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Evidence from Small-scale Supply Systems in Rural Brazil

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Department of International Economic Policy
Institute for Economic Research
University of Freiburg
D-79085 Freiburg, Germany
Platz der Alten Synagoge 1

Tel: +49 761 203 2342
Fax: +49 761 203 2414
Email: iep@vwl.uni-freiburg.de

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What Determines Access to Piped Water in Rural Areas?

Evidence from Small-scale Supply Systems in Rural Brazil

Julia Alexa Barde, December 2014*

This paper compares the increases in access rates to piped water in rural Brazil by localized water supply systems under two different management models. It finds that small-scale supply systems operated and maintained by user associations lead to significantly higher increases in access rates than comparable systems implemented and operated by local governments. Additional results point towards higher accountability as the reason for better performance. This paper is the first to evaluate the success of community-based water supply projects in rural areas by comparing them to non-participatory projects and is based on a valid econometric identification strategy. As service delivery is decentralized in Brazil, the results also contribute to the discussion of the merits and risks of decentralized water supply. In order to overcome the endogeneity problem, I use a difference-in-difference estimator in combination with a kernel matching approach. Treatment effects are robust to various specification changes; tests show no structural differences between treatment and control groups.

*Julia Alexa Barde, Department of International Economics, Institute of Economic Research, University of Freiburg, Platz der Alten Synagoge 1, 79085 Freiburg, Germany. E-mail: julia.alexa.barde@vwl.uni-freiburg.de. The study in this paper benefited enormously from discussions with several people at the University of Freiburg: Günther G. Schulze, Bernd Fitzenberger, Krisztina Kis-Katos, Katrin Sommerfeld, Antonio Farfan-Vallespín, and the participants of our (joint) seminars. Part of this research was done during a research stay at IPEA/Rio de Janeiro, where several persons helped with very fruitful discussions and generously provided data access: Ronaldo Seroa de Motta, Erivelton Pires Guedes, José Ferres, Jorge Hargrave, and Eustáquio José Reis. The same is true for Antonio-Tadeu Oliveira (IBGE) and Léo Heller (UFMG). Research assistance by Gustavo Parra de Andrade, Leonardo Kröger, Leonardo Palhuca, and Flavia Sardinha is gratefully acknowledged. All these people considerably improved this research, all remaining errors are mine.

1. Introduction

Access to piped water has been increasing considerably in urban areas of the developing world over the last two decades. In rural areas, however, it is still lagging behind: Only 28 percent of the 1.6 billion people who gained access to piped water on premises between 1990 and 2012 live in rural areas (Joint Monitoring Programme, 2014b, p. 16). Worldwide, only a total of 29 percent of the rural population have access to piped drinking water on their premises today (ibid., p. 29). These figures show that most of the rural population are still deprived of safe, convenient, and cheap access to water. Access to piped water reduces significantly the risk of water-related diseases if compared to more basic solutions of access (Gamper-Rabindran et al., 2010; Jalan and Ravallion, 2003). It also increases the quantity used for all types of water-related activities and increases non-health related welfare by reducing the time spent on fetching water (Devoto et al., 2012; Ilahi and Grimard, 2000). Thus providing access to piped water to the rural population has become a policy priority in many middle income countries, which already have high levels of access to basic sources of improved water.[1] Brazil, for example, declared universal access to piped water a policy priority for the next twenty years (Ministério das Cidades, 2011a).

While the goal is thus clear, the way how increases in access rates to piped water in rural areas can be achieved most effectively has been discussed for the last four decades. Two central insights emerged from this debate so far. First, centrally supplied large-scale infrastructure for household connections as in urban areas is not an efficient solution in most rural areas in developing and transition countries. Low population density in rural areas impedes economies of scale, and remoteness from urban areas makes timely operation and maintenance by staff from central suppliers difficult (Cairncross and Valdmanis, 2006; Churchill, 1987; Isham et al., 1995). Second, the experience with donor-driven aid projects focusing on small-scale supply systems in rural areas has shown that top-down implementation of small-scale supply systems does not work either in most rural areas. Anecdotal evidence from the 1970s and 1980s shows that especially wells and stand pumps put in place by governments and development agencies in rural areas were most found in disrepair and unused only after a short time. In some places, rural communities did not perceive new wells and standpipes as improvements over the old wells and buckets they had been using so far and continued to use traditional sources (Briscoe and de Ferranti, 1988). In

[1] The WHO and UNICEF categorize water sources according to their potential to protect drinking water from outside contamination (Joint Monitoring Programme, 2000, 2014a). Access to piped water on the premises is classified as an improved water source. Public taps and protected boreholes or wells on the premises as other (more basic) improved sources. See Chapter 2.2 for further discussion.

other places, the communities did not feel responsible for systems implemented by external agents and did thus not contribute to their maintenance (Kleemeier, 2001; Whittington et al., 2009). Based on these experiences, development experts started to recommend participatory, community-based approaches in order to set up successful small-scale water supply systems in rural areas. The idea was that if users choose convenient technologies and service levels and contribute money or labor, they would increase sustainability of the systems by taking care of operation and maintenance (Joint Monitoring Programme, 2000; World Bank, 2003b). Today, donor-driven community-based projects are ubiquitous in the developing world (Mansuri and Rao, 2004; Prokopy, 2009).

Do community-based participatory projects live up to these expectations and lead to better access to safe water in rural areas? The quite extensive literature on the effectiveness of community-based and participatory projects in health and education in principle attests good performance with respect to the quality and quantity of service delivery.[2] Evidence from the supply of drinking water is, however, limited. The existing research focuses mostly on the determinants of success of community-based drinking water projects at the household or village level by comparing different community-based projects (Isham and Kähkönen, 2002; Madrigal et al., 2011; Marks and Davis, 2012; Prokopy, 2004, 2005, 2009; Sun et al., 2010). Results indicate for example that participation of beneficiaries needs to be more substantial than pure contributions of cash or labor to make participation a success, and that success is largest if beneficiaries are involved in decisions about supply system location, technologies of supply, and implementation timing. While this type of insights is indispensable to inform successful project design, these studies cannot establish whether non-participatory project types would perform worse in comparison (Mansuri and Rao, 2013). None of the above studies uses traditional top-down projects as comparison group. Only such a comparison could establish whether community-based projects are more effective in increasing access to safe water in rural areas than non-participatory projects.

A very small number of papers tries to compare community-based projects to top-down projects. Newman et al. (2002) find with a small sample from Bolivia that water quality

[2]Mansuri and Rao (2004) survey numerous randomized studies that show e.g. increases of school attendance or vaccination rates among children, improvements of test scores, and decreases in below age of five mortality rates due to community involvement in projects. See Banerjee et al. (2010), Bjorkman and Svensson (2009), and Pradhan et al. (2014) for recent examples. Kremer and Holla (2009) provide a review about participatory development projects in education. Mansuri and Rao (2013) provide a comprehensive review of evaluations of community-based projects in forest and other natural resources management as well as in the health and education sector. Results show that community participation "modestly improve[s]" the desired outcomes such as resource management and infrastructure quality (Mansuri and Rao, 2013, p. 6).

of wells from community-based projects is higher than water quality from old, centrally implemented wells if the community gets trained in maintenance. Sun et al. (2010) find in a cross-sectional analysis that the mere presence of a water and sanitation association in villages in rural Ghana correlates positively with higher access rates to safe drinking water and with better quality of the water. Narayan (1991) and Isham et al. (1995) find in a document-based review of 121 rural water supply projects in Asia, Latin-America, and Africa that more intensive participation forms lead to higher access rates to safe water. In the projects with the lowest participation intensity in this study, external implementation agencies share at most information about the project design with the beneficiaries. This comes very close to non-participatory projects. Sara and Katz (2005) analyze field data from 125 rural water projects from all over the developing world in the 1990s. They find that the more the projects were demand-driven, the more sustainable they were over time. All projects in this study were, however, meant to be managed and operated by the users after implementation and are as such not truly non-participatory at the stage of evaluation.[3] Although these results are very suggestive, they are either descriptive by definition, use comparison groups that are not truly non-participatory, or use cross-sectional estimators, which do not allow for reliable conclusions. This literature, however, does not allow answering the question whether community-based water supply projects increase access to safe water by more than projects implemented and managed by government units. Yet, only this finding would enable evidence-based policy approaches and legitimize the huge investments into participatory water supply projects, which are currently undertaken all over the world. This paper tries to close this gap with an econometrically sound evaluation of participatory versus non-participatory drinking water projects in rural Brazil.

The contribution of this paper to the literature on community-based drinking water supply is twofold. First, based on data from rural Brazil, it addresses the fundamental question whether participatory approaches in water supply perform better than top-down approaches. It evaluates and compares the increases in access rates due to small-scale water

[3] Mansuri (2012) compares the success of community-based infrastructure projects in Pakistan to projects implemented by the (central) government. She finds that design and construction in community-based projects outperform government projects. Khwaja (2009) compares community-based infrastructure projects induced by a local NGO in Pakistan to community-based projects induced by government departments and finds that the NGO-induced projects lead to better maintenance of infrastructure. Mansuri (2012) has not yet been published as a scientific research paper, and it is not entirely clear from the descriptive source whether government projects in her study are left to community management after completion, as it is the case in the project analyzed by Khwaja (2009) and Sara and Katz (2005), or whether operation and maintenance are further assumed by the government, as it is the case in this research.

supply systems that were implemented and managed by water user associations between 2000 and 2008 to systems implemented and managed by local governments during the same time. It also provides evidence on why participatory projects might perform better than non-participatory projects.

Second, this paper improves on the econometric approach used in the literature on community-based water supply so far. The main methodological issue when comparing two types of projects is the endogeneity of the project type. Communities in which water user associations implement projects to improve water access could be systematically different from communities with non-participatory projects. If one of these differences, for example higher bureaucratic efficiency of the municipal administration, increases the probability of a participatory project and the performance of the new water supply project at the same time, the effect of interest – the effect of user participation on access rates to piped water – would be biased by an omitted variable. The studies by Newman et al. (2002), Sara and Katz (2005) and Sun et al. (2010) are cross-sectional analyses, which do not address this potential endogeneity of project type choice other than by controlling for a limited set of potential determinants of project success and project type. In contrast, this paper uses a large panel of Brazilian municipalities and compares participatory project performance to non-participatory project performance. The comparison is based on a difference-in-difference estimator, which controls for all unobserved time-invariant heterogeneity that could affect project type choice and project performance at the same time. The difference-in-difference estimator is complemented by a multinomial matching approach (Lechner, 2001). Matching assures that the treatment municipalities with participatory water supply projects are as similar as possible to the control group with non-participatory local government projects with respect to all time-invariant and time-varying observable variables, which could simultaneously determine access to piped water and project type choice. In order to shed light on the circumstances and drivers of project choice, the estimation of propensity scores for the matching is informed by semi-structured interviews that were conducted with municipality officials and experts from the water sector in Brazil. In absence of a natural or quasi-natural experiment, this combined strategy of a matching and difference-in-difference estimator to control for all systematic differences between the two project groups allows to come as close as possible to the causal effect of user participation on access rates in rural areas. Several robustness checks and checks for structural differences between treatment and control group underline the validity of this econometric approach.

Apart from the contribution to the analysis of community-based drinking water supply, this paper also contributes to the literature on decentralized service delivery in developing and transition countries. In Brazil, the smallest jurisdictional unit, the municipality, is responsible for local service delivery in health, education, and water and sanitation (Arretche, 2004). Furthermore, mayors and municipal councils are re-elected every four years and therefore directly accountable to the beneficiaries of local service supply. Such a setting can have two opposing effects. On the one hand, local politicians and officials are supposed to know better about the needs of their constituency than higher government layers and, due the re-election constraint, they probably will also better respond to these needs (Bardhan, 2002; Seabright, 1996). On the other hand, decentralized financial and program responsibilities also increase the risk of corruption of the democratic process by local elites (Bardhan and Mookherjee, 2006). There is evidence from developing countries that, if electoral accountability is low, earmarked public transfers by the central level to local government units may be diverted by local elites (Reinikka and Svensson, 2004), or that (non-earmarked) local budgets may be misused by local officials in order to cater to their families or networks (Sjahrir et al., 2014). In this paper, I compare the increase in access rates to piped water in rural areas that are either provided by a water-user association or a local government project. This comparison does not only allow to study the effect of participatory approaches but also to analyze the performance of their decentralized counterparts. In principle, both types of projects, community-based projects and projects by local governments, are close to the beneficiaries and accountability is therefore high. However, due to direct user involvement, accountability in water-user association projects may be higher.

The results confirm the main hypothesis of the study: Whereas municipalities with local government projects do not experience increases of access rates that are significantly different from the national trend, municipalities with user associations realize increases of around 6 percentage points above the average. The results further suggest that the better performance of community-based projects is due to higher accountability in participatory projects. In municipalities where government projects are implemented and accountability is stronger because of the presence of local media or social pressure groups, access rate increases are comparable to those in community-based project areas.

The study proceeds as follows. The next section explains the institutional background of the water supply sector in Brazil and describes the developments of small-scale supply systems. Section 2 presents the data for the empirical analysis and provides descriptive evidence. Section 3 discusses the empirical identification strategy. Section 4 analyzes the choice of the different project types based on the interviews with academic and sector experts. Section 5 presents results and robustness checks. Section 6 analyzes the heterogeneity of treatment effects and the channels by which user associations lead to higher increases in access rates. Section 7 concludes.

2. Rural Water Supply in Brazil

2.1. Institutional Background

The current situation in the water sector in Brazil has been shaped by the heritage of the military regime and its sectoral policy in the 1970s, the *Plano national de saneamento basico* (PLANASA).[4] It explicitly favored the urban over the rural areas (World Bank, 1979). From before the military regime until the end of PLANASA in 1992, access to piped water on premises increased significantly in Brazil from around 30 percent in 1950 to around 60 percent in 1990. But while access to piped water at home from the general network was 80 percent in the urban areas in 1990, it was only 6.6 percentage in the rural areas (IBGE, 1991; Rezende and Heller, 2002).

In order to enable the large overall expansion of access to piped water, the military regime founded 26 regional state-owned water and sanitation companies at the level of the Brazilian states in the 1970s. The *Companhias Estaduais de Saneamento Basico* (CESB) operated at the level of the states and were meant to replace the municipality governments in the water sector who whad been in charge of supplying water up to this time. Funds for investments into the sector were centralized and only accessible for municipalities through concessions to the regional firms. As the CESB focused on urban access and municipalities could not invest on their own, most available funds for the sector were channeled towards urban areas for at least the next 20 years.[5] With the new constitution in 1988 and the following decentralization, the responsibility of the municipalities for water and sanitation supply was again enshrined in law.[6] However, the new democratic federal government did

[4]The description of the historical development of the sector is based on Rezende and Heller (2002) and Heller (2006), unless otherwise mentioned.

[5]Not all municipalities joined the CESB. Around 1,000 of the 3,974 Brazilian municipalities, predominantly the wealthier municipalities with well functioning infrastructure, continued to provide water on their own. World Bank (1979) names a few centrally-implemented rural development projects during the military regime. However, they were all marginal when compared to the urban expansions mentioned above.

[6]The constitution is not entirely clear about the level of government that has the ultimate decision making power with respect to water and sanitation provision. In particular, there is considerable uncertainty about the responsible body in metropolitan areas as the constitution also defines the federal states to be in charge of water and sanitation supply in these areas. Since the financial viability of many regional firms depends on the concessions for the large metropolitan areas, the right of the municipalities to

not start to work on a new sector policy until the mid 2000s. After the end of PLANASA in 1992, the CESB continued to exist and still dominate water supply in Brazil today. As of 2008, the majority of the municipalities, 63 percent, were invariably supplied by regional companies, who still focus on urban areas.[7] Despite decentralization, municipalities' budgets still cannot cover sector expansion due to the large investment requirements (Arretche, 2004). Funding availability from upper government layers, especially for local governments, remained also limited until the end of the 1990s. This tight budget situation is one of the leading causes why the CESB still dominate water supply today. Due to this long decelerated transition to financially decentralized service delivery after the end of the military regime, rural water supply in Brazil is still strongly lagging behind the urban areas.

2.2. Access to Piped Water in Rural Brazil

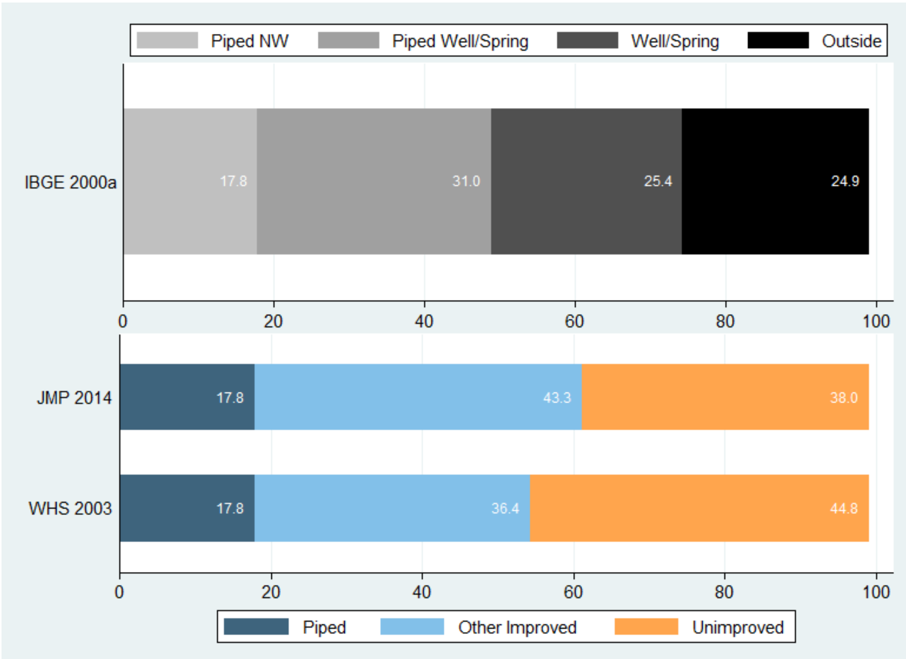
In the beginning of the sample period of this study, in the year 2000, only 17.8 percent of the rural population had access to piped water on premises from the general network (IBGE, 2000a). In contrast, 89.1 percent of the urban population was connected on their premises to the general network. Figure 1 lists the different access types that prevailed in rural Brazil in 2000 according to census data (first row, IBGE 2000a). 31 percent of the rural population also used water from taps in their homes or on their lot, however, water to these taps came from private wells or springs on their premises and not from the general network. 25.4 percent of the rural population used water from private wells or springs without a pipe system. 24.85 percent fetched water from sources outside their lot. These figures from the Brazilian Census do not classify water sources according to the level of protection against pollution that they offer. It thus remains unclear from row 1 how large the need for access to safe water in Brazil in 2000 actually was.

Row 2 and 3 in Table 1 show the assessment of the situation by two different international data sets. Whereas access to piped water from the network is considered to be safe in general, private wells or springs, which are used by a total of 56.4 percent of the rural population in Brazil, are not all considered improved water sources. Since private wells

decide about the type of provider has been questioned at this level (Castro Galvão, 2009). Recently, the Brazilian constitutional court issued a decree with respect to clarify the issue. As this study focuses on rural areas and is not studying ownership effects of main suppliers (see below), this uncertainty does not affect the present study.

[7]Own calculations based on PNSB 2008, see section 4.1. If the focus on urban areas reflected political goals in the 1970s, the CESB nowadays focus on urban areas rather because of the huge costs that connecting the rural areas to the central system would entail. See section 4.2 for further details.

Figure 1: Access Types to Drinking Water in Rural Brazil in the Year 2000, According to Different Categorizations



Notes. The table shows the access rates to different types of water according to the Brazilian Census in year 2000 in row 1 (IBGE, 2000a). "Piped NW" means piped access to water from the general network, "Piped Well/Spring"' piped access to water from a private well or spring on the premises, "Well/Spring" access to a private well or spring on premises, and "Outside" access to a water source outside the own yard or plot. Rows 2 and 3 show how the Joint Monitoring Programme in 2014 and the World Health Survey from 2003 assess the access situation in 2000 with respect to the potential protection against pollution following the JMP definitions of improved (piped and other improved) and unimproved water access. Around 1 percent of the population surveyed in the census did not provide information. Rows 2 and 3 can be found in Joint Monitoring Programme (2014a).

and springs deliver *a priori* untreated groundwater, the water quality depends on the protection against pollution from organic or chemical matter that they provide. This is a function of the depth of the well, the depth of the aquifer, the type and condition of casing and head of the well, and the distance between the well and polluting activities (Conboy and Goss, 1999). These aspects determine the distance bacteria have to travel to reach the water table. The Joint Monitoring Programme by the WHO and Unicef (JMP) accordingly identifies wells that allow for access to safe water by their condition, casings, and heads (Joint Monitoring Programme, 2014b). Using the census data from 2000 shown in table 1, the JMP considers all wells in rural Brazil that are connected to water pipes for internal distribution ("Piped from Well/Spring") as improved water sources. Further, it assumes half of all wells and springs without piped distribution system ("Well/Spring") as improved water sources (Joint Monitoring Programme, 2014a). The World Health Survey from 2003 qualifies this very optimistic understanding of the census data. It finds that only 36.4 percent of the Brazilian rural population uses improved private wells. According to these two sources, between 38 and 44.8 percent of the rural population in Brazil had access to unsafe water sources in 2000. Scientific reports from the field portray an even worse situation and document large samples of contaminated wells despite of adequate linings and protection (Bortoluzzi et al., 2007; Heckman et al., 1997a; Nogueira et al., 2003).

Pollution is not the only problem of private wells in rural Brazil. As they are mostly connected to shallow aquifers, they may dry out relatively quickly in times of drought. This is especially relevant in the semi-arid North-east of Brazil (Döll and Hauschil, 2002; Finan and Nelson, 2001; World Bank, 2003a). None of the above assessments of the water access situation in rural Brazil takes this factor into account. Therefore the 38 to 44.8 percent may even underestimate the lack of safe water in rural Brazil. Against this background, access to safe water seems to be guaranteed in the best way by access to piped water from a central supply system that is connected to either a deep aquifer or to a larger reservoir. Deep aquifers, reservoirs, and distribution pipes to the households assure protection against pollution and hold available larger quantities of water. From the early 1990s on, local initiatives started therefore to connect rural populations to central water supply systems.

2.3. Local Initiatives to Increase Rural Water Access

In spite of the predominance of the regional CESB and their continuing focus on urban areas, the larger autonomy of local governments in terms of sectoral policy as well as the availability of new public funds for infrastructure projects at the local level have led to a considerable change in the provider situation since the the beginning of the nineties. In several states in North-eastern Brazil, state governments together with international development agencies have launched development projects to provide funding and operational support to rural communities that wanted to put in place new water supply systems.[8] In some cases the projects cooperate with the CESB of the respective state, which provides technical assistance to the communities. In Bahia, CENTRAL, an umbrella association for community-level user associations managing small-scale water supply systems, started in 1995 and provides rural communities with blue prints for organizational structures, technical assistance for project implementation, and funding. In Céara, the state government founded SISAR, which, financed by the German development bank KfW, builds on CENTRAL's experience and implemented projects in around 127 municipalities until 2009. In Piauí, a similar organization, PROSAR, was launched in 2003, which implemented projects in 13 municipalities until 2008. All of these projects have in common that money is directly transferred to pre-existing user associations and that involvement of the local government is relatively small. As municipal governments have been responsible for water and sanitation provision since decentralization by constitution, there has to be some minimal involvement to officially devolve responsibility from the local government to the water user association. The degree of involvement varies. In most cases the local government signs a concession contract to transfer responsibility for provision to the association. In some other cases, as for example with SISAR, the municipality holds up to 20 percent of the seats in the project council that manages the new small-scale systems. The new water systems mostly consist of a new deep well and a distribution system to all households within the community.

Beside donor-funded projects other initiatives also emerged. In Rio Grande do Norte, where water is scarce due to the semi-arid climate, CAERN, the regional state-owned water company, developed a specific program providing funding for rural communities that live close to main pipelines connecting urban centers to reservoirs and dams. Conditional on the existence of an association that manages the system and pays for all investment within the community (pipes, hydrometers), CAERN pays and builds a connecting supply line from the main pipe to the community.

Apart from these rather institutionalized processes that allow organized communities to be part of a larger project, associations also get active on their own. Since associations cannot apply independently for public funds in Brazil, they cooperate with local governments in order to access funding from specific state and national programs. Municipalities

[8] The following description is based on Ministério das Cidades (2011b), which provides a detailed discussion of the different projects. Heller (2006) provides another description of the projects mentioned here. See Coirolo and Lammert (2009) for an additional description of the World Bank-funded projects.

can apply for these programs and then transfer money or ownership of systems to the associations. This happens especially in the richer South of Brazil, where sub-national development programs like in the North-east are rare.

In the period 2000 to 2008, water user associations with or without the help of larger umbrella projects implemented small-scale supply systems in almost 600 Brazilian municipalities (see section 4.1 below). In the same time, local governments put in place small-scale water supply systems in another 600 municipalities. This paper compares the increases in access to piped water in rural areas in areas supplied by user associations and areas provided for by local governments. Table 1 shows the increases in access rates to piped

Table 1: Piped Water Access Rates by Provider Situation

Variable	**No change**	**+ loc**	**+ assoc**	**Difference**
# of observations	*3717*	*592*	*583*	**+loc/+assoc**
		Mean Values 2000		
Total access rate	.59	.528	.549	0.021
Urban	.866	.832	.859	0.027**
Rural	.152	.153	.160	0.007
		Increase between 2000 - 2010		
Total access rate	.094	.101	.143	0.042***
Urban	.047	.048	.071	0.023***
Rural	.085	.096	.174	0.079***

Notes. The table shows mean values and average increases between 2000 and 2010 by supplier situation. The last column shows the differences in means of the municipalities with local government projects and association projects. ** difference significant at 5% level, *** difference significant at 1% level. Data from IBGE (2000a) and IPEA (2014).

water on premises from the general network in Brazil in 2000. It distinguishes between municipalities without any specific rural project ("No change"), municipalities in which user associations implemented new supply systems ("+ assoc"), and municipalities whose local governments put in place new supply systems in rural areas ("+ loc"). Whereas access rates in the year 2000 were distributed relatively evenly over the three types of municipalities, the increases until 2008 differ substantially. Municipalities in which water user associations implemented new supply systems experienced on average larger increases in access rates in the total municipality, but also in rural and urban areas separately. This observation motivates the present research and at the same time highlights the main threat for identification. Is it true that municipalities with user associations experience significantly larger increases of rural access rates to piped water because the new projects are implemented and managed by the users themselves, or are there some other common factors in these municipalities that drive the increases? If the larger increase in rural areas can be econometrically isolated from the increase in urban areas (where the small-scale supply systems are not implemented), this would confirm the hypothesis that user involvement leads to better project performance in the rural water supply sector.

3. Methodology & Identification

In order to compare the increase in access rates in the two types of rural projects, I run the following specification on the sample of municipalities with local government and water user association projects:

$$y_{it} = \alpha + \beta_1 D.ruralassoc_{it} + \mathbf{X}'_{it}\beta + \delta_i + \mu_t + \epsilon_{it} \quad (1)$$

where y_{it} is the access rate to tap water in rural areas of municipality i in year t and $D.ruralassoc_{it}$ is the treatment dummy, which is one if a water user association implements the project in this municipalities' rural areas and remains zero if a local government sets up the new system. β_1 thus measures the difference in access rate increases between rural areas with water user association projects and with local government projects. $\mathbf{X}_{it}$ is a vector of time-varying control variables, δ_i stands for a vector of municipality dummies, and μ_t for year dummies. ϵ_{it} is a time-varying, municipality-specific error.

One obvious concern with this specification is that determinants driving the choice of the project type (participatory or non-participatory, where participatory is the treatment) also determine the outcome variable, the access rate to piped water. The coefficient of the treatment indicator, β_1, would be biased in this case. Ideally, in order to discard any bias from selection into treatment, one would like to compare the differences in outcomes of treatment municipalities that took part in the treatment and of treatment municipalities that did not. Applied to the problem at hand this means that one would like to compare municipalities in which water user associations implemented water supply projects (the treatment) to municipalities in which the probability that a water user association implemented and managed the new project was exactly of the same magnitude as in the treatment municipality (i.e. they could have been a treatment municipality) but the project was eventually (and randomly) implemented by the local government and not by a water user association. Obviously, the second group of municipalities which is exactly equal to the treatment municipalities but is nevertheless not in the treatment group does not exist. I use a matching approach to come as close as possible to this ideal control group. With matching the missing counter factual mean outcome of this group is estimated from the existing observations, which are reweighed according to their probability to select into treatment. The weights are calculated from the estimation of the propensity of treatment. Matching may outperform linear estimation of an almost fully saturated model if the distribution of the averages of the covariates of treatment and control group are very different or if the conditional expectations of these values are non-linear (Imbens, 2014). Matching estimators relax the strong functional assumptions of linear estimators and assure that the mean outcome value of the control group is extrapolated from a comparable part of the distribution. Matching thus assures that treatment and control group are as similar as possible to each other.

Apart from observed heterogeneity, which I address by matching techniques, a far larger concern is unobserved heterogeneity, which could also bias the estimation of the effect of interest. Matching relies, as linear estimators do, on the assumption of unconfoundness: Conditional on the determinants of treatment selection (or the propensity to select into treatment), the outcome has to be independent of selection into treatment. Therefore, I base the analysis of the effect of interest on an estimator exploiting the within variation of access rates in rural areas at the municipality level. This allows the outcomes to be dependent on time-invariant unobserved determinants of treatment selection and prevents any bias from such variation. Heckman et al. (1997b, 1998) propose such an estimator, which combines both elements, the matching and the difference-and-difference estimator: It weighs the comparison observations in the difference-in-difference setting with a kernel that minimizes a weighted difference in propensity scores between treatment and control group.

I use multinomial probit estimation in order to estimate the probability that a municipality chooses a specific project type, i.e. the treatment propensity. The dependent variable for this estimator is a categorical variable that allows for the three main situations of water supply in rural areas that I distinguished in table 1: municipalities without any specific project in rural areas in 2008, municipalities with user association projects in 2008, and municipalities with local government projects in 2008. The next section will substantiate the choice of the dependent variable and the grouping of the three categories. Even though I can eventually only compare two situations at the time using the difference-in-difference estimator with kernel weights (here participatory vs. non-participatory projects), the multinomial setting allows to include all three options that municipalities have. By using multinomial probit, I follow Lechner (2001, 2002) and first predict the probabilities for all three options from a multinomial probit using the group of municipalities without specific rural projects as the baseline category. Using these predicted probabilities, I then compute the conditional probabilities of the two options that I want to compare. Finally, I use these conditional probabilities as propensity scores in the matching approach of Heckman et al. (1997b).

Apart from the direct comparison of the increases in access rates in rural areas with the two project types it would also be interesting to compare these increases to the general increase in access rates in rural areas without any specific project. I therefore run the following specification with the total sample of all Brazilian municipalities:

$$y_{it} = \alpha + \gamma_1 D.ruralassoc_{it} + \gamma_2 D.ruralmun_{it} + \mathbf{X}'_{it}\beta + \delta_i + \mu_t + \epsilon_{it} \qquad (2)$$

The coefficient γ_1 now measures the difference in access rate increases in rural areas of municipalities with user association projects and municipalities without specific project in its rural areas. γ_2 measures the same difference for municipalities with local government projects and without any project. Thus, specification 2 allows a comparison of the increases in access rates in rural areas of municipalities with rural projects to the average increase in access rates to piped water in rural areas in Brazil, and therefore allows putting into perspective the performance of the two project types. As in the unweighted version of specification 1, the coefficients of interest, γ_1 and γ_2, might be biased because of confounding variables that are not captured by the difference-in-difference setting. However, as explained above, the propensity scores predicted from the multinomial probit can only be used to compare two types of municipalities at a time. Thus, a comparison of all three situations at once is not possible. I will present unweighted results for specification 2.

4. Data & Propensity Score Estimation

4.1. Data

In order to study the effects of different types of management, I use data from two main data sets, the *National Basic Sanitation Survey* (*Pesquisa Nacional de Saneamento Basico, PNSB* in the following) and the national census, and data from *Ipeadata*.[9] The *PNSB* provides information about the provider situation for all Brazilian municipalities in the years 1989, 2000, and 2008. Most importantly, it lists the number and types of water suppliers that provide access to piped water on premises. Such providers can be local governments or local firms, water user associations, or regional firms (CESB). *PNSB* thus

[9] *PNSB* and census data used in this study are available through the *Banco Multidimensional de Estatísticas* by the Brazilian Statistical Office (www.bme.ibge.gov.br). The 1989 wave of *PNSB* is not available online. The economic research institute *IPEA* provides free access to harmonized data from various Brazilian data sets through its online service *Ipeadata* (www.ipeadata.gov.br).

allows to follow the emergence of new water supply projects in all Brazilian municipalities. Table 2 shows the provider situation in all Brazilian municipalities for the three points of

Table 2: Provider situation in 1989, 2000 and 2008 in Brazil

	(1) CESB	(2) Local	(3) Main + loc	(4) Main + assoc	(5) Main + loc + assoc	(6) Other	(7) Missing	(8) Municipalities
1989	2674	999	566	.	.	3	249	4491
2000	2663	1379	956	131	53	209	188	5507
2010	2139	1366	1119	435	256	116	133	5564

Notes. The table lists the number of municipalities in the three years according to their water supplier. The main supplier can either be exclusively a CESB or a local provider (columns 1 and 2), or the main supplier (CESB or local provider) can be complemented by an additional provider in rural areas (columns 3 to 5). "Main + loc" means that the main provider is complemented by an additional small-scale supply system by the local provider, "Main + assoc" means that a water user association manages an additional small-scale system, and "Main + loc + assoc" means that both providers manage an additional system. "Other" includes municipalities supplied exclusively by private providers or intermunicipal/-federal cooperatives. "Missing" is the number of municipalities that did not provide information for PNSB. "Municipalities" is the number of total municipalities in Brazil. Data from Pesquisa Nacional do Saneamento Básico (PNSB) and IBGE (2012).

time according to *PNSB*. In the year 1989, CESB supplied water to 2674 municipalities and local providers provided water to 566 municipalities (columns 1 and 2). Until the year 2000, the provider situation became more diverse and apart from the 2663 (1379) municipalities exclusively supplied by a CESB (local provider), 956 municipalities were supplied by a main provider (CESB or local provider) and an additional local provider (government or firm, column 3). In 131 municipalities, a water user association complemented the main provider (column 4), and in 53 municipalities, both, an additional local provider and a water user association were providing water (column 5). It is exactly these last cases (rows 3 to 5), in which additional water providers appear in between the two waves, that are of interest in this study. They indicate that a new small-scale system was set up in the rural areas of the municipality and also indicate by whom. With this information I construct the dummies *D.ruralloc* and *D.ruralassoc*, which turn one if a new (additional) project by a local provider or by a water user association appears in a PNSB wave, respectively. If both types of projects appear within the same municipality, I put these municipalities into the category *D.ruralassoc*.[10] From 2000 to 2008, local governments put in place new water supply systems in 592 municipalities and water user associations set up new systems in 583 municipalities.

The last column in Table 2 shows the the total number of municipalities. Due to frequent changes of municipality borders after the end of the military regime, the number of municipalities heavily increased between 1989 and 2000. As the municipalities in *PNSB* cannot be harmonized between the two waves of 1989 and 2000, I can not use the first

[10] Using them as a single category in specification 2 and in an unweighted version of specification 1 does not change the results in any significant way.

wave. It is not possible to link access rates to piped water from the total municipality in 1989 to access rates of the daughter municipalities in 2000. Thus, the effect of a new project cannot be isolated as the exact group that benefits from the project is not available. I therefore only use the waves of 2000 and 2008 and exclude the much smaller number of municipalities that split between these two years. I run robustness checks in section 5.2 in order to assure that this sample selection does not affect my results.

I combine the provider information from *PNSB* with information at the municipal level from the censuses from 1990, 2000, and 2010 and *Ipeadata*. Table 3 and 4 show summary statistics at the municipal level for the year 2000.[11] All variables are presented according to their (future) provider situation in 2008. This allows assessing the differences between the municipalities that decide for one of the two project types between 2000 and 2008 and those who do not create additional projects. The descriptive statistics thus shed light on unconditional pre-treatment differences that could drive the decision to implement a specific project type (or not) and the access rates in the municipalities. The first block of table 3 shows that municipalities with rural initiatives by local governments are remarkably similar in distributions of important socio-economic aspects such as GDP per capita, administrative spending, spending on health and water and sanitation, or the rate of urbanization to municipalities with association projects. Municipalities with local governments investing in rural projects are a little bit larger on average and population density is higher. A significant difference is that social movements requesting access to piped water for unconnected districts are observed in 25.6% of the municipalities in which a local government became active between 2000 and 2008 and only in 10.5% of the municipalities where user associations became active.[12] Further, the latter are better educated on average and predominantly situated in the North-east and South of Brazil. Local governments started projects mainly in the Southeast and North-east. Compared to municipalities without any specific rural activities, municipalities with rural projects are on average smaller and less urbanized, poorer and less developed. Table 4 compares the situation in urban and rural areas of the three different groups and shows mean alphabetization rates, median monthly wages, and median years of schooling of household heads. Whereas the split between rural and urban areas among the non changing-municipalities and the project municipalities shows the same picture as before, the ratios reveal that with respect to education, rural areas in project municipalities perform a lot worse than their urban counterparts. That

[11] The appendix lists all variable definitions and sources for the variables used in this paper.

[12] Each municipality is composed by one or more districts, territorial sub-units without administrative powers. Usually, there is one district per village outside the seat of the municipality.

Table 3: Descriptive Statistics for the Year 2000 by Supplier Situation in 2008 at the Municipal Level

Variable	**No change**	**+ loc**	**+ assoc**
GDP pc	4.201	3.190	3.131
	(4.945)	*(5.214)*	*(3.446)*
Tax income pc	.151	.071	.100
	(.704)	*(.092)*	*(.276)*
Admin spending pc	.742	.648	.651
	(.309)	*(.274)*	*(.174)*
GDP share agric (%)	.281	.280	.256
	(.185)	*(.165)*	*(.181)*
Health & WSS exp pc	.496	.390	.396
	(.562)	*(.206)*	*(.235)*
Income gap (10/40)	23.759	29.328	24.931
	(57.086)	*(74.071)*	*(22.446)*
Higher education (%)	3.422	2.317	2.914
	(2.989)	*(2.238)*	*(2.672)*
Longevity	.716	.680	.694
	(.081)	*(.082)*	*(.075)*
Population size	27,780.72	23,406.02	22,090.03
	(185317.3)	*(54321.93)*	*(54877.09)*
Population density	.119	.122	.079
	(.364)	*(.251)*	*(.140)*
Urbanization rate	.593	.536	.541
	(.232)	*(.210)*	*(.199)*

Variable	**No change**	**+ loc**	**+ assoc**
# of districts	1.598	1.759	2.176
	(1.981)	*(1.44)*	*(2.063)*
South	.211	.155	.282
	(.408)	*(.363)*	*(.450)*
Southeast	.335	.232	.044
	(.472)	*(.422)*	*(.206)*
North	.057	.049	.003
	(.232)	*(.216)*	*(.058)*
Northeast	.314	.484	.593
	(.464)	*(.500)*	*(.491)*
Center	.081	.077	.076
	(.273)	*(.268)*	*(.266)*
District w/o ws	.112	.200	.229
	(.316)	*(.400)*	*(.420)*
District w/o deep well	.477	.436	.373
	(.499)	*(.496)*	*(.484)*
Request new ws	.160	.256	.105
	(.367)	*(.437)*	*(.306)*
Propensity score (p2/(p3+p2))		.336	.661
		(.251)	*(.212)*

Notes. The table shows mean values by supplier situation. Standard deviation in parentheses. The number of observations varies with data availability from 3,624 to 3,751 observations for the group of municipalities without specific projects ("No change"), 570 to 592 for the group of municipalities with a local government project ("+ loc"), and 564 to 590 for the group of municipalities with associations or both types of projects ("+ assoc"). Districts are geographical sub-units of municipalities. Definitions and data sources can be found in the appendix. Data from IBGE (2000a) and IPEA (2014).

Table 4: Descriptive Statistics for the Year 2000 by Supplier Situation in 2008: Rural and Urban Situation

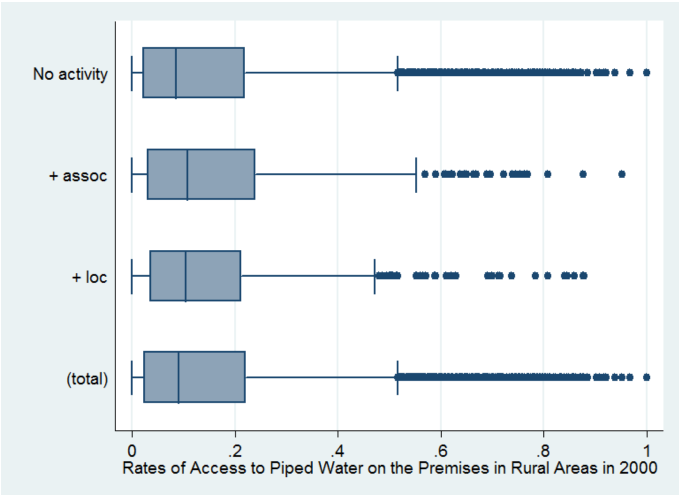
Variable	**No change**	**+ loc**	**+ assoc**
Alphab rate Urban	0.762	0.711	0.689
	(0.138)	*(0.136)*	*(0.154)*
Alphab rate Rural	0.667	0.577	0.569
	(0.198)	*(0.189)*	*(0.216)*
Alphab rate Ratio	0.859	0.797	0.805
	(0.148)	*(0.148)*	*(0.156)*
Median income Urban	244.65	199.19	206.92
	(106.81)	*(74.21)*	*(89.88)*
Median income Rural	194.39	156.46	167.33
	(86.42)	*(68.34)*	*(83.95)*
Median income Ratio	0.82	0.80	0.81
	(0.25)	*(0.23)*	*(0.23)*
Median school Urban	3.48	2.99	2.76
	(1.31)	*(1.31)*	*(1.49)*
Median school Rural	2.42	1.69	1.68
	(1.55)	*(1.51)*	*(1.61)*
Median school Ratio	0.64	0.48	0.50
	(0.37)	*(0.37)*	*(0.40)*

Notes. The table shows mean values by supplier situation. Standard deviation in parentheses. The alphabetization rate gives the percentage of population being able to read and write. Median income (in R$) and median of years of schooling refer to the household head. 1 R$ was 1.83 US-$ in 2000 (World Bank exchange rates), i.e. the median urban income of a household head was 133.69 US-$ in the no changes group (244.65 R$). Ratios are rural over urban values. Data from IBGE (2000a) and IPEA (2014).

is, educational inequality between rural and urban areas is larger in municipalities where rural projects occur.

As stated in section 3, I choose the municipalities with no specific rural activities as a baseline for the propensity score estimation. The validity of this approach depends on whether the decision to implement a system or not in municipalities with no rural activities so far is not structurally different from the decision for one of the two project types. An obvious difference in determinants may be the access rates to piped water in rural areas before projects were implemented. If the municipalities without new projects have relatively high access rates in rural areas and therefore do not need to implement new water supply systems, the decision they face would effectively be fundamentally different from the decision about the project type. Figure 2 shows that the distribution of access rates to

Figure 2: Distribution of Access Rates in 2000 According to Project Status in 2008



Notes. This figure shows the distribution of average access rates to piped water in rural areas in the three different groups. Each boxplot shows the values of the first, second and third quartile of the distribution (vertical left hand, middle and right hand lines of the boxes), the lowest and highest values of the distribution that are not smaller or lager than the first or third quartile plus 1.5 times inter-quartile range (adjacent lines to the whiskers), and observations beyond those values (dots). The dots consist of four to five percent of the total observations in each category. Data from IBGE (2000a)

piped water from the general network is very similar in the three groups. Unconditionally, municipalities with low access rates opt as often for new projects as for no project. Also, municipalities with high access rates are not disproportionally present in the no-activity group. For example, in the "no activity"-category, the third quartile access rate is 21.9 percent and 24 percent in the "+ assoc" group. In order to further substantiate my proposition to use the group without specific rural projects as baseline category, I include pre-treatment access rates to piped water as an explaining variable in the probit model explained below. Access rates in rural areas in 2000 turn out to be insignificant in all specifications.[13]

4.2. Propensity Score Estimation: What Drives Local Initiatives for Rural Water Supply?

In order to inform the estimation of the propensity scores for kernel matching, officials and experts from the Brazilian water sector were interviewed using semi-structured interview techniques. In total, 22 municipality representatives, three presidents of user associations, four sector experts from academia and the Brazilian government, and seven representatives

[13]Table 5, which shows the probit results for propensity score calculation, does not show this variable as I cannot condition the matching on my output variable.

from regional firms were interviewed by phone in late 2013 and early 2014 to learn about the determinants of the decision to implement new small-scale supply systems in rural areas and the determinants of project type choice. The interviews were conducted by a Brazilian research assistant, who identified himself as being part of a research project about water and sanitation in Brazil at the University of Freiburg in Germany. A sample questionnaire can be found in the appendix.

The municipalities that were interviewed were chosen randomly with the restriction that they represent all three municipality types equally. We interviewed six municipalities with new user-based projects, eight municipalities with new government projects, and eight municipalities with new government and user-based projects. The persons interviewed were in most cases head of the departments responsible for water and sanitation in the municipality. Depending on the municipality, this was the department of public works, environment, agriculture, or urban planning. In four cases, we spoke with officers from the responsible department. In general, it was very difficult to contact the municipalities, especially smaller and poorer municipalities. In total, out of 400 calls, only 70 calls were answered and 22 interviews eventually took place. Municipal representatives who picked up the phone never denied the possibility of an interview, but most of the time the responsible person could not be contacted even after several calls.

The experts we interviewed were chosen based on their co-authorship and involvement in the description of the sector in Ministério das Cidades (2011b) and Ministério das Cidades (2011a). Both volumes are part of a recent and comprehensive assessment of the water and sanitation sector in Brazil. It accompanies the new sectoral strategy *Plansab*, first presented in the end of 2013, and is written jointly by scholarly experts and ministry officials.

We tried to interview all 27 regional firms, however, we could only contact seven for interviews. The others did either not pick up the phone or did not want to take part in the interview. The interviews with the regional companies were either very difficult or not very informative. Only the representatives of two regional firms, which have own regional projects to support user-based initiatives (see above), were very friendly and informative.

The atmosphere of most other interviews was very good and cooperative. Interestingly, questions referring to the political motivations behind the projects were either answered very enthusiastically and with examples (presidents of associations, municipality officials) or very briefly and defensively (regional firms, municipality officials). Some interviewees got skeptical when they were asked about the political background of the projects and then mentioned that they wanted the whole interview to be confidential before they continued to answer. Many interviewees only specified their first names, others required the interview explicitly to be anonymous before the interview started.

Combined with some further descriptive statistics, the interviews allow to understand whether the baseline that I propose for the multinomial probit is an appropriate choice. The results from the interviews can be summarized by four group of determinants of the project choice: necessity of new systems, financial considerations, political considerations, and ability to manage a new system.

Necessity. With respect to the question why a new systems was implemented at all, the interviewees mentioned missing access to appropriate water sources either because of droughts, pollution, malfunctioning systems, or growing population as the prime motivations for the implementation of new systems (1, 6, 7, 9, 11, 20, 22, 24, E4).[14] They also highlighted missing willingness of regional companies to invest into rural areas because of political concerns (11, 21, 22) and high costs (E3, E5, E6).

Financial considerations. According to the interviewees, the high implementation costs of new water supply systems in rural areas prevent the municipalities very often from setting up a new system. Officials from local administrations stressed that, if a new system needs to be implemented, cooperating with a user association led to significant cost reductions for municipalities. Many of the communities in question live far away from the city center. Therefore, connecting them to the main system is technically and financially not viable (1, 5, 7, 11, 15). Further, municipalities would need new staff to manage a new system (7, 8, 21), and bureaucratic requirements for daily business are less complex if responsibility is assumed by an association (7, 15, 21). These two reasons were also mentioned by all of the regional company officials as reasons for lacking investments by regional companies in rural areas. Some of the CESB state the urban focus in their by-laws, for others it is not institutionalized. That regional companies shy away from rural investments because of financial reasons was further confirmed by sector experts (E3, E5, E6). With respect to the organizational choice, one municipal representative said that for small poor municipalities, own investments were simply no choice and that these municipalities therefore were happy to cooperate with an association if there was one (E6). Also, interviewees that work in associations stressed that costs were an important determinant

[14]The codes in parentheses refer to the interview notes which are available from the author upon request. Numbers refer to interviews with municipality or association representatives, numbers preceded by an E refer to interviews with experts, and numbers preceded by an R refer to interviews with regional firms.

for associations to implement new systems. Associations are deemed to respond quicker in case of problems with wells or pipes (9, 26, 23, 24) and know better about the preferences of the users (7, 8, 24). Both aspects reduce costs with respect to a municipal or regional solution.

Political considerations. Politically, implementing and managing a new system on its own is interesting for the local administrations in order to secure votes for the mayor (2, R1, E6). The interviewees emphasized that new systems from a regional firm would lead to higher prices for water in poor areas (11, 13, 16, 22, 23, 24), leading to discontent among the local population, and that keeping prices from own systems low or not charging at all promised votes for the mayor (13, E6). In the richer southern states, two interviewees reported that farmers would not be willing to accept regional firm investments because of potential price increases, and therefore founded associations (4, 5). Interviewees from the association side reported that associations freed water users from political bargaining with the municipal administration (15, R1, R3, E6), that misuse of money would be reduced (23), and that by founding a water user association, users would not have to depend on promises by the politicians anymore, which would not be fulfilled after election (24). Also the decision made by regional firms not to invest in rural areas seems to be driven by political concerns (11, 21, 22). Municipal representatives stated that they believed their municipality too small in terms of population and economic strength in order to pressure the CESB for investments in rural areas. One interviewee stated that state-owned CESB would only invest where media coverage was high in order to secure votes for the governor of the state.

Ability to Manage a Supply System. Two interviewees explained why their municipalities could not transfer operation and maintenance to an association in order to reduce costs of provision although they would like to. In one case the association had problems to organize itself in a sufficient manner for public goods provision (15), in the other case the association was afraid of lacking financial support by the municipality (22).

The literature about the incentives for local policy makers to implement projects in their electoral district confirms the results from the interviews. Andersson (2003) distinguishes between political and financial incentives for municipal policy makers to engage in local development projects. With respect to financial incentives, he refers to the costs of project implementation and the availability of public funds to cover these costs. I have cited evidence of increasing funds availability for Brazilian municipalities from the early 2000s on (see section 2). With respect to political incentives, the literature generally states that politicians choose local projects according to their potential to improve their re-election chances. For Brazil, Ferraz and Finan (2011) show that municipal applications for state and federal funds for public works (also in the water and sanitation sector) increase before elections. World Bank (2003a) confirms that Brazilian politicians face high public pressure to realize especially highly visible and large projects to mobilize voters.

With respect to the determinants of local beneficiary projects on the other hand, the collective action literature emphasizes the relative wealth, the literacy rate, and the size of the community as important drivers of beneficiaries' initiatives (Prokopy, 2009). Evidence from the collective management of local resources such as irrigation systems shows that socio-economic heterogeneity among users reduces the likelihood of collective action (Dayton-Johnson, 2000; Dayton-Johnson and Bardhan, 2002). Aggarwal (2000) further shows that transaction costs of collective action, i.e. for negotiation, monitoring, and enforcing, vary with social norms, peer pressure, and other types of social heterogeneity.

Table 5 shows the variables that I use to proxy the main determinants of the implementation a new small-scale system and the project type that were mentioned in the interviews and in the literature. It also gives the results of the multinomial probit estimation.[15] No specific rural activity is the baseline ("base"), new systems with an association ("+ assoc") or with the local government ("+ loc") the two alternative choices. Interpretation of the raw coefficients allows to know whether one of the two alternatives is more likely (positive coefficient) or less likely (negative coefficient) than the base option. The first three columns show a specification with municipality level variables. Columns 4 to 6 expand the specification to variables at the rural and urban level and columns 7 to 9 display additional results for time-varying variables.

The first block of variables measures the costs of implementation of a new project (financial aspects). I measure costs by the number of districts (sub-units of municipalities), population size, and population density. All three indicators capture scale economies. In order to approximate the lack of an adequate system (necessity), I include two indicator variables, one for districts without a water supply system and one for districts without a

[15] Probit is chosen over logit as multinomial probit is the preferred estimator of propensity scores in matching (Caliendo and Kopeinig, 2008). Logit estimation delivers mostly the same results as probit estimation, however the assumptions with respect to the validity of the estimator are stronger than with probit. In particular, with logit the independence of the different alternatives must be assured, otherwise the estimator would be biased.

Table 5: Multinomial Probit, 2000 (pre-treatment)

	Dependent variable: choice of rural activity								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	base	**+ assoc**	**+ loc gov**	**base**	**+ assoc**	**+ loc gov**	**base**	**+ assoc**	**+ loc gov**
Population density		0.151	0.114		0.125	0.0908		-0.0583	-0.00140
		(0.211)	(0.145)		(0.242)	(0.155)		(0.311)	(0.203)
Population size		-1.86e-06**	5.04e-07		-3.65e-07	7.33e-07		-4.13e-07	7.61e-07
		(8.20e-07)	(3.68e-07)		(8.14e-07)	(5.72e-07)		(8.11e-07)	(5.73e-07)
# of districts		0.0567**	-0.0863***		0.0240	-0.109***		0.0290	-0.109***
		(0.0271)	(0.0307)		(0.0281)	(0.0315)		(0.0282)	(0.0316)
District w/o deep well		-0.375***	-0.167**		-0.371***	-0.134*		-0.415***	-0.152**
		(0.0783)	(0.0732)		(0.0827)	(0.0753)		(0.0838)	(0.0763)
District w/o ws		0.571***	0.998***		0.559***	0.997***		0.530***	0.996***
		(0.118)	(0.119)		(0.122)	(0.121)		(0.123)	(0.121)
Urbanization rate		-0.607***	-0.123		-1.375***	0.0190		-1.577***	-0.0329
		(0.233)	(0.220)		(0.275)	(0.247)		(0.281)	(0.251)
GDP share agric (%)		-0.943***	-0.359		-1.414***	-0.0641		-1.371***	-0.0528
		(0.279)	(0.252)		(0.319)	(0.288)		(0.321)	(0.290)
Request new ws		-0.316***	0.380***		-0.242**	0.348***		-0.258**	0.336***
		(0.107)	(0.0892)		(0.112)	(0.0923)		(0.112)	(0.0929)
Income gap (10/40)		-9.20e-05	0.000112		-0.00218	-0.000365		-0.00238	-0.000412
		(0.000845)	(0.000559)		(0.00172)	(0.000657)		(0.00174)	(0.000646)
Margin of victory		0.174	0.0207		0.169	0.121		0.218	0.157
		(0.265)	(0.259)		(0.279)	(0.267)		(0.281)	(0.268)
Health & WSS exp pc		-0.485***	-0.542***		-0.662***	-0.510***		-0.582***	-0.481***
		(0.164)	(0.161)		(0.166)	(0.165)		(0.167)	(0.166)
Higher education (%)		0.0439*	-0.0572**		0.136***	-0.0362		0.141***	-0.0359
		(0.0231)	(0.0248)		(0.0282)	(0.0283)		(0.0284)	(0.0285)
Voter turnout		1.910***	-0.00719		2.233***	0.710		2.424***	0.892
		(0.591)	(0.567)		(0.620)	(0.603)		(0.630)	(0.612)
GDP per capita		-0.0298**	0.0138		-0.000956	0.0193**		0.00180	0.0203**
		(0.0143)	(0.00865)		(0.0124)	(0.00866)		(0.0125)	(0.00878)
Longevity		0.132	-2.167***		2.069***	-1.273*		2.205***	-1.360*
		(0.683)	(0.665)		(0.775)	(0.743)		(0.781)	(0.747)
Tax income per capita		0.184	-1.427***		0.495***	-0.973**		0.438***	-1.032**
		(0.173)	(0.473)		(0.130)	(0.471)		(0.130)	(0.480)
North		-0.679	-0.714***		-1.083**	-0.823***		-1.205**	-0.801***
		(0.492)	(0.206)		(0.515)	(0.215)		(0.558)	(0.218)
South		1.385***	0.0574		1.716***	0.204		1.680***	0.220*
		(0.137)	(0.115)		(0.155)	(0.127)		(0.159)	(0.133)
Center		1.336***	0.107		1.322***	0.155		1.315***	0.149
		(0.175)	(0.147)		(0.185)	(0.153)		(0.189)	(0.156)
Northeast		1.827***	0.0268		1.148***	-0.195		1.155***	-0.195
		(0.152)	(0.115)		(0.187)	(0.143)		(0.189)	(0.144)
Alphab rate Rural					2.802	-1.177		2.589	-1.333
					(3.468)	(3.378)		(3.500)	(3.396)
Alphab rate Urban					-4.296	0.625		-4.149	0.741
					(2.817)	(2.721)		(2.843)	(2.736)
Alphab rate Ratio					-1.217	0.476		-1.101	0.563
					(2.216)	(2.217)		(2.236)	(2.227)
Female head (%) Rural					-4.427***	0.378		-4.573***	0.371
					(1.133)	(0.990)		(1.144)	(0.997)
Median income Rural					0.00928***	0.00471**		0.00935***	0.00481**
					(0.00190)	(0.00201)		(0.00192)	(0.00202)
Median income Urban					-0.0108***	-0.00644***		-0.0106***	-0.00639***
					(0.00178)	(0.00170)		(0.00180)	(0.00172)
Median income Ratio					-2.396***	-1.503***		-2.422***	-1.522***
					(0.458)	(0.455)		(0.462)	(0.459)
Median school Rural					-0.412***	-0.0314		-0.417***	-0.0419
					(0.148)	(0.140)		(0.149)	(0.140)
Median school Urban					0.106	0.101		0.0997	0.101
					(0.0865)	(0.0824)		(0.0869)	(0.0829)
Median school Ratio					0.387	-0.226		0.395	-0.191
					(0.304)	(0.319)		(0.305)	(0.320)
Change to regional main								-0.110	0.472***
								(0.190)	(0.137)
Change to local main								-0.378***	-0.189**
								(0.102)	(0.0885)
Δ Pop dens								-1.061	-0.354
								(0.670)	(0.489)
Δ Admin								-0.647**	-0.214
								(0.315)	(0.300)
Constant		-3.788***	0.619		1.012	0.700		1.083	0.642
		(0.725)	(0.656)		(1.945)	(1.849)		(1.958)	(1.856)
Observations	4,866	4,866	4,866	4,666	4,666	4,666	4,666	4,666	4,666

Notes. The table shows raw coefficients from multinomial probit regressions on municipality level variables (columns 1-3), rural and urban level variables (4-6), and time varying variables (7-9). The baseline category ("base") is the group of municipalities without specific rural projects. Columns titled "+ assoc" test whether the likelihood that an association emerges to set up a new systems is more likely than the choice of the base category. Columns titled "+ loc" test the same for local government projects. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

deep well. Deep wells allow to connect to deeper sources of groundwater, which are a priori better protected from drought and pollution (see section 2). The construction of deep wells is more expensive, i.e. the indicator for a district without deep well could also proxy the costs of a new water supply system. The third block of variables captures political factors that influence the decision process. I measure political determinants by the urbanization rate, the agricultural share in municipal GDP, and an indicator variable for the existence of a beneficiaries' movement requesting a new water supply system. Whereas the first two variables indicate the size of potential voter groups that could benefit from new supply systems in rural areas, the latter indicates whether politicians can gain in political terms by responding to the needs of their constituency. I also include the margin of victory of the mayoral elections in 2000 to proxy the degree of political competition. The higher the competition, the smaller the margin and the higher the probability that an incumbent launches or promises to launch new projects in order to attract pivotal voters.[16] The last variable in this block is the expenditure for the health and the water and sanitation sector per capita in 2000. As data that differentiates between the two sectors is not available, I use this variable as a proxy for the importance and interest that a municipality attaches to health and well-being of its population. With respect to the necessary ability to manage an association and a small-scale supply system, I mainly use variables, which describe the general level of development of the municipality (share of population, life expectancy, tax income per capita, GDP per capita, regional dummies) and the education level (share of population with at least one year of university education)[17]. I also use the voter turnout rates in the 2000's municipal elections in order to proxy political involvement of the citizens. Voting is mandatory in Brazil and voter turnout can therefore rather be considered a proxy of political interest of the population than of political competition. Further, I test whether inequality measured by the income gap between the richest 10 percent and the poorest 40 percent impacts on the probability for rural activities.

Some variables are available at the rural and urban level (results shown in column 4 to 6). The share of female-headed households can serve as a proxy of poverty of the community as women usually have less income. Alphabetization rates, the median of years of schooling,

[16]Ferraz and Finan (2011) use the same variable. See Besley et al. (2010) on political competition and pivotal voters. Additionally, it would be very interesting to include further political variables that proxy the re-elections incentives of local politicians, such as term limits (Ferraz and Finan, 2011). However, the period under study in this research covers three municipal elections, 2000, 2004, and 2008, so that hypotheses about non-ambiguous effects of term limits are not possible. This is also true for the margin of victory in the 2004 mayoral elections, which I do not include here.

[17]I also used other educational levels, for example the share of population with at least 8 years of education. However, they do not contribute to the explanation of the propensity.

and the median income again capture the stage of development of the area in question. The ratio between rural and urban characteristics depicts the inequality between rural and urban areas, which can contribute to decisions for project implementation.

The decision for a new small-scale water supply system may be also driven by changes over time. Since I only have of census data for 2010 (post-treatment), I cannot use all variables that I use to control for the pre-treatment situation in 2000 as first differences to capture changes between 2000 and 2010. Especially the urbanization rate, GDP per capita, or expenditure for health and water and sanitation in 2010 may be a result of the treatment rather than a determinant of the project choice. Using these changes as explaining variables in the probit estimation would balance the samples on outcomes or on variables that are strongly correlated to the outcomes. Therefore, I can only use a limited set of variables that vary over time and may drive the treatment. In order to account for pre-treatment changes that could affect the propensity score, I use dummies for changes in the main provider in a municipality and first differences of population density and administrative spending per capita. As documented in section 2, most CESB have been neglecting the rural areas since the 1970s, but some of them, however, set up specific programs for rural area community projects. If a municipality switches its main provider from a local one to the regional company between 2000 and 2008, this could therefore affect the probability of a new project in rural areas. I account for this probability with two dummies, which turn one if a municipality switched its main provider in the urban area in between 2000 and 2008 to a regional provider ("change to regional main") or to a local provider ("change to local main"). It is highly unlikely that a municipality switches its main provider due to new projects implemented in the rural areas. Additionally, I control for changes in population density and efficiency dynamics of the local administration. Increases in population density may reduce costs of water provision, and changes in the efficiency of a municipality (as measured by administrative spending per capita) may also affect the costs of setting up new systems.

The fact that I cannot control for changes in other important cost and demand determinants of the decision to implement new water projects could in principle invalidate the matching as the treatment indicator would not be truly exogenous. I will address this question in detail in the robustness checks in section 5.2. I will also test for a common trend in treatment and control municipalities before the treatment took place. All tests indicate that no time varying heterogeneity biases the results.

The results in table 5 confirm the overall expectations developed from the above discussion. Costs are negatively related with the emergence of both types of projects, and necessity is positively correlated (district without water supply system). The indicator variable has a negative sign, which hints to the probability that it rather captures costs than necessity. As expected, many variables have opposing effects on the probability to choose a specific project type. The higher the urbanization rate and, therefore, the lower the political power of rural communities, the lower the probability of an association project. If social initiatives requested a system in 2000, it is more likely that a project is implemented by a local government. The higher education and the higher voter turnout, the higher the probability that an association implements a new supply system. However, some of the results are also counter-intuitive (e.g. the median years of schooling in rural areas) or contradictory to each other (e.g. longevity and GDP p.c.). This may be due to the fact that the pre-treatment regression model only estimates correlations and cannot be interpreted as causal. However, in order to balance the samples, the probit model does not need to be causal (Caliendo and Kopeinig, 2008; Imbens, 2014). The fact that the coefficients for many variables have opposing signs for the two different project options is enough to assure balancing of the sample with the results from this estimation.

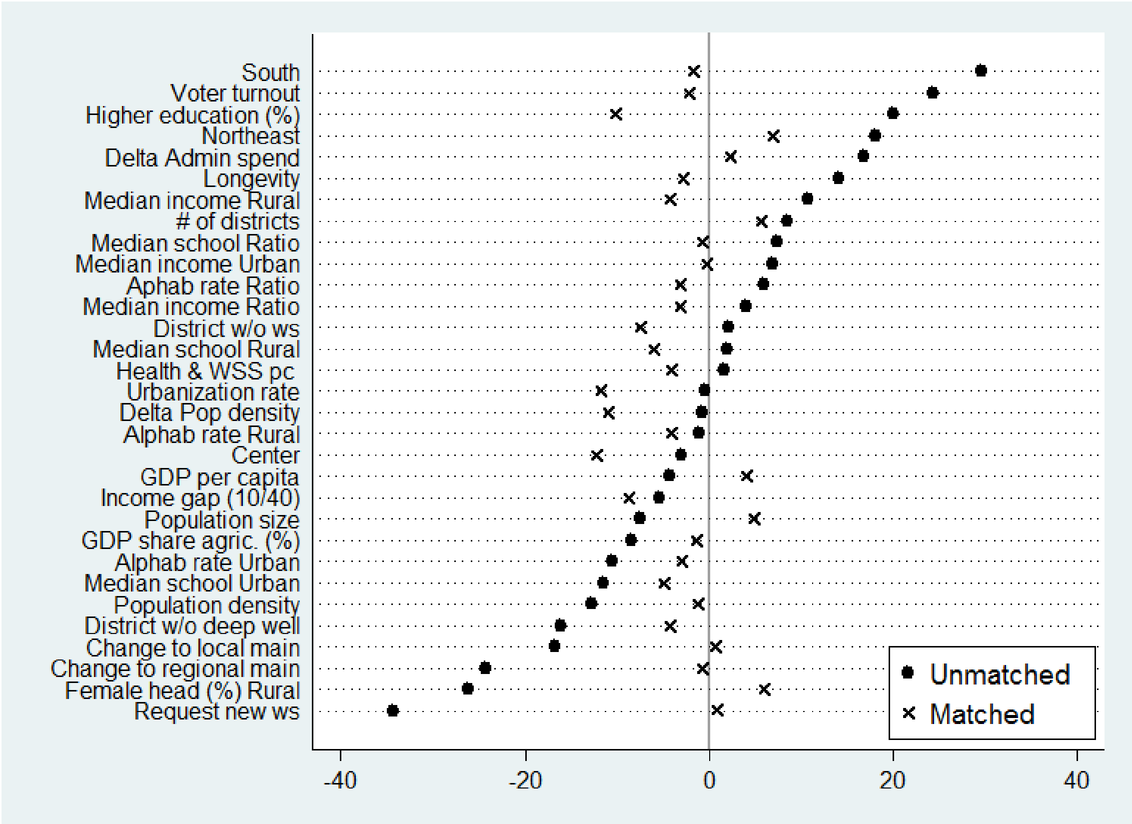
In order to balance the samples, the propensity scores based on the predicted values from the probit model are used to calculate kernel weights for the control group (government projects) in order to make it as similar as possible to the treatment group (association projects). The propensity score ps of a given municipality is the conditional probability to choose an association over a local government project (Lechner, 2001):

$$ps = \frac{p(+assoc)}{p(+assoc) + p(+loc)} \tag{3}$$

where the unconditional probabilities $p()$ are obtained from the probit estimation. The kernel weight for each observation in the control group is then computed as the sum of weighted propensity score differences between the control group observation and all treatment group observations where the weight decreases as a function of the difference (Heckman et al., 1997b, 1998). These weights will be used in the difference-in-difference estimation below.[18] Figure 3 shows the reduction of the standardized differences between the means of control and treatment group proposed by Rosenbaum and Rubin (1985) before and after reweighing the observations of the control sample with the kernel weights obtained from the sample with rural variables and first differences. The figure gives the difference of means as a share of the combined standard deviation of both samples. Thus, it illustrates the quality of the matching as it depicts how close the covariate distributions

[18]See Galiani et al. (2005) for a similar application of this estimator in the context of water privatization.

Figure 3: Standardized Biases in Means Before and After Matching, 2000



Notes. The figure shows standardized biases of weighted and unweighted means of treatment and control group following Rosenbaum and Rubin (1985). Kernel weights are calculated from the last multinomial probit specification given in table 5 and additional higher order terms. Refer to table B.2 in the appendix for the underlying values.

in treatment and control group are after matching.[19] As could be expected from the summary statistics in table 1, the biases in terms of standard deviations of the two groups are not very large even before matching, except for some variables also highlighted above (for example the indicator variable for social lobby groups). Rosenbaum and Rubin (1985) suggest that standardized biases should be below 20 percent of the combined standard deviation. The decrease in the standardized biases that results from weighing with the kernel weights is satisfying with respect to this threshold value, especially for the variables with very different mean values before matching. The mean bias between the two samples reduces from 11.9 percent to 4.2 percent without rural and urban variables, from 13.3 to 4.1 percent with rural and urban variables, and from 12 to 4.6 percent if first differences are added.

[19]Table B.2 in the appendix shows the mean values before and after weighing as well as the reduction of standardized biases and t-test for means differences.

5. Results

5.1. Difference-in-difference Results

Before turning to the estimates from the weighted samples, table 6 gives simple difference-in-difference estimates without applying matching procedures. The underlying specification uses either municipalities with no specific rural activities as the baseline (columns 1-5) or municipalities with an additional small-scale system project by a local government (columns 6-8). The first column gives the coefficients estimated without any further covariates. The average increase in access rates in municipalities that had rural investments accompanied by user associations is significantly different from zero at the one percentage level and amounts to an increase of 7 percentage points. The increase in municipalities where local governments were responsible of rural supply systems is significant but very small. The simple difference-in-difference setting without covariates only accounts for time-invariant determinants of treatment and outcome variables. If there are changes in between the two observation periods that affect treatment and outcome at the same time, the estimates presented in column 1 will be biased. Column 2 and 3 show that the results are robust to the inclusion of important time varying variables that I also used in part for the estimation of propensity scores and weight calculation. I first include the indicators for a change in the main supplier of drinking water in the municipality. The main supplier may be either a local provider (government or independent public provider) or a regional provider. Changing the main provider might have made the new activities in rural areas feasible at all as some regional companies provide special programs designed to support user associations. In column 3, I add further time varying variables that either control for demand side or supply side factors that could bias the estimates. Population density and the urbanization share reduce the costs of supply of pipe networks but also increase demand. GDP per capita controls for changes in the purchasing power of the constituency of a given municipality. Administrative spending on personnel captures whether the productivity of the municipality has changed over time, which could also affect selection. The last additional variable I add is expenditure for the health and water and sanitation sector. The coefficient of interest of the increase in rural access to piped water remains constant and significant for user associations but turns insignificant for local governments. In column 4, I cluster standard errors at the level of the 26 federal states in order to adjust errors not only for cross-sectional correlation but also for time series correlation at the state level.[20]

[20] See Angrist and Pischke (2009) on serial correlation in difference-in-difference settings (p. 315ff.) and clustering with a small number of clusters (p. 319ff.).

Table 6: Differences-in-Differences, 2000-2010

	Dependent variable: access to piped water in rural areas					
	(1)	(2)	(3)	(4)	(5)	(6)
		base: no change			base: + loc	
+ loc	**0.0107***	**0.0123****	**0.00662**	**0.00662**		
	(0.00580)	(0.00595)	(0.00614)	(0.0162)		
+ assoc	**0.0687*****	**0.0694*****	**0.0667*****	**0.0667***	**0.0795*****	**0.0795****
	(0.00946)	(0.00953)	(0.00987)	(0.0347)	(0.0124)	(0.0309)
t_{2010}	-0.0885***	-0.0883***	-0.0217***	-0.0217	-0.0868***	-0.0868
	(0.00275)	(0.00276)	(0.00839)	(0.0399)	(0.0222)	(0.0625)
Change to regional main		0.00146	0.000234	0.000234	-0.00601	-0.00601
		(0.00770)	(0.00797)	(0.0115)	(0.0225)	(0.0187)
Change to local main		0.0122	0.0139	0.0139	0.0216	0.0216
		(0.00832)	(0.00890)	(0.0156)	(0.0237)	(0.0243)
Population density			0.0534**	0.0534*	0.249***	0.249**
			(0.0235)	(0.0295)	(0.0769)	(0.104)
Admin spending pc			0.256***	0.256**	0.0779	0.0779
			(0.0247)	(0.120)	(0.0584)	(0.120)
Urbanization rate			-0.333***	-0.333***	-0.121	-0.121
			(0.0542)	(0.104)	(0.122)	(0.183)
GDP pc			-0.00107	-0.00107	-0.00896***	-0.00896*
			(0.00123)	(0.00100)	(0.00279)	(0.00461)
Health & WSS exp pc			0.00199	0.00199	0.00653	0.00653
			(0.00559)	(0.00893)	(0.0230)	(0.0243)
Constant	0.237***	0.234***	0.178***	0.178	0.260***	0.260
	(0.00231)	(0.00355)	(0.0407)	(0.162)	(0.0878)	(0.174)
Observations	10,448	10,448	9,928	9,928	2,168	2,168
R-squared	0.215	0.216	0.244	0.244	0.357	0.357
Number of municpalities	5,389	5,389	5,344	5,344	1,161	1,161
Clusters	mun	mun	mun	UF	mun	UF

Notes. The table shows difference-in-difference estimates of the effect of different project types on rural access rates in the period 2000 to 2010. Columns 1 to 3 use the group of municipalities without specific rural projects as baseline category ("no change"). They tests whether rural access rates in municipalities with government projects ("+ loc") or municipalities with association projects ("+ assoc") increase significantly more than access rates in the baseline category. Columns 5 and 6 use the group of municipalities with government projects ("+ loc") as the baseline category. They test whether access rates in municipalities with association projects increase significantly more than access rates in government projects municipalities. Errors in parentheses. Standard errors are either clustered at the municipality level ("mun") or the state level ("UF"). There is a maximum of 27 states in Brazil. ** significant at 5% level, *** significant at 1% level.

As policies and development trends of Brazilian municipalities, especially with respect to funding support for the water and sanitation sector, are very different between states but homogeneous within states, adding observations from the same state may not add as much new variation to the regression as observations from other states. Clustering at the state level reduces significance considerably, but the cluster number is also very small.

The last two columns of table 6 (5 and 6) show results for the comparison of access rate increases in municipalities with user associations as compared to access rate increases in municipalities with local government projects in rural areas. That is, the baseline group is now the group of municipalities with local government projects. The difference in increases is again statistically significant and of the same magnitude as before. This last fact is not surprising as the increase in access rates in rural areas in government project municipalities was not statistically different from the national trends in the regressions with the full sample.

The regressions in table 6 show a very consistent picture. While rural areas with association projects show increases of access rates to piped water significantly above the average increase, rural areas with local government projects do not differ from the national trend without any specific rural project.

With the weights obtained from the multinomial probit in section 4.2, I now re-estimate specification 1, presented in the table 6 column 5 and 6, which compares access rate increases in rural areas for municipalities with either local government projects or user association projects. Weighting the control observations according to their similarity to the treatment municipality account for heterogeneity between the two groups that could drive the treatment effect.[21] Table 7 shows the results. Column 1 repeats the results from the unweighted difference-in-difference estimation from table 6. The observation number is constrained to the sample with kernel weights here and therefore smaller than in the original sample. Column 2 and 3 show the results from kernel weighting with standard errors adjusted for municipal clusters and state clusters. As the propensity scores are estimated, the last column shows a bootstrapped means-test between treatment and control sample. The error even reduces and the coefficient remains stable. The coefficients are a somewhat smaller than in the fixed effects estimation without matching, but still large and significant. In municipalities where user associations are involved in the implementation of new projects, the projects lead to an increase in rural access rates that is around 6 percentage points higher than in municipalities where the investments are solely made by

[21] I use weights calculated from the last probit specification in table 5 which includes first differences. However, the results are insensitive to the choice of weights.

the municipal administration.

Table 7: Difference-in-difference Estimation with Kernel Weights, 2000 - 2010

Dependent variable:	**access rate increase, rural**			
	(1)	**(2)**	**(3)**	**(4)**
	FE	kernel weights	kernel weights	kernel, bs
+ assoc	**0.0772*****	**0.0658*****	**0.0658****	**0.0659*****
	(0.0134)	(0.0161)	(0.0271)	(0.0237)
t_{2010}	0.0757***	0.0855***	0.0855	
	(0.0242)	(0.0304)	(0.0523)	
Observations	1,899	1,899	1,899	955
R-squared	0.339	0.390	0.390	
Number of mun's	1,008	1,008	1,008	
Clusters	Mun	Mun	UF	UF
Replications				100

Notes. The table shows difference-in-difference estimates of the increase in access rates in rural areas where user associations started small-scale supply systems for drinking water before 2009 ("+ assoc"). The baseline category is the group of municipalities where projects in rural areas were implemented by the local government. The first column repeats the unweighted specification from table 6, columns 2 and 3 show weighted regressions. The last column shows a means test between the two categories with bootstrapped standard errors. ** significant at 5% level, *** significant at 1% level.

5.2. Robustness Checks

As time-invariant heterogeneity is absorbed by the difference-in-difference setting, the main threat to identification in the above analysis is that the error term is correlated to the explaining variables due to unobserved time varying heterogeneity. Stated differently, the main challenge of identification in this setting is to assure that the increase in access rates in rural areas is only linked to the change in the provider situation and to exclude all other changes over time that took place in the same municipalities but not in the control group municipalities. With the available census data I control for some changes that may affect treatment decisions when estimating the propensity scores. Table 8 shows several robustness checks with respect to the assumption that no other changes over time confound the treatment effect. For comparison, the first column shows the results from the kernel weighted difference-in-difference estimates. In the second column, the dependent variable is replaced by access rates to piped water in urban areas. If there were changes between 2000 and 2010 within a municipality with rural associations' projects that enabled access rates to increase in general and not only in rural areas, the treatment dummy should have the same effect on urban access rates. Such a change could be, for example, a change in policies or institutions increasing the efficiency of public works or investments. The coefficient of

Table 8: Difference-in-difference Estimation with Kernel Weights, 2000 - 2010, Robustness Checks

Dependent variable:	**access rates to piped water in urban (2) and rural areas (1, 3-7)**						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
	rural	urban	regions	main supplier	restricted	restricted, 90-00	selection test
+ assoc	**0.0658*** **	**0.00391**	**-0.0360**	**0.0511*** **	**0.0460** **	**0.0144**	0.0564***
	(0.0161)	(0.0120)	(0.0288)	(0.0162)	(0.0189)	(0.0191)	(0.0160)
t_{2010}	0.0855***	0.0616**	0.0718**	0.0887***	0.138***		0.0793**
	(0.0304)	(0.0255)	(0.0312)	(0.0297)	(0.0361)		(0.0332)
t_{2000}						0.204***	
						(0.0435)	
+ assoc * south			**0.0773** **				
			(0.0316)				
+ assoc * northeast			**0.142*** **				
			(0.0292)				
Local main				**0.0972*** **			
				(0.0350)			
s_{t-1}							**-0.00201**
							(0.0196)
Constant	0.183*	0.953***	0.187*	0.203*	0.344***	0.238**	0.164
	(0.110)	(0.0603)	(0.110)	(0.107)	(0.103)	(0.0930)	(0.111)
Observations	1,899	1,757	1,899	1,899	1,053	865	1,758
R-squared	0.390	0.245	0.411	0.401	0.382	0.363	0.380
Number of Mun's	1,008	996	1,008	1,008	556	556	996

Notes. The table shows robustness checks to the specification 3 in table 7, repeated in column 1 in this table. Column 2 repeats the same specification but uses the access rates to piped water in urban areas as a dependent variable. Column 3 interacts the treatment dummy ("+ assoc") with two different regions. Column 4 interacts the treatment dummy with the main supplier in the municipality. It is equal to 1 if the main supplier is a local firm or government. Columns 5 to 7 test whether the treatment municipalities behave differently already in the decade before (1990 to 2000). Column 5 repeats the standard specification from column 1 for the sample of municipalities that did not split between 1990 and 2000. Column 6 runs the same specification for the time period 1990 to 2000. Column 7 implements a test for selection bias using a dummy for municipalities that split between 1990 and 2000, s_{t-1}. Standard errors are clustered at the municipality level. * significant at 10% level, ** significant at 5% level, *** significant at 1% level.

the treatment dummy, however, is not significantly different from zero. Another issue could be that, as rural areas lag considerably behind in terms of access rates to piped water, all investments of main suppliers and local governments were focused on rural areas and that therefore no progress was made in urban areas in general. The time dummy for the year 2010 in column 2 shows that average access rates to piped water in urban areas increased during the period in question. However, as the treatment indicator coefficient shows, the increase of urban access rates in municipalities with association projects in rural areas is not significantly different from this general increase.

Brazil is historically characterized by a strong difference in development between the agricultural and relatively rich South and the poor, semi-arid North-east. As described in section 2, user association projects are mainly implemented in these two regions. One concern could therefore be that the richer Southern municipalities, which have more own financing capacity than municipalities in the North-east, started to invest more into water supply systems between 2000 and 2010 and that the effect captured by the treatment dummy is driven by this development. If this were true, the effect would not be due to user association projects but to this general development in the Southern municipalities. In column 3 of table 8, I interact the treatment dummy with dummies for municipalities in the South and North-east. It turns out that both interactions are significantly different from zero and that the main treatment effect (" + assoc") measuring average increase in all regions turns insignificant.[22] The treatment effect for the North-eastern municipalities is significantly larger than the one in the Southern municipalities.[23] This means that the increase in access rates in rural areas with water user association projects is even larger in the Northern municipalities. The effect captured by the treatment dummy in column 1 therefore cannot be driven by developments that took place in the South only.

Section 2 highlights that the rural areas have been neglected by the regional companies since their foundation in the 1970s. Even though the regional companies are dominating water supply in Brazil, not all municipalities are connected by regional firms. Another concern for identification could therefore be that the effect of the treatment dummy is driven by municipalities where local governments or local firms supply water to the municipality. Although it is credible that, in times of missing investment capacity, local suppliers also focused on urban areas where most of the population lives, local suppliers might have invested more in rural areas than regional firms and municipalities with association projects

[22] The latter might be due to sample size as most projects with associations are implemented in the other two regions. All three variables are jointly significant at the 1 percent level.

[23] The difference of 6.4 percentage points is significant at the 1 percent level (standard error: 0.023, p-value: 0.006).

and local (main) suppliers therefore might drive the effect. In column 4, I interact the treatment dummy with an indicator for a local supplier to test this concerns. The treatment dummy, now capturing the increase of rural access rates in municipalities with association projects and a regional main supplier, and the interaction are both significantly different from zero. The difference between both coefficients is 4.6 percentage points but not statistically different from zero (standard error: 0.0414, p-value: 0.265). Thus there is no significant difference in access rate increases in rural areas due to different main suppliers in the municipalities with rural association projects.

The last three columns of table 8 implement a very common robustness check in the treatment evaluation literature. If the treatment municipalities were structurally not different from the control municipalities with respect to changes over time, then the trend observed for the outcome variable before treatment should be the same. This is the common trend assumption that is implicit in the before-after study design. Applied to this study's setting, this means that the increase in access rates in rural areas in the decade before the rural associations appeared should be no different in municipalities with association and municipalities with local governments investing in the next decade. Although I data about the supplier situation in 1990 and access rates are available for 1990, the implementation of the common trend test is complicated by the fact that a lot of municipalities split in the 1990s (see table 2 in section 4.1). For these municipalities, I cannot compare access rates from 1990 to those in 2000 because the underlying population changed. I therefore implement the test for a restricted sample, which only contains municipalities that did not split between 1990 and 2000. Column 5 repeats the specification from column 1 for the restricted sample. Although the coefficient is a little smaller, it is still highly significant and of a comparable magnitude. In column 6, the dependent variable is the access rate to piped water in rural areas in 1990 and 2000 instead of in 2000 and 2010. The treatment dummy ("+ assoc") therefore identifies municipalities whose rural areas will receive treatment in the next decade. The indicator is insignificant. Thus, there is no difference in the average increase of access rates in rural areas between treatment and control municipalities in the period before projects in rural areas where implemented. This result attenuates the concern that the treatment indicator could capture differences in general development trends between the treatment and control group. Since I restrict the sample considerably for this test, the validity of this result hinges on the assumption that the municipalities in the restricted sample do not behave differently from the municipalities that are excluded. If this was the case, the result of the test could be due to this structural difference between samples. As suggested by Wooldridge (2002) in the case of sample attrition, the last column in table 8 implements a test proposed by Nijman and Verbeek (1992) to test for structural differences between the two samples. The specification in column 7 uses again data from 2000 to 2010 and is complemented by a selection dummy, s_{t-1}, which is equal to one if a municipality split before 2000 and therefore drops in the restricted sample.[24] If there is correlation between the sample choice and the unobserved time-varying components of the error terms, the selection dummy would be significant. Column 7 confirms that structural differences between the two samples play no role since the selection indicator is not significantly different from zero. Another indicator of the fact that the two samples behave the same is the treatment coefficient, which is very similar in size and significance.

6. Heterogeneity of Effects & Channel Analysis

The above results show that access to piped water increased significantly more in rural areas with user association projects than in areas with local government projects and that this effect is most likely not driven by unobserved heterogeneity. This section analyzes the underlying causes of these differences in performance by introducing heterogeneity with respect to accountability mechanisms among project municipalities.

Decentralization of fiscal resources or political power as it has taken place in Brazil after the end of the military regime is expected to improve local service delivery. The idea is that local policy makers, as compared to their central counter parts, do not only dispose of more information with respect to the needs of local populations, but will also use this knowledge to design policies that are more in favor of the local population due to higher accountability to the local electorate (Bardhan, 2002). Whereas politicians in a centralized environment are held accountable through elections, as well, they can compensate more easily for inefficient provision of some public goods by performing better with other goods as they provide all goods and not just one or a few like local politicians. (Farfán-Vallespín, 2012). Additionally, disappointed voters may be less able to prevent re-election of politicians in centralized systems because they have to compete with other, perhaps more satisfied voters in the larger electorate (Seabright, 1996). Despite of the intuitive concept of how decentralization can improve local service delivery, experiences in many developing and transition countries have shown that the benefits of decentralization critically depend on the strength of local accountability mechanisms and the design of decentralization (Sjahrir et al., 2014). If local accountability is low, local elites may capture transfers from the central government or divert own incomes. Decentralization

[24] The difference in sample size between column 1 and 7 is due to the newly emerging municipalities. Their selection dummy is missing and therefore they drop.

may thus eventually worsen service delivery through the devolution of political power to local elites (Bardhan, 2002; Bardhan and Mookherjee, 2006). The hypothesis of this study is that local water user association projects perform better than projects by the local government. User associations know better about the preferences of the beneficiaries of the project and have stronger incentives to correctly implement and maintain the new supply system. However, this should in principle also be true for decentralized government units if these are tied to the preferences of the local constituency by elections. Why is it then that the projects implemented and managed by water user associations perform so much better than projects by local governments? According to the risks of decentralization mentioned above, compromised accountability of local officials may be one reason. This section tests whether local government projects lead to higher access rate increases if accountability mechanisms to discipline political decision makers are stronger.

Bardhan and Mookherjee (2000) propose several factors that may increase local accountability in decentralized environments. Two out of them can be applied to the present study. First, the degree of electoral competition may reduce the risk of local capture. The higher the risk that an incumbent may lose elections to one of her competitors, the stronger the incentive to act in the interest of the voters. Second, the amount of information available for voters can impact positively on accountability of local politicians.[25] Bardhan (2002) further proposes that unelected community organizations or awareness raising campaigns may strengthen local accountability. These propositions allow to test for the impact of higher accountability on access rate increases in the municipalities with local government projects. If more accountability leads to higher increases in access rates, this would suggest that local government projects can result in better service delivery if the re-election incentives of local government officials and politicians are enforced by more transparency or political competition. Such a result would also indirectly suggest that projects by water user associations lead to higher increases in access rates because the involvement of users in the project increases the accountability of the responsible persons.

Panel A of table 9 shows difference-in-difference estimates for the group of municipalities in which local governments implemented small-scale supply systems in rural areas. Panel B shows the same estimates for the sample of association project municipalities. As the treatment indicator is now equal for all municipalities, the time dummy for the post-treatment year 2010 is interacted with different variables that proxy the accountabil-

[25] Bardhan and Mookherjee (2000) further propose that the level of cohesion in lobby groups, the level of voter uncertainty, the value of campaign funding in local and national elections, and different electoral systems at different jurisdictional levels may influence the degree of accountability. However, the available data in this study do not allow testing for these hypotheses.

Table 9: Difference-in-difference Estimation, Accountability Channels, 2000-2010

	Dependent variable: access to piped water, rural					
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Sample of Municipalities with Local Government Projects						
Request new ws	0.0793***					
	(0.0231)					
Participation 2008		0.0409**				
		(0.0165)				
Margin 2000			-0.0580			
			(0.0730)			
Margin 2004				-0.150**		
				(0.0594)		
Local radio station					0.0408*	
					(0.0204)	
Local tv station						0.104***
						(0.0234)
Constant	0.293***	0.358***	0.312**	0.347***	0.307**	0.315***
	(0.0918)	(0.109)	(0.118)	(0.105)	(0.110)	(0.106)
Observations	962	962	947	952	951	955
R-squared	0.328	0.307	0.299	0.310	0.301	0.315
Number of Mun's	522	522	522	521	520	521
Panel B: Sample of Municipalities with Association Projects						
Request new ws	0.00404					
	(0.0334)					
Participation 2008		0.0106				
		(0.0383)				
Margin 2000			-0.0118			
			(0.0649)			
Margin 2004				-0.0493		
				(0.124)		
Local radio station					0.0262	
					(0.0168)	
Local tv station						0.0441
						(0.0299)
Constant	0.135	0.140	0.184	0.117	0.0826	0.143
	(0.182)	(0.168)	(0.204)	(0.190)	(0.190)	(0.188)
Observations	963	963	952	950	950	963
R-squared	0.456	0.456	0.460	0.447	0.454	0.457
Number of Mun's	507	507	507	507	506	507

Notes. The table shows difference-in-difference estimates of the increase in access rates in rural areas in which local governments (panel A) or associations (panel B) started small scale supply systems for drinking water before 2008, and in which accountability was a priori higher because of the presence of media, social lobbying groups, and electoral competition. Standard errors are clustered at the municipality level and shown in parentheses. All control variables used in previous fixed effects regressions are included. Additionally, all regression include an interaction of the urbanization share in the year 2000 and the time dummy of the year 2010. ** significant at 5% level, *** significant at 1% level. Variables in columns 1 and 2 are from PNSB (2000), variables in columns 3 and 4 from IPEA (2014), and variables in columns 5 and 6 from IBGE (1999).

ity channels suggested by Bardhan (2002). In column 1, the time dummy is interacted with a dummy that is equal to one if there was a social movement or an organization requesting a new water supply system in the given municipality in the year 2000. These social movements or organizations can be neighborhood associations or churches, but also specific water associations (IBGE, 2000b). It turns out that the increase in access rates in local government projects is significantly different from zero and comparable in magnitude to increases in municipalities with user association projects if a local social movement or organization requests a new system. One explanation for this increase could be that these organizations monitor politicians more closely in the event of a new project and that elected officials therefore stick to their promises fearing to loose voters. Column 2 also shows an increase in access rates above the average if some type of participation of the users was implemented between 2000 and 2008. *PNSB* reports for each wave whether the municipality uses participatory approaches to involve citizens in decision making about water and sanitation in the municipality. However, this dummy is not without caveats in the present context. If the dummy is equal to one in 2008 but zero in 2000, it is not clear in which year the participation mechanism was implemented and if this was before or after the water supply project implementation. Additionally, *PNSB* does not report any details with respect to the type of the participatory mechanism. The coefficient should thus be interpreted with caution. Its sign and significance, however, give support to the finding in column 1. Columns 3 and 4 test whether access rate increases are higher in municipalities with higher political competition. I use the margin of victory of the mayor to its immediate competitor in the mayoral elections in 2000 and 2004 as proxies for political competition. As expected, both coefficients are negative: the larger the distance in victory between the mayor and its competitor, the lower the access rates increase. Only the margin in the 2004's elections in local government project municipalities is significantly related to access rates. Again, this can be due to the uncertainty of project timing. Columns 5 and 6 test whether access rate increases are higher in municipalities where accessibility of information is higher. I proxy this by interacting the time dummy with a dummy for the existence of a local radio station or local tv station in the year 1999. Both variables turn out to be positively and significantly related with higher increases in access rates.

Taken all together, the results in table 9 suggest that project performance in municipalities with local government projects is strongly related to the accountability of local politicians and increases if this accountability is enforced by transparency or pressure mechanisms. Panel B repeats the same regressions for the group of municipalities with water-user association projects. All interactions turn out to be insignificant. Accountability of local politicians does not play a role in participatory projects. This delivers important suggestions for the reasons behind the results in the main part of this paper. The difference in effects among the two types of projects is driven most likely by differences in accountability of water-user associations and local politicians.

7. Conclusion

This paper shows that participatory drinking water supply projects in rural Brazil increase access to piped water significantly more than projects by local governments. If user associations implemented and managed small-scale supply projects, access rates to piped water from the general network increased on average by six percentage points more from 2000 to 2010 than if local governments implemented and managed the projects. Comparing this figure to the general increases in access rates in rural Brazil during the same period illustrates how substantial this difference is. The unconditional increase in access rates to piped water from the general network in rural Brazil was on average 9.5 percent, starting from a level of 17.8 percent in the year 2000. The increase in access rates in rural areas with local government projects was the same; however, access rates in rural areas with participatory projects increased on average by six percent more, which is more than an additional 60 percent of the average increase. With this result, this paper provides first conclusive evidence that user involvement is indeed a fruitful approach to increase access to safe water in rural areas.

The results in this study are based on a difference-in-difference estimator combined with multinomial matching. The latter produces weights used in the difference-in-difference estimation to balance treatment and control group with respect to observed and dynamic heterogeneity. Various robustness checks, which allow for heterogeneity in access rates over time and across project municipalities, suggest that the estimated effect must be very close to the true effect. Most importantly, the test for common pre-treatment trends in access rates among the treatment and control municipalities shows no significant differences. Further, project municipalities with and without treatment have the same (conditional) increases in access rates to piped water in urban areas. This suggests that there is no heterogeneity left at the municipality level that may bias the effect of interest.

Apart from reducing endogeneity concerns, the matching procedure allows analyzing the project choice and, together with the interviews, reveals further interesting results. Whereas project implementation regardless of the governance form correlates positively with the necessity of a new system and negatively with its costs, the probability that a user-based project is implemented in a given rural area is positively correlated to proxies of the electoral weight of the rural population and its educational level. In contrast, political factors, such as the existence of a social initiative that requests a new water supply system or higher political competition in the local elections, correlate positively with the appearance of new local government projects. This latter mechanism is further underlined by the anecdotal evidence provided by sector experts in the interviews, which informed this study. Academic experts but also municipality officials emphasized that water supply infrastructure and especially the pricing of drinking water from the general network are important stakes in local elections in Brazil. The investigation of the reasons for lacking performance of local government projects in the second part of this study points to the political economy of infrastructure supply, as well. It shows that within the group of local government project municipalities access rates increase significantly more if interest groups or local media, which monitor local politicians, are present, or if political competition is higher. The very same mechanisms do however not increase access rates in municipalities with user association projects. It therefore seems plausible that low accountability of local politicians drives the difference in effects between the two project types.

Against the backdrop of the veritable boom of community-based projects in drinking water supply development all over the world, the main result of this paper is reassuring. It shows that, at least in rural Brazil, the population could benefit significantly from more investments into community-based small-scale supply systems of drinking water. In order to analyze under which circumstances this result is transferable to other environments, case studies from other countries should verify the present results in other contexts and with other data. Although hardly imaginable at the time being, longer panels or the evaluation of randomized user-based projects could improve upon this study methodologically, as well.

The additional results in this study suggest that equally good performance of water supply projects could be reached by local government projects if politicians were bound more closely to the preferences of their constituency. Thus, increasing transparency of public infrastructure projects should be a main priority if one aims at improving the performance of decentralized government units in local service delivery. If citizens have the possibility to voice their preferences, as through the social interest groups in this study, or can better monitor politicians through the media to inform their election decisions, local officials are more likely to behave in the interest of their voters. In the end, it depends on the local circumstances and resources whether participatory projects or larger accountability of local politicians lead to better results in the short run. In Brazil, a stable and in the same time dynamic democracy, which has itself committed to the fight against corruption and mismanagement, both approaches have been proven to yield good results in this study. Nevertheless, the results also show that a lot remains to be done. With respect to the bad performance of projects by local governments, it would be highly interesting to study what exactly happens with the funds transferred to the local governments for the projects. Ferraz et al. (2012) report suggestive evidence from the public auditing system in Brazil, which verifies whether earmarked transfers from the central government are used as planned. In several cases, water supply projects by local governments remained unfinished after the official project ended, e.g. newly constructed wells were not connected to the households, or projects were eventually implemented in other than the designated project areas.

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A. Appendix

A.1. Questionnaire

The semi-structured interviews with municipal representatives in charge of the water and sanitation supply in the municipality were based on the following questionnaire. It provides an example for the questions that we asked during the interviews. If interviewees mentioned aspects with respect to water and sanitation provision that were of interest for our research but not on the questionnaire, we discussed and evaluated these aspects, as well. The questions, especially question 9 and its subquestions, were adapted to the provider situation of the municipality. The questionnaires and interviews were translated from English to Portuguese and vice-versa. The interviews with academic experts, members of associations, and representatives of the state companies were based on very similar questionnaires. All interview questionnaires are available from the author.

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Name of interviewee:
Position:
Date of interview:
Municipality, State:
Municipality code:

1. What types of providers are providing services in your municipality? What is their legal form?
2. What services do they provide?
3. What are the advantages of the different types from the perspective of the municipality? Please, compare the advantages and disadvantages of a municipal provider/local firm and an association.
4. Why is it the association/Why is it the local provider managing the facility in specific areas?
5. What different sources of finance are there in case the municipality wants to expand or maintain the network? Where is the money coming from?
6. Are sources of money different for the different provider types? Why? Explain.

7. In case the municipality is only involved because of some financing/administrative reason: Could you detail how it is done? Could you explain the role of the municipality?

8. What are the advantages of the new provider situation over the old one?

9. Were any of the following reasons relevant?

   a) Were there any inefficiencies/reasons (for split or joining) linked to financing?

   b) Were there any reasons linked to discontent with the state provider?

   c) Was there a district/area not served before the additional provider started its services? If so, what services were not available?

   d) Was there any investment into new infrastructure to expand access before or when the municipality decided to join/overtake the provision? By whom was the investment?

   e) Who paid for the investment? Who owns the facility? Who is now managing the facility?

   f) Was there any political change that made the change (split/joining/new association) necessary? If so, describe the political change, please.

   g) Was there any political change that made the change (split/joining/new association) politically feasible? If so, describe the change, please.

10. If additional questions emerge, can I contact you again? When and by what means would you like to be contacted?

11. Can you think of another person that I could interview with respect to these questions?

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A.2. Definitions and Data Sources

Table B.1: Definitions and Sources of Variables (in the order of their appearance in the text)

Variable	Definition	Source
GDP pc	Average GDP per capita at the municipal level in R$ of 2000	IBGE (2000a)
Tax income pc	Average income of the municipality from taxes, fees, and VAT divided by municipality population in R$ of 2000	IPEA (2014)
Admin spending pc	Public spending for staff and inputs of the administration, legislation, justice, defense, and security sectors divided by municipality population, in R$ of 2000	IPEA (2014)
GDP share agric (%)	Share of agricultural GDP in total municipal GDP	IPEA (2014)
Health & WSS exp pc	Municipal expenditure for health, water and sanitation divided by municipality population in R$ of 2000	IPEA (2014)
Income gap (10/40)	Ratio of mean income per capita of the richest 10 percent of the municipality and the poorest 40 percent of the municipality	IPEA (2014)
Higher education (%)	Share of population who went at least one year to university (have more than 11 years of education)	IPEA (2014)
Voter turnout	Voter participation in the mayoral elections	IPEA (2014)
Longevity	Based on the average life expectancy in the municipality: (observed age at death - 25)/(85 - 25)	IPEA (2014)
Population size	Number of residents per municipality	IBGE (2000a)
Population density	Population size divided by the area of the municipality in square meters	IBGE (2000a)
Urbanization rate	Residents in urban areas divided by total number of residents of the municipality	IBGE (2000a)
# of districts	Number of geographical sub-units within one municipality, usually without any administrative powers	IBGE (2013)
South	Dummy variable, equals one if the municipality is in the region South. Brazil is divided into five regions: South, Southeast, North, Northeast, and Center.	IBGE (2013)
Southeast	Dummy variable, equals one if the municipality is in region Southeast.	IBGE (2013)
North	Dummy variable, equals one if the municipality is in the region North.	IBGE (2013)
Northeast	Dummy variable, equals one if the municipality is in the region Northeast.	IBGE (2013)
Center	Dummy variable, equals one if the municipality is in the region Center.	IBGE (2013)
District w/o ws	Dummy variable, equals one if at least one district in the municipality has no water supply system in 2000.	PNSB (2000)
District w/o deep well	Dummy variable, equals one if at least one district in the municipality has no well that connects to a deep aquifer in 2000.	PNSB (2000)
Request new ws	Dummy variable, equals one if there is a group requesting a new water supply system in 2000; groups can be water user associations, churches, or other groups.	PNSB (2000)
Alphab rate Urban	Share of urban population that are able to read and write	IBGE (2000a)
Alphab rate Rural	Share of rural population that are able to read and write	IBGE (2000a)
Alphab rate Ratio	Ratio of the rural and urban alphabetization rates	IBGE (2000a)

Notes. The table lists all variables used in this paper with their definitions and sources. Descriptive statistics can be found in tables 3 and 4.

Table A.1: Definitions and Sources of Variables (...continued)

Variable	Definition	Source
Median income Urban	Median income in the urban area of the municipality, in R$ of 2000	IBGE (2000a)
Median income Rural	Median income in the rural area of the municipality, in R$ of 2000	IBGE (2000a)
Median income Ratio	Ratio of the rural and urban median incomes	IBGE (2000a)
Median school Urban	Median of years of schooling in the urban area of the municipality	IBGE (2000a)
Median school Rural	Median of years of schooling in the rural area of the municipality	IBGE (2000a)
Median school Ratio	Ratio of the median of years of schooling in rural and urban areas	IBGE (2000a)
Margin (of victory)	Difference between vote share for the mayor and the vote share of her closest competitor in percentage points	IPEA (2014)
Female head (%) Ratio	Ratio of rural and urban share of households with female head	IBGE (2000a)
Change to regional main	Dummy variable, turns one in 2008 if the main supplier in the municipality changes between 2000 and 2008 from a local to a regional supplier (CESB)	PNSB (2000)
Change to local main	Dummy variable, turns one in 2008 if the main supplier in the municipality changes between 2000 and 2008 from a regional to a local supplier.	PNSB (2000)
+ assoc	Dummy variable, turns one in 2008 if a small-scale water supply system was set up between 2000 and 2008 in the rural areas of the municipality by a water user association or a water user association and a local provider.	
+ loc	Dummy variable, turns one in 2008 if a small-scale water supply system was set up between 2000 and 2008 in the rural areas of the municipality by a local provider.	PNSB (2000)
Participation 2008	Dummy variable that turns 1 in 2008 if the municipality implemented some participation mechanisms for service users between 2000 and 2008. Further details about the type of participation are not available.	PNSB (2000)
Local main	Dummy variable, equals 1 if the the main supplier in the municipality is a local supplier.	PNSB (2000)
Local radio station	Dummy variable, turns one if there is a local radio station in 1999.	IBGE (1999)
Local tv station	Dummy variable, turns one if there is a local tv station in 1999.	IBGE (1999)

Notes. The table lists all variables used in this paper with their definitions and sources. Descriptive statistics can be found in tables 3 and 4

Table B.2: Reduction of Standarized Biases by Matching

		Mean Treated	Mean Control	Bias (%)	Reduction of bias (%)	t-value	p > |t|
GDP pc	Unmatched	3.1127	3.295	-4.3		-0.66	0.509
	Matched	3.1127	2.9443	4	7.6	1.11	0.269
Population size	Unmatched	19065	21775	-7.4		-1.15	0.252
	Matched	19065	17309	4.8	35.2	1.04	0.296
Income gap (10/40)	Unmatched	22.718	24.184	-5.4		-0.84	0.401
	Matched	22718	25.093	-8.8	-62	-2.17	0.03
Population density	Unmatched	0.07339	0.08772	-12.8		-1.98	0.048
	Matched	0.07339	0.07472	-1.2	90.7	-0.2	0.843
Urbanization rate	Unmatched	0.5439	0.54473	-0.4		-0.06	0.95
	Matched	0.5439	0.56773	-11.7	2770.7	-1.86	0.063
# of districts	Unmatched	1.9665	1.833	8.5		1.31	0.19
	Matched	1.9665	1.8761	5.7	32.3	0.93	0.351
District w/o ws	Unmatched	0.20711	0.19833	2.2		0.34	0.736
	Matched	0.20711	0.23671	-7.4	-236.9	-1.1	0.273
District w/o deep well	Unmatched	0.35356	0.43215	-16.1		-2.49	0.013
	Matched	0.35356	0.37461	-4.3	73.2	-0.67	0.501
South	Unmatched	0.31799	0.18998	29.7		4.59	0
	Matched	0.31799	0.32517	-1.7	94.4	-0.24	0.813
Center	Unmatched	0.08159	0.08977	-2.9		-0.45	0.652
	Matched	0.08159	0.11565	-12.2	-316.4	-1.76	0.079
Northeast	Unmatched	0.55021	0.45929	18.2		2.82	0.005
	Matched	0.55021	0.51605	6.9	62.4	1.05	0.292
Higher education (%)	Unmatched	2.9176	2.472	20.1		3.11	0.002
	Matched	2.9176	3.1414	-10.1	49.8	-1.53	0.126
Longevity	Unmatched	0.6986	0.68741	14.2		2.2	0.028
	Matched	0.6986	0.70077	-2.8	80.5	-0.47	0.641
Request new ws	Unmatched	0.11297	0.24217	-34.3		-5.3	0
	Matched	0.11297	0.10981	0.8	97.6	0.15	0.877
GDP share agric (%)	Unmatched	0.27003	0.28479	-8.4		-1.3	0.194
	Matched	0.27003	0.27229	-1.3	84.7	-0.2	0.841
Voter turnout	Unmatched	0.87361	0.85702	24.4		3.78	0
	Matched	0.87361	0.87513	-2.2	90.8	-0.36	0.722
Alphab rate Urban	Unmatched	0.70385	0.71864	-10.5		-0.162	0.105
	Matched	0.70385	0.70802	-3	71.8	-0.44	0.659
Alphab rate Rural	Unmatched	0.58899	0.59116	-1.1		-0.17	0.869
	Matched	0.58899	0.59729	-4.1	-281.6	-0.6	0.551
Aphab rate Ratio	Unmatched	0.81551	0.80641	5.9		0.91	0.364
	Matched	0.81551	0.82029	-3.1	47.5	-0.46	0.647
Female head (%) Rural	Unmatched	0.11588	0.12781	-26.1		-4.04	0
	Matched	0.11588	0.11316	6	77.2	0.97	0.331
Median inc Rural	Unmatched	171.06	163.18	10.7		1.65	0.1
	Matched	17106	174.22	-4.3	59.9	-0.63	0.531
Median inc Ratio	Unmatched	0.82517	0.81603	4.1		0.63	0.527
	Matched	0.82517	0.83222	-3.2	22.9	-0.51	0.608
Median inc Urban	Unmatched	208.21	202.66	7		1.09	0.278
	Matched	208.21	208.37	-0.2	97.1	-0.03	0.975

Notes. The table shows the means of the treatment and control sample before and after weighing by the kernel weights. The computation of standardized biases of weighted and unweighted means of treatment and control group follows Rosenbaum and Rubin (1985). Kernel weights are calculated from the last multinomial probit specification given in table 5 and additional higher order terms. See Figure 3 for a graphical presentation of the standardized biases. The last two columns show the results of a simple t-test on the means and the according p-values. Note that the t-test is biased by sample size and the bias reductions are adjusted for sample size.

Table A.2: Reduction of Standarized Biases by Matching (...continued)

		Mean Treated	**Mean Control**	**Bias (%)**	**Reduction of bias (%)**	**t-value**	**p > |t|**
Med school Rural	Unmatched	1.8253	1.7933	2		0.32	0.753
	Matched	1.8253	1.9193	-6	-193.9	-0.89	0.372
Med school Urban	Unmatched	2.8954	3.0407	-11.5		-1.79	0.074
	Matched	2.8954	2.957	-4.9	57.6	-0.75	0.455
Med school Ratio	Unmatched	0.534	0.5056	7.4		1.15	0.252
	Matched	0.534	0.5368	-0.7	90.3	-0.11	0.914
Healt & WSS exp pc	Unmatched	0.39187	0.38836	1.6		0.25	0.799
	Matched	0.39187	0.40054	-4.1	-146.9	-0.63	0.527
Change to regional main	Unmatched	0.03347	0.09186	-24.2		-3.75	0
	Matched	0.03347	0.0354	-0.8	96.7	-0.16	0.871
Change to local main	Unmatched	0.15063	0.21503	-16.7		-2.58	0.01
	Matched	0.15063	0.14774	0.7	95.5	0.12	0.901
Delta Pop density	Unmatched	-0.00534	-0.00516	-0.8		-0.12	0.906
	Matched	-0.00534	-0.00277	-11	-1341.7	-1.98	0.048
Delta Admin spend	Unmatched	0.36167	0.34075	16.9		2.61	0.009
	Matched	0.36167	0.35885	2.3	86.5	0.36	0.719

Notes. The table shows the means of the treatment and control sample before and after weighing by the kernel weights. The computation of standardized biases of weighted and unweighted means of treatment and control group follows Rosenbaum and Rubin (1985). Kernel weights are calculated from the last multinomial probit specification given in table 5 and additional higher order terms. See Figure 3 for a graphical presentation of the standardized biases. The last two columns show the results of a simple t-test on the means and the according p-values. Note that the t-test is biased by sample size and the bias reductions are adjusted for sample size.