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Does decentralization increase government responsiveness to local needs? Evidence from Bolivia

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Abstract

This paper examines whether decentralization increases the responsiveness of public investment to local needs using a unique database from Bolivia. Empirical tests show that investment patterns in human capital and social services changed significantly after decentralization. These changes are strongly and positively related to objective indicators of need. Nationally, these changes were driven by the smallest, poorest municipalities investing devolved funds in their highest-priority projects. The findings contradict common claims that local government is too corrupt, institutionally weak, or prone to interest-group capture to improve upon central government's allocation of public resources.

JEL classification: D72; D73; H41; H42; H72; O18
Keywords: Decentralization; Local government; Participation; Targeting; Bolivia

1. Introduction

Over the past two decades decentralization has become one of the broadest movements, and most debated policy issues, in the world of development.[1] It is at the center of reform efforts throughout Latin America and many parts of Asia and Africa; and under the guises of subsidiarity, devolution and federalism is also central to policy discourse in the European Union, United Kingdom and United States. A key argument used by its proponents (see, for examples, Shah, 1998; Wallis and Oates, 1988; World Bank, 1994; UNDP, 1993) is that decentralization makes government more responsive to local needs by 'tailoring levels of

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[1] Manor (1997) refers to 'a quiet fashion of our time' while Campbell (2001) calls it *The Quiet Revolution*.

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consumption to the preferences of smaller, more homogeneous groups'.[2] Opponents (see for example, Crook and Sverrisson, 1999; Smith, 1985) counter that local government's lack of human, financial and technical resources will prevent it from providing appropriate public services under decentralization, and thus power should remain in the hands of central governments that are relatively resource rich. Despite going to the heart of the decentralization debate, these claims have not been extensively tested. What evidence does exist is largely anecdotal and/or inconclusive. This paper seeks to answer the question of responsiveness clearly and convincingly for one remarkable case: Bolivia. I examine how decentralization changed local investment patterns across all Bolivian municipalities, and the extent to which these changes were related to objective measures of local need.

The decentralization literature is enormous, spanning five decades and scores of countries. That part relating to government responsiveness is happily smaller, and falls into two general categories: small and large sample studies. The former rely mostly on qualitative evidence and descriptive statistics, adopt a case study approach, and focus usually on a single country, or develop comparisons between a small number of countries. The level of analysis is usually more nuanced than large sample work, but the conclusions that emerge often suffer from a low level of generality. Most of the existing evidence on responsiveness can be found here.

Results relating to responsiveness are limited, as broad surveys by Piriou-Sall (1998) and Smoke (2001) make clear. Case studies reported in Rondinelli et al. (1983) find that decentralization made government more responsive to local needs in Papua New Guinea by improving the capacity of provincial administrators, and improved the access of people in neglected rural areas to central government resources and institutions 'perceptibly' in Indonesia, Morocco, Pakistan, Thailand and Tunisia. Manor (1999) finds evidence that decentralization enhanced the responsiveness of government in the Philippines, India and Côte d'Ivoire. And a World Bank (1995) case study of Colombia shows that satisfaction with government and local services improved notably after decentralization. On the other hand, Samoff (1990) finds the evidence on responsiveness strongly negative, asserting that decentralization schemes around the world have largely failed to work. They have neither enhanced local capacities nor improved local programs, in large part because they were neutralized by elaborate mechanisms of central supervision and control. Slater (1989) supports this view with a detailed example from Tanzania.

Large sample studies, by contrast, benefit from the consistency, empirical transparency and high degree of generality that econometrics provides. But this stream of research is still quite new, and significant problems with measurement and data comparability across diverse countries (or regions), as well as the possibility of omitted variables, raise important concerns.[3] Perhaps because of such difficulties, most econometric studies have addressed the question of responsiveness only tangentially, or at a very general level.

Noting that the effects of decentralization are complex, Zax (1989) finds that electoral considerations lead to significantly higher levels of spending in US states and municipalities which permit initiatives. Humplick and Moini-Araghi (1996) find that unit costs of road maintenance are lower and roads of better quality where maintenance is decentral-

[2] Wallis and Oates (1988, p. 5).

[3] Estache and Sinha (1995) discuss data problems in detail.

ized. Fisman and Gatti (2000) find that fiscal decentralization is consistently associated with lower measured corruption across a sample of countries. For a sample of 80 countries, Huther and Shah (1998) find positive correlations between decentralization and indices of political participation, social development, a quality index of economic management, and an overall quality of government index, from all of which they infer causal relationships. And finally, Galasso and Ravallion (2000) use careful econometrics to show that pro-poor program benefits increased with decentralization in Bangladesh.

The sum of these and many other findings is that 50 years of research has failed to establish clearly whether decentralization makes government more or less responsive to its citizens. This study seeks to combine the strengths of the two approaches outlined above in order to answer the question for a provocative recent natural experiment. I combine the rigor and generality of a data intensive, econometric approach with a one-country focus which allows me to avoid problems of data comparability and control for external shocks, political regime, institutions, and other exogenous factors. In this way I examine the effects of decentralization carefully through the length and breadth of Bolivia. The characteristics of Bolivian reform—a very significant change in policy at a discrete point in time—make this case particularly well-suited for study. The data I use are of surprising scope and quality, including political, institutional, administrative and even procedural (good-government type) indicators for all 311 municipalities. The use of such variables constitutes an innovation of this paper.

The remainder of the paper is organized as follows. Section 2 explains Bolivia's decentralization program and examines the changes in national resource flows which it brought about. Section 3 formalizes the main features of the policy debate mentioned above in a model that analyzes the trade-off between local government's knowledge of local needs vs. central government's technical and organizational advantage in the provision of public services in districts with heterogeneous preferences. Section 4 discusses the empirical methodology, tests whether decentralization changed public investment patterns across Bolivia's 311 municipalities, and then examines the determinants of this change, focusing on variables of need. Section 5 concludes.

2. Decentralization in Bolivia

2.1. Popular participation and the decentralization reform

Bolivia entered the 1990s with one of the most centralized states in the region, a product of its 1952 revolution when the ascendant Nationalist Revolutionary Movement expropriated the 'commanding heights' of the economy and embarked upon a state-led modernization strategy. Governing elites in La Paz sought initially to use the state to erase the social relations of the past and create a new, more egalitarian society.[4] Forty years of military coups punctuated by episodes of civilian rule exacerbated this tendency, leaving the reins of political and economic power firmly in the hands of the President and his cabinet. Against this general background, decentralization was announced in 1994. The

[4] Klein (1993, pp. 236–240), author's translation.

scale of the change in resource flows and political power that it brought about were considerable. The core of the decentralization reform consists of four points.[5]

1. The share of national tax revenues devolved from central government to municipalities was doubled to 20%. More importantly, whereas before these funds were apportioned according to ad hoc, highly political criteria, after decentralization they are allocated on a strict per capita basis (see below).
2. Title to all local health, education, roads, irrigation, culture and sports infrastructure was transferred to municipalities free of charge, along with the responsibility to administer, maintain and equip it, and invest in new infrastructure.
3. Local Oversight Committees (*Comités de Vigilancia*) were established to oversee municipal spending of Popular Participation funds, and propose new projects. These consist of representatives from local, grass-roots groups who can freeze disbursements from central government, effectively paralyzing the vast majority of local governments, if they judge that funds are being misused. These committees report directly to local grass-roots organizations, and thus represent an alternative channel by which popular demand enters into local policy-making.
4. One hundred and ninety-eight new municipalities—64% of the total—were created, and existing ones expanded to include suburbs and surrounding rural areas.

The reform heralded a new era of municipal government for the overwhelming majority of Bolivian towns and cities. In many parts of Bolivia where before the state was present, if at all, in the form of a local schoolhouse, health post, or perhaps military garrison or customs office, each reporting to its respective ministry, there was now for the first time elected local government accountable only to local voters.

2.2. Descriptive statistics

The extent of the change is perhaps best appreciated by examining the changes in resource flows it catalyzed. Fig. 1 shows that before decentralization 308 Bolivian municipalities divided amongst them a mere 14% of all devolved funds, while the three main cities took 86%. After decentralization their shares reversed to 73% and 27%, respectively. The per capita criterion resulted in a massive shift of resources in favor of smaller, poorer districts.

A more important and telling change was to the composition of investment. Fig. 2 shows central and local government investment by sector for the periods 1991–1993 and 1994–1996. The differences are large. In the years leading up to reform, central government invested most in transport, hydrocarbons, multisectoral[6] and energy, which together accounted for 73% of public investment during 1991–1993. After decentralization local governments invest most heavily in education, urban development, and water and sanitation, together accounting for 79% of municipal investment. Of the sectors

[5] Secretaría Nacional de Participación Popular (1994). *Ley de Participación Popular*.

[6] A hodgepodge, including feasibility studies, technical assistance and emergency relief, that is difficult to categorize.

City	Central-to-Local Revenue Sharing (Bs'000)			% of National Total	
	1993	1995	% Change	1993	1995
La Paz	114,292	61,976	-46%	51%	10%
Santa Cruz	51,278	63,076	23%	23%	10%
Cochabamba	25,856	38,442	49%	12%	6%
3 Cities Sub-total	**191,427**	**163,494**	**-15%**	**86%**	**27%**
Rest of Bolivia	**32,099**	**444,786**	**1286%**	**14%**	**73%**
Total	223,525	608,280	172%	100%	100%

N.B. Average exchange rate: US$1=Bs.5

Fig. 1. The changing allocation of public funds.

accounting for roughly 3/4 of total investment in both cases, central and local government have not even one in common. The evidence implies that local and central government have very different investment priorities.

Lastly, it is instructive to examine how investment was distributed geographically among Bolivia's municipalities before and after decentralization. Figs. 3 and 4 show investment per capita in ascending order for the years immediately before and after decentralization, where each dot represents a municipality. Fig. 3 shows that per capita investment before decentralization was highly unequal, with large investments in three

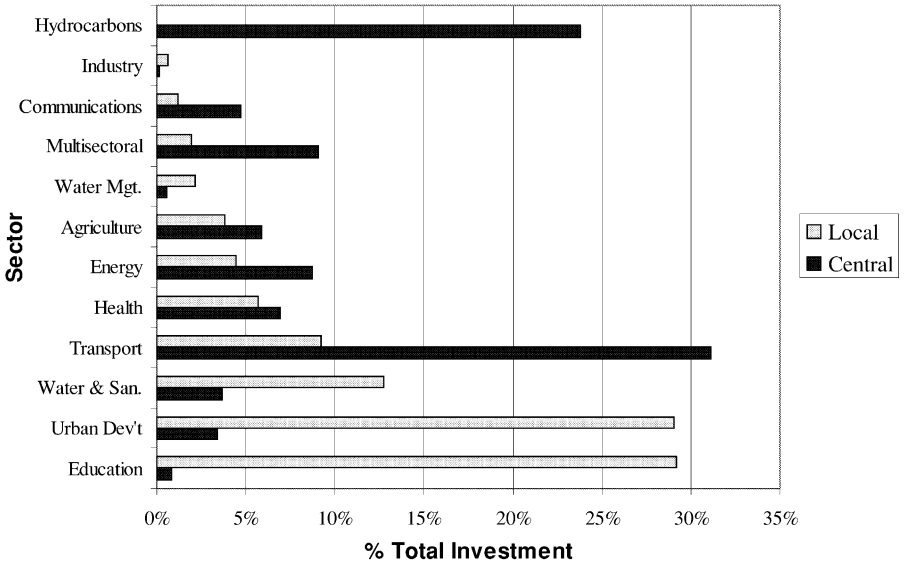

Fig. 2. Local vs. central government investment.

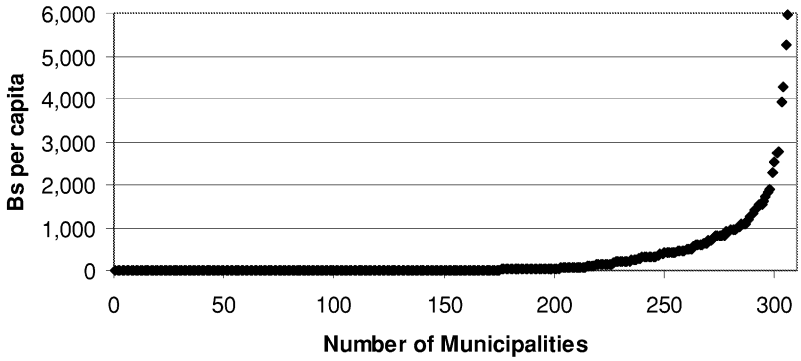

Fig. 3. Investment per capita, 1991–1993 (highest four obs. dropped).

districts and the vast majority at or near zero.[7] Fully half of the observations are at zero, and another 50 are barely above it. Centralized investment was thus hugely skewed in favor of a few municipalities which received enormous sums, a second group where investment was non-trivial, and the unfortunate 2/3 of districts which received little or nothing. Compare this with Fig. 4, which shows municipal investment after decentralization: no districts are at zero investment and over 2/3 are in a band between Bs.100–300/capita.[8] These crude indicators imply that central government—with a much larger budget and free rein over all of Bolivia's municipalities—chose a very unequal distribution of investment across space, while decentralized government distributes public investment much more evenly.

Decentralization is thus associated with major changes in both the distribution and use of public resources in a short span of time. There is something worth studying in Bolivia.

3. Theory

Even in an empirical paper, it is useful to develop a simple model which organizes our thoughts and focuses attention on key differences between central and local government. The model will also be useful in interpreting the empirical results of Section 4. But first consider the literature.

3.1. The literature

In terms of productive efficiency, central government should be naturally superior to local government so long as returns are at least slightly increasing.[9] Any economic case for decentralization must therefore invoke a counterbalancing source of efficiency in which local government has an advantage. Different authors have approached the problem in

[7] Fig. 3 actually downplays the degree of inequality, as the highest four municipalities are dropped to avoid distorting the vertical axis further. The dropped observations range from Bs.8000–52,000/capita.

[8] Investment sums here are much lower because they exclude central government funds.

[9] See Oates (1985) for a discussion.

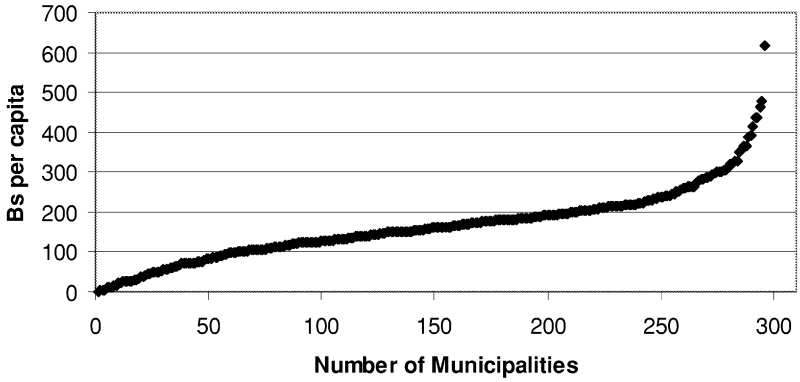

Fig. 4. Local investment per capita, 1994–1996.

different ways. Tiebout's (1956) seminal work posits a world in which individuals move costlessly amongst localities that offer different levels of provision of a public good. The ensuing competitive equilibrium in locational choices produces an efficient allocation. But this approach assumes a highly mobile population and fixed governments, which is at odds with both anecdotal evidence from Bolivia and studies of the (comparatively mobile) United States, as Bardhan (2001) points out.[10] A better assumption would seem to be that government is the mobile element in most local democratic systems, changing with relative frequency, whereas the population is essentially fixed over typical, 4- or 5-year electoral periods. European countries' notably low rates of internal migration support this view. Tiebout-style 'voting with your feet' is undoubtedly a valid mechanism for preference revelation at the margins, and may be more important for particular services, such as education. But the principal mechanism for joining demand and supply for public goods must involve the political process. Indeed this is arguably why local government exists at all.

Oates (1972) examines heterogeneity in tastes and spillovers from public goods through a model in which local government can tailor public goods output to local tastes, whereas central government produces a common level of public goods for all localities. He finds that decentralization is preferred in systems with heterogeneous tastes and no spillovers; with spillovers and no heterogeneity, centralization is superior on efficiency grounds. But Oates' results rest largely on his assumption of uniform central provision of public goods which, though it mirrors an empirical regularity, is theoretically ungrounded and problematic when viewed in the Bolivian context. Besley and Coate (1999) provide a model in which this restriction is lifted. Like Oates, they invoke uniform taxation to finance public goods provision. But they then devise a model of central policy-making in which elected representatives bargain over public goods provision in multiple districts. For heterogeneous districts, they find that decentralization continues to be welfare superior in the absence of spillovers, but centralization is no longer superior when spillovers are present. They also find that higher heterogeneity reduces the relative performance of centralization for any level of spillovers. Their underlying logic is that heterogeneity creates conflicts of interest between

[10] Bardhan cites Hanson and Hartman's (1994) finding that few poor people move amongst US states in search of higher welfare benefits.

citizens of different districts. This affects the selection and behavior of representatives, leading to degraded legislative performance in choosing public policies. This model is both more representative of how real central governments operate, and more in keeping with the facts of Bolivia's transition to decentralization. The results below can be interpreted as an indirect test of their findings, given reasonable assumptions about representative local utility functions. Thus construed, my results weakly support their findings.

3.2. The model

A country is made up of T districts, each with population n_j where the subscript j denotes district. Individuals, subscripted i, have linear utility $U_i = x_i + \theta_i b(g_j)$ where x_i is the amount of private good consumed by individual i, g_j is the amount of public good available in district j, and θ_i is individual i's preference for public good g_j. I use θ_{mj} to denote the local median preference for the public good in district j. Local welfare is defined as median utility, $U_{mj} = x_{mj} + \theta_{mj} b(g_j)$. The function of government is to provide public goods, which it finances with a local head tax. Following the logic of decentralization's proponents, I assume that local government ascertains θ_{mj} accurately, whereas central government ascertains θ_{mj} with probability p and θ_{-mj} with probability $(1-p)$. Probability varies as $p \in [0, 1]$, and θ_{-mj} is defined as an unrestricted value of θ other than θ_{mj}. Following decentralization's critics, I model central government's supposed superior human and technical resources as a cost advantage in the provision of public goods. Hence the head tax needed to finance a given level of provision under central government is $\alpha g_j / n_j$ with $0 < \alpha \leq 1$, whereas the tax under local government is g_j / n_j. We can think of this cost advantage in terms of superior technical knowledge, or an organizational advantage which lowers the cost of complex public goods, or traditional economies of scale.[11,12]

Under decentralization, local government's problem in district j is

$$\max_g \left[\theta_m b(g) - \frac{g}{n} \right] \tag{1}$$

where for simplicity I drop all subscripts j. Local government thus maximizes provision of the public good given median local preference, which it finances with a head tax. Taking first-order conditions and re-arranging yields

$$b'(g) = \frac{1}{n\theta_m}. \tag{2}$$

The level of public good provided by local government is thus an implicit function of θ_m, the median preference for the public good, and of the population n. Citizens receive the level of public good that they prefer, which they pay for fully.

[11] Certain types of public health interventions, for example, require specialized technical knowledge which central government may be able to obtain more cheaply than local government.

[12] One can also imagine conditions in which $\alpha > 1$, if the center has none of the advantages mentioned above and uses higher-cost labor than local governments, for example.

Central government's problem is

$$\max_{g_1,\ldots,g_T}\left[\sum_j(p\theta_{mj}+(1-p)\theta_{-mj})b(g_j)-\sum_j\alpha\frac{g_j}{n_j}\right]. \tag{3}$$

Solve for district j. Taking first-order conditions and re-arranging yields

$$b'(g)=\frac{\alpha}{n(p\theta_m+(1-p)\theta_{-m})}. \tag{4}$$

The level of public good provided by central government is thus an implicit function not only of local median preference and population, but also of the probability that central government correctly assesses local preferences, the difference between 'true' local preferences and those otherwise ascertained by central government, and central government's cost advantage.

Hereafter the amounts of the public good provided in equilibrium by local and central governments, defined by Eqs. (2) and (4), respectively, are denoted g_l and g_c. Utility is a strictly concave function of g, and hence $b''(g)<0$. Comparing the two equations, it is easy to see that, ceteris paribus, public goods provision under central government will be higher than under local government when the former has a cost advantage $(\alpha<1)$. Citizens will prefer central government which, for a given head tax levied, provides more of the public good than does local government.

For the sake of simplicity, I assume from this point on that $\theta_{-m}=0$ and analyze central government's assessment of local preferences via the $p\theta_m$ term. The central government equilibrium is now defined by $b'(g_c)=\alpha/(np\theta_m)$. Where $p<1$, central government underestimates local preferences, and ceteris paribus public goods provision will be lower than under local government. As there is no cost advantage the budget constraint does not change, and citizens consume less g and more x. This implies lower utility, and so citizens prefer local government provision. When $p=1$ the center accurately assesses local preferences, provision is equal to that under local government, and citizens are indifferent between the two regimes.

By setting $b'(g_c)=b'(g_l)$ we can find critical values for the indifference points at which the countervailing effects are equal. It is straightforward to see that if $\alpha=p$, citizens will be indifferent between central and local government, as the center's inaccuracy in assessing local preferences is counterbalanced by its cost advantage, and provision of $g_c=g_l$. If $\alpha>p$, the cost advantage is dominated by the center's inaccuracy in measuring local preferences, and $g_c<g_l$. Citizens will prefer local government. If $\alpha<p$, then the center's cost advantage outweighs its inability to perceive local preferences accurately, and $g_c>g_l$. Citizens prefer central government. These results are summarized in Fig. 5.

For simplicity, the analysis above depicts the function of the public sector as the provision of a single public good g, and examines the effects of competing political and institutional factors on that provision. In reality, of course, local and central governments provide many public and private goods and services, and perform a large variety of functions which this approach is too simple to capture. Cost advantage and assessment inaccuracies are likely to affect these different activities in different ways. Section 4

Assuming	Condition	Result	Preference
$\theta_{-m}=0$	$\alpha>p$	$g_c<g_l$	Local
	$\alpha<p$	$g_c>g_l$	Central

Indifference condition: $b'(g_c) = b'(g_l) \Rightarrow \frac{\alpha}{np\theta_m} = \frac{1}{n\theta_m}$.

Fig. 5. Citizens' preferences for central vs. local government.

examines this question empirically by comparing central and local investment patterns across 10 different sectors for Bolivia before and after decentralization.

4. Empirical tests: decentralization and investment

4.1. Methodology

My objective is to test whether decentralization made public investment more responsive to local needs in Bolivia. This can usefully be decomposed into two questions: (i) did the pattern of public sector investment change with decentralization? and if so, (ii) do indicators of need determine that change? It is possible that public investment did not change with decentralization. If so decentralization and centralization would be largely equivalent from an economic perspective, though one might be preferable to the other on political or administrative grounds. If decentralization did change investment patterns it becomes important to try to characterize this change in terms of welfare and distribution, and determine which social and institutional factors were most important in defining it. Ideally public goods would be measured in quality-adjusted units of output, separated by type. But such information is unavailable for Bolivia, and instead I measure investment inputs in the form of resources expended on public investment projects. This approach has the advantage of using natural, non-controversial units, and of facilitating comparisons across different sectors. I separate these flows into 13 sectors, of which I analyze 10 (see Fig. 7).[13]

For each sector I estimate the model

$$G_{mt} = \beta_1 \alpha_m + \beta_2 \alpha_m^* + \beta_3 \delta_t + \varepsilon_{mt} \tag{5}$$

where α_m and δ_t are vectors of state and year dummy variables as per above, and α_m^* is the product of α_m and a decentralization dummy variable which takes the values 0 before 1994 and 1 after (i.e. post-decentralization).[14] Investment patterns are thus decomposed into three terms: a year effect, δ_t, which captures year shocks and time-specific characteristics; a state effect, α_m, which captures all of the characteristics of a state fixed in time; and a

[13] Multisectoral includes a sufficient diversity of projects as to be functionally meaningless as a category. And almost no local governments invest in hydrocarbons or mining, rendering comparisons across regimes impossible.

[14] Thus α_m^* takes the value 0 for all municipalities and all years before 1994, and is identical to α_m for all years from 1994 onwards.

decentralization-interacted state effect, α_m^*, which captures state-specific characteristics commencing in 1994 which were previously absent. As decentralized public goods provision began in 1994, this term will capture the effects of local government, local civic associations and other local institutions that sprang up with the reform, and social and political dynamics more generally that impact upon local government but lay dormant under central rule. Any systemic changes in Bolivia's politics or economy that affect all municipalities in similar ways, such as a national policy initiative or an external shock, will be captured by the year term, δ_t. Thus the β terms capture only those effects that are municipality-specific. The data cover the period 1987–1996.

I then perform three tests.

1. $\beta_1 = \beta_2$ means test. This is a simple *t*-test to determine whether the means of the α_m and α_m^* coefficients are significantly different for each sector. Significance indicates that decentralization changed national investment patterns through the effects and actions of local governments.
2. $\beta_{1m} = \beta_{2m}$ individual tests. This *F*-test checks municipality by municipality whether the decentralization-interacted state coefficients are different from the simple state coefficients for investment in a given sector. A significant *F*-test constitutes evidence that decentralization caused a change in local investment patterns in a particular municipality. Significance in many municipalities constitutes stronger evidence that decentralization changed national investment patterns.
3. Lastly, I place the *differences* in state dummy coefficients on the LHS and estimate the model

$$\beta_2 - \beta_1 = \zeta S_m + \eta Z_m + \varepsilon_m \tag{6}$$

for each of 10 sectors, where S is a scalar or vector of the existing stock of public services (variously defined, as we will see below) at an initial period, and Z is a vector of institutional and civic variables, both indexed by municipality m. This approach isolates those changes in investment patterns resulting from a move to a decentralized regime and then examines its determinants.

The LHS variable should by construction be unrelated to all factors which remain constant between the two periods, and thus I omit socio-economic, regional and other variables which do not vary between the centralized and decentralized regimes. I assume that the variables in Z, as well as the stock of public services in the 10 sectors of interest, S, are constant over the period in question.[15]

Literally hundreds of variables that might be included in the Z vector are available for Bolivia. To facilitate analysis, and in order to combine very specific Z-type variables into indicators that are meaningful and useful, I characterize them according to the groups in Fig. 6, and construct principal component variables (PCVs) for each.

[15] For most of the demographic and socio-economic variables in question, which tend to show change that is statistically significant only over longer periods of time, this is reasonable. It is less reasonable in the case of the S variable. Unfortunately the data leave no choice.

PCV Group	PCV No.	Interpretation - Variable increases in... listed in order of importance, where applicable (see Appendix B for details)
Civil Institutions	1	Strength of local civil institutions and organizations
Private Sector	1	Dynamism of the local private sector
Training & Capacity-Building	1	Intensity of the local capacity-building efforts undertaken by/for local government
Information Technology	1	IT systems - hardware and software
Project Planning	1	Informed project planning which follows consensual and open procedures

Fig. 6. Interpretation of PCVs.

This process is explained in detail in Appendix B, which also lists all need variables used, PCVs and their constituent variables with factor loadings, and PCV interpretations. Eq. (6) can thus be written

$$\beta_2 - \beta_1 = \zeta S_m + \eta_1 Z_{1m} + \cdots + \eta_5 Z_{5m} + \varepsilon_m, \tag{7}$$

where subscripts 1 to 5 denote the groups above.

In theoretical terms, the main coefficient of interest is ζ, which I interpret as an indicator of the degree to which investment is based on need. This is rooted in the assumption of decreasing marginal utility of a public service as the level of provision of that service rises. In the language of the model, let $\theta_m = U'(g) < 1$. I use two types of information as indicators of the stock of public services: (1) the penetration rates[16] of public services or benefits in the local population, r, or the population without access to the same, $1 - r$,[17] and (2) the initial per capita stock of infrastructure (at the outset of decentralization). Examples of these are: (1) the literacy and illiteracy rates, the share of population without water or sewerage; and (2) the number of sports facilities and markets per capita in 1994. Of these, type 1 variables can be considered truer indicators of need, as they better capture the criterion of public service use by the population and are likely to be better measures of the flow of benefits produced by public investments. Type 2 variables indicate existence more than exploitation by the local population, and hence should be less accurate indicators of need. I use type 2 variables when type 1 variables are unavailable. It is also important to note that need here is a relative concept, rising and falling with $U'(g)$. This is an important distinction, as the semantics of its common usage imply that need is an absolute, and even discrete, concept, existing in some places (at some times) but not in others.

Following the argument in Section 3.2, I expect ζ to be negative when S_m is measured by the penetration rate r, and positive when measured by $(1 - r)$. If S_m is measured by r, a negative coefficient suggests that decentralized government invests more heavily in a type of public good where it is scarce, and hence presumably where it is more strongly preferred. A positive coefficient implies that decentralized investment increases with the level of service provision, accentuating pre-existing differences in public goods endowments amongst municipalities. I interpret this as evidence that the relationship posited in 3.2 is backwards, and central government allocates public investment with more sensitivity to need than local government. A coefficient equal to zero suggests that local government does not take the

[16] Note that 'rate' here denotes a stock and not flow concept.

[17] I use both for education, and obtain the expected variation in sign in our results (see below).

existing stock of public goods into account in making its investment decisions, implying that local preferences should not appear in the expression.

The variables in Z are not included as mere controls, however. Their coefficients, η, are of interest insofar as they help explain the institutional, civic and procedural determinants of decentralized investment decisions, and so constitute indirect tests of the theoretical argument above. The case put forward by political scientists[18] for local government's superior assessment of local preferences and needs includes greater sensitivity to grass-roots demand, greater accessibility of local lobby groups to local government, and greater political accountability to the local populace. Some of the ways in which this can happen include the use of participative planning techniques, and the existence of private sector and civic organizations that are strong and dynamic. Remember that these factors were not relevant to central decision-making, which occurred at the center. Hence I interpret positive coefficients on these PCVs as weak evidence that local government assesses preferences more accurately than central government, implying that the value of p is less than 1 and the difference between real preferences and those perceived by the center $(\theta_m - \theta_{-m})$ is high.

4.2. Results

Fig. 7 shows the results from the means test $\beta_1 = \beta_2$. Mean values are significantly different at the 0.1% level for education, water and sanitation, agriculture, transport, urban development and communication, and at the 1% level for industry and tourism and water management. In health, values are significantly different at only the 13% level, and worse for energy. The evidence is that decentralization changed national investment patterns in the first eight sectors. Examination of the β_2 values indicates that the effect of local government on average investment under decentralization was to increase investment in education, urban development, water management and perhaps health, no change in energy, and decrease investment in agriculture, transport, communication, industry and tourism, and (puzzlingly given the increase in water management) water and sanitation. But Fig. 8 shows that the number of municipalities investing in these sectors increased for all except agriculture. This implies that the concentration of investment fell, as more municipalities invested in a large number of (often smaller) projects in nine sectors.

Fig. 9 shows the number of municipalities where we can reject the hypothesis $\beta_{1m} = \beta_{2m}$, that is, the number of municipalities where decentralization changed investment patterns significantly during the first three years. The test is significant in about 3/4 of municipalities for water and sanitation and education, and in 1/3 of municipalities for urban development and water management, but in only 1/5 of municipalities for agriculture and health and fewer in other sectors. This suggests that investment patterns changed significantly for water and sanitation, education, urban development and water management, did not change for industry and tourism, energy, communication and transport, with agriculture and health on the border between significantly different and not. Taking into account the results from test 1, I conclude that agriculture spending did change significantly between the two periods, while for health it may have but the evidence is inconclusive. Thus two sectors can be added

[18] See for example Wolman in Bennet (1990).

Sector	Variable	Mean	Std Error	Test t-statistic	Test P Value
Education	β_1	0.00128	0.00032	-22.798	0.0000
	β_2	0.01685	0.00042		
Water & Sanitation	β_1	0.00374	0.00043	17.343	0.0000
	β_2	-0.01174	0.00049		
Agriculture	β_1	0.00867	0.00080	8.667	0.0000
	β_2	-0.00535	0.00086		
Transport	β_1	0.05464	0.00890	5.967	0.0000
	β_2	-0.05152	0.00890		
Urban Development	β_1	0.00307	0.00049	-5.324	0.0000
	β_2	0.00791	0.00053		
Communication	β_1	0.00191	0.00032	4.011	0.0001
	β_2	-0.00055	0.00031		
Industry & Tourism	β_1	0.00101	0.00023	3.768	0.0002
	β_2	-0.00071	0.00023		
Water Management	β_1	0.00075	0.00018	-2.932	0.0034
	β_2	0.00182	0.00020		
Health	β_1	0.00258	0.00038	1.540	0.1238
	β_2	0.00141	0.00041		
Energy	β_1	-0.00489	0.00185	1.281	0.2004
	β_2	-0.00963	0.00186		

Fig. 7. Test 1: coefficients equal? Test $\beta_1 - \beta_2 = 0$.

to the two above for which decentralization did not significantly change investment patterns across Bolivia's 311 municipalities. From this point the analysis focuses on water and sanitation, education, urban development, water management and agriculture.

These results should be interpreted in light of the following: (i) half of all municipalities in Bolivia received no public investment at all during the three years before decentralization, and these are for the most part the poorest municipalities. As all municipalities have funds to invest post-decentralization, the most pronounced changes in investment patterns are accounted for by the poorest municipalities. And, (ii) given high levels of poverty and low levels of public investment before decentralization, poor municipalities have a need for investment in more than one sector. Thus rather than spread resources thinly, the evidence suggests that most districts reasonably choose to concentrate investment in a few, high-priority sectors during the initial years of decentralization. Although I cannot test this hypothesis directly, it is consistent with qualitative evidence presented in Faguet (2002).

The results are driven by the investment of poorer districts responding to their greatest needs. By revealed preference we can infer that local administrations in these areas

Sector	Before	After	Change
Urban Development	66	675	923%
Education	75	685	813%
Health	95	484	409%
Water Management	46	175	280%
Communications	38	97	155%
Water & Sanitation	202	506	150%
Energy	180	259	44%
Industry & Tourism	44	60	36%
Transport	357	444	24%
Agriculture	343	309	-10%

Fig. 8. Number of municipalities receiving investment, by sector (in municipality-years).

prioritize basic social service projects above productive projects, and productive (i.e. income-enhancing) projects in turn above economic infrastructure. Hence they will tend to invest in education and water before agriculture, and agriculture before transport or communication. Because only a few years of post-decentralization data are available, the *F*-test is expected to fail in low-priority sectors, as poor municipalities received little or no investment under central government and continue to invest little under decentralization. In high-priority sectors, however, investment will leap upwards from a very low base if decentralization matters. This is indeed what happens. Decentralization leads to an increase in investment in water and sanitation and education in 3/4 of all municipalities, and urban development and water management in 1/3. There are moderate changes in investment patterns in agriculture and health, and very little change in transport, communication, energy and industry and tourism. In conclusion, decentralization did

Sector	No. Significant	% Significant
Water & Sanitation	224	76%
Education	209	71%
Urban Development	107	36%
Water Management	105	36%
Agriculture	65	22%
Health	49	17%
Transport	29	10%
Communication	7	2%
Energy	7	2%
Industry & Tourism	7	2%

Fig. 9. Test 2: coefficients equal? Test $\beta_{1m} - \beta_{2m} = 0$.

change the pattern of Bolivian public investment, and this difference was strongest in the social services and urban development.

Test 3 investigates the determinants of the difference in dummy state variables, $\beta_2 - \beta_1$, equivalent to the increase in investment due to decentralization. Results are examined sector-by-sector, beginning with education.

4.2.1. Education

Investment rises under decentralization where the illiteracy rate is higher, and thus where need is greater. This implies that local government is more sensitive to local need than central government. This finding is not sensitive to specification or the measure of illiteracy used, as is evident in Fig. 10, where the literacy rate is significant and negative. In terms of the model of Section 3.2, the results imply that $p < 1$, and hence that the center assesses local preferences less accurately than local government. Educational investment falls where the private sector is stronger, a finding which is again insensitive to specification. This is most likely because private firms lobby for resources to flow to other sectors where they stand to profit more. The results for urban development (below) support this interpretation. Civil institutions, by contrast, lead to an increase in investment

	Model*				
Independent Variable	I	II	III	IV	V
Private Sector PCV1	-0.000983	-0.00121	-0.00106	-0.0003	-0.00056
	(-2.466)	(-3.004)	(-2.689)	(-1.004)	(-1.619)
Project Planning PCV1	-0.000538	-0.00049	-0.00055	-0.00037	-0.00052
	(-0.919)	(-0.830)	(-0.925)	(-0.703)	(-0.879)
Civil Institutions PCV1	0.000973	0.00101	0.00103		
	(1.752)	(1.774)	(1.839)		
Training & Capacity Building PCV1				-0.00063	
				(-0.591)	
Information Technology PCV1					0.00118
					(1.010)
Illiteracy Rate (Adult)	0.000173			0.00019	0.0002
	(2.906)			(3.116)	(3.306)
Illiteracy Rate (Over-6's)			0.00018		
			(2.505)		
Literacy Rate		-0.00011			
		(-1.844)			
Local Education Authority	0.005603	0.00534	0.00543	0.0053	0.00479
	(1.421)	(1.356)	(1.378)	(1.354)	(1.379)
_constant	0.0075759	0.02037	0.00806	0.00722	0.00704
	(1.814)	(3.728)	(1.816)	(1.862)	(1.731)
R-square	0.0176	0.0136	0.0162	0.0155	0.0172
Prob>F	0.001	0.0025	0.0016	0.0128	0.0104

* OLS regressions reported with robust standard errors
t-stats in parentheses; PCV1 = 1st pricipal component variable

Fig. 10. Test 3: $\beta_2 - \beta_1 = \zeta S_m + \eta_1 Z_{1m} + \cdots + \eta_5 Z_{5m} + \varepsilon_m$.

after decentralization, suggesting grass roots support for education (i.e. parents worried about their children). Participative planning methodologies have no effect on investment, nor do information technology or local training and capacity-building activities.

4.2.2. Water and sanitation

Investment rises under decentralization where more people have no sewerage (Fig. 11). It also rises where the share of population without access to drinking water increases, though this finding is sensitive to specification and drops out when other variables are included in the model. Thus local governments invest more where need is greatest. This implies that $p < 1$ in the model above. Participative planning methodologies are significant and negative, thus decreasing investment, and the private sector and civil institutions are both insignificant. The latter is surprising given the positive effect of civil institutions on investment in education.

4.2.3. Water management

The water management sector is related to water and sanitation but is broader in scope, including reservoirs and wastewater treatment lagoons, levees, and storm drainage works (Fig. 12). In general the degree of overlap between the two sectors is high, and similar indicators of need are used for both. Investment in water management is lowest where the share of population with no access to water is highest, rises as more people have access to public and private standpipes, and falls again as internal plumbing becomes widespread.

	Model*			
Independent Variable	I	II	III	IV
Private Sector PCV1	0.000123		-0.000856	-0.000712
	(0.130)		(-1.265)	(-1.058)
Project Planning PCV1	-0.003165		-0.003322	-0.003517
	(-2.002)		(-2.237)	(-2.205)
Civil Institutions PCV1	-0.001227			
	(-1.230)			
Training & Capacity Building PCV1			-0.001129	
			(-1.161)	
Information Technology PCV1				-0.000196
				(-0.163)
% Pop. w/out Sewerage	0.000194		0.000170	0.000180
	(1.881)		(1.768)	(1.756)
% Pop. w/out Water		0.000157		
		(1.791)		
_constant	-0.030616	-0.027167	-0.028461	-0.029259
	(-3.324)	(-4.492)	(-3.348)	(-3.217)
R-square	0.0323	0.0064	0.0320	0.0302
Prob>F	0.0000	0.0743	0.0000	0.0000

* OLS regressions reported with robust standard errors
t-stats in parentheses; PCV1 = 1st pricipal component variable

Fig. 11. Test 3: $\beta_2 - \beta_1 = \zeta S_m + \eta_1 Z_{1m} + \cdots + \eta_5 Z_{5m} + \varepsilon_m$.

	Model*			
Independent Variable	I	II	III	IV
Private Sector PCV1	0.000171	0.000170	0.000056	0.000155
	(0.602)	(0.609)	(0.405)	(0.758)
Project Planning PCV1	-0.000550	-0.000540	-0.000533	-0.000525
	(-0.877)	(-0.878)	(-0.906)	(-0.829)
Civil Institutions PCV1	-0.000171	-0.000182		
	(-0.655)	(-0.655)		
Training & Capacity Building PCV1			-0.000024	
			(-0.063)	
Information Technology PCV1				-0.000445
				(-1.326)
% Pop. w/out Water	-0.000087		-0.000088	-0.000088
	(-2.363)		(-2.339)	(-2.412)
% Pop. w/Water (Int. Plumbing)		0.000135		
		(0.879)		
% Pop. w/Private Standpipe		0.000067		
		(1.639)		
% Pop. w/Public Standpipe		0.000101		
		(2.012)		
% Pop. w/out Sewerage	0.000085	0.000110	0.000087	0.000077
	(2.217)	(1.485)	(2.249)	(2.097)
% Pop. w/"Other" Sewerage**	0.000113	0.000139	0.000112	0.000103
	(1.793)	(2.481)	(1.850)	(1.725)
_constant	-0.001260	-0.012457	-0.001367	-0.000426
	(-0.393)	(-1.441)	(-0.404)	(-0.136)
R-square	0.0110	0.0114	0.0103	0.0116
Prob>F	0.0832	0.1422	0.0824	0.0635

* OLS regressions reported with robust standard errors
t-stats in parentheses; PCV1 = 1st pricipal component variable
** "Other" Sewerage refers to non-public-utility, non-septic-tank methods of sewerage disposal.

Fig. 12. Test 3: $\beta_2 - \beta_1 = \zeta S_m + \eta_1 Z_{1m} + \cdots + \eta_5 Z_{5m} + \varepsilon_m$.

Investment is also highest where few people have access to sewerage, or access to rudimentary sewerage, and decreases as municipal sewerage systems become widespread. These results point to investment that increases in need at intermediate and high levels of provision. But at the lowest levels of provision, local government fails to respond to need and central government is superior. The model can explain this indirectly, if in these neediest districts the costs and complexity of making initial investments in water are so great (e.g. from developing water sources, laying water mains and building treatment plants) that local governments cannot undertake them alone, but once these initial investments are made the marginal costs of extending the system are manageable. In the language of the model, central government has a cost advantage over local government

for initial investments, $\alpha < 1$. But at intermediate and higher levels of provision $p < 1$ and local government's needs-orientation dominates. Perhaps surprisingly, civic and institutional variables appear to have no effect on investment—only variables of need matter.

4.2.4. Agriculture

It is notable that even though agricultural investment decreased after decentralization—fewer municipalities invested here (see Fig. 8) and the mean difference in state variables is negative and significant—investment nonetheless increases with the male malnutrition rate, a finding which is insensitive to specification (Fig. 13). This implies that decentralized investment in this sector increases with need. Hence $p < 1$ in the model above. Once again participative planning techniques decrease agricultural investment under decentralization, and the number of private sector enterprises and civil institutions has no effect. Investment is similarly unaffected by local training and capacity-building programs and installed IT capacity.

4.2.5. Urban development

The initial (i.e. pre-decentralization) stock of infrastructure is used directly as the measure of need (Fig. 14). Investment under decentralization increases as the initial number of markets per capita increases, and as the number of general sports facilities per capita increases as well. Investment is thus decreasing in need in this sector, as opposed to the others considered above, and this finding is not sensitive to specification. Thus it

	Model*		
Independent Variable	**I**	**II**	**III**
Private Sector PCV1	-0.000286	-0.000665	-0.000837
	(-0.156)	(-0.466)	(-0.657)
Project Planning PCV1	-0.005871	-0.005644	-0.005932
	(-1.819)	(-1.727)	(-1.853)
Civil Institutions PCV1	-0.000401		
	(-0.226)		
Training & Capacity Building PCV1		-0.001492	
		(-0.420)	
Information Technology PCV1			0.000885
			(0.303)
Malnutrition Rate (Low), Males	0.000720	0.000680	0.000702
	(1.962)	(1.987)	(1.931)
_constant	-0.032749	-0.031594	-0.032157
	(-2.936)	(-2.981)	(-2.918)
R-square	0.0198	0.0209	0.0201
Prob>F	0.0768	0.0818	0.0798

* OLS regressions reported with robust standard errors
t-stats in parentheses; PCV1 = 1st pricipal component variable

Fig. 13. Test 3: $\beta_2 - \beta_1 = \zeta S_m + \eta_1 Z_{1m} + \cdots + \eta_5 Z_{5m} + \varepsilon_m$.

	Model*		
Independent Variable	I	II	III
Private Sector PCV1	0.004749	0.004869	0.005125
	(4.486)	(4.804)	(4.704)
Project Planning PCV1	-0.000801	0.000263	0.000175
	(-0.994)	(0.219)	(0.143)
Civil Institutions PCV1	0.000439		
	(0.750)		
Training & Capacity Building PCV1		-0.000540	
		(-0.716)	
Information Technology PCV1			-0.000609
			(-0.285)
# Markets per capita (1994)	0.136135	0.124015	0.108250
	(6.130)	(3.048)	(2.371)
# Sports Facilities per capita**	4.728497	4.758151	4.814974
(1994)	(2.815)	(2.991)	(3.013)
_constant	0.006800	0.005830	0.005801
	(4.340)	(3.244)	(3.176)
R-square	0.0684	0.0474	0.0474
Prob>F	0.0000	0.0000	0.0000

* OLS regressions reported with robust standard errors
t-stats in parentheses; PCV1 = 1st pricipal component variable
** Defined as other than football fields, multi-use courts and coliseums.

Fig. 14. Test 3: $\beta_2 - \beta_1 = \zeta S_m + \eta_1 Z_{1m} + \cdots + \eta_5 Z_{5m} + \varepsilon_m$.

would seem to be central government that more accurately assesses local need in this sector, and local government that mis-estimates it. Investment increases with the number of private sector firms, which is as expected given that urban development projects often result in lucrative contacts for these firms. Investment is unaffected by participative planning techniques and civil institutions, implying that it is not a high priority at the grass-roots level. Neither training programs nor IT affects investment.

5. Conclusions

Decentralization significantly changed public investment patterns in Bolivia. Throughout the country, investment changed unambiguously in education, water and sanitation, water management, agriculture and urban development after the 1994 reform. And these shifts are strongly and positively related to real local needs. In education, water and sanitation, water management, and agriculture, post-decentralization investments are higher where illiteracy rates are higher, water and sewerage connection rates lower, and malnutrition a greater risk, respectively. These changes were driven by the actions of Bolivia's 250 smallest, poorest

municipalities investing newly devolved public funds in their highest-priority projects. Decentralization thus led to higher investment in human capital and social services as the poorest regions of the country chose projects according to their greatest needs. In terms of the model of Section 3.2, this implies that decentralized provision dominated central provision in these sectors through local government's superior sensitivity to local needs. These results are consistent with evidence elsewhere (see Faguet, 2002, Chapter 3) that examines the broader determinants of central vs. local investment separately.

In econometric terms, the most interesting feature of the results is that no terms other than need are consistently significant across the five principal sectors analyzed. Relationships of need are robust and insensitive to specification. By contrast social, institutional and procedural variables are infrequently significant across sectors, and seem to account for little total variation.

Indeed, the only apparent effect of private sector firms is to transfer resources from education to urban development. Civil institutions are significant only for education, where they increase investment, and insignificant everywhere else. Training, capacity-building and IT are insignificant for all sectors. This implies that the differences in investment patterns chronicled above are not related to the number of private enterprises or civil institutions, or driven exogenously by training programs or information technology, but are instead determined by local needs. That decentralization in Bolivia led to investment increases in precisely those districts with the worst demographic indicators and infrastructure endowments runs counter to what numerous researchers, using mostly case studies and qualitative approaches, have found in the past. And it directly contradicts the common argument that decentralization leads to poor-quality government in communities that are deprived.

The data presented in this paper are from one of the poorest countries in the Western hemisphere, and took years to collect, clean and organize. But its quality is sufficient to permit significant and counter-intuitive results. This suggests that the application of a similar methodology—detailed econometric analysis of the *local* political economy—to more developed countries could prove quite fruitful. The increasing trend toward decentralization is also bound to provide more natural experiments for researchers to study. Lastly, the above analysis leaves open the question of how political power is distributed in a central government, the institutional mechanisms by which governments sense and take up local demand for public services, and the precise nature of the organizational or technical advantages or scale economies which might benefit one level of government over another. That is, p, θ_m and α are all exogenous here. Further research is needed to understand these processes and endogenize them in our models of public goods provision.[19]

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[19] I examine these questions elsewhere for the case of Bolivia; see Faguet (2002).

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Appendix A. Data summary

Variable	Obs	Mean	Std. Dev.	Min	Max
Principal Component Variables					
pcps1	302	-3.2400E-09	1.5298	-0.3015	18.0787
eereg_cm	306	202.7255	1229.8060	0	14117
eereg_ea	306	0.5556	2.0973	0	30
eereg_fi	310	2.6097	26.7243	0	454
pcpp1	310	2.3600E-09	1.5915	-2.7175	2.2313
catastur	310	0.1581	0.3654	0	1
dpoacoor	310	0.8548	0.9991	0	4
dpoaotro	310	0.6968	1.1790	0	4
epodham	310	0.8355	0.3713	0	1
evalres	310	0.8226	0.3826	0	1
idenalc	310	0.7968	0.4030	0	1
idencons	310	0.4129	0.4932	0	1
idencv	310	0.7323	0.4435	0	1
idenpdm	310	0.3742	0.4847	0	1
info_ed	310	0.5581	0.4974	0	1
info_sa	310	0.5839	0.4937	0	1
pdm94	310	0.3032	0.4604	0	1
plan_sye	310	0.5839	0.4937	0	1
reconu_a	310	0.6839	0.4657	0	1
pcci1	303	2.4000E-09	2.2150	-2.1130	14.5313
cv	310	0.6419	0.4802	0	1
indig2	310	0.6290	3.5208	0	51
jvec2	310	8.9548	26.2524	0	247
otbregi	308	34.25	41.3093	0	299
otbregi2	310	46.9226	49.6351	0	339
otbs_e	307	50.2280	59.0375	0	520
otbs_pj	305	43.8557	52.5067	0	416
otbsoli	308	40	43.9176	0	323

Variable	Obs	Mean	Std. Dev.	Min	Max
pctr1	310	-5.4000E-09	1.6762	-2.8227	4.2889
capadpe	310	0.2516	0.4346	0	1
capci1	310	0.2	0.4006	0	1
capci2	310	0.5710	0.4957	0	1
capdis	310	0.4871	0.5006	0	1
caplemu	310	0.3452	0.4762	0	1
caporad	310	0.3	0.4590	0	1
capprin	310	0.3613	0.4812	0	1
capprop	310	0.3903	0.4886	0	1
temacz	310	0.5194	0.5004	0	1
temadis	310	0.3161	0.4657	0	1
temaorad	310	0.5065	0.5008	0	1
temaprop	310	0.4290	0.4957	0	1
pbit1	310	1.6400E-08	1.5235	-1.5591	5.0864
sitotal	310	0.4355	0.4966	0	1
siotro	310	0.2226	0.4167	0	1
sisin_ad	310	0.1548	0.3623	0	1
sisin_ai	310	0.6968	0.4604	0	1
sisinidp	310	0.3258	0.4694	0	1
sicom	310	0.2806	0.4500	0	1
impresor	310	0.2903	0.8737	0	10
Need Variables					
sa_minsa	310	32.0264	20.0876	0	85.5147
sa_otro	310	4.3985	7.4206	0	65.2706
desmod	294	8.2202	4.4993	0	26.2548
dilos	310	0.9161	0.2776	0	1
analf	310	30.4638	15.8231	5.5	78.7
ed_alfa	310	69.0462	15.9098	21.2128	94.5433
edana6	310	26.5292	13.1925	6.3780	69.7183
dile	310	0.5032	0.5008	0	1
sin_alca	310	76.1424	21.8893	14.6586	100
sin_agua	310	74.3487	21.1723	17.9204	100
merca4pc	304	0.0014	0.0108	0	0.1517
infot4pc	286	6.0100E-05	0.0006	0	0.0095
deslevh	294	23.0698	7.2684	0	57.1429
sin_luz	310	76.0124	25.4209	5.9936	100
agua_nr	310	67.6176	23.3971	10.4521	100
alca_sin	310	76.2768	21.8418	14.6586	100
alca_otr	310	16.1283	16.3147	0	64.1026
agua_dv	310	8.9680	10.3644	0	56.4501
agua_fv	310	16.7037	13.7505	0	65.9341
agua_ft	310	6.7107	7.1615	0	48.2235
teatr4pc	304	2.8300E-05	8.3400E-05	0	0.0007

Appendix B. Methodology, including principal component analysis and interpretation

The surprisingly large amount of information available for Bolivia during the period 1987–1996 demands a strategy for choosing, from among 1200+ variables, those which are most appropriate and most closely related to the underlying concepts I wish to test. In particular, a number of measures in which I am interested are present in my dataset as multiple, finely differentiated variables. I have data on, for example, 16 varieties of capacity-building exercises undertaken by municipalities, and 13 different local actors who assisted in drafting municipal development plans. The challenge is to reduce such groups to at most one indicator each without loss of information.

My empirical strategy is iterative, and begins by finding the best idiosyncratic model of public investment for each of the 10 sectors of interest. I fit the equation

$$G_m = \zeta S_m + \eta Z + \varepsilon_m, \tag{B.1}$$

separately for central public investment (1991–1993) and local public investment (1994–1997) where G_m is aggregate investment per capita in the public good subscripted by municipality, S_m is a scalar or vector of the existing stock of public goods of that type (variously defined) at an initial period, and Z is a vector of socio-economic, demographic, regional, political, institutional, administrative and procedural variables which might affect investment decisions. The use of the Z term follows the literature on the demand for public goods exemplified by Bergstrom and Goodman (1973) and Rubinfeld et al. (1987) within the context of the available data. In particular, no income data are available at the municipal level in Bolivia, and so I substitute several alternative indicators of income and wealth, for example type of cooking fuel, and housing size, quality and related characteristics. But I expand the scope of the Z vector considerably compared to previous authors by including measures of the strength of local political forces as well as municipal institutional capacity. This innovation allows me to investigate the micropolitical basis of local government decision-making, explored in detail in Faguet (2002).

No constraints across sectors are allowed on the particular variables admissible in Z. I use the Huber/White estimator of variance to produce consistent standard errors in the presence of non-identically distributed residuals. This produces 10 different models of public sector investment, one for each sector. Individually these models are quite satisfactory, with high R^2 and few variables insignificant. But because of large variation in the specification of the Z vector, comparison across sectors is problematic. Additionally, on a theoretical level these models would seem to assert that public investment in different sectors happens according to different processes, in which different variables intervene. This is evidently unsatisfying.

In a second iteration I re-estimate Eq. (B.1) holding the Z vector constant across all sectors. But I take advantage of the previous stage by using only those variables found significant there; in this sense the previous stage constitutes a method for reducing the 1200+ indicators to a subset of 197. But a dimensionality problem persists even so. I then

employ a method of forward and backward substitution and elimination in order to reduce this subset to 22 variables encompassing the 13 categories of Z, in specifications of 23–30 variables overall. These models benefit from being readily comparable across sectors. The ratio of significant to insignificant variables drops sharply compared to the first stage, however, and R^2 values are somewhat lower.

The insignificance of the variables chosen is not entirely separable from the issue of comparability, however. In these results none of the variables is significant in most of the sectors, and many are significant in only 2 or 3. How do we interpret a given variable across sectors, knowing that an alternative one from the same group would produce a different pattern of significance and insignificance? For example, how do we interpret the insignificance of training and capacity-building variables in most models when we know from stage 1 that there is at least one alternative such variable that is significant in each sector? We evidently cannot assert for any sector that capacity building does not matter; we must conclude that the comparability constraint forces us to omit from our models information that is important in explaining investment behavior.

Indeed, given that there are 197 variables, many of them quite specific, which have explanatory power over the dependent variable, *any* subset of 20, 30, or even 100 will omit valuable information. We require a solution that allows us to retain the full breadth of information, and yet produce a specification which is both comparable and parsimonious. I turn to principal component analysis, a data reduction technique in which the objective is to find the unit-length combinations of explanatory variables with the highest variance. I follow Maddala (1977) in calculating variables z_1 to z_k where z is a linear combination of the x variables

$$z_1 = a_1x_1 + a_2x_2 + \cdots + a_Lx_L$$

$$z_2 = b_1x_1 + b_2x_2 + \cdots + b_Lx_L \text{ etc.}^{20}$$

ranked in order of variance, with highest first. Principal component analysis regresses y on $z_1, z_2, \ldots, z_k$, where $k < L$ and z's are constructed so as to be orthogonal. So long as the z's chosen represent combinations of variables that have economic meaning and can be interpreted, this provides a method for estimating parsimonious models with limited loss of information.

I calculate a set of principal component variables (PCVs) based on the raw variables retained in stage 1. I discard all those with low eigenvalues, as per normal procedure, and then find the remaining subset which optimally estimate Eq. (B.1), where Z is a vector of PCVs. The eigenvectors associated with each of the PCVs used in this article are listed below; factor loadings on the raw variables can be read vertically down each column. Detailed interpretations of each PCV follow.

[20] For further treatment of this topic, see also Greene (1997).

Eigenvectors and Factor Loadings

Civil Institutions

Eigenvectors

Variable	1
cv	0.09745
indig2	0.01988
jvec2	0.29229
otbregi	0.4194
otbregi2	0.43286
otbs_e	0.42137
otbs_pj	0.42934
otbsoli	0.42372

Project Planning

Eigenvectors

Variable	1
catastur	0.04701
dpoacoor	-0.00839
dpoaotro	-0.07581
epoaham	0.00306
evalres	0.07426
idenalc	-0.00973
idencons	0.0145
idencv	0.09214
idenpdm	0.14818
info_ed	0.53349
info_sa	0.51649
pdm94	0.14019
plan_sye	0.56911
reconu_a	0.24654

Training

Eigenvectors

Variable	1
capadpe	0.28556
capci1	0.30671
capci2	0.2612
capdis	0.2793
caplemu	0.34451
caporad	0.38803
capprin	0.37869
capprop	0.34559
temacz	-0.14204
temadis	-0.20036
temaorad	-0.22559
temaprop	-0.18667

Information Technology

Eigenvectors

Variable	1
sitotal	0.51744
siotro	0.36119
sisin_ad	0.42748
sisin_ai	-0.27289
sisinidp	0.28173
sicom	0.38812
impresor	0.3385

Private Sector

Eigenvectors

Variable	1
eereg_cm	0.61675
eereg_ea	0.56212
eereg_fi	0.55103

Interpretation of PCVS

Civil institutions: this is an indicator of the number of organizations and institutions of local civil society. It rises in all the variables, especially in the more general measures. I interpret it as a proxy for the strength of local civil institutions.

Private sector: this PCV rises in the number of private businesses registered locally. I construe it as an indicator of the dynamism of the local private sector.

Training: this variable rises in categories of training (i.e. institutional strengthening) received by the municipality and falls in those requested but not yet received. Hence I interpret it as a measure of the intensity of capacity-building efforts undertaken by/for local government.

Information technology: this PCV rises in the IT systems—hardware and software (especially software)—at the disposal of each municipality.

Project planning: this PCV loads positively where municipalities use information on education and health when planning projects, where sectoral regulations are followed in water and sanitation, where a Municipal Development Plan exists, and where councilmen and oversight committees identify investment projects using the MDP and urban cadaster. It loads negatively where the mayor is the one who identifies investment projects, and where problems arise with the Annual Operating Plan. This is thus a straightforward indicator of informed project planning which follows consensual and open procedures.

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