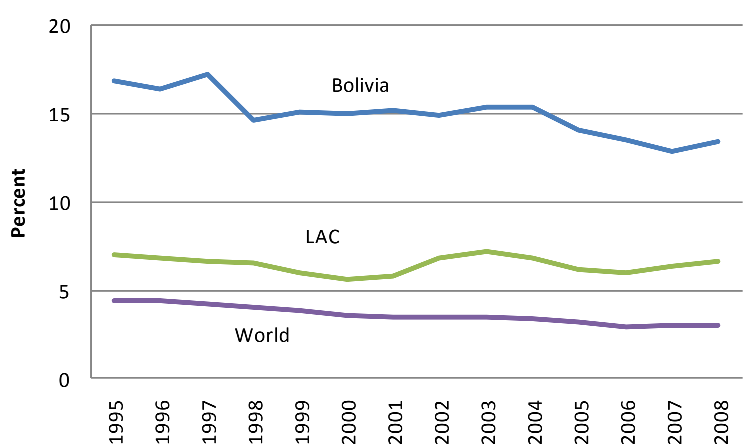
Public investments in Agriculture in Bolivia

1. An overview of agriculture in Bolivian economy

Agriculture plays a key role in development. For early developers, agriculture can be a key engine to growth and in poor countries an undeniable source of poverty relief (see for instance Christiansen et al 2006, Datt and Ravallion 1998 and Nin-Pratt et al 2010). As a country develops, however, and industrialization (and services) begin to surface, a natural decline in the relative importance of agriculture in the economy tends to take place. This trend is particularly noticed in the participation of agricultural GDP in total GDP. The decreased share is a reflection of the much higher value-added of other sectors, but also of a more efficient agricultural sector which becomes more and more mechanized and requires decreasing work forces. In Latin America as whole, the shares of agricultural participation to GDP have been low at least the last 10 years (see figure 1), as have equivalent global figures.

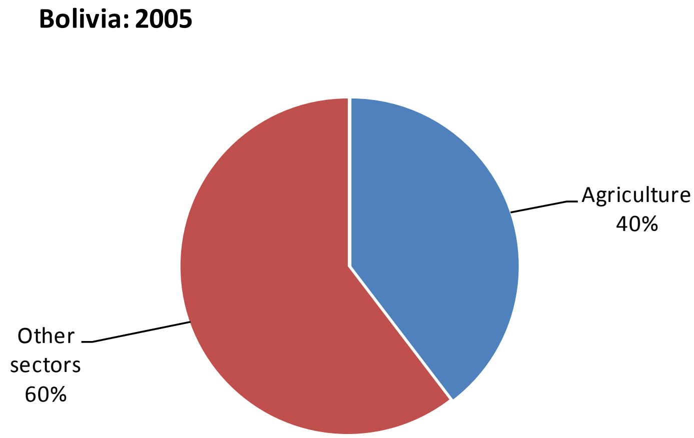
Figure 1: ***Share of agricultural GDP in total GDP***

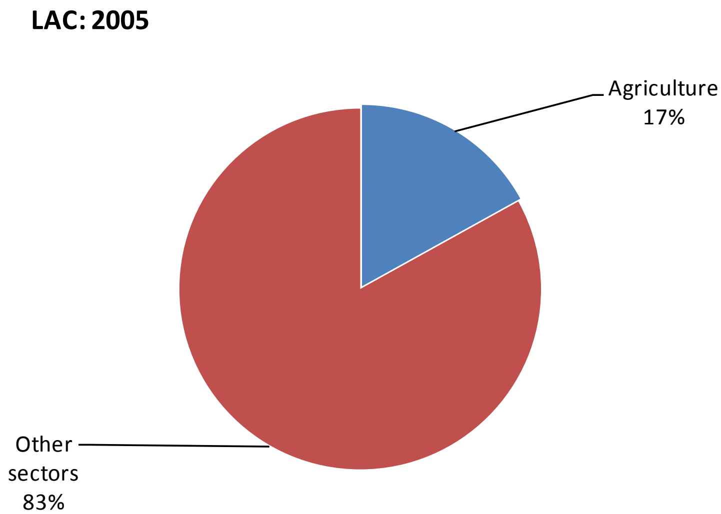


Source: World Bank Development Indicators database
Note: The share of agricultural GDP in total GDP for the world was not available for 2008. We assume that the 2007 value was the best estimate for 2008.

Bolivia still presents fairly high rates of agricultural participation in GDP, approaching almost 15 percent in 2005, and only slightly less in 2008. Large shares of agricultural GDP are also reflected in the 40 percent ratio of labourers employed in the agricultural sector in Bolivia, compared to only 17 percent in LAC in 2005 (see figure 2).

Figure 2: ***Share of employment in agriculture and in other sectors***

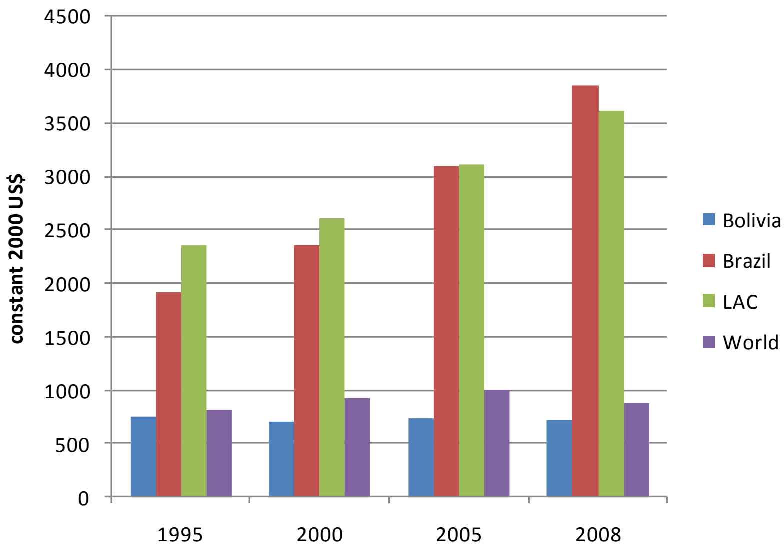




Source: World Bank Development Indicators database
[a] The last year of data available for Bolivia was 2002..

The large share of workers in agriculture combined with the large participation of agriculture in the economy spell out a picture of low productivity in Bolivia. Indeed, this is reflected in the low value of agriculture GDP per worker (see figure 3), for which Bolivia is lower than the world average, and considerably lower than Brazil and LAC.

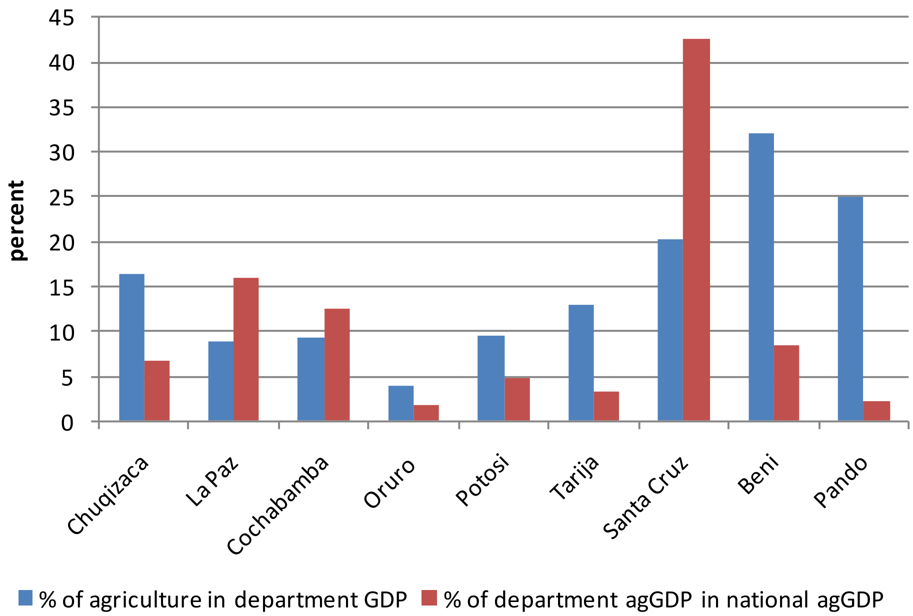
Figure 3: ***Agricultural GDP per worker***



Source: World Bank Development Indicators database

Within Bolivia, agricultural value-added varies considerably by department. In departments like Beni, Pando, and Santa Cruz, agriculture accounts for more than 20 percent of departmental GDP. At the same time, La Paz, Cochabamba and Oruro fared 10 percent or less in 2007 (see figure 4). The striking aspect of figure 4 is, however, the participation of Santa Cruz in national GDP, reaching 43 percent in 2007, representing a twenty-fold difference relative to Oruro or Pando.

Figure 4: ***Share of agriculture GDP in department GDP and in national agriculture GDP in 2007***



Source: Instituto Nacional de Estadistica de Bolivia

These marked differences between Bolivia's economy and the rest of LAC, as well as among states in Bolivia definitely give rise to questions regarding the inner workings of the Bolivian economy, and particularly the actions the government has taken (via investments) to either stimulate or curb the agricultural sector and the economy as a whole. The role of investments in creating demand and promoting growth in Bolivia, therefore, needs to be scrutinized further.

In this section, we look at two aspects of the public investment picture in Bolivia: efficiency and equity. The analysis of efficiency is done via the estimation of a dynamic panel model, following the overall principles established in Arellano and Bover (1995). To analyze the actual levels of efficiency (post-estimation of the production function), additional estimations and statistical tests are performed along with descriptive tables and graphics. For equity, a two-stage approach was adopted: first, by obtaining information on departments levels of poverty based on a 2005 –nationally representative—household data, concentration curves of restricted agricultural investments and extended agricultural investments could be drawn up to show the degree of inequality in departments; second a comparison via tables and non-parametric regression analysis was made to establish the links between efficiency, equity and population. Combining these two aspects aims to provide an integrated understanding of the dynamics of public investment in Bolivia.

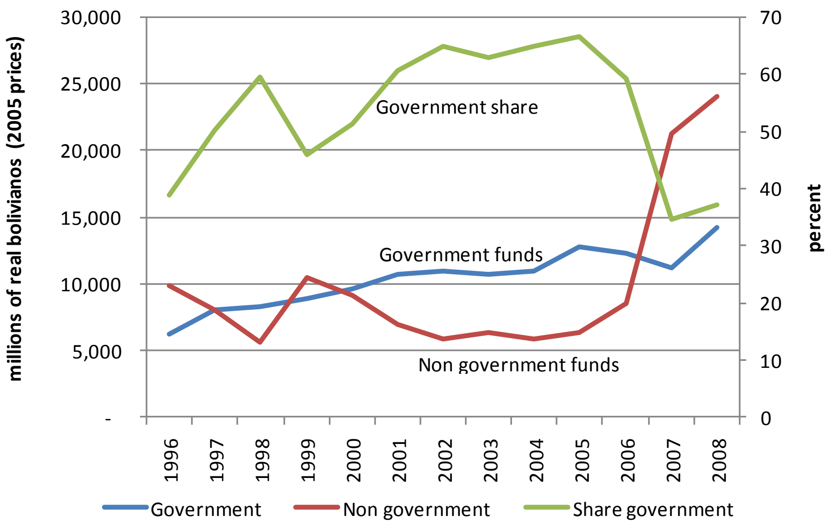
2. Public investments at the national and regional level

National level

A sizeable amount of investments across all sectors (agriculture and non-agriculture) have been placed in Bolivia in recent years. From 1996-2008, slightly over 263 billion real bolivianos at 2005 prices (approximately 35 billion US dollars) were spent nationally.   Nearly the totality of these investments were earmarked to sectors not-directly related to agriculture, particularly sectors such as education and health. In fact, over the 12 year period an average of only 1.4 percent of total investments were allocated specifically to agriculture.

Until 2006, the government of Bolivia was overall the largest provider of funds for total public investments across all sectors (agricultural and non-agricultural), accounting for more than 50 percent of the total amount of resources. In 2007 and 2008 however, the contribution of other donors (including national and international ones) increased drastically (see figure 5).   It is important to note that until 2007 and 2008, funding was stagnant regardless of the source.

Figure 5*: Total investment by source of funds*



Source: Authors calculation based on data put together by the World Bank, UDAPE (Unidad de Análisis de Políticas Sociales y Económicas), and FAM (Federación de Asociaciones Municipales de Bolivia).
Note: Government funds are the total funds from the National Treasury. Non-government funds are the sum of funds from foreign donor (credit and grant), domestic credit, and other sources.

Sub-national level

Allocation of public funding to provinces and municipalities in Bolivia is typically proportional to population. However, perhaps due to the presence of parties other than the government in the donor mix, the investment funding apportioned to departments between the 2000-2008 period did not meet the population criterion. In fact, for a number of departments a negative correlation between population and investments was observed (see table 1). Departments in table 1 are sorted in descending order of population size in 2008. The ratio of investment per capita demonstrates this issue more clearly and promptly shows the considerable differences among departments.

Table 1*: Public investment per capita*

	2000	2002	2004	2006	2008	Population
	(real bolivianos at 2005 prices)					
La Paz	32.5	38.6	67.2	85.0	89.0	2,756,986
Santa Cruz	40.2	165.0	26.8	73.8	63.9	2,626,699
Cochabamba	134.2	117.8	70.3	226.1	88.1	1,786,035
Potosí	89.5	86.5	94.8	113.3	414.3	780,392
Chuquisaca	111.7	87.5	135.7	144.3	114.6	631,059
Tarija	249.8	178.6	325.1	1690.4	951.7	496,988
Oruro	72.3	86.4	102.1	327.6	385.9	444,092
Beni	68.8	84.4	69.3	412.1	222.7	430,048
Pando	400.5	249.1	202.4	1862.7	295.5	75,335

Source: Public investment was extracted from a dataset put together by World Bank, UDAPE, and FAM.
Note: Public investments include all type of investment, agricultural and non agricultural.

Public investment that has an impact on the agricultural sector is classified into two broad categories of spending in the dataset: restricted agricultural spending and extended agricultural spending. Within these two categories, investment is disaggregated into various components. Restricted agricultural spending includes investment directly related to the agricultural sector such as irrigation, agricultural research and extension. On the other hand, extended agricultural spending are expenditures that impact agriculture but not directly such as investment on the environment, on rural electrification and roads.

Table 2 presents the share of agricultural (restricted and extended), health, and education spending in total public spending at the departmental level. This provides insights as to how the agricultural sector has fared relative to education and health. Looking first at the average across all departments, table 2 reveals that education was the most important sector in terms of expenditures. In 2008 for example, 36.6 percent of total public spending was accounted for by education compared with 6.3 percent for health, and 23.1 percent for agriculture. Over time however, the share of education decreased, from 41.7 percent in 1996 to 36.6 percent in 2008. The share of health remained overall constant while the share of agriculture increased from 15.6 percent to 23.1 percent between 1996 and 2008. As expected, the relative importance of each spending component varies across departments. In 2008, agriculture accounted for nearly 40 percent of total public spending in Potosi and Beni compared with only 12.6 percent in Santa Cruz. Spending on health was most important in Beni and Pando accounted respectively for 18.4 percent and 16.6 percent of total public spending in 2008, and the least important in Tarija with only 1.1 percent in that same year.

Table 2: ***Share of agriculture, health and education in total public spending***

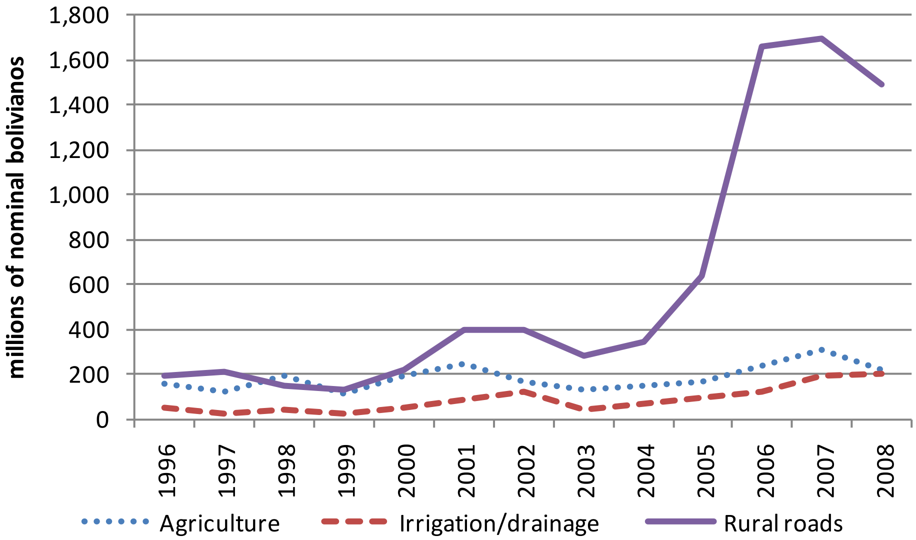
	1996	2000	2005	2008
		(percent)		
Share of agriculture				
Chuquisaca	21.2	18.6	18.8	14.8
La Paz	11.5	8.2	11.4	16.7
Cochabamba	14.8	27.1	20.3	16.6
Oruro	14.4	8.4	13.1	30.2
Potosí	26.4	16.2	5.9	38.3
Tarija	27.5	21.9	40.6	32.4
Santa Cruz	11.3	10.4	9.3	12.6
Beni	16.8	12.5	11.2	39.8
Pando	21.3	24.2	13.1	19.0
Average	*15.6*	*15.4*	*17.2*	*23.1*
Share of health				
Chuquisaca	10.4	12.5	12.0	n.a.
La Paz	10.9	11.9	11.0	10.3
Cochabamba	8.8	8.3	9.6	n.a.
Oruro	6.1	5.7	9.7	n.a.
Potosí	8.9	8.3	8.7	5.6
Tarija	n.a.	7.8	5.4	1.1
Santa Cruz	5.8	9.6	13.2	14.0
Beni	15.3	15.6	14.0	18.4
Pando	12.6	10.2	31.1	16.6
Average	*7.9*	*9.8*	*10.7*	*6.3*
Share of education				
Chuquisaca	40.3	42.8	44.5	n.a.
La Paz	61.7	60.8	66.8	64.2
Cochabamba	54.9	46.8	53.2	56.4
Oruro	51.1	36.0	60.2	34.4
Potosí	50.2	54.7	58.7	30.1
Tarija	n.a.	24.2	18.0	n.a.
Santa Cruz	26.9	43.1	52.2	48.7
Beni	48.5	49.7	42.0	52.8
Pando	41.0	25.5	21.3	26.1
Average	*41.7*	*46.1*	*49.3*	*36.6*

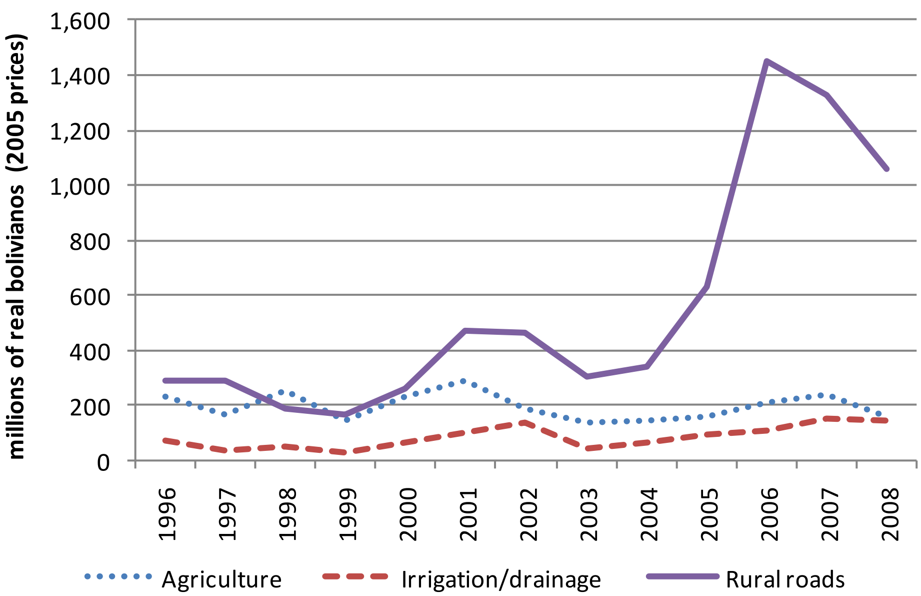
Source: Author's calculation. Agriculture spending is the sum of restricted and extended expenditures from the investment dataset put together by the World Bank, UDAPE, and FAM. Health and Education spending is from FAM.

To gain insights on the trends and shares of expenditures that go directly to the agricultural sector as opposed to infrastructure, spending components were organized into the following three groups: (i) irrigation and drainage (a component of restricted spending); (ii) rural roads (include bridges and is part of extended spending); and (iii) agriculture. Specifically, agriculture include the following restricted spending components: research, extension, development, sanitation (e.g. plant and animal health), and other agricultural expenditures (e.g. food security, support to the food industry, local economic development). It also includes natural resources and environment which are part of extended spending. These three categories of spending account for the bulk of restricted and extended spending across the nine departments. Agriculture and irrigation/drainage accounted together for over 95 percent of restricted agricultural spending from 1996 to 2008, while rural roads accounted for 67-86 percent of extended agricultural spending over the same period. All expenditures outside the restricted and extended spending categories (such as education, health, and defence) are excluded from calculations in the remainder of this section.

Figure 6 illustrates the trend and relative importance of public spending on agriculture, irrigation/drainage, and rural roads across all departments over the 1996-2008 period in nominal and real terms. Overall, spending on rural roads was not only higher than that of irrigation/drainage and agriculture but also increased sharply over time, particularly after 2005. In real terms (2005 prices), rural roads investments increased from 287.7 million bolivianos in 1996 to 1,056 million bolivianos in 2008. In relative terms, the share of rural roads in agricultural spending (i.e. the sum of restricted and extended) increased from 44.7 percent in 1996 to 61.1 percent in 2008 (table 3). In contrast, the share of agriculture declined from 35.9 percent in 1996 to 9.1 percent in 2008, while the share of irrigation/drainage remained overall constant at about 8-11 percent. Table 3 shows the relative importance of each category of spending in each of the 9 departments. As expected, a wide dispersion is observed across departments. In 2008, about 22 percent of total agricultural public expenditure (restricted and extended) was allocated to agriculture in Santa Cruz compared with less than 3 percent in La Paz and Potosi. Interestingly, the importance of agriculture in restricted and extended agricultural spending decreased sharply in Pando and Potosi after 2005. In 1996, 2000, and 2005, Pando and Potosi allocated 38 percent and more of restricted and extended agricultural spending to agriculture. In 2008, the corresponding share was only 9 percent in Pando and 1.3 percent in Potosi. In the meantime, the share of rural roads in restricted and extended agricultural spending increased drastically in these 2 states, from 48 percent to 64 percent between 1996 and 2008 in Pando, and from 21 percent to 72 percent in Potosi over the same period Spending on irrigation and drainage was most important in Cochabamba accounting for 26 percent of agricultural restricted and extended spending in 2008 and the least important in La Paz (1.2 percent).

Figure 6: ***Spending on rural roads, agriculture, and irrigation across all departments***





Source: Authors calculation based on data put together by the World Bank, UDAPE, and FAM
Note: Expenditures were deflated using the GDP deflator available from the World Bank Development Indicators database.

Table 3: ***Share of agriculture, irrigation, and roads in total of spending (restricted + extended) by department***

	1996	2000	2005	2008
		(percent)		
Agriculture				
Beni	7.2	24.6	16.9	15.0
Chuquisaca	36.1	28.3	13.6	13.6
Cochabamba	74.2	27.9	16.3	12.8
La Paz	5.9	23.8	4.4	2.5
Oruro	34.1	31.2	12.3	8.9
Pando	49.5	53.4	43.9	8.8
Potosí	38.0	40.4	51.6	1.3
Santa Cruz	35.4	15.9	32.3	22.4
Tarija	38.8	74.6	8.3	10.0
Average	*35.9*	*35.1*	*14.4*	*9.1*
Irrigation/Drainage				
Beni			0.2	
Chuquisaca	17.8	3.9	55.1	12.2
Cochabamba	13.2	9.9	10.9	26.2
La Paz	0.1	0.0	1.4	1.2
Oruro	12.1	1.1	2.9	3.2
Potosí	37.0	12.6	5.2	6.6
Santa Cruz		36.8	2.7	3.6
Tarija	11.0	4.4	4.1	12.3
Average	*11.3*	*9.8*	*8.7*	*8.3*
Rural roads				
Beni	62.4	46.5	60.9	64.9
Chuquisaca	42.2	58.0	17.4	55.0
Cochabamba	8.3	45.1	57.8	54.9
La Paz	82.0	61.1	58.4	69.1
Oruro	16.2	43.0	42.6	70.8
Pando	47.7	45.3	23.9	64.1
Potosí	21.0	22.2	17.4	71.8
Santa Cruz	63.4	37.2	55.1	45.1
Tarija	41.2	12.2	69.5	54.0
Average	*44.7*	*40.0*	*56.4*	*61.1*
Other agriculture (restricted and extended)				
Beni	30.4	28.9	22.0	20.1
Chuquisaca	3.9	9.8	13.8	19.3
Cochabamba	4.2	17.1	15.0	6.2
La Paz	12.0	15.2	35.9	27.2
Oruro	37.6	24.7	42.2	17.2
Pando	2.8	1.3	32.2	27.1
Potosí	4.0	24.8	25.9	20.3
Santa Cruz	1.2	10.1	9.8	28.9
Tarija	9.1	8.8	18.1	23.7
Average	*8.1*	*15.1*	*20.4*	*21.5*

Source: Authors calculation based on data put together by the World Bank, UDAPE, and FAM
Note: Other agriculture includes all type of expenditures that were classified as restricted or extended but were not included in our three spending groups, i.e. agriculture, irrigation/drainage, and rural roads.
No irrigation/drainage spending reported for the following departments and years: Beni in 1996, 2000, and 2008; La Paz in 2000; Santa Cruz in 1996.

Table 4 shows the departmental share for each category of expenditures, providing some insights on the spatial concentration of spending. In all years, over 60 percent of all public spending on agriculture was accounted for by the top three departments. Public spending on irrigation/drainage and rural roads were also spatially concentrated. In 2008, Tarija alone accounted for 40 percent of total spending on irrigation/drainage while two departments (Tarija and Potosi) accounted for nearly half of rural roads spending in Bolivia.

Table 4: ***Departmental share of spending on agriculture, irrigation/drainage, and rural roads***

	1996	2000	2005	2008
		(percent)		
Agriculture				
Beni	0.7	2.7	4.0	9.2
Chuquisaca	10.7	7.5	7.7	6.3
Cochabamba	27.1	23.9	20.2	12.8
La Paz	2.6	8.0	4.3	4.0
Oruro	5.2	4.0	3.3	9.7
Pando	2.3	4.9	5.1	1.3
Potosí	16.0	11.5	10.9	2.6
Santa Cruz	21.5	5.5	22.9	24.0
Tarija	14.0	31.9	21.7	30.1
Total	*100*	*100*	*100*	*100*
Irrigation/Drainage				
Beni			0.1	
Chuquisaca	16.7	3.7	51.6	6.1
Cochabamba	15.3	30.4	22.4	28.6
La Paz	0.1		2.2	2.1
Oruro	5.9	0.5	1.3	3.8
Potosí	49.4	13.0	1.8	14.8
Santa Cruz		45.7	3.2	4.2
Tarija	12.6	6.7	17.5	40.5
Total	*100*	*100*	*100*	*100*
Rural roads				
Beni	5.1	4.4	3.7	5.9
Chuquisaca	10.0	13.5	2.5	3.8
Cochabamba	2.4	33.9	18.4	8.2
La Paz	28.7	18.1	14.7	16.0
Oruro	2.0	4.9	2.9	11.5
Pando	1.7	3.6	0.7	1.4
Potosí	7.1	5.6	0.9	22.0
Santa Cruz	31.0	11.3	9.9	7.2
Tarija	11.9	4.6	46.2	24.2
Total	*100*	*100*	*100*	*100*
Other agriculture (restricted and extended)				
Beni	13.7	7.3	3.7	5.2
Chuquisaca	5.1	6.0	5.5	3.7
Cochabamba	6.8	33.9	13.2	2.6
La Paz	23.2	11.9	25.0	18.0
Oruro	25.5	7.4	7.9	7.9
Pando	0.6	0.3	2.6	1.6
Potosí	7.4	16.5	3.8	17.7
Santa Cruz	3.2	8.1	4.9	13.0
Tarija	14.5	8.8	33.3	30.2
Total	*100*	*100*	*100*	*100*

Source: Authors calculation based on data put together by the World Bank, UDAPE, and FAM
Note: see table 3.

In most departments, agriculture GDP is positively correlated with restricted agricultural spending but the correlation coefficient was significant only in Chuquisaca, La Paz, Oruro, and Potosi (table 5). Out of these four departments only Chuquisaca observed a share of agriculture in total GDP that was greater than 10 percent (see figure 4). On the other hand, agricultural GDP is negatively correlated with restricted and extended agricultural spending but the coefficients were not significant except for Oruro and Cochabamba.

Table 5: ***Correlation of agricultural GDP with restricted agricultural expenditure and combined expenditures (restricted and extended)***

Department	Restricted Spending	Restricted and Extended Spending
Beni	0.1560	-0.5869
	(0.1157)	(0.1261)
Chuquisaca	0.1515	-0.5654
	(0.0385*)	(0.1440)
Cochabamba	0.0851	-0.8550
	(0.1408)	(0.0068*)
La Paz	0.3680	-0.6329
	(0.0000*)	(0.0921)
Oruro	0.3194	-0.8658
	(0.0000*)	(0.0054*)
Pando	0.1999	0.5205
	(0.0814)	(0.1860)
Potosí	0.2269	0.6947
	(0.0011*)	(0.0558)
Santa Cruz	0.0074	-0.3656
	(0.8993)	(0.3732)
Tarija	-0.0349	-0.3325
	(0.7584)	(0.4210)

Source: Authors calculation based on data put together by the World Bank, UDAPE, and FAM
Note: In parenthesis is the level of significance. An asterisk indicates that the correlation coefficient is significant at 95 percent confidence interval.

Using the GDP at the municipal level as an indicator of wealth, we grouped the municipalities by decile for each year between 2000 and 2007. In table 6, we compare the share of agriculture, irrigation/drainage, and rural roads spending for the 10 percent poorest and 10 percent richest municipalities from 2000 to 2007. Interestingly, investment on irrigation/drainage was overall more important in the poorest municipalities than in the richest. In 2007, irrigation and drainage accounted for 20.2 percent of public spending in the 10 percent poorest municipalities compared with only 7.3 percent in the 10 percent richest. Investments on rural were also more important in the 10 percent poorest municipalities than in the 10 percent richest. Overall in both groups, the share of investment in rural roads declined over time while the share irrigation/drainage and agriculture follow an erratic pattern.

Table 6: ***Municipal share of spending on agriculture, irrigation/drainage, and rural roads***

	2000	2001	2002	2003	2004	2005	2006	2007
				(percent)				
10 % poorest								
Agriculture	17.4	23.2	45.1	13.4	16.9	14.4	22.2	15.4
Irrigation/drainage	1.2	9.4	18.1	24.1	18.3	16.7	8.0	20.2
Rural roads	60.5	54.9	13.1	30.1	39.3	35.1	30.7	34.2
Other agriculture (restricted and extended)	20.8	12.6	23.7	32.3	25.6	33.8	39.2	30.2
Total	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*
10 % richest								
Agriculture	5.9	15.6	31.1	64.0	17.9	18.2	16.8	28.5
Irrigation/drainage	2.8	8.9	2.8	1.8	8.9	12.7	9.3	7.3
Rural roads	68.8	45.8	18.1	13.8	21.1	42.1	28.4	25.2
Other agriculture (restricted and extended)	22.5	29.8	48.1	20.5	52.0	27.0	45.5	39.1
Total	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

Source: Authors calculation based on data put together by the World Bank, UDAPE, and FAM
Note: We ran a means test for the entire agricultural sector (i.e. restricted agricultural spending) comparing the bottom and top decile. All years between 2000 and 2007 showed statistically significant differences between the top and bottom deciles. Other agriculture includes all type of expenditures that were classified as restricted or extended but were not included in our three spending groups, i.e. agriculture, irrigation/drainage, and rural roads.

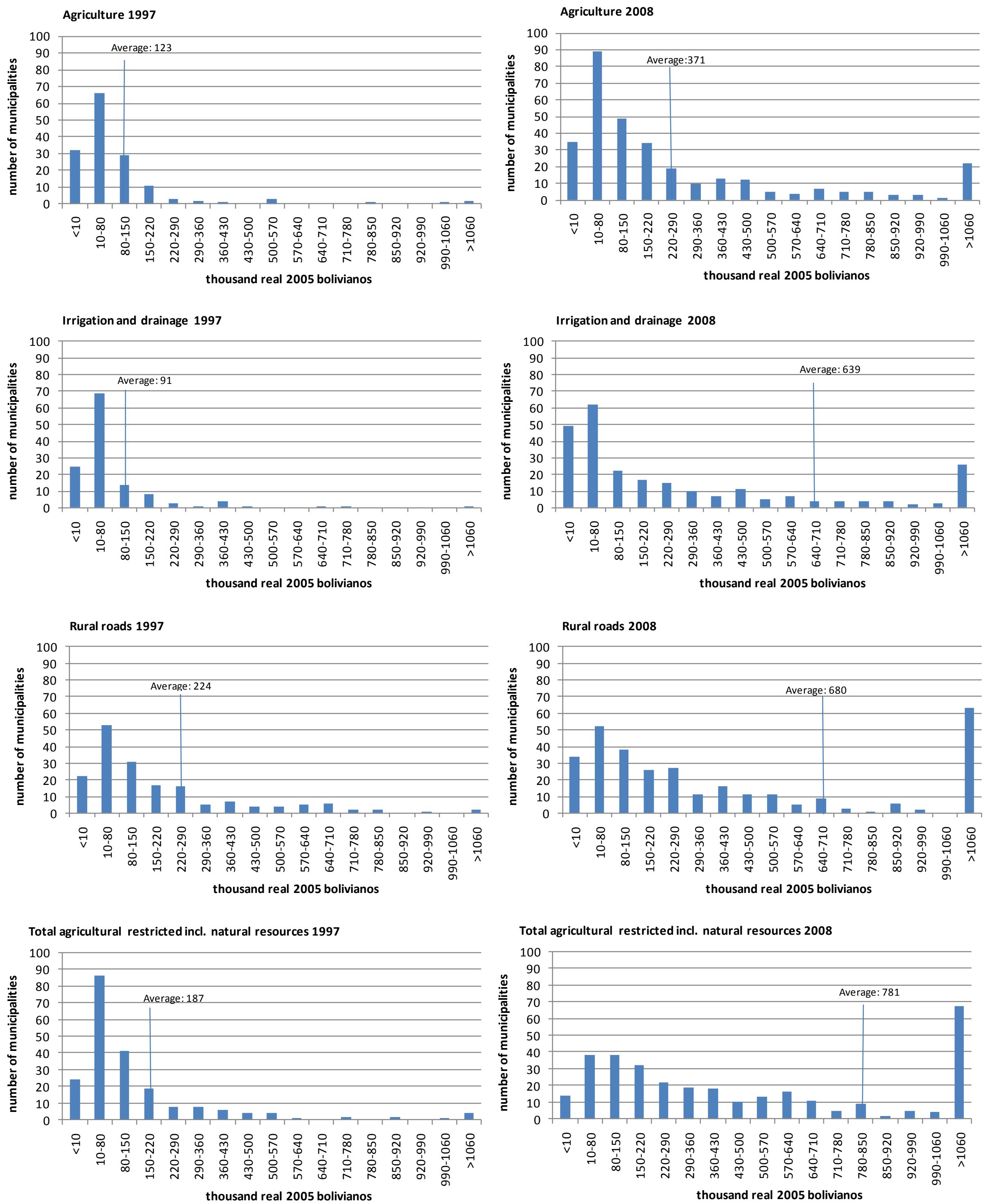
Figure 7 shows the distribution of spending at the municipal level for the three categories of spending discussed above, namely agriculture, irrigation/drainage, and rural roads in 1997 and 2008 in. In addition the distribution of total restricted agricultural spending augmented with spending on natural resources was added.

Overall for all types of spending, the distribution is clearly skewed to the left in 1997 and is shifting rightward. Looking first at agricultural spending, almost all municipalities (138 out of 151 or 91 percent) spent less than 220,000 real bolivianos in 1997 while only 4 (2.6 percent) spent more than 570,000 real bolivianos. However, in 2008, only 207 out of316 municipalities (65.5 percent) spent less than 220,000 real bolivianos while 50 municipalities (15.8 percent) invested more than 570,000 real bolivianos. The average spending on agriculture across all municipalities increased from 123,000 real bolivianos in 1997 to 371,000 real bolivianos in 2008. This clearly shows a rightward shift in distribution over time for agriculture.

For irrigation and drainage, the shift is even more pronounced as shown in figure 7. Most municipalities were clustered to the left in 1997, with 108 municipalities out of 128 (84 percent) spending less than 150,000 real bolivianos on irrigation and drainage. Only 4 municipalities (or 3 percent) spent over 430,000 real bolivianos. By 2008, the variation among municipalities became more pronounced. The share of municipalities that spent less than 150,000 real bolivianos on irrigation and drainage declined to 53 percent in 2008 while over 70 municipalities (or 28 percent) spent more than 430,000 bolivianos. As a result the average spending on irrigation and drainage across all municipalities increased by more than 7-fold from 91,000 in 1997 to 639,000 in 2008.

Similar patterns are observed for rural roads and for total agricultural restricted spending. In 1997, there were only 7 municipalities out of 177 (7 percent) that spent over 710,000 real bolivianos on rural roads compared with 75 municipalities out of 315 (24 percent) in 2008. Likewise, the share of municipalities that spent more than 710,000 real bolivianos across all categories of restricted agricultural spending increased from 4 percent in 1997 to 28 percent in 2008. While the shift in agricultural, irrigation/drainage, rural roads, and agricultural restricted spending has clearly moved to the right and municipalities have invested more in agriculture, the spread between larger investors and smaller investors remains significant and provides ample room for investigation.

Figure 7: ***Distribution of municipal restricted and extended agricultural spending***



Source: Authors calculation based on data put together by BM, UDAPE, and FAM

Note: The average refers to the average spending across all municipalities.

Issues of allocation of investment bring to surface two very important aspects of public investments: efficiency and equity. This, of course, only takes place because resources and both finite and scarce, which in turn means that the process of allocation and spending public money should yield the best possible economic and social outcomes. In Bolivia, questions of scarcity and fairness are considerable and as such a careful look at the economic and social implications of investments is warranted.

3. Efficiency analysis

The concept of efficiency employed in this review has to do with two key objectives:

1. assessing whether investments in the restricted agricultural and extended agricultural sectors contributed to the growth of agricultural GDP
2. Investigating whether investments were applied and allocated to departments in an amount and intensity that optimally maximizes the use of scarce public funding. In simpler terms, given a fixed level of investments and a given level of technical expertise, what is the best way to invest in order to achieve the highest possible agricultural GDP.

Two very traditional methods are often used to assess efficiency: Data Envelopment Analysis (DEA) and econometric analysis (particularly stochastic frontier analysis). These two methods are guided by the same principle (i.e. maximizing/minimizing outputs/inputs given the fixed quantities of inputs/outputs) but are based on very different premises. DEA assumes that best scenario outcome (i.e. the production frontier) given an input and an output is determined by the differences in input mixes and technical change. In other words, production frontier is not susceptible to occasional shocks in production, and for this reason it is called a deterministic frontier. The second approach takes a different approach. Being a parametric method, it decomposes the error term into inefficiency and random shocks, and the frontier is constructed based on the conditions present during the period, which can be better or worse than the deterministic frontier, depending on the type of random shocks.

Three important measures emerge from these methods: (i) technical inefficiency which provides an indication of how far individuals or entities (for the current purposes, these would be municipalities and departments) are from the frontier (i.e. how municipalities fare relative to the most efficient ones); (ii) allocative efficiency which provides an indication of how far municipalities are from the optimal price;

and (iii) economic efficiency which is the product of the two previous measures. Allocative efficiency and economic efficiency require the estimation of a cost function[1], as opposed to a frontier estimation, for which price data would be required. For a detailed description of these methods, please see Khumbakar and Lovell (2000), and Coelli, Prasada Rao and Battese (1998).

This paper is particularly concerned with technical efficiency. The choice to use a stochastic model as opposed to a deterministic frontier approach reflects the belief that within a five year period it is very likely that unexpected events changed the way under which investments were made. In addition, the model chosen allows for a greater understanding of the effects of different (restricted agricultural v.s. extended agricultural) investments on agricultural gdp, and particularly accounting for the lagged effects of investments. Much like the work on the effects of research and development, investments in general require some time to generate the desired effects.

Econometric Model

This paper uses a variant of the stochastic frontier model and is particularly concerned with the estimation of technical efficiencies. In particular, the analysis takes advantage of the panel nature of the dataset to incorporate dynamic effects of agricultural GDP (i.e. lagged values of GDP in the right hand side) in the estimation of the technical efficiencies. The basic unit of analysis used in the econometric specification is the municipality. Once efficiencies are estimated for each municipality, average efficiencies are calculated for the nine departments.

Dynamic models allow for the control of unobserved heterogeneity at the municipality level in a dynamic set up, which is very appropriate given the lag in investment effects. It also permits the use of time dummies variable to isolate year effects as well as to enable the calculation of technical change, without biasing the estimates (as it would occur in a traditional fixed effects estimation). The work of

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[1] Two distinct approaches can be used to estimate efficiencies. The primal approach looks at production, in which an output variable is compared to inputs in the production of that output. This is the approach followed here, agricultural gdp as a function of investments in agriculture. A second approach is the cost approach in which the total cost of production is compared to input prices and total output. Both approaches provide equally valid results. The cost approach is also known as the dual approach.

Ayed-Mouelhi and Goaied (2003) was particularly helpful in providing insights to this methodology, and served as a basis for the model construction.

The basic setup of the econometric analysis consists of regressing agricultural GDP on lagged values of agricultural GDP and two "production" inputs: stock[2] of restricted investments in agriculture and stock of extended investments in agriculture. A typical dynamic model takes the following form, as outlined in Arellano and Bond (1991), and Arellano and Bover (19959:

$$Y_{it} = \alpha + \beta X_{it} + \delta Z_{it} + \sum \gamma Dt + u_i + \varepsilon \qquad (1)$$

Where i corresponds to the ith municipality, t refers to year, alpha is a constant, β is a vector of coefficients to be estimated, X is a matrix of strictly exogenous covariates, δ is a vector of coefficients to be estimated, Z is a matrix of pre-determined or endogenous covariates, Dt are time dummies, γ are parameters to be estimated, u_i are the panel level effects, and epsilon the random error.

It is unlikely that investments in general, and in agriculture in particular, are completely exogenous to agricultural GDP, meaning that they are possibly correlated to the error term. Thus, in the specification above the investments stocks were considered to be pre-determined, i.e correlated with previous error terms.

Structurally, the estimations presented in this paper follow the so-called system GMM (generalized methods of moments), as outlined by Arellano and Bover (1995) and Blundell and Bond (1998) . The system GMM is an improvement from the original difference GMM[3]. In the latter, first-differenced pre-determined variables are instrumented with all the available lags in levels. When first difference variables are too close to a random walk, lagged levels are poor instruments to the first differences. To circumvent this problem, the system GMM adds a level equation to the system, which is instrumented

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[2] Stock variables were created – following the perpetual inventory method-- by adding current levels of investments plus investments of the previous years depreciated by 15 percent. The primary reason for using stocks was to account for the cumulative effects of investments, i.e. investments in year t compound the effects of investments in year t-1, which in turn compound the effects of investment in year t-2 and so on.

[3] In panel datasets with large (cross-sections) N and small (number of time periods) T, the system GMM provides better estimates of efficiencies (relative to a difference GMM), as it prevents efficiencies from being contaminated by municipality specific effects. Contamination occurs particularly because panel level effects are removed by the first differencing. The additional moment conditions added by the system GMM can offer some efficiency gains (Blundell and Bond 1998).

with appropriate lags of its own first differences. System GMM also allows for the use of orthogonal deviations as opposed to first-differences. Like first-differences, orthogonal deviations also remove individual fixed effects, but does so by subtracting the mean of all available future observations and multiplying an appropriate scale factor that yields independent and identically distributed ε. In panel datasets with gaps, using orthogonal deviations preserve the original sample size since it does not lose information on more than one period for a given missing error term. Orthogonal deviations were used in this paper.

A number of different lag structures were attempted both for the dependent variable and the two investment variables. Varying lag structures is helpful in understanding the dynamic relationship of current realizations of investments as opposed to previous ones. It also provides a range on which to place results, and to assess the robustness of estimates. The results presented in table 7 were chosen as these were the most conservative estimates in terms of the significance of the covariates. Current observations of agricultural GDP growth or changes within a given year are unlikely to have an effect on the levels of agricultural GDP for that particular year, as it takes time for the economy to adjust to changes. By the same token, previous levels of agricultural GDP and of economic activities are likely to show effects in later years and in some cases persist until new economic realities become effective and are perceived by players in the economy. Hence, the choice of a lagged agricultural GDP variable in the right hand side. For investment variables, it is appropriate to include also a present realization of investments, in addition to the lagged one, particularly because a number of different investment categories are present in the investment variables, and it is likely that different categories will have effects sooner than others.

Both the transcendental translog functional form and the Cobb Douglas were estimated. However, likelihood ratio tests indicated that the squared terms and the cross-products were not jointly significant suggesting that Cobb Douglas is an adequate functional form. Results only include the latter functional form.

Though not reported in the results discussed below, dummy variables for each year and each department were incorporated in the model. The dummies for departments were used as instruments for the level equations. Department dummies account for department specific differences such as infrastructure, weather and other relevant variables. It would have been better to include specific variables in the production function to account for these exogenous factors, but such variables did not exist at the municipal level. An attempt was made to include dummy variables for specific years and departments for which relevant changes in infrastructure or weather were noted (based on data at the department level); however, these new dummy variables were all dropped due to collinearity, since both year and department dummies were already included.

Data and variables

The Ministry of Finances in Bolivia, in conjunction with the World Bank, put together a comprehensive dataset on public investments in Bolivia. The data contain information on three levels of public spending (federal, departmental and municipal) and ranges from 1996 to 2008. Expenditures are categorized by sector (agriculture, livestock, fishery, other (non-agricultural) expenditures etc.), government activity, project, and a number of other sub-groups. The descriptive analysis in this paper draws from information on the three levels of government, but the econometric and efficiency analysis uses municipal level data.

The data provided by the Bolivian government grouped the data into restricted agricultural spending, extended agricultural spending and a third category encompassing the remainder of expenditures that do not relate to agriculture. Restricted agricultural spending includes research, extension, irrigation, machinery, inputs and infrastructure. Extended spending includes roads, electricity, irrigation management etc, and the third non-agricultural expenditure group includes expenditures such as health and education. Generally speaking, the first two types of spending are related to agriculture (the first one more so than the second), while the third type is completely unrelated to agriculture. As expected, non-agricultural spending accounted for the lion share of total expenses, as spending in other activities greatly surpasses spend in agriculture-related activities. Within agricultural spending, restricted spending can be seen as direct investments in agriculture, while extended expenditures can be seen as indirect investments in agriculture. Because of the somewhat unknown a priori effects of other spending on agriculture, the analysis conducted here separated out the categories of spending into strictly agricultural and extended investments, hence spending in any services that are not directly or indirectly related to agriculture is not included. Both restricted agricultural and extended spending variables were compiled using the actual spent amounts, provided under the title of "realized budgets". Stock variables were created using a 15 percent depreciation rate (the usual rate found in many studies).

One obstacle encountered in the analysis was the absence of agricultural GDP data at the municipal level, which was required to serve as a left hand side variable in the econometric estimation. Given that the allocation of public funding is directly correlated with population, the shares of population at each municipality to total departmental population were used to apportion total departmental agricultural GDP to municipalities. In fact, at the departmental level – for which agricultural gdp data exist – all departments showed very high (0.8 and above) and significant correlations between population and ag gdp. In addition, department level dummies were added in the regressions to account for departmental fixed effects.

Econometric estimations performed on municipality-level data were of a panel-nature. Table 7 provide basic descriptive information about the panel setup, such as averages between and within panels, number of time periods, and number of cross-sections. Spending information in the table is in 2005 real bolivianos. For the econometric analysis, all relevant variables were transformed by natural log.

Table 7: ***Panel descriptives and means of input stock variables***

Variable		Mean	Std. Dev.	Observations
Restricted Agricultural investments	Overall	470,319	972,761	N = 1,536
	Between		522,466	n = 243
	Within		801,462	T-bar = 6.32
Extended Agricultural investments	Overall	1,299,170	4,126,308	N = 1,402
	Between		2,659,593	n = 257
	Within		2,671,558	T-bar = 5.46

Note: N=Number of non-missing observations; n=Number of cross sections; T-bar=average number of time period across cross sections; Means are in 2005 real bolivianos.

Econometric results

Results of the system GMM regression are presented in table 8 below.

Table 8: ***Econometric results of system GMM estimator***

Variable	Coefficients
Log of agricultural GDP	
L1.	1.0310***
Log of restricted spending in agriculture.	
--.	-0.0003
L1.	0.0028
Log of extended spending in agriculture	
--.	-0.0194***
L1.	0.0008
_cons	-0.3247***
N	788
First-order auto-correlation	0.01
Second-order auto-correlation	0.0856
Hansen test for exogeneity of instruments	0.1254

Note: Instruments for the difference equation were lags in the order of two in onward for agricultural GDP, restricted agricultural spending and extended agricultural spending. The higher lag order was included as the independent variables are considered to be pre-determined. Instruments for the level equation included differenced agricultural GDP, differenced restricted and extended spending, along with department and year dummies.

The GMM system results indicate the positive effect of the first lag realization of previous agricultural GDP on current GDP. Restricted agricultural investments were not significant irrespective of the lag structure. Contemporaneous levels of extended agricultural investments were significant and negative but not its lagged version.

These results point to a few relevant points: First, the lack of significance of agricultural investments in agricultural GDP, irrespective of the lag structure, is troubling, as the growth of agricultural GDP certainly requires investments in agriculture. This can be partially explained by the fact that the range of potential agricultural investments may present a more complicated lag structure particularly since research and development and extension are part of agricultural investments and these typically require a much longer lag to take effect. The negative effect of extended agricultural investments on agricultural GDP may imply that some investments can have negative effects in the short term as deficits may occur or other negative externalities. Alternatively, it may also suggest a poor investment strategy that is not appropriately targeting the correct sectors of the economy.

As indicated previously, a number of lag structures were tested and the results presented here are robust to most specifications, further supporting the results discussed in this section.

Dynamic models (i.e. models in which lagged dependent variables are also used as right hand side variables) often present serious econometric issues regarding the suitability of instruments. The two main diagnostic tests often reported for dynamic panels are an autocorrelation test for first and second order, and a test of exogeneity of instruments. With non-robust variance estimators, the most used test is the Sargan test, which tests the null hypothesis that instruments are exogenous (i.e. not correlated with the error term). An appropriate model should fail to reject the null. However, when robust variance estimators are used, the Sargan test cannot be applied and, as a result, the Hansen test can be used to test for exogeneity of instruments.

In table 8, the results of both tests are presented and the specification used in this paper passes both tests. The adequacy of instruments has been the object of David Roodman's work, which has been instrumental in the testing and choice of instruments for this paper. In fact, the Stata estimator used in this paper was written by Roodman.

Technical efficiencies

From the estimation the GMM system above we can obtain estimates of the technical efficiencies. These are defined as the exponentiated differences between the maximum residual value and the average residual across all municipalities (see equations 2 and 3). The normalization that takes place in the calculation of efficiencies makes all efficiencies relative to the most efficient municipality.

$$\alpha_i = \max(uhat_i) - uhat_i \quad (2)$$

Where uhat is the average residual from the ith municipality. Technical efficiency (eff) is then given by:

$$eff_i = \exp{-\alpha_i} \quad (3)$$

Given the large of municipalities it is not practical or feasible to analyze patterns of efficiency or their distribution at the municipality level. Hence, a number of different distributional points were calculated at the departmental level and are discussed below. The specification above suggests that efficiencies are invariant in time, hence the efficiency of each municipality is the same across time.

Table 9 presents and ranks departments according to the most efficient municipality in each department for the 2000-2007 period. Presenting maximum efficiencies by departments allows for a clear visualization of which department contains the frontier municipality as well as how other municipalities in other departments compare to the frontier.

Table 9: ***Highest level of efficiency by department and average restricted and extended spending for 2000-2007***

Department	Efficiency	Restricted	Extended
Oruro	1	272,928	343,457
Chuquisaca	0.95	553,855	1,147,007
La Paz	0.95	256,000	1,041,940
Pando	0.95	280,055	458,317
Potosí	0.95	487,345	722,341
Cochabamba	0.94	426,719	1,423,347
Santa Cruz	0.92	281,110	768,151
Tarija	0.92	1,573,229	2,146,826
Beni	0.88	220,878	806,615

Note: expenditures in 2005 real bolivianos.

In figure 8, a box plot of efficiencies grouped at the departmental level displays a number of different points in the distribution. The body of each bar (shaded in blue) is bounded by the 25th and 75th percentile, and the line within the bar represents the median point (50th percentile). Outside the body, the two vertical lines point to the minimum and maximum efficiency points within each department. Finally the dots represent outliers.

A number of insights can be drawn from table 9 and figure 8. First, it becomes immediately clear that Oruro is home to the municipality that is at the frontier, as can be inferred from the dot located on the top line (at 1). This is the municipality of Sabaya in Oruro. Pando and La Chuquisaca follow closely in second and third places. Least efficient departments were Santa Cruz, Tarija and Beni. Figure 8 provides other insights into the distribution of efficiencies within each department. For instance, efficiencies in Oruro, Cochabamba and Santa Cruz are considerably more spread out than in other departments, which indicate more variability in the performance of municipalities, i.e. considerable differences exist in the way investments are spent in these three departments. Tarija, on the other hand, has a very concentrated distribution of efficiencies, as does Beni, suggesting the municipalities lie closer together in terms of performance.

Figure 8a show the distribution of technical efficiencies before and after the new administration took office in 2006. While it is important to remember that efficiencies for a given municipality are fixed over time, it is possible to gain insight into the changes in the distribution of efficiencies by department, accounting for the likely different number of municipalities and the availability of data. Indeed, there are some noticeable changes that took place between the two periods. For instance, the spread of efficiencies in departments like Santa Cruz, Oruro and Potosi has changed, with Santa Cruz becoming more concentrated, and the other two departments becoming less concentrated after the new administration.

Figure 8*: Distribution of technical efficiencies*[4] *for 2000-2007, by department.*

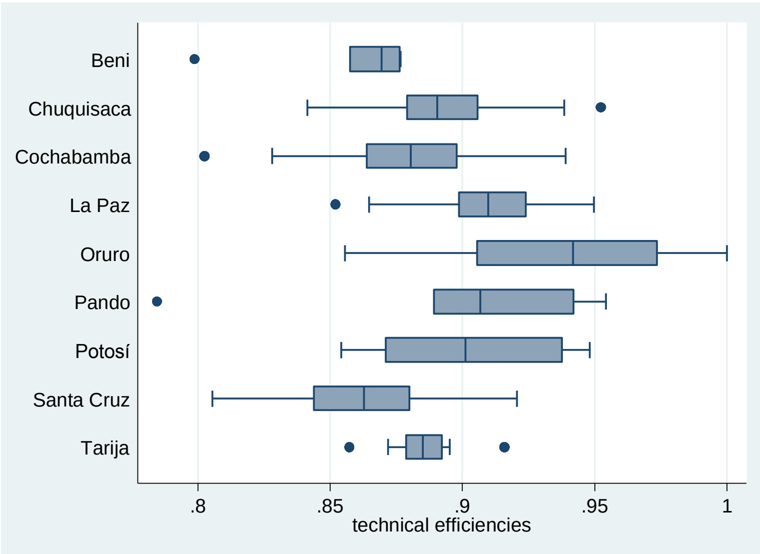
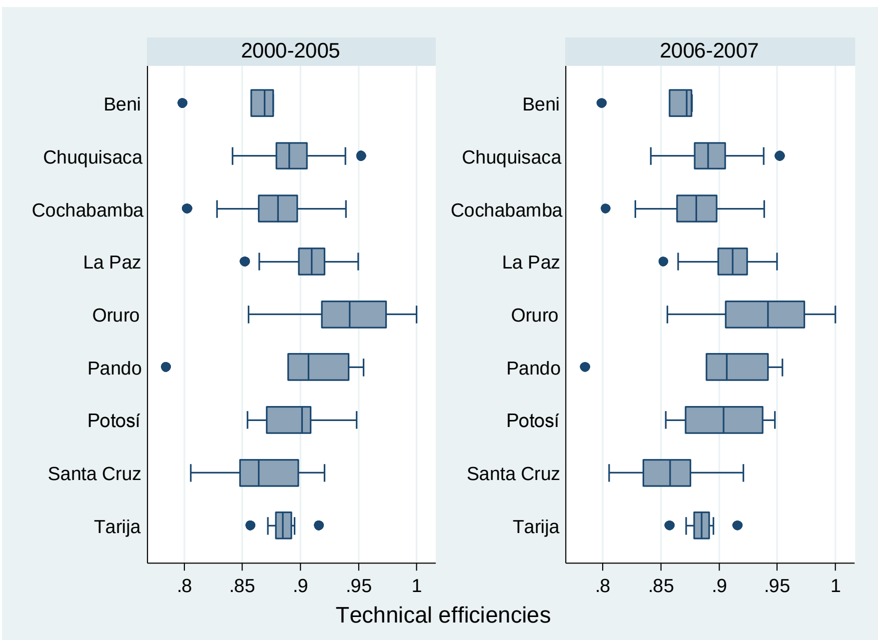


Figure 8a: Distribution of efficiencies before and after the new administration.



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[4] The dots observed in figures 8a and 8b represent outliers. These outliers are the municipalities which have either approached the frontier and therefore are distant from the other points in the distribution, or have scored very low efficiencies and also remained outside the distribution.

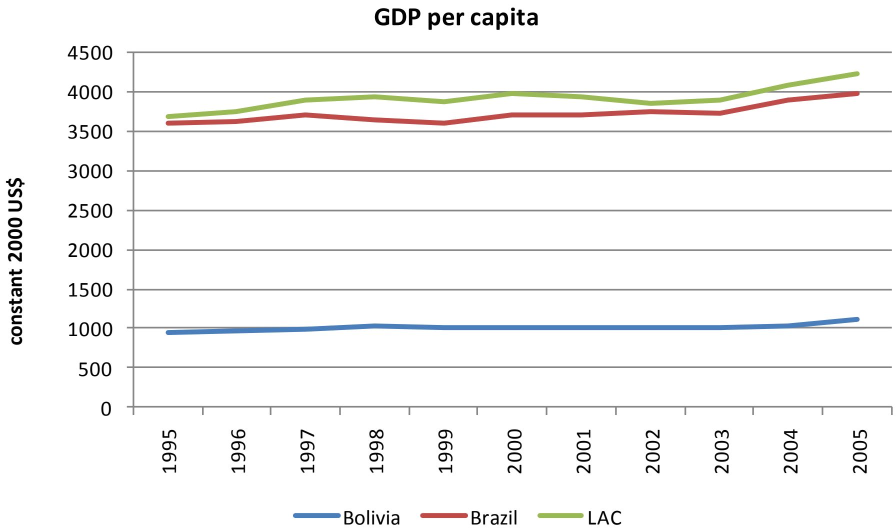
The ranking of departments provides a useful reference regarding the performance of different departments relative to the use of investments. A more important point, however, relates to the meaning associated with a department being more efficient than another department. The notion of efficiency – as employed here – deals with the maximization of ag gdp given fixed levels of inputs. More specifically, the efficiencies plotted in figure 8 show how a given department utilizes the two inputs (restricted agricultural investments and extended agricultural investments) relative to the best and optimal use of inputs and in a way to maximize agricultural gdp. Being more efficient suggests that a given department employs resources in ways that lead to a more optimal use of resources. Number 1 indicates full efficiency, which suggests that there is room for improvement for a number of municipalities and departments in Bolivia in terms of efficiently using of public investments in agriculture and minimizing the existent inefficiencies. The measure of efficiency applied in this paper is relative by nature, and should be interpreted as such. In other words, efficiencies of municipalities are ranked relative to the most efficient municipality, as can be seen from equation 2.

4. Equity analysis

The efficiency analysis further elucidated the issue of significant disparities across departments in Bolivia. This section draws from some of the results of the efficiency analysis, and data from household surveys as well as secondary sources to provide a snapshot of equity issues in Bolivia.

It is often useful and helpful to start by looking at how the country as a whole has performed in relative terms on the issue of poverty and inequality. Research has established pretty firmly that one of the key solutions to poverty is growth, both in overall GDP and in agricultural GDP. In figure 9, a plot of Bolivia's recent per capita GDP performance is compared to that of Brazil (the largest country in Latin America) and to the entire set of Latin American countries (LAC). Scaling issues aside, Bolivia's GDP has remained almost flat for the 1995-2005 period. And it is also positioned at a much lower level of GDP than LAC and Brazil. Even if we assume that Brazil is driving half of LAC's performance, Bolivia's per capita GDP would still be nearly half of that of LAC.

Figure 10: ***Per capita GDP in Bolivia, Brazil, and***



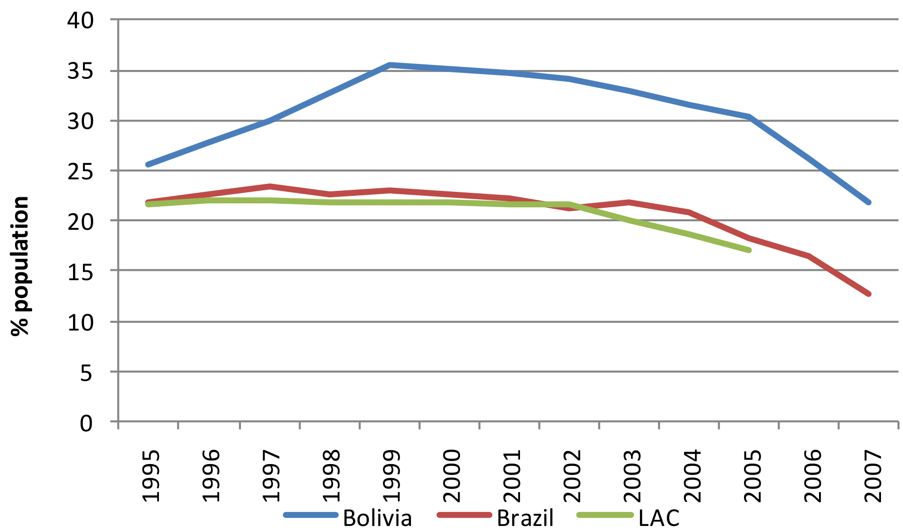
Sluggish growth performance has translated into increased poverty levels during much of the 1990s, followed by progressive declines starting in 1999 (figure 10). Two measures are often used to assess both the spread of poverty and the extent to which it affects people:

a) Poverty headcount (incidence): this is a simple indication of the number of people (or share in the population) that fall below a given poverty line. For the purposes of this work, we have employed a 2 dollar a day poverty line. This measure provides an indication as to the degree that poverty is an issue in a country, and is often the first measure to be described in an analysis of poverty.
b) Poverty gap (depth of poverty): this measure reflects the average distance between households and the poverty line. In simpler terms, it compares the per-capita income of a household/individual to the poverty line, and calculates the difference between them. This measure includes only households that fall below the poverty line.

Figure 10 illustrates the spread of poverty in Bolivia, Brazil and LAC and shows that the share of people below the $2 dollar a day mark is substantial surpassing 30 percent in some years for Bolivia[5].

[5] Estimates of moderate poverty put together by the Bolivian National Statistics Bureau place the poverty figure at over 60 percent of the population over the same period. These estimates were based on household surveys.

Figure 11: ***Poverty headcount ratio at PPP$ 2 a day***



Within Bolivia, estimates of poverty vary considerably between urban and rural areas and across departments. Using the 2005 household survey, representative at the national level, figures 11 and 12 provide estimates of the average poverty incidence and poverty gap by department in Bolivia[6]. From the incidence figure, the dispersion in the levels of poverty across Bolivia is dramatic. While Pando, Santa Cruz and Beni have less than 20 percent of people considered poor, La Paz, Cochabamba and Potosi approach nearly 50 percent. Similarly, in figure 12 the average poverty gap (i.e. the average distance between poor households and the poverty line) also shows dramatic differences in the country. At a more aggregate level, the distinction between urban and rural also provides a stark contrast on both incidence and the poverty gap (see figure 13).

[6] Estimates based on data of the head of the household only. Poverty lines vary slightly by department oscillating between 1.2 and 1.53 dollars a day (in 2005 USD – 1 USD=7.95 bolivianos on December 31st 2005).

Figure 11: ***Poverty incidence by department in Bolivia***

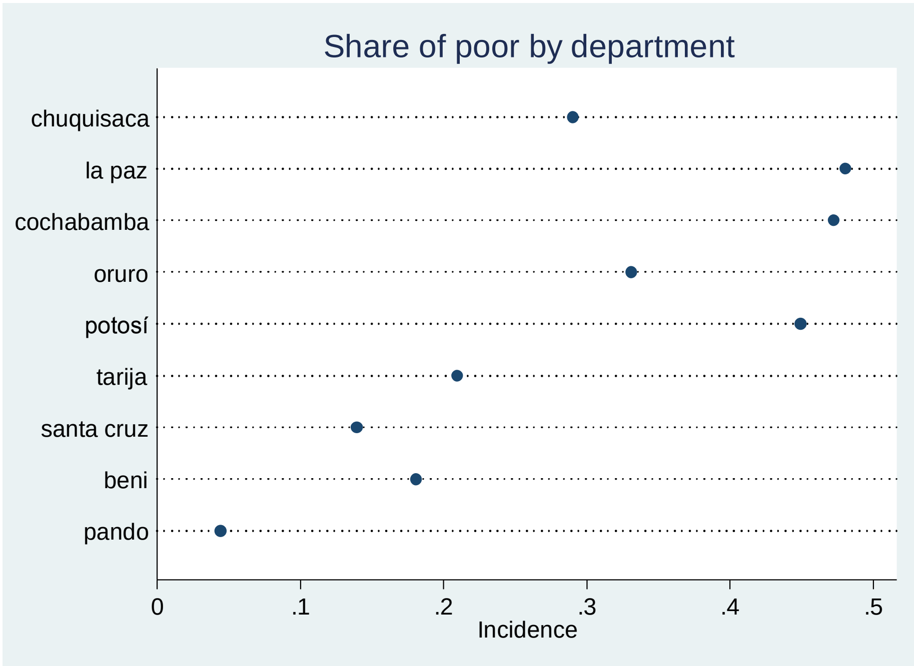


Figure 12: ***Poverty gap by department in Bolivia***

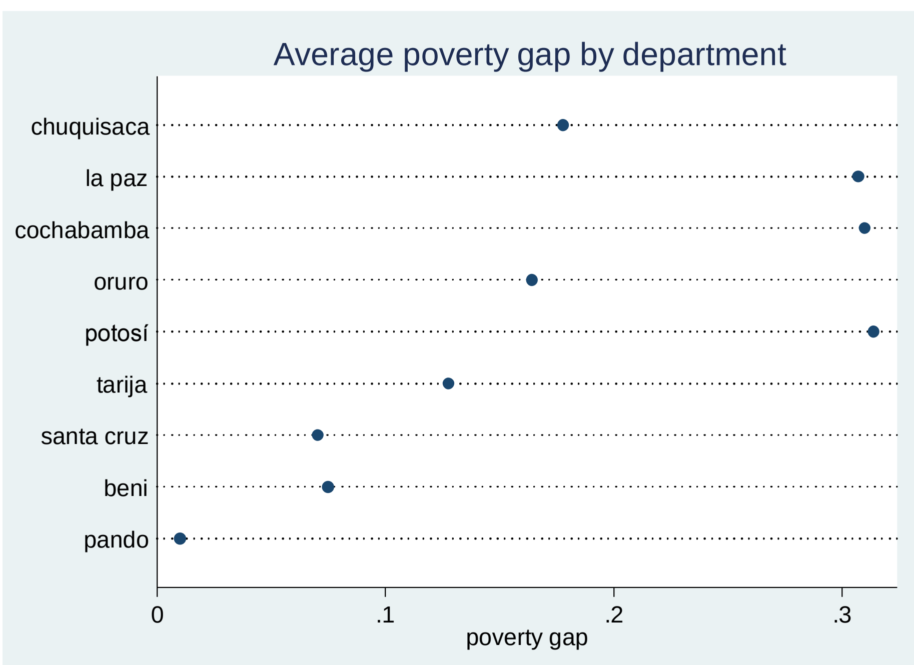
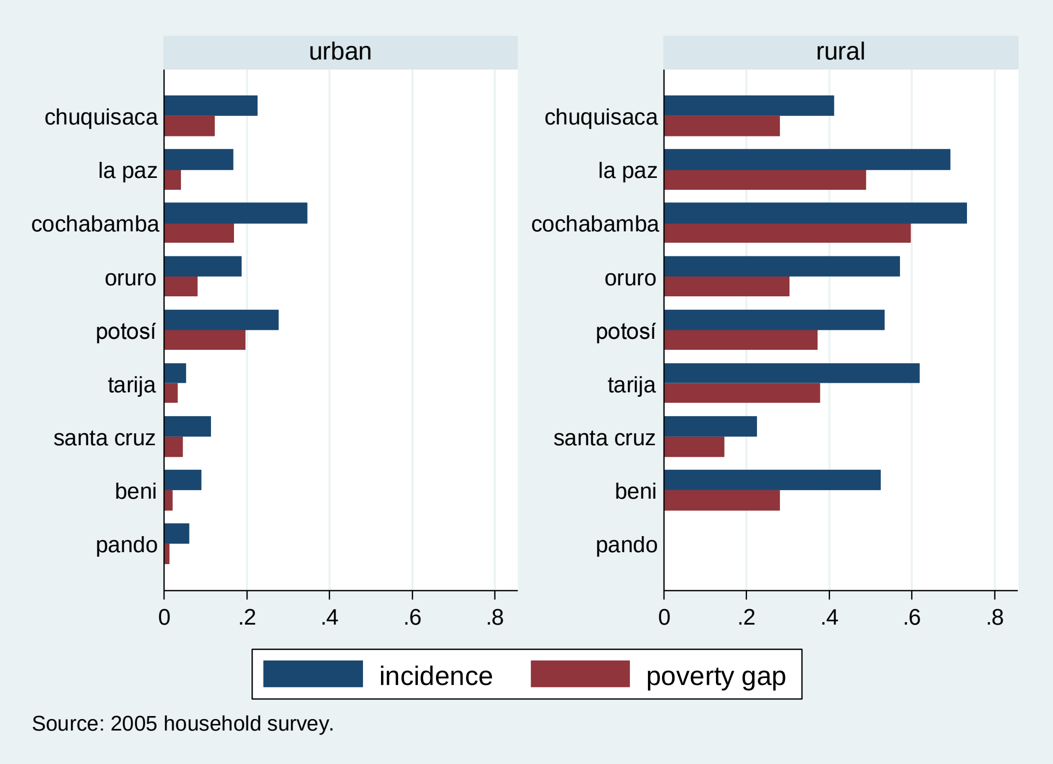


Figure 13: ***Rural and urban poverty incidence and poverty gap in***

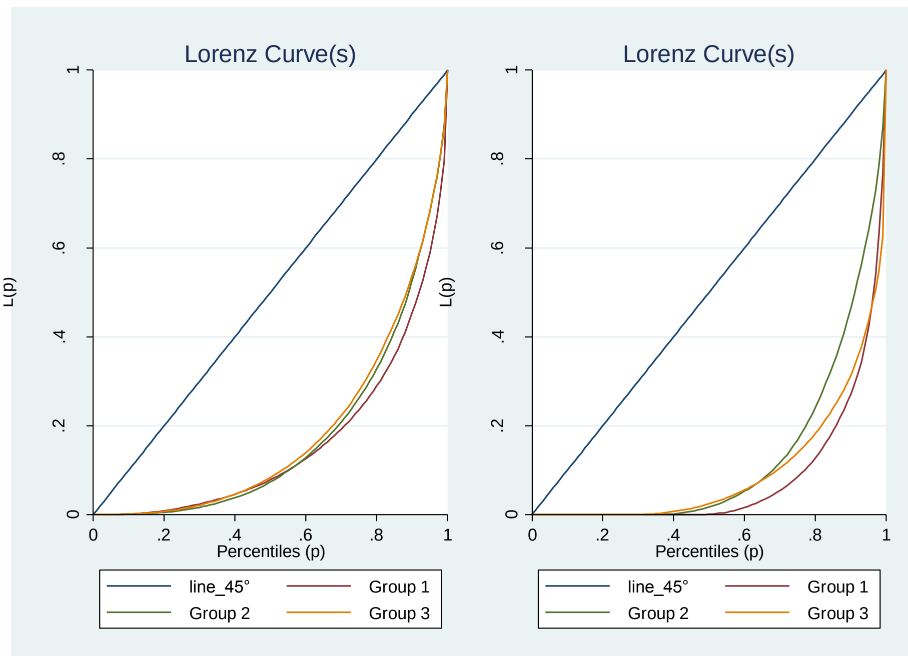


The analysis of household data has established that there is considerable poverty in Bolivia, and that significant variation exists among departments. The differences in the magnitudes of poverty incidences and poverty gaps inevitably raise the issue of inequality. From a public investment perspective, inequality translates into the possibility of very different outcomes for investments depending on what region or department investments are made. In light of the analysis done thus far, the issue of inequality raises two questions: first, is the distribution of investments also geographically unequal? And second, what is the link between dramatically different levels of poverty across departments and efficiency in public spending? To stay within the context of the analysis, equity considerations will be examined from the perspective of agricultural investments. Bolivia contains a diversity of municipalities, which receive varying degrees of investments and present significantly different pictures in terms of poverty and efficiency as described previously. If investments in agriculture – be it direct or indirect – is the key to prosperity and development – as has been demonstrated by many (see for instance, Datt and Ravallion, 1998)-- then it is only pertinent to analyze how these investments are distributed following an equity criterium. The analysis that follows in figure 14 presents concentration curves (also known as

Lorenz curves) of three groups of departments, classified according to the results obtained from the household data: less poor (group 1=Beni, Santa Cruz and Pando), medium (group 2=Tarija, Oruro and Chuquisaca) and poor (group 3=La Paz, Cochabamba and Potosi).

Figure 14: ***Inequality in investment across groups of departments for restricted agricultural and extended agricultural sectors respectively.***

Restricted agricultural spending Extended agricultural spending



The Lorenz curves presented in figure 14 provides a simple illustration of inequality in investments specific to agriculture (i.e. restricted spending) vis-à-vis investments related to but not specific to agriculture (i.e. extended) spending. This is done via graphing the cumulative probability distribution of investments for the three groups of departments, ranked according to their relative wealth. The forty-five degree line represents the ideal equality scenario, in which a given percentile of the income/investment (say 20 percent) of a group would correspond to the same percentile (20 percent) of the total income/investment in that group. The other lines in figure 14 represent the cumulative distribution of investments by groups. The farther away a line is from the 45 degree line, the more unequal a group is. In practical terms, greater distance from the 45 degree line indicates that municipalities within a given group receive considerably different amounts of resources, relative to what would be an equitable distribution. By and large municipalities in all groups have significant levels of inequality in investments. It can be argued that the second plot is the one that matters most since it concentrates a larger share of total investments in agriculture. Unfortunately, in figure 15 the curves for groups one and three cross, making it impossible to state (purely based on these curves) which group (one or three) is better off. Only for departments within group 2 – the intermediate group between less poor and poor- it is possible to state that these are the least unequal. While it is not possible to state clearly whether richer departments are better or worse off than poorer departments, it is somewhat disturbing that both rich and poor are home to similar levels of inequality. To enrich the context in which the relationships between poverty, inequality and efficiency, it is often useful to table and test statistically for correlations among these three dimensions, particularly efficiency and inequality.

Table 10 groups the nine departments by terciles, and classifies them by increasing order of wealth and efficiency[7]. It also presents a chi-squared test of independence between wealth and efficiency. For each pair of combinations between wealth and efficiency, table 9 presents the absolute and relative frequency of that combination present in the dataset. The hypothesis that these two indicators are independent is rejected at less than 1 percent. However, simply by looking at the frequency distribution it's hard to reach a sort of conclusions as to how these two measures are associated.

[7] A choice had to be made as to which point in the distribution of efficiency (i.e. the mean, median, highest percentile) to choose as a guide to ranking departments. For analytical sake, we thought it would be relevant to have those departments that contain municipalities closer to the frontier as the most efficient ones, and as such we chose the maximum value as a ranking variable.

Table 9*: Frequency of municipalities by degree of wealth and efficiency*

	Wealth			
Efficiency	low	medium	high	Total
Low	0	160	78	238
Medium	232	96	132	460
High	413	80	0	493
Total	645	336	210	1,191

Pearson chi2(4)=522 Pr = 0.000

To aid in the interpretation of the frequency tables above, we provide below results of two non-parametric regressions (see Conover, 1988) using efficiency (and wealth) rankings as the left hand side and categories of wealth and population, as well as an indicator for the new administration on the right hand side. The wealth measure used in the rank regressions was based on the incidence of poverty.

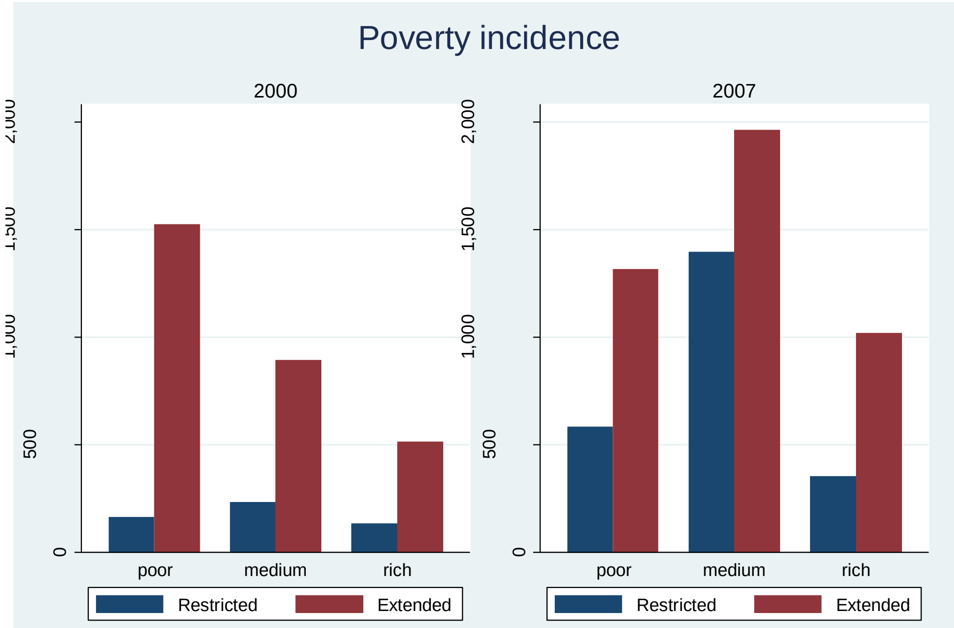
Table 11: ***Econometric results of rank regressions of efficiency and wealth on population, wealth and the new administration.***

	dependent variable	
Variable	(1)Efficiency	(2)Wealth
Wealth levels		
Medium	-0.81***	
High	-0.93***	
Population levels		
Medium	0.22***	-0.75***
High	0.23***	-1.06***
New administration (dummy)	0.03	0.03
_cons	2.41***	2.44***
N	1,191	1,191
r2	0.39	0.23
r2_a	0.39	0.22

Regression 1 in table 11 suggests that levels of wealth have a significant negative effect on efficiency. Relative to poor municipalities, both medium and high levels of wealth reduce efficiencies. Population levels have a statistically positive significant effect on efficiency. Relative to low population, both medium and high sized departments observe a gain in efficiency, by similar margins. The second regression on table 11 shows the effects of population on wealth. Unlike the efficiency regression, higher population levels decrease wealth, and the higher the population level the greater the reduction in wealth. The new administration which took office in 2006 had no discernible effect in efficiency or wealth levels, perhaps as a result of the fact that the data only covers two years of his mandate (2006-07).

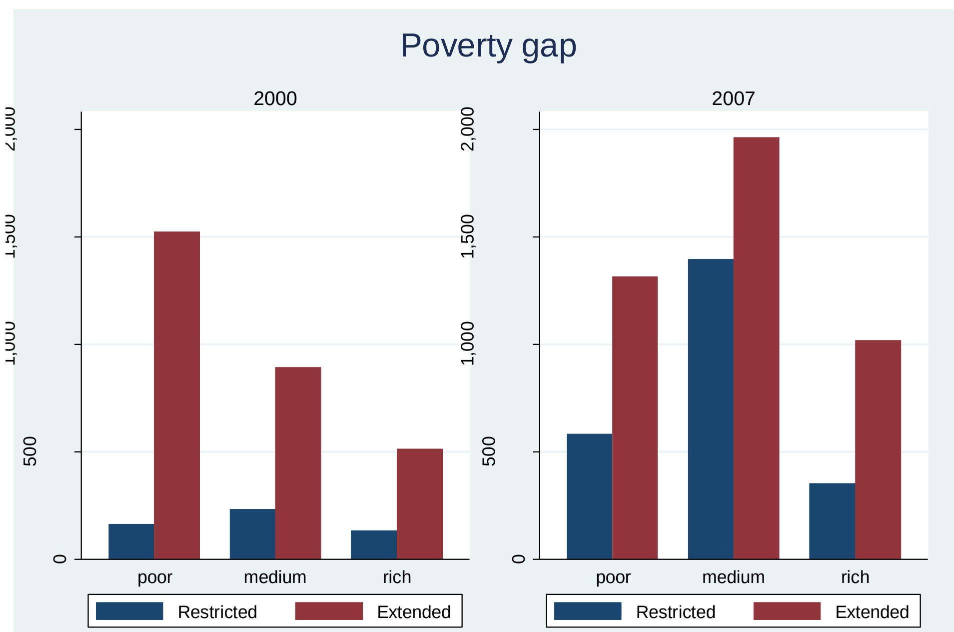
To better understand why wealth has a negative effect on efficiency, figure 15 plots the average spending in restricted and extended agricultural investments by level of wealth (measured as poverty incidence) and in the first and last year of analysis (2000 and 2007). In 2000, poorer departments were getting considerably more money than medium and rich departments particularly for extended agricultural investments. In terms of restricted spending, poorer departments were also getting more money than rich departments, but not more than medium ones. In 2007, investment in restricted and extended spending increased significantly, notably for medium and poor departments. Both years give support to the findings of the rank regressions. More resources in poorer departments allows for a less restrictive investment strategy, which enables municipalities to target more important areas. This is especially clear when comparing the regression results for medium and rich departments, in which the coefficients of efficiency reduction are considerably smaller for medium than for rich departments, painting association between investment levels and efficiency. Figure 15a uses the poverty gap measure to rank departments as opposed to poverty incidence. As observed in the figure, no differences in the levels of investments by levels of poverty gap can be noticed.

Figure 15: ***Average restricted and extended spending by level of poverty incidence for 2000 and 2007.***



Note: spending in 1000s of real 2005 bolivianos

Figure 15a: ***Average restricted and extended spending by level of poverty gap for 2000 and 2007.***



Note: Spending in 1000s of 2005 real bolivianos.

Combined these results point to several interesting aspects:

1. Size (in terms of population) matters for both efficiency and wealth, but in different ways. While departments with greater population levels tend to be more efficient, the reverse is true for wealth i.e. more population is associated with decreased wealth.
2. Being a wealthier department (relative to incidence of poverty) does not imply in more efficiency, but this can be explained by the large differences in investment amounts among levels of wealth.
3. The measure against which poverty is measured (incidence or gap) does not affect regression results and in the distribution of spending by levels of wealth. Regression results (not reported) show negative gains in efficiency with increased levels of wealth
4. Longer time-series data are needed in order to assess whether the new administration inaugurated in 2006 will have an effect on the way municipalities perform and on the implications on poverty.
5. The pro-poor strategy that seems to have been adopted by the Bolivian is generating good results for the poor. However, it’s important that other departments can also work towards more efficient investing and doing so likely requires more investments in medium and rich departments.

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