Online Appendix for:

The Buck Stops Where? Federalism, Uncertainty, and Investment in the Brazilian Water and Sanitation Sector

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A Appendix

A.I Observations by Year

In this appendix, I investigate the non-balanced nature of the SNIS dataset. The dataset does not include all municipalities in Brazil and participation in the dataset increases over the study period. The number of municipality observations per year is detailed in the table below.

Table A.1: Observations by Year

	Provider Type		
Year	Self-Run	State-Run	Total
2001	189	1,373	1,562
2002	202	1,564	1,766
2003	233	1,556	1,789
2004	277	2,337	2,614
2005	321	2,651	2,972
2006	440	3,953	4,393
2007	460	3,965	4,425
2008	539	3,973	4,512
2009	766	3.979	4,745
2010	845	3,976	4,821
2011	830	3,999	4,829
2012	942	4,020	4,962

As the dataset does not provide information on investment decisions for some municipalities before 2005, it is impossible to test the parallel trends assumption for this group. Therefore, I restrict the main specification of the paper to the set of municipalities for which I can credibly establish the pre-reform counterfactual. Running the difference-in-differences with the entire unbalanced panel results in coefficient estimates that are qualitatively similar but attenuated in statistical significance (see table A.2 below).

Table A.2: WS Investment - Unbalanced Panel

		Source of Investments			Destination of Investments		
	Total Investment	Self Financing	Loans and Debt	Government Grants	Investment in Water	Investment in Sewer	Other Investments
Self-run company, Post-reform	1,238	1,009***	980.4**	24.83	138.4	835.8*	246.3***
	(795.2)	(273.0)	(454.1)	(184.1)	(371.5)	(466.1)	(75.93)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	36,153	36,153	36,153	36,153	36,153	36,153	36,153
Adjusted Within R^2	0.283	0.0231	0.0145	0.0390	0.245	0.182	0.0246
Mean Dep. Variable	1296	369	251	194	515	624	91

This specification is identical to the one in table 3, except that the specification is run over the entire unbalanced sample. Cluster robust standard errors in parentheses. Significantly different than zero at 99 (***), 95 (**), 90 (*) percent confidence. All specifications include municipality and year fixed effects.Standard errors are clustered at the WS company level, with a total of 846 clusters. Investment levels are measured in ,000s Reals. All specifications include additional controls for municipal population, finances (GDP and taxes), agriculture and livestock production, annual temperature and rainfall measures, and a time-trend interacted with the initial investment level.

A.II Legislation Passage Date

In this appendix, I address the potential concern of the timing of the legislation when constructing the treatment indicator. The reform was proposed in Congress in 2005 and was finally ratified as National Water Law 11.447 in January 2007. While there is a clear increase in investment from municipal companies starting in 2005 (and argued earlier in the paper as a significant policy push by the Lula administration), it is arguable that the threat of state takeover was not fully removed until the bill became law. I run a DID specification in which $Reform_{mt}$ is equal to 1 for all years t after the passage of the law in 2007. Results of this specification are shown in appendix Table A.3. The coefficients are comparable in magnitude and significance to the coefficients from the main specification.

Table A.3: WS Investment - Legislation Passage Date

		Source of Investments			Destination of Investments		
	Total Investment	Self Financing	Loans and Debt	Government Grants	Investment in Water	Investment in Sewer	Other Investments
Self-run company, Post-enactment	2,855*	1,909***	2,281**	-114.8	435.1	1,935*	481.6***
	(1,558)	(522.9)	(1,020)	(374.4)	(735.4)	(1,076)	(175.4)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,460	14,460	14,460	14,460	14,460	14,460	14,460
Adjusted Within R^2	0.299	0.0339	0.0225	0.0493	0.258	0.196	0.0245
Mean Dep. Variable	2731	717	535	395	1074	1321	192

This specification is identical to the one in table 3, except that the main regressor of interest is defined in reference to the final passage of Bill 5.296. Cluster robust standard errors in parentheses. Significantly different than zero at 99 (***), 95 (**), 90 (*) percent confidence. All specifications include municipality and year fixed effects. Standard errors are clustered at the WS company level, with a total of 149 clusters. Investment levels are measured in ,000s Reals. All specifications include additional controls for municipal population, finances (GDP and taxes), agriculture and livestock production, annual temperature and rainfall measures, and a time-trend interacted with the initial investment level.

A.III Excluding Linear Time Trend

In this appendix, I address the potential concern of including a linear time trend interacted with a municipality's initial level of investment in the empirical specification. The inclusion of the time trend in the main specification addresses the concern that certain municipalities started with higher initial levels of investment, and that this disparity may have increased over time, which would not be accounted for with the inclusion of municipality fixed effects. However, inclusion of the linear time trend could potentially induce a large bias if the trends are nonlinear or is the initial slopes are correlated with treatment, for example. To allay these concerns, I rerun the main specification without the linear time trend, with results presented in table A.4. The coefficients are comparable in magnitude and significance to the coefficients from the main specification.

Table A.4: WS Investment - No Linear Time Trend

		Source of Investments			Destination of Investments		
	Total Investment	Self Financing	Loans and Debt	Government Grants	Investment in Water	Investment in Sewer	Other Investments
Self-run company, Post-reform	3,493***	1,845***	2,142**	-42.35	936.4*	2,077**	453.5***
	(1,318)	(490.4)	(917.1)	(281.3)	(532.7)	(895.0)	(145.3)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,460	14,460	14,460	14,460	14,460	14,460	14,460
Adjusted Within R^2	0.0160	0.0208	0.0406	0.0788	0.142	0.00941	
Mean Dep. Variable	2731	717	535	395	1074	1321	192

This specification is identical to the one in table 3, except that the specification does not include the linear time-trend. Cluster robust standard errors in parentheses. Significantly different than zero at 99 (***), 95 (**), 90 (*) percent confidence. All specifications include municipality and year fixed effects. Standard errors are clustered at the WS company level, with a total of 149 clusters. Investment levels are measured in ,000s Reals. All specifications include additional controls for municipal population, finances (GDP and taxes), agriculture and livestock production, annual temperature and rainfall measures.

A.IV Underdeveloped Regions of Brazil

In this appendix, I investigate whether the results of table 3 are being driven by the municipalities in the North and Central-West regions of Brazil. These regions are significantly less developed and densely populated than the costal regions of Brazil, while having the largest municipalities by area (see figure 1). These regions in the study sample are composed of the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima, and Tocantins in the North, and Goiás and Mato Grosso do Sul in the Central-West. I run the main specification separately for municipalities exclusively in the Central-West and North regions, and excluding them. Results from these two specifications are presented in panel A and panel B of table A.5, respectively. The estimates for the "CW+N only" sample are generally similar to those in table 3, although the standard errors are much larger, causing the estimates to be fairly imprecise. Panel B of table A.5 excludes the municipalities in these two regions, with the results being very similar in both magnitude and significance to the main specification and ruling out that these two regions are driving the results of the paper.

Table A.5: WS Investment - Underdeveloped Regions

		Source of Investments			Destination of Investments		
	Total Investment	Self Financing	Loans and Debt	Government Grants	Investment in Water	Investment in Sewer	Other Investments
Panel A: Only N & CW Regions							
Self-run company, Post-reform	5,839	-272.1	6,840	-843.6	377.8	5,236	240.8
	(6,085)	(253.3)	(6,521)	(911.8)	(882.2)	(5,593)	(283.7)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,488	4,488	4,488	4,488	4,488	4,488	4,488
Adjusted Within R^2	0.215	0.0243	0.204	0.0947	0.319	0.110	0.115
Mean Dep. Variable	802	318	267	163	357	374	52
Panel B: Excluding N & CW Regions							
Self-run company, Post-reform	2,572*	1,908***	1,682**	-92.20	555.6	1,512*	450.8***
	(1,335)	(534.9)	(837.3)	(327.5)	(603.3)	(851.5)	(156.0)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	9,972	9,972	9,972	9,972	9,972	9,972	9,972
Adjusted Within R^2	0.311	0.0385	0.0217	0.0860	0.262	0.211	0.0237
Mean Dep. Variable	3599	897	656	500	1397	1747	255

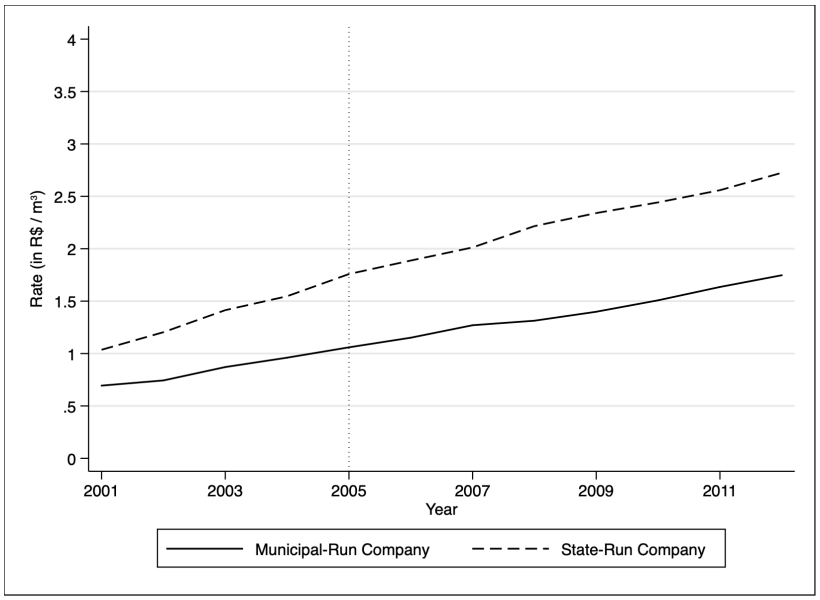
This specification is identical to the one in table 3, except that it splits the regressions based on whether or not the municipalities are in the Central-West and North regions of Brazil. Cluster robust standard errors in parentheses. Significantly different than zero at 99 (***), 95 (**), 90 (*) percent confidence. All specifications include municipality and year fixed effects. Standard errors are clustered at the WS company level, with a total of 149 clusters. Investment levels are measured in ,000s Reals. All specifications include additional controls for municipal population, finances (GDP and taxes), agriculture and livestock production, annual temperature and rainfall measures, and a time-trend interacted with the initial investment level.

A.V Average Tariff Rate

In this appendix, I study the effect (if any) that the reform had on the tariffs charged to users. As the reform led to significant increases in investment for municipal-run companies, the impact on end-user tariffs for water and sanitation services is ambiguous. If the primary source of self-financing for companies was through collections and billing, then one may expect the significant increase in self-financed investment by municipal-run companies after 2005 to coincide with a significant hikes in tariffs. However, if the increased investment led to increases in efficiency and cost reductions, then companies may have potentially passed these savings on to consumers through lower tariff rates.

Figure A.1 presents the average tariff rate for combined water and sanitation services over the study period. It is important to note that while the majority companies use increasing-block tariffs (Barbosa and Brusca, 2015), the data provided by the SNIS does not contain information on the precise tariff structure for each company, and rather uses the average tariff rate for benchmarking purposes.

Figure A.1: Average Tariff



This figure shows the average tariff rate by each type of WS company for a given year. Average tariff rate is defined by the SNIS as the ratio of *Total Direct Revenue* over the *Total Volume Billed* for both water and sanitation. The solid line represents the average tariff for all municipalities that self-provide WS service. The dashed line represents the average tariff across all municipalities that have WS services provided by state companies. The vertical dotted line depicts the year the Bill 5.296/2005 was proposed.

There are three distinctive features of the figure: average tariff rates are increasing over time for both company types, state-run companies charge higher rates on average than their municipal-run counterparts, and *there was no significant tariff hike by municipal-run companies after 2005*. The lack of significant rate hikes may be attributed to two factors. Firstly, while not regulated to a significant degree, the federal government established guidelines in 1997 for companies to follow on the structure and objectives for water charges (OECD, 2017). Additionally, most companies apply a low social tariff on the first block of consumption, which accounts for the usage of most residential consumers and for which it would be difficult to alter in a significant manner without a lengthy policy review (World Bank, 2004).

A.VI Mortality Summary Statistics

This appendix reports the summary statistics for the mortality data used in subsection IV.C. Mortality data comes from the Ministry of Health's DATASUS database, which provides annual death counts at the municipal level for various age groups. Table A.6 presents the summary statistics for the age groups seen in table 7. The mean and standard deviation is reported for the pooled observations by company type and age cohort, which show a wide variation across the study period.

Table A.6: Mortality Summary Statistics by Company Type

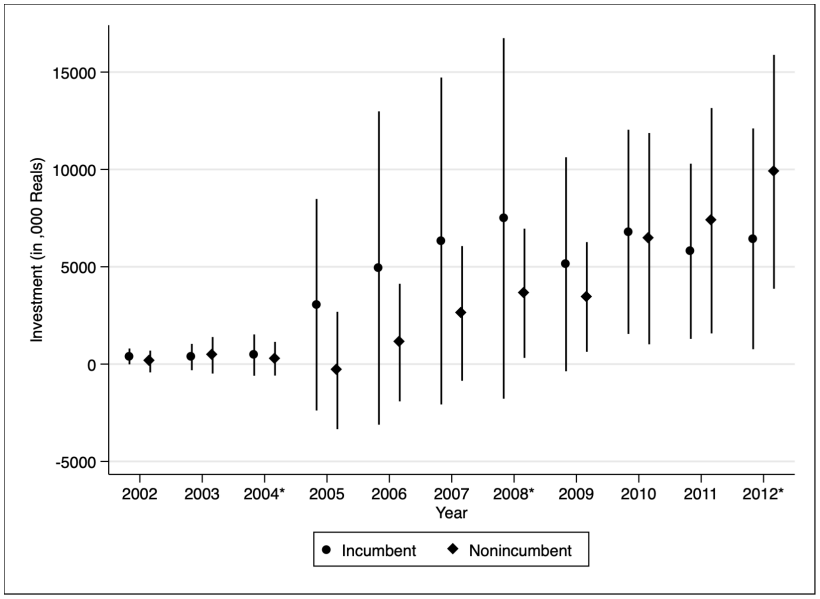
	Municipal-Run Companies		State-Run Companies		
Age Group	Mean	Std Dev	Mean	Std Dev	Observations
Under 1 Year	37.87	55.65	20.04	88.44	16,149
1 - 4 Years	6.15	9.24	3.36	14.18	16,149
5 - 9 Years	3.60	5.39	1.91	7.98	16,149
10 - 14 Years	4.65	6.97	2.45	10.49	16,149
15 - 19 Years	15.85	27.18	9.13	46.81	16,149
20 - 29 Years	47.79	76.57	25.25	126.35	16,149

This table shows summary statistics for mortality by various age groups for both types of WS companies. Mean and standard deviation are calculated for the pooled sample over the study period.

A.VII Investment, Elections, and Incumbency

In this appendix, I address an alternative explanation for the observed increase in investment; the reform made salient to voters that mayors were responsible for the delivery of water and sanitation, with this increased accountability causing the increase in investment. Unfortunately I cannot directly measure the perceived accountability, so am unable to directly test whether the authority of self-run companies was more salient after the reform. Instead, I use an insight from Ferraz and Finan (2011) that increased accountability would have a larger impact on incumbent mayors who are up for reelection. In their paper, they find that mayors with reelection incentives were significantly less corrupt; mayors up for reelection misappropriated 27 percent fewer resources than mayors without this incentive. I perform a similar analysis looking at yearly total investment for self-run municipalities based on whether the mayor was an incumbent for the upcoming election cycle. The coefficients for incumbent and non-incumbent municipalities are shown in figure A.2. In line with the reform, there is an increase in total investment after 2005, however, the investment choices in *incumbent* and *non-incumbent* municipalities are similar, providing evidence that accountability during an election cycle was not the primary driver of WS investment decisions.

Figure A.2: Annual Total Investment by Incumbency Status of Mayor



This figure shows coefficients predicting the average yearly total investment by self-run municipalities. Mayoral elections years are marked with (*) and took place in 2004, 2008, and 2012. *Incumbent* is defined as whether a municipality had an incumbent mayor that was up for reelection during the next election cycle. Coefficients are measured relative to 2001.