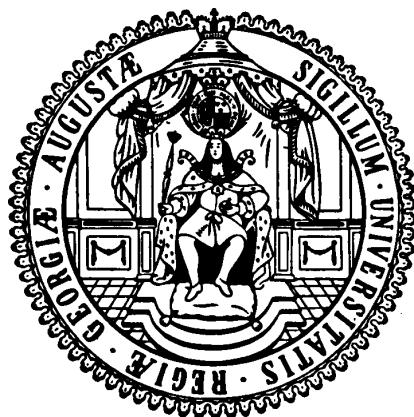


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**Macroeconomic and Distributional Effects of  
Devaluation in a Dollarized Economy:  
A CGE Analysis for Bolivia**

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# **Macroeconomic and Distributional Effects of Devaluation in a Dollarized Economy:**

## **A CGE Analysis for Bolivia<sup>\*</sup>**

### **Abstract:**

In this paper, a real-financial CGE model is employed for Bolivia to simulate the macroeconomic and distributional effects of exchange rate policy in a highly dollarized economy. Overall, dollarization appears to matter more through real than through financial-sector effects. The main macroeconomic result of the simulations is that the potential of nominal devaluation to smooth the adjustment path after a negative shock primarily depends on the absence of wage indexation. Only if nominal wages are constant in the short run, devaluation reduces unemployment and cushions the reduction of real GDP induced by the shock. Financial de-dollarization tends to be contractionary in Bolivia but different degrees of financial dollarization hardly change the real sector effects. As concerns distributional effects, nominal devaluation in no circumstance reduces the poverty effect of the external shock. Even the significant short-run macroeconomic expansion that occurs without wage indexation does not translate into significant poverty alleviation, given the offsetting effects of devaluation on real factor incomes, real interest incomes, and real transfers received by households.

Keywords: Dollarization, Poverty, Computable General Equilibrium Model, Bolivia

JEL-classification: 016, D3, C68

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## I. Introduction

In resource-based developing economies that suffer from recurrent external shocks, there ought to be a large potential role for exchange rate policy as a means of mitigating the ensuing macroeconomic instability. Real devaluation after a negative external shock could be expected to have an expansionary effect, thereby smoothing the adjustment path of the economy. At the same time, real devaluation could be expected to favor poor export-competing producers at the expense of wealthier import-consuming parts of the population (Klasen et al. 2004). Among the factors that might compromise a devaluation strategy in such a setting, de-facto dollarization, which is wide-spread in Latin America (Heysen 2005), figures prominently. De-facto dollarization implies high pass-through of nominal exchange rate changes, which reduces the effectiveness of nominal devaluation with respect to achieving a real devaluation, and a high degree of financial dollarization, which affects the wealth and real balance effects of a nominal devaluation (Levy-Yeyati and Sturzenegger 2003: 11–14).

Against this backdrop, the present paper evaluates the macroeconomic, distributional and poverty impacts of devaluation in one particular country, Bolivia, employing a recursive-dynamic real-financial Computable General Equilibrium (CGE) model. Being highly dollarized, highly indebted, poor, and shock-prone at the same time, Bolivia is an ideal candidate for such a case study. The country is still confronted with the protracted economic crisis that started in the late 1990s with the negative impact of El Niño and a sharp reversal of FDI inflows following the drastic devaluations in Brazil and Argentina in 1999 and 2002. This raises two questions. Would a more active exchange rate policy have been helpful to restore the country's international competitiveness, and would a stronger real depreciation have helped to mitigate the distributional consequences of external shocks by favoring poor export and import-competing producers at the expense of wealthier import-consuming segments of the population?

The remainder of the paper is structured as follows. Chapter II discusses the major links between devaluation and dollarization, both in general terms and with specific reference to Bolivia. The modeling framework is introduced in Chapter III. Chapter IV contains the simulation results. Three assumptions about dollarization are considered: full dollarization, financial dollarization, and partial financial dollarization. The paper closes with some concluding remarks in Chapter V.

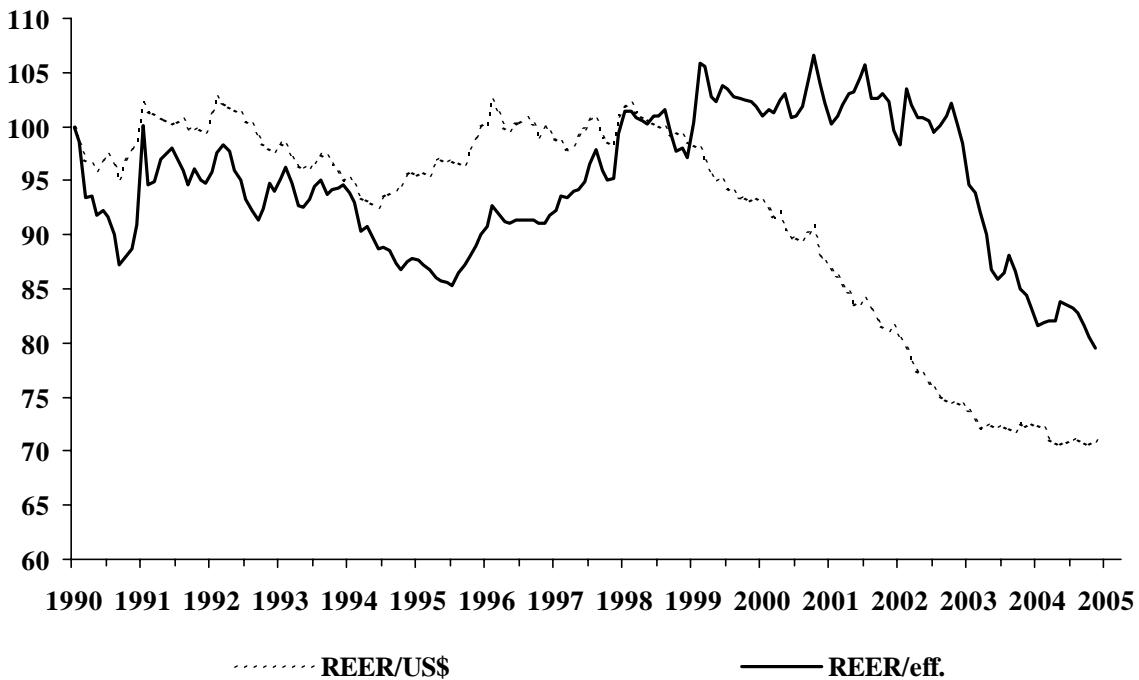
## **II. Devaluation and Dollarization**

The scope for using exchange rate adjustment in order to smooth external shocks is limited by the potential pass-through to inflation and the impact on the financial system. Bolivia's quasi-crawling peg has helped to avoid excess exchange rate volatility and to provide a visible, short-term anchor for inflation. However, such an exchange rate regime faces important shortcomings due to a lack of transparency about the final target of the central bank, the limited scope for rapid exchange rate adjustments due to the high potential pass-through of the exchange rate to inflation, and concerns about the financial system soundness in view of a high degree of financial dollarization (IMF 2003).

Portfolio balance models considering both sides of banks' balance sheets find that financial dollarization depends on the volatility of real return on assets denominated in each currency. This is a function of the volatility of real exchange rates changes relative to inflation rate changes. An important implication is that policies such as a quasi-crawling peg that target at least to some extent a stable real exchange rate should not expect to reduce financial dollarization. Another implication is that economies with a high pass-through due to widespread dollar pricing as a result of previous high inflation rates will exhibit higher dollarization ratios irrespective of their current inflation levels (Levy-Yeyati and Sturzenegger 2003).

This fits quite well with the stylized facts of exchange rate policy and dollarization in Bolivia. As can be seen in Figure 1, the quasi-crawling peg regime in Bolivia actually delivered real exchange rate stability until recently. This allowed for a remonetization of the economy. The ratio of deposits to GDP increased from a low level of about 15 percent at the beginning of the 1990s to about 40 percent at the end of the 1990s. At the same time, however, Bolivia became probably the most dollarized economy among those that have stopped short of full dollarization. In 2003, the degree of deposit dollarization in the banking system rose to about 92 percent, dollar-denominated deposits accounted for 77 percent of broad money and bank credit to the private sector in dollars was close to 97 percent (IMF 2003).

Figure 1 — Real US\$ and Effective Exchange Rates (Index 1990/1 = 100), 1990/1–2004/12



Source: IMF, International Financial Statistics, var. issues; own calculations.

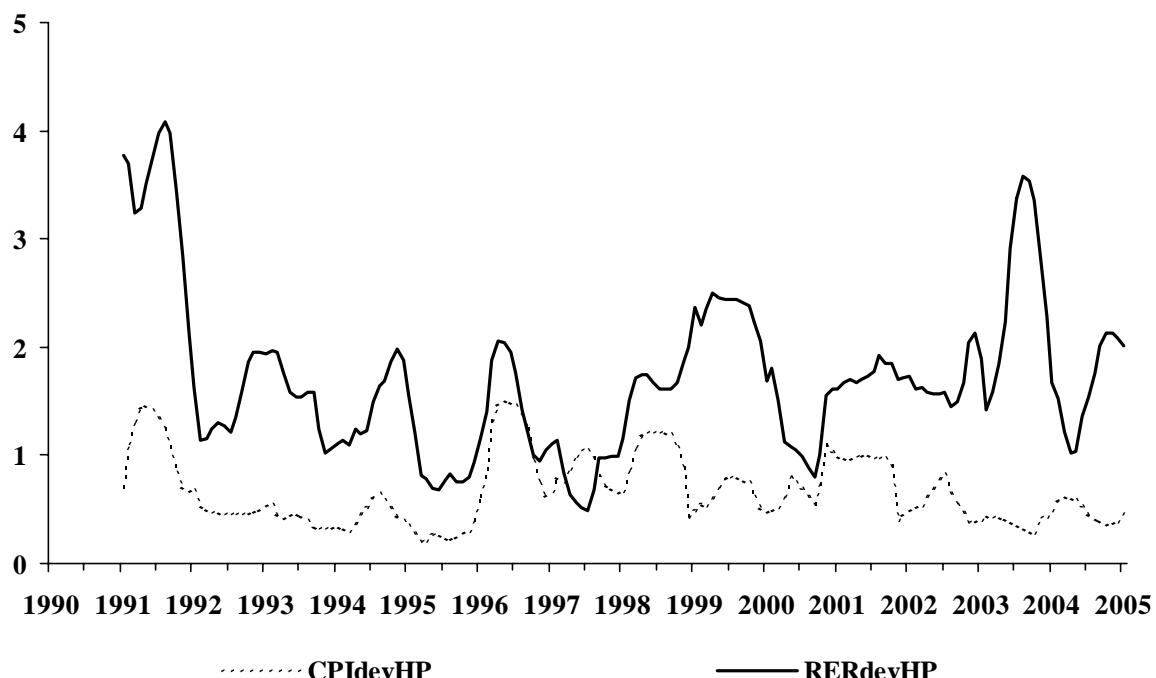
The extent of financial dollarization in Bolivia can actually be explained by the relative variance of the real exchange rate and the inflation rate (IADB 2005; De Nicoló, Honohan, Ize 2003). Constructing a minimum variance portfolio and controlling for restrictions on foreign currency deposits and tradability of output reveals a strong positive correlation for Latin American and Caribbean countries, with Bolivia and Uruguay figuring prominently with respect to a relatively high variance of inflation rates and deposits dollarization.

The IMF (2003) argues that a gradual shift towards a more flexible exchange rate regime would allow Bolivia to be better prepared to face adverse shocks. By lowering the expected volatility of inflation and raising that of the real exchange rate, a more flexible exchange rate regime combined with an announced commitment to price stability would help induce a gradual increase in confidence in the local currency.

However, such a conclusion has to be evaluated very carefully. Figure 2 reveals that the relative variance of inflation rates has been rather low in Bolivia since the early 1990s. The moving 12-month standard deviation of deviations from a HP-filtered trend (which may proxy expectations) shows that real exchange rate variability has been higher throughout almost the whole period.

It is also not clear whether or not a lower degree of dollarization would imply an increased effectiveness of exchange rate policy. It is necessary to distinguish the effects of financial dollarization from the effects of wage indexation increasing the pass-through of exchange rate changes on domestic prices. The fact that a lower relative stability of inflation rates may reduce financial dollarization does not necessarily change the degree of wage indexation which determines the effectiveness of the exchange rate instrument. Loboguerrero and Paniza (2005) show that for Latin American countries wage flexibility indeed decreases with inflation rates. They argue that this indicates a high level of indexation in countries like Bolivia which successfully stabilized domestic prices. However, the evidence for single countries is not conclusive (Table 1). Looking at deviations from a HP filtered trend, Bolivia and Peru show the strongest wage responses to output fluctuations, i.e. the lowest degree of indexation, among a sample of 12 Latin American countries. The same empirical test using first differences results in mostly insignificant coefficients. The latter result would be consistent with a high degree of wage indexation for most Latin American countries including Bolivia.

Figure 2 — Variability of Consumer Prices (CPI) and the Real Effective Exchange Rate (REER) (standard deviation of difference from a HP-filtered trend for the last 12 months), 1991/1–2005/1



Source: IMF, International Financial Statistics, var. issues; own calculations.

Table 1 — Wage Response to Output Fluctuations in Latin American Countries,  
1987–1996

|            | First Differences |      | HP Filter   |      |
|------------|-------------------|------|-------------|------|
|            | Coefficient       | R2   | Coefficient | R2   |
| Argentina  | 0.64***           | 0.64 | 0.84***     | 0.52 |
| Bolivia    | 0.37              | 0.22 | 2.49*       | 0.3  |
| Brazil     | 2.84              | 0.18 | 1.15        | 0.06 |
| Chile      | -0.21             | 0.06 | 0.68*       | 0.2  |
| Colombia   | 0.09              | 0.06 | 0.9         | 0.16 |
| Costa Rica | 0.19              | 0    | 0.7         | 0.07 |
| Guatemala  | 0.65              | 0.09 | 0.32        | 0    |
| Mexico     | 0.12              | 0    | 2.29***     | 0.82 |
| Panama     | 0.38              | 0.05 | 0.17        | 0.04 |
| Peru       | 4.74*             | 0.33 | 2.51***     | 0.88 |
| Uruguay    | 0.04              | 0    | 0.91**      | 0.41 |
| Venezuela  | 0.26              | 0.02 | 1.21**      | 0.41 |

Source: González (2002); Appendix I.

Therefore, the assessment of a nominal devaluation in order to adjust to a negative external shock needs to distinguish between different degrees of real and financial sector dollarization. In the real sector, alternative indexation rules can reflect different pass-through scenarios. This will have a direct impact on the effectiveness of a devaluation, with a high pass-through rendering the exchange rate instrument almost ineffective for achieving a real devaluation. To the contrary, financial dollarization is expected to have an impact even if nominal devaluation is not effective.

Early real-financial CGE-models already considered both positive demand and negative supply side effects of financial dollarization (see, e.g., Easterly 1990). Positive demand effects are due to the fact that a devaluation increases the value of dollar-denominated deposits in terms of the national currency. This positive wealth effect can be expected to reduce savings and, thus, to increase consumption. A nominal devaluation will, therefore, be more expansionary than without deposit dollarization. More recently, the focus of the literature shifted to negative supply side effects through liability dollarization. Here, an expansionary effect of a devaluation may be attenuated or even reversed by the effects of devaluation in firms that are highly leveraged in dollar debt. Krugman (1999) and Aghion et

al. (2001), e.g., assume this balance sheet effect to be large enough to dominate the expansionary Mundell-Fleming effect (see also Céspedes et al. 2000). As argued by Calvo and Reinhart (2002), pervasive liability dollarization may be a cause of fear of floating. Indeed, Levy-Yeyati et al. (2003) showed that foreign currency-denominated liabilities are positively related with the probability of pegging the exchange rate against a major currency.

It is also clear that both real and financial sector dollarization should have distributional consequences by either affecting the possibility to smooth the adjustment to a negative shock which affects poor households in the tradable sector or by changing the relative wealth position of poor households depending on their net asset position in the financial sector.

### **III. A Real-Financial CGE Model for Bolivia**

To capture the major links between devaluation and dollarization along the lines discussed above, we constructed a CGE model for Bolivia that explicitly incorporates financial portfolio balances. In presenting the modeling framework, we first deal with the accounts describing the real and financial transactions in the base year 1997, and then move on to explain the structure of the model, placing particular emphasis on some key transmission mechanisms.

#### ***1. Social and Financial Accounts***

Table 2 lists the activities, production factors and economic agents for which real and financial flows are recorded in a Social Accounting Matrix (SAM), and financial stocks in corresponding Accumulation Balances.<sup>1</sup> In keeping with our focus on the distributional impact of exchange rate policy, the SAM exhibits a high degree of differentiation among sectors (sectoral distribution), factors of production (extended functional distribution) and households (socio-economic distribution). The sectoral disaggregation is driven by the need to account for differences in tradability as these differences are the key determinant of the resource reallocation resulting from devaluation. As shown in Table 3, modern agriculture, oil&gas, and mining are most strongly export-oriented, while intermediate goods and capital goods can be regarded as typical import-competing activities. At the other end of the spectrum, some sectors (utilities, construction, informal services, public services) produce pure non-tradables.

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<sup>1</sup> A full documentation of the SAM and the Accumulation Balances, along with a detailed explanation of all major entries, can be found in Thiele, Piazolo (2003).

Table 2 — Classification of the CGE Model

| Activities/<br>Goods and Services   | Production Factors   | Economic Agents   |
|---|--|---|
| <i>Informal Sectors</i>   | <i>Labor</i>   | <i>Households</i>   |
| – Traditional agriculture<br>– Informal services  | – Skilled labor<br>– Agricultural unskilled labor<br>– Non-agricultural unskilled labor<br>– Smallholder labor<br>– Urban informal labor           | – Smallholders<br>– Agricultural workers<br>– Non-agricultural workers<br>– Employees<br>– Urban informals<br>– Employers |
| <i>Formal Sectors</i>   | <i>Physical Capital</i>  | <i>Enterprises</i>  |
| – Modern agriculture<br>– Oil&gas<br>– Mining<br>– Consumer goods<br>– Intermediate goods<br>– Capital goods<br>– Utilities<br>– Construction<br>– Formal services<br>– Public services | – Corporate (formal) capital<br>– Employers' capital<br>– Urban informals' capital<br>– Smallholders' capital<br>– Public (infrastructure) capital | – State enterprises<br>– Private enterprises  |
|   |  | <i>Government</i>   |
|   |  | <i>Rest of the world</i>  |
|   |  | <i>Financial institutions</i>   |
|   |  | – Commercial banks<br>– Central Bank  |

A distinctive feature of the model is its explicit treatment of traditional agriculture and (urban) informal services as informal production sectors, where most of the poor earn their living. Workers in these sectors are considered self-employed, relying mainly on their own labor input and using only small amounts of capital. Formal sectors, by contrast, tend to produce with more capital-intensive techniques and, like the public services sector, hire skilled and unskilled workers. In capital markets, a distinction is made between unincorporated and corporate capital. Three household groups (smallholders, urban informals, and employers) own unincorporated capital and receive income from utilizing it. Corporate capital, by contrast, is owned by private and public enterprises, which invest in all formal sectors and retain the respective factor income. Finally, public infrastructure capital is identified as a separate production factor that affects the level of sectoral production.

Table 3 — Sectoral Tradability

|                         | Exports/Production | Imports/Absorption |
|-------------------------|--------------------|--------------------|
| Traditional agriculture | 0.07               | 0.09               |
| Modern agriculture      | 0.34               | 0.05               |
| Oil & gas               | 0.22               | —                  |
| Mining                  | 0.65               | 0.09               |
| Consumer goods          | 0.16               | 0.15               |
| Intermediate goods      | 0.17               | 0.39               |
| Capital goods           | 0.06               | 0.86               |
| Utilities               | —                  | —                  |
| Construction            | —                  | —                  |
| Informal services       | —                  | 0.03               |
| Formal services         | 0.09               | 0.04               |
| Public sector           | —                  | —                  |

Source: Thiele and Piazolo (2003).

The model distinguishes six representative household groups, which are basically characterized by their factor endowments. This is justified because factor income is the single-most important income source in Bolivia. In addition, workers and the self-employed are disaggregated regionally as their earning possibilities and consumption patterns tend to vary between regions. Four of the six household groups (smallholders, urban informals, and agricultural and non-agricultural workers) can be considered as poor. In order to calculate the evolution of poverty and income distribution on the basis of information about individual household income rather than average income of these broad socio-economic groups, the model is linked to household survey data by simply scaling up and down individual incomes in the survey according to the model results.

The financial sector of the model distinguishes commercial banks and the Central Bank as intermediaries. Beside the financial assets and liabilities accumulated in the domestic banking system (cash holdings, deposits, and loans), private and public enterprises have accumulated a considerable amount of FDI, the government has incurred high external debt, and some agents (employees, employers, public and private enterprises) hold limited amounts of shares in domestic enterprises. Given that the aim here is to analyze the impact of devaluation in a

dollarized economy, the net dollar asset position of economic agents is of particular importance. Table 4 shows that enterprises and the government but also smallholders and urban informals are net debtors. Only employer and employee households are net creditors. Overall, the Bolivian economy carries a considerable dollar debt burden due to the high level of external liabilities.

Table 4 — Accumulated Dollar-denominated Net Financial Assets in Domestic Commercial Banks (ND) and Abroad (NDA) (Share of Income and Assets)

|                          | ND/Income | NDA/Income          | ND/Assets | NDA/Assets |
|--------------------------|-----------|---------------------|-----------|------------|
| Smallholders             | -45.0     | 0.0                 | -32.7     | 0.0        |
| Agricultural workers     | -0.1      | 0.0                 | -1.4      | 0.0        |
| Non-agricultural workers | -0.1      | 0.0                 | -1.6      | 0.0        |
| Employees                | 18.5      | 0.0                 | 28.1      | 0.0        |
| Urban informals          | -13.7     | 0.0                 | -7.5      | 0.0        |
| Employers                | 17.2      | 10.2 <sup>a</sup>   | 5.3       | 3.1        |
| Private corporations     | -358.5    | -462.8 <sup>b</sup> | -11.6     | -14.9      |
| State enterprises        | 1.2       | -75.1 <sup>b</sup>  | 0.2       | -11.0      |
| Government               | -18.3     | -153.8 <sup>c</sup> | -3.7      | -31.5      |
| Commercial banks         | n.a.      | n.a.                | n.a.      | -8.0       |
| Central Bank             | n.a.      | n.a.                | n.a.      | 24.3       |

<sup>a</sup>Bank deposits abroad. – <sup>b</sup>Foreign direct investment inflows. – <sup>c</sup>Public debt.  
n.a. = not applicable.

Source: Thiele and Piazolo (2003).

## 2. *Structure of the Model*

A comprehensive mathematical treatment of a neoclassical version of the model employed here appears in Wiebelt (2004). Hence, in what follows only a brief non-technical description will be given.

### Production and Demand

Domestic production technology is represented by constant elasticity of substitution (CES) functions throughout the formal economy, while in the two informal sectors primary factors

are combined via a Cobb-Douglas production function to account for the fact that labor can fairly easily substitute for the very basic capital goods used in these sectors. Despite the flexible production technology, the overwhelming importance of self-employed labor implies that smallholders and urban informals can hardly adjust supply in the short run. Adjustment to adverse demand shocks will thus work through a fall in prices, which in turn reduces income. Both formal and informal sectors use intermediate inputs in fixed proportions to production. In addition, based on the view that cumulative public investment improves the productivity of private activities, public capital enters the production relationship via a CES function where it is combined with the aggregate of private production factors (Agenor et al. 2003). Trade is modeled in the conventional way by means of a constant elasticity of transformation (CET) function relating domestically sold and exported goods, and a CES function relating domestically produced and imported goods (Armington assumption).

To capture the reality of Bolivian employment, the model assumes a high degree of labor market segmentation (see Table 2). In the urban labor market, the barriers for informal workers to enter the formal workforce are taken into account by assuming limited mobility between these labor market segments, i.e., people are stuck in low-paid informal sector jobs, and for open unemployment of all formal labor categories, which appears to be an accurate characterization of the Bolivian labor market in recession years when rates of open unemployment tend to rise to non-negligible levels.

Alternative assumptions about wage formation in the three formal labor markets reflect different degrees of indexation in the real sectors. On the one extreme, it is assumed that nominal wages are constant, i.e., do not react to changes in consumer prices. On the other extreme, workers assume a strong pass-through of devaluation and index wages to consumer price inflation. It is to be expected that the pass-through in this scenario is high compared to the scenario without wage indexation.

On the demand side, households' allocation of expenditures on different goods is specified as a linear expenditure system (LES), with poorer households devoting larger budget shares to price-independent subsistence consumption than richer households. Total household consumption is linear in disposable income with a real balances term added, while public consumption is assumed to be a policy variable. Real investment levels are determined endogenously for each economic agent except the government, whose investment is assumed to be set by an exogenous policy decision. Together with exogenous technical progress and given growth rates for variables such as labor supply and real government expenditures, the

endogenous evolution of private investment generates the dynamics of the model in the form of a sequence of static equilibria.

## **Financial Sector**

The model's financial sector follows the approach developed by Rosensweig and Taylor (1990), which is in turn based on Tobin's portfolio-theoretic framework, where the interaction of stocks and flows plays a decisive role. Starting from the beginning-of-period stocks of assets and liabilities, financial markets match the savings and investment decisions of all economic agents over the period, comprising the accumulation of both physical and financial assets and liabilities. The financial markets handle simultaneously the flows arising from savings and financial accumulation, and those arising from the reshuffling of existing portfolios due to changes in asset returns. For the latter, it is assumed that individual agents have only limited possibilities to substitute among different assets, which is captured by CES functions of relative rates of return. A further characteristic of the financial sector is that specific economic agents, e.g. smallholders, may be constrained in their access to credit, which is clearly the case for most of Bolivia's informal producers. This is modeled by determining bank credit to the respective agent residually after all other agents' credit demand is satisfied (Jemio 2001).

The identification of stocks in the model makes it possible to account for the revaluation of assets and liabilities, which is of great importance in the highly dollarized Bolivian economy where the value of most domestic financial assets and liabilities is at least partially indexed to movements in the exchange rate. Together with the accumulation occurring over the period, these revaluations determine the end-of-period stocks of assets, liabilities and net wealth for each economic agent.

## **Key Transmission Channels**

Some specific real-financial interactions need to be detailed further because of the central role they play in determining the impact of devaluation. *First*, consumption and savings of each household group are affected by a wealth term, which is defined as net financial wealth lagged one period and deflated by the household-specific consumer price index. This definition implies that devaluation will lead to an increase in wealth (and thus higher consumption and lower savings) if the share of dollar assets in total financial holdings exceeds the elasticity of the consumer price index to the exchange rate. The latter depends

positively both on the share of imported goods in the consumption basket and on the extent to which wages are adjusted in response to the devaluation. Given that workers have almost no dollar income, there is a clear distributional trade-off involved in wage adjustments. These raise the inflationary response to devaluation and thereby lower the real balances of creditors such as employees and employers. The above real balance condition for asset stocks can also be expressed in flow terms, i.e., real interest income from financial assets will increase if the share of the dollar-denominated assets exceeds the elasticity of the consumption deflator to the exchange rate.

*Second*, nominal private investment by agent is determined endogenously in the model after savings and the financial portfolio has been determined.<sup>2</sup> For each investing agent, the identity

$$\text{investment} = \text{saving} - \Delta\text{assets} + \Delta\text{liabilities}$$

must hold, i.e., agents with a saving-investment surplus accumulate (net) financial assets and thereby finance the deficits of the other agents. Thus financial flows also enter the investment function. Nominal private investment is deflated by the replacement cost of capital. The outcome of devaluation on investment depends on its effect on household savings, which has been discussed above, and on the real balance effect. The real balance effect of devaluation will be negative if the share of dollar liabilities in total liabilities exceeds the replacement costs of capital. The replacement costs of capital, in turn, depend on the pass-through of exchange rate changes on domestic prices and on the share of domestic capital inputs. This implies that devaluation will increase the debt burden if the pass-through is low and the share of dollar debt is high. If the pass-through approaches unity and there is near purchasing power parity, by contrast, the debt burden will be reduced by devaluation through its inflationary impact. The above reasoning can also be applied to individual investing agents, with a slightly different interpretation for net creditors such as employers: they experience a positive real balance effect in case of a high dollar asset share and a low pass-through that preserves the real value of their assets.

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<sup>2</sup> Another option, which is chosen by Easterly (1990), is to specify investment by economic agent as a function of the cash flow, i.e. gross profits less taxes, interest payments, and capital losses on debt. This specification reflects widespread credit rationing and internal self-financing of enterprises, but does not seem to be appropriate for Bolivia, where the dominating investors such as private enterprises are closely linked to banks and thus are likely to have preferential access to credit (Jemio 2001).

Because dollarization and interest rates are assumed to be exogenous in the model, devaluation does not affect the portfolio choices of households and enterprises. The implicit assumption is that private agents adjust their portfolios after a devaluation in order to hold a constant share of dollar assets (liabilities).

*Third*, if financial balances are taken into account, the government can influence its own real balances through its control over the nominal exchange rate. Even if there is full pass-through of devaluation into wages, the government's position will improve through the fall in the real value of its external debt. However, the model assumes that real investment and real consumption are held constant by the government. That implies that there are no repercussions from government expenditures on the macroeconomic effects of a devaluation. There are, however, distributional effects because nominal expenditures and nominal transfers increase with inflation for public services – mainly determined by wage inflation – while the real value of transfers depends on household-specific inflation.

The way in which all these effects operate in conjunction is determined by the model closure, which places the model on the continuum of neoclassical versus Keynesian and short run versus long run. The model closure adopted here is short run in the sense that it assumes quantity adjustment on formal labor markets, but it is not strictly Keynesian – like, for example, in Easterly (1990) – because prices are allowed to clear goods markets. On the financial side, the equilibrating variables are the level of foreign exchange reserves and government debt. All interest rates and the exchange rate are fixed, as are both current and capital government expenditures in real terms. The assumptions underlying this closure are that in a recession the monetary authority makes no attempt to control the quantity of money, and that the government can fairly easily obtain additional funds from international institutions (e.g., a stand-by loan from the IMF) instead of trimming expenditures such as public sector wages.

## IV. Simulation Results

### 1. Benchmark and Simulations

The model is calibrated for 1997, i.e. a year when Bolivia still benefited from improvements in its terms-of-trade, strong inflows of foreign direct investment, and a stable macroeconomic situation. In the base run, the dynamics of the model are driven by a constant rate of increase in the labor supply, a constant rate of increase in FDI inflows and a constant rate of

depreciation of 2 percent annually. The latter mirrors the de-facto crawling-peg exchange rate regime implemented at the time.

The shock scenario, which reflects the need for Bolivia to adjust to a new macroeconomic situation, includes two major shocks. First, the negative impact of El Niño is accounted for by a reduction of the productivity increases in traditional and modern agriculture. Second, the reversal of FDI inflows is specified as a permanent reduction in the net FDI to GDP ratio.<sup>3</sup>

The devaluation scenario assumes that Bolivia experiences these shocks but, different to this shock scenario, the monetary authorities react with a discretionary, one-time increase in the rate of devaluation from 2 percent to 10 percent. Hence, the results for the devaluating scenario reflect the combined effects of external shocks and additional devaluation. This allows to analyze whether net devaluation can mitigate the impact of the shocks.

Three sets of simulations are run, reflecting alternative assumptions about real and financial sector dollarization: A full dollarization scenario, which assumes full indexation of wages to consumer price inflation as well as almost full dollarization of commercial bank deposits and credits (90 and 95 percent of total); a financial dollarization scenario, which assumes constant nominal wages in the real sector while maintaining almost full dollarization in the financial sector; and, finally, partial financial dollarization scenarios with alternative changes of the exogenous share of dollar assets and liabilities captured by a revaluation coefficient (RC): a lower RC scenario where dollarization is reduced to half its initial ratio, a lower deposit RC scenario that only halves the ratio of deposit dollarization, and a lower loan RC scenario that only halves the ratio of loan dollarization. As will be seen in the discussion of the results below, this helps to identify the different transmission channels for an impact of a nominal devaluation on consumption and investment.

## **2. Full Dollarization**

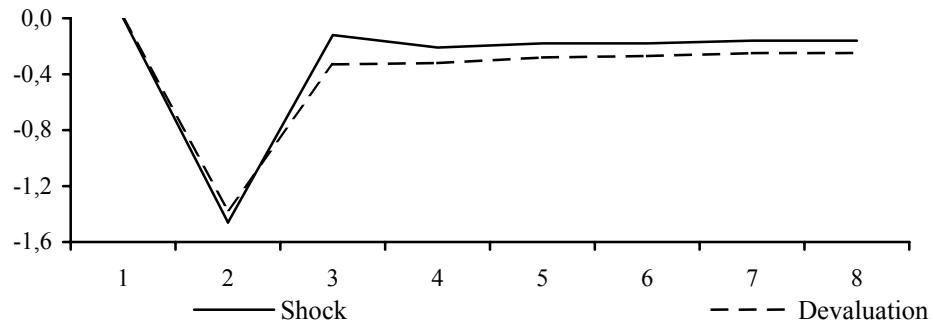
As expected and clearly shown in Figures 3a-d, temporary exchange rate adjustment may hardly help to cushion the short-run negative macroeconomic impacts of external shocks if wages are fully indexed to the consumer price index. The major immediate impact of

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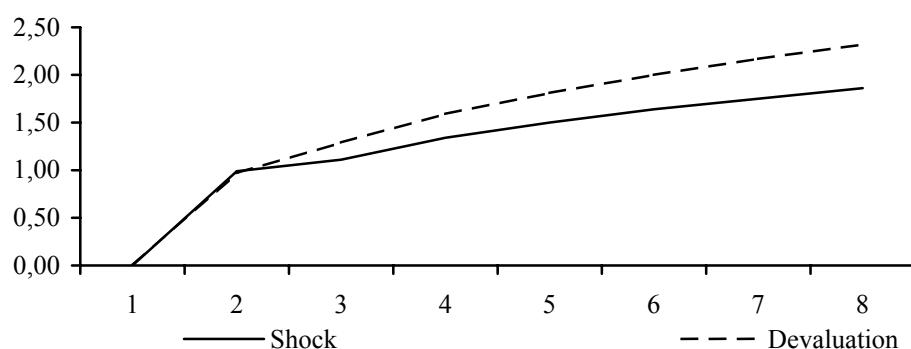
<sup>3</sup> For a detailed account of the macroeconomic, sectoral, and distributional effects of this shock scenario, see Lay et al. (2004). Here the shock scenario only serves as a benchmark against which the effects of a devaluation are evaluated.

Figure 3 — Full Dollarization: Shock and Devaluation Effects on Macroeconomic Indicators (deviation from base run growth rates, percentage points)

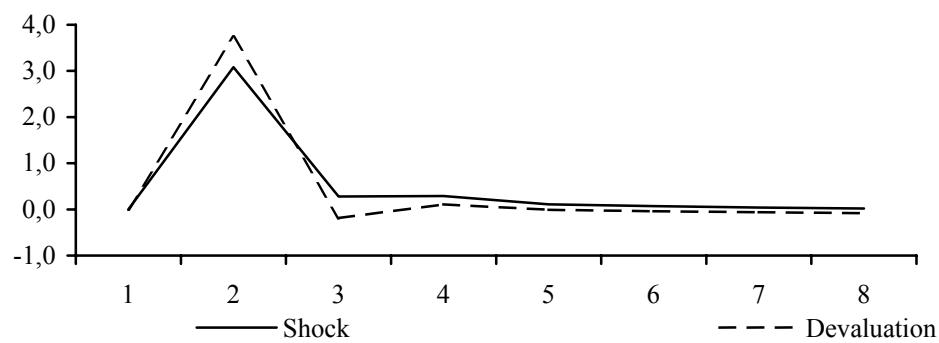
a. Real GDP Growth



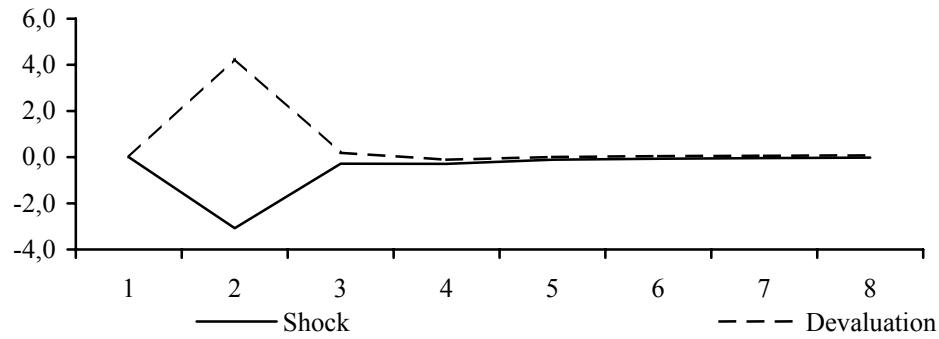
b. Unemployment Rate



c. Real Exchange Rate<sup>a</sup>



d. Real GDP Deflator



<sup>a</sup>Nominal Devaluation minus change in GDP Deflator.

devaluation is higher domestic prices with employment and output almost unaffected compared to the isolated shock simulation. As in the shock scenario, the unemployment rate increases by one percentage point from 5 to 6 percent. The inflationary impact follows the rate of devaluation, leaving relative prices almost unaffected. In particular, the policy appears ineffective in achieving a sizeable depreciation of the real exchange rate that would be necessary to stimulate export growth and import substitution. Initially, the volumes of both exports and imports rise slightly, leaving the trade deficit unaffected. Gradually, when GDP recovers and the real exchange rate appreciates, the trade deficit even exceeds its level of the isolated shock simulation.

With the exception of government investment, which is exogenously given, individual agents' investment is affected very differently in the short-run depending on their net financial asset positions. As would be expected from the discussion of dollar indebtedness in section III, smallholders experience the sharpest drop in investment. Their investable funds decline by 16 percent compared to the shock simulation, as a result of the capital losses on dollar-denominated debt, while the replacement cost of capital rises by 6 percent. The squeeze on urban informals' investment is much less because of the modest indebtedness. Employers, on the other hand, actually benefit from their net asset position in dollars but the capital gains resulting from the devaluation are more than compensated by rising capital cost. Finally, private corporations can increase their investment despite their net dollar indebtedness in the domestic banking system because "domestic" financial capital losses are more than compensated by capital gains, which result from the revaluation of accumulated foreign direct investment. Revaluation gains of state enterprises, on the other hand, are only partly offset by rising replacement cost of capital. Overall, the devaluation leads to a restructuring of investment from the unincorporated to the corporate sector and a lower reduction of investment compared to the shock simulation. However, the relative rise of investment in the short-run does not materialize in higher GDP growth in the medium-run because the short-run expansionary effects that result from revaluations are more than compensated in the medium-run by their lagged contractionary effects.

Two types of lagged effects result from revaluations. First, the revaluation has an impact on the agents' interest surplus and thereby on medium-run income. With identical deposit and credit interest rates and a higher dollarization of loan accounts than deposit accounts, the revaluation that results from the devaluation leads to a reduction of interest income and therefore gross income, investment and consumption. Again net debtors to commercial banks,

such as smallholders, urban informals, and private enterprises experience the highest income losses while employees, employers and state enterprises benefit from the revaluation of their net deposits. Since the net debtors are also the major investing agents in Bolivia, medium-run investment out of income falls. Second, the different net financial asset positions of households also affect – with a one-period lag – consumption. However, the impact of revaluations of pre-period net wealth on consumption is limited despite the high degree of financial dollarization, given moderate marginal propensities to consume out of wealth (assumed to be 5 percent for all households), and a moderate increase in devaluation compared to the base run (10 versus 2 percent). Consumption of agricultural and non-agricultural workers is unaffected by the revaluation since their bank deposits equal credits. Consumption rises for employees and employers, falls for urban informals, and remains almost constant for smallholders despite them being significant net debtors. Overall, the negative impact of revaluations on investment dominates, implying that medium-run GDP growth is somewhat lower than in the shock scenario.

As for the distributional consequences of the devaluation, the absence of an expansionary impact even in the short run implies that if the devaluation were to mitigate the worsening of the poverty situation resulting from the shock it would have to be associated with a marked improvement in the distribution of income.<sup>4</sup> If anything, however, income inequality increases somewhat (Table 5). As net creditors in the domestic banking system the two richest household groups, employers and employees, benefit from the revaluation of their dollar assets and higher real interest income while the two poorest groups, smallholders and urban informals, are hit by higher interest cost on their dollar-denominated liabilities.

The other major components of real household income, factor rewards and transfers, are largely unaffected. Nominal transfers are linked to nominal government expenditures, which in turn adjust to yield the exogenously given real government expenditures. As a result of the inflationary impact of devaluation, both nominal expenditures and nominal transfers rise. In

<sup>4</sup> The changes in the Gini coefficient or any other summary measure of inequality associated with these income changes have to be interpreted carefully because the corresponding survey does not contain reliable information on interest income. Interest income and payments have been added to household factor income and are distributed according to factor endowments in order to calculate summary distributional and poverty indicators.

<sup>5</sup> The changes in the Gini coefficient or any other summary measure of inequality associated with these income changes cannot be calculated in a meaningful way because the corresponding survey does not contain reliable information on interest income.

real terms, however, transfers are virtually constant as the nominal expansion is almost exactly matched by increases in the household-specific consumer price indices.

Table 5 — Full Dollarization: Shock and Devaluation Effects on Distributional and Poverty Indicators<sup>a</sup> (deviation from base run; percentage points)

|                                | Shock                  |                         | Devaluation            |                         |
|--------------------------------|------------------------|-------------------------|------------------------|-------------------------|
|                                | Short-run <sup>b</sup> | Medium-run <sup>c</sup> | Short-run <sup>b</sup> | Medium-run <sup>c</sup> |
| <i>All households</i>          |                        |                         |                        |                         |
| Per-capita income <sup>d</sup> | -1.8                   | -3.6                    | -2.1                   | -4.2                    |
| Gini                           | 0.1                    | 0.1                     | 0.0                    | 0.1                     |
| Headcount                      | 0.9                    | 1.1                     | 0.8                    | 1.4                     |
| Poverty gap                    | 0.5                    | 0.9                     | 0.5                    | 1.1                     |
| <i>Urban households</i>        |                        |                         |                        |                         |
| Per-capita income <sup>d</sup> | -1.8                   | -3.7                    | -2.2                   | -4.4                    |
| Gini                           | 0.2                    | 0.2                     | 0.1                    | 0.3                     |
| Headcount                      | 1.2                    | 1.6                     | 1.3                    | 2.0                     |
| Poverty gap                    | 0.6                    | 1.1                     | 0.6                    | 1.4                     |
| <i>Rural households</i>        |                        |                         |                        |                         |
| Per-capita income <sup>d</sup> | -1.3                   | -2.1                    | -1.0                   | -2.9                    |
| Gini                           | 0.0                    | -0.1                    | -0.1                   | -0.1                    |
| Headcount                      | 0.4                    | 0.2                     | 0.1                    | 0.3                     |
| Poverty gap                    | 0.4                    | 0.5                     | 0.2                    | 0.7                     |

<sup>a</sup>Income based measures. The headcount expresses the share of the population whose income is below the poverty line, while the poverty gap measures how far off households are from the poverty line. – <sup>b</sup>Shock and devaluation period, respectively. – <sup>c</sup>Six periods after the shock and devaluation, respectively. – <sup>d</sup>Percentage change.

With respect to factor incomes, the three household groups supplying formal labor services (agricultural and non-agricultural workers, employees) can – due to wage indexation – keep their real wages at initial levels. Since in addition the number of unemployed people, who are assumed to share in the income of those employed, is hardly affected, average real factor incomes of these three household groups do not change. Smallholders and urban informals, the two poorest household groups, incur minor losses due to the slight fall in demand over the medium run, which exerts downward pressure on the prices they receive.

All this translates into lower per-capita incomes and slightly higher medium-run poverty headcounts and poverty gaps than in the shock scenario. The impact on the incidence and depth of poverty is somewhat more pronounced in urban than in rural areas as rural households tend to be further below the poverty line and are less affected by the devaluation of the Boliviano.

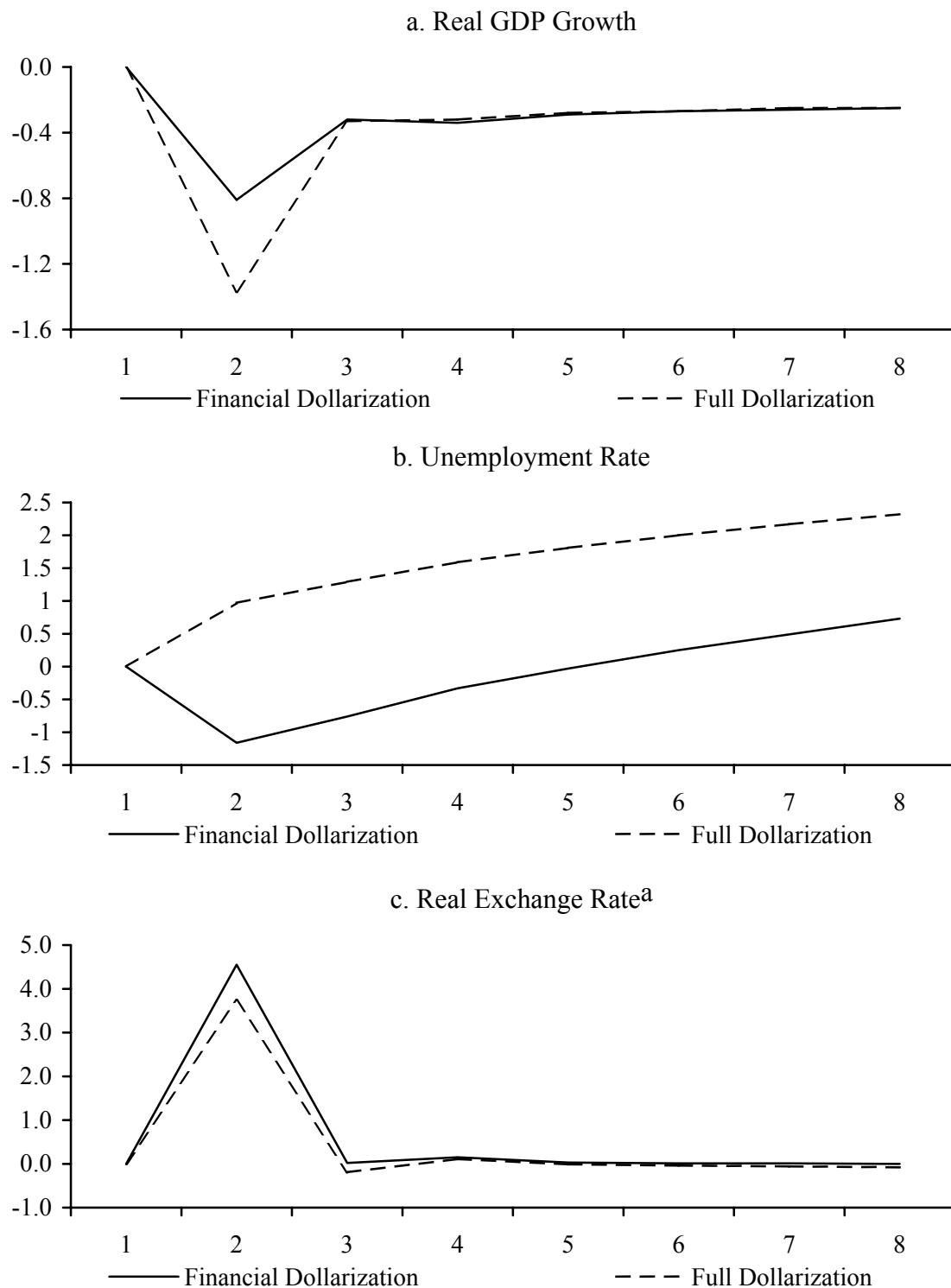
### ***3. Financial Dollarization***

The pass-through of devaluation is less pronounced if wages are not indexed, meaning that the policy is effective in achieving a real depreciation in the short run. Compared to the full dollarization scenario, the devaluation immediately reduces real product wages in export industries thereby stimulating export growth. Moreover, lower real wages in import competing sectors provide an incentive for import substitution. The combined rise in commodity exports and fall in commodity imports and the accompanying rise in foreign-exchange earnings have a positive impact on overall growth and employment (Figures 4a-d).

Over the medium-run, the expansionary effect of the devaluation fades and the economy returns to the isolated shock trend, but at a slightly higher real exchange rate and significantly higher levels of employment. The lagged effects of deposit and loan revaluations on private investment and consumption are identical to those in the case of full dollarization, and, together with exogenously determined growth rates for government investment and consumption, imply that GDP growth is also identical.

The distributional outcome of the devaluation is the result of – partly offsetting – movements in all different income components. First, analogous to the case of full wage indexation, employers and employees experience a rise in real interest income of up to 2 percentage points. Second, real factor incomes are affected via two main channels. On the one hand, the real devaluation causes a reallocation of resources from nontradable to tradable sectors. The strongest response occurs in modern agriculture, where production increases by roughly 8 percent in the short-run, creating additional employment for agricultural workers. This employment effect appears to overcompensate the real wage losses suffered by those agricultural workers already employed, the net result being a rise in average real factor

Figure 4 — Full vs. Financial Dollarization: Devaluation Effects on Macroeconomic Indicators (deviation from base run, percentage points)



<sup>a</sup>Nominal Devaluation minus change in GDP Deflator.

incomes by 4 percentage points. By contrast, for non-agricultural workers, who partly work in nontradable and partly in tradable sectors, and even more strongly for employees, who are largely confined to the nontradable segment of the economy, the wage effect dominates, reducing their real factor incomes by 3 and 5 percentage points, respectively. On the other hand, the two mainly demand-driven sectors, traditional agriculture and informal services, benefit from the additional income created by the devaluation. This leads to 2 and 3 percentage points higher real factor incomes in the short run for smallholders and urban informals, respectively.

Third, the real value of government transfers decreases by approximately 5 percentage points for all household groups. This is because the price for public services and the consumer price index with which transfers are deflated do not move in parallel. Due to a lack of pressure from public sector wages, the former rises only slightly so that only a small increase in nominal government expenditures is necessary to keep real expenditures constant, which leads to an equally small increase in nominal transfers. Consumer prices, by contrast, fully absorb the inflationary impact of the devaluation, thereby eroding the purchasing power of transfers. This effect tends to cancel out the poverty-reducing effect of rising real factor incomes, implying that on balance the poverty outcome does not improve compared to the situation with indexed wages (see Table 6). The short-run expansion induced by an additional real devaluation in the case of wage flexibility thus clearly does not turn out to be pro-poor. A more favorable impact on poverty could only be expected if the government were to take steps towards protecting the real value of the transfers received by the poor.

#### ***4. Partial Financial Dollarization***

The short and medium-run impact of devaluation on real GDP, the unemployment rate and the real exchange rate under different degrees of dollarization of the commercial banking system is shown in Figures 5a-c. It is clear from Figure 5c that changes in the degree of dollarization have almost no impact on the real exchange rate, neither in the short-run nor in the medium run. The comparison of the lower-deposit-RC and the lower-loan-RC-scenarios reveals that a reduction of deposit dollarization is contractionary compared to the financial dollarization scenario discussed above, while a de-dollarization of loans is expansionary. This

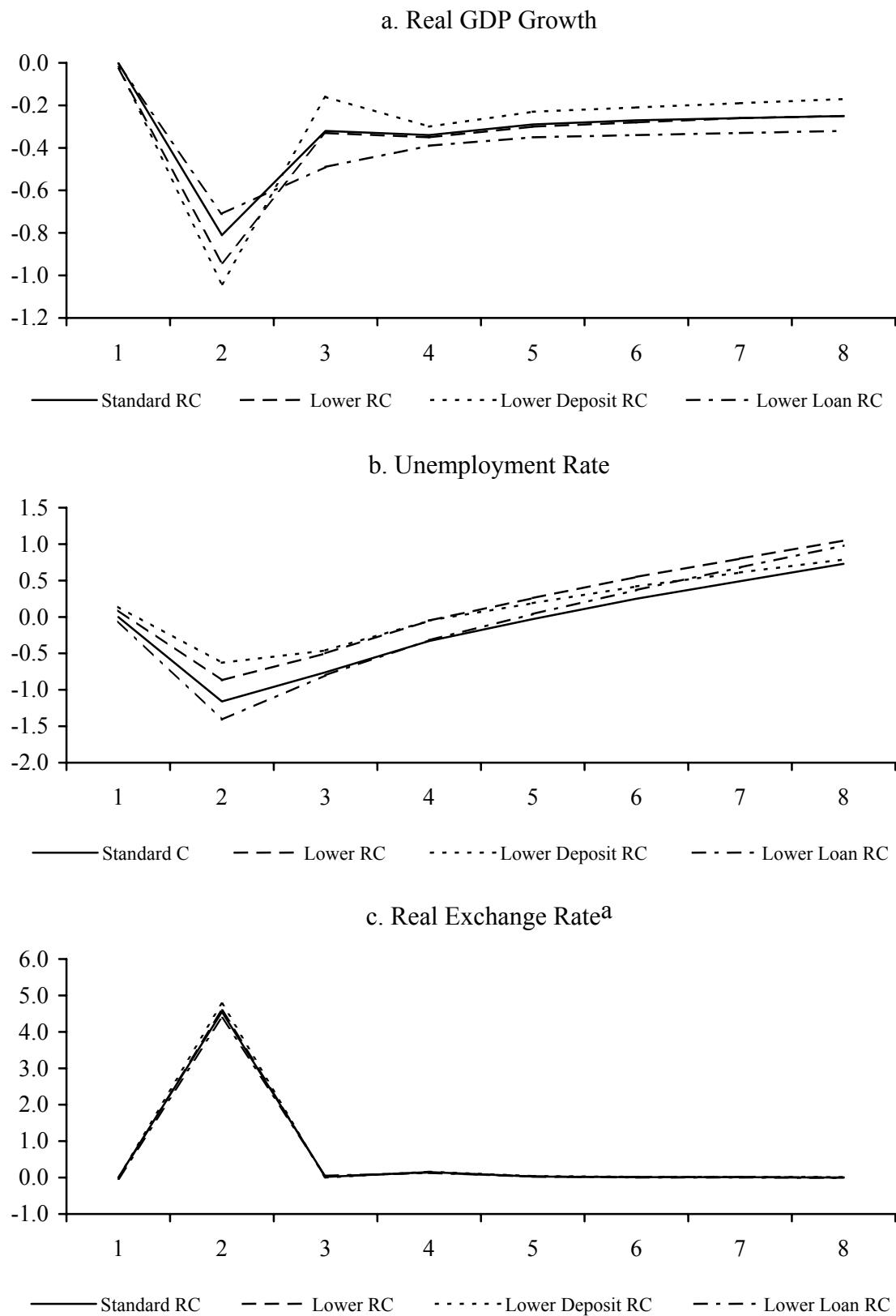
Table 6 — Full vs. Financial Dollarization: Devaluation Effects on Distributional and Poverty Indicators<sup>a</sup> (deviation from base run; percentage points)

|                                | Full dollarization     |                         | Financial dollarization |                         |
|--------------------------------|------------------------|-------------------------|-------------------------|-------------------------|
|                                | Short-run <sup>b</sup> | Medium-run <sup>c</sup> | Short-run <sup>b</sup>  | Medium-run <sup>c</sup> |
| <i>All households</i>          |                        |                         |                         |                         |
| Per-capita income <sup>d</sup> | -2.1                   | -4.2                    | -2.4                    | -4.8                    |
| Gini                           | 0.0                    | 0.1                     | -0.1                    | 0.0                     |
| Headcount                      | 0.8                    | 1.4                     | 1.1                     | 1.5                     |
| Poverty gap                    | 0.5                    | 1.1                     | 0.5                     | 1.1                     |
| <i>Urban households</i>        |                        |                         |                         |                         |
| Per-capita income <sup>d</sup> | -2.2                   | -4.4                    | -2.6                    | -5.0                    |
| Gini                           | 0.1                    | 0.3                     | 0.0                     | 0.2                     |
| Headcount                      | 1.3                    | 2.0                     | 1.6                     | 2.0                     |
| Poverty gap                    | 0.6                    | 1.4                     | 0.7                     | 1.3                     |
| <i>Rural households</i>        |                        |                         |                         |                         |
| Per-capita income <sup>d</sup> | -1.0                   | -2.9                    | -0.8                    | -2.9                    |
| Gini                           | -0.1                   | -0.1                    | -0.1                    | -0.2                    |
| Headcount                      | 0.1                    | 0.3                     | 0.2                     | 0.8                     |
| Poverty gap                    | 0.2                    | 0.7                     | 0.1                     | 0.6                     |

<sup>a</sup>Income based measures. The headcount expresses the share of the population whose income is below the poverty line, while the poverty gap measures how far off households are from the poverty line. – <sup>b</sup>Shock and devaluation period, respectively. – <sup>c</sup>Six periods after the shock and devaluation, respectively. – <sup>d</sup>Percentage change.

is reflected both in the different rates of GDP growth and the different rates of unemployment reduction. A de-dollarization of deposits implies less revaluation gains from devaluation while revaluation losses that result from the dollarization of loans remain unaffected. As a result, there are less investable funds available. Hence, de-dollarization of deposits reduces potential expansionary effects of a devaluation. In the case of de-dollarization of loans less revaluation losses at constant revaluation gains increase investable funds. Hence, de-dollarization of credits reduces potential contractionary effects of a devaluation. As can also be seen in Figure 5a, the investment effects that result from the revaluation of the deposit side dominate those resulting from the credit side in the case of Bolivia. Therefore, the effect of a de-dollarization of both assets and liabilities is on balance contractionary in the short-run. This is also reflected in the results for the unemployment ratio.

Figure 5 — Partial Financial Dollarization: Devaluation Effects on Macroeconomic Indicators (deviation from base run; percentage points)



<sup>a</sup>Nominal Devaluation minus change in GDP Deflator.

In the medium-run, the impact of revaluation gains and losses induced by an equiproportional reduction of the degree of dollarization fades and GDP and the unemployment rate coincide with their shock levels. It is also evident that de-dollarization on the credit side affects mostly private enterprises leading to a smooth adjustment of investment and therefore a smooth adjustment to the medium-run growth path of the shock simulation. By contrast, revaluations on the deposit side are mostly felt by households. Higher net revaluation losses as a result of de-dollarization of deposits induce households to reduce their investment expenditures while increasing their consumption expenditures in the post-devaluation period, which has a slightly expansionary impact on real GDP growth.

As one might expect, the distributional effects of attempts to reduce financial dollarization run mainly through the revaluation of assets and liabilities and thus mainly concern the two richest household groups. If we consider deposit de-dollarization in isolation, the result is that employees and employers experience a fall in real interest income due to a weaker appreciation of their assets. A de-dollarization of loans works in the opposite direction, but with a considerably smaller impact. Taking both sides of the balance sheet together, employees receive 2 percentage points and employers 1 percentage point less interest income, i.e. financial de-dollarization leads to lower income inequality, albeit to a very limited extent. As concerns the evolution of poverty, with full as well as deposit de-dollarization the urban and national headcount rise by about 0.5 percentage points in the short run (Table 7), which reflects a small reduction in urban informals' real factor incomes due to lower domestic demand. This effect slightly increases over the medium run.

## V. Concluding Remarks

In this paper, a real-financial CGE model has been employed for Bolivia to simulate the macroeconomic and distributional effects of exchange rate policy in a highly dollarized economy. Two characteristics of a dollarized economy have been considered: Dollarization may involve wage indexation with the consequence of a high pass-through of a nominal devaluation on domestic prices, and it may involve a high ratio of assets and liabilities in dollars with the consequence of revaluation of wealth and real balances in the case of exchange rate changes.

Table 7 — Financial De-Dollarization: Devaluation Effects on Distributional and Poverty Indicators<sup>a</sup> (deviation from base run; percentage points)

|                                | Initial dollarization  |                         | Lower dollarization    |                         | Lower deposit dollarization |                         | Lower loan dollarization |                         |
|--------------------------------|------------------------|-------------------------|------------------------|-------------------------|-----------------------------|-------------------------|--------------------------|-------------------------|
|                                | Short-run <sup>b</sup> | Medium-run <sup>c</sup> | Short-run <sup>b</sup> | Medium-run <sup>c</sup> | Short-run <sup>b</sup>      | Medium-run <sup>c</sup> | Short-run <sup>b</sup>   | Medium-run <sup>c</sup> |
| <i>All households</i>          |                        |                         |                        |                         |                             |                         |                          |                         |
| Per-capita income <sup>d</sup> | -2.4                   | -4.8                    | -2.8                   | -5.6                    | -3.0                        | -5.6                    | -2.2                     | -4.9                    |
| Gini                           | -0.1                   | 0.0                     | -0.1                   | 0.0                     | -0.1                        | -0.1                    | -0.1                     | 0.0                     |
| Headcount                      | 1.1                    | 1.5                     | 1.4                    | 2.2                     | 1.5                         | 2.0                     | 1.1                      | 1.7                     |
| Poverty gap                    | 0.5                    | 1.1                     | 0.6                    | 1.2                     | 0.7                         | 1.2                     | 0.4                      | 1.1                     |
| <i>Urban households</i>        |                        |                         |                        |                         |                             |                         |                          |                         |
| Per-capita income <sup>d</sup> | -2.6                   | -5.0                    | -3.1                   | -5.9                    | -3.3                        | -5.9                    | -2.4                     | -5.1                    |
| Gini                           | 0.0                    | 0.2                     | 0.1                    | 0.2                     | 0.1                         | 0.1                     | 0.0                      | 0.3                     |
| Headcount                      | 1.6                    | 2.0                     | 2.1                    | 3.1                     | 2.2                         | 2.9                     | 1.5                      | 2.3                     |
| Poverty gap                    | 0.7                    | 1.3                     | 0.9                    | 1.6                     | 0.9                         | 1.5                     | 0.6                      | 1.4                     |
| <i>Rural households</i>        |                        |                         |                        |                         |                             |                         |                          |                         |
| Per-capita income <sup>d</sup> | -0.8                   | -2.9                    | -1.0                   | -3.0                    | -1.0                        | -2.8                    | -0.8                     | -3.1                    |
| Gini                           | -0.1                   | -0.2                    | -0.2                   | -0.3                    | -0.2                        | -0.3                    | -0.1                     | -0.2                    |
| Headcount                      | 0.2                    | 0.8                     | 0.2                    | 0.7                     | 0.1                         | 0.5                     | 0.2                      | 0.7                     |
| Poverty gap                    | 0.1                    | 0.6                     | 0.1                    | 0.5                     | 0.1                         | 0.5                     | 0.1                      | 0.6                     |

<sup>a</sup>Income based measures. The headcount expresses the share of the population whose income is below the poverty line, while the poverty gap measures how far off households are from the poverty line. – <sup>b</sup>Shock and devaluation period, respectively. – <sup>c</sup>Six periods after the shock and devaluation, respectively. – <sup>d</sup>Percentage change.

The main macroeconomic result of the simulations is that the potential of nominal devaluation to smooth the adjustment path after a negative shock primarily depends on the indexation of wages. In the case of complete indexation, the main consequence of nominal devaluation is a temporary increase of inflation, with only a minor real devaluation and almost constant output. To the contrary, if nominal wages are constant in the short run, unemployment is reduced and the reduction of real GDP induced by the shock is cushioned significantly. Different degrees of financial dollarization hardly change this qualitative result. Short-term smoothing of adjustment to the shock is only observed in the case of a lower degree of loan dollarization. This is because loan dollarization has a recessionary impact as nominal devaluation increases the real debt burden for enterprises, thereby reducing investment. With a lower degree of loan dollarization, this recessionary impact is moderated. The reverse is true for deposit dollarization, which raises asset values and thus investable funds in case of a devaluation. With lower dollarization, this expansionary effect is reduced. Overall, the second effect dominates in Bolivia.

As concerns distributional effects, the most interesting result is that nominal devaluation in no circumstance reduces the poverty effect of the external shock. Even the significant short-run macroeconomic expansion that occurs without wage indexation does not translate into significant poverty alleviation, which is due to the fact that the real value of transfers received by households decreases. The fall in real transfers comes about via the government budget. Given a lack of pressure from public sector wages, public sector prices rise only slightly so that only a small increase in nominal government expenditures is necessary to keep real expenditures constant, which leads to an equally small increase in nominal transfers. Household-specific consumer prices, by contrast, rise much more strongly, thereby eroding the purchasing power of transfers.

Overall, dollarization appears to matter more through real than through financial-sector effects. This result may change, however, if some simplifying assumptions like fixed interest rates and constant real expenditure of the government would be relaxed. A richer formulation of the government and the financial sector separating partial dollar indebtedness of the corporate sector to commercial banks from Boliviano indebtedness of the unincorporated sector to development banks and alternative monetary policy scenarios could be useful to further investigate the robustness of results.

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