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# How Best to Use the Extraordinary Natural Gas Revenues in Bolivia? Results from a Computable General Equilibrium Model<sup>\*</sup>

by

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La Paz, December 2006

**Abstract:**

The high oil prices and the sharp increases in royalties mean that the natural gas boom in Bolivia has become very important for the economy, and particularly important as a source of government revenues. Using a CGE model, Andersen *et al* (2006) show that the natural gas boom is likely to boost GDP growth by about 1 percentage point per year. However, if the government continues with past spending and investment patterns, the boom is also likely to have a very adverse effect on the income distribution, so much so that the poorest half of the population is likely to experience absolute reductions in their real income levels compared to a scenario without gas boom. The present paper explores alternative uses of natural gas revenues in the CGE model to see if a better outcome can be engineered.

**Keywords:** Natural Gas, Inequality, CGE model, Bolivia

**JEL classification:** Q33, Q43

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# 1. Introduction

A recent paper by Andersen *et al* (2006) used a CGE model of the Bolivian economy to simulate some of the changes that were likely to occur in the Bolivian economy due to the increased natural gas exports, focusing particularly on the changes in income distribution that were likely to arise from these economic changes. The simulations showed that the natural gas boom looks very good from the viewpoint of the government: GDP growth rates are consistently higher than in the NO GAS scenario and the government has substantially more resources available for spending and investment, implying a smaller budget deficit, less indebtedness, more public investment and better paid teachers and doctors. However, if the government spends and invests all the additional revenues following the same pattern as in the base year (1997), then the natural gas boom is likely to have a very adverse effect on the income distribution. So much so that the two biggest and poorest groups (rural small holders and urban informals) actually see absolute reductions in their real incomes compared to the NO GAS scenario.

The predicted deterioration of the income distribution and the consequent increase in poverty is a result of the structure of the Bolivian economy. Particularly important is the existence of two poor, informal sectors which are largely excluded from participating in the boom, as their informal status implies that they cannot provide goods and services for the sectors that prosper under the natural gas boom (mainly the public sector and the construction sector and to a lesser extent various service sectors). Equally important is the lack of mobility between the two informal sectors and the remaining formal sectors, a situation which explains the very large and persistent gap between rich and poor in Bolivia.

One might expect some positive trickle down effects towards the poor, informal sectors if formal sector employees, who benefit substantially from the natural gas boom, start buying more informal goods and services. However, it is equally likely that the richer public sector employees switch towards buying *more* formal goods and services (they need to present

more facturas due to their higher incomes) and *less* informal goods, in which case the informal sectors would be further separated from the formal economy.

There are at least two options that might prevent such a negative outcome of the natural gas boom. One possibility is if the government does not spend and invest all the natural gas revenues, but instead redistributes it directly to the population, so that everybody is assured a share of the revenues. The second possibility is to help informal sector workers move into the formal sectors which prosper in the natural gas economy.

The purpose of this paper is to analyze the feasibility, advantages, and drawbacks of these two options.

The remainder of the paper is organized as follows. Section 2 briefly describes the structure of the CGE model and the main assumptions used in the different scenarios. Section 3 shows the predicted effects of the natural gas exports to Brazil and Argentina if the government continues past patterns of spending, investment and transfers. Section 4 shows the results of a simulation in which the government redistributes a large part of the natural gas revenues directly to the population instead of spending it. Section 5 analyzes the implications of increased mobility of workers between informal and formal sectors. Section 6 concludes.

## **2. Assumptions**

This section briefly explains the main assumptions underlying the three different scenarios to be analyzed and compared.

### *Assumptions*

The Computable General Equilibrium (CGE) model used in this paper as well as in Andersen *et al* (2006) and Andersen & Faris (2002) is a standard 12-sector recursively

dynamic model. It is based on the 1997 disaggregated Social Accounting Matrix for Bolivia described in Thiele & Piazzolo (2002).

There is one capital category and five types of labor: skilled, unskilled agricultural, unskilled non-agricultural, smallholder, and urban informal. Amongst the labor classes, labor is mobile only between the two unskilled classes and between the smallholders and the informal sector. There are six household categories defined by the source of their income.

Public investment is assumed to increase the stock of public goods (infrastructure, property rights, etc.), which increases the productivity of all productive sectors. This is an admittedly optimistic assumption in a country which is usually found to be among the most corrupt in the world ([www.transparency.org](http://www.transparency.org)).

For more information about the model, please consult Andersen & Faris (2002).

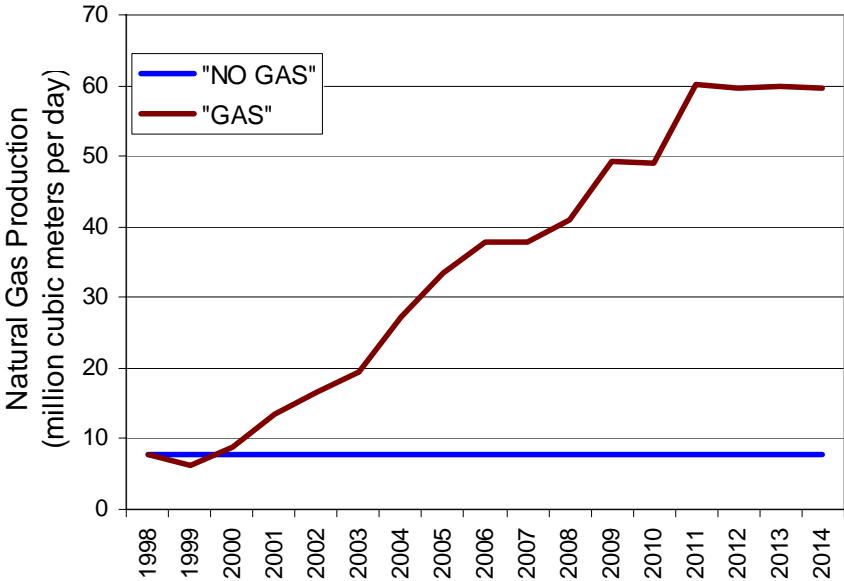
### *Scenarios*

This paper will compare three different scenarios. The base scenario (NO GAS) is a counterfactual simulation which maintains oil and gas production at the low levels observed in 1998. Then there are two GAS scenarios which differ only in the way the government uses its hydrocarbon revenues. The GAS – NORMAL SPENDING scenario assumes that the government maintains the pattern of spending, investment and transfers that was observed in the base year, just on a larger scale. In contrast, the GAS – TRANSFERS scenario assumes that the government transfers a large share of revenues (45%) directly to the population.

Both GAS scenarios assume a vastly increased natural gas production which is necessary to fulfill the long run contracts signed with Brazil and Argentina (see Figure 1). The figures for “GAS” during the period 1998 to 2005 correspond to actually observed production

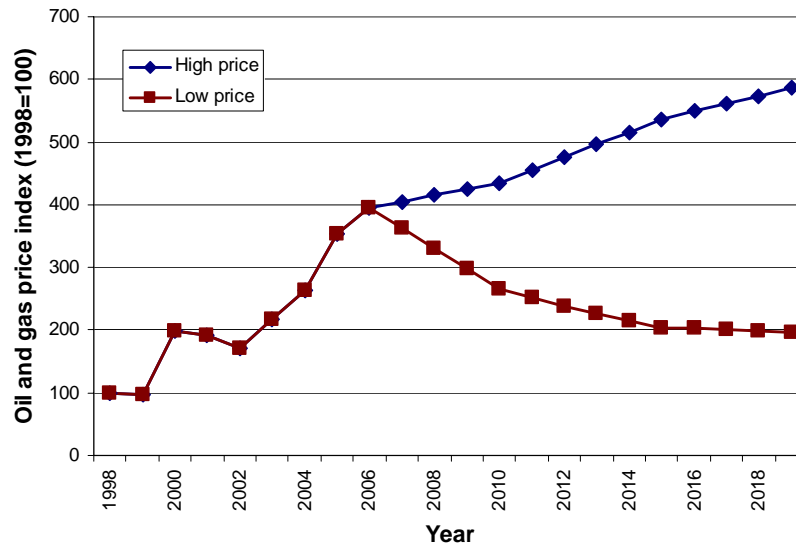
volumes. The rest is a conservative projection based on the natural gas export volumes stipulated in long run contracts with Brazil and Argentina.

Figure 1: Natural gas production scenarios in Bolivia, 1998-2014.



Due to the unpredictability of future oil prices, Andersen *et al* (2006) uses two different prices scenarios. In both scenarios, oil and gas prices follow the actual development of prices between 1998 and 2005. The “High price” scenario assumes that prices keep increasing reaching a level corresponding to about \$70/barrel in 2019 (6 times higher than the level observed in 1998), whereas the “Low price” scenario assumes that prices will soon start falling, reaching a level around \$20/barrel in 2019 (see Figure 2). In this paper we will use only the “High price scenario”.

Figure 2: Alternative price scenarios for CGE simulations



Source: Andersen *et al* (2006).

Finally, it is assumed that royalties and taxes follow actual numbers between 1998 and 2005, increase to 50% of gross revenues at wellhead in 2006 and stays at that level for the rest of the simulation period.

### 3. Simulation results with normal government spending

The simulation results show substantial positive effects from the natural gas boom on GDP growth. In the GAS – NORMAL SPENDING scenario the model predicts additional GDP growth of 1-2 percentage points for most years in the projection period (see Figure 3). This is due to the continuous expansion of natural gas production, plus the substantial investments in public goods, which are assumed to make everybody more productive.

*Figure 3: Increase in GDP growth rates due to natural gas exports  
(with normal government spending)*



The increase in GDP is not evenly distributed across sectors, however. While production in the oil and gas sector increases tremendously, production in the mining sector would drop by some 20 percent due to the appreciation of the real exchange rate caused by the natural gas boom. Output from modern agriculture is also predicted to fall initially (for the same reason), but it is expected to recover later due to the increase in productivity caused by the large public investments in public goods.

All other sectors are predicted to benefit from the natural gas boom, especially Utilities, Construction and Capital Goods, which all benefit from the large increase in public investments (see Figure 4).

Figure 4: Changes in sectoral production due to natural gas exports  
(with normal government spending)

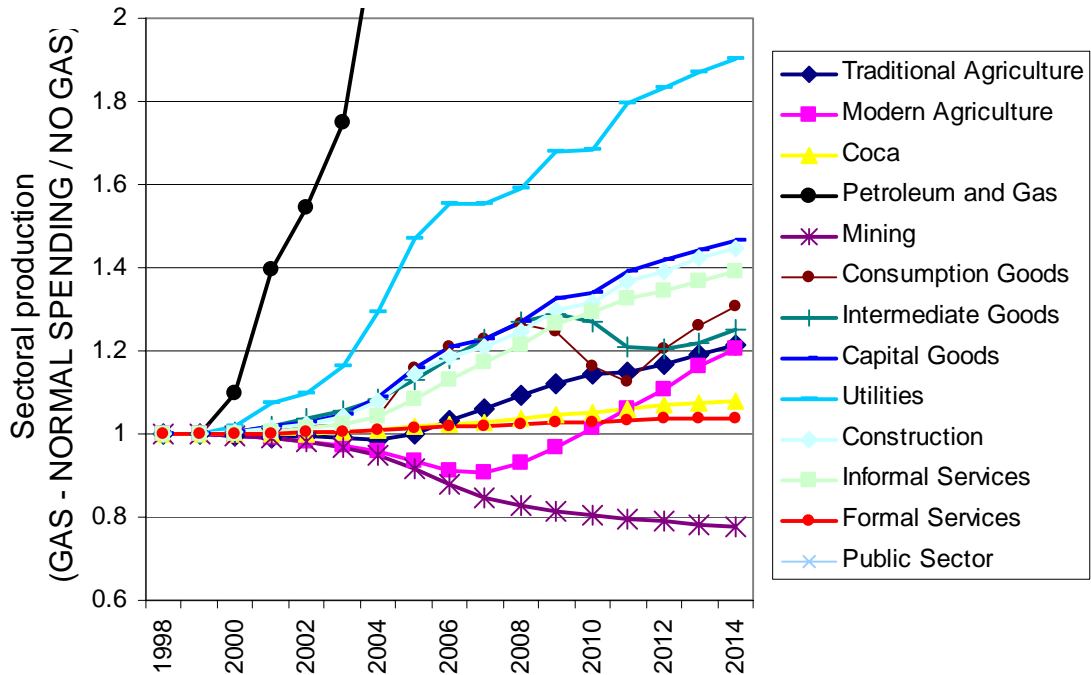
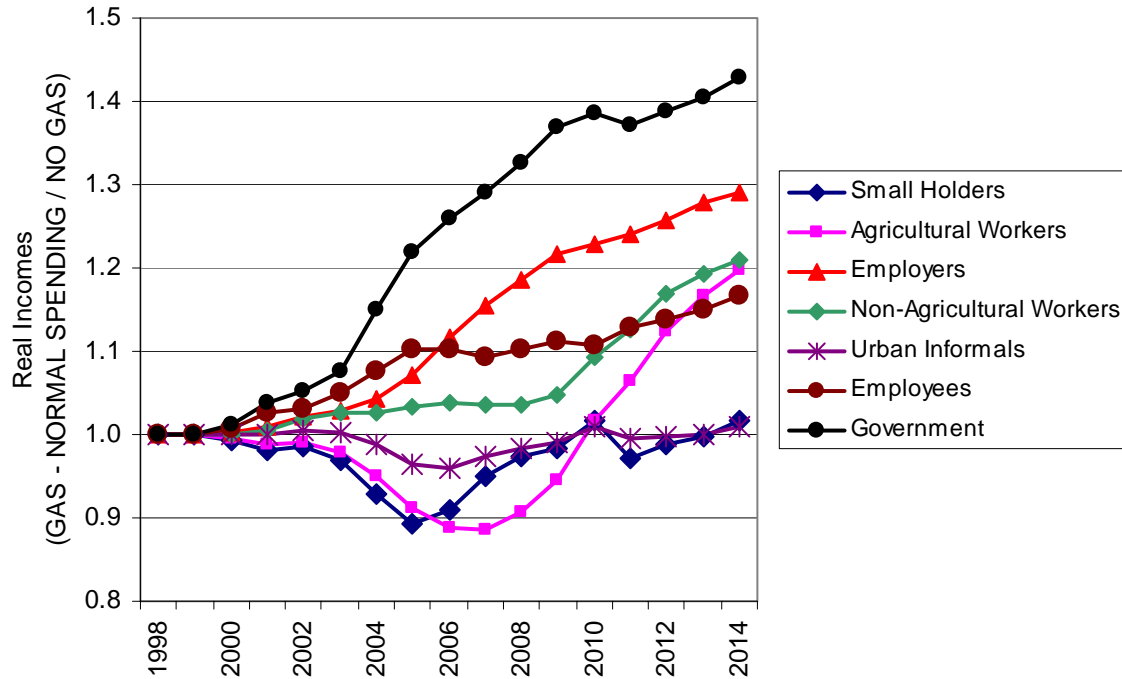


Figure 5 shows that real incomes increase correspondingly for most types of households. Apart from the government itself, the big winners of the gas boom are Employers, especially those in Construction and Utilities. They share some of the benefits of the increased activity with their Employers (skilled) and Workers (unskilled).

There are two large groups who are almost completely by-passed by the boom, and who actually see falls in their real incomes during most of the projection period. These are the two initially poorest types of households: rural Small-Holders (40% of all households) and Urban Informals (25% of all households).

Figure 5: Changes in real incomes due to natural gas exports  
(with normal government spending)



The fact that the initially richest groups benefit greatly from the natural gas boom while the initially poorest loose out, implies that both inequality and poverty increases due to the natural gas boom, at least if the government doesn't change the way it spends, invests and redistributes its revenues.

#### 4. Direct transfers instead of government spending

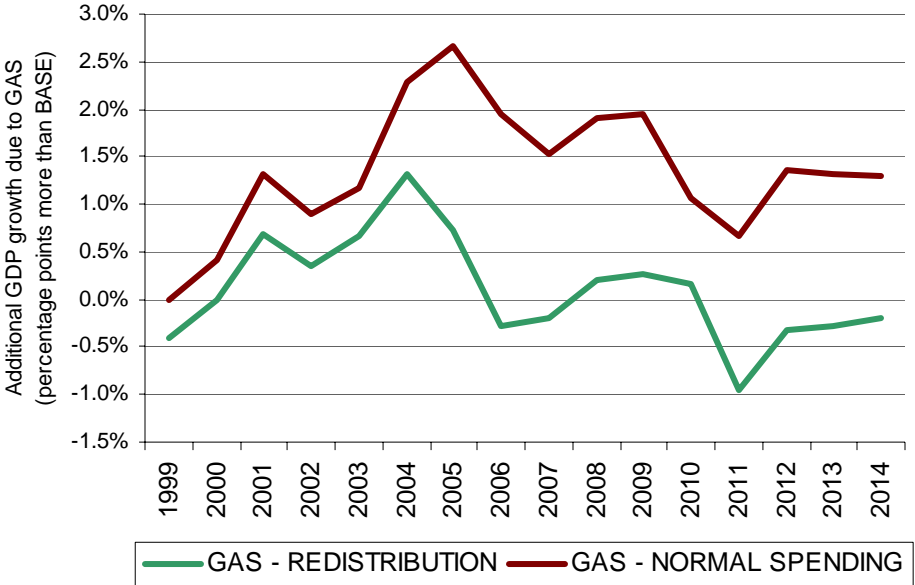
If the substantial public revenues arising from natural gas exports (about \$700 million per year at the moment) were distributed directly to the whole population instead of going through the public sector machinery which tends to benefit mainly skilled workers (teachers,

medical workers, bureaucrats, secretaries, etc.) and construction workers, we would expect a much better outcome in terms of the income distribution.

In order to investigate the consequences of such a scheme of unconditional transfers we run the same simulations as above, but with the change that 45% of hydrocarbon revenues are distributed directly to the whole adult population in equal amounts. The remaining 55% are used for normal government spending and investment. The extreme case of 100% of hydrocarbon revenues being distributed directly to the people could not be simulated as the CGE model could find no solution; 45% was the highest share the model could handle.

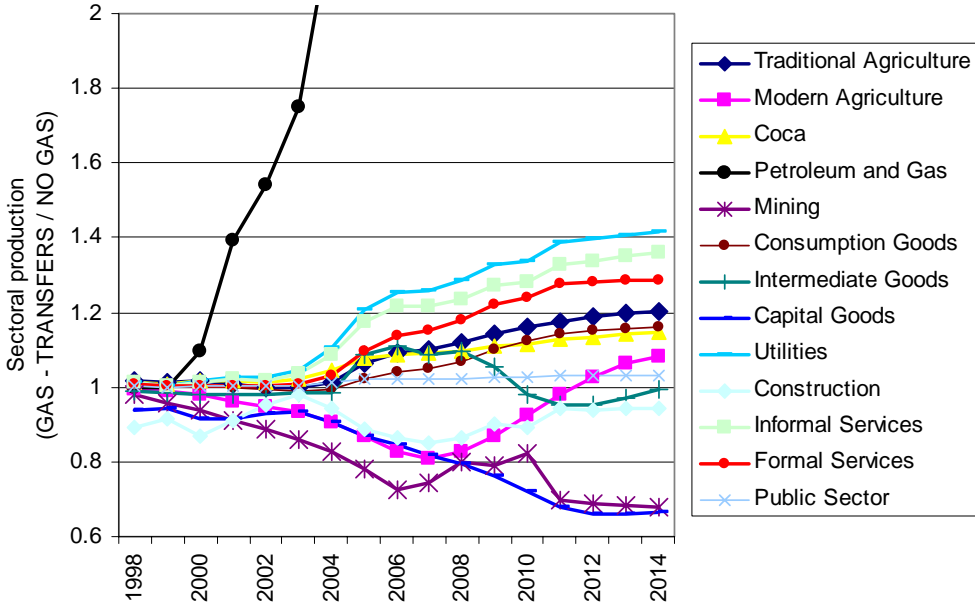
Figure 6 shows that GDP growth rates would be much smaller in the TRANSFER scenario than in the NORMAL SPENDING scenario. Indeed, the additional GDP growth due to the gas boom would be close to zero. The reason for this is mainly the much lower level of government investment in public goods. With less public goods (such as roads), all private producers are assumed to be less productive.

Figure 6: Increase in GDP growth rates due to natural gas exports, different scenarios



The sharp increase in production from the hydrocarbon sector is compensated by the drop in production in other export sectors, due to the Dutch Disease phenomenon (see Figure 7). By comparing Figure 4 and Figure 7, we see that sectoral production is lower in almost all sectors in the TRANSFER scenario compared to the NORMAL SPENDING scenario. The exceptions are Coca and Formal Services, which do slightly better in the TRANSFER scenario.

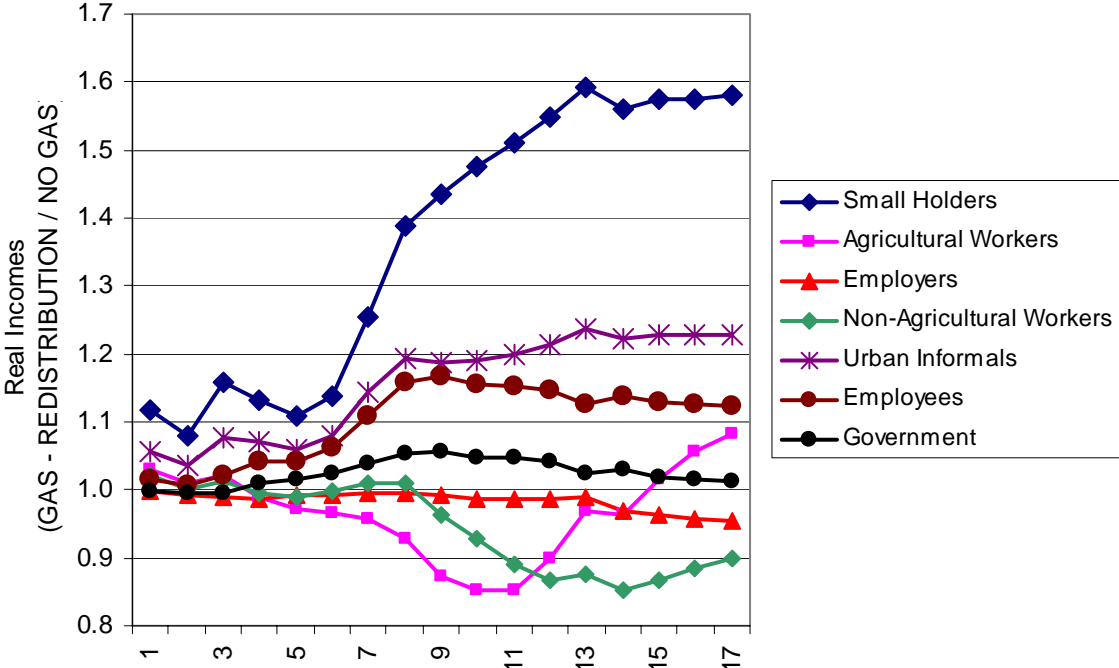
Figure 7: Changes in sectoral production due to natural gas exports, (Transfer scenario)



Real incomes received by the poorest households increase dramatically in the TRANSFER scenario, which is in sharp contrast to the results of the NORMAL SPENDING scenario in which the poorest households see absolute reductions in real incomes. In the TRANSFER scenario, rural Small-Holders improve their incomes by more than 50% compared to the NO GAS scenario, and Urban Informals see an increase of almost 25% (see Figure 8). Skilled Employees do almost as well as they do in the NORMAL SPENDING scenario, whereas Unskilled Workers are substantially worse off. The transfers they would receive

from the government are not enough to compensate them for the lower incomes due to less activity in Mining, Construction and Modern Agriculture.

Figure 8: Changes in real incomes due to gas boom with direct transfers



Since the initially poorest (and largest) groups improve their incomes most, both inequality and poverty would fall in this scenario. Thus, although the natural gas boom would hardly have an effect on GDP growth rates, it would have a significantly beneficial effect on poverty and inequality. At least while the boom lasts.

### 5. Improved mobility between labor groups

The other option for improving the distributional outcomes of the natural gas boom in Bolivia is to facilitate the movement of workers from the two large informal sectors (rural small-holders and urban informals) to the remaining formal sectors which all prosper in the natural gas economy (with normal government spending).

Especially the construction sector should be able to absorb quite a lot of additional unskilled workers. Figure 4 shows that the construction sector increases by about 40% compared to the NO GAS scenario, which implies that it might be able to hire up to 80.000 additional construction workers, if it does not raise the salary levels.

The public sector might also use its additional incomes to hire more public sector employees instead of paying higher salaries to existing staff. With the 40% higher real incomes suggested by the model (see Figure 5 above), the public sector could hire close to 100.000 additional employees. Since the public sector hires mostly skilled workers (more than 75% of public sector employees have a high school degree), the public sector probably wouldn't be able to absorb more than 25.000 people from the informal sectors, however.

Informal services (mainly domestic help) increase by 20-40% (see Figure 8), which implies that this sector might be able to absorb another 50.000 unskilled workers, mainly women.

In total, if the booming sectors used all their additional income to hire additional workers instead of increasing salaries for existing workers, these sectors might conceivably absorb up to 25% of existing rural small-holders and urban informals. This would happen gradually over the next decade or so, if the natural gas boom with high oil-prices continues that long.

In this scenario, most of the gains from the natural gas boom would go to those who manage to switch from a low-income sector to a higher-income sector. Those who were already in a higher-income sector would not benefit much, as the higher incomes for the whole group would be shared among more group members.

The mechanisms through which mobility could be improved are different for rural small-holders and urban informals. Rural small-holders would generally have to move physically from dispersed rural areas to urban or semi-urban areas, where formal jobs for unskilled workers can be found. This is often difficult, as rural small-holders are frequently tied to

their land, as the lack of formal private property rights often means that they cannot sell their lands at a fair price. Even when they can, the proceeds are often too low to pay for the start up costs it would require to start a new life in the city (see Andersen & Nina, 2006). In addition, the language and cultural barriers may be daunting, especially for the older generations.

The government and the aid community can make rural-urban migration less costly by providing adequate urban infrastructure (city planning, roads, sanitation, electricity, schools, health clinics, etc) in the main receiving cities (mainly the outskirts of Santa Cruz de la Sierra, El Alto, and Cochabamba) in a timely manner. Another service that would help is to provide a simple, speedy and fee free process of obtaining property rights, which would make it easier to sell and buy properties and thus to move to where opportunities are best. Initiatives aimed at keeping the rural population in place are obviously counter-productive in this respect.

The change from being self-employed and free to decide what to do and when to do it to becoming a worker with rigid work hours and little control is perhaps the biggest deterrent. Entrepreneurs in El Alto report that one of their biggest obstacles to growth is the unreliability of the labor force, as workers are often late or do not show up at all<sup>1</sup>.

The limits to mobility between the urban informal sector and the urban formal sector are completely different. Large parts of the urban informal sector are very dynamic and clearly have potential to grow into formal enterprises if the obstacles to turn formal were removed. The main obstacles to this are related to bureaucracy, taxes and labor laws, so they are not impossible to remove. Basically, a small informal family business is blessedly free of bureaucracy and pay little if any taxes. But if they should wish to turn into a formal business employing workers and paying regular salaries, they are met with a mountain of bureaucracy, labor laws which make it very expensive to get rid of un-necessary workers, and steep increases in taxes.

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<sup>1</sup> Results from workshops conducted with entrepreneurs in El Alto by Grupo Integral in the fall of 2006.

To make the transition smoother, and thus create more formal sector jobs, it is necessary to make labor laws more flexible. This means less job-security for those who already have formal sector jobs, but better opportunities for the poor to get a job and thus escape poverty.

It is also necessary to smooth the dramatic jump in taxes, which can be done either by raising taxes on informal businesses or reducing them for the formal businesses, or both. If it was made much simpler to register a formal business, the government could simply require all businesses to become formal, and not tolerate informal, non-contributing businesses. They could also create incentives, such as subsidized credit from sectoral development banks, which make it more attractive to become formal.

## **6. Conclusions**

This paper has simulated the effects of the natural gas exports to Brazil and Argentina in a Computable General Equilibrium model, and the simulation results show that the economic outcomes depend completely on how the revenues are spent. If the government keeps spending, investing and redistributing as they did in the late 1990s, the natural gas boom will cause significant additional GDP growth (1-2% extra per year), but the benefits will be so unevenly distributed that inequality and poverty increases. This is because the two largest and poorest segments of the population (rural small-holders and urban informals) are largely bypassed by the benefits of the boom, but suffer higher costs-of-living together with everybody else.

In contrast, if a substantial share of natural gas revenues is redistributed directly to the whole adult population, poverty and inequality will decrease, but there will be little additional GDP growth, as the government will not have as many funds available for investment in public productivity enhancing goods.

Considering the possibility that the public sector may not be able to invest the hydrocarbon revenues 100% efficiently in public goods that increase the productivity of everyone, it is likely that the difference in GDP growth between the two scenarios is not as large as the simulations suggest. When taking this quite likely possibility into account, the scenario with redistribution becomes relatively more favorable. Another factor that works in this direction is the possibility that the savings and investment rate of the poor is higher for the government transfers than for their earned income, which barely covers the basics, and thus has savings rates close to zero. The CGE model assumes that the savings rate is constant, which may be unrealistic.

Since the simulations assumed a consistently high oil price, there is little volatility in natural gas revenues in the model simulations. In reality, oil prices are very volatile, and thus not good to rely on for basic public expenditures, such as salaries to teachers, health workers, and armed forces.

An interesting combination of uses may be to allocate a fixed amount of revenues every year to ordinary government spending (education, health, police, etc) and distribute the excess revenues directly to the population. This would provide a stable, predictable income for the government, which is good as the needs for government expenditures are quite stable and predictable. It would also provide unpredictable incomes for the households, which is good, since unexpected incomes usually are associated with a higher propensity to save than steady and predictable incomes (see, for example, Adams 2002). If hydrocarbon transfers to the households were too regular, they might be substituted for other types of income which would require hard work, which means that labor supply would be reduced and GDP would fall.

Since the natural gas boom some day will end, it is important to avoid that households become too dependent on the transfers. Experiences from other transfer programs (specifically the BONOSOL program in Bolivia) show that a large unexpected payment (such as the first BONOSOL payment) have a much more beneficial effect on household

investment than smaller, but regular, transfers which tend to turn into consumption (see Martinez 2006).

It is also important that the government does not become dependent on hydrocarbon revenues, so it should make serious efforts to increase its tax base, which means stimulating the formalization of the economy as well as facilitating rural-urban migration.

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