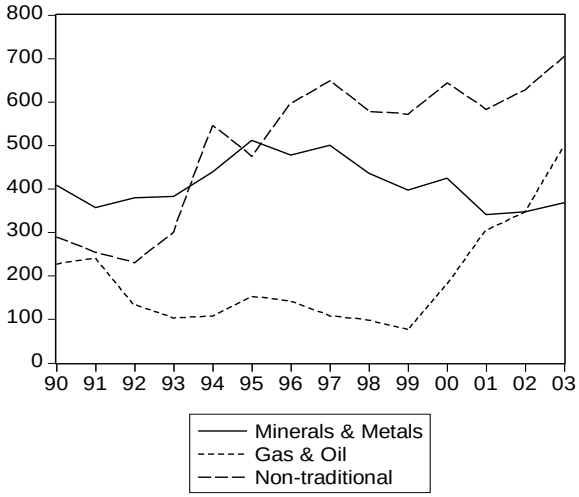
general tendency to increase and contribute to diversification of Bolivian exports, in 1999 those exports also experienced a slow down compared to previous two or three years.

Figure 5
Real exchange rate



Source: Central Bank

Figure 6
Evolution of exports



Source: Central Bank

How did the above events affect the balance of payments? Table 1 shows that although the capital account (foreign saving flows) compensated for traditional current account deficit, its flow levels had decreased substantially after 1998. Between 1998-2002, the capital account decreased by 55% explained by the combined effect from 66% decrease in FDI, 117% decrease in net private capital and almost three fold increase in new net government debt.

Table 1
Balance of payments (million $us)

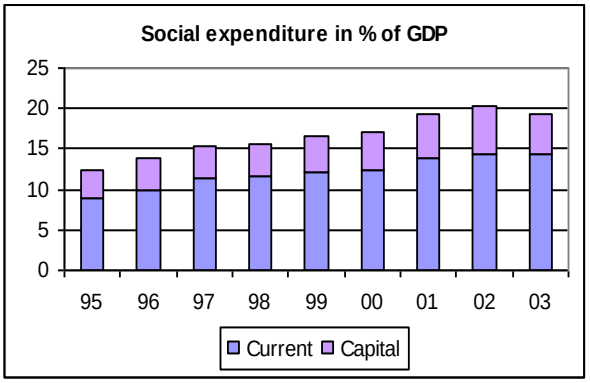
	1998	1999	2000	2001	2002	2003(p)
Current account	-666.9	-488.5	-446.45	-273.95	-352.03	35.74
Goods, services and rent	-1007.3	-874.4	-833.23	-670.06	-721.5	-405.36
Unilateral transfers	340.4	385.9	386.78	396.11	369.47	441.1
Capital account	1268.46	924.9	461.99	445.65	699.73	103.81
Foreign direct investment	1023.44	1008	733.9	703.3	674.1	194.9
Net government debt	104.3	113.5	110.49	202.65	304.18	391.8
Net private capital	229.1	-128.6	-430.5	-430.2	-268.1	-404
Other	-88.38	-68.0	48.1	-30.1	-10.45	-78.89
Error & omissions	-476.38	-409.85	-54.04	-209	-640.4	-62.23
Balance	125.18	26.55	-38.5	-37.3	-292.7	77.32

Source: UDAPE

By 1998 the market led growth model helped the government concentrate half of its spending in social expenditure in general (Figure 7) and pro-poor expenditure in particular (15.63% and 10.2% of GDP by 1998 respectively). Figure 8 shows that pro-poor expenditure has been increasing during economic recession, reaching its

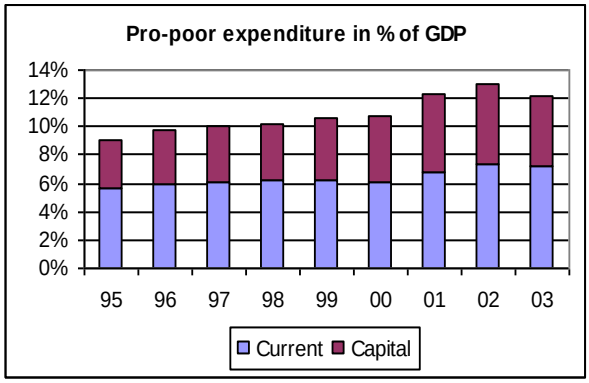
highest level so far by 2002 (13.1% of GDP), with the characteristic that current expenditure has been greater then capital expenditure. As Figure 9 shows, this was accomplished in a period were government income (Yg) decreased due to recession, generating a fiscal deficit of 9% of GDP by 2002 (DF) and forcing contraction of government's current spending (GCg) in general but not of government investment (Ig).

Figure 7



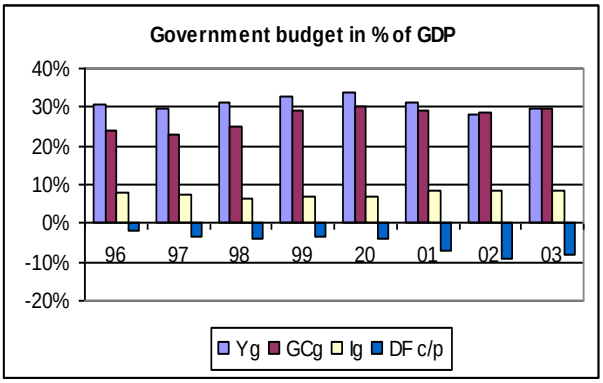
Source: UDAPE

Figure 8



Source: UDAPE

Figure 9



Source: UDAPE

Pro-poor expenditure includes total current and capital expenses on education, health, rural development, housing and sanitation. Social expenditure includes, in addition to pro-poor expenditure, pension payments and contributions, university transfers and veterans (*beneméritos* in Spanish). Its financing comes from government income, mostly for current expenses, and from foreign credit and donations, HIPC resources and the National Compensation Program, mostly for capital expenses.

A question is whether pro-poor expenditure or more generally social expenditure has been able to compensate welfare losses caused by shocks to the economy. Who in society were affected the most and in what magnitude. What would have been the magnitude of welfare gains if the economy did not experience external and internal shocks. These are among the questions this paper tries to answer strictly

during the period of economic recession[5]. The market led model that is put to a test during this period must be evaluated with a longer vision, which is not done here. However, here we can mention some of the latest papers that evaluate its performance.

Based on a general equilibrium model, Thiele and Wiebelt (2003) conclude that Bolivian economic growth for the period 1985-99 cannot be called pro-poor, because it bypassed traditional agriculture and the urban informal sector where most of the poor earn their living. They also conclude that the goals of the Bolivian poverty reduction strategy can be reached only under optimistic assumptions, its performance fall short of expectations once external shocks are taken into account (such as El Niño). The evolution of poverty is likely to remain uneven, with considerable improvements in urban areas and a high degree of persistence in rural areas. The differentiated impact of the growth process on household income, observed for Bolivia, is likely to be the rule rather then the exception.

Barja and Urquiola (2003) and Barja, McKenzie and Urquiola (2004) conclude that privatization in infrastructure sectors (telecommunications, electricity and water services) has improved net consumer welfare in main urban areas (with larger impact on the lower income quintiles). Based on regression analysis they show that welfare gains occurred because greater access to services has outweighed welfare loses from some price increases. Based on administrative data they conclude that infrastructure sectors (including the oil and gas industry) had gain in internal efficiency and investment and by large the oil and gas industry attracted most of foreign investment and also generated the greatest prospect for future growth. However, privatization was oversold in the employment and household income front, particularly beyond main urban areas, and has been rejected by the majority of population by the perception that its benefits had reached the few.

Based on administrative data, Garron, Capra and Machicado (2003) show that while privatization did not have significant impact on profitability, it increased operating efficiency, reduced employment at the firm level and decreased fixed assets. Based on regression analysis they show that privatization itself has been a significant factor in explaining the improvement of operating efficiency. Other significant factors are the size of firms, the presence of regulation and quality of management.

Based on a recursive-dynamic general equilibrium model, Jemio y Wiebelt (2003) conclude that Bolivia is highly vulnerable to external shocks in the form of decreasing world prices of exports and decreasing foreign direct investment and portfolio flows. Moreover, the spontaneous adjustment is severely restricted due to limited possibilities of substitution in the markets of goods and factors, as well as institutional restrictions about portfolio alternatives. Structural characteristics of the economy also affect the outcome of anti-shock policies. An expansionary fiscal policy is not feasible due to its negative impact to the balance of payments and fiscal equilibrium. In contrast, a nominal depreciation of the Boliviano does increase

[5] It is interesting to note that economic recovery in 2004-05 (as shown in Figure 1) was also led by positive external shocks and policy (mainly the new hydrocarbon legislation) rather than by increases in productivity or investment.

growth and employment, and also improves the fiscal and external balance. Despite structural rigidities, a nominal depreciation does generate a real depreciation sufficiently strong to stimulate the necessary resource reallocation for an effective adjustment. Regarding the poverty reduction efforts, they conclude that the combination of foreign debt relief (HIPC II initiative) with a fiscal expansion does generate greater rates of growth, lesser fiscal and external disequilibrium and lesser unemployment.

Based on regression analysis with household survey data, Andersen (2003) uses the determinants of education gap to show very low social mobility in Bolivia. Low social mobility helps explain poverty persistence over time and may be due to inadequate public education, corruption, marriage selectivity, insufficient rural-urban migration and labor market imperfections.

The Bolivian Poverty Reduction Strategy Paper (PRSP, 2001) represents the initial government policy in this front and has as main premise that poverty, inequity and social exclusion are the most severe problems that affect democracy and governance in Bolivia. The strategy was originally funded on HIPC II resources, distributed to Bolivian 314 municipalities based on criteria defined on the 2000 National Dialogue, and who in turn invest in social projects. Based on administrative data, the latest government evaluation of the strategy (UDAPE, 2003) reveals several internal and external sources of funding besides HIPC II and introduces a pro-poor expenditure measurement which was traced back to 1995. Evaluation of the strategy already suggests change in its vision, from a strictly social assistance to the poor view to an employment and income generation view through investment in small producer projects.

III. A simple macro model

1. Analytical framework

The analytical framework of the 1-2-3 model (extended version with government and investment[6]) is presented in Devarajan, Lewis and Robinson (1990), Devarajan, Lewis and Robinson (1993), Devarajan *et al* (1997) and Devarajan and Go (2003). A brief description is presented here and in Annex I.

The 1-2-3 model refers to a single country with a small open economy that produces two goods: a non-traded domestic good *D* and an export good *E*. From the consumption point of view, the country consumes an import good *M*, which is not produced in the economy, and the domestic one. Some of its basic characteristics and assumptions are the following:

- The model has four actors: a producer, a household, the government and the rest of the world.

[6] The extended version adopted in the current study (based on Devarajan, Lewis and Robinson, 1990 and Devarajan *et al* 1997), includes government revenues and expenditures, savings, and investment, in order to consider policy instruments that are used to adjust macroeconomic imbalances.

- It is a static model for a given growth rate of the economy with no intertemporal elements.
- The model identifies an equilibrium relationship between the real exchange rate and the balance of trade, which is fixed exogenously.
- The model contains no monetary elements and any solution to the system depends only on relative prices (it is a "real" model).
- The model takes the two factors of production (capital and labor) as constant, and it doesn't consider any imported or domestic intermediate goods.
- The domestic and export goods are imperfect substitutes.
- The output of the domestic good is an imperfect substitute for imports in consumption.
- World prices of exports and imports are fixed exogenously (small country assumption equivalent to price takers).
- Aggregate production is fixed, which is equivalent to assuming full employment of all primary factor inputs.

The model can be summarized in the following simple programming model (without government), where a consumer utility function or absorption is maximized, which is equivalent to maximize social welfare, subject to: i) a technology constraint that represents the maximum combination of output, given a fixed proportion of production factors (production possibility frontier); ii) a balance of trade constraint that is determined exogenously; and iii) a market clearing condition for the domestic good *"D"*.

$$\text{Maximize} \quad Q^S(M, D^D) = \mathrm{A_q}\left[\omega_q\, M^{-\eta} + (1-\omega_q)\, D^{D\,-\eta}\right]^{-(1/\eta)}$$

$$\text{Subject to:} \quad \mathrm{A_t}\left[\theta_t\, E^{\rho} + (1-\theta_t)\, D^{S\,\rho}\right]^{1/\rho} \le \overline{X}$$

$$pw^m\, M - pw^e\, E \le \overline{B}$$

$$D^D \le D^S$$

2. An application to Bolivia

a. Elasticity estimation

Table I.1 in Annex I presents the first order conditions of consumer utility maximization (equation 4 in Annex I) and producer profit maximization (equation 3 in Annex I). Both equations represent long term relationships among the variables of interest, which include the elasticity of substitution and the elasticity of transformation. Both elasticities were estimated for the Bolivian case based on quarterly data for the period 1990:01-2004:02. Annex II presents the methodology, strategy and econometric procedure followed for elasticity estimation. The estimated co integrating equations are the following:

CES Model: log(M/D) = (-1.61 – 0.004 t – 0.37 dcrisis) - 0.81 log(PM/PD) + Res2
CET Model: log(E/D) = (-1.38 + 0.01 t - 0.18 dcrisis) + 0.248 log(PE/PD) + Res1

The CES model result suggests on average an elasticity of substitution of 0.81 in the consumption of the import good relative to the domestic good when there is a change in their relative prices. Its negative sign is consistent with theory. The CET model result suggests on average an elasticity of substitution of 0.248 in the production of the export good relative to the domestic good when there is a change in their relative prices. Its positive sign is consistent with theory.

b. Base year national accounts data

Table 2 presents the social account matrix or income flows (nominal flows) among actors in the Bolivian economy, expressed in million Bs. and Table 3 presents the same accounts with greater detail in several accounts.

Table 2
Social account matrix for the 1-2-3 Model*, 1998

Receipts	Expenditures						
	Commodity	Producer	Household	Government	Capital	World	**Total**
Commodity			35,144	6,658	11,053		52,855
Producer	37,599					9,223	46,822
Household		40,297		3,053		726	44,075
Government	687	6,528	2,920				10,135
Capital			6,012	69		4,661	10,742
World	14,569						14,569
Total	52,855	46,825	44,075	9,780	11,053	14,610	

Source: Authors own computations.
(*) Each cell represents a payment from a column account to a recipient in a row account.

Table 3
Basic macroeconomic data for the 1-2-3 Model, 1998

Acounts	Millions of Bs.	Output=1	Acounts	Millions of Bs.	Output=1
National Accounts			**Fiscal Account**		
Output (Value Added)	40.297	1,00	Total Revenue	14.235	0,35
Wages	15.278	0,38	NonTax	4.784	0,12
			Current Expenditure	13.290	0,33
GDP at market prices	46.822	1,16	Goods & Services	8.443	0,21
Private Consumption	35.144	0,87	Financial expenditures	932	0,02
Public Consumption	6.658	0,17	Transfers (tr)	3.053	0,08
Investment	11.053	0,27	Other current expenditures	863	0,02
Exports	9.223	0,23	Capital Expenditure	2.712	0,07
Imports	15.256	0,38	Fiscal Balance	-1.767	-0,04
Tax Revenue			**Balance of Payments**		
Sales & Excise Tax	5.811	0,1442	Exports - Imports	-4.661	-0,12
Import Tariffs	720	0,02	Net Profits & Dividends	216	0,01
Export Duties	0	0,00	Interest Payments	-1.111	-0,03
Payroll Tax	0	0,00	Net Private Transfers (remittances)	726	0,02
Personal Income Tax	202	0,01	Net Official Transfers (grants)	1.152	0,03
Capital Income Tax	2.718	0,07	Current Account Balance	-3.678	-0,09
Total	9.451	0,23			
			External Debt	25.668	0,64
			Debt Service Payments	2.019	0,05

Source: Authors own computations.

c. Base year model

Table 4 presents the estimated parameters for the CET and CES elasticities, from which the ρ and η parameters are computed. Based on those parameters and the 1998 output data, the scale and share parameters are also computed, which is the calibration procedure used in the model. Table 5 presents the base year 1998 data for the exogenous and endogenous variables of the model. Table 6 shows the initial values for all the equilibrium conditions in the model.

Table 4
Parameters and calibration

Parameters	Formulas	Value
Elasticity for CET (Ω)		0.25
Elasticity for CES (σ)		0.81
Scale for CET (A_t)	$X/(\theta_t*E^{(\rho)}+(1-\theta_t)*D^{s\wedge(\rho)})^{(1/\rho)}$	3.26
Share for CET (θ_t)	$1/(1+(P^d/P^e)*(E/D^s)^{(\rho-1)})$	0.99
Rho for CET (ρ)	$(1/\Omega) + 1$	5.03
Scale for CES (A_q)	$Q^s/(\omega_q*M^{(-\eta)}+(1-\omega_q)*D^{D\wedge(-\eta)})^{(-1/\eta)}$	1.88
Share for CES (ω_q)	$((P^m/P^d)*(M/D^D)^{(1+\eta)})/(1+ (P^m/P^d)*(M/D^D)^{(1+\eta)})$	0.31
Nu for CES (η)	$(1/\sigma) -1$	0.23

Source: Authors own computations. See Annex I and II for more details.

Table 5
Base year values for the endogenous and exogenous variables

Exogenous Variables	Base Year	Endogenous Variables	Base Year
World Price of Imports (pw^m)	0.95	Export Good (E)	0.23
World Price of Exports (pw^e)	1.00	Import Good (M)	0.40
		Supply of Domestic Good (D^S)	0.77
Import Tariffs (t^m)	0.05	Demand of Domestic Good (D^D)	0.77
Export Duties (t^e)	0.00	Supply of Composite Good (Q^S)	1.17
Indirect Taxes (t^s)	0.12	Demand of Composite Good (Q^D)	1.17
Direct Taxes (t^y)	0.07		
		Tax Revenue (T)	0.23
Savings rate (s^y)	0.14	Total Income (Y)	1.09
Govt. Consumption (G)	0.15	Aggregate Savings (S)	0.27
Govt. Transfers (tr)	0.08	Consumption (C)	0.78
Foreign Grants (ft)	0.03		
Net Priv Remittances (re)	0.02	Import Price (P^m)	1.00
Foreign Saving (B)	0.10	Export Price (P^e)	1.00
Output (X)	1.00	Sales Price (P^t)	1.12
		Price of Supply (P^q)	1.00
		Price of Output (P^x)	1.00
		Price of Dom. Good (P^d)	1.00
		Exchange Rate (R)	1.00
		Investment (Z)	0.24
		Government Savings (S^g)	0.02
		Walras Law (Z-S)	0.00

Source: Authors own computations. See Annex I for more details on model and notation.

Table 6
Equations, equilibrium conditions and base year values

Real Flows	Formula	Value
CET Transformation	$A_t*(\theta_t*E^{(\rho)}+(1-\theta_t)*D^{s^{(\rho)}})^{(1/\rho)}$	1.00
Supply of Goods	$A_q*(\omega_q*M^{(-\eta)}+(1-\omega_q)*D^{d^{(-\eta)}})^{(-1/\eta)}$	1.17
Domestic Demand	Cn+Z+G	1.17
E/D Ratio	$((P^e/P^d)/(\theta_t/(1-\theta_t)))^{(1/(\rho-1))}$	0.30
M/D Ratio	$((P^d/P^m)*(\omega_q/(1-\omega_q)))^{(1/(1+\eta))}$	0.51
Nominal Flows	**Formula**	
Revenue Equation	$t^m*pw^m*R*M + t^e*P^e*E + t^s*P^q*Q^d + t^y*Y$	0.23
Total Income Equation	$P^x*X+ tr*P^q + re*R$	1.09
Savings Equation	$s^y*Y+R*B+S^g$	0.27
Consumption Function	$Y*(1-t^y-s^y)/P^t$	0.78
Prices	**Formula**	
Import Price Equation	$R*pw^m*(1+t^m)$	1.00
Export Price Equation	$R*pw^e/(1+t^e)$	1.00
Sales Price Equation	$P^q*(1+t^s)$	1.12
Output Price Equation	$(P^e*E+P^d*D^s)/X$	1.00
Supply Price Equation	$(P^m*M+P^d*D^d)/Q^s$	1.00
Numeraire	1.00	1.00
Equilibrium Conditions	**Formula**	
Domestic Good Market	$D^d - D^s$	0.00
Composite Good Market	$Q^d - Q^s$	0.00
Current Account Balance	$pw^m*M - pw^e*E$ -ft – re	0.10
Government Budget	$Tax - G*P^t – tr*P^q + ft*R$	0.02

Source: Authors own calculations. See Annex I for more details.

IV. Evaluating household welfare and poverty

1. Analytical framework

Sen (1976) describes two properties of good poverty indicators, named monotonicity and transfer axioms. Kakwani (1980) proposed a third property named transfer sensitivity axiom to obtain decomposable indicators. Table 7 summarizes the three axioms and their interpretation.

Table 7
Properties of poverty indicators

Axiom	Interpretation
Monotonicity	A reduction in the welfare variable (consumption or income) of a poor household must increase the poverty measure. Ceteris paribus other things.
Transfer	A pure transfer of income (or consumption) from a poor household to any other household that is richer must increase the poverty measure. Ceteris paribus other things.
Transfer sensitivity	If a transfer ($t > 0$) takes place from a poor household with income or consumption y_i to a poor household with income or consumption $y_i + d$ ($d > 0$), then the magnitude of increase in poverty must be smaller for larger y_i. Ceteris paribus other things.

Source: Based on Foster, Greer and Thorbecke (1984).

Foster, Greer and Thorbecke (1984) developed a parametric family of poverty measures that satisfy the three axioms, as follows:

$$P_\alpha = \frac{1}{N}\sum_{i=1}^{N}(1-\frac{x_i}{z})^\alpha \ \mathrm{I}(x_i < z)$$

Where $x = (x_1, x_2,\ldots, xN)$ is a vector of a welfare variable (household income or consumption), N the total population, z the poverty line ($z > 0$) that represents the cost of a basket of basic needs, α is a positive parameter which represents societal aversion to poverty, and I is an indicator function that takes the value of 1 if the welfare variable is less than the poverty line ($x_i < z$) and 0 otherwise.

When α = 0 the indicator is named *Headcount Ratio (P_0)*, it is the number of poor people measured as the fraction of population below the poverty line. When α = 1 the indicator is named *Poverty Gap (P_1)*, which considers differences between poor people by measuring the distance existing between income or consumption and the threshold. According to Deaton (1997), the contribution of individual *i* to aggregate poverty is larger the poorer is *i*. P_1 can also be interpreted as a per capita measure of the total shortfall of individual welfare levels below the poverty line; it is the sum of all the shortfalls divided by the population and expressed as a ratio of the poverty line itself. P_1 will be increased by transfers from poor to non poor (second axiom), or from poor to less poor who thereby become non poor. When α =2 the indicator is named *Severity of Poverty (P_2)* or also *FGT* (by the initials of the authors) and is a weighted sum of income shortfalls of the poor people. P_2 is a sensitive indicator to the distributions among the poor (third axiom).

Computation of poverty indicators *Pa*, require selection of a welfare variable (household income or consumption) and definition of a poverty line. Regarding the welfare variable, there are differences between selecting household income or household consumption. The income view is that of learning about the purchase capacity of a household in obtaining the goods and services that will satisfy their basic needs or not, it is an ex ante interpretation of welfare, with the characteristic that volatility of income over time may also produce volatility of welfare indicators. The consumption view is that of learning about the actual household purchase of the goods and services that satisfy or not their basic needs, it is an ex post interpretation of welfare, and tends to remain relatively stable over time. In this study both income and consumption structures will be computed, although the poverty indicators themselves are based on consumption solely.

Regarding the poverty line and following the World Bank (1993), the objective is to define an income or consumption level that is sufficient to purchase the minimum standard of nutrition and other necessities, also referred to as a basket of basic needs with food and non-food components. Following the World Bank (2003), the operational steps to define poverty lines are:

(i) Adopt a nutritional requirement for good health, such as 2,100 Calories per person per day.

(ii) Estimate the cost of meeting the food energy requirement or food component (z_{food}), using a diet that reflects the habits of households located near the poverty line (e.g. those in the lowest, or second-lowest, quintile of the income distribution; or those consuming between 2,000 and 2,200 Calories).

(iii) Add a non-food component ($z_{non\ food}$). The most current practice uses the Orshansky coefficient defined as the reciprocal of average food share, also named Engel's coefficient.

(iv) Then the basic needs poverty line is given by:

$$z_{basicneeds} = z_{food} + z_{nonfood}$$

This study adopts the poverty line computed by UDAPSO (1995). The poverty line value was updated to 1999 considering changes in the Consumer Price Index.

Once the poverty indicators *Pα* are computed and in order to make welfare comparisons between households, it is important to consider their differences in size and composition. Medina (2002) explains that the equivalence scales are indexes that measure the relative cost of living considering different sizes and compositions of households. These are composed by the consumer unit equivalence and economies of scale, the first considers needs of the household members according to their characteristics and the second reflects the reduction in the marginal cost with additional household members.

Following the World Bank (2003) the solution to the welfare comparison problem is to apply a system of weights, named *Adult Equivalent Scale (AES)*. For a household of any given size and composed by adults and children, an equivalence scale measures typically the number of adult males which that household is deemed to be equivalent to. Consequently, each member of the household counts as some fraction of an adult male and the household size is the sum of these fractions of adult equivalents. This study uses the AES computed by the *Organization for Economic Cooperation and Development (OECD)*, recommended by the World Bank (2003), and defined as:

$$AES = 1 + 0.7(adults - 1) + 0.5\,children$$

The equation reflects a parametric scale as function of the relative needs of the household members. Interpreting its functional form, AES has a value of 1 with the first adult, every additional adult is equivalent to 0.7 of the first adult, and each child is equivalent to 0.5 of the first adult.

2. An application to Bolivia

a. The Bolivian household survey

The National Institute of Statistics (INE) collects data from households since 1999 under the MECOVI Program[7]. The living conditions surveys have national coverage with independent and cross-sectional samples every year. The 1999 survey used in this study has a sample size of 3000 households.

The main objective of the MECOVI surveys is to generate information on the living conditions and poverty of households. The questionnaire is designed to produce detailed income and expenditures data to allow computation of monetary welfare indicators. In addition, the questionnaire includes education, health, employment, housing and basic services modules, allowing computation of non-monetary welfare indicators. In general, the data allows for the analysis of poverty over time and its distribution across households, as well as the computation of indicators of the extent and severity of poverty.

b. Computation of aggregate consumption

The food module in the MECOVI survey questionnaire, distinguishes between food consumed inside the households and food consumed outside the households. In the first case, households consume food purchased in markets, obtained by self-production and received from other households or persons (called *other sources* in the questionnaire). In the second case, consumption outside the household corresponds to elaborated food consumed individually by household members (e.g. dinners). To compute the total consumption of food, all items declared were standardized to monthly consumption and then aggregated considering purchases, self-production and other sources.

Regarding non-food items, the MECOVI-household-survey registers a wide range of information (e.g. education, health, water, phone, etc) some of which is excluded for not corresponding to the welfare definition or consumption concept. In the filtering process, all expenditures that are not frequent like legal fees, home repairs and improvements, taxes, expenditures on social ceremonies (e.g. marriages, births, etc.) are dropped, based on the explanation given by Deaton and Zaidi (2002) that expenditures on taxes and levies are not part of consumption, and should not be included. Furthermore, all purchases of financial assets, as well as amortization of debt and interest payments are also excluded from aggregate consumption. Two other items not included are gifts and transfers, given their inclusion in the household that acts as a recipient. Finally, some special items like health expenditures (e.g. hospital and medicines) are also excluded, because they do not reflect an increase in welfare since households expend money on them only in the event that a member gets sick or injured.

[7] The MECOVI Household Survey implemented by INE received financial and technical support from the World Bank, Inter-American Development Bank and the Economic Commission for Latin America and Caribbean.

Table 8 summarizes computation of aggregate consumption and its structure. In 1999 Bolivia had 1.85 million households, 62.7% in urban areas and 37.3% in rural areas, reflecting the relative importance of urbanization in the country[8]. Aggregate consumption in urban areas was 2.96 times greater than in rural areas, showing an important difference between geographical areas.

The ratio of food consumption inside the household with respect to the total consumption represents 46% in urban areas and 70% in rural areas. Education, housing and non food expenditures in urban areas are greater than rural areas, reflecting better access to services and markets in urban areas.

Table 8
Consumption of households by geographical areas, 1999
(Bolivianos per month)

Description	*Urban*	*Rural*	*Bolivia*
Food consuption inside the household	940.9	482.7	771.1
Food consuption outside the household	197.5	36.9	138.0
Non Food Expenditures	365.7	100.7	267.5
Education Expenditures	302.1	46.1	207.2
Housing expenditures	222.0	18.7	146.6
Total Consumption	**2,028.2**	**685.1**	**1,530.4**
Number of households	**1,163,084**	**691,656**	**1,854,740**

Source: Authors own computations based on MECOVI 99.

Table 9 further disaggregates the structure of consumption by quintiles and areas. At the national level, the consumption of the richest quintile is 11.6 times greater than the poorest quintile; 9.6 in urban areas and 10.1 in rural areas.

Engel's law (the share of food consumption decreases in richest households) is evidenced inside the urban and rural areas. Comparing the first four quintiles, there are small differences in the structure of consumption, but the last quintile presents bigger expenditures in non food and education expenditures. Differences on extreme quintiles show inequality and polarized characteristic of consumption in Bolivia.

Curiously, the share of housing expenditure in the poorest households is too high in urban areas; this may reflect efforts of the poorest households to access basic services (e.g. water, electric energy).

[8] INE defines urban as those cities with populations greater then 2000. This definition has been criticized in that it may underestimate the weigh of rural areas.

Table 9
Structure of consumption of households by quintiles, 1999

Description	Quintiles of consumption					
	1 (poorest)	*2*	*3*	*4*	*5 (richest)*	*Total*
			Urban			
Food consuption inside the household	63%	61%	58%	52%	40%	46%
Food consuption outside the household	5%	8%	8%	10%	10%	10%
Non Food Expenditures	10%	13%	14%	16%	21%	18%
Education Expenditures	6%	7%	9%	13%	18%	15%
Housing expenditures	16%	12%	10%	10%	11%	11%
Total Consumption (Bs per month)	**365.8**	**737.5**	**1,182.1**	**1,794.5**	**3,515.4**	**2,028.2**
			Rural			
Food consuption inside the household	76%	71%	71%	66%	62%	70%
Food consuption outside the household	3%	6%	5%	7%	7%	5%
Non Food Expenditures	12%	15%	14%	16%	18%	15%
Education Expenditures	6%	6%	7%	8%	9%	7%
Housing expenditures	2%	2%	3%	3%	4%	3%
Total Consumption (Bs per month)	**293.9**	**689.6**	**1,156.6**	**1,761.9**	**2,963.2**	**685.1**
			Bolivia			
Food consuption inside the household	75%	67%	61%	53%	41%	50%
Food consuption outside the household	4%	6%	8%	10%	10%	9%
Non Food Expenditures	12%	14%	14%	16%	21%	17%
Education Expenditures	6%	7%	8%	12%	18%	14%
Housing expenditures	4%	6%	9%	9%	11%	10%
Total Consumption (Bs per month)	**300.8**	**709.1**	**1,175.9**	**1,790.4**	**3,494.5**	**1,530.4**

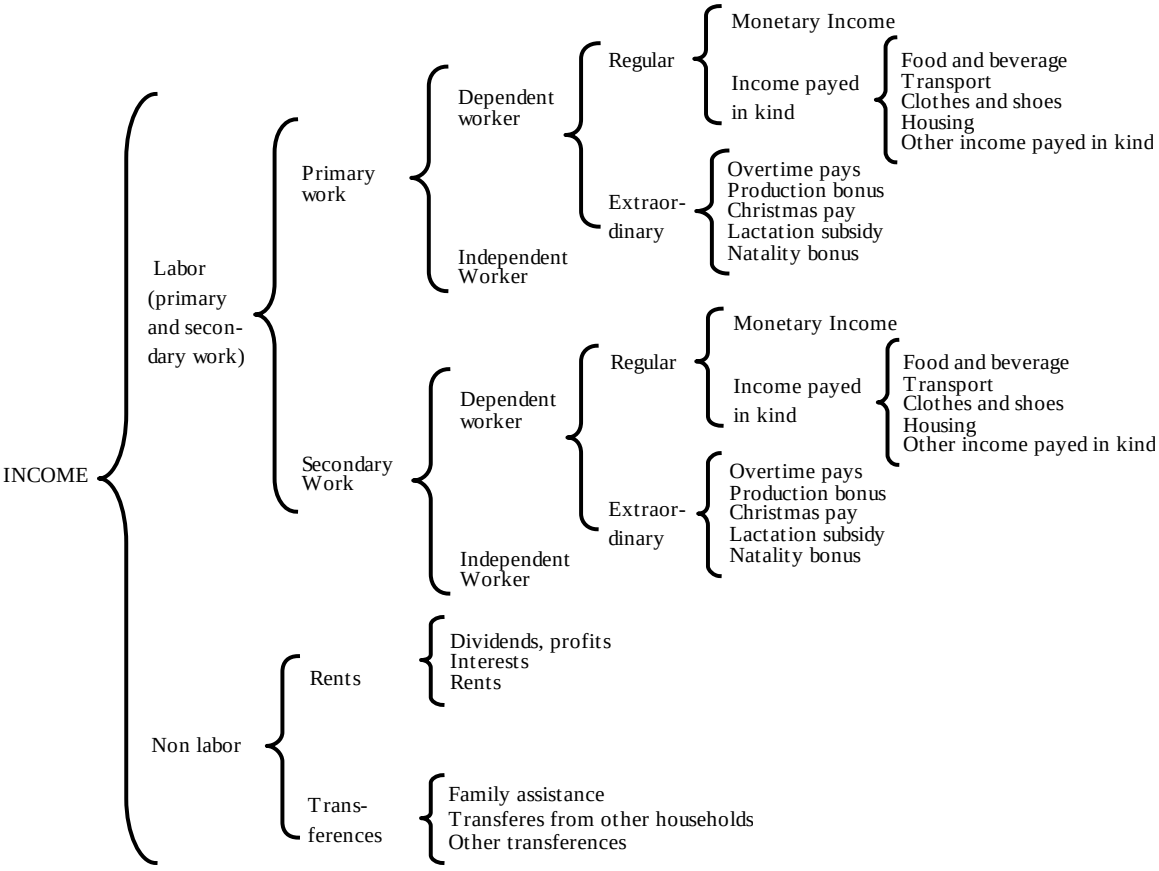
Source: Authors own calculations based on MECOVI 99

c. Computation of the aggregate income

Income is one of the most important variables in the household economy; it provides the resources to finance current consumption and savings. Total household income is the sum of resources received by factor and non factor sources, representing the total purchasing power of a household in a given time period.

The income structure of Bolivian's household survey is as follows:

Figure 8
Income structure of household survey



Source: Authors.

Table 10 is the computed structure of household labor and non labor income by quintiles, where aggregate labor income from primary and secondary sources was computed without extraordinary income[9]. Primary work is the most important source of labor income in urban and rural areas, with increasing importance for the higher income quintiles. Secondary work is a relatively more important source of labor income in rural areas, while non labor income from rents and transfers are relatively more important in urban areas, particularly for the lower income quintiles.

[9] Labor income that is not received periodically, but occasionally. It is not considered to avoid overestimation of disposable income.

Table 10
Structure of household income by quintiles, 1999

Description	Quintiles of income					
	1 (poorest)	*2*	*3*	*4*	*5 (richest)*	*Total*
		Urban				
Labor	54%	79%	82%	85%	87%	86%
Primary work	53%	76%	81%	82%	82%	81%
Secondary work	1%	3%	2%	3%	6%	5%
Non labor	46%	21%	18%	15%	13%	14%
Rents	14%	9%	8%	7%	9%	8%
Transfers	32%	12%	10%	8%	4%	6%
Total (Bs. per month)	**77**	**449**	**927**	**1,721**	**4,656**	**2,147**
		Rural				
Labor	86%	89%	92%	90%	94%	91%
Primary work	78%	77%	77%	81%	84%	79%
Secondary work	8%	11%	14%	9%	10%	11%
Non labor	15%	12%	9%	10%	9%	10%
Rents	0%	1%	2%	3%	1%	2%
Transfers	13%	9%	5%	7%	2%	6%
Total (Bs. per month)	**73**	**390**	**878**	**1,661**	**3,787**	**505**
		Bolivia				
Labor	83%	85%	85%	86%	88%	87%
Primary work	75%	77%	80%	82%	82%	81%
Secondary work	7%	8%	6%	4%	6%	6%
Non labor	17%	15%	15%	14%	12%	13%
Rents	2%	5%	6%	7%	9%	8%
Transfers	15%	11%	8%	7%	4%	6%
Total (Bs. per month)	**74**	**412**	**911**	**1,709**	**4,600**	**1,415**

Source: Authors own computations based on MECOVI 1999.

d. Poverty indicators

Table 11 presents the computed poverty indicators. The adjusted headcount ratio at the national level indicates that 41.4% of Bolivian households were poor in 1999, that is, they consume under the poverty line. This indicator changes dramatically when comparing urban (23.7%) with rural areas (71.5%). As a reference the urban poverty line is 328.1 bolivianos per capita monthly (54.4 $us), the rural poverty line is 233.6 bolivianos per capita monthly (40.1 $us) and the national poverty line is 293.1 bolivianos per capita monthly (50.4 $us).

The adjusted poverty gap at the national level indicates that the poor households have a mean shortfall of 39.8% of poverty line value and require on average an additional per capita consumption of 116.5 bolivianos per month to overcome their poverty condition. This indicator also shows large differences when comparing the depth of poverty between urban (24.6%) with rural areas (48.4%).

The adjusted intensity or severity of poverty at the national level indicates an average of 37.8% degree of inequality among poor households. The severity of poverty is greater in rural areas than urban areas, reflecting less inequality between poor people in urban areas and more in rural areas.

Table 11
Poverty indicators based on consumption, 1999

Description	*Head count ratio (P0)*	*Poverty gap (P1)*	*Intensity (P2)*	*Per capita consumption (Bs by month)*
		Without adjustment		
Urban	47.6%	15.9%	7.1%	435.9
Rural	84.6%	48.8%	32.6%	141.0
Bolivia	**61.3%**	**28.1%**	**16.6%**	**326.6**
		Adjusted by Adult Equivalence Scale		
Urban	23.7%	24.6%	25.6%	602.2
Rural	71.5%	48.4%	44.7%	200.0
Bolivia	**41.4%**	**39.8%**	**37.8%**	**453.1**

Source: Authors own computations based on MECOVI 1999
Urban poverty line: 328.1 bolivianos per capita monthly
Rural poverty line 233.6 bolivianos per capita monthly
National poverty line 293.1 bolivianos per capita monthly

It is important to notice that these computations differ from official indicators for three reasons:

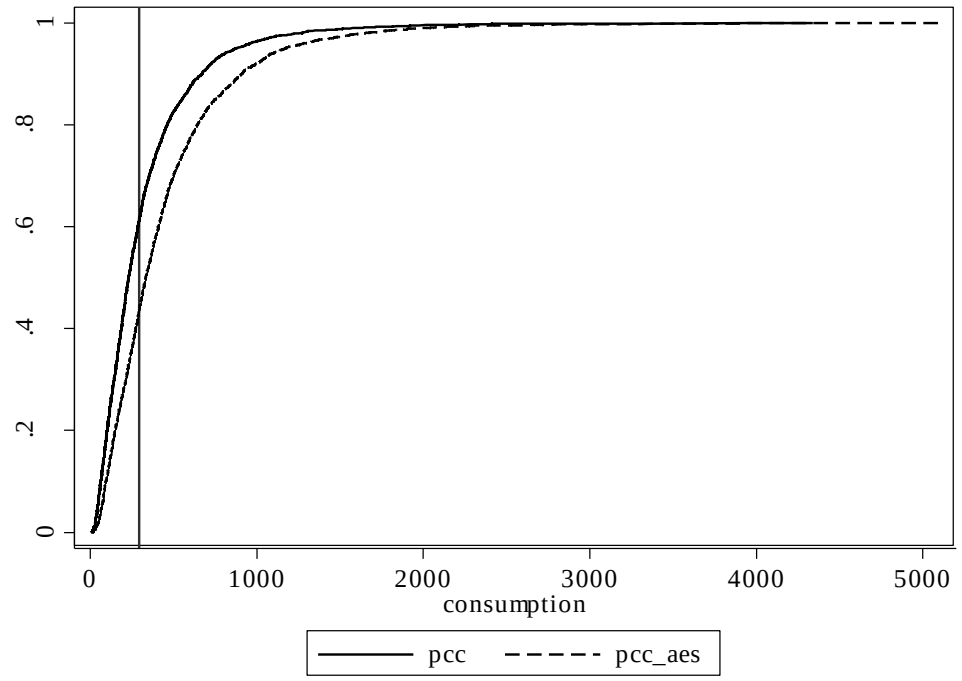
(i) The official welfare indicator is a mix of income (in urban areas) and consumption (in rural areas). This may not be a better conceptual definition since income and consumption have different implications.
(ii) INE's definition of consumption includes health expenditures and estimations of durable goods. In the case of durable goods, the primary source of information is not consistent and has a subjective basis.
(iii) The official welfare indicator is not adjusted by Adult Equivalence Scales.

Comparing results of Table 11, the national adjusted *Head count ratio* is smaller in 19.9% compared to the unadjusted indicator. The AES adjustment has a notably effect especially in poorest and households of big size. Considering the other two indicators, the adjustment allows increases of about 20% at the national level in the poverty gap and intensity indicators. The poverty gap is deeper in urban areas then was originally thought with the unadjusted measure; however, the unadjusted

measure did well in rural areas. Also inequality among the poor is greater in urban and rural areas then was originally thought with the unadjusted measure.

Comparisons of the distribution of aggregate consumption reveal the effect of the adjustment in per capita consumption (see Figure 8).

Figure 8
Effect of AES in Per capita consumption (pcc)



Source: Authors own calculations.
ppc is per capita consumption (Bs. per month).
ppc_aes is per capita consumption adjusted by adult equivalence scale.
The vertical line is z.

V. Impact of shocks on household welfare

This chapter is developed in two sections; first the 1-2-3 Model is used to simulate shocks to the economy in order to generate information on changes in prices and income. Second, the information on changes in prices and income is then used together with the household data to generate changes in poverty indicators as well as changes in income and expenditures by quintiles. This simple procedure is the 123PRSP model as presented in Devarajan and Go (2003). This framework is also referred to as a top-down approach in former literature, see for example Bourguignon, Robilliard and Robinson (2003), with further developments in Ferreira, Leite, Pereira da Silva and Picchetti (2005), Robilliard, Bourguignon and Robinson (2006).

The objective is to simulate what happened in the 1998-2002 period, with 1998 being the base year and 1999-2002 as the second period which will be compared to the base year (comparative statics). Given that 1998 was the year of highest growth with a correspondent level of welfare accomplished, then the second period would be of loss of welfare, which we want to measure in terms of poverty indicators as well as in changes in income and expenditure.

1. Limitations

There are several limitations to this analysis and methodology that must be mentioned:

- Pro-poor government expenditure in education, health and infrastructure for development will have its full returns in terms of poverty reduction only in the long run. Therefore what we measure here is only the short run effects of government expenditures, believing that these expenditures will have a short run effect on overall household income and expenditures.

- Given that the distribution of income and consumption by quintiles is based on a fixed year (1999), which are applied to overall changes in household income and consumption, then this methodology cannot simulate the more complicated process of income and consumption redistribution. However, Annex IV presents an analysis of the differences between the simulated and observed results.

- Given that the 1-2-3 model is built on highly aggregate macroeconomic data, then this model cannot simulate the more complicated process of resource distribution by economic sectors and its consequent effects on household income and expenditures.

- Given the simplicity of the 1-2-3 model, its static nature does not allow for more complicated recursive and dynamic effects within the macro connections and less so between the macro and household connections.

2. Experiments and macro outcomes

In this section it is of interest to determine the direction and order of magnitude of impact of shocks and pro-poor expenditure policy on the macro economy. The analysis has the following sequence:

- Impact from a terms of trade shock alone;
- Impact from a reduction in foreign saving alone;
- Impact from an increase in total social expenditure alone;
- Impact from an increase in pro-poor expenditure alone;
- Impact from output growth alone;
- Impact from all of the above cases simultaneously, except pro-poor expenditure which is part of total social expenditure.

The first external shock considered is a drop in the terms of trade. The Bolivian trade data shows that the economy experienced a 7% drop in its export price index and a 1% drop in the import price index during 1998-2002. The combined effect produces a 6% drop in the terms of trade. The terms of trade are capturing not only the effect of price drops due demand contraction of Bolivian exports but also the price effects of exchange rate crisis in neighbouring countries.

The second external shock considered is a decrease in foreign saving. The Bolivian balance of payments data shows that the capital account has decreased in 45% during 1999-2002 compared to 1998. This is explained by three accounts, i) FDI flows dropped 34.1% during that period, generating a 28% decrease in the capital account balance compared to 1998, ii) net government foreign debt flows have increased by 191% during that period, generating a 15% increase in the capital account compared to 1998, iii) other net private capital has reversed during that period generating a capital flight of 3.17 times the positive flow of 1998, generating a 40% decrease in the capital account compared to 1998.

The measurement of pro-poor expenditure came as a result of the need to evaluate the BPRS. These expenditures are part of total social expenditures and part of overall government expenditures. Pro-poor expenditures data show that these have increased in total by 153.06 million $us during 1999-2002 and by 107.36 million $us in its capital component, representing a 17.7% and 31.2% increase compared to 1998 respectively. In the 1-2-3 model this was introduced as an increment of government consumption by 12.7% and an increment of foreign grants by 51.4% respectively. Total social expenditures data show that these have increased in total by 250.5 million $us during 1999-2002 and by 108.7 million $us in its capital component, representing an 18.8% and 31.8% increase compared to 1998 respectively. In the 1-2-3 model this was introduced as an increment of government consumption by 20.7% and an increment of foreign grants by 52% respectively.

As seen in Figure 1, GDP has grown an average of 1.74% during 1999-2002; this lower growth rate was introduced in the model as an increase in output by 1.74%. Finally all cases of shocks, expenditure policy and low growth were simulated simultaneously to determine the direction and magnitude of their net effect on macro variables.

Table 12 presents the macroeconomic outcome from all simulations in terms of the model's endogenous variables. The first column is the starting situation in 1998 or base year. The second column is the macro outcome from the terms of trade shock alone. The third column is the macro outcome from a reduction in foreign saving flows alone. The fourth and fifth columns are the macro outcome from expenditure policy, pro-poor and total social. The sixth column is the macro outcome from output growth alone and the final column is the macro outcome from the net impact of the combined terms of trade, foreign saving reduction and output growth simultaneously.

The full impact of the terms of trade shock results in a 1.5% decrease in consumption and a 5.5% decrease in total income compared to the base year. Also a 5.1% decrease in tax revenues and 4% decrease in aggregate savings, implying that without these last two happening, consumption would have decreased further. There is no observed change in investment. However, the drop of the domestic good price relative to the price of the export good and import good results in a 0.13% increase in the production and consumption of the domestic good, a 0.4% decrease in exports and 3.3% decrease in imports.

Table 12
Macro outcome from shocks and expenditure policy

Endogenous Variables	Base	Terms of trade	Foreign saving	Pro-poor expenditure	Social expenditure	Output growth	All cases
Export Good (E)	0.229	0.228	0.235	0.227	0.227	0.233	0.237
Import Good (M)	0.396	0.383	0.354	0.410	0.410	0.402	0.358
Supply of Domestic Good (Ds)	0.771	0.772	0.765	0.773	0.773	0.784	0.781
Demand of Domestic Good (Dd)	0.771	0.772	0.765	0.773	0.773	0.784	0.781
Supply of Composite Good (Qs)	1.168	1.154	1.117	1.183	1.183	1.186	1.136
Demand of Composite Good (Qd)	1.168	1.154	1.117	1.183	1.183	1.186	1.136
Tax Revenue (Tax)	0.234	0.222	0.208	0.243	0.243	0.237	0.207
Total Income (Y)	1.093	1.033	0.993	1.125	1.126	1.107	0.977
Aggregate Savings (S)	0.274	0.263	0.208	0.274	0.261	0.280	0.193
Consumption (Cn)	0.776	0.764	0.769	0.779	0.779	0.789	0.769
Import Price (Pm)	0.999	0.989	0.999	0.999	0.999	0.999	0.989
Export Price (Pe)	0.999	0.932	1.000	0.999	0.999	0.999	0.932
Sales Price (Pt)	1.122	1.079	1.031	1.152	1.152	1.119	1.012
Price of Supply (Pq)	0.999	0.960	0.917	1.025	1.025	1.996	0.901
Price of Output (Px)	0.999	0.943	0.906	1.030	1.030	1.996	0.876
Price of Dom. Good (Pd)	0.999	0.946	0.877	1.039	1.039	0.995	0.859
Exchange Rate (Er)	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Investment (Z)	0.244	0.244	0.202	0.238	0.226	0.250	0.189
Government Savings (Sg)	0.022	0.020	0.016	0.017	0.004	0.026	0.003
Walras Law (Z-S)	0.000	-0.001	0.000	0.000	0.000	0.000	-0.001

Source: Authors own computations.

The full impact of foreign savings flow reduction results in a 0.9% decrease in consumption and a 9.1% decrease in total income compared to the base year. Also an 11.1% decrease in tax revenues and 24.1% decrease in aggregate savings, implying that without these last two happening, consumption would have decreased further. There is also a 17.2% decrease in investment. However, the drop of the export good price relative to the domestic and the drop of the domestic good price relative to the price of the import good results in a 0.77% decrease in the production and consumption of the domestic good, a 2.62% increase in exports and 10.6% decrease in imports.

The full impact of social expenditure policy results in a 0.38% increase in consumption and a 3% increase in total income compared to the base year. Also a 3.8% increase in tax revenues, 4.7% decrease in aggregate savings and a 7.4% decrease in investment. In the case of pro-poor expenditure alone there are some slight differences in that income increases a bit less, aggregate savings don't change and investment decreases less. However, in both cases the increase of the domestic good price relative to the price of the export good and import good results in a 0.2% increase in the production and consumption of the domestic good, a 0.8% decrease in exports and 3.5% increase in imports. This last result shows that pro-poor expenditure and social expenditure in general conflicts with policies that promote exports and import substitution, that is, conflicts with policies that promote the production of tradables.

The full impact of output growth results in a 1.7% increase in consumption and 1.3% increase in total income compared to the base year. Also a 1.3% increase in tax revenues, 2.2% increase in aggregate savings and 2.4% increase in investment. There is a drop of the domestic good price relative to the price of the export good and import good, however output growth increased production of the domestic and exports goods as well as demand of the import good, although with some differences. It results in a 1.7% increase in the production and consumption of the domestic good, 1.7% increase in exports and 1.5% increase in imports.

Finally, the full impact of the combined effect of all cases simultaneously results in a 0.9% decrease in consumption and 10.6% decrease in total income compared to the base year. Also an 11.5% decrease in tax revenues and 29.5% decrease in aggregate savings, implying that without these two happening, consumption would have decreased further. There is also 22.5% decrease in investment. However, the drop of the domestic good price relative to the price of the export good and import good results in a 1.3% increase in the production and consumption of the domestic good, a 3.5% increase in exports and 9.6% decrease in imports.

A first conclusion is that under macroeconomic stability (no shocks and 1998 macro conditions) social expenditure policy would have had an important positive impact first on aggregate income and second on aggregate consumption and tax revenues, but negative impact on savings, investment and production of tradables.

A second conclusion is that the combined positive effects from social expenditure policy and low output growth on aggregate consumption, income and savings did not compensate the negative impacts from the combined terms of trade shock and reduction in foreign saving flows.

3. Experiments and poverty outcomes

The connection between the simple macro model and household welfare evaluation is based on the idea proposed by Devarajan and Go (2003) although it is not

applied literally[10]. With the information on changes in income (wages and profits) and prices of the three goods given by the macro model, together with initial levels of labor income and commodity consumption given by the household surveys, the impact of shocks and macro policies on household welfare can now be computed.

Aggregate consumption includes various items of food consumption and non-food consumption. Given that the definition of export (*E*), import (*M*) and domestic (*D*) goods have their origin in the input-output matrix, all items in the MECOVI survey were codified according to its respective row of the IOM. This procedure allows computing the household expenditure in terms of domestic and import goods, and gives the possibility to connect simulations of the 1-2-3 model (with changes in prices of the domestic and import goods) to each household, showing the effects on consumption after changes in these prices.

Table 13 shows the linking codes between items of consumption and the Input-Output matrix rows.

Table 13
Consumption of domestic and imported goods (in percent)

Description	Quintiles of consumption					
	1 poorest	*2*	*3*	*4*	*5 richest*	*Total*
			Urban			
Expenditure in Domestic goods (D)	97	96	95	93	90	92
Expenditure in Imported goods (M)	3	4	5	7	10	8
Total Consumption (Bs month)	437	926	1,333	1,839	3,240	2,016
			Rural			
Expenditure in Domestic goods (D)	96	94	94	92	92	94
Expenditure in Imported goods (M)	4	6	6	8	8	6
Total Consumption (Bs month)	339	760	1,081	1,625	2,532	684
			Bolivia			
Expenditure in Domestic goods (D)	96	95	95	93	90	93
Expenditure in Imported goods (M)	4	5	5	7	10	7
Total Consumption (Bs month)	346	828	1,280	1,811	3,217	1,522

Source: Authors own calculations.

The specific connection between the macro model and the household surveys is done through the use of an income multiplier and an expenditure multiplier. The income multiplier is simply the percent change in total income directly obtained from the simple macro model, but introduced to households only through labor income. The expenditure multiplier has two components, the expenditure multiplier

[10] Households maximize an indirect utility function (v), which is a function of wages (w), profits (n) and prices (p). This indirect utility function is obtained from utility maximization as a function of net labor supply of households L and net commodity demand C, subject to the restriction that profits are the residual of commodity consumption expenditure pC minus labor income w: $v = v(w, n, p)$ and $dv/(\partial v/\partial \pi) = wL(dw/w) + d\pi - pC(dp/p)$.

for the domestic good (GHd) and the expenditure multiplier for the import good (GHm). Each of these components was computed the following way:

$GHd_{02} = Pd_{02}\ Qd_{02} = (Pd_{98} + \Delta Pd_{98\text{-}02})\ (Qd_{98} + \Delta Qd_{98\text{-}02})$
$= Pd_{98}\ Qd_{98} + Pd_{98}\ \Delta Pd_{98\text{-}02} + \Delta Pd_{98\text{-}02}\ Qd_{98} + \Delta Pd_{98\text{-}02}\ \Delta Qd_{98\text{-}02}$
Multiplier for d = $GHd_{02}/\ GHd_{98}$

$GHm_{02} = Pm_{02}\ Qm_{02} = (Pm_{98} + \Delta Pm_{98\text{-}02})\ (Qm_{98} + \Delta Qm_{98\text{-}02})$
$= Pm_{98}\ Qm_{98} + Pm_{98}\ \Delta Pm_{98\text{-}02} + \Delta Pm_{98\text{-}02}\ Qm_{98} + \Delta Pm_{98\text{-}02}\ \Delta Qm_{98\text{-}02}$
Multiplier for m = $GHm_{02}/\ GHm_{98}$

Where Pd and Pm are prices of the domestic good and import good respectively, obtained from the macro model. Qd and Qm are the quantities of the domestic and the import good respectively, also obtained from the macro model.

Table 14 shows the impact of shocks, expenditure policy and growth on household income and consumption by areas (Tables III.2 to III.6 in Annex III show impact by quintiles). In the case of the terms of trade shock, people experiment loss of income by 4.8% nationally and loss of consumption by 5.3% nationally, and by similar percentages in both urban and rural areas. For the case of decreasing foreign saving flows, people experiment loss of income by 0.6% nationally and loss of consumption by 12.8% nationally, and by similar percentages in both urban and rural areas. Absolute losses of income and consumption are increasing the higher the income quintile and greater in urban areas, however, that is not necessarily the case in relative terms, for both negative shocks.

Table 14
Impacts on household income and consumption (Bs per capita per month)

	Income		*Consumption*		*Change in*	
Quintile	*Base*	*Current*	*Base*	*Current*	*Income*	*Consumption*
			Terms of trade shock			
Urban	670.5	638.2	598.1	566.4	-32.3	-31.6
Rural	146.6	139.3	199.5	189.0	-7.3	-10.6
Total	476.3	453.3	450.4	426.5	-23.1	-23.8
			Reduction in foreign saving flows			
Urban	670.5	666.4	598.1	521.6	-4.1	-76.4
Rural	146.6	145.7	199.5	173.9	-0.9	-25.6
Total	476.3	473.4	450.4	392.8	-2.9	-57.6
			Social expenditure policy			
Urban	670.5	744.5	598.1	622.4	74.1	24.4
Rural	146.6	163.3	199.5	207.7	16.7	8.2
Total	476.3	529.1	450.4	468.7	52.8	18.4
			Output growth			
Urban	670.5	733.4	598.1	605.1	62.9	7.1
Rural	146.6	160.8	199.5	201.9	14.2	2.4
Total	476.3	521.2	450.4	455.7	44.8	5.3
			All cases			
Urban	670.5	657.0	598.1	520.9	-13.5	-77.1
Rural	146.6	143.5	199.5	173.7	-3.1	-25.8

Total	476.3	466.7	450.4	392.2	-9.6	-58.1

Source: Authors own computations (See Tables III.2 to III.6 in Annex III).

In the case of social expenditure policy, people experiment gains in income by 11% nationally and gains in consumption by 4% nationally, and by similar percentages in both urban and rural areas. For the case of output growth, people experiment gains in income by 9.4% nationally and gains in consumption by 1.2% nationally, and by similar percentages in both urban and rural areas. Absolute gains of income and consumption are increasing the higher the income quintile and greater in urban areas, however, that is not necessarily the case in relative terms, for both positive shocks.

The combined impact of shocks, social expenditure policy and growth shows that people have experimented loss of income by 2% nationally and loss of consumption by 12.9% nationally, and with similar percentages in both urban and rural areas. Absolute losses of income and consumption have increased the higher the income quintile and greater in urban areas, although that is not necessarily the case in relative terms.

One first conclusion from these experiments comes from comparing the magnitudes of the differential effects on household income and consumption levels by quintiles and areas. The negative effect on income has been greater from the terms of trade shock and the negative effect consumption has been greater from reduction in foreign saving flows.

A second conclusion is that under macroeconomic stability (no shocks and 1998 macro conditions), social expenditure policy would have had an important positive impact first on household income and second on household consumption by quintiles and areas.

A third conclusion is positive effects from the combined social expenditure policy and low output growth on income and consumption, did not compensate the negative impacts from the combined terms of trade shock and foreign saving reduction.

Table 15 shows the impact of shocks, expenditure policy and low growth on poverty measures expressed in the FGT indicators. The terms of trade shock increases the number of poor by an average of 1.1% points nationally, more in urban areas then in rural areas. Poverty gap decreases nationally by 0.2% points and poverty intensity decreases nationally by 0.1% points. The negative change of the poverty gap and poverty intensity percentages nationally is explained by the effect of the new poor, who would usually be the ones that were just above the poverty line and who would require less additional income to recover its previous welfare position. By areas the poverty gap and poverty intensity decreases in urban areas but increases in rural areas.

Table 15: Change in FGT Poverty Indicators (in percent)

	Head Count (P0)	*Poverty Gap (P1)*	*Intensity (P2)*	*Change in*		
				P0	*P1*	*P2*
Base year						
Urban	23.8	24.6	9.6			
s.e.	(0.019)					
Rural	71.5	48.5	29.1			
s.e.	(0.032)					
Total	41.4	39.9	22.0			
s.e.	(0.021)					
Terms of trade shock						
Urban	25.0	24.4	9.5	1.2	-0.2	-0.1
s.e.	(0.019)					
F	12.0					
Rural	72.3	48.6	29.3	0.8	0.2	0.2
s.e.	(0.031)					
F	5.48					
Total	42.5	39.7	22.0	1.1	-0.2	-0.1
s.e.	(0.021)					
F	17.34					
Decrease in foreign saving flows						
Urban	27.3	25.1	9.8	3.5	0.4	0.2
s.e.	(0.020)					
F	36.95					
Rural	74.6	49.0	29.8	3.2	0.5	0.7
s.e.	(0.029)					
F	14.78					
Total	44.8	39.8	22.1	3.4	-0.1	0.1
s.e.	(0.020)					
F	50.89					
Social expenditure policy						
Urban	22.7	24.6	9.5	-1.1	0.0	0.0
s.e.	(0.018)					
F	8.97					
Rural	71.0	48.0	28.7	-0.5	-0.5	-0.4
s.e.	(0.033)					
F	8.53					
Total	40.6	39.8	21.9	-0.9	-0.1	-0.1
s.e.	(0.020)					
F	13.49					
Output growth						
Urban	22.7	24.6	9.5	-1.1	-0.1	0.0
s.e.	(0.018)					
F	8.97					
Rural	71.0	48.0	28.6	-0.5	-0.5	-0.4
s.e.	(0.033)					
F	8.53					
Total	40.6	39.7	21.9	-0.9	-0.1	-0.1
s.e.	(0.020)					
F	13.49					
All cases						
Urban	26.2	24.8	9.7	2.4	0.2	0.1
s.e.	(0.020)					
F	26.3					
Rural	73.5	48.9	29.6	2.0	0.4	0.5
s.e.	(0.030)					
F	13.07					
Total	43.7	39.8	22.1	2.3	0.0	0.1
s.e.	(0.020)					
F	39.36					

Notes: s.e. is standard errors and F-Statistics are for the null that current and base year values are equal. In all cases this hypothesis is rejected at less then 1%. The testing procedure is explained in Annex III.
Source: Authors own computations.

The foreign saving flow reduction increases the number of poor by an average of 3.4% points nationally, more in urban areas then in rural areas. Poverty gap decreases nationally by 0.1% points and poverty intensity increases nationally by 0.1% points. The negative change in the poverty gap percent nationally is again explained by the characteristics of the new poor. However, the poverty gap and poverty intensity increases in both urban and rural areas when calculating them separately, more so in rural areas in both cases.

The social expenditure policy decreases the number of poor by an average of 0.9% points nationally, more in urban areas (1.1% points) then in rural areas (0.5% points). The poverty gap and poverty intensity would also decrease nationally by 0.1% points, explained fully by their decrease in rural areas.

Similarly, the low output growth decreases the number of poor by an average of 0.9% points nationally, more in urban areas (1.1% points) then in rural areas (0.5% points). The poverty gap and poverty intensity would also decrease nationally by 0.1% points, mostly explained by its decrease in rural areas in the first case and explained fully by its decrease in rural areas in the second case.

The combined effect of shock, expenditure policy and low output growth have increased the number of poor by an average of 2.3% points nationally, more in urban areas (2.4% points) then in rural areas (2% points). The combined effect does not show an effect on the poverty gap when measured nationally, but it shows an increase in urban and rural areas when measured separately, more so in rural areas (0.4% points) then in urban areas (0.2% points). The combined effect shows an increase in poverty intensity by 0.1% points nationally and also by areas, more so in rural areas (0.5% points) then in urban areas (0.1% points).

A first conclusion is that poverty increases, measured by the head count ratio, has been greater from reduction in foreign savings flows then from the terms of trade shock. Poverty increases, measured by the poverty gap and poverty intensity is concentrated in rural areas, and has been greater from the impact of reduction in foreign saving flows then from the terms of trade shock.

A second conclusion is that under macroeconomic stability social expenditure policy would have had an important impact in reducing the number of poor nationally, more in urban areas then in rural areas. It would have also reduce the poverty gap and poverty intensity in both areas, although more so in rural areas.

A third conclusion is that the combined positive effects from poverty reduction through social expenditure policy in an environment of low output growth, did not compensate the negative impacts on all measures of poverty from the combined terms of trade shock and reduction in foreign saving flows.

A fourth conclusion is that under individual or combined shocks, effects tend to be greater on the head count poverty measure then on the poverty gap and poverty intensity measures. Although in part this may be due to methodological limitations,

it could also be due to the structural characteristics of income and consumption distribution.

Given the diverse characteristics of the Bolivian population, captured by the 1999 survey, we can know which groups were impacted the most and by what magnitude. This information is presented in Table 16 based on the combined effects of shocks, expenditure policy and low growth on poverty. The number of poor increased the most in the age group of 19-30 nationally and in urban areas. In rural areas the most affected were in the age group of 31-45. In terms of sex, the number of poor increased the most among males, nationally and in both urban and rural areas.

When analyzing the increase in the number of poor by ethnicity, the classified as Spanish were impacted the most nationally and secondly the Aymara and Quechua equally. In rural areas the most affected were also the classified as Spanish and secondly the classified as "other". In urban areas the number of poor increased the most among the Aymara and secondly among the Quechua and Spanish. By self-identification, the number of poor increased the most under the classification of "none" Quechua or Aymara, nationally and in urban areas, being second the self-identified as "other" and Aymara. In contrast, in rural areas the number of poor increased the most under the self-identification of "other".

In terms of education, first those with incomplete primary education were affected the most nationally and in urban areas, increasing the number of poor. Second was the population with complete or incomplete secondary education. In rural areas the number of poor increased the most first among those with an incomplete secondary education and second among those with complete or incomplete primary education.

In terms of employment, the number of poor increased the most among the unemployed nationally and in rural areas, secondly the inactive and those not in working age (PENT). In the case of rural areas the number of poor increased by 15.4% points among the unemployed. In urban areas the number of poor increased the most first among the inactive and second among all other employment classification equally.

By economic activity, the number of poor increased the most in the industry sector, nationally and in both urban and rural areas. By economic condition and by sector, the number of poor increased the most in the classification of "house" (house work), nationally and in urban areas. In rural areas, the number of poor increased the most when "independent" and when "formal" or "informal".

Table 16
Poverty profile by geographical area (head count ratio in percent)

	Base year			All cases			Difference		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Age group									
Less18	28.5	73.4	46.7	30.9	75.7	49.1	2.4	2.3	2.4
19-30	20.9	67.0	32.2	23.7	68.9	34.8	2.8	1.9	2.6
31-45	19.1	67.4	34.9	21.2	70.2	37.3	2.1	2.8	2.3
45-64	20.1	71.0	41.0	22.7	71.8	42.8	2.5	0.8	1.8
>=65	16.9	73.8	47.4	18.2	75.2	48.8	1.4	1.4	1.4
Sex									
Male	23.8	70.3	41.2	26.3	72.5	43.6	2.6	2.2	2.4
Female	23.7	72.6	41.7	26.1	74.4	43.8	2.3	1.8	2.1
Ethnicity									
Quechua	34.8	79.9	69.5	37.2	81.8	71.5	2.4	1.8	2.0
Aymara	39.3	84.3	66.7	43.8	84.7	68.7	4.5	0.4	2.0
Spanish	20.0	48.3	24.9	22.3	51.7	27.4	2.3	3.4	2.5
Other	59.4	73.4	68.5	59.4	75.5	69.8	0.0	2.0	1.3
Self-identification									
Quechua	26.6	76.7	55.0	28.1	78.5	56.7	1.5	1.8	1.7
Aymara	32.0	77.9	51.6	34.9	78.3	53.4	2.9	0.4	1.8
None	25.8	56.0	35.7	29.2	57.6	38.5	3.4	1.6	2.8
Other	15.7	45.2	20.2	18.0	48.7	22.7	2.3	3.5	2.5
Education									
None	36.6	81.7	66.8	38.5	82.7	68.2	1.9	1.0	1.3
Incomplete Primary	30.0	70.0	48.0	33.2	72.5	50.8	3.2	2.5	2.8
Complete Primary	23.0	52.9	31.1	24.4	54.8	32.7	1.4	2.0	1.6
Incomplete Secondary	20.6	51.1	25.3	22.9	54.7	27.9	2.3	3.6	2.5
Complete Secondary	15.5	48.7	18.1	17.9	49.2	20.5	2.5	0.5	2.3
Professional, Technical	6.3	17.9	6.8	7.9	18.9	8.4	1.6	1.0	1.6
Migrant condition									
Non-migrant	23.9	77.9	46.0	26.6	79.6	48.2	2.6	1.8	2.3
Migrant	23.5	55.9	33.3	25.6	58.5	35.6	2.1	2.6	2.3
Employment									
PENT	30.3	75.5	50.5	32.6	78.1	52.9	2.3	2.6	2.4
Employed	21.0	71.5	43.5	23.3	73.0	45.4	2.3	1.4	1.9
Unemployed	26.6	56.6	28.0	28.9	72.0	30.9	2.3	15.4	2.9
Inactive	22.4	62.3	30.1	25.1	65.1	32.8	2.7	2.8	2.7
Economic Activity									
Primary sector	45.0	75.8	73.9	47.0	77.0	75.1	2.0	1.1	1.2
Industry	30.5	61.8	34.6	33.2	66.7	37.6	2.7	4.9	3.0
Services	15.5	29.8	16.7	17.6	32.6	18.9	2.1	2.8	2.2
Condition									
Dependent	20.2	44.8	23.7	22.4	46.2	25.8	2.2	1.4	2.1
Independent	20.8	70.3	43.7	23.2	72.2	45.9	2.4	1.9	2.2
Employer	8.4	45.3	15.7	8.4	45.3	15.7	0.0	0.0	0.0
Unpaid	33.0	79.2	70.4	35.7	80.3	71.8	2.7	1.1	1.4
House	17.6	25.7	18.6	22.0	25.7	22.4	4.3	0.0	3.8
Sector									
Formal	14.0	34.9	16.7	15.8	36.4	18.6	1.9	1.5	1.8
Informal	24.9	74.3	51.6	27.3	75.7	53.5	2.4	1.5	1.9
House	17.6	25.7	18.6	22.0	25.7	22.4	4.3	0.0	3.8

Source: Authors own computations

VI. Conclusions and policy implications

Shocks and poverty reduction policy were analyzed individually and jointly in an environment of low growth in an effort to simulate the actual experience of the Bolivian economy during the period 1999-2002. The analytical method was based in the connection of a simple macro model of the 1-2-3 type with household data (Devarajan and Go, 2002). Analysis was made in terms of the direction and order of magnitude of the differential effects of shocks and policy on i) macro aggregate consumption, income, saving and prices, ii) on income and consumption levels of households, and iii) on poverty measures.

The following are some conclusions and implications:

1. The terms of trade shock experienced by the Bolivian economy had a greater negative impact on household income then the experienced reduction in foreign saving flows. At the same time, reduction in foreign saving flows had greater negative impact on household consumption then the terms of trade shock.

2. Poverty increase measured by the head count ratio has been greater from reduction in foreign saving flows then from the terms of trade shock. Poverty increase measured by the poverty gap and poverty intensity has concentrated in rural areas, and has also being greater from reduction in foreign saving flows then from the terms of trade shock.

3. Under macroeconomic stability (no shocks and 1998 macro conditions) social expenditure policy for poverty reduction would have had an important positive impact on aggregate income, consumption and saving, on household income and consumption levels (more so in income then consumption), in reducing the number of poor (more in urban then rural areas), and in reducing poverty gap and poverty intensity (more so in rural areas).

4. The combined positive effects from social expenditure policy in an environment of low output growth, did not compensate the combined negative impacts from the terms of trade shock and reduction in foreign saving flows.

5. Under individual or combined shocks, effects tend to be greater on the head count poverty measure then on the poverty gap and poverty intensity measures. Although in part this may be due to methodological limitations, it could also be due to the structural characteristics of income and consumption distribution.

These conclusions show that under macroeconomic disequilibrium poverty reduction efforts become policies of poverty containment or safety net programs during a period of economic recession. They also show that if poverty reduction is seen as a long term objective, particularly in a country that is starting at high poverty levels, then commitment to long term macroeconomic stability must be a key general policy. It also suggests that this general policy must be accompanied by policies directed at ensuring positive growth under disequilibrium, given that the economy will certainly experiment other episodes of shocks in the medium and long term.

The paper also shows that the magnitude of poverty reduction effort does matter. If effort produces small positive effects compared to large negative effects of shocks, then poverty reduction policy is not real. If effort actually produces larger positive effects compared to negative effects of shocks, then poverty reduction policy may be real. However, if effort is larger, the macro analysis warns of other macroeconomic effects from social expenditures policies for poverty reduction, those of export decreases, import increases and investment decreases.

Bolivia probably doesn't have the financial resources for a greater scale poverty reduction effort. If this is the case, then a more effective way to avoid welfare losses and maximize poverty reduction is to defend macroeconomic stability. This implies work on preparing for external shocks and on structural aspects of the economy, like greater export and trade diversification and large improvements in domestic productivity.

Some of the conclusions also suggest that the objective of poverty reduction in terms of the number of poor alone can not be sufficient, this should be accompanied by other objectives equally or more important related to the quality of poverty reduction. This implies work on rigid structural aspects like improvement of income and consumption distribution and social mobility.

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ANNEX I
DESCRIPTION OF THE 1-2-3 MODEL

Table I.1
Assumptions about imperfect substitution

Assumption	Function[11]	Maximization
The domestic and export goods are assumed to be imperfect substitutes.	This imperfect substitutability is captured by the economy's production possibility frontier, for convenience specified as a CET function with transformation elasticity Ω: $\overline{X} = G\left(E, D^S; \Omega\right)$ $\overline{X} = \mathrm{A_t}\left[\theta_t\, E^{\rho} + (1-\theta_t)\, D^{S\,\rho}\right]^{1/\rho}$ (1)	Profit maximization by producers, given the CET function, yields to the first-order condition: $\frac{E}{D^S} = g\left(P^e, P^d, \Omega\right)$ $\frac{E}{D^S} = \left[\frac{(1-\theta_t)\, P^e}{\theta_t\, P^d}\right]^{1/(\rho-1)}$ (3)
The output of the domestic good is assumed to be an imperfect substitute for imports in consumption.	This imperfect substitutability in composite commodity is given by a CES function with substitution elasticity σ: $Q^S = F\left(M, D^D; \sigma\right)$ $Q^S = \mathrm{A_q}\left[\omega_q\, M^{-\eta} + (1-\omega_q)\, D^{D\,-\eta}\right]^{-(1/\eta)}$ (2)	Utility maximization by consumers, given the CES function, yields to the first-order condition: $\frac{M}{D^D} = f\left(P^m, P^d, \sigma\right)$ $\frac{M}{D^D} = \left[\frac{\omega_q\, P^d}{(1-\omega_q)\, P^m}\right]^{-1/(\eta+1)}$ (4)

Source: Based on Devarajan, Lewis and Robinson (1993) and Devarajan *et al* (1997)

Aside from Equations (1), (2), (3), and (4) showed in Table I.1, equation (5) is part of the "real flows" side of the model, which defines total demand for the composite good (absorption) showing that the value of the goods demanded must equal aggregate expenditure:

$$Q^D = C + Z + \overline{G} \qquad (5)$$

In Equation (5), C represents aggregate consumption; Z represents aggregate real investment and $\overline{G}$ is the real government demand.

[11] The two main characteristics of the CES/CET functions are: i) they are homogeneous of degree one (linearly homogeneous); and ii) they have a constant elasticity of substitution.

Table I.2
Price equations in the model

Assumption	Function	Dual price equations
There is a fix world price for E (pw^e)	The domestic price of E (taking into account that there is no export subsidy rate in the Bolivian case) is determined by: $P^e = \mathrm{R}\ \mathrm{pw}^{\mathrm{e}}$ (6) where R is the nominal exchange rate	The price of the composite good P^x (aggregate output)[12] is the cost-function dual to the first-order condition of equation 3. $P^x = g_1\left(P^e, P^d\right)$ Given the linearly homogeneity of the dual price equation and using Euler's theorem, we obtain the following expenditure identity: $P^x = \frac{P^e\ E + P^d\ D^S}{X}$ (8)
There is a fix world price for M (pw^m)	The domestic price of M (including import tariffs: t^m) is determined by: $P^m = \left(1 + t^m\right)\mathrm{R}\ \mathrm{pw}^{\mathrm{m}}$ (7) where R is the nominal exchange rate	The price of the composite commodity[13] P^q is the cost-function dual to the first-order condition of equation 4. $P^q = f_1\left(P^m, P^d\right)$ Given the linearly homogeneity of the dual price equation and using Euler's theorem, we obtain the following expenditure identity: $P^q = \frac{P^m\ M + P^d\ D^D}{Q}$ (9)

Source: Based on Devarajan, Lewis and Robinson (1993) and Devarajan *et al* (1997)

Complementing the information presented in Table I.2, two additional price equations are introduced: i) one that considers the sales price of composite goods P^t when indirect taxes (t^s) are added to the price of the composite good (P^q); and ii) a numeraire price, in this case the nominal exchange rate R, since only relative prices matters:

$$P^t = (1 + t^s)\ P^q \quad (10)$$

$$R = 1 \quad (11)$$

[12] The composite good price P^x corresponds to GDP deflator.
[13] The composite good price P^q corresponds to an aggregate consumer price or cost-of-living index.

Regarding the market-clearing equilibrium conditions[14], supply must equal demand for *"D"* and *"Q"* (Equations 12 and 13 respectively), the balance-of-trade constraint must be satisfied adjusting grants (*ft*) and remittances (*re*) from abroad (Equation 14), and also the government-budget constraint (public savings) must be considered as the residual of tax revenue (*T*) plus foreign grants less government consumption ($\overline{G}$) and transfers (*tr*) to households (Equation 15).

$$D^D - D^S = 0 \quad (12)$$
$$Q^D - Q^S = 0 \quad (13)$$
$$pw^m M - pw^e E - ft - re = \overline{B} \quad (14)$$
$$S^g = T + ft\ R - P^t\ \overline{G} - P^q\ tr \quad (15)$$

The income flows (nominal flows) among the actors in the economy can be tabulated in a social account matrix (SAM) with six accounts: one for each actor, a "capital" account that reflects the saving-investment balance, and a "commodity" account that keeps track of absorption. Table I.3 presents this social account matrix.

Table I.3
Social account matrix for the 1-2-3 model[15]

Receipts	Expenditures						
	Commodity	Producer	Household	Government	Capital	World	Total
Commodity			$C\ P^t$	$P^t\ \overline{G}$	$P^t\ Z$		$P^t\ Q^{D16}$
Producer	$P^t\ D^D$					$R\ pw^e\ E$	$P^t D^D + Rpw^e E$
Household		$P^x\ \overline{X}$		$tr\ P^q$		$re\ R$	$Y = P^x\ \overline{X} + tr\ P^q + re\ R$
Government	$t^m\ R\ pw^m\ M$	$t^s P^q Q^D$	$t^y Y$				T
Capital			$s^y Y$	S^g		$R\ \overline{B}$	$S = s^y Y + S^g + R\ \overline{B}$
World	$R\ pw^m\ M$						$R\ pw^m\ M$
Total	$P^q\ Q^S$	$GDP + t^s P^q Q^D$	Y	Outflow	$P^q\ Z$	$R\ pw^e\ E + re\ R + R\ \overline{B}$	

Source: Devarajan, Lewis and Robinson (1990)

Four equations can be extracted from the information presented in Table I.3; Equation (16) that corresponds to household income "*Y*" (sum of 3rd row), Equation (17) determining government revenue *"T"*[16] (sum of the 4th row: $T = t^m\ R\ pw^m\ M + t^S\ P^q\ Q^D + t^y Y$), Equation (18) representing total savings "*S*", and finally Equation (19) that determines aggregate household consumption "*C*". The latter can be obtained rearranging terms of the 3rd column[17] and takes the following form:

$$C\ P^t = Y\ (1 - s^y - t^y) \quad (19)$$

[14] The equilibrium conditions are not all independent. To prove this, it suffices to show that the model satisfies Walras's Law.
[15] Each cell represents a payment from a column account to a recipient in a row account.
[16] According to equation 5.
[17] Note that in the Bolivian economy there are no export subsidies.
[18] Note that all income is spent on the single composite good.

Summarizing, the full analytical model is a system of nineteen equations with nineteen endogenous variables. Endogenous and exogenous variables are listed below:

Table I.4
List of variables of the 1-2-3 model

Endogenous variables		Exogenous variables	
E	: Export good	pw^m	: World price of import good
M	: Import good	pw^e	: World price of export good
D^S	: Supply of domestic good	t^m	: Tariff rate
D^D	: Demand for domestic good	t^e	: Export duties
Q^S	: Supply of composite good	t^s	: Sales/excise/value-added tax rate
Q^D	: Demand for composite good	t^y	: Direct tax rate
P^e	: Domestic price of export good	tr	: Government transfers
P^m	: Domestic price of import good	ft	: Foreign transfers to government
P^d	: Producer price of domestic good	re	: Foreign remittances to private sector
P^t	: Sales price of composite good	s^y	: Average saving rate
P^x	: Price of aggregate output	$\overline{X}$	: Aggregate output
P^q	: Price of composite good	$\overline{G}$	: Real government demand
R	: Nominal exchange rate	$\overline{B}$	: Balance of trade/Foreign savings
T	: Tax revenue	Ω	: Export transformation elasticity
S^g	: Government savings	σ	: Import substitution elasticity
Y	: Total income		
C	: Aggregate consumption		
S	: Aggregate savings		
Z	: Aggregate real investment		

ANNEX II
ECONOMETRIC PROCEDURE AND ELASTICITY ESTIMATION

1. Methodology and data source

The 123 macro model divides the economy into two sectors (tradable (E+M) and non-tradable (D)) and three goods markets (export good E, domestic good D and import good M). In this economy the production possibilities frontier is specified as a constant elasticity of transformation (CET) function with transformation elasticity between E and D^s. Utility in consumption is specified as a constant elasticity of substitution (CES) function with substitution elasticity between D^D and M. Production and consumption decisions are determined by the relative prices of E and D in the first case and of M and D in the second case. Export and import prices are exogenous making the domestic price endogenous.

The purpose of this Annex is to present the methodology, data source and processing, study of the statistical properties of the data and finally production of estimates of the constant elasticity of transformation (CET) and constant elasticity of substitution (CES), required for the 123 model. It is desired that estimation of these parameters best represent the Bolivian economy.

In the CES case, utility maximization by households subject to a standard budget constraint can be expressed in the following form:

$$\text{Maximize} \quad [\omega(M_t)^{-\eta} + (1-\omega)(D^D{}_t)^{-\eta}]^{-1/\eta}$$

$$\text{Subject to:} \quad M_t * P^M{}_t + D^D{}_t * P^D{}_t = Q^S{}_t * P^Q{}_t$$

The parameter η determines the elasticity of substitution between consumption of the import good and consumption of the domestic good, which is given by $v = 1/(1+\eta)$ for $-\infty<\eta<+1$, ω is the share parameter, P^M is the price of the import good, P^D is the price of the domestic good, $Q^S * P^Q$ is a budget constraint expressed in terms of the composite good and t is time. Solution of the maximization problem yields the following optimality condition for the allocation of consumption:

$$M_t/D^D{}_t = [((1-\omega)/\omega)*(P^M{}_t/P^D{}_t)]^{-1/(\eta+1)}$$

This condition reduces to the following log-linear testable relationship:

$$\ln (M_t/D^D{}_t) = \alpha_0 + \alpha_1 \ln (P^D{}_t/P^M{}_t) \textit{where} \quad \alpha_0 = v \ln (\omega/(1-\omega)) \quad \textit{and} \quad \alpha_1 = v$$

In the CET case, maximization of aggregate production subject to a constant elasticity of transformation function can be expressed in the following form:

$$\text{Maximize} \quad E_t * P^E{}_t + D^S{}_t * P^S{}_t = X°{}_t * P^X{}_t$$

$$\text{Subject to} \quad X° = [\theta (E_t)^{\rho} + (1-\theta)(D^S{}_t)^{\rho}]^{1/\rho}$$

The parameter ρ determines the elasticity of transformation between the production of the export good and the domestic good, which is given by $u = 1/(\rho-1)$ for $1< \rho <+\infty$, θ is the share parameter, P^E is the price of the export good, P^S is the price of the domestic good, $X°*P^X$ is the value of aggregate product X° which is fixed. Solution of the maximization problem yields the following optimality condition for the allocation of production:

$$E_t/D^S_t = [((1-\theta)/\theta)*(P^E_t/P^S_t)]^{1/(\rho-1)}$$

This condition reduces to the following log-linear testable relationship:

$$\ln (E_t/D^S_t) = \beta_0 + \beta_1 \ln (P^E_t/P^S_t) \quad \textit{where} \quad \beta_0 = u \ln ((1-\theta)/\theta) \quad \textit{and} \quad \beta_1 = u$$

Both testable relationships based on the CET and CES functions describe a long run equilibrium condition, therefore it is of interest to estimate a co integrating relationship among the variables. In the first case the elasticity corresponds to the long-run equilibrium relationship between the production ratio and the price ratio of the export good relative to the domestic good. In the second case the elasticity corresponds to the long-run relationship between the consumption ratio and the price ratio of the import good relative to the domestic good. In each case the price ratio describes an internal real exchange rate, in the first case it is a production exchange rate (depreciation is an incentive for exports) and in the second it is a consumption exchange rate (depreciation is an incentive for imports).

The source for the data is the national accounts statistics produced by the Bolivian National Institute of Statistics (INE). INE produces national accounts data on a quarterly basis and time series for all of its components are available from the first quarter of 1990 to the second quarter of 2004 (the last two quarters are preliminary), in nominal and real terms (base 1990). The time series required for the study must be consistent with an economy that produces two goods (one export and one domestic) and demands two goods (one import and one domestic). For the elasticity of substitution in supply (CET function) we need the quarterly time series of the export good (EE), domestic good (DCK), price of the export good (PE) and price of the domestic good (PD). For the elasticity of substitution in demand (CES function) we need the time series of the import good (MCK), domestic good (DCK), price of the import good (PM) and price of the domestic good (PD). All of these can be obtained from the national accounts with the following processing:

EE = no processing required.
MCK = Total imports MM – intermediate imports and raw materials.
DCK = Total household demand+total government demand+total investment–MCK.
PE = Nominal EE / Real EE
PM = Nominal MCK / Real MCK
PD = Nominal DCK / Real DCK
EE/DCK = Ratio of export good production to domestic good production.
PE/PD = Ratio of the export good price to the domestic good price.
MCK/DCK = Ratio of import good consumption to domestic good consumption.
PM/PD = Ratio of the import good price to the domestic good price.

2. Statistical properties of the data

The following figures present the raw quarterly time series of interest, where ED=EE/DCK is the real production ratio of the export good relative to domestic good, PED= PE/PD is the price ratio of the export good relative to the domestic good, MD=MCK/DCK is the real consumption ratio of the import good relative to the domestic good and PMD=PM/PD is the price ratio of the import good relative to the domestic good.

Figure II.1

Figure II.2

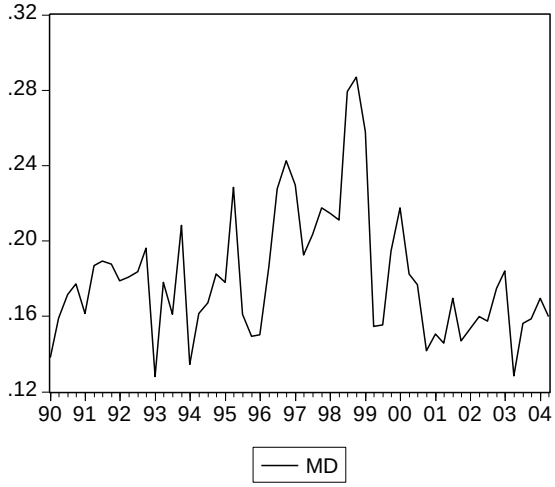


Figure II.3

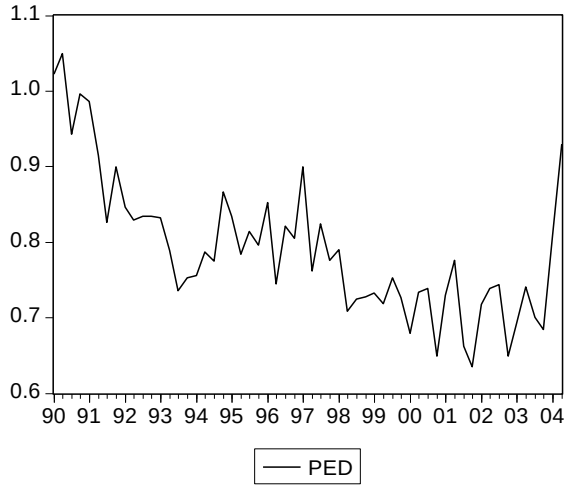
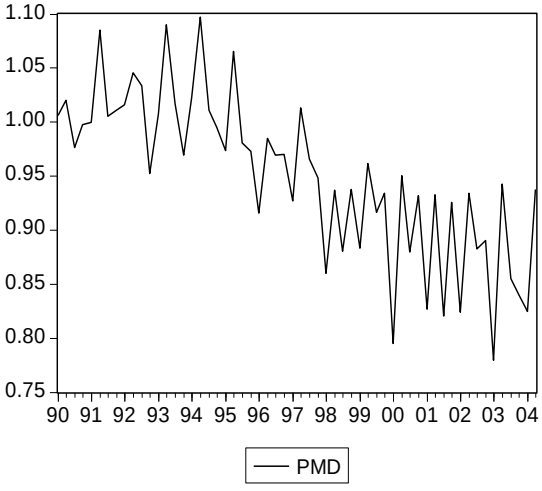


Figure II.4



Source: Authors own computations.

Table II.1 presents the standard ADF test applied to the data in levels, indicating the variables LED=log(ED), LMD=log (MD), LPED=log (PED) and LPMD=log (PMD) are all non-stationary under different test specifications. Table II.2 presents the standard ADF test applied to the data in first difference, indicating the first difference of LED and LMD are stationary under different test specifications. The

first difference of LPED is also stationary except when a constant and trend are included in the test specification. The first difference of LPMD is stationary only when a constant is included in the test specification.
Comparing Table II.1 and II.2 it is possible to conclude that the variables LED and LMD are integrated of first order or I(1). The variable LPED is not I(1) only when the test includes constant plus trend. The variable LPMD is I(1) only when the test includes a constant.

Table II.1
ADF unit root tests for the variables in levels

Variable	Specification	Lag length	ADF statistic	Stationarity
LED	None	1	-0.875	Non-Stationary
	Constant	1	-1.783	Non-Stationary
	Constant, trend	1	-2.523	Non-Stationary
LMD	None	4	-0.078	Non-Stationary
	Constant	4	-1.883	Non-Stationary
	Constant, trend	4	-1.961	Non-Stationary
LPED	None	5	-0.522	Non-Stationary
	Constant	5	-2.375	Non-Stationary
	Constant, trend	5	-1.605	Non-Stationary
LPMD	None	10	0.577	Non-Stationary
	Constant	10	-0.435	Non-Stationary
	Constant, trend	10	-1.665	Non-Stationary

Notes: (*), (**) and (***) denotes rejection of the null hypothesis of unit root at 10%, 5% and 1% respectively. The lag length was selected by the Akaike Information Criterion (AIC).
Source: Authors own calculations

Table II.2
ADF unit root tests for the variables in first difference

Variable	Specification	Lag length	ADF statistic	Stationarity
Δ_1 LED	None	3	-4.963***	Stationary
	Constant	3	-5.122***	Stationary
	Constant, trend	3	-5.250***	Stationary
Δ_1 LMD	None	3	-5.553***	Stationary
	Constant	3	-5.496***	Stationary
	Constant, trend	3	-5.511***	Stationary
Δ_1 LPED	None	4	-2.482**	Stationary
	Constant	4	-2.325**	Stationary
	Constant, trend	4	-2.882	Non-Stationary
Δ_1 LPMD	None	9	-1.694*	Non-Stationary
	Constant	9	-3.007**	Stationary
	Constant, trend	9	-2.807	Non-Stationary

Notes: (*), (**) and (***) denotes rejection of the null hypothesis of unit root at 10%, 5% and 1% respectively. The lag length was selected by the Akaike Information Criterion (AIC).
Source: Authors own calculations.

Traditional unit root and co-integration tests were developed for non-seasonal or zero frequency data, which could also be applied to quarterly data only if it is proven that unit roots at other frequencies are not present (half frequency or biannual unit root and one fourth frequency of annual unit root). It is important to notice that the elasticity of interest in this study corresponds to the long run

equilibrium relationship between LED and LPED and between LMD and LPMD, that is, it is strictly a non-seasonal or zero frequency relationship in the data.

Seasonal differencing is often used to remove non-stationarity in seasonal data. In this case the quarterly difference operator is $\Delta_4 y_t = y_t - y_{t-4}$. Table II.3 presents the ADF test applied to the quarterly difference of the data. Results show that the quarterly difference of LED is non-stationary under any test specification, which supports the result, that this variable is I(1). The quarterly differences of LMD and of LPED are stationary only when no deterministic variables are included in the test specification. The quarterly difference of LPMD is stationary only when a constant is included in the test specification. Stationarity of the quarterly difference implies that the time series may contain either a non-seasonal unit root, a biannual unit root, an annual unit root, or a combination of these types of unit roots.

Table II.3
ADF unit root tests for the variables in quarterly difference

Variable	Specification	Lag length	ADF statistic	Stationarity
Δ_4 LED	None	5	-1.297	Non-Stationary
	Constant	5	-1.496	Non-Stationary
	Constant, trend	5	-1.686	Non-Stationary
Δ_4 LMD	None	5	-2.291**	Stationary
	Constant	5	-2.283	Non-Stationary
	Constant, trend	5	-2.234	Non-Stationary
Δ_4 LPED	None	1	-2.695***	Stationary
	Constant	1	-2.551	Non-Stationary
	Constant, trend	1	-3.066	Non-Stationary
Δ_4 LPMD	None	6	-1.800*	Non-Stationary
	Constant	6	-3.191**	Stationary
	Constant, trend	6	-3.001	Non-Stationary

Notes: (*), (**) and (***) denotes rejection of the null hypothesis of unit root at 10%, 5% and 1% respectively. The lag length was selected by the Akaike Information Criterion (AIC).
Source: Authors own calculations.

The HEGY procedure introduced by Hylleberg et al. (1990) is appropriate to find out which types of unit roots are contained in the data. The quarterly difference operator $\Delta_4 = (I-L^4)$ can be decomposed as, $(I-L^4) = (I-L)(I+L)(I+L^2) = (I-L)(I+L+L^2+L^3)$, which has four roots, one at zero frequency, one at two cycles per year and two complex pairs at one cycle per year. The HEGY procedure consists in the following testable regression model, which can be estimated by OLS,

$$y_{4t} = \mu_t + \pi_1 y_{1,t-1} + \pi_2 y_{2,t-1} + \pi_3 y_{3,t-2} + \pi_4 y_{3,t-1} + (\text{lags of } y_{4t}) + \varepsilon_t$$

where,
$y_{1t} \equiv (I+L)(I+L^2)y_t = y_t + y_{t-1} + y_{t-2} + y_{t-3}$
$y_{2t} \equiv -(I-L)(I+L^2)y_t = -(y_t - y_{t-1} + y_{t-2} - y_{t-3})$
$y_{3t} \equiv -(I-L)(I+L)y_t = -(I-L^2)y_t = -(y_t - y_{t-2})$
$y_{4t} \equiv \Delta_4 y_t = y_t - y_{t-4}$
μ_t = constant, trend and seasonal dummies
Lags of y_{4t} are included to ensure white noise residuals
ε_t = i.i.d. residuals.

Based on the HEGY regression the following hypothesis can be tested using critical values computed by Hylleberg et al:

H_A: $\pi_1=0$ or non-seasonal unit root
H_B: $\pi_2=0$ or biannual unit root
H_C: $\pi_3=\pi_4=0$ or annual unit root

Table II.4 presents estimated statistics from application of the HEGY regression to the data. In the case of LED there is consistent rejection of H_B and H_C and failure to reject H_A implying unit root only at zero frequency (non-seasonal unit root), that is, the variable must be I(1). This result supports the previous finding.

Table II.4
HEGY tests for seasonal unit roots

Variable	Variable and specification	Lag length	't' $\pi_1=0$	't' $\pi_2=0$	'F' $\pi_3=\pi_4=0$
LED	None	0	-1.263	-3.164****	9.756****
	C	0	-0.420	-3.150****	9.568****
	C, t	0	-1.074	-3.119****	9.453****
	C, q_1 q_2 q_3	0	-0.610	-3.146**	13.666****
	C, t, q_1 q_2 q_3	0	-1.232	-3.124**	13.506****
LPED	None	0	-0.023	-3.272****	5.294****
	C	0	-2.905*	-3.152****	3.393**
	C, t	0	-1.214	-3.099****	3.324**
	C, q_1 q_2 q_3	0	-2.905*	-3.284**	3.846
	C, t, q_1 q_2 q_3	0	-1.288	-3.234**	3.760
LMD	None	0	-0.101	-2.192**	19.009****
	C	0	-1.958	-2.241**	19.710****
	C, t	0	-2.038	-2.202**	19.096****
	C, q_1 q_2 q_3	0	-1.981	-2.111	20.255****
	C, t, q_1 q_2 q_3	0	-2.055	-2.077	19.590****
LPMD	None	0	0.990	-0.899	2.173
	C	0	-0.082	-0.886	2.039
	C, t	0	-2.985	-0.856	2.208
	C, q_1 q_2 q_3	0	-0.255	-1.908	6.578*
	C, t, q_1 q_2 q_3	0	-3.153	-2.057	7.056**

Notes: Critical values where obtained from the HEGY tables for n=48.
For the HEGY 't' test (*), (**), (***) and (****) denotes rejection of the null hypothesis at 10%, 5%, 2.5% and 1% respectively. For the HEGY 'F' test (*), (**), (***) and (****) denotes rejection of the null hypothesis at 90%, 95%, 97.5% and 99% respectively. Residuals of all regressions are white noise and approximately normally distributed without the addition of lags of y_{t4}. The q_i are seasonal dummies.
Source: Authors own calculations.

In the case of LPED and LMD there is consistent rejection of H_B and H_C and failure to reject H_A when no seasonal dummies are included in the test specification. That is, LPED and LMD are I(1) as found before as long as no seasonal dummies are included in any regression procedure.

In the case of LPMD there is consistent failure to reject H_A, H_B and H_C implying unit root at all frequencies (consistent with earlier findings). This result suggests that for LPMD there is need to filter out the unit root components other then the one of

interest at zero frequency, this way the new LPMD, say LPMD1, would be I(1). The filter to remove the seasonal roots would be the following, where y_{1t} is the filtered series already computed above: $(I-L^4)/(I-L)y_t = (I+L+L^2+L^3)\ y_t = y_{1t}$.

3. Co-integration test

The issue is to find weather the variables of interest are co integrated, that is if there is a linear combination of the pair of variables LMD and LPMD1 and the pair of variables LED and LPED that is stationary. If these pairs of variables are co integrated, then the linear combination would express the long term relationship among them.

Engle and Granger (1987) proposed a two-step estimator for models involving co-integrated variables. In the first step, the co-integrating parameters are estimated by running a static regression in the levels of the variables. In the second step, these are used in estimating an error correction model. Both steps require only OLS. The first step is our main interest here, in testing whether the residuals of the estimated regression in levels produces a stationary time series. The following are the estimated co-integrating equations:

CET co-integrating equation:

log(E/D) = (-1.38 + 0.01 t - 0.18 dcrisis) + 0.248 log(PE/PD) + Res1

CES co-integrating equation:

log(M/D) = (-1.61 – 0.004 t – 0.37 dcrisis) - 0.81 log(PM/PD) + Res2

where t is time and dcrisis is a dummy variable that captures the shift during the current period of economic crisis, taking a value of 1 from the first quarter of 1999 to the second quarter of 2004 and 0 otherwise. Res1 and Res2 are the residuals of the estimated equations.

Table II.5 presents the standard ADF test applied to the estimated residuals of the co-integrating equations. Results show evidence of stationarity for Res1 when no deterministic variables are included or when only a constant is included in the test specification. Results also show consistent evidence of stationarity for Res2 under any deterministic specification of the test with one lag. There is also evidence of stationarity for Res2 when no deterministic variables are included in the test specification with four lags.

The CET co-integrating equation suggests on average an elasticity of substitution of 0.248 in the production of the export good relative to the domestic good when there is a change in their relative prices. In addition the positive sign indicates that, when the price of the export good increases while the price of the domestic good remains constant, the production of the export good will increase and the production of the domestic good will decrease. Result in accordance to theory.

Table II.5
ADF unit root tests for the residuals of long term equations

Variable	Specification	Lag length	ADF statistic	Stationarity
Res1	None	1 (AIC)	-3.271***	Stationary
	Constant	1 (AIC)	-3.239**	Stationary
	Constant, trend	1 (AIC)	-3.197*	Non-Stationary
Res2	None	4 (AIC)	-2.281**	Stationary
	Constant	4 (AIC)	-2.250	Non-Stationary
	Constant, trend	4 (AIC)	-2.208	Non-Stationary
Res2	None	1 (SIC)	-3.985***	Stationary
	Constant	1 (SIC)	-3.952***	Stationary
	Constant, trend	1 (SIC)	-3.918**	Stationary

Notes: (*), (**) and (***) denotes rejection of the null hypothesis of unit root at 10%, 5% and 1% respectively. The lag length was selected by the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC), both criteria coincide for Res1 but diverge for Res2.
Source: Authors own calculations.

The CES co-integrating equation suggests on average an elasticity of substitution of 0.81 in the consumption of the import good relative to the domestic good when there is a change in their relative prices. In addition the negative sign indicates that, when the price of the import good increases while the price of the domestic good remains constant, the consumption of the import good will decrease and the consumption of the domestic good will increase. Result in accordance to theory.

Although both estimated co-integrating parameters are inelastic, the CET parameter is more inelastic compared to the CES parameter, implying that producers are much slower to react to price changes (probably due to structural rigidities) compared to consumers.

The following are the corresponding error correction models (ECM) or second step of the Engle and Granger estimation procedure, where $\varepsilon 1_t$ and $\varepsilon 2_t$ are white noise residuals.

CET ECM: $\Delta \log(E/D)_t = 0.006 - 0.44\ Res1_{t-1} + \varepsilon 1_t$
t-Stat: (0.46) (-3.64)
R2=0.19
Skewness= -0.45
Kurtosis= 4.37

CES ECM: $\Delta \log(M/D)_t = -0.0002 - 0.32\ \Delta \log(M/D)_{t-3} - 0.65\ Res2_{t-1} + \varepsilon 2_t$
t-Stat: (-0.01) (-3.26) (-5.56)
R2=0.50
Skewness= -0.46
Kurtosis= 3.94

ANNEX III
HOUSEHOLD TABLES

Table III.1
Adult equivalence scale by household size, 1999

Household size	*Minimum*	*Maximum*	*Mean*
1	1.0	1.0	1.0
2	1.5	1.7	1.7
3	2.0	2.4	2.3
4	2.5	3.1	2.8
5	3.0	3.8	3.4
6	3.5	4.5	4.0
7	4.2	5.2	4.6
8	4.5	5.9	5.1
9	5.2	6.6	5.9
10	5.7	7.1	6.4
11	6.8	7.2	7.0
12	7.5	8.3	7.9
16	10.3	10.3	10.3
Total	**1.0**	**10.3**	**3.6**

Source: Authors own calculations based on MECOVI 1999

Table III.2
Impact on households from negative terms of trade shock
(Bs per capita per month)

	Income		Consumption		Difference	
Description	Base	Current	Base	Current	Income	Consumption
URBAN						
1 (poorest)	200.8	192.3	108.5	102.8	-8.5	-5.8
2	249.2	236.3	223.7	211.8	-12.8	-11.9
3	380.5	361.8	336.1	318.2	-18.8	-17.9
4	546.2	519.0	510.9	483.8	-27.2	-27.1
5 (richest)	1,203.6	1,146.9	1,059.6	1,003.7	-56.7	-55.9
Total	670.5	638.2	598.1	566.4	-32.3	-31.6
RURAL						
1 (poorest)	68.4	65.0	90.3	85.5	-3.4	-4.8
2	142.8	135.8	205.8	194.9	-7.0	-10.9
3	262.0	248.9	333.7	316.0	-13.1	-17.7
4	388.6	369.4	503.4	476.8	-19.1	-26.6
5 (richest)	641.7	607.8	1,012.4	958.9	-33.9	-53.5
Total	146.6	139.3	199.5	189.0	-7.3	-10.6
TOTAL						
1 (poorest)	77.8	74.0	91.6	86.7	-3.8	-4.9
2	186.4	177.0	213.1	201.8	-9.4	-11.3
3	355.5	338.0	335.6	317.8	-17.6	-17.8
4	525.3	499.2	509.9	482.9	-26.2	-27.0
5 (richest)	1,185.6	1,129.6	1,058.1	1,002.3	-56.0	-55.8
Total	476.3	453.3	450.4	426.5	-23.1	-23.8

Source: Authors own calculations.

Table III.3
Impact on households from reduction in foreign saving flows
(Bs per capita per month)

	Income		Consumption		Difference	
Description	Base	Current	Base	Current	Income	Consumption
URBAN						
1 (poorest)	200.8	199.7	108.5	94.5	-1.1	-14.0
2	249.2	247.5	223.7	194.9	-1.6	-28.8
3	380.5	378.1	336.1	292.9	-2.4	-43.2
4	546.2	542.7	510.9	445.4	-3.5	-65.5
5 (richest)	1,203.6	1,196.4	1,059.6	924.6	-7.2	-135.0
Total	670.5	666.4	598.1	521.6	-4.1	-76.4
RURAL						
1 (poorest)	68.4	68.0	90.3	78.7	-0.4	-11.6
2	142.8	141.9	205.8	179.4	-0.9	-26.4
3	262.0	260.3	333.7	290.9	-1.7	-42.8
4	388.6	386.1	503.4	439.1	-2.4	-64.4
5 (richest)	641.7	637.4	1,012.4	883.0	-4.3	-129.4
Total	146.6	145.7	199.5	173.9	-0.9	-25.6
TOTAL						
1 (poorest)	77.8	77.3	91.6	79.8	-0.5	-11.8
2	186.4	185.2	213.1	185.8	-1.2	-27.4
3	355.5	353.3	335.6	292.5	-2.2	-43.1
4	525.3	522.0	509.9	444.6	-3.3	-65.3
5 (richest)	1,185.6	1,178.5	1,058.1	923.3	-7.1	-134.8
Total	476.3	473.4	450.4	392.8	-2.9	-57.6

Source: Authors own calculations.

Table III.4
Impact on households from social expenditure policy
(Bs per capita per month)

	Income		Consumption		Difference	
Description	Base	Current	Base	Current	Income	Consumption
URBAN						
1 (poorest)	200.8	220.3	108.5	113.0	19.5	4.5
2	249.2	278.6	223.7	232.9	29.4	9.2
3	380.5	423.5	336.1	349.9	43.0	13.8
4	546.2	608.5	510.9	531.8	62.4	20.9
5 (richest)	1,203.6	1,333.5	1,059.6	1,102.7	129.9	43.1
Total	670.5	744.5	598.1	622.4	74.1	24.4
RURAL						
1 (poorest)	68.4	76.3	90.3	94.0	7.9	3.7
2	142.8	158.8	205.8	214.2	16.0	8.4
3	262.0	291.9	333.7	347.3	29.9	13.7
4	388.6	432.4	503.4	524.0	43.9	20.5
5 (richest)	641.7	719.4	1,012.4	1,053.7	77.7	41.3
Total	146.6	163.3	199.5	207.7	16.7	8.2
TOTAL						
1 (poorest)	77.8	86.5	91.6	95.4	8.7	3.8
2	186.4	207.9	213.1	221.9	21.5	8.7
3	355.5	395.8	335.6	349.3	40.2	13.8
4	525.3	585.2	509.9	530.8	59.9	20.9
5 (richest)	1,185.6	1,313.8	1,058.1	1,101.1	128.2	43.0
Total	476.3	529.1	450.4	468.7	52.8	18.4

Source: Authors own calculations.

Table III.5
Impact on households from low output growth
(Bs per capita per month)

	Income		Consumption		Difference	
Description	Base	Current	Base	Current	Income	Consumption
URBAN						
1 (poorest)	200.8	217.4	108.5	109.8	16.6	1.3
2	249.2	274.2	223.7	226.3	25.0	2.6
3	380.5	417.0	336.1	340.1	36.5	4.0
4	546.2	599.1	510.9	517.0	53.0	6.1
5 (richest)	1,203.6	1,313.9	1,059.6	1,072.2	110.3	12.6
Total	670.5	733.4	598.1	605.1	62.9	7.1
RURAL						
1 (poorest)	68.4	75.1	90.3	91.4	6.7	1.1
2	142.8	156.4	205.8	208.2	13.6	2.4
3	262.0	287.4	333.7	337.6	25.4	4.0
4	388.6	425.8	503.4	509.4	37.2	6.0
5 (richest)	641.7	707.6	1,012.4	1,024.4	65.9	12.0
Total	146.6	160.8	199.5	201.9	14.2	2.4
TOTAL						
1 (poorest)	77.8	85.2	91.6	92.7	7.4	1.1
2	186.4	204.6	213.1	215.7	18.3	2.5
3	355.5	389.7	335.6	339.5	34.2	4.0
4	525.3	576.2	509.9	516.0	50.9	6.0
5 (richest)	1,185.6	1,294.4	1,058.1	1,070.7	108.9	12.6
Total	476.3	521.2	450.4	455.7	44.8	5.3

Source: Authors own calculations.

Table III.6
Impact on households from all combined cases
(Bs per capita per month)

	Income		Consumption		Difference	
Description	Base	Current	Base	Current	Income	Consumption
URBAN						
1 (poorest)	200.8	197.2	108.5	94.4	-3.6	-14.1
2	249.2	243.8	223.7	194.6	-5.4	-29.0
3	380.5	372.7	336.1	292.5	-7.8	-43.6
4	546.2	534.8	510.9	444.8	-11.4	-66.1
5 (richest)	1,203.6	1,179.9	1,059.6	923.4	-23.7	-136.2
Total	670.5	657.0	598.1	520.9	-13.5	-77.1
RURAL						
1 (poorest)	68.4	67.0	90.3	78.6	-1.4	-11.7
2	142.8	139.8	205.8	179.2	-2.9	-26.7
3	262.0	256.5	333.7	290.5	-5.5	-43.2
4	388.6	380.6	503.4	438.5	-8.0	-64.9
5 (richest)	641.7	627.5	1,012.4	881.9	-14.2	-130.6
Total	146.6	143.5	199.5	173.7	-3.1	-25.8
TOTAL						
1 (poorest)	77.8	76.2	91.6	79.7	-1.6	-11.9
2	186.4	182.4	213.1	185.5	-3.9	-27.6
3	355.5	348.2	335.6	292.1	-7.3	-43.5
4	525.3	514.4	509.9	444.0	-10.9	-65.9
5 (richest)	1,185.6	1,162.2	1,058.1	922.1	-23.4	-136.0
Total	476.3	466.7	450.4	392.2	-9.6	-58.1

Source: Authors own calculation.

Poverty Hypothesis Testing

The analysis of household welfare is based on poverty indicators computed using the MECOVI household survey of 1999.

The MECOVI survey has a stratified and two stages sample design. The four strata used correspond to a geographical stratification. The sample selection has two stages; the Primary Sample Units (PSU) selection in a first stage, and the selection of households inside the PSU selected, in a second stage. The Table below presents the number of PSU´s and sample size.

Table III.7
MECOVI sample design

Strata	*Primary Survey Units (PSU)*	*Persons in sample*
Main cities	167	5,611
Rest of urban area	26	960
Rural area	44	1,575
Disperse area	72	4,885
Total	**309**	**13,031**

Source: INE.

The statistical significance of results must be analyzed considering the characteristics of sample design. Two tests were performed, first for the significance of poverty chances and second for significance of poverty differences in poverty profiles.

Test of poverty changes:

The main indicator of poverty changes is the head count ratio (denoted as P0), which represents the percentage of poor population. We compare this indicator in base year with the indicator after every shock analyzed. For example, in the terms of trade case, the null hypothesis was: Head count ratio in base year is equal to Head count ratio obtained after the terms of trade shock. Does poverty increase in this case have statistical significance?

Table III.8
Testing significance of one poverty outcome

	Base year	*Terms of trade*
TOTAL		
Head count ratio	0.4144365	0.4252108
Standard error	0.0210234	0.0210128
F(1, 305)		17.34
Prob > F		0.0000

Source: Authors own calculations.

The Wald test statistic computed is:

$$\frac{d-k+1}{kd}W \sim F(k, d-k+1)$$

Where: d = number of PSU´s minus the number of strata and k = degrees of freedom. In our example, the F(1,305) statistic is 17.34 and the p-coefficient is less than 0.00001. Therefore, the poverty increase has statistic significance. The following Table is the outcome from applying this test to the poverty outcome of every shock.

Table III.9
Testing significance over all poverty outcomes

	Base year	Terms of trade	Foreign saving	Social expenditure	Output growth	All cases
TOTAL						
Head count ratio	0.4144365	0.4252108	0.448269	0.4059149	0.4059149	0.4372323
Standard error	0.0210234	0.0210128	0.0209469	0.0209888	0.0209888	0.0209702
F(1, 305)		17.34	50.89	13.49	13.49	39.36
Prob > F		0.0000	0.0000	0.0003	0.0003	0.0000
URBAN						
Head count ratio	0.2376038	0.249976	0.272807	0.2270452	0.2270452	0.2619642
Standard error	0.0193698	0.0199026	0.0209009	0.0186608	0.0186608	0.0204875
F(1, 305)		12	36.95	8.97	8.97	26.3
Prob > F		0.0006	0.0000	0.0030	0.0030	0.0000
RURAL						
Head count ratio	0.7147295	0.7227902	0.7462343	0.7096669	0.7096669	0.734868
Standard error	0.0326362	0.0319245	0.0292208	0.0330455	0.0330455	0.030672
F(1, 305)		5.48	14.78	8.53	8.53	13.07
Prob > F		0.0199	0.0001	0.0038	0.0038	0.0004

Source: Authors own calculations.

Test of poverty differences in poverty profiles:

A poverty profile allows comparisons of poverty in subpopulations. The age-group, sex, ethnicity and other variables was selected for analysis. Starting with a base year poverty measure (head count ratio) and comparing the same poverty measure after all shocks, it is possible to identify particular groups were poverty has increased.

In the case of sex, the null hypothesis is that the after shocks head count ratio of males is equal to head count ratio of females. In the ethnicity case, the null is that the after shocks percentage of poor people is equal for Aymara, Quechua, Spanish

and others. For example, at the national poverty level, does the difference in percent of female poor respect to male poor have statistic significance?

Table III.10
Testing significance of one poverty profile

	Base year	*All cases*	*Difference*
Male	41.2	43.6	2.4
Female	41.7	43.8	2.1

Source: Authors own calculations.

The F statistic is 2.18 and p-value is 0.145, therefore we fail to reject the null hypothesis. The following Table is the outcome from applying this test to all poverty profiles.

Table III.11
Testing significance over all poverty profiles

Variable	F statistic		Prob > F
Age group	F(4, 302)	1.31	0.2654
Sex	F(1, 305)	2.18	0.1405
Ethnicity	F(3, 303)	0.52	0.6669
Self-identification	F(3, 303)	0.67	0.5680
Education	F(5, 301)	2.52	0.0298
Migrant condition	F(1, 305)	0.00	0.9816
Employment	F(3, 303)	1.52	0.2081
Economic Activity	F(2, 304)	2.96	0.0532
Condition	F(4, 302)	8.20	0.0000
Sector	F(2, 304)	0.24	0.7854

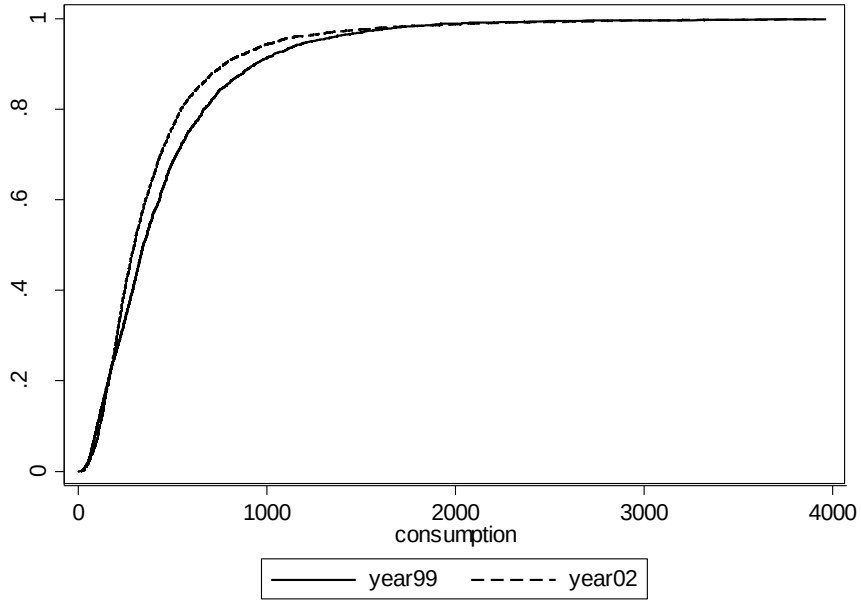
Source: Authors own calculations.
Null Hypothesis: head count ratio $_i$ = head count ratio $_j$, where i and j are categories.

ANNEX IV
SIMULATED VERSUS ACTUAL OBSERVATIONS

1. Changes in consumption distribution

One important assumption made in the simulation study is that the distribution of consumption does not change between the base year 1999 and the forecast year 2002. However, in order to establish the degree of error that may have resulted from this assumption, we may ask how much did consumption distribution actually changed between 1999 and the actual observations of 2002. Figure IV.1 presents the distribution of consumption computed from the household survey of each of those years, in both cases including the equivalence scale adjustment.

Figure IV.1
Changes in consumption distribution between 1999 and 2002



Source: Authors own computations.

Comparison of the behavior of the accumulated distribution between those two years show no change in both the lower and the higher segments of the distribution, meaning that the poorest and the richest of the population have not experienced any change in their well being after four years. The middle segment of the distribution does show some change, suggesting this segment did improve their well being between 1999 and 2002. However, the segment in which the study concentrates is the segment of the poor, were there has not been significant change in the distribution of consumption between 1999 and 2002, therefore the assumption made in the study seem reasonable. Further analysis requires Stochastic dominance testing.

2. Differences between simulated and observed poverty measures

The conclusions of the study are based on the assumption that the 2002 forecasted poverty measures, resulting from the simulation that includes all shocks simultaneously, are equal to the actual poverty measures of 2002. To establish the degree of error that may have resulted from this assumption, we need to measure the magnitude of that difference. Table IV.1 compares the simulated FGT poverty indicators with the actual FGT poverty indicators, the latter computed from the household survey of 2002.

Table IV.1
Differences between simulated and observed poverty indicators for 2002

	Head count ratio P0	*Poverty Gap P1*	*Poverty Intensity P2*
	Simulated		
Urban	26.2	24.8	9.7
Rural	73.5	48.9	29.6
Total	43.7	39.8	22.1
	Observed		
Urban	34.4	28.1	11.3
Rural	65.2	43.5	24.3
Total	46.1	36.4	18.3
	Difference = Observed – Simulated		
Urban	8.2	3.3	1.6
Rural	-8.3	-5.4	-5.3
Total	2.4	-3.4	-3.8

Source: Authors own calculations.

The percent of total observed poverty in 2002, measured by the head count ratio P0, is greater by 2.4 percentage points compared to the one obtained by the simulation. That is the simulation results based on this indicator maybe slightly underestimated. Considering P1 and P2, the simulation produces slightly deeper poverty gap and poverty intensity measures compared to its actual behavior. In this case differences are above three percentage points in each P1 and P2. Overall, the simulated and actual results for the total case are very close.

Greater differences tend to appear when comparing results under the urban-rural classification. The difference in both cases is above eight percentage points for P0 with changing signs, that is the simulation overestimated the number of rural poor and underestimated the number of urban poor by about eight percentage points. The simulation also overestimated by more then five percentage points in rural areas for each P1 and P2. In the urban areas there was underestimation of more then three percentage points in the case of P1 and only 1.6 percentage points in the case of P2.

These identified differences imply that other less significant economic and social events, not considered here, have also affected in part the well being of households.