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Inequality of Access to Public Services of Basic Sanitation in Brazilian Municipalities: Analysis of Kuznets Curve and Selectivity of Public Policies Hypothesis

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Abstract

This study investigates the effects of economic growth and possible political motivations in the distribution of access to public basic sanitation services in Brazilian municipalities. Along with municipality indicators relating to inequality of access associated with income and the location of households in urban or rural areas and using panel econometric estimates, three hypotheses are checked: 1) the relationship between inequality of access and municipality *per capita* income in an "inverted-U" shape based on the Kuznets Curve (KC); or 2) in the shape of an "N", following KC criticisms; and 3) the relationship between inequality of access and total access in "inverted-U" suggesting a possible selectivity in public sanitation policies in Brazil. In general, the evidence obtained refutes the KC hypothesis and some evidence supports the "N" shape, especially for spatial inequalities. The evidence is more robust as regards the hypothesis of selectivity of public policies.

Keywords

Basic Sanitation, Inequality of Access, Economic Growth, Policy Selectivity, Panel Data

1. Introduction

Basic sanitation may be defined as the set of infrastructures, facilities and services for water supply collection, treatment and distribution, sanitary sewage collection, treatment and final destination, solid waste management (garbage) collection and final destination and rainwater management. These services are natural monopolies with low technological dynamism. In other words, market competition is economically unfeasible. Moreover, they are inelastic-demand services, especially with water (Ménard & Sausier, 2000; Turolla, 2002; Helm, 2020; Oliveira, 2020).

Inadequate provisions for sanitation services result in negative externalities on the environment, health, and, consequently, human development and sustainable development. The impact tends to be greater on the poorest. Because of this, distributional effects may occur. For instance, the contamination of soils and water contributes to the proliferation of diseases. In children, such diseases affect their physical and intellectual development and school performance, with repercussions throughout life; in adults, it affects their productivities, which reflects on the income and production (Heller, 1997; Bohra et al., 2017).

The economic characteristics associated with the social effects justify effective public participation in the sector, either by direct supply and/or regulation (Turolla, 2002; Helm, 2020). In Brazil, a direct public supply is predominant. Concerning this fact and the socioeconomic returns, it would be reasonable that access to basic sanitation services to be universalized. However, this is not the case in Brazil. This country has serious deficits in access to sanitation. In addition, previous studies show that access to basic sanitation is unequally distributed due to the municipality and household characteristics, such as per capita income. The same previous studies argue that such characteristics may arise, on the demand side, to differences in payment capacities for access, to environmental and health awareness, and consumer political participation; on supply side, aspects related to the economic viability of the provision (costs and capacities to collect and invest), as well as political motivations (Mendonça et al., 2003; Saiani, 2006; Rezende et al., 2007; Bichir, 2009; Saiani et al., 2013).

This study intends to contribute to the debate by exploring non-egalitarian distributions of access to basic sanitation services according to two household characteristics: income and location (urban or rural areas). The aim is to investigate the effects of economic growth and possible political motivations in the distribution of access based on these characteristics. To this end, municipality indicators of income inequality are calculated (differences of access between 20% richer-households and 20% poorer-households); and indicators of spatial inequality (differences between urban and rural access).

The indicators are calculated for all Brazilian municipalities using census data made available for 2000 and 2010 to three services: water supply, sewage collection, and garbage collection. These indicators are used in panel econometric estimations that test three hypotheses. The first is derived from the Kuznets Curve (KC), according to which, income inequality and *per capita* income level would have an "inverted-U" relationship (Kuznets, 1955; Deutsch & Silber, 2000). That is to say, inequality increases with economic growth at lower levels of *per capita* income; however, reaching a given level of income, inequality begins to decrease. Thus, as the inequality of access to basic sanitation tends to be correlated with income inequality, it is possible that it also has an "inverted-U" trajectory throughout the growth.

Critics of the KC argue that income inequality increases again as a result of growth in higher income levels. Therefore, the relationship between inequality and income level would have a shape close to an "N" (List & Gallet, 1999; Churchill et al., 2018; Sayed & Peng, 2020). This is the second hypothesis tested in this study relating to the inequalities in access to basic sanitation services. Possible explanations for both the KC and the "N" shape go through the adoption of public policies. Thus, the possible relationships found here may implicitly reflect political motivations (Bishop et al., 1991; List & Gallet, 1999; Glaeser, 2005; Piketty, 2014).

The third hypothesis explicitly refers to political issues. This is the possibility of selectivity governing public policies. In other words, due to the capture of the State by interest groups, class conflicts, the technical culture of public servants, political-electoral objectives and economic viability, policies would serve primarily the richer and more educated segments of society or areas that tend to concentrate them; and just later would they turn to the rest of society (Marques, 2000; Marques & Bichir, 2001; Saiani et al., 2013). To corroborate this hypothesis in basic sanitation services, the relationships between municipality indicators to access inequality and their respective indicators of total access should be in an "inverted-U" shape. That is, access inequality would increase as the coverage (full access) expands; however, after a given level, inequality would decrease.

Finally, it is important to point out that assessment of access inequalities associated with income discriminating between urban and rural areas and, especially, between the two is not greatly explored in literature, but it is cited as a major challenger to developing countries to achieve the development goals (Wolf et al, 2013; Chaudhuri & Roy, 2017) and Brazil appears among the countries with the greatest spatial inequalities in access to sanitation services (WHO & UNICEF, 2015). It is also worth mentioning that access is considered to be the existence of the collective action of public providers, pointed out in the literature as the most appropriate for each service to reduce costs and generate negative externalities. As regards water and sewage, the main alternative individual actions are also considered. With garbage, only collective action—alternative actions generate large externalities. The results for this service can guarantee greater robustness to the interpretation of possible relations obtained as a result of political motivations, since, unlike the others, it is not exclusive. So, access depends relatively less on the decision of joining together of the households and more directly from providers' decisions.

Besides this introduction and the final considerations, this work is divided into four more sections. The second section presents the theoretical and empirical referential that base the hypotheses of KC, the "N" shape, and the selectivity in public policies. The third section presents the indicators of access and inequality of access to sanitation services calculated here and, through these, characterizes the problem as to the distribution of coverage according to income and the location of households. Empirical strategies are discussed in the fourth section and the results in the fifth.

2. Theoretical and Empirical Referential

2.1. Hypotheses of the Kuznets Curve and the "N" Shape

Income inequality and economic growth (or economic development) are central themes in the economic debate. In the 1950s, the discussion as to the relation between the two variables was highlighted due to the evidence of Kuznets (1955). This work, when analyzing data from the United States, England, and Germany observes a nonlinear relation between inequality and *per capita* income level. Graphically, by plotting the first variable on the vertical axis and the second on the horizontal axis, a curve is obtained in an "inverted-U" shape, although not necessarily symmetric. Therefore, at lower levels of income, income inequality increases as a function of growth; however, there is a level of maximum income (turning point) from which it begins to fall.

This hypothesis was called the Kuznets Curve (KC). After the initial finding, several studies have tried to justify the shape. Deutsch & Silber (2000) divide possible justifications into three groups, according to the theories underlying them: dual economy, endogenous growth, and public choice. In the first, we find Kuznets (1955) work itself, according to which the phenomenon stems from the transition of relevance from the economic sectors, from the less dynamic (or traditional) to the more dynamic. At lower levels of *per capita* income, there is a migration of workers from rural to urban areas, with the marginal income of rural labor (agriculture) tending to be lower than that of urban labor (industry). Therefore, in the transition from rural to urban predominance, inequality increases with the stabilization of migration inequality reduces.

The principal argument for the justifications associated with the endogenous growth theory is that in the initial stages of *per capita* income the unequal distribution is an essential condition for some groups to invest in human capital, mainly due to imperfections in the credit market and distortions in savings rates. As growth occurs, there is a spillover of knowledge towards the poorest, reducing inequality (Ághion & Bolton, 1992; Galor & Tsiddon, 1996; Dahan & Tsiddon, 1998; Barro, 2000).

Justifications related to the public choicetheory are based on the interactions between political mechanisms and the socioeconomic structure. For some, policies are endogenous; for others, exogenous. In the first case, an explanation is substantiated by discussions of median voter theorem and social tensions. As the result of the election depends on the median voter (or most of the electorate), if one is deprived of income (or if oneself income is low), this demand of redistributive policies, such as voting for candidates who offer them. Moreover, in the face of high inequality, the poorest can adopt behaviors that result in social tensions and, consequently, encourage the wealthy to demand redistributive policies

(Barro, 2000; Deutsch & Silber, 2000).

Possible positive relationships between growth, education, and political participation also support justifications associated with endogenous policies. With low levels of income, a small part of the population invests in human capital and exerts political control. In this manner, few redistributive policies are adopted and inequality increases. As income rises, a larger share of the population accumulates human capital, participates in politics, and demands redistributive actions, which tend to be adopted because of the politicians' goal of maximizing electoral opportunities, and inequality falls (Gradstein & Justman, 1999; Deutsch & Silver, 2000).

In the works that consider policies as exogenous, the "inverted-U" is explained by the regressive effect of taxation, which initially increases inequality; however, by financing investments in physical and human capital, one generates conditions for it to fall. Another explanation is the capacity of the population to organize themselves to demand redistributive policies, which tend to be greater the higher urbanization is (Deutsch & Silver, 2000; Glaeser, 2005).

More recent studies suggest that the relationship between inequality and income level would in reality have the shape close to an "N". That means, at higher levels of income, there is a reversal of the fall in inequality, which again increases. One of the first studies to show empirical evidence in this regard was by List & Gallet (1999), although this possibility was already discussed. Bishop et al. (1991) justify the "N-shape" for the dual economy approach, arguing that the increase in inequality results from the transition from a manufacturing to a service-based economy; in other words, from the differential of incomes and the migration of workers between sectors.

Katz & Murphy (1992) explain the "N" by the increase in demand for more skilled workers due to factors that alter the dynamics of the labor market, such as technological changes and expansion of international trade. However, for Glaeser (2005) and Piketty (2006, 2014), the "N" relationship stems from tax issues, labor laws, and redistributive policies.

Thus, by the brief review carried out so far, one can affirm that economic and political aspects are complementary to the explanation of the "inverted-U" or "N", especially because of redistributive policies as to inequality. Such policies are influenced by the preferences and capacity of individuals to exert pressure on the rulers and also by the rulers' interest in meeting the demands of the population, motivated by the maximization of electoral opportunities. Also, specific historical and institutional aspects of each location are other determinants of the adoption of this type of policy (Glaeser, 2005; Piketty, 2006).

Finally, it is worth mentioning that several studies have empirically tested the hypotheses of the KC and N by different methods and different samples, periods, and measures of inequality and growth (or development). Independently of the empirical strategy, some obtainsevidence that corroborates the KC hypothesis; others refutes it. Moreover, there is also evidence supporting the relationship in the "N" shape. International results are systematized in the reviews published by Adelman & Robinson (1989), Deutsch & Silber (2000), Fields (2001), and Piketty (2006).

In Brazil, there are studies with analyzes of States and Municipalities—segmented by States or for the whole country. For state data, check Lledó (1996), Taques & Piza (2010), and Linhares et al. (2012). For municipality data, check Bêrni et al. (2002), Bagolin et al. (2004), Jacinto & Tejada (2004), Salvato et al. (2006), Barros & Gomes (2008) and Figueiredo et al. (2011). In general, the results are not conclusive concerning KC and there are pieces of evidence regarding the "N". Saiani et al. (2013) tested the "inverted-U" and the "N" for municipality indicators relating to inequality of access associated with income to water supply, sewage collection, and garbage collection. Only in the first service, they do not refute the "N". In the other two, neither the "inverted-U" nor the "N-shape" is observed.

2.2. Hypotheses of Selectivity in Public Policies

In the literature of political science, some hypotheses explain the inequality of access to public services due to discretionary policies. One is that of structural (or classist) selectivity derived from the Marxist view. It is argued that the policies are strategic means that enable interventions by the State, which in capitalism has among their defining elements accumulation and legitimation. These reflect a paradoxical character of the State: its sustentation depends on accumulation; but to be legitimate, it must meet social demands. Accumulation raises such demands, affecting expenses, and resulting in a dilemma between guaranteeing the reproduction of capital or labor. As they have more power resources, the policies may tilt towards capital holders. In other words, they can be selective oriented only, or primarily to the ruling class (Miliband, 1972; Jessop, 1983; Przeworski, 1994; Rodrigues, 1997).

This structural capture of the State is explained on the Marxist view by theories of influence and limiting factors. In the first, the capitalist State is considered an instrument of the ruling class to guarantee the institutional support for its interests. In the second, it is impossible for political institutions become instruments of non-capitalist interests. Claus Offe criticizes such theories arguing that they are restricted to external relations and not to internal motivations of the state machine itself. According to the author, the influence exerted by the dominant classes is already rooted in the power structures, with the State having some degree of discretion and autonomy to be selective in its policies (Offe, 1975, 1984; Offe & Volker, 1984).

Beginning from the selectivity arguments in the policies of Offe, several works discuss his possible determinants. Marques (2000) and Marques & Bichir (2001), for instance, point to the hypothesis of hierarchical selectivity, which reinforces the argument that the State provides priority or differentiated services to some groups of the population; however, the selectivity comes from the technical culture of the state professionals (bureaucrats) who effectively execute the policies. That is to say, of the ideas, beliefs, and visions of society (explicit or implicit), which influence bureaucracy and not class conflicts as in the structural approach. In this way, bureaucrats can tilt policies, prioritizing the rich and educated, if they understand that state priorities should reflect the social hierarchy.

It is plausible to think that hierarchical selectivity may also derive from the electoral motivations of the rulers, based on the ideas of the public choicetheory. Rulers can be discretionary in favor of some social groups—the richer and more schooled, for example—because of their greater ability to organize and exert political pressure; in other words, looking for potential electoral results. Ames (1995a, 1995b) and Gradstein & Justman (1999) defend the electoral bond hypothesis. Marques (2000), Marques & Bichir (2001), and Marques (2006) relativize it concerning the role of bureaucracy in the implementation of policies and reinforce the need for the disadvantaged groups to mobilize and press to be attended.

The discretion of policies may not yet have the direct motivation to benefit groups, but this is a consequence. The selectivity may be economic-spatial. For instance, urban infrastructures such as the basic sanitation services analyzed in this study have lower costs in terms of greater and more concentrated users (economies of scale and density). Public providers, seeking economic viability, may invest primarily in central or more populated areas, which also tend to concentrate the wealthiest that guarantees higher collection in the case of charging for access. Real estate in these areas rises in value. The poorest may be unable to afford rent increases or, if they are owners, feel encouraged to sell or rent, moving to peripheral areas, contributing to residential segregation (Bichir, 2009; Saiani et al., 2013).

According to Marques (2000, 2006), Marques & Bichir (2001), and Bichir (2009), investments in basic sanitation in Brazil are historically motivated by economic-spatial and political selectivity. It is worth mentioning the study by Marques (2000) that evaluating investments in sanitation in Rio de Janeiro between the 1960s and 1990s, verified that those carried out in areas classified as "upper class" were close to those of "low class", which would refute the hypothesis of selectivity. However, the stock (and quality) of the infrastructures in the former were higher signaling that earlier investments were made for the "upper class" and that, in the period under review, they were redirected to the "lower class".

Another study that stands out is the one carried out by Bichir (2009), by multivariate analysis, suggests the existence of selectivity in investments in sanitation in central areas to the detriment of peripheral areas in the city of São Paulo. However, Saiani et al. (2013), through empirical strategies similar to those of this work—discussed in the third section, verify relations in the "inverted-U" shape between municipality indicators of access inequality associated with household income and total access (coverage) to sanitation services (water supply, sewage collection or garbage collection). In other words, in the initial stages of coverage consolidation, the inequality of access between rich and poor tends to increase; however, when coverage is reached, the inequality decreases. These shreds of evidence corroborate the hypothesis of policy selectivity.

3. Municipality Access Indicators to Sanitation: Characterization of the Problem

Access to sanitation services in Brazil is not universalized and is unevenly distributed according to the municipality and household attributes. In this study, two attributes are relevant: location (urban or rural) and household income. Concerning the former, due to economies of scale and density, it is plausible to expect that in urban areas, with larger contingents and population concentrations, the coverage will be greater for collective forms offered by service providers; while in rural areas, compensating the collective action, individual efforts are more intense. These facts occur; however, individual actions are still widely adopted in urban centers due to the lack of provision and/or non-adherence of households[1].

In the presence of collective actions, non-adherence reflects the capability of households to pay, which justifies the increase in the probability of access as household income increases. Even if services are not charged or subsidy mechanisms are in place, such as in part of municipalities[2], the cost of connecting to water supply and sewerage networks may limit access for the poorest. Besides, regardless of payment, people opt for access if they can appreciate the benefits, which come from income-related factors, such as education (Mendonça et al., 2003; Rezende et al., 2007; Bichir, 2009; Saiani et al., 2013).

Additional explanations for the inequalities of access can be related to the dynamics of municipality income and policies. These are explored in the following sections. Beforehand, it is important to illustrate the problem. For this purpose, municipality indicators of total access and inequality of access are calculated. To explain the data collection, the data source and the data sample, first it is important to point out that the option for municipalities is because they are the service holders, which is defined in the 1988 Constitution and the Basic Sanitation and Solid Waste Laws[3], with some reservations for the metropolitan regions. The municipalities may provide the services directly or grant them to state-owned companies or private companies.

It is also worth mentioning that domiciliary data from the 2000 and 2010 Demographic Census of the Brazilian Institute of Geography and Statistics (IBGE) are considered. One limitation arises from the fact that access data is

[1]Check: Mendonça et al. (2003), Saiani (2006), Rezende et al. (2007), Bichir (2009), and Saiani et al. (2013).

[2]Information of the number of municipalities with the collection and subsidies is available in IBGE (2008).

[3]Respectively, Federal Laws No. 11,445 and No. 12,305. For more details, check: Brazil (1988, 2007, 2010).

only available for permanent private households (dwellings built exclusively for housing). However, there are other types: provisional dwellers (dwellings in non-residential units with non-dwelling units); and collectives (hotels, prisons, asylums, orphanages, convents, hospitals, lodgings, etc.).

Also, due to the availability of data, three services are evaluated: water supply, sewage, and garbage collection. Due to the lower risk of contamination of water resources and soils, which generate negative environmental and health externalities, the general network is considered the most adequate way to access water supply and sewage collection and cleaning services for the collection of garbage (directly or by a dumpster). These forms are more associated with provider decisions (collective actions) because access depends on the adhesion of the users (demand), but the supply is necessary. Although there are public actions, alternatives depend more on individual actions with potential negative externalities. Wells for water and septic tanks for sewerage are options with lower externalities. For garbage, alternatives generate large externalities (e.g., burning and dumping on land and water resources)[4].

Considering these aspects and the parameters established in the Basic Sanitation Law and complementary studies (Brazil, 2007; SNSA, 2011), in this work is interpreted that a household has access to the water supply if the origin of the water is from the water mains network or a well[5]; for sanitary sewage, if there is a collection by general mains network or septic tank; and for the collection of garbage if it is for cleaning services (direct or dumpster). Hence, in the first two services, collective action (general mains network), and the best alternative individual actions (wells and septic tanks, respectively) are considered. In for garbage, only collective action, which makes this service an important basis of comparison to evaluate political motivations, since it is non-exclusive access depends less on user compliance and more on public actions financed by tax revenues.

As one of the objectives of this work is to evaluate public selectivity, municipalities with private provision are disregarded[6]. Concerning water supply and sanitary sewage, these are identified by data from the National Sanitation Information System (SNIS), and the Brazilian Association of Private Utilities of Public Sewage and Water Utilities (ABCON). Over the period, 188 municipalities (3.38% of the total) had or have begun to have a private provision of water and 179 (3.21% of the total) in sewage. As for garbage, there are privatizations, but it is not possible to identify all cases. This is not a strong limitation regarding the analyses, because, due to the non-exclusivity and the establishment of parameters of a provision in concession contracts, it is plausible to suppose that public

[4]Check, for instance: Mendonça et al. (2003), Libânio et al. (2005), Rezende et al. (2007), and SNSA (2011).

[5]Or spring, for the reason that in the IBGE Censuses, this form of access is considered together with the wells.

[6]Thus, potential effects of privatizations are disregarded, such as reduced access for the poorest due to tariff adjustments, intolerance to non-payment and extinction or non-adoption of subsidies (Galiani et al., 2005).

decisions influence more direct access to this service.

After identifying the households with access and samples from the municipalities, for all municipalities, plus for 2000 and 2010, municipal indicators of total access (urban and rural areas), urban and rural are calculated. These denote the proportion of households in the respective area with access to the service under analysis. **Table 1** shows the calculated indicators, according to the dimensions considered (services, forms of access and areas), and the evolution of their averages.

In **Table 1**, one can see expansions as to the coverage of the three services, independent of the form of access and the area. Also, as expected, individual actions are representative even in urban areas, but insufficient to fully compensate for the lack of main access, especially in sewage. It is also verified that the services are in different stages of consolidation as to coverage. Sanitary sewage has smaller coverings, even taking into account the pit/sump. Considering only collective actions, the coverage of garbage collection (total, urban and rural) is the highest in 2010, with water from the mains being higher than in 2000. This fact may reflect, in part, a change in historical preference of public investments for waterworks strengthened during the National Sanitation Plan (Planasa).

In a nutshell, Planasa, which ran from 1971 to 1992, was a model for financing federal investments in sanitation. For much of its duration, the water supply was prioritized and the sanitary sewage was in the background. Other services, such as garbage collection, only entered the program in its final years (MPO & IPEA, 1995; Turolla, 2002). The privilege towards water is explained by political and

Table 1. Municipality indicators for access to basic sanitation services: dimensions considered and evolution of average values (%) from 2000 to 2010.

Services	Forms	Areas	Indicator Names	2000	2010	Δ%*
Water Supply	Mains	Total	Total Water Mains	57.1	68.1	19.3
		Urban	Urban Water Mains	83.4	89.6	7.4
		Rural	Rural Water Mains	14.6	24.0	64.4
	Mains or Wells	Total	Total Water Mains-Well	85.8	92.0	7.2
		Urban	Urban Water Mains-Well	91.7	97.1	5.9
		Rural	Rural Water Mains-Well	78.5	84.4	7.5
Sanitary Sewage	Mains	Total	Total Sewage Mains	22.7	29.4	29.5
		Urban	Urban Sewage Mains	31.6	39.1	23.7
		Rural	Rural Sewage Mains	2.1	2.9	38.1
	Mains or Septic Tanks	Total	Total Sewage Mains-Tank	34.0	42.1	23.8
		Urban	Urban Sewage Mains-Tank	45.5	52.2	14.7
		Rural	Rural Sewage Mains-Tank	12.4	18.7	50.8
Garbage Collection	Direct or Skip	Total	Total Garbage	52.2	69.4	33.0
		Urban	Urban Garbage	78.6	93.3	18.7
		Rural	Rural Garbage	10.4	26.9	158.7

Sources: IBGE, 2000 and 2010 Censuses. Own elaboration. Δ%* percentage variation from 2000 to 2010.

economic motivations. Considering its essentiality to human survival the water services is preferable to users in comparison to other services, whose benefits are perceived diffusely by health externalities. Thus, investments in water supply generate greater political and electoral support and users are more willing to pay for access (BNDES, 1996; MCIDADES, 2009).

Table 1 also shows that average coverage independently of services and forms of access is higher in urban areas, which reflects the already mentioned economic motivation (economies of scale and density) in services with high social returns. The unequal distributions of access between urban and rural areas, as well as that associated with household income, are better characterized in this study through municipality inequality access indicators. To calculate inequalities associated with income the households of a given area (total, urban or rural) are sorted out for each municipality and year, by monthly household *per capita* income identifying the quintiles of the distribution. Afterward, the proportions of households with access to each service and form in the 5th and first quintiles (richest and poorest, respectively) are calculated; finally, the differences (in percentage points) between these proportions[7], which correspond to the municipality inequality indicators associated with income, are obtained. For spatial access inequalities, we consider differences (percentage points) between the proportions of urban and rural households with access to the service and the form of the same under analysis.

Table 2 displays the twenty inequality indicators of access as calculated according to the dimensions considered (services, forms of access, types of inequality and areas served), and their average evolution between 2000 and 2010. It is observed that in almost all indicators, there was a retraction in the period of differences in access between richer and poorer and between urban and rural areas, except for urban-rural inequalities in sewage—greater for only collective action and, more significantly, the inequality associated with income in rural areas as to garbage.

The main evidence to highlight the data in **Table 2** is that over the two years all the averages of the indicators are positive, that is, there are inequalities of access associated with the household income regardless of the areas where the households are located and between these areas. Comparing **Table 1** and **Table 2**, it can be understood that, in some cases, minor inequalities may occur with low or high total access. This is precisely one aspect which is explored below.

4. Empirical Strategies

In the literature, several studies have tested the Kuznets Curve (KC) hypothesis ("inverted-U" hypothesis) by econometric estimates with cross-section data considering a second-degree polynomial concerning the measure of economic growth (or economic development), with *per capita* income being the most used

[7]For indicators of total access inequality, all households of municipalities are ordered; for urban indicators, only urban households; for rural indicators, only rural households.

Table 2. Municipality indicators of inequality in access to basic sanitation services: considered dimensions and evolution of average values (percentage points) from 2000 to 2010.

Services	Forms	Types	Areas	Indicators	2000	2010	Δ%*
Water supply	Mains	Income	Total	Ine.Income Total Water Mains	21.7	15.1	−30.4
			Urban	Ine.Income Urban Water Mains	8.8	3.8	−56.8
			Rural	Ine.Income Rural Water Mains	3.2	2.6	−18.8
		Spacial	Total	Ine.Urban-Rural Water Mains	68.8	65.7	−4.5
	Mains or Well	Income	Total	Ine.Income Total Water Mains-Well	9.2	5.6	−39.1
			Urban	Ine.Income Urban Water Mains-Well	6.5	2.1	−67.7
			Rural	Ine.Income Rural Water Mains-Well	4.8	3.4	−29.2
		Spacial	Total	Ine.Urban-Rural Water Mains-Well	13.2	12.7	−3.8
Sanitary sewage	Mains	Income	Total	Ine.Income Total Sewage Mains	11.6	10.0	−13.8
			Urban	Ine.Income Urban Sewage Mains	8.3	6.1	−26.5
			Rural	Ine.Income RuralSewage Mains	0.9	0.6	−33.3
		Spacial	Total	Ine.Urban-Rural Sewage Mains	29.6	35.9	21.3
	Mains or Pit	Income	Total	Ine.IncomeTotal Sewage Mains-Tank	18.2	12.6	−30.8
			Urban	Ine.Income Urban Sewage Mains-Tank	15.0	8.9	−40.7
			Rural	Ine.Income Rural Sewage Mains-Tank	5.6	3.6	−35.7
		Spacial	Total	Ine.Urban-Rural Sewage Mains-Tank	33.1	33.2	0.3
Garbage collection	Direct or Skip	Income	Total	Ine.Income Total Garbage	23.7	17.7	−25.3
			Urban	Ine.Income Urban Garbage	13.0	4.6	−64.6
			Rural	Ine.Income Rural Garbage	3.8	5.7	50.0
		Spacial	Total	Ine.Urban-RuralGarbage	6.8	6.6	−2.9

Sources: IBGE, 2000 and 2010 Censuses. Own elaboration. Δ%*: percentage variation from 2000 to 2010.

proxy. To test the "N-shape" hypothesis, the studies consider a third-degree polynomial relative to the measure of economic growth (or economic development). Fields & Jakubson (1994) criticize cross-section data to evaluate the hypotheses due to the relationships arising from the dynamic processes of transformations in the economy justifying the use of panel data. According to Bagolin et al. (2004), in this type of evaluation, panel methods reduce biases of unobserved site-specific attributes that induce unique trajectories.

Among the panel methods, the literature suggests that fixed effects are more adequate for testing the hypotheses since they allow one to evaluate if inequalities of different localities follow similar trajectories along with the evolution of income (different intercepts). Another advantage is the correction of bias arising from the correlation between fixed times omitted variables and regressors as well as if temporal dummies are inserted if time-variant effects are common to localities. Such a method is employed in this work (robust standard errors and within estimator). Hausman tests are performed to determine the best suitability of fixed effects compared to random effects (Greene, 1997; Baltagi, 2001). The models are based on Equation below (4.1).

$$DA_{it}^{s} = a_0 + a_1 Y_{it} + a_2 \left(Y_{it}\right)^2 + a_3 \left(Y_{it}\right)^3 + a_4 A_{it}^{s} + a_5 DR_{it} + a_6 X_{it} + T_t + u_i + \varepsilon_{it} \quad (4.1)$$

The estimates are carried out using municipality data referring to 2000 and 2010 censuses. Therefore, t = 2000, 2010 and i represent each of the Brazilian municipalities with data made available by IBGE. With the purpose of evaluating the public provision, as well as in the descriptive analyses of the previous section, municipalities with private provision are disregarded.

In contrast to most of the studies that evaluate the KC and "N-shape" hypotheses, this work does not consider measures of income inequality, but rather the 20 indicators of inequality of access to sanitation services presented in the previous section (**Table 2**). Consequently, the dependent variables correspond to income and spatial access inequalities for each service: water supply, sewage collection, and garbage collection.

The Y_{it} measure of economic growth (or economic development) is the municipality *per capita* income (R$ thousands of 2010), described later in **Table 3**. As already mentioned, the hypotheses are tested by a polynomial of 3˚ in relation to this measurement. To accept the "N-shape" hypothesis, the coefficients of the polynomial must be significant, positive in level and cubed and negative squared: $a_1 > 0, a_2 < 0$ and $a_3 > 0$. In addition, the second derivative must be tested to corroborate the shape: considering the coefficients to obtain the first derivative of (4.1) in relation to a Y_{it}; calculating the critical pointsfinding the second derivative and substituting the critical points in same. If one of the values is less than zero and the other is higher, there are local maximum and minimum points (Chiang, 1982), confirming the "N-shape" hypothesis. Such test is only carried out for meaningful relationships. On the other hand, if: $\mathrm{a}_1 > 0, \mathrm{a}_2 < 0$ and $a_3 > 0$ or a_3 and if it is not significant, the relation has the shape of KC ("inverted-U" hypothesis).

In literature, there is evidence of a positive relationship between access and income in Brazilian municipalities (Mendonça et al., 2003; Saiani, 2006; Rezende et al., 2007; Bichir, 2009; Saiani et al., 2013). By demand side, possible explanations refer to greater schooling, political participation, and environmental and health awareness; by supply side referring to the capacity of one's collection of resources (tariffs and tributaries) and, consequently, of investment. One can be assumed that if full access is determined the municipality income can also affect its distribution. The only study found to explore a nonlinear relation between income inequalities and municipality income is that of Saiani et al. (2013), which uses some indicators corresponding to those presents here in **Table 2**. Therefore, this work, besides being from distinct years, considers more indicators, which guarantees more evidence to assess inequalities associated with access with income and, unbelievably, spatial (urban-rural).

Table 3. Explanatory variables: descriptions and evolutions of the average values from 2000 to 2010.

Variables	Descriptions	2000	2010	Δ%*
Income *per capita*	Ratio between the sum of the income of all resident individuals and the total number of these individuals (R$ thousand 2010)	0.3	0.5	66.7
Total Income Inequality	Difference between the proportions of municipality income of the 5th and first quintiles of household income *per capita* (pp.**)	56.3	51.5	−8.5
Urban Income Inequality	Difference between the proportions of urban municipality income of the 5th and first urban quintiles of household income *per capita* (pp.**)	55.5	50.2	−9.5
Rural Income Inequality	Difference between the proportions of rural municipality income of the 5th and first rural quintiles of household income *per capita* (pp.**)	53.7	50.4	−6.1
Urban-Rural Inequality	Difference between the proportions of municipality income of urban and rural households (pp.**)	34.6	42.0	21.4
Urbanization	Urban population (% total)	58.9	63.8	8.3
Density	Ratio between total population and total area (inhabitants/km^2)	33.8	35.6	5.3
Population	Population Resident population (thousands of inhabitants)	30.7	34.3	11.7
Area	Total area (thousands of km^2)	1.5	1.5	0.0
Illiteracy	Persons 25 years of age or older who cannot read and write (% of total)	21.8	16.2	−25.7
Sector Services	Formal links in sector of services and totals (% of total)	56.5	56.7	0.4
Fecundity	Average number of children at the end of the productive period	2.9	2.2	−24.1
Youth	Population under 18 years old (% of total)	13.0	12.0	−7.7
Elderly	Population over 65 years old (% of total)	6.5	8.4	29.2

Sources: IBGE, 2000 to 2010 Censuses. Own elaboration. Δ%*: percentage variation from 2000 to 2010. p.p**: percentage point.

Jha (1996) argues that some evidence favorable to KC hypothesis was obtained with samples coming from very heterogeneous localities and that, when only the most similar ones are considered, the corroboration of the hypothesis is not possible or is less robust. This fact suggests that the results for the total sample may reflect other differences between localities and not just the income-inequality relationship. The author then reinforces the suggestion made by Ahluwalia (1976) to include control variables that reflect observed attributes that may determine income inequality.

In this work, such a recommendation is followed by the inclusion of covariates that represent municipality attributes that can affect the inequality of access. The choice of these is based on literature and respects the availability of data. The first term represented by A_{it}^{s} in Equation (4.1) corresponds to the access to the service *s* by the form and the area under discussion. The twenty access indicators previously discussed (**Table 1**), each one for the respective indicator of inequality of access, are used. In this way, when the dependent variable is an inequality of access associated to income in its total, the control is carried out by the indicator of total access to the service and form in analysis; for inequalities of access in urban areas, by the indicator for urban access; in rural areas, by way of rural access; and for spatial access inequalities (urban-rural), for total access[8].

Access indicators are used as covariates because it is plausible to assume that access inequalities are influenced by coverage, since it can, for example, determine the economic viability of the provision even with subsidies. It is also expected to deal with the omitted variable slant, assuming that access relates to unobserved attributes that are variants in time, and that also affects their inequality. Also, the relationship between access and its distribution is precisely one of the objects of analysis of this work, which is taken up later.

According to Rezende et al. (2007), to analyze access to sanitation one must consider determinants of demand and supply sides. By demand side, factors that influence the home to adhere to collective action, if any exists, or to seek individual actions. Considering the discussion of the second section, such factors are related to the income of the users, which explains, in part, the municipality income inequalities associated with income and justifies covariate that represents income distributions. The four factors considered here are represented in (4.1) by and described in **Table 3**. For estimates in which the dependent variables are income inequalities associated with the total income, the covariate is the total income inequality; in urban areas, urban income inequality; in rural areas, rural income inequality; and spatial (urban-rural) areas, urban-rural inequality[9].

The other covariates of **Table 3**, represented in (4.1) by, denote, to some degree, determinants of income inequality dynamics, according to the brief review of the second section, or of access to sanitation (by demand or supply sides). Evidence from literature indicates an increase in access accompanying increases in population, urbanization, population density, and education of the municipalities. These relationships may reflect developmental spin-offs. The first is population concentration in urban areas, reducing the distance between people and thereby increasing their capacity to organize and exert political pressure. The second is the increase of the portion of the population with higher educa-

[8]For instance, for the dependent variable *Ine. Income Urban Water*, the control is made by indicator *Urban Water Mains*; for the dependent variable *Ine. Income Rural Sewage Mains*, by the *Rural Sewage Mains*; and for the dependent variable *Ine. Urban-Rural Garbage* by *Total Garbage*.

[9]Since municipality indicators of inequality of access that consider differences in levels of coverage between the 5th and 1st quintiles of *per capita* household income and between urban and rural areas are used, income distribution measures also consider differences between the 20% richest and the 20% poorest and spatially (urban-rural). In this case, differences in the appropriations of municipality incomes (total, urban or rural).

tion and, consequently, political participation. The third is environmental and health awareness. The convergence of these factors may result in an increase in the demand for basic sanitation services, pressing governments, motivated by the maximization of electoral opportunities, to invest in expanding access (Mendonça et al., 2003; Saiani, 2006; Rezende et al., 2007; Bichir, 2009; Saiani et al., 2013).

Another explanation is that the relationships reflect economies of scale and density in the sector. The variable area can also control cost differences due to the size of the territory to be served in addition to the potential effect of secession of districts. The population may also reflect the number of taxpayers, which enables the financial supply for the payment of tariffs and taxes. The participation of the services sector and the rate of urbanization can also affect (tax) collection and investment as the principal municipality taxes are levied on urban services and real estate.

In municipalities with larger proportions of young and old and fecundity, the pressure for actions in sanitation may be higher, because people in these age groups and situations are more susceptible to suffer from diseases caused by environmental problems (Heller, 1997; Bohra et al., 2017). Besides, since the non-young and not the elderly contribute more to the municipality (tax) collection, the smaller the share of the population in these age groups, the greater the capacity to invest tends to be.

Finalizing the explanation of (4.1), in extension to observed attributes, the estimations control the effects of unobserved attributes which are distinct between municipalities and fixed in time—fixed effects (u_i)—and unobserved attributes contained between municipalities and time variants—*dummy* 2010 (T_t). The fixed effects are important because of cultural, institutional, geographical and climatic aspects, among other specific aspects, determining the dynamics of inequality and the supply of sanitation. Also, for water and sewage there are public municipality and state suppliers. As the type of provider does not change much over time, it can be controlled by fixed effects. The *dummy* 2010 controls institutional changes affecting all municipalities. For example, the Basic Sanitation Law of 2007, which defined provision parameters (Brazil, 2007; SNSA, 2011).

To test the hypothesis of selectivity in public policies for basic sanitation, models based on Equation (4.2) are estimated, which differs from Equation (4.1) as they consider *per capita* income only at level, and they insert in a non-linearity manner the access indicators A_{it}^s by means of a second-degree polynomial. In this manner how the average trajectories of access inequalities along the coverage consolidations are evaluated. These estimates are also performed with municipality panel data by fixed effects (t = 2000, 2010), ascertaining the best fit concerning the random ones made by the Hausman test. The covariates are the same as (4.1).

$$DA_{it}^s = a_7 + a_8 Y_{it} + a_9 A_{it}^s + a_{10}\left(A_{it}^s\right)^2 + a_{11} DR_{it} + a_{12} X_{it} + T_t + u_i + \varepsilon_{it} \tag{4.2}$$

The selectivity hypothesis is corroborated if the coefficients associated with the second-degree polynomial in relation to the access are significant, positive in level and negative in squared $a_9 > 0$ and $a_{10} < 0$. In other words, if a relationship in an "inverted-U" shape is found between the indicator of inequality of access to the service *s*, in the form and area under analysis, and its respective access indicator. This indicates that, at the beginning of the coverage consolidation, the inequality of access increases; however, as from a certain level, the expansion of coverage reduces inequality. So, the relation has a point of maximum (*turning point*) in which the average access ($\bar{A}$) is calculated by deriving Equation (4.2) found with the estimated coefficients of access $\left(\bar{A} = -a_9/2a_{10}\right)$.

The functional form adopted for the selectivity test follows the proposal of Saiani et al. (2013), who found evidence favorable to the hypothesis for the same three services considering municipality indicators of access inequality corresponding to those here called: *Ine.Income Total Water Mains*, *Ine.Income Total Sewage Mains* and *Ine.Income Total Garbage* (**Table 1**). The present work, as well as the distinct years, uses more indicators, which guarantees additional evidence for inequalities of access associated with income and, in an unprecedented way, spatial (urban-rural).

5. Results

Next, the results that make it possible to validate or not the KC ("inverted-U") and "N-shape" hypotheses of for the relations between municipality indicators of inequality of access to sanitation services and *per capita* income are analyzed, as well as the hypothesis of selectivity in the public policies for the sector, signaled by the relations between the inequalities of access and the respective coverage. So as not to move away from the scope of this work, only the estimated coefficients relevant to test the hypotheses[10] are reported and analyzed. It is worth mentioning that all the Hausman tests suggest the best suitability of the fixed effects in relation to the random effects.

Table 4 presents the results that allow us to evaluate the relationship between income inequality indicators of access associated with income in urban and rural areas and municipality *per capita* income. It is observed only in the sanitary sewage, specifically in the collection by general mains, estimated coefficients associated to the third-degree polynomial of *per capita* income which, besides being significant (1%), follow the signal standard necessary to corroborate the "N-shape" hypothesis: positive at level and cube and negative at the square. The second derivative test confirms the shape, signaling a maximum, followed by a minimum. The relationship is not maintained when considering, jointly, access by the main alternative individual action (septic tank).

As for garbage, which considers access only by the collective action of public cleaning services (direct collection or skips), no significant coefficients associated with *per capita* income are verified. However, for water supply, there are

[10]The other estimated coefficients (covariates and dummy 2010) can be obtained from the authors.

Table 4. KC and "N" tests: inequalities of access associated with income in urban and rural areas.

Variables/Services/ Forms of Access	Water Supply		Sanitary Sewage		Garbage Collection
	Mains	Mains or Well	Mains	Mains or Septic Tank	
Income *per capita*	−0.521***	−0.464***	0.355***	0.094	−0.073
	(0.102)	(0.074)	(0.061)	(0.090)	(0.104)
Income *per capita*^{2}	0.421***	0.594***	−0.493***	−0.163	−0.483***
	(0.132)	(0.096)	(0.081)	(0.116)	(0.132)
Income *per capita*^{3}	−0.177***	−0.228***	0.200***	0.064	0.249***
	(0.060)	(0.040)	(0.037)	(0.053)	(0.058)
Covariates	Yes	Yes	Yes	Yes	Yes
Dummy 2010	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Observations	11.062	11.062	11.078	11.078	11.428
Prob > F	0.000	0.000	0.000	0.000	0.000
Hausman Test	217.48***	96.93***	299.92***	346.27***	193.94***
Y_1 Maximum (R$ mil)	---	---	0.30	---	---
Y_2 Minimum (R$ mil)	---	---	0.62	---	---

Sources: IBGE, 2000 to 2010 Censuses. Standard errors (robust) in parentheses. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

significant coefficients (1%) associated to the third-degree polynomial of *per capita* income; but they do not follow the patterns of signs to corroborate the KC ("inverted-U") or "N-shape" hypotheses. In fact, the relationship, as much for access only by collective action (mains) as for being in conjunction with the alternative individual action (wells) has an "inverted-N" shape: negative at level and cube and positive when squared. Therefore, at a lower *per capita* income level, inequality of access to water decreases; from a certain level, begins to increase; nevertheless, after a certain level decrease again[11].

Table 5 shows that, in water supply, both by mains or wells, the results are similar to the totals only for urban areas, that is, they signal relationships in an "inverted-N" shape: significant coefficients (1%), negative *per capita* income at level and cube and positive squared. As for sanitary sewage, there is a significant coefficient (10%) and positive only for *per capita* income in the level of collection by general mains. This indicates that inequality of access associated with income from collective action by public providers increases as *per capita* income rises. However, as for garbage, the relationship is shaped close to a "U": significant coefficient (1%) and negative of income at level; significant (5%) and positive squared and not significant at cube. Consequently, collective action results

[11]Results contrary to those of Saiani et al. (2013), which observe the "N-shape" in water for different years (1991 and 2000).

Table 5. KC and "N" tests: inequalities of access associated with income in urban areas.

Variables/Services/ Forms of Access	Water Supply		Sanitary Sewage		Garbage Collection
	Mains	Mains or Well	Mains	Mains or Septic Tank	
Income *per capita*	−0.359***	−0.377***	0.124*	−0.047	−0.283***
	(0.078)	(0.062)	(0.068)	(0.110)	(0.090)
Income *per capita*^{2}	0.524***	0.612***	−0.124	0.137	0.270**
	(0.094)	(0.081)	(0.082)	(0.136)	(0.108)
Income *per capita*^{3}	−0.199***	−0.255***	0.050	−0.030	−0.053
	(0.039)	(0.035)	(0.034)	(0.060)	(0.043)
Covariates	Yes	Yes	Yes	Yes	Yes
Dummy 2010	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Observations	11.062	11.062	11.078	11.078	11.428
Prob > F	0.000	0.000	0.000	0.000	0.000
Hausman Test	85.17***	163.33***	156.46***	314.11***	183.02***
Y_1 Maximum R$ mil)	---	---	---	---	---
Y_2 Minimum (R$ mil)	---	---	---	---	---

Sources: IBGE, 2000 to 2010Censuses.Standard errors (robust) in parentheses. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

in inequality of access as *per capita* income increases, but this falls after a certain level.

Table 6 shows the results of the estimates that consider only rural areas. In water supply, the inequality of access (general mains and general mains or well) associated with income does not present a significant relation with *per capita* income. The same is observed for garbage. As regards sewage, non-significant coefficients are also verified in the collection by mains. In the mains or septic tank, the coefficients of the third-degree polynomial of *per capita* income are significant (1% or 5%) and follow the pattern of signs to corroborate the "N-shape" hypothesis: positive in *per capita* income at level and cube, and negative at squared. The second derivative test confirms this shape.

For indicators of spatial access inequality (differences in coverage between urban and rural areas), Table 7 shows that in the water supply by mains, an "inverted-N" relationship is again observed. The coefficients of the third-degree polynomial of income *per capita* are significant (1%), negative at level, and cube and positive at square. These results suggest that urban-rural access inequality decreases with growth at lower levels of income; however, upon reaching a certain level increase, yet decreasing again at a higher level. For general mains or well access the coefficients are not significant.

For the other services, relationships are found in the shapes of KC ("inverted-U") and, mainly, the "N". As regards sewage, the inequality of urban-rural access by the collective action of public services (mains) has a relation in "N-shape" with

Table 6. KC and "N" tests: inequalities of access associated with income in rural areas.

Variables/Services/ Forms of Access	Water Supply		Sanitary Sewage		Garbage Collection
	Mains	Mains or Well	Mains	Mains or Septic tank	
Income *per capita*	0.090	0.145	0.058	0.205**	0.030
	(0.114)	(0.099)	(0.045)	(0.101)	(0.095)
Income *per capita*^{2}	−0.265	−0.136	−0.054	−0.354**	−0.074
	(0.177)	(0.124)	(0.062)	(0.141)	(0.117)
Income *per capita*^{3}	0.139	0.049	0.013	0.183***	0.007
	(0.092)	(0.051)	(0.030)	(0.071)	(0.052)
Covariates	Yes	Yes	Yes	Yes	Yes
Dummy 2010	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Observations	11.062	11.062	11.078	11.078	11.428
Prob > F	0.000	0.000	0.000	0.000	0.000
Hausman Test	59.80***	82.10***	82.95***	99.83***	91.09***
Y_1 Maximum R$ mil)	---	---	---	0.39	---
Y_2 Minimum (R$ mil)	---	---	---	0.75	---

Sources: IBGE, 2000 to 2010 Censuses. Standard errors (robust) in parentheses. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

Table 7. KC and "N" tests: inequalities of spatial access (urban-rural).

Variables/Services/ Forms of Access	Water Supply		Sanitary Sewage		Garbage Collection
	Mains	Mains or Well	Mains	Mains or Septic tank	
Income *per capita*	−0.444***	0.030	0.217***	0.369**	2.377***
	(0.135)	(0.128)	(0.061)	(0.144)	(0.184)
Income *per capita*^{2}	0.502***	−0.069	−0.285***	−0.403**	−3.919***
	(0.181)	(0.170)	(0.082)	(0.202)	(0.277)
Income *per capita*^{3}	−0.242***	0.034	0.114***	0.123	1.557***
	(0.080)	(0.069)	(0.039)	(0.102)	(0.138)
Covariates	Yes	Yes	Yes	Yes	Yes
Dummy 2010	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Observations	11.062	11.062	11.078	11.078	11.428
Prob > F	0.000	0.000	0.000	0.000	0.000
Hausman Test	301.90***	239.62***	290.47***	481.51***	416.43***
Y_1 Maximum R$ mil)	---	---	0.30	0.21	0.26
Y_2 Minimum (R$ mil)	---	---	0.56	0.51	0.83

Sources: IBGE, 2000 to 2010 Censuses. Standard errors (robust) in parentheses. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

per capita income: the coefficients of the polynomial of 3˚ are significant (1%), positive at level and cube and negative squared. In addition, the test of the second derivative corroborates the shape, signaling a maximum point followed by a minimum. So, the inequality of urban-rural access to sewage collection by general mains increases in lower levels of municipality income, it reduces from a certain level and increases again at higher levels. Considering mains or pit, the relation is in "inverted-U": coefficient significant (5%) and positive *per capita* income level; significant (5%) and negative squared and not significant at cube. It can be inferred, then, that access by the alternative individual solution septic tank compensates, at higher incomes, the expansion of inequality in the collective action (mains).

For garbage, the collective action of cleaning services (direct or skip collection) also results in a relationship close to an "N" between the inequality of access in urban and rural areas. The coefficients associated with the third-degree polynomial of *per capita* income are significant (1%), positive at level and cube, and negative squared. In appreciation, the second derivative test corroborates the shape—maximum point succeeded by a minimum. Then, it is possible to suggest that the inequality of urban-rural access to garbage collection by cleaning services rises with lower incomes, decreases as from a certain level, and rises again at higher levels. Evidence as to garbage guarantees robustness as to the interpretation of the results coming from public policies due to the fact of non-exclusivity to make access depend more on the providers.

Table 8 shows the results which allow one to evaluate selectivity in public

Table 8. Selectivity tests: access inequalities associated with income in urban and rural areas.

Variables/Services/ Forms of Access	Water Supply		Sanitary Sewage		Garbage Collection
	Mains	Mains or Well	Mains	Mains or Septic tank	
Access	0.906***	0.992***	0.985***	1.060***	1.070***
	(0.040)	(0.078)	(0.034)	(0.027)	(0.034)
$Access^2$	−1.002***	−0.957***	−1.129***	−1.051***	−1.128***
	(0.040)	(0.054)	(0.045)	(0.031)	(0.031)
Covariates	Yes	Yes	Yes	Yes	Yes
Dummy 2010	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Observations	11.062	11.062	11.078	11.078	11.428
Prob > F	0.000	0.000	0.000	0.000	0.000
Hausman Test	342.06***	91.15***	264.07***	244.45***	366.33***
$\bar{A}$ Maximum (%)	55.3	48.2	57.3	49.6	52.7

Sources: IBGE, 2000 to 2010 Censuses. Standard errors (robust) in parentheses. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

policies in urban and rural areas. In all services, the coefficients of the second-degree polynomials of the coverage are significant (1%) and with the standard of signs that corroborate the hypothesis: positive at level and negative at squared. Thus, inequalities of access associated with household income increase as coverage increases; however, from a given level these inequalities begin to fall[12]. For water and sewage, the *turning points* of collective action (mains) together with individual actions (well and pit) are lower, which reflect the compensatory character of the latter. Since it is a non-exclusive service, which depends less on the decision to adhere to households and more directly on investment decisions of public providers, the relationship in the collection of garbage is very strong evidence as to the interpretation regarding the existence of selectivity in policies.

Considering only urban areas, **Table 9** shows that the relationships between municipality inequality access indicators associated with household income and coverage also have the shape close to an "inverted U". The coefficients associated with the second-degree polynomials of the coverage are significant (1%), positive at level and negative at squared. As in municipalities as a whole (**Table 8**), in water and sewage, the *turning points* of the collective actions (general mains) and individual actions (well and septic tank) together are inferior to those of collective action alone. Besides, the relationship in garbage collection reinforces the attribution of selectivity.

Table 9. Selectivity tests: access inequalities associated with income in urban areas.

Variables/Services/ Forms of Access	Water Supply		Sanitary Sewage		Garbage Collection
	Mains	Mains or Well	Mains	Mains or Septic tank	
Access	0.871***	1.161***	0.710***	0.882***	1.039***
	(0.047)	(0.056)	(0.034)	(0.031)	(0.033)
Access^2	−0.904***	−1.150***	−0.781***	−0.846***	−1.124***
	(0.044)	(0.050)	(0.036)	(0.032)	(0.030)
Covariates	Yes	Yes	Yes	Yes	Yes
Dummy 2010	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Observations	11.062	11.062	11.078	11.078	11.428
Prob > F	0.000	0.000	0.000	0.000	0.000
Hausman Test n	147.43***	64.13***	109.87***	167.90***	90.23***
$\bar{A}$ Maximum (%)	51.9	49.5	55.0	48.0	54.1

Sources: IBGE, 2000 to 2010 Censuses. Standard errors (robust) in parentheses. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

[12]Results like those by Saiani et al. (2013), who observe the "inverted-U" for others years.

Table 10 presents the results for rural areas. As the total and in the urban area, these suggest the existence of selectivity in public policies for basic rural sanitation, in the sense that the richest households benefit primarily as the coverage increases; after these are more consolidated, actions are redirected with greater effects on the poorest households. This argument is based on the significant coefficients (1%) of the second-degree polynomial of the positive and negative squared coverage. That is, the "inverted-U" relationship between almost all indicators of inequality of access associated with income in rural areas and the respective indicators of total access. The exception is for sewage by collective action (general mains), which presents no statistically significant relation.

As regards water, the *turning point* of collective actions (mains) and individual actions (well) is lower than that of collective action alone, as in previous results, reflecting the compensatory character of individual action. The relationship in garbage collection also guarantees robustness as to the interpretation of the presence of selectivity. Confronting the *turning points* of Tables 8-10, one can verify that they are larger in rural areas, in all services and comparable forms, which suggests a greater difficulty of reversing the inequalities of access between the 20%richest and the 20% poorest.

Table 11 shows the results to evaluate spatial selectivity in public policies, in other words, bias to first serve urban areas. In all services, the coefficients associated with the second-degree of access polynomial are significant (1%), positive at the level, and negative at square. That is, relations between indicators of spatial access inequality and corresponding access indicators present the "inverted-U" shape including garbage. So, there is robustness for the interpretation

Table 10. Selectivity tests: access inequalities associated with income in rural areas.

Variables/Services/ Forms of Access	Water Supply		Sanitary Sewage		Garbage Collection
	Mains	Mains or Well	Mains	Mains or Septic tank	
Access	0.199***	0.329***	0.043	0.368***	0.417***
	(0.036)	(0.054)	(0.109)	(0.038)	(0.033)
$Access^2$	−0.232***	−0.371***	−0.033	−0.415***	−0.483***
	(0.045)	(0.042)	(0.271)	(0.053)	(0.038)
Covariates	Yes	Yes	Yes	Yes	Yes
Dummy 2010	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Observations	11.062	11.062	11.078	11.078	11.428
Prob > F	0.000	0.000	0.000	0.000	0.000
Hausman Test	43.14***	82.83***	103.81***	137.19***	72.79***
$\bar{A}$ Maximum (%)	58.3	56.4	---	56.4	57.9

Sources: IBGE, 2000 to 2010 Censuses. Standard errors (robust) in parentheses. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

Table 11. Selectivity tests: special inequalities of access (urban-rural).

Variables/Services/ Forms of Access	Water Supply		Sanitary Sewage		Garbage Collection
	Mains	Mains or Well	Mains	Mains or Septic tank	
Access	1.903***	2.068***	1.735***	1.638***	2.513***
	(0.073)	(0.172)	(0.038)	(0.046)	(0.053)
$Access^2$	−2.165***	−1.927***	−0.910***	−1.570***	−2.575***
	(0.066)	(0.114)	(0.050)	(0.057)	(0.046)
Covariates	Yes	Yes	Yes	Yes	Yes
Dummy 2010	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes
Observations	11.062	11.062	11.078	11.078	11.428
Prob > F	0.000	0.000	0.000	0.000	0.000
Hausman Test n	520.12***	325.78***	278.32***	823.80***	506.62***
$\bar{A}$ Maximum (%)	56.9	46.6	26.2	47.9	51.2

Sources: IBGE, 2000 to 2010 Censuses. Standard errors (robust) in parentheses. ***Significant at 1%. **Significant at 5%. *Significant at 10%.

of results as deriving from selectivity. Therefore, as coverage expands, urban-rural access inequalities increase; but, after reaching a certain coverage level, these inequalities decrease. It is worth noting the low *turning point* in the collection of sewage per mains, which may reflect low access in any area (Table 1).

6. Conclusion

To evaluate the effects of economic growth (or economic development) and political motivations on the distribution of access to basic sanitation services, in this study municipality indicators of inequality access to sanitation services associated with household income and spatial (urban-rural) are constructed and used as dependent variables in estimates that test three hypotheses: 1) relations between inequalities of access and municipality income level in an "inverted-U" shape based on the Kuznets Curve (KC); alternatively, 2) in an "N-shape", as defended by KC critics; and 3) relations between access inequalities and levels of coverage in the "inverted-U" shape based on the hypotheses of selectivity in public policies.

The descriptive analyzes show that there are significant access deficits in the water, sewage, and garbage services in total area, and in urban and rural areas. Which be a concern. There are also inequalities of access associated with household income, both in total area and in urban and rural areas and between them. This fact can generate distributive effects, since the poorest are more vulnerable to diseases resulting from contamination of soils and water resources due to sanitation problems and agricultural production is more directly affected. Therefore, public policies should be concerned with such effects. However, inequalities can be just consequences of policies.

In general, the evidence refutes the KC hypothesis ("inverted-U" shape hypothesis) for the relations between economic growth (or economic development) and access inequalities, both associated with household income and spatial. The exception is the inequality between urban and rural access to sanitary sewage by general mains or septic tanks. So, in this case, the growth of municipality income from a given level results in a fall in inequality of access. This fact is also observed but coming from relations close to an "inverted-N shape", to inequalities of access to water supply associated with income (total and urban) and spatial (between urban and rural)—in this case, only by mains. In rural areas, inequalities in access to water are not significantly related to income, as in other services for different forms and areas. An even more serious finding is the existence of "N" relationships, especially in relation to inequalities between urban and rural in sewage and garbage, which suggests that income growth may increase inequalities access spatial.

The results also indicate that the selectivity hypothesis has great capacity in explaining inequalities in access to sanitation. In almost all services, forms of access, and areas served, the "inverted-U" shape of relationships between the indicators of inequality of access and their coverage is observed. In other words, as service coverage expands, the inequality of access associated with income or spatial (between urban and rural) increases; however, when certain coverage is reached, the inequality falls.

Therefore, this article provides evidence that although services result in high social returns and, consequently, should be universalized, public policies are selective, targeting more directly and with priority the richest segments of the population or areas with economic viability for provision. In this way, the poorest and rural population is vulnerable to all diseases associated with inadequate sanitation, and the consequences for education and income that they entail. This means that they have less access to basic public health than the population that is prioritized. Therefore, changes in the formulation of public policies are necessary so that the poorest and rural population is made a priority. This article also shows that economic development (GDP growth) does not reduce inequality in sanitation services, even accentuating them in some cases.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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