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Spatial Income Inequality and Provision of Local Public Services

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Introduction

Spatial income inequality has received a considerable interest in the empirical literature. This stylized fact drives diverse aspects of regional economic growth with important consequences in social, geographical and political aspects. Moreover, regional disparities affect socio-economic development of individuals and extend their effects to the unequal distribution of living standards and opportunities across communities. One manifestation of spatial income inequality can be observed in the stratification of socioeconomic groups across space by linking this fact directly with the provision of local public services. In this sense, segregated groups not only reside in isolated communities but also, they live in diverse local jurisdictions that can differ in terms of fiscal and administrative capacities to provide local public services. Therefore, local governments matter because can exacerbate spatial income inequality due to its influence on the spatial distribution of local public services. The last element is crucial to understand why the quantity or quality of local public services differs across communities by affecting mainly to the poorest population, who are the most important target group for the application of these public policies.

This thesis consists of three chapters that explore the relationship between spatial income inequality and the distribution of local public services. Particularly, the three chapters consider the relevant role that local governments play in the provision of these services. By doing so, we analyze the case of Chile, one of the most unequal countries of the world with a Gini index above 50 percent. This country has received a remarkable attention by scholars, researchers, and policymakers mainly for two aspects. First, the outstanding economic performance of Chile that can be observed on crucial socioeconomic indicators such as the poverty rate with a significant reduction from 40 percent in 1987 to 14 percent in 2014. Second, an important interest has received the high and persistent income inequality that the country exhibits where space plays an important role in its composition. Paredes, Iturra, and Lufin (2014) showed that 21 percent of income inequality can be attributable to differences across communities. Although this

aspect is crucial to understand its persistence over time, this new evidence does not provide a complete picture of how this spatial income inequality is working. This thesis contributes to the better comprehension of this problem by considering the provision of local public services as a critical source of spatial income inequality. Therefore, differences in terms of financial and administrative capacities of local governments can determine the distributional effects of decentralized public policies such as education or healthcare which are designed to reduce income inequality. Finally, this thesis contributes to improving the association between the spatial income inequality manifestations and institutional aspects for a better understanding of this aspect which has been relatively less explored by the empirical literature.

Chapter 1 studies how the omission of local public policies can affect the results of conventional measures of spatial income inequality. This paper offers an interesting overview of spatial income inequality and how it is affected by the provision of local public services in Chile. In this sense, we recognize that financial and institutional restrictions that local government face can explain the unequal distribution of local revenues across communities. Main results suggest that local public policies have been more effective than cash transfers to reduce income inequality. However, the inclusion of local public services managed largely by local governments increases spatial income inequality by about 20 percent. In this way, this paper highlights the surge of local public governments as a new potential source of inequality which cannot be ignored by the literature. This last statement is used as starting point for the second chapter to study how disparities in the provision of local public services can be observed in the space.

Chapter 2 goes beyond the role of local public services by studying the relationship between their spatial distribution and residential segregation. The latter is considered as the most important manifestation of spatial income inequality because relates the location and characteristics of individuals with social equity issues. In this vein, the paper studies how the spatial accessibility to local public services is equitably distributed among different social and economic groups across

the Metropolitan Area of Santiago (MR), Chile. In this way, we assume the residential segregation is not only observed in the clear distinction of economic groups across communities, also, it can be reinforced by the unequal distribution of local public services across the space. From this analysis, we can observe high disparities for accessing to local public services which are affecting more to the poorest population. Under this scenario, this crucial target group of public policies is affected by a "double-disadvantage" due to its exclusion from urban systems and its limited access to services such as education, healthcare or transportation (Borsdorf, Hidalgo, & Zunino, 2013) (Li H. , Wang, Shi, Deng, & Wang, 2017). Moreover, we found evidence that confirms that Chilean social housing policies could be considered as one cause of residential segregation given the resettlement of the poorer population to the periphery of the MR which is reinforced by the insufficient accessibility levels they must assume.

Finally, Chapter 3 explores other aspects of spatial income inequality issues that concern the relationship between the spatial distribution of urban amenities and housing prices. Urban amenities have received a great attention by the scientific literature because can explain why some cities are more attractive than others. On the other hand, a large empirical body recognizes that the spatial distribution of amenities matters because they might stimulate regional economic growth, urban population, and employment. In this paper, we address this relationship through a hedonic pricing modeling and a set of urban amenities that includes local private and public services. Moreover, we recognize that capitalization of urban amenities into housing prices can be spatially heterogeneous distributed. Main results suggest that urban amenities play an important role in the definition of housing prices. However, we found important differences between private and local public services. Particularly, private services such as schools or hospitals have positive capitalizations in housing prices, meanwhile their public versions have negative valuations in housing prices. Again, these results can be related to administrative and financial restrictions that municipalities face providing local public services. Lastly, public policy implications can be redirected to optimize the spatial

distribution of local public services by improving the match between residents' demand and their provision.

Chapter 1

The Effect of Local Public Services on Spatial Income Inequality: An Application for Chile

Abstract

Despite the important role that disposable incomes play on spatial income inequality that still persists in the country, this evidence continuously omits the value of relevant public policies designed with the purpose of overcoming this problem. Therefore, the omission of local public services such as public schools or healthcare services can generate an incomplete and misleading picture about how income inequality is working. In this paper, we explore how the omission of local public services affects conventional measures of spatial income inequality by using information about eight local public services divided between shared and exclusive functions given their degree of dependency to the central government, and microdata about households' characteristics from 2009, 2011 and 2013. Main results suggest that the inclusion of these policies reduces significantly overall income inequality. However, different effects on spatial income inequality for services can be found. For instance, shared functions (education and healthcare services) financed mainly with conditional transfers, reduce spatial income inequality by about 2 percent in comparison with the same component without to include these services. Exclusive functions (infrastructure, administration, culture, recreational, social and community services) that are largely funded and managed by local governments increase spatial income inequality by about 20 percent. These results evidence that high variability of expenditures, especially on exclusive functions, might increase disparities between communes with important consequences on living conditions of residents. Finally, this paper highlights the existence of a new potential source of income inequality attributable to the role of local governments as providers of public services, which is continuously ignored by policymakers.

Keywords: Extended income, local public services, Linear Expenditure System, spatial income inequality, three stage Theil decomposition.

JEL-CODES: H41, H75, R28

1. Introduction

For many emerging and developing countries, the Chilean economy is considered as a good example due to its successful economic performance. For instance, the annual average growth of GDP was 4.1 percent during the period 1991-2005, significantly higher than the average world growth. The effects of this economic growth can be observed in crucial socioeconomic indicators as the poverty rate which has been reduced from 40 percent in 1987 to 14 percent during 2013.[1] However, this optimistic scenario contrasts with the high inequality that still persists in the country. According to estimations of the Organization for Economic Cooperation and Development (OECD), Chile is one of the most unequal countries in the world with a Gini index above 50 percent. This situation is not a surprise for the Chilean literature: previous estimations performed by Solimano and Torche (2008) proved that Gini index has been high and persistent from 1987 (58 percent) to 2006 (55 percent). Several reasons have been explored to determine why inequality remains high. From the fiscal perspective, some explanations argue that low levels of fiscal expenditures due to low tax revenues have not permitted high investments in essential public goods as education, which could have been more effective to increase the quality of human capital on the lowest income classes (López & Miller, 2008). On the other hand, the Chilean economy characterized by a high dependency to natural resources promoted larger subsidies to resource-intensive industries, which resulted in lower incentives to increase the demand of high-quality human capital by knowledge-intensive industries. Thus, low investments in human capital among the poorest population and the rise of capital-intensive firms' concentration increased the resources in few hands (López & Miller, 2008). Also, this consequence can be confirmed by the high spatial income

[1] World Bank Data Set.

inequality that Chile exhibits. Paredes, Iturra, and Lufin (2014) showed that 21 percent of Chilean income inequality can be attributable to differences across spatial units. Both results reveal that the role of the spatial dimension might be crucial to understanding the behavior of income inequality and its persistence over time.

Despite the evidence remarks that concentration of resources is important to understand the behavior of spatial income inequality, this still provides an incomplete picture of the general problem. For instance, conclusions of both papers are focused on the analysis of cash incomes but not on the evaluation of local public policies designed to reduce poverty and income inequality. Thus, the results obtained are limited and provide a limited picture of resources that also generate welfare. In other words, the omission of the value of local public services from the conventional ways to measure income inequality can yield an incomplete and misleading context about how the distribution of well-being is carrying out (Callan & Keane, 2009) (Aaberge, Bhuller, Langorgen, & Mogstad, 2010). Similarly, it can underestimate important effects of public policies with redistributing purposes which are assigned to the population through transfers managed by local governments (Paulus, Sutherland, & Tsakloglou, 2010). Even though high levels of centralism of the Chilean state, its constitutional law recognizes the functional and decentralized administration of the country by transferring important functions related to the socioeconomic development of citizens to municipal levels. Moreover, the public policy agenda designed by the central government to increase the opportunities of the poorer by improving their access to public services such as education and healthcare services is largely supported by municipalities in terms of management or resources. This highlights the essential role that local governments perform in the provision of public policies with the objective of satisfying inhabitants' needs given their better knowledge about their preferences. Especially, this role might be remarkable when municipalities are often viewed as drivers of local development with purposes of guarantying territorial convergence (Amstrong & Taylor, 2000).

For these reasons, the aim of this paper is to explore how the omission of the value of local public policies can affect conventional measures of income inequality by analyzing the role of eight local public services: education, healthcare, municipal activities, administration, community services (infrastructure), culture, recreational and social services. In this paper, we compute the extended income; a new definition of incomes proposed by Aaberge et Al (2003) which is understood as the sum of disposable income and the value of local public services provided by municipalities. This methodology involves two steps: valuation and allocation of local services. For valuation, the authors propose a linear expenditure system (hereafter LES), a useful tool to explain differences in spending that emerge by attaining minimum standards of production among local services and municipalities. Next, allocation of local public services is based on estimates of sector-specific minimum expenditures from LES, which permits the identification of individuals with similar socioeconomic characteristics to become a potential recipient of these local public services.

The original application of this model uses information at the municipal level for Norway including a set of eight sectors in one LES, assuming all services are provided only by local governments. In other words, this application ignores two important situations. First, the provision of local services also depends on conditional transfers from central governments. Also, the designing of some public policies depends also on central agencies. We believe this dependency can affect the behavior of municipalities as providers local public services because some crucial public services such as education and healthcare are supporting by conditional transfers from central government, and some operational aspects depend exclusively on central offices' arrangements. In both cases, the primary role of municipalities is managing resources received from the central government to final users which implies a less participation of local governments in funding and creation of local public policies. On the other hand, public services such as administration, infrastructure or culture are largely supported by municipalities and their provision depends on funding sources available into communities and local management capacities. Clearly, these municipal expenditures would be affected

by a high variability and then, large differences between municipalities might emerge. Following these implications, this paper computes LES by recognizing the different degrees of dependency for each local public service. In the Chilean case, local services can be divided into shared and exclusive functions according to different roles that central and local governments must perform. Education and healthcare services are shared functions because their provision is joint with the central government, which are supported mainly by conditional transfers. On the other hand, infrastructure, administration, recreational and cultural services, community and social services are recognized as exclusive functions because are supported largely by municipal resources and depend solely on local management capacities. Thus, LES is computed for both, shared and exclusive functions, respectively. In this way, we can observe how municipal budget restrictions or low administrative capacities to manage local public services might affect the efficient targeting of resources with the aim of reducing inequality and poverty. Our hypothesis implies that education and healthcare services might have a significant participation in the reduction of spatial income inequality, whereas the role of exclusive functions might be limited and dependent on management capacity of municipalities which can differ across local governments.

To estimate the extended income, this paper uses information from the National System of Municipal Information SINIM (Subsecretaria de Desarrollo Regional) from 2009, 2011 and 2013. This dataset contains information about municipal expenditures of eight local public services listed above. Next, the extended income is computed by adding the value of local public services to autonomous and monetary incomes, respectively, accordingly with the allocation rules used for each service. Microdata of incomes and individual characteristics are obtained from the National Socioeconomic Characterization Survey CASEN (Ministerio de Desarrollo Social, 2016) from 2009, 2011 and 2013. Finally, these new measures of income are decomposed into a spatial and individual component according to the methodology proposed by Paredes, Iturra, and Lufin (2014). Based on the ideas of Akita (2003), these authors proposed the three-stage decomposition method by decomposing the Theil indicator following the Chilean spatial division: regions,

provinces, and communes. In this way, this paper explores different spatial sources of income inequality by considering the crucial role that local governments perform on the between communes' component due to their participation in the production of local public services.

The results highlight that municipalities spend fewer resources on exclusive functions than shared functions which mean that there exist important limitations in terms of funding sources. Consequently, local services might suffer an important variability across municipalities. Other differences between local public services can be explained by the political participation of local councils into decisions about municipal expenditures which are more relevant for exclusive functions than shared functions. This evidence shows the important participation of central government in the provision of education and healthcare services in terms of controlling and funding. On the other hand, the results indicate the inclusion of the value of shared and exclusive functions reduces overall income inequality by 9 percent and 25 percent, respectively. However, both services have different effects on spatial income inequality. We found that shared functions reduce spatial income inequality, meanwhile exclusive functions which increase spatial income inequality. These local public services are controlled, managed and funded by municipalities and then, we can observe how the high variability on municipal expenditures might increase disparities between communes. Overall, these findings could confirm the existence of a new potential source of income inequality attributable to local governments and their performance on the delivery of local public services.

This paper is structured as follows. The next section presents more details about the institutional framework where Chilean local governments operate. The third section shows the methodology used to study the behavior of Chilean municipalities in the provision of local public services, as well as their effects on spatial income inequality. The fourth section shows the empirical application of the models proposed. The last section concludes.

2. Institutional Framework

Although that Chilean Constitutional Law describes to Chile as a unitary country, the administration of State is recognized as functional and decentralized (or deconcentrated) territorially. It implies that functions directly related to the socio-economic development of local communities have been transferred from central bodies to regional and municipal administrations. For instance, Chilean municipalities have received important functions as result of the decentralization process that the central government implemented during 1980. From that period, local governments multiply their functions and consequently became the most important provider of local public services, receiving from the central government the administration of crucial services such as education and healthcare. Because to this process, the public version of education and healthcare are provided jointly between the central and local government, meanwhile other functions such as infrastructure, culture and recreational services, etc., are provided exclusively by municipalities and which depend completely on the performance at the local level.

Even if this constitutes an important advance to improve levels of efficiency and equity, Chile still maintains a high level of centralism, thus, subnational governments should face important fiscal and administrative barriers to provide local public services. Specifically, municipalities must face important administrative limitations to develop community programs considering local community needs. In other words, municipalities are managers of public programs designed completely by central offices (ministries) and thus, municipal performance is limited their preferences (Vial, 2014). On the other hand, municipalities should face important fiscal restrictions to provide local services. For instance, several imbalances between functions transferred and the municipal disposable incomes available to support municipal activities still persist and then, some municipalities do not have sufficient resources to cover all municipal activities. Also, Chilean municipalities must get incomes from the same sources across the country, independently if these are available or not in the community. The consequences of these restrictions have not been clearly identified by the scientific literature, however, apparently are determined by the unequal

development of local communities due to the greater concentration of local public services in communities with more probabilities to obtain resources and high levels of local management capacity. Paradoxically, subnational levels are the only institutions which are designed with the objective of promoting the development of local communities due to their proximity to individual needs.[2]

This paper puts focus on eight local public services that municipalities provide which are subdivided into two classifications given their dependency to the central government. For instance, education and healthcare services are shared functions because these are provided jointly between the central and local governments. Despite that municipalities cannot modify these centralized programs, the costs of providing both services depend on conditional transfers from central government and municipal resources; during the last 15 years, conditional transfers from central government have represented by average 70 percent and 61 percent of total incomes dedicated to the provision of education and healthcare services, respectively.[3] For both services, the role of municipalities is administrating these resources by distributing them in paying salaries to employees and professionals related, maintaining schools and general medical centers infrastructures, material purchases, etc. On the other hand, expenditures in infrastructure, community services, social and cultural services and activities associated with the internal administration of municipalities are exclusive functions because these depend on the local management capacity of each municipality. In addition, these activities are supported mainly for municipal resources which are composed by local taxes (housing, commercial, garbage taxes and others), fees (vehicle registration permits, traffic penalties, and others),[4] and incomes obtained from the Municipal Common

[2] The Municipal Law (Nº 18.695) defines to municipalities as autonomous entities, with legal personality and own heritage. Their objective is to satisfy the needs of local communities to ensure their participation on social, economic and cultural progress.

[3] SINIM; Sistema de Información Municipal (2016).

[4] This item represents the municipal permanent incomes because depends on the income sources available into each municipality (IPP; Ingresos Propios Permanentes). Municipalities have a full control of these incomes.

Fund (FCM).[5] For these services, municipalities have an active role because they are responsible for these services and it affects directly local amenity provision, as well as living standards of inhabitants.[6]

Figure 1 shows the expenditure structure of Chilean Municipalities during the period 2009-2013 to visualize some details about the general behavior of municipalities. Municipal expenditures mainly are concentrated on education and health care services according to the dispositions of the central government. In this sense, education and healthcare services correspond to public policies created with the aim of ensuring the access of all population with an especial attention on the poorest segments. For these reasons, it is possible to expect that municipalities concentrate all their efforts on providing both services to support the state-owned system. With respect to exclusive functions, municipal expenditures are considerably lower in comparison with respect to shared functions. The only exception is found for the administration item which includes municipal's expenditures on personnel wages, operational costs and among other expenditures. In this case, municipalities support these activities by using own incomes which are suffering a high variability given to the availability of funding sources in each municipality.

3. Methodology

In this section, we describe the methodology used to compute the influence of local public services on spatial income inequality. In this way, this paper has the aim to compute the extended income which is defined as the sum of household disposable incomes plus the value of local public services. To accomplish this objective, the methodology is subdivided into three parts. The first part corresponds to the valuation of local public services by using the model proposed by Aaberge and

[5] The municipal common fund (FCM; Fondo Común Municipal) is a mechanism of redistribution of municipal incomes created with the objective of reducing the spatial concentration of municipal incomes. This fund is financed completely by municipalities with incomes derived from local taxes and these resources are redistributed between municipalities given poverty and income indicators.

[6] See appendix A for more details about municipal's functions.

Langorgen (2003) to capture the spending behavior of local governments. Then, the information obtained from this step is used on the second part which corresponds to the allocation of valuation of local public services to different target groups, and the extended income is computed. Finally, this extended income is used into the analysis of spatial income inequality performing the proposition of Paredes et Al. (2014) which decomposes the Theil index into a spatial and individual component. These steps are developed in the following subsections.

3.1. The value of local public services

A new alternative to value local public services has been proposed by Aaberge and Langorgen (2003) those who introduce a complete demand system to account by the heterogeneity that arises from differences in costs between municipalities to produce a given set of public goods. This method is derived from a model of spending behavior of local governments, where the spending on different services is specified as a function of economic, social, demographic and geographical variables (Aaberge, Bhuller, Langorgen, & Mogstad, 2010). In general terms, the spending behavior of municipalities is studied following the logic of median voter models in which the decision is centered on the individual's preferences about the place they choose to live. Instead, this approach assumes that differences in costs of attaining minimum standards are affected by the decisions of local governments, and then the provision of local public services are affected by the municipal's capacity to produce a package given a municipal income level.

In particular, the authors use a Linear Expenditure System (hereafter, LES) to represent the municipal-specific costs of attaining minimum standards of various local public services which permits a simultaneous treatment of services sectors, with exogenous variables that are affecting the municipal expenditures. In this sense, the system allows the consideration of the intrinsic heterogeneity associated with the preferences on service sectors and target groups across local governments. According to these ideas, the model is represented by a Stone-Geary utility function to characterize the utility of a given local government subject to the total per capita

income of a local government.[7] By maximizing this utility function with respect to the quantity of service that an individual must receive, and subject to the budget constraint that local governments must face, it is possible to obtain the municipal's expenditure for an specific service i,

$$u_i = \alpha_i + \beta_i(y - \alpha) + \varepsilon_i \qquad (1)$$

Where u_i is the expenditure per capita on service sector i, α_i is the minimum expenditure required to provide a service i, β_i is the marginal budget share for the spending in service sector i, and $\alpha = \sum_{i=1}^{s} \alpha_i$ is the minimum required expenditure on all local services. The difference between the total per capita income and the minimum required expenditure $(y - \alpha)$ can be interpreted as a discretional income, that is the income remaining when the minimum expenditures have been covered by local governments. Finally, ε_i is the stochastic parameter associated to each service.

At this stage, this model fails to incorporate information related to the price variation for all public services, because data usually does not include direct information about prices. Thus, LES must include some restrictions to overcome this problem. For instance, some authors have proposed to impose an additional restriction by setting one of the minimum expenditure parameters equal to zero. However, this practice has not theoretical fundamentals. To solve this problem, the model allows for heterogeneity in parameters by imposing a functional form on the parameter-heterogeneity (Aaberge, Bhuller, Langorgen, & Mogstad, 2010). This approach is a key fact into the model because it offers an attractive way to model the spending behavior across local governments, by identifying the variables that can affect differences in costs of obtaining minimum standards on local services, as well as preference differences between communities.

[7] See Aaberge and Langorgen (2003), (2006), (2010), for more details about the derivation of the model.

For instance, some variables can affect the minimum expenditure required to provide a service. This idea permits to recognize that costs associated with minimum expenditures may vary because of different production technologies or differences in factor prices. Also, this minimum requirement may be affected by other exogenous impacts as the central government regulations and norms developed jointly by municipalities. For these reasons, α_i not only depends on production technology aspects, also it depends on the cost structure associated to each municipality. Let $z_1, z_2, \dots, z_r$ be r variables that are affecting the sector-specific subsistence expenditures. This set of variables can include observable characteristics of local governments such as the distance to urban centers, indicators for cities and small municipalities to control the presence of scale economies and variations in productivity across municipalities. Also, this matrix includes demographic variables that can affect the structure of needs inside a municipality as the proportion of people using a specific public service. Then, a more flexible identification of the minimum expenditure parameter can be formalized as,

$$\alpha_i = \alpha_{i0} + \sum_{j=1}^{r} \alpha_{ij} z_j \qquad (2)$$

Where α_{i0} is the constant associated with the minimum expenditure system and $\sum_{j=1}^{r} \alpha_{ij} z_j$ is the sum of the coefficient associated with the vector of variables that are affecting minimum expenditures by sector.

On the other hand, some variables can affect the preferences of the community in the provision of local goods. In this sense, local tastes affect the allocation of discretionary income on some specific sectors and then, local authorities can decide about how to use those resources. Let $t_1, t_2, \dots, t_m$ be m variables that are affecting the variation in local tastes on the discretionary income. These variables include characteristics related with the population composition of municipalities as the average education level of individuals or the private disposable income. Then, the marginal budget share can be written as,

$$\beta_i = \beta_{i0} + \sum_{j=1}^{m} \beta_{ij} t_j \qquad (3)$$

Including the conventional adding sum up restrictions on parameters of LES,

$$\sum_{j=1}^{m} \beta_{ij} = 0$$
$$\sum_{j=1}^{m} \beta_{i0} = 1 \qquad (4)$$

And by substituting into the equation (1) both, the minimum expenditure parameters and marginal budget share formalized in equations (3) and (4), respectively, the model is completely identified.

3.2. Allocation Methods of Local Public Services

Another important step in the analysis of local government expenditures is the allocation of the value of local public services to different target groups.[8] In general, local governments must report information about resources located to different public services, however, the allocation of spending by target groups is not observed and then, the amount of money that municipalities devoted to each target groups cannot be easily identified. A feasible solution to this problem was proposed by Aaberge, Bhuller, Langorgen, & Mogstad (2010), which permits to identify the relative priority of different target groups into each municipality using information captured by minimum expenditures. In other words, the model proposes that minimum quantities are determined by the relative size of different target groups. Assuming the existence of different target groups j which are identified by demographic variables included in the model for each service, expenditures are

[8]A target group is defined as people with identical needs to receive specific local public services. Then, the methodology seeks to identify individuals with similar specific characteristics to become a potential recipient of a local public service.

allocated in the same proportions as the minimum expenditures. Therefore, the allocation of spending to different target groups can be specified as,

$$u_{ij} = \frac{\alpha_{ij}}{\sum_{j=1}^{k} \alpha_{ij}} \bar{u}_i \qquad (5)$$

Where u_i is the predicted expenditure of a service i obtained from equation (1), α_{ij} is the minimum expenditure for each sociodemographic variable included into the model and $\sum_{j=1}^{k} \alpha_{ij}$ is the sum of all minimum expenditures of k target groups for each service. For instance, equation (5) is used to allocate the expenditures of public education services because it is possible to identify two potential target groups, these are the proportion of primary and secondary students enrolled at public schools. On the other hand, when target groups are not clearly identified, it is assumed that the target group is the population as a whole.

After the identification of expenditures for different target groups, the second step is to distribute the value of local public goods according to different needs of recipients. In specific, this step requires the identification of individuals with similar socioeconomic characteristics of becoming a potential recipient for a specific public service. Conventionally, the literature recognizes two different approaches to accomplish this objective. The first is the actual consumption approach which allocates the value of local public services to individuals that actually are using a public good. This approach is usually used to allocate education expenditures. The second type is the insurance value approach which computes the use of public goods according to the identification of factors that increase (or decrease) the probability of using a public service. For instance, this allocation form is appropriate for healthcare services, because the amount allocated represents the insurance value that an insured person would have to pay to the provider to receive the service (Verbist, Föster, & Vaaluvuo, 2012). This approach assumes that central government provides the same funding as an insurance policy where the value of the premium is the same for all individuals sharing the same characteristics (Marical, d'Ercole, Vaalavuo, & Verbist, 2008). Finally, both allocation approaches

are used to compute extended income by adding to disposable incomes the value of local public services.

3.3. The effect of public local services on the spatial decomposition of income inequality

Since Theil index is additively decomposable and satisfies many of the desirable properties as a measure of income inequality,[9] Akita (2003) proposed the two-stage Theil decomposition which suggests a simple region-province-commune decomposition to obtaining three important components of the overall inequality; within-provinces, between-provinces, and between-regions. Despite that this methodology fails in to explain the dispersion of individual's incomes within the underlying regional unit, it can provide a clearer picture about regional inequalities, by recognizing that public policy interventions focused at spatial level might have different effects on the distribution of incomes given the concentration of human capital and economic activities, as well as the unequal distribution of natural resources at the territory (Akita, 2003). Hence, the decomposition of inequality in these components becomes relevant when the objective of the study is to make a regional inequality measure comparable, which requires respecting the basic principles of socio-geographical regionalization of a country (Novotny, 2007). Also, this methodology offers an important opportunity to extend this two-stage decomposition to other hierarchical structure of the case study, focusing the analysis where the spatial income inequality is operating. For instance, this opportunity was taken by Paredes et Al (2014) those who following the ideas of Akita (2003) proposed the three-stage decomposition method extending the original decomposition to a region-province-commune-individual structure. The relevance of this decomposition is strongly justified from the public policy perspective because it includes an important spatial dimension (commune level) which is commonly used in public policy interventions focused on individuals. Also, Chile has disaggregated information of these three-spatial scales that policy-makers cannot ignore (Paredes, Iturra, & Lufin, 2014) and then, this new decomposition

[9] These properties are mean Independence, population-size, and the Pigou-Dalton principle of transfers. More details in Shorrocks (1982).

can provide a strong methodological tool with the purpose of generating territorial policies in order to reduce income inequality by providing a complete understanding of this phenomena.

Methodologically, the decomposition proposed by Paredes et Al (2014) to compute the overall inequality considering the region-province-commune-individual structure is proposed as follow,

$$T_i = \sum_r \sum_p \sum_c \sum_i \left(\frac{Y_{rpci}}{Y}\right) \log\left(\frac{Y_{rpci}/Y}{N_{rpci}/N}\right) \quad (6)$$

Where Y_{rpci} is the income of individual i, in commune c in province p in region r; Y is the income of all individuals; n_{rpci} is the individual i in commune c in province p in region r, and N is the total population.

Defining T_{ir} with the objective of measuring the between-income inequality for region r,

$$T_{ir} = \sum_p \sum_c \sum_i \left(\frac{Y_{rpci}}{Y_r}\right) \log\left(\frac{Y_{rpci}/Y_r}{N_{rpci}/N_r}\right) \quad (7)$$

the equation (6) can be decomposed as,

$$\begin{aligned} T_i &= \sum_r \left(\frac{Y_r}{Y}\right) T_{ir} + \sum_r \left(\frac{Y_r}{Y}\right) \log\left(\frac{Y_r/Y}{N_r/N}\right) \\ &= \sum_r \left(\frac{Y_r}{Y}\right) T_{ir} + T_{BR} \end{aligned} \quad (8)$$

Thus, the overall-regional income inequality T_i is the sum of the within-region component and the between-region component. Similarly, to measure the within-commune income inequality for commune c in province p in region r, T_{cr} can be written as,

$$T_{rc} = \sum_{i} \left(\frac{Y_{rpci}}{Y_{rpc}}\right) \log\left(\frac{Y_{rpci}/Y_{rpc}}{N_{rpci}/N_{rpc}}\right) \quad (9)$$

By substituting equation (9) in equation (7), T_{ir} can be decomposed as,

$$\begin{aligned} T_{ir} &= \sum_{p}\left[\sum_{c}\left(\frac{Y_{rpc}}{Y_{rp}}\right)T_{rc} + \sum_{c}\left(\frac{Y_{rpc}}{Y_{rp}}\right)\log\left(\frac{Y_{rpc}/Y_{rp}}{N_{rpc}/N_{rp}}\right)\right] \\ &= \sum_{p}\left[\sum_{c}\left(\frac{Y_{rpc}}{Y_{rp}}\right)T_{rc} + T_{cr}\right] \\ &= \sum_{p}\sum_{c}\left(\frac{Y_{rpc}}{Y_{rp}}\right)T_{rc} + \sum_{p}\left(\frac{Y_{rp}}{Y_{r}}\right)T_{cr} \\ &\quad + \sum_{p}\left(\frac{Y_{rp}}{Y_{r}}\right)\log\left(\frac{Y_{rp}/Y_{r}}{N_{rp}/N_{r}}\right)\sum_{p}\sum_{c}\left(\frac{Y_{rpc}}{Y_{rp}}\right)T_{rc} \\ &\quad + \sum_{p}\left(\frac{Y_{rp}}{Y_{r}}\right)T_{cr} + T_{pr} \end{aligned} \quad (10)$$

Where T_{rc} measures the income inequality between communes in region r, and T_{pr} is the measurement of the income inequality between provinces in region r. Finally, T_{ir} is substituted in the equation (8) and then,

$$\begin{aligned} T_i &= \sum_{r}\sum_{p}\sum_{c}\left(\frac{Y_{rpc}}{Y_{rp}}\right)T_{rc} + \sum_{r}\sum_{p}\left(\frac{Y_{rp}}{Y_{r}}\right)T_{cr} + \sum_{r}\left(\frac{Y_{r}}{Y}\right)T_{pr} + T_{BR} \\ &= T_{WC} + T_{BC} + T_{BP} + T_{BR} \end{aligned} \quad (11)$$

Equation (11) represents the three-stage Theil inequality decomposition which each value obtained might be attributed to the individual location where the observation is located (Paredes, Iturra, & Lufin, 2014). The last equation is used with the purpose of computing spatial income inequality using the new information about incomes from previous sections.

4. Empirical Results

This paper focuses the analysis on expenditures of eight local public services described on the previous sections. Of course, the most important services that municipalities provide are education and healthcare services because both are designed with the aim of guarantying the accessibility to poorest families. Education services are compulsory for all children aged 6-19 those who are divided in two levels, primary and secondary with a duration of eight and four years, respectively. On the other hand, health care services might be used for all inhabitants, however, people registered at government insurance scheme (National Health Care System; FONASA) have higher probabilities of using than individuals registered at private system. Other services such as municipal activities, administration, culture, recreational, social and community services include municipal's expenditures in maintenance of roads, luminary, cleaning services, maintenance of public spaces, cultural programs, etc., which are directly affecting the life quality of the population. The recipients of these services are the population as a whole. Conventionally, the procedure to compute LES is to estimate the model simultaneously through Iterative Feasible Generalized Least Square (IFGLS). This method offers consistent estimates of Maximum Likelihood Estimator (MLE) assuming that errors are homogeneous with mean equal to zero and unrestricted covariance matrix. We adopted this approach to estimate the model.

This paper uses two sources of information. The first dataset is provided by the National System of Municipal Information SINIM (Sistema Nacional de Información Municipal), which offers a complete description of the Chilean municipalities accountancy from 2009 (277 municipalities), 2011 (281 municipalities) and 2013 (287 municipalities).[10] This dataset is supported for the

[10] The sample represents for about 90 percent of all representative municipalities statistically. Chile has 345 municipalities, however, only 321 municipalities are statistically representative. In addition, not all municipalities provide information about their financial statements and then, the dataset collected just contains information about those municipalities that provide the eight local public services listed above.

Sub-secretary of Regional Development SUBDERE (Subsecretaria de Desarrollo Regional), which offers an electronic platform where municipalities must report their financial statements with the objective of controlling the municipal's financial behavior, as well as, to increase their transparency levels.[11] In addition, this dataset provides information about socioeconomic characteristics of the population collected by other official institutions. From this source, we use expenditure information of eight local public services that municipalities provide, which are presented on per capita basis in the summary statistics of table 1. These results report that municipality's expenditures are larger for education services, administration and health care. For instance, education services expenditures increased from 158.007 CLP in 2009 to 198.397 CLP in 2013. The same trend is followed by administration's expenditures which increased from 143.609 CLP in 2006 to 152.409 CLP, and healthcare which expenditures increased from 48.191 CLP to 74.755 CLP in 2013. However, the most important feature of these expenditures is that all services are characterized by a high variability which means that municipalities might face important structural changes that are affecting directly their local organization such as the implementation of new public policies or the reduction of the number of recipients (e.g. public education) that could increase the per capita amount of resources allocated in public services. Another important characteristic of municipal expenditures is observed in figure 2, that is, the high concentration of expenditures around the center following the spatial pattern of population.

The second dataset is provided by the National Socioeconomic Characterization Survey CASEN (Encuesta de Caracterización Socioeconómica Nacional) for years 2009, 2011 and 2013. These datasets contain information about household incomes, as well as, other important socioeconomic characteristics of the population that cannot be captured by the municipality's datasets. From this information, we use two versions of household incomes available. The first is the autonomous income, which is defined as the income derived from a labor contract. The second is the

[11] This dataset is available at http://www.sinim.gov.cl

monetary income which is defined as the autonomous incomes plus cash transfers (e.g. subsidies). This income is included in the analysis to control the influence of social policies directed to individuals provided by the central government with the objective of reducing poverty and inequality. With respect to the spatial characteristics of the country, Chile divided into 15 regions which correspond to the highest administrative level. Also, the country is divided into provinces which is the second administrative level and communes, the third administrative level. The table 2 shows a description of the number of households available for each dataset, as well as, the number of communes, provinces, and regions covered during the period. This paper uses the same number of communes (municipalities) as in the local municipal behavior analysis. Finally, the figure 3 shows the spatial behavior of the average of autonomous household incomes by communes where it is possible to observe the uneven distribution of population and incomes around the center where is located the capital of the country (Metropolitan Region). In this sense, these maps put in evidence the spatial pattern that characterizes income inequality: the high concentration of social and economic activities around the capital of the country.

4.1. Heterogeneity in subsistence expenditures and marginal budget shares

In this section, the results obtained from the estimation of the model defined by equations 1 – 6 are reported for years 2009, 2011 and 2013, respectively. These estimates include a set of demographic variables and other features of municipalities that might influence on the minimum expenditures, as well as on the marginal budget shares.[12] By following the theoretical reasoning of the model, the coefficients can be interpreted as partial marginal effects which means that a coefficient represents the increment in the minimum quantity when the target group is increased by one individual. Given the institutional configuration of the distribution of local public services between municipalities and central governments and the availability of information, LES is computed for shared functions (education and healthcare services), as well as for exclusive functions (the remainder of services). Under this setup, LES for shared functions is computed for

[12] See appendix B.

277, 281 and 287 municipalities for 2009, 2011 and 2013, respectively. On the other hand, LES for exclusive functions is computed for 246, 244 and 261 municipalities for 2009, 2011 and 2013. In particular, the dataset for exclusive functions is composed by municipalities that are providing all the package of services considered into the analysis. These municipalities are cities (more than 5.000 inhabitants) and urban jurisdictions. The results for both groups of services are shown in the following subsections.

4.1.1. Shared Functions

The results of the computation of LES for shared functions, education and healthcare services, respectively, are shown in tables 3 – 5. Target groups for education services can be easily identified because local authorities have information of the number of students enrolled in primary and secondary schools with the purpose of redistributing conditional transfers received by the central government. Thus, the proportion of students using primary and secondary public education are included as sociodemographic variables into the model. Both variables report the amount of money that municipalities should devote when a target group increases in one unit. Results indicate that for the education sector, children in schooling age increase education expenditures for all municipalities because primary and secondary schools are compulsory for all children aged 6-19 years. However, minimum expenditures tend to increase more with an additional child aged 14-19 years enrolled at secondary schools. This result suggests that municipalities and central government spend more resources in this target group because these students should face more demanding courses requiring more teachers with higher qualifications in comparison with students enrolled at primary levels. Also, this result follows the trend of central government subventions which are higher for students enrolled at secondary schools. During 2009, the partial marginal effect of increasing a target group in one more student was 89.540 CLP for children enrolled in primary schools and 146.100 CLP for students enrolled in secondary schools. After the implementation of some public policies with the purpose of increasing educational quality of public schools, resources increased significantly and then, during 2013 the partial marginal effect increased to 128.200

CLP for students enrolled at primary schools and 181.900 CLP for students enrolled in secondary schools.

In contrast with education services, target groups of healthcare services cannot be easily identified and then, we assume that expenditures in this service do not depend as a function of sociodemographic variables considering as a target group the population as a whole. In this case, health care expenditures are characterized for being divided into two parts: the first corresponds to a basic capacity which is financed by both, municipalities and central government, respectively. The second part is an additional cost which must be supported by families through healthcare insurance that every family must hire, which can be public (National Health Care System; FONASA) or private.[13] As primary health care services must be provided to all individuals given the constitutional laws, all inhabitants might use these services, however, the poorest population and individuals registered in FONASA have a high probability of using them in comparison with individuals registered in the private sector. Thus, we do not have strong evidence to assume that local government expenditures can vary across the population registered in FONASA and then, all inhabitants are considered as potential recipients of primary health care services. Therefore, the minimum expenditure for these services is represented by the constant associated with its equation. For healthcare services, the partial marginal effect of one more individual is found to increase by an additional amount of 111.100 CLP during 2009. However, this marginal effect decreased to 99.540 CLP for 2013.

[13] In Chile, the health care insurance is compulsory for all workers and pensioners whom must pay at least 7 percent of their incomes. In this point, families should choose between public system (FONASA) or private system. If individuals decide to register in the private system, they must pay an additional amount of money (voluntary) to opt to a health care plan which depends of their incomes, medical risk, family medical history, etc. In the case of health care services provide by municipalities, both public and private affiliates can use them. However, private affiliates must pay a higher amount for the service demanded.

Regarding with variables to control economies of scale are shown to be significant in both sectors. For instance, dummy variable associated with small municipalities has a positive impact on education and healthcare services which implies the existence of fixed costs in the operation of local governments. In addition, the existence of economies of scale is proved also with dummy variables for cities (with equal or more 5.000 inhabitants) and agglomerations (with equal or more 100.000 inhabitants). Both variables show a negative effect on education and healthcare expenditure confirming that small municipalities face higher per capita fixed cost in comparison to the biggest ones. On the other hand, variables used to control centrality are only negative and significant for healthcare services implying that municipalities closer to urban centers face higher expenditures in this case. This result is confirmed by population density which shows a positive impact on healthcare expenditures evidencing that the incidence of diseases might be higher in zones where there exists a high concentration of people who are more susceptible to pollution or unhealthy lifestyles. Thus, high levels of urbanization that Chile exhibits might confirm this result because it is possible to observe a high concentration of people living closer to urban areas and then, healthcare expenditures are higher than dispersed settlements due to their urban character.[14] In contrast with other services, the variable related with the dependency to Municipal Common Fund (FCM), included into the analysis to capture the effect of the smallest municipalities located in dispersed areas is found to be positive and significant only for education services, implying that costs of providing education on a decentralized level is higher in sparsely and smaller populated areas due to economies of scale. In this sense, small municipalities in dispersed areas spend more own resources in education services by confirming that healthcare services are activities largely located in urban areas. Finally, variables such as PSU' effectiveness and unemployment rate by commune have a positive impact education and healthcare services, respectively, meanwhile, poverty rate exhibits a negative effect on health care expenditures.

[14] Following Word Bank's computations, 90 percent of population was living in urban areas during 2015 (Word Bank Databank, 2016)

With respect to marginal budget share coefficients, note that the average of education of individuals 30-59 years of age is found to be positive and significant for healthcare services implying that local authorities put more attention to these services when the population is more educated because they might demand more high-quality services. On the other hand, the average of education is found to be negative and significant for education services due to the lower probability of these individuals of becoming recipients of them. In addition, average housing rent variable shows a positive and significant effect on education expenditures which means that communities demand more quality education services because the increment of this amenity's level might increase housing valuation. However, the effect of this variable is negative for health care services. This result might be related to low-quality levels these services exhibit which would reduce the valuation of households. Finally, the effects of other variables such as the average income per capita and political participation of councils are not significant for both services. This result is relevant in special for political participation of councils because it is a proof about the limited participation of local authorities in the definition of new strategies in education and health care services which are dominated largely by the influence of the central government.

4.1.2. Exclusive Functions

The results of LES are shown in tables 6 – 8. For all these services such as infrastructure, administration, culture, recreation, social, and community services, local government expenditures do not depend on sociodemographic variables because it is not possible to identify clearly the recipients of these services due to the availability of information. Thus, the minimum expenditure for every service is represented by the constant associated with every service's equation and then, the target group associated with each service is the population as a whole. With respect to variables used for controlling by economies of scale and centrality are shown to be significant in largely of services. For instance, inverse population variable is positive and significant in all sectors by implying that small municipalities must face higher unit costs to provide these local public services. Moreover, this result implies the existence of fixed costs in the operation of local governments. As usual,

small municipalities have smaller target groups than the largest ones, and therefore per-capita fixed costs are higher in comparison with other municipalities. In addition, the results show that municipalities geographically dispersed face higher expenditures in infrastructure and recreational services than municipalities with higher densities and closer to urban centers. In this sense, the distance to urban centers used to capture the effects of centrality exhibits a significant positive effect for both services. Also, the variable associated to the Municipal Common Fund (FCM) dependency included into the analysis to capture the effect of the smaller municipalities located in dispersed settlements is found to be negative and significant in all services. Municipalities with a high dependency on this funding source might spend fewer resources in exclusive functions, apparently, due to the lower availability of own resources for their provision. Thus, it is possible these municipalities are concentrating more priorities on other important local public services such as education and healthcare services than others which could affect negatively living standards of communities.

Regarding marginal budget share coefficients, note that variables affecting these parameters are more relevant for exclusive functions than shared functions. Specifically, political participation of councils and income per capita variables become more important into decisions of local governments to provide public services according to characteristics of the population. For instance, average income per capita has a positive effect on administration, culture and recreational services which means that local authorities put more attention to cover this kind of services when communities are richer. In particular, this result might determine that the richest families are becoming on users in communities where local authorities show more attention to provide services that increase living conditions of communities. On the other hand, political participation of councils shows ambiguous results for administration, culture and social services. For example, political participation has a negative effect on cultural services during years 2009 and 2011 which implies that local authorities devote fewer efforts to provide this service, meanwhile, the same variable has a positive effect during 2013. A similar pattern can be observed for administration, recreational and community services,

where political participation has a negative effect on administration and recreational services for 2009, and positive and significant effects for 2011 and 2013, while political participation has a positive effect on community services in 2009 and a negative effect during 2011 and 2013. These results coincide with changes of local authorities during 2011 and then, it is possible that these could affect the objectives of municipal councils by generating a different pattern of expenditures between periods and municipalities. Finally, the average of housing rent shows a negative effect on administration and culture services during 2009-2011, and a negative effect for recreational services during 2011. These results indicate that municipal expenditures are lower when housing rent of communities are high, which it is an opposite result with respect to the expected because an increment of municipal efforts to provide better administration, cultural and recreational services might increase housing valuation. However, these results are reversed for recreational services from 2011 and for cultural services during 2013. On the other hand, the average of housing rent has a positive effect on community and social services which means that local authorities devote more resources to increase levels of infrastructure, maintenance of roads and public space, or subventions to population when housing rents are higher because this item corresponds to an important funding source of municipalities and then, efforts for increasing these services can be translated into more resources from this potential local tax in the future.

4.2. Allocation of local public services

For the Chilean case, education services are allocated using the actual consumption approach given the identification of two target groups that actually are using education services. On the other hand, healthcare, social and community services are allocated using the insurance value approach. For instance, healthcare services are allocated in proportion to the probability of being a recipient of these services. To compute this probability, a probit analysis is applied using socioeconomic information about whether or not individuals have visited a practitioner in the last 3 months, age, sex, if individuals are enrolled at the National Health Care Security System (hereafter, FONASA) and if individuals are living below the poverty line. The probability computed is found to increase with the age of individuals, women,

with individuals enrolled at FONASA and with individuals below the poverty line. The same strategy is applied for social services and community services and then, the probability of households of being recipients of these services is computed. From the socio-economic survey CASEN, individuals are asked whether or not their family is enrolled in the *Chile Solidario* program.[15] This program is provided by central government; however, municipalities commonly act as administrators because they are responsible to identifying households that are sharing the requirements of being recipients. In this case, the probability of receiving social services is found to decrease with the head of household's age and family's incomes and to increase with female-headed households and with families living below the poverty line. Using these probabilities for each individual and each family, households receive a share of the value of health care, social and community services proportional to the probability of receiving health care services or social assistance, respectively. The remainder of services is allocated using the actual use approach assuming that the value of these services is distributed uniformly across families and each family receives the same allocation of money which only varies by municipality. Finally, the extended income is computed adding up the value of these services to disposable incomes.

4.3. A new definition of incomes

To analyze the effect of the value of local public services on spatial income inequality, in this paper we consider two different measures of cash incomes that usually are used in this type of studies. The first is the autonomous income which is defined as the income derived from a labor contract. The second is the monetary income which is defined as the autonomous income plus cash transfers or subsidies. To compute the extended income, we add the value of local public services to autonomous and monetary incomes, respectively. Hereafter, these new incomes are referred as extended autonomous incomes and extended monetary incomes, and these are used to test the robustness of results. To avoid scale effect problems, the

[15] This program is a package of different subsidies created with the purpose of helping the poorest families. For instance, this package includes water's subsidy (a discounted copayment in the final price), family's subsidies, program for retention of students in schools and others.

four measures of incomes have been divided by the number of inhabitants by household.

4.4. Spatial Analysis

In this section, we show the results of the spatial decomposition of income inequality proposed at the previous sections, using information about monetary and autonomous incomes provided by socioeconomic surveys, as well as extended incomes (extended monetary and extended autonomous incomes, respectively) computed according to the proposition of Aaberge et Al (2003). In line with the computations performed by Solimano and Torche (2008) and Paredes, Iturra and Lufin (2014), Chilean income inequality continues its trend to decrease during the last years. Including new information (2011 and 2013, respectively), results apparently have the same pattern as estimations obtained by previous works. Figure 4 shows the evolution of Theil index in the period 2009-2013 for autonomous and monetary incomes. Both types of incomes are included in the analysis because it is possible to analyze the role of cash transfers on income inequality. As expected, income inequality tends to decrease showing a similar pattern between types of incomes. An exception has been found in 2011 where Theil index slightly increases, however, this change is reversed to its lowest level during 2013. In addition, Theil index for monetary incomes is lower than Theil index for autonomous incomes, which means that cash transfers directed to individuals have been relevant to reduce income inequality, however, these results do not indicate the significance of this change. To determine the statistical significance of this reduction, figure 4 also includes confidence intervals (at 95 percent of confidence) which were estimated via bootstrapping in 100 replications. The logic of this analysis is the following; if confidence intervals are overlapping between them it implies that reduction (or increment) of income inequality has not been significant for a specific period. Results suggest that income inequality's reduction was significant only for years 2009 and 2013 because both confidence intervals do not overlap for both periods. This finding follows the results obtained by Paredes, Iturra and Lufin (2014) those who suggested that cash transfers have been insufficient to reduce income inequality, at least for 2011 respectively.

To account for the spatial location of households and its effects on income inequality, the three-stage nested Theil decomposition proposed in equation 16 is computed and shown in figure 5. As results obtained by Novotny (2007) and Paredes, Iturra, and Lufin (2014), both autonomous and monetary incomes have similar patterns revealing the important role of the space in the Chilean income inequality. On average, 19 percent of income inequality can be attributable to the spatial location of households which confirms that its spatial dimension is an important source of overall income differentiation. In figure 5 two important features can be detected. First, it is possible to observe a reduction of income inequality within communes which fell from 84 percent in 2009 to 80 percent in 2013 due to public policies oriented to individuals (Paredes et Al, 2014). However, also this evidence reaffirms that there exist other mechanisms operating in a spatial scale that might push the increment of income inequality between municipalities. This last idea is crucial to understand the potential role that municipalities might perform on spatial income inequality through the provision of local public services which might be affected by funding sources restrictions or local management capacities that suffer an important variability across municipalities. Finally, these factors can be relevant to determine how local public services and their spatial distribution can affect living conditions of communities, especially when the spatial location of individuals might determine their opportunities to access to these services.

The following subsections describe the results for the spatial analysis of income inequality considering the effect of local public services through the classification proposed in the previous sections. We believe that characteristics of local public services in terms of dependency to central government funding might influence on spatial income inequality, by modifying the behavior of local governments to provide these services. In this sense, different roles performed by municipalities to provide shared and exclusive functions are influenced to a greater or lesser extent by central government preferences. For instance, municipalities must act as managers of resources devoted to providing education and healthcare, which are

largely financed by central governments. Also, local governments have a limit participation on the design of both public policies because it is an important purpose performed by central offices (ministries) to ensure the accessibility of these services to all population establishing a special focus on the poorest population. In contrast, the provision of exclusive functions depends on the management capacity of municipalities which differs among local governments. Also, these services receive a less control from central government because all the responsibility to provide them corresponds to municipalities by law. On the other hand, exclusive functions are largely supported by municipal's incomes which are subjected to a fixed structure of funding imposed by central government. Thus, resources devoted to finance these local public services are characterized by a high variability between municipalities which depend on the availability of funding sources in each community. We believe these differences on the provision of local public services regarding with funding sources, as well as control and management capacities might affect measures of spatial income inequality, contributing to increase disparities on living standards across individuals and communes.

4.4.1. Shared Functions

Figure 6 shows the evolution of Theil index for extended monetary and extended autonomous incomes considering education and health care services which are provided by municipalities, however, these are largely financed by central government. In average, the inclusion of the value of education and healthcare services reduces income inequality by about 9 percent in absolute terms. As both extended incomes are computed using information about monetary and autonomous incomes, their income inequality evolution follows the same pattern and then, results do not report relevant conclusions. Thus, to account for effects of shared functions on income inequality figure 7 shows the Theil index for extended monetary incomes and monetary incomes and their confidence intervals, respectively. Bootstrapping suggests that education and healthcare services have been more effective to reduce income inequality for all periods. As Aaberge et al (2003) proposed, the inclusion of the value of these services might be more effective to reduce income inequality than central government individual's

subventions, by guarantying the accessibility of the poorest population to these kinds of services, the main purpose of both public policies. Therefore, this result is crucial to understand the important role that local governments perform on individual's well-being contributing to equalize the accessibility of these public services to all individuals.

In this sense, the spatial location of individuals might be relevant to analyze the spatial behavior of income inequality. In other words, the inclusion of the value of education and health care services is still relevant to account for the existence of other mechanism affecting spatial income inequality due to the greater effectivity of these local public services to reduce income inequality. Thus, Theil's decomposition for extended autonomous and extended monetary incomes is shown in figures 8 and 9, respectively.[16] On average, 18 percent of overall inequality can be attributable to the spatial scale, 2 percent less than the proportion of spatial inequality computed for monetary and autonomous incomes, respectively. In fact, this reduction of spatial income inequality can be related to an increment of income inequality within communes (or the individual component of income inequality), meanwhile, spatial components of overall income inequality remain stable for all the definitions of incomes. These evidences show the important role of education and healthcare services increasing opportunities to all population even if the increment on the individual level of income. Finally, results imply that shared functions are accomplishing central government purposes because apparently, these are increasing the accessibility to all individuals to both local public services independently of their spatial location.

4.4.2. Exclusive functions

Figure 10 shows the evolution of Theil index for extended monetary and extended autonomous incomes considering only exclusive functions for its computation. The provision of these public services is the responsibility of local governments, which are supported largely by municipality's income sources. Applying the same

[16] Bootstrapping results for spatial components of income inequality in appendix C.

empirical strategy for shared functions, the value of exclusive functions reduces income inequality by about 25 percent, which means these services have been allocated to individuals of the lowest income classes. In addition, bootstrapping suggests the value of exclusive functions reduces significantly income inequality for all periods. These results reinforce the position of local governments as drivers of local development generating local initiatives with the purpose of reducing inequality between individuals given their better knowledge of communities' preferences and the potential reduction of transactions costs in the delivering of public goods.

To account for the spatial location of individuals, Theil's decomposition for extended autonomous and extended monetary incomes is shown in figures 11 and 12.[17] The inclusion of exclusive function on monetary and autonomous incomes increases spatial income inequality in 22 percent which is higher in comparison to the same component without to consider the value of local public services. For instance, income inequality among individuals decreased from 81 percent to 75 percent during the period 2009-2013. However, other important feature of income inequality can be observed from this analysis: income inequality between communes increased from 11 percent in 2009 to 14 percent in 2013, which also it is higher to the same component without exclusive functions. This evidence shows that a part of income inequality related to the spatial scale might attributable to local governments and their performance on the redistribution of exclusive functions at the population. In this sense, local governments accomplish an important role reducing income inequality between individuals which permits to guide the local development of their communities. However, also it is possible to observe a potential tradeoff between municipal functions and their local management capacities which apparently are not uniformly distributed between municipalities. Also, the high variability of municipal expenditures that depends on restrictive funding sources might influence the provision of local public services because some municipalities do not have sufficient resources to support them. Finally, different priorities across municipalities would affect the provision of services; small

[17] Bootstrapping results for spatial components of income inequality in appendix D.

municipalities can prefer to provide education and healthcare services following the preferences of central government than culture services because this service supposes the use of resources that would not be available.

In summary, this new evidence provides four important characteristics of the Chilean income inequality. First, income inequality has decreased, however, it is still high in comparison with other countries (Paredes, Iturra, & Lufin, 2014). Second, the reduction of inequality during the period studied can be attributable to the effect of social policies directed to individuals, because the within inequality shows a decreasing trend during the last years. Third, the results suggest the inclusion of local public services into the analysis has a significant effect on the reduction of income inequality. Therefore, public services provided by local governments might be more effective than cash transfers if the purpose of policymakers is to increase the accessibility of the poorest households. On the other hand, the effect of local public services on spatial inequality can differ due to the dependency of these local services to funding sources. For instance, shared functions (education and healthcare services) financed largely by central government can reduce spatial income inequality accomplishing the main purpose of these public policies: to ensure the accessibility of education and health care services to all population, in special to the poorest population. However, exclusive functions which are financed and managed largely by local governments increase spatial income inequality. The results suggest the inclusion of these services reduces income inequality among individuals, however, it increases inequality across communes. This increment might be due to the role of local governments in the provision of public services because apparently, their local capacities are not uniformly distributed between communities.

5. Conclusions and further remarks

This paper has the objective of exploring how the omission of the value of local public services can affect conventional measures of income inequality. Using the methodology proposed by Aaberge and Langorgen (2003), an extended income is computed through a complete linear expenditure system (LES) considering

differences in costs to obtain minimum-standards of various local public services in a simultaneous treatment. Thus, LES is estimated as a function of economic, social, demographic and geographical factors that might affect the municipal capacity to produce a local public service package given the preferences of municipalities and individuals. This approach is used to explore the behavior of Chilean municipalities from 2009, 2011 and 2013 using information of eight public services that local governments provide: education, health care, administration, infrastructure, culture, recreational, social and community services. In contrast with the original application of the model, this approach recognizes the provision of local public services also depends on the central government in terms of designing and funding sources. We believe this factor can affect the behavior of municipalities due to different roles they assume to produce each service. In this sense, this paper computes different LES for shared functions (education and health care services), which depend largely on the central government in terms of funding sources and designing, and exclusive functions (the remain of services) which are largely funded by local governments. This model is computed through Iterated Feasible Generalized Least Square (IFGLS) which provides consistent estimates of Maximum Likelihood Estimator (MLE).

The results evidence that a common characteristic for shared and exclusive functions is economies of scale. For instance, results show that small municipalities spend more resources in providing local public services, especially education, health care, infrastructure and recreational services. However, municipalities closer to urban areas spend more resources in providing health care services than others. This result is confirmed by population density which implies that high incidence of diseases in places with an important concentration of people may increase expenditures due to pollution and unhealthy life. However, important differences between municipalities can be found when other variables are considered in the analysis. Municipalities with a high dependency on MCF (municipal common fund) spend fewer resources in exclusive functions in contrast with education services in which it is possible to find a positive effect of this variable. This result might be due to these services are financed by municipal funding sources that suffer a high

variability across municipalities. Then, municipalities may concentrate high priority on education and healthcare services because arrangements of central government, meanwhile the provision of exclusive functions might be concentrated in places with more probability to access to municipal funding sources.

Other important differences between types of services are related to marginal budget share coefficients. Variables such as political participation of local councils are more relevant for exclusive functions than shared functions. This result shows the limited participation of local governments in the design of education and health care policies and reveals the important role of the central government in terms of controlling and funding. On the other hand, exclusive functions depend largely on local management capacities which are mostly controlled by municipal councils. Also, average income per capita of communities is found to have a positive effect only on exclusive functions, especially in local public services such as administration, cultural and recreational services by determining that local authorities put more attention to cover these services when individuals are richer. Furthermore, municipal expenditures in healthcare services are higher when the population is more educated because they might demand high-quality services. However, education expenditures are lower when the population is more educated due to their lower probability of using these services. Finally, housing prices could increase expenditures in education services because these would raise housing valuation but also reduce expenditures in healthcare services because are associated with lower housing valuation.

Next, the value of local public services is allocated on the population through different target groups and different needs of recipients, following allocation rules for each service and then, extended income is computed adding to autonomous and monetary incomes the valuation of services. From this step, extended autonomous and extended monetary incomes are computed which are used to analyze the effect of local public services in spatial income inequality. Using the three-stage decomposition method proposed by Paredes, Iturra, and Lufin (2014), new incomes are decomposed by following the hierarchical structure of the country: region-

province-commune-individual. Results indicate that the inclusion of the value of shared and exclusive functions reduces income inequality in 9 percent and 25 percent, respectively, showing the important role of these services on the reduction of overall inequality. However, despite that both services reduce overall income inequality; different effects can be found on spatial income inequality. In this sense, shared functions (education and health care services) reduce spatial income inequality, according to the purpose of both services that ensure the accessibility to these services to all population. By contrast, exclusive functions which are controlled, managed and financed largely by local governments increase spatial income inequality, evidencing the high variability in local management capacities and funding sources which depend on a fixed structure imposed by central government. Thus, these differences can determine the existence of high disparities between communes affecting directly opportunities of accessing to better living conditions that apparently are concentrated in places with more probabilities to obtain municipal resources and higher levels of local management capacities.

Overall this paper offers a new perspective to analyze income inequality. First, this approach includes the important role of local governments as crucial actors in the delivery of local public services. Previous analyzes ignore the role of decentralized public policies that are designed with the objective of reducing income inequality such as education and healthcare services. Therefore, the inclusion of local public services can increment the understanding of the behavior of income inequality and its persistence over time. These findings highlight the role of local governments as drivers of local development which requires redirecting the creation of public policies to community scale where also spatial inequality is operating. However, policymakers might face potential costs that would emerge from coordination problems of public policies operating in different scales. Finally, this paper omits some important factors that could affect the results. For instance, this paper does not explore spillover effects that emerge from the provision of local public services. Also, quality of local public services has not been considered in the analysis and to ignore this problem can overestimate the real impact of local public services on spatial income inequality. A future research is aimed in this line with the purpose

of obtaining a clear picture about how these factors potentially can affect spatial income inequality.

Figure 1: Municipal Expenditures Structure of Chilean Municipalities 2009-2013

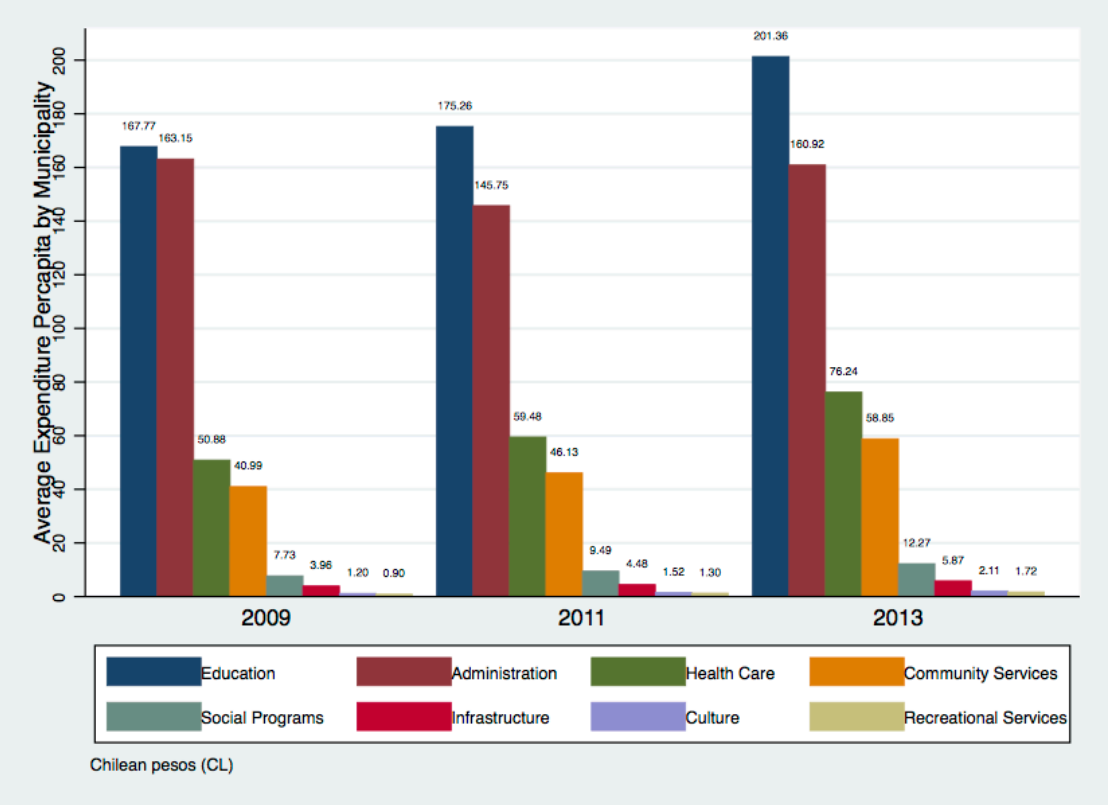

Figure 2. Map of Chile. Administrative division, Gastner-Newman's cartogram of population and municipal expenditure percapita

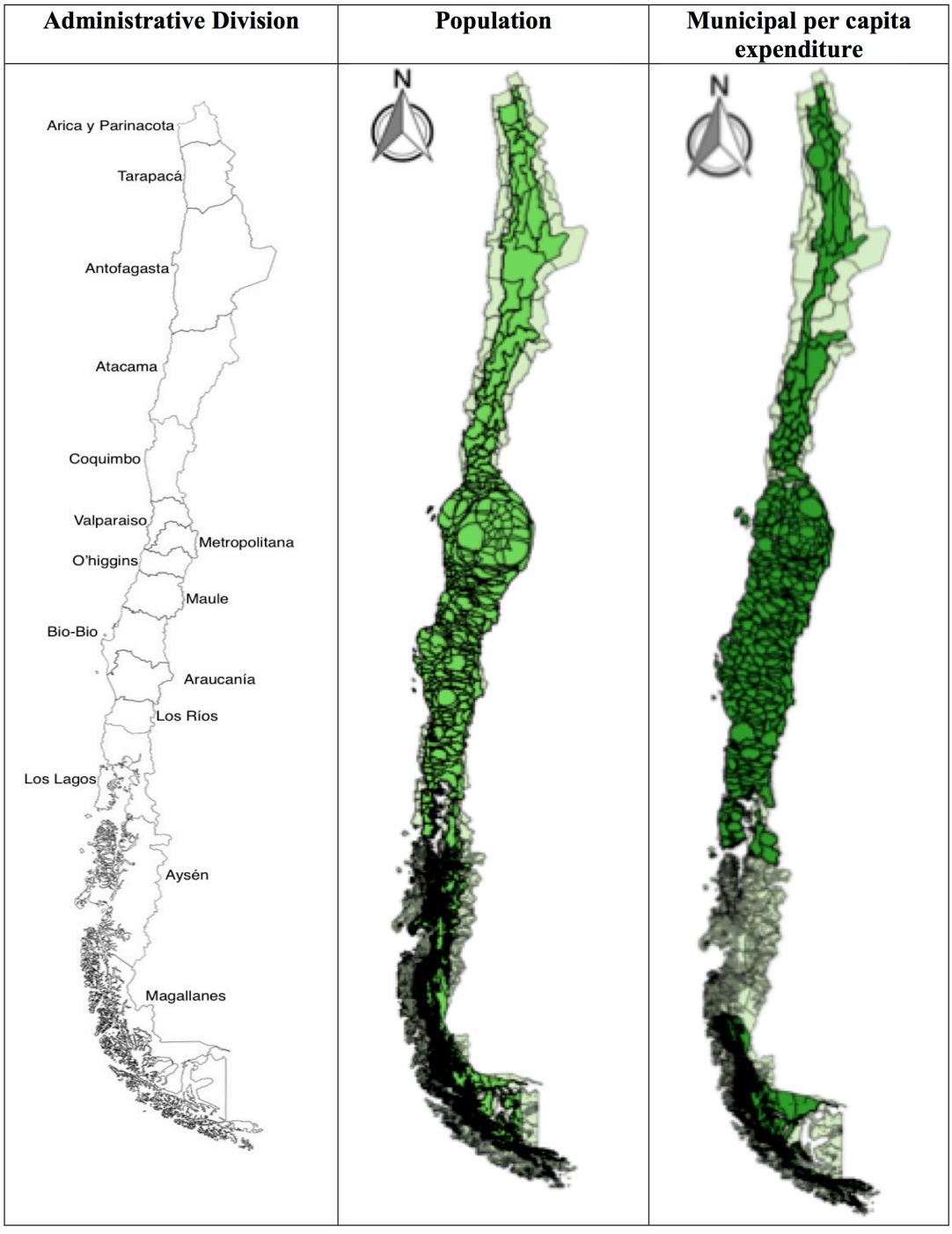

Figure 3: Map of Chile. Administrative Division. Gastner-Newman's Cartogram of population and average household incomes

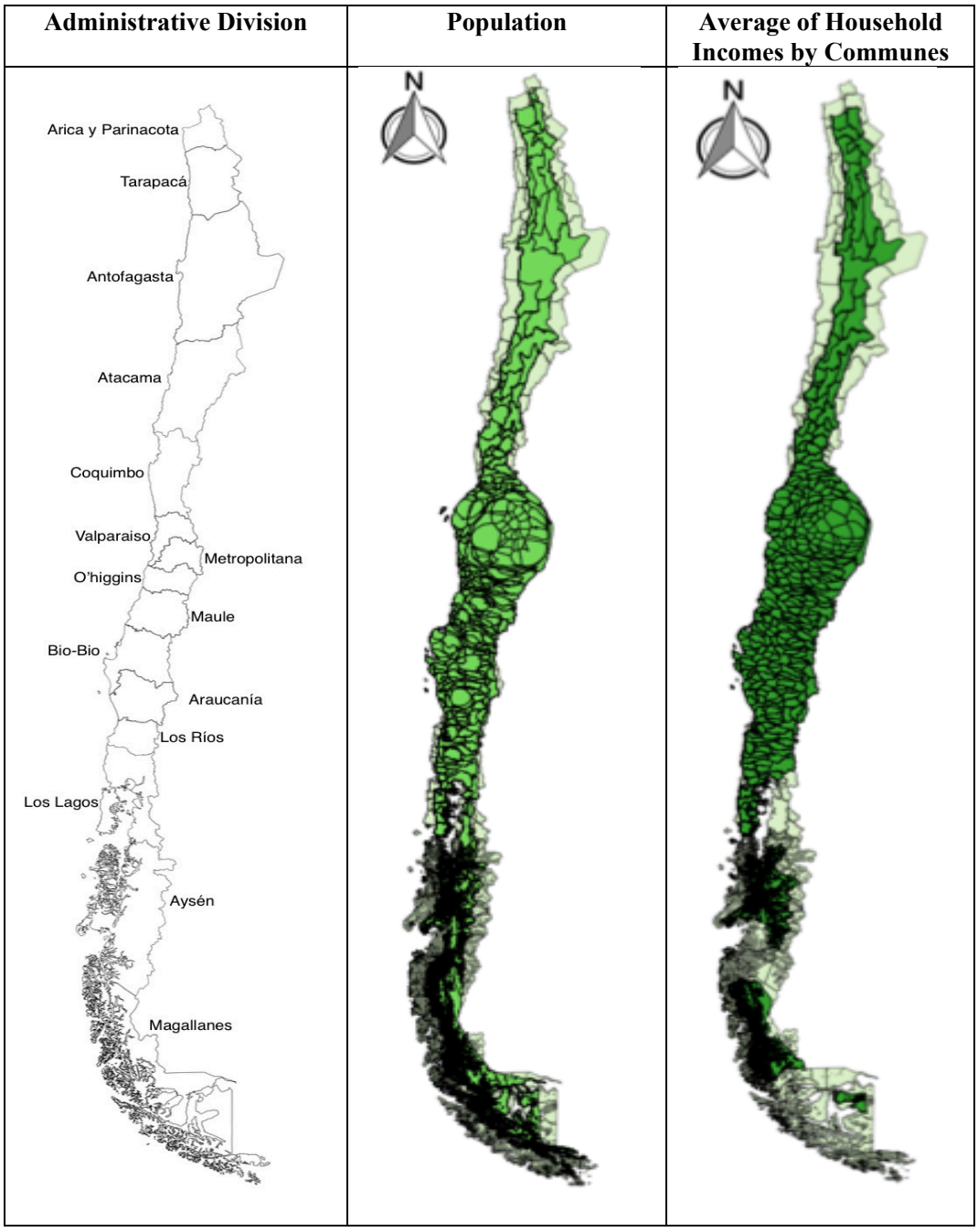

Figure 4: Overall Theil Index. Monetary and Autonomous Income From 2009-2013

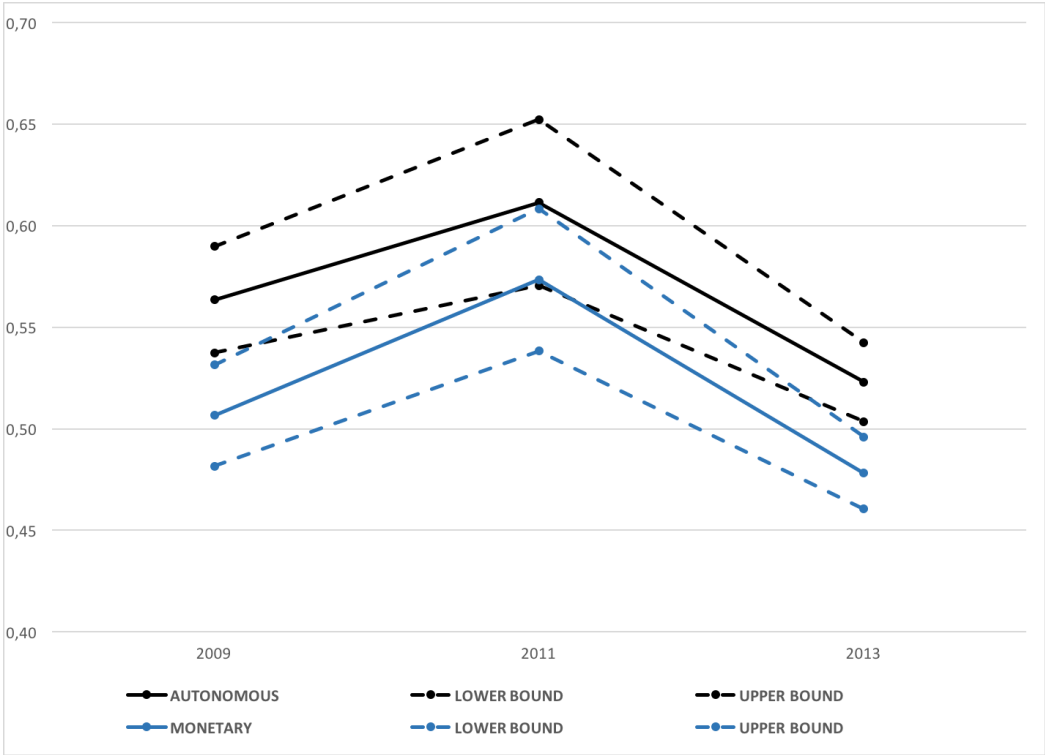

Figure 5: Three-stage inequality decomposition of Theil index. Autonomous and monetary incomes from 2009-2013

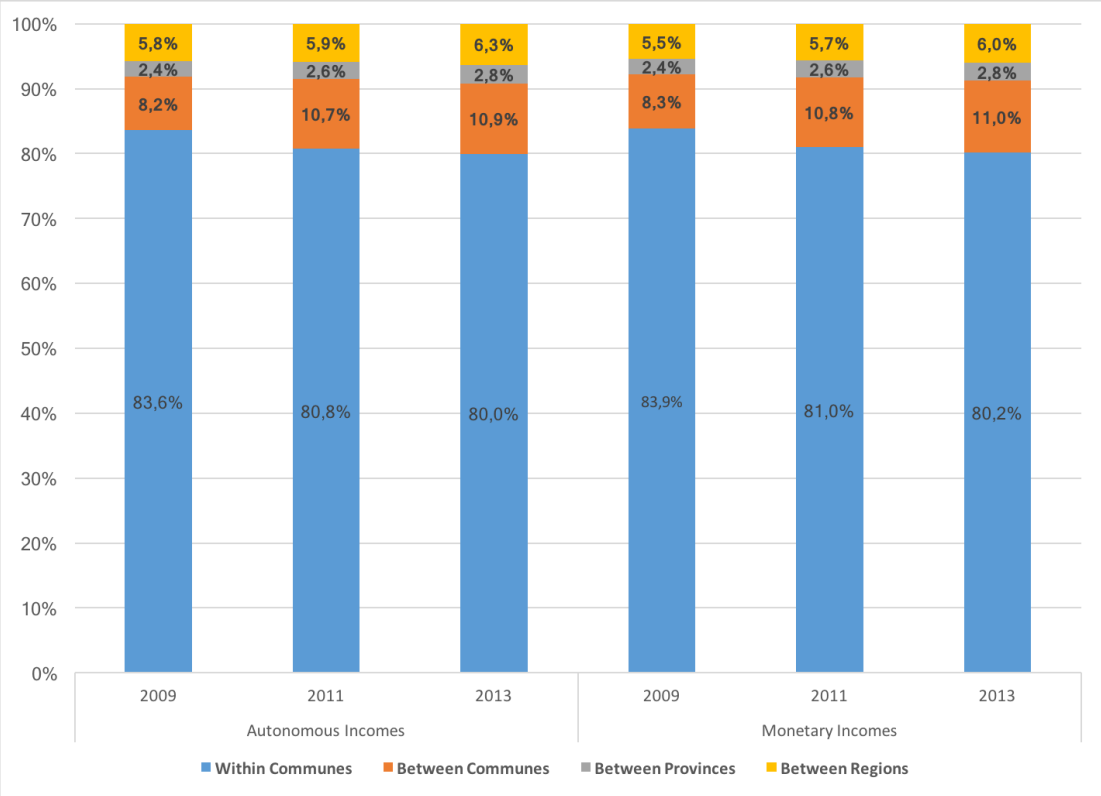

Figure 6: Overall Theil index. Shared functions. Extended Monetary and Extended Autonomous Income from 2009-2013

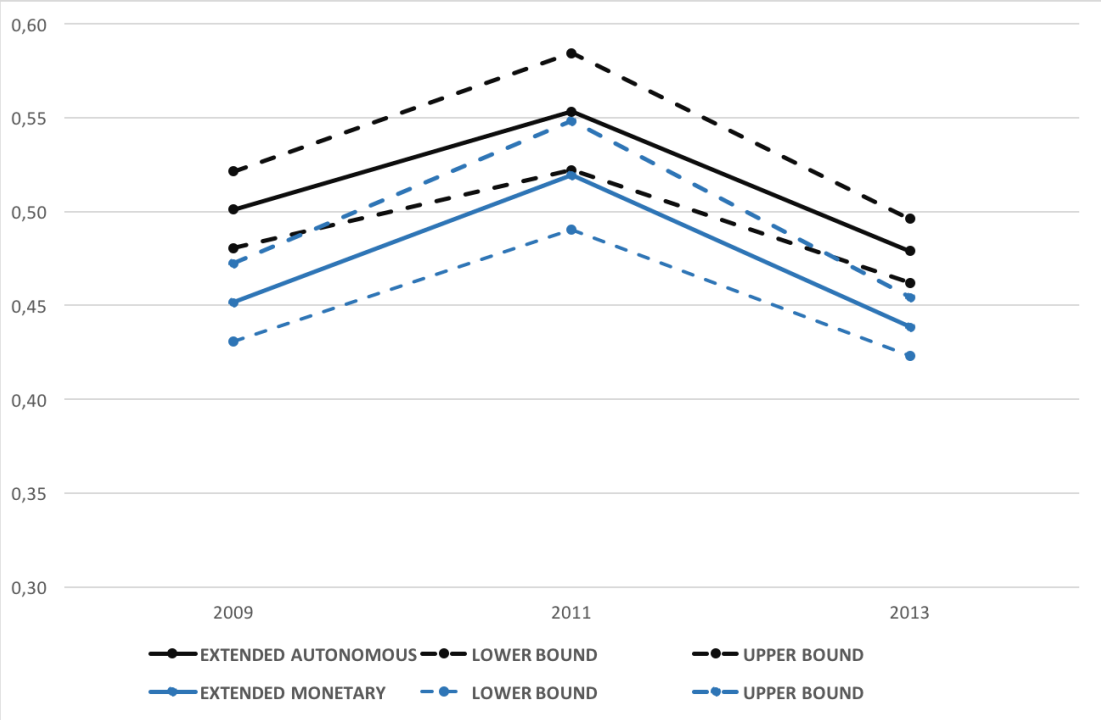

Figure 7: Overall Theil index. Shared functions. Extended Monetary and Monetary Income from 2009-2013

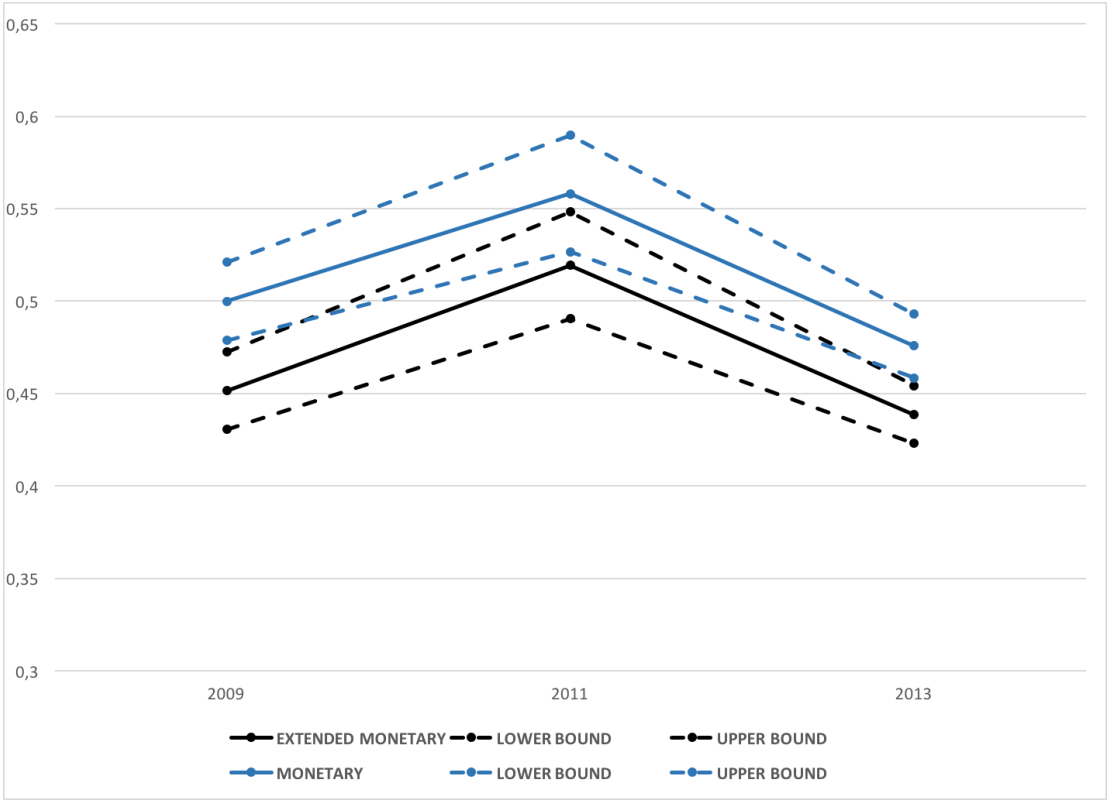

Figure 8: Three-stage inequality decomposition of Theil index. Shared functions. Extended autonomous and autonomous incomes from 2009-2013

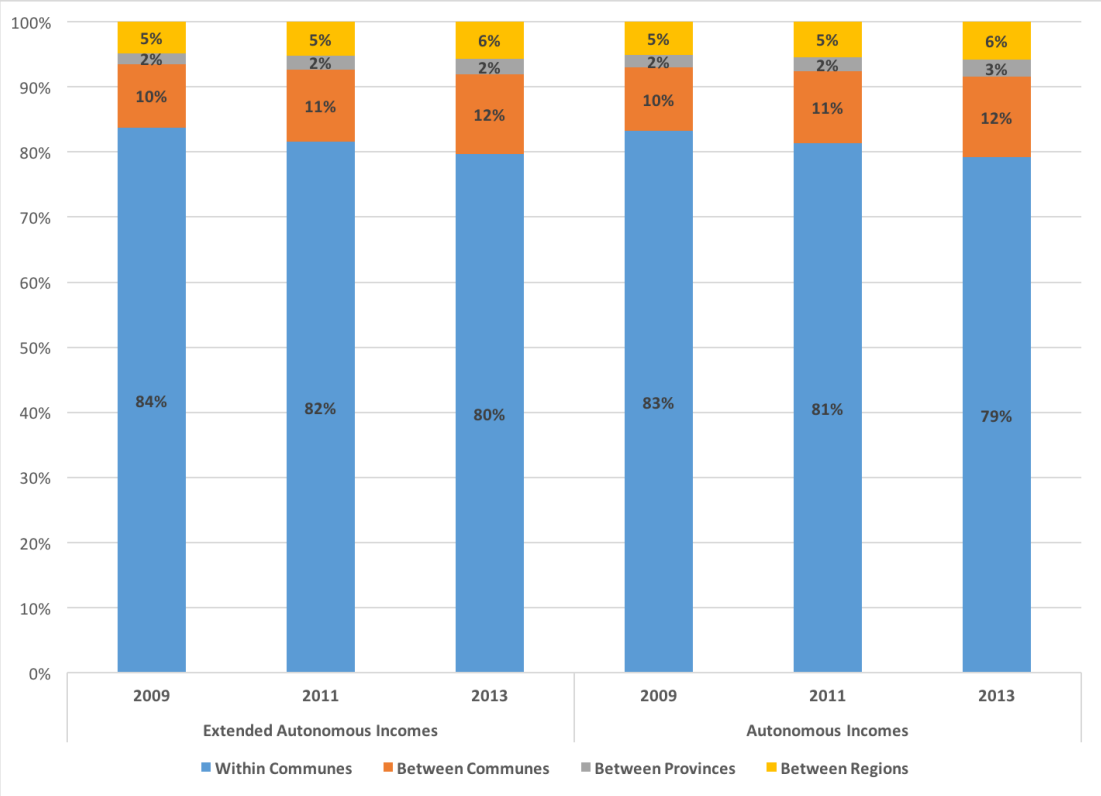

Figure 9. Three-stage inequality decomposition of Theil index. Shared Functions. Extended and Monetary Incomes from 2009-2013

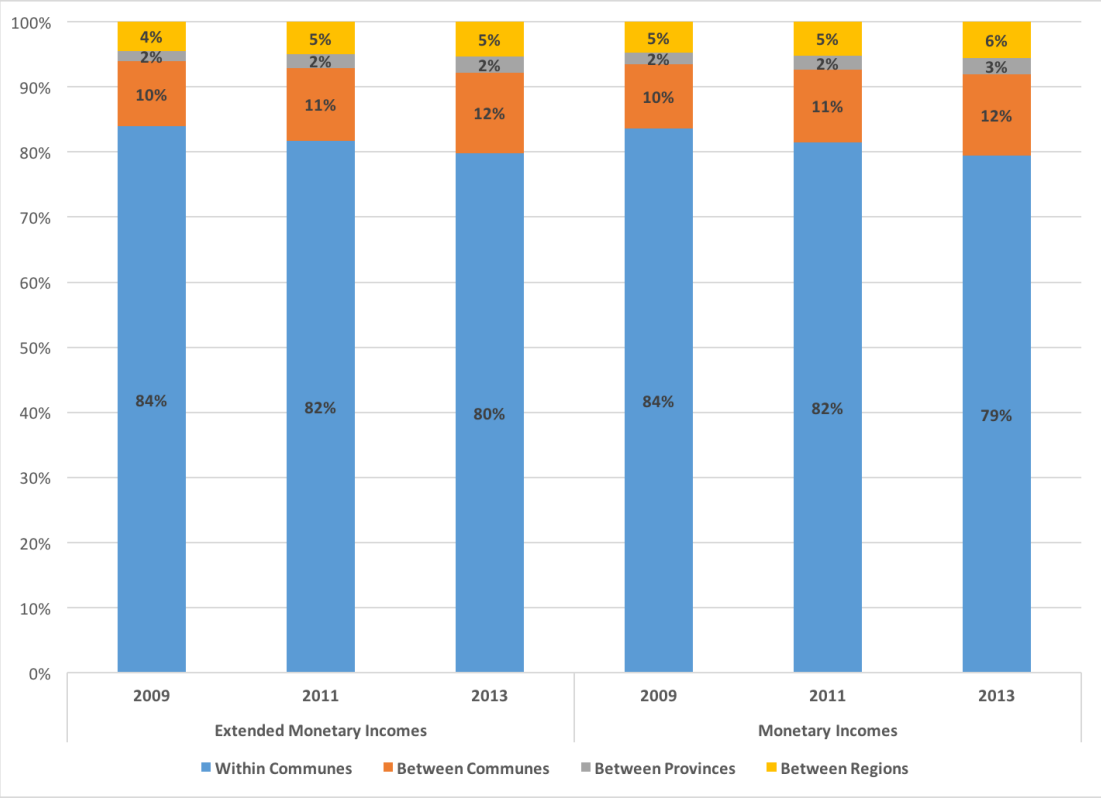

Figure 10: Overall Theil index. Exclusive functions. Extended monetary and extended autonomous income from 2009-2013

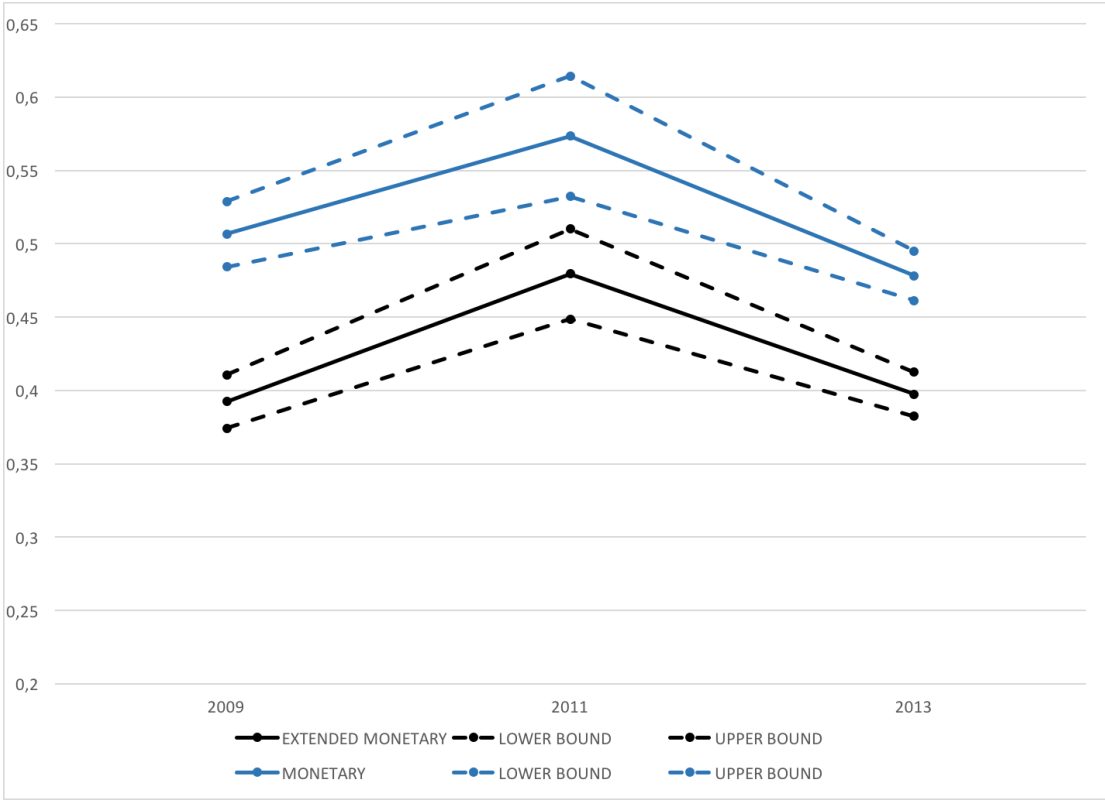

Figure 11: Three-stage inequality decomposition of Theil index. Exclusive functions. Extended autonomous and autonomous incomes from 2009-2013

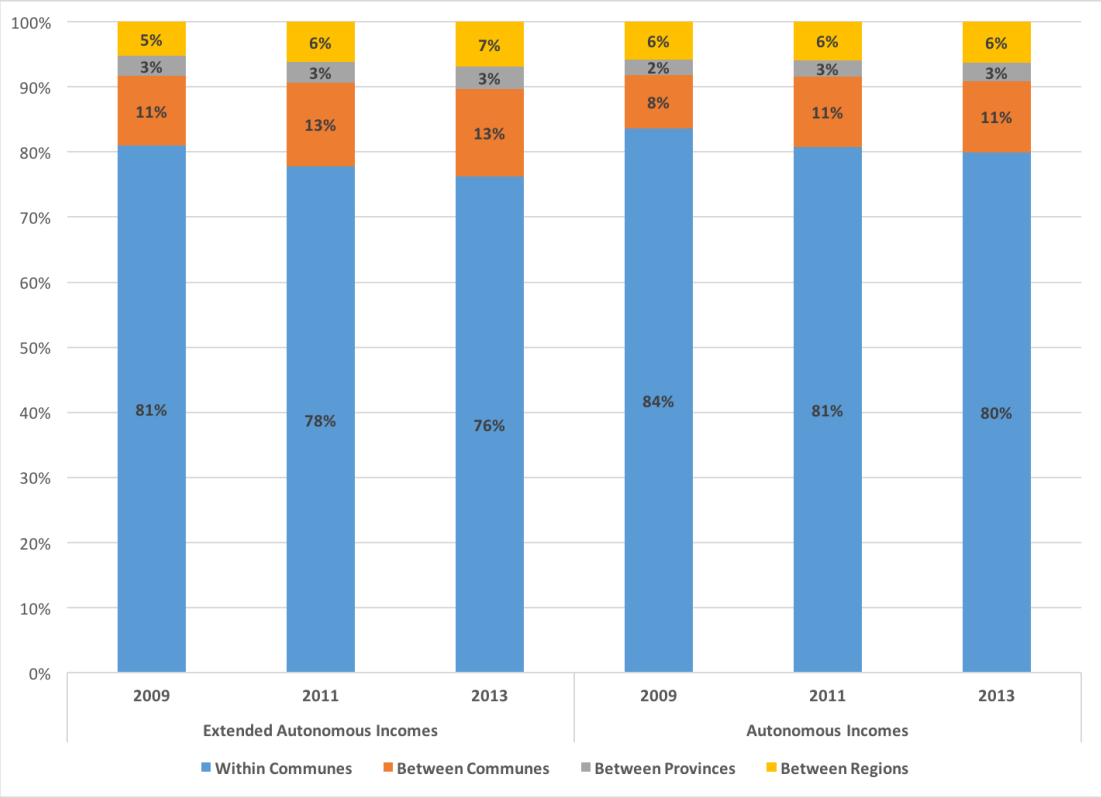

Figure 12: Three-stage inequality decomposition of Theil index. Exclusive functions. Extended Monetary and Monetary Incomes from 2009-2013

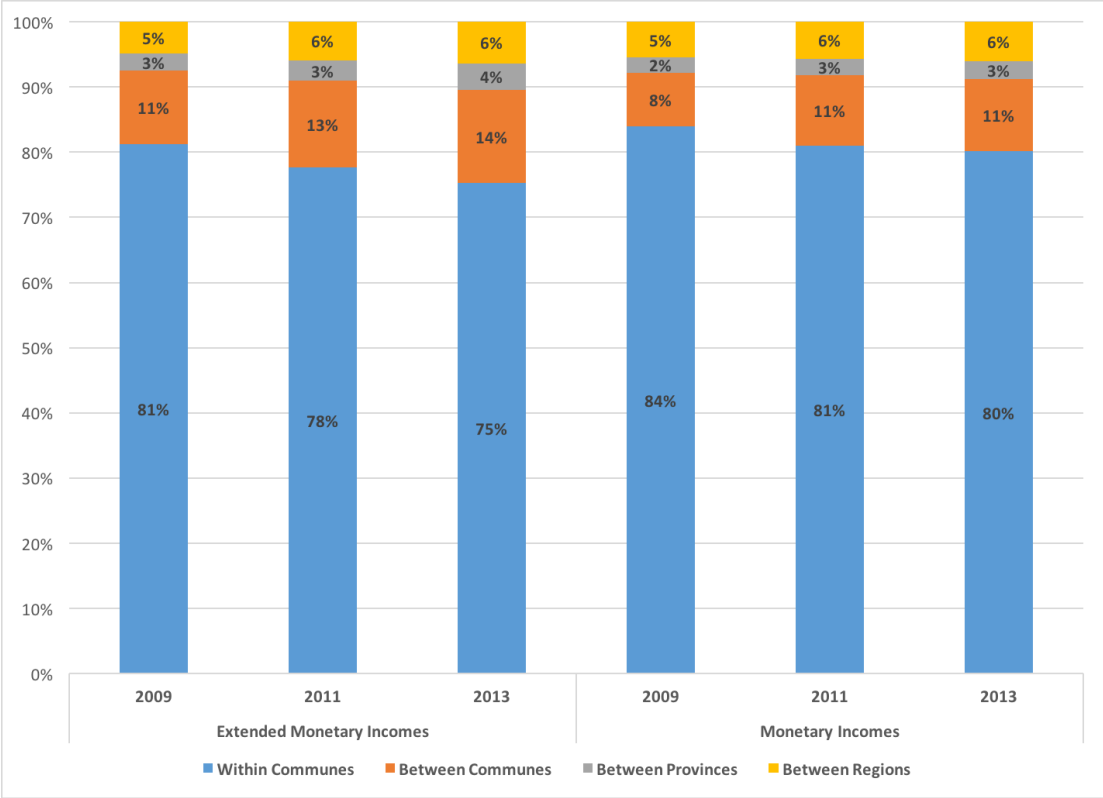

Table 1: Summary Statistics of Municipal Public Expenditures Per-capita by Sectors from 2009-2013

Year	2009	2011	2013
Education Services			
Mean	158,007	172,251	198,397
Standard Deviation	80,084	91,459	113,226
Minimum	25,314	11,478	13,650
Maximum	543,270	689,903	947,749
Number of Municipalities	277	282	289
Health Care Services			
Mean	48,191	57,806	74,755
Standard Deviation	23,254	29,518	37,867
Minimum	2,404	2,480	3,833
Maximum	149,581	235,639	309,406
Number of Municipalities	277	282	289
Municipal Activities			
Mean	4,178	4,279	5,581
Standard Deviation	8,474	7,025	9,066
Minimum	0,001	0,009	0,072
Maximum	91,892	69,028	84,061
Number of Municipalities	246	245	262
Administration			
Mean	143,609	134,090	152,409
Standard Deviation	138,494	141,860	160,512
Minimum	25,490	21,875	21,622
Maximum	1.058,422	1.617,363	1.632,218
Number of Municipalities	246	245	262
Culture			
Mean	1,350	1,800	2,305
Standard Deviation	2,493	3,287	4,856
Minimum	0,006	0,004	0,001
Maximum	27,616	34,260	64,629
Number of Municipalities	246	245	262
Recreational Services			
Mean	1,089	1,546	1,904
Standard Deviation	1,811	1,889	2,208
Minimum	0,002	0,013	0,006
Maximum	16,662	17,751	1.330,576
Number of Municipalities	246	245	262
Social Services			
Mean	7,400	9,953	12,397
Standard Deviation	7,267	15,639	11,529
Minimum	0,233	0,007	0,039
Maximum	61,782	220,136	690,947
Number of Municipalities	246	245	262
Community Services			
Mean	39,493	45,491	58,795
Standard Deviation	34,999	36,177	62,121
Minimum	0,398	1,650	9,179
Maximum	320,314	383,173	578,874
Number of Municipalities	246	245	262

Table 2: Summary Statistics of Monetary and Autonomous Incomes, number of households and Spatial Units

	Exclusive Functions			Shared Functions		
Year	2009	2011	2013	2009	2011	2013
Monetary Incomes						
Number of Households	50.087	44.801	55.872	57.598	51.527	60.184
Mean	178.247	247.719	237.855	179.051	247.581	235.867
Standard Deviation	293.144	457.673	352.789	287.792	443.312	348.831
Minimum	56	342	833	56	342	833
Maximum	14.900.000	46.100.000	16.400.000	14.900.000	46.100.000	16.400.000
Autonomous Incomes						
Number of Households	50.087	44.801	55.872	57.598	51.527	60.184
Mean	170.376	241.412	229.819	171.263	241.377	227.839
Standard Deviation	294.763	459.045	354.908	289.451	444.692	350.955
Minimum	56	170	83	56	114	83
Maximum	14.900.000	46.100.000	16.400.000	14.900.000	46.100.000	16.400.000
Spatial Units						
Number of Communes	246	245	262	277	282	289
Number of Provinces	46	46	46	46	46	46
Number of Regions	14	14	14	14	14	14

Table 3: Estimates of subsistence expenditures, minimum expenditures and marginal budget share parameters for 2009. Estimation via Maximum Likelihood

	Education Services	Health Care Services
Subsistence Expenditure Parameters		
Constant (Minimum Expenditure)	13.87** (-0.0231)	111.1*** (-0.0001)
Population share using primary public education services	89.54 *** (0.0000)	
Population share using secondary public education services	146.1*** (0.0000)	
Dependency to FCM	-0.72 (-0.8555)	-23.13 (-0.2146)
Distance to urban centers		-0.00765** (-0.0213)
Density	-0.0000182 (-0.9603)	0.00122 (-0.4823)
Inverse Population	-0.0748 (-0.4809)	-0.36 (-0.4731)
Dummy for Agglomerations	-7.930** (-0.0438)	-37.14** (-0.0435)
Dummy for Small Municipalities	6.597** (-0.0132)	33.18*** (-0.0061)
Dummy for cities	-11.71*** (-0.0003)	-45.06*** (-0.0014)
Poverty rate		-17.32 (-0.3819)
Psu's effectiveness	8.193*** (-0.0001)	
Unemployment rate		128.7* (-0.0724)
Marginal Budget Share Parameters		
Constant	0.396*** (-0.0042)	0.0105 (-0.9296)
Average education level for individuals 30-59 years	0.0022 (-0.9018)	0.0503*** (-0.0023)
Average income per capita	-0.000239 (-0.1996)	0.0000427 (-0.7782)
Political participation of councils	0.201 (-0.1053)	-0.116 (-0.2248)
Average housing rent	0.00268** (-0.0147)	-0.00177** (-0.0436)
R2	0.94	0.59
N	277	277

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: Estimates of subsistence expenditures, minimum expenditures, and marginal budget share parameters for 2011. Estimation via Maximum Likelihood

	Education Services	Health Care Services
Subsistence Expenditure Parameters		
Constant (Minimum Expenditure)	-6.675 (-0.4024)	37.55 (-0.2522)
Population share using primary public education services	109.1*** (0.0000)	
Population share using secondary public education services	203.8*** (0.0000)	
Dependency to FCM	6.483* (-0.076)	11.43 (-0.4167)
Distance to urban centers		-0.00203 (-0.544)
Density	0.000807 (-0.2328)	0.00395* (-0.0534)
Inverse Population	0.0208 (-0.8815)	0.16 (-0.7796)
Dummy for Agglomerations	1.084 (-0.7983)	5.243 (-0.7513)
Dummy for Small Municipalities	7.934** (-0.02)	40.16*** (-0.0066)
Dummy for cities	0.107 (-0.9834)	-3.289 (-0.881)
Poverty rate		7.839 (-0.751)
Psu's effectiveness	5.140** (-0.0261)	
Unemployment rate		-63.77 (-0.331)
Marginal Budget Share Parameters		
Constant	0.360** (-0.0321)	0.491*** (-0.0039)
Average education level for individuals 30-59 years	0.0368* (-0.0647)	-0.0217 (-0.2888)
Average income per capita	-0.000545*** (-0.01)	0.000717*** (-0.0027)
Political participation of councils	0.073 (-0.1053)	0.0493 (-0.2248)
Average housing rent	0.00190** (-0.0219)	-0.00298*** (-0.0015)
R2	0.96	0.58
N	281	281

t statistics in parentheses
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

Table 5: Estimates of subsistence expenditures, minimum expenditures and marginal budget share parameters for 2013. Estimation via Maximum Likelihood

	Education Services	Health Care Services
Subsistence Expenditure Parameters		
Constant (Minimum Expenditure)	-0.439 (-0.9179)	99.54*** (-0.0003)
Population share using primary public education services	128.2*** (0.0000)	
Population share using secondary public education services	181.9*** (0.0000)	
Dependency to FCM	4.196** (-0.0464)	8.234 (-0.6603)
Distance to urban centers		-0.0101** (-0.0406)
Density	-0.0000263 (-0.8832)	0.00196 (-0.2722)
Inverse Population	-0.00234 (-0.9733)	-0.449 (-0.3668)
Dummy for Agglomerations	-1.172 (-0.521)	-6.493 (-0.6557)
Dummy for Small Municipalities	6.695*** (-0.0019)	38.09*** (-0.0033)
Dummy for cities	2.216 (0.4676)	-5.39 (-0.7514)
Poverty rate		-55.79* (-0.056)
Psu's effectiveness	3.765* (-0.0735)	
Unemployment rate		96.87 (-0.2882)
Marginal Budget Share Parameters		
Constant	1.347*** (0.0000)	-0.325* (-0.0899)
Average education level for individuals 30-59 years	-0.0948*** (-0.0002)	0.0737*** (-0.0011)
Average income per capita	0.000873* (-0.0979)	-0.000704 (-0.1387)
Political participation of councils	-0.028 (-0.7782)	0.125 (-0.1722)
Average housing rent	-0.0000192 (-0.9644)	0.000207 (-0.5944)
R2	0.96	0.71
N	287	287

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Estimates of subsistence expenditures, minumum expenditures and marginal budget share parameters for 2009. Estimation via Maximum Likelihood

	Infrastructure	Administration	Culture	Recreational Services	Social Services	Community Services
Subsistence Expenditure Parameters						
Constant (Minimum Expenditure)	2.065	21.87***	0.434	0.902*	2.313	9.905***
	(-0.4385)	(-0.0096)	(-0.4635)	(0.0871)	(0.2152)	(0.0000)
Dependency to FCM	-1.497	-37.81***	-0.23	-0.963*	1.018	-9.400***
	(-0.6051)	(0.0000)	(-0.716)	(0.0968)	(0.6232)	(0.0012)
Distance to urban centers	0.00107		-0.0000884	0.000309	-0.000200	
	(-0.2821)		(-0.6892)	(0.1199)	(0.7983)	
Density	0.0000128	0.0011	-0.0000251	0.0000782	-0.0000306	0.000426
	(-0.9668)	(-0.232)	(-0.6875)	(0.1991)	(0.8895)	(0.1146)
Inverse Population	0.0929*	1.226***	0.0293**	0.0207*	0.129***	0.181***
	(-0.0888)	(0.0000)	(-0.0207)	(0.0574)	(0.0005)	(0.0003)
Dummy for Agglomerations	-1.399	-0.765	0.282	-0.330	0.909	1.119
	(-0.5151)	(-0.9174)	(-0.5436)	(0.4342)	(0.5320)	(0.5500)
Poverty rate						-2.018
						(0.7486)
Marginal Budget Share Parameters						
Constant	0.00624	0.669***	0.0369***	0.00509	-0.00517	0.230**
	(-0.8026)	(0.0000)	(0.0000)	(0.3397)	(0.7880)	(0.0188)
Average education level for individuals 30-59 years	0.00514	0.0632***	-0.00225***	0.000386	0.00321	-0.0320**
	(-0.1671)	(-0.0017)	(-0.0092)	(0.6270)	(0.2612)	(0.0289)
Average income per capita	0.0000177	0.000797***	0.0000383***	0.0000267***	-0.000000430	-0.000129
	(-0.6669)	(-0.0003)	(-0.0002)	(0.0027)	(0.9892)	(0.4276)
Political participation of councils	-0.01	-0.454***	-0.0235***	-0.00383	-0.0450**	0.101
	(-0.6951)	(-0.001)	(0.0000)	(0.4800)	(0.0211)	(0.3152)
Average housing rent	-0.00034	-0.00695***	-0.000112**	-0.000129***	0.000137	0.00165*
	(-0.1282)	(0.0000)	(-0.0296)	(0.0070)	(0.4260)	(0.0622)
R2	0.27	0.92	0.58	0.28	0.42	0.34
N	246	246	246	246	246	246

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 7: Estimates of subsistence expenditures, minimum expenditures and marginal budget share parameters for 2011. Estimation via Maximum Likelihood

	Infrastructure	Administration	Culture	Recreational Services	Social Services	Community Services
Subsistence Expenditure Parameters						
Constant (Minimum Expenditure)	2.360	-0.995	1.161	1.216***	6.601	10.48***
	(0.1405)	(0.9138)	(0.1053)	(0.0067)	(0.1260)	(0.0000)
Dependency to FCM	-6.184***	-9.940	-1.375	-1.221**	-6.797	-6.131**
	(0.0006)	(0.3083)	(0.1009)	(0.0187)	(0.1755)	(0.0248)
Distance to urban centers	0.00111*		-0.000200	0.000365*	-0.00348*	
	(0.0749)		(0.5241)	(0.0648)	(0.0779)	
Density	-0.00000814	-0.00100	0.0000200	7.68e-08	-0.000236	0.000221
	(0.9667)	(0.4013)	(0.8353)	(0.9989)	(0.6608)	(0.3875)
Inverse Population	0.150***	1.082***	0.0352**	0.0255***	0.274***	0.144***
	(0.0000)	(0.0000)	(0.0173)	(0.0068)	(0.0024)	(0.0011)
Dummy for Agglomerations	0.634	20.89**	0.881	0.104	2.464	2.286
	(0.6236)	(0.0138)	(0.1415)	(0.7751)	(0.4825)	(0.1754)
Poverty rate						-7.150
						(0.2352)
Marginal Budget Share Parameters						
Constant	0.0871***	0.393***	-0.0454***	-0.00261	0.00212	0.204**
	(0.0000)	(0.0028)	(0.0000)	(0.5735)	(0.9618)	(0.0162)
Average education level for individuals 30-59 years	-0.00554***	0.0157	0.00609***	0.0000327	0.00312	-0.0144
	(0.0018)	(0.3195)	(0.0000)	(0.9532)	(0.5565)	(0.1582)
Average income per capita	0.0000106	-0.000224*	0.00000893	-0.00000630	-0.000115***	-0.0000418
	(0.4146)	(0.0548)	(0.1770)	(0.1265)	(0.0039)	(0.5825)
Political participation of councils	-0.0645***	1.222***	-0.0196**	0.00611	-0.0908	-0.360***
	(0.0009)	(0.0000)	(0.0444)	(0.3189)	(0.1196)	(0.0015)
Average housing rent	0.0000358	-0.000845*	-0.0000576**	0.0000409**	0.000636***	0.00137***
	(0.5260)	(0.0975)	(0.0441)	(0.0228)	(0.0003)	(0.0000)
R2	0.56	0.91	0.48	0.14	0.21	0.45
N	245	245	245	245	245	245

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Estimates of subsistence expenditures, minimum expenditures and marginal budget share parameters for 2013. Estimation via Maximum Likelihood

	Infrastructure	Administration	Culture	Recreational Services	Social Services	Community Services
Subsistence Expenditure Parameters						
Constant (Minimum Expenditure)	3.747*	23.29***	1.468*	0.530	67.578***	15.64***
	(0.0852)	(0.0007)	(0.0782)	(0.3542)	(0.0066)	(0.0001)
Dependency to FCM	-7.391***	-30.56***	-0.633	-0.758	-4.013	-5.062
	(0.0017)	(0.0000)	(0.4994)	(0.2412)	(0.2044)	(0.3006)
Distance to urban centers	0.00143*		0.000365	0.000822***	-0.000492	
	(0.0737)		(0.3389)	(0.0018)	(0.6993)	
Density	-0.0000196	0.000584	0.00000352	0.00000736	-0.000202	-0.000226
	(0.9316)	(0.3008)	(0.9687)	(0.9061)	(0.5167)	(0.5977)
Inverse Population	0.157***	0.850***	0.0123	0.0393***	0.217***	0.0999
	(0.0015)	(0.0000)	(0.4966)	(0.0015)	(0.0002)	(0.2845)
Dummy for Agglomerations	-0.126	2.112	0.0698	0.604	0.941	1.774
	(0.9436)	(0.7059)	(0.9170)	(0.1906)	(0.6758)	(0.6004)
Poverty rate						-19.25*
						(0.0734)
Marginal Budget Share Parameters						
Constant	0.0157	1.382***	0.0575***	-0.0342***	-0.0983*	0.366
	(0.6265)	(0.0000)	(0.0002)	(0.0014)	(0.0503)	(0.1337)
Average education level for individuals 30-59 years	0.00505	-0.108***	-0.00954***	0.00292**	0.0135**	-0.00656
	(0.1979)	(0.0004)	(0.0000)	(0.0252)	(0.0279)	(0.8263)
Average income per capita	-0.0000875	0.00125***	0.000144***	-0.0000310	-0.0000653	-0.0000760
	(0.1234)	(0.0048)	(0.0000)	(0.1013)	(0.4617)	(0.8607)
Political participation of councils	-0.0486***	0.383***	0.0545***	0.0220***	-0.0186	-0.175*
	(0.0004)	(0.0003)	(0.0000)	(0.0000)	(0.3832)	(0.0946)
Average housing rent	-0.0000538*	-0.0000592	0.0000592***	0.0000268***	0.0000478	-0.000144
	(0.0695)	(0.7968)	(0.0000)	(0.0066)	(0.3010)	(0.5255)
R2	0.59	0.92	0.68	0.24	0.39	0.50
N	262	262	262	262	262	262

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix A: Description of Municipal Activities

Activity	Definition	Target Groups
Education	This function has the objective of providing formal and informal education to population, according with the dispositions of the actual political constitution. In Chile, primary and secondary education are mandatory, then State must support a free system with the purpose of ensuring the accessibility for all population. For this reason, municipalities jointly with education ministry provide the public version of education services. In particular, municipalities carry out activities with the administration of the service while education ministry designs educational programs and curricular bases. In general, municipality's expenditures include the payment of wages of teachers and personnel related with the provision of public education, payment of utility services, facility purchases, teaching materials, building maintenance, etc.	In Chile education is divided into two levels. The first level is the primary which corresponds to the basic formation of the student. The duration of this cycle is eight years. This level is provided to children aged 6-13 years. This level is compulsory. The second level is secondary which is provided to children aged 13-19 years. The duration of this cycle is 4 years. As the primary level, secondary is compulsory.
Primary Health Care	This function has the objective of provide primary health care services to all population. However, municipalities put focus in to provide these services to poorest population those do not have access to private versions of these services. In this sense, municipal responsibilities are related with the administration of general medical centers (urban and rural). Then, their expenditures include the payment of personnel's wages, payment of utility services, medical facility purchases, pharmaceutical products or surgical supplies, building maintenance, etc.	All population. Special focus on • Poorest population • Population enrolled at the national health care system (FONASA).
Community Services	These services are provided with the objective of satisfying the needs of local communities, which are directly related with life's quality of population. For example, these services are: protection to environment, maintenance of roads, luminary, cleaning services, maintenance of public spaces, etc.	All population
Social Services	This function has the objective of protecting to population and families, promoting the harmonic integration of all sectors of population, and to ensure equal opportunities of participation on the society to all population. These expenditures are used in order to improve the living conditions of inhabitants and their well-being, such as subventions, social assistance, employment programs, etc.	All population
Cultural Services	This function promotes the access of population to cultural activities.	All population
Recreational Services	This function promotes the access of population to recreational activities	All population
Municipal Activities	This service includes expenditures in goods and services with the objective of covering celebrations, opening ceremonies, festivities and others.	All population
Administration	Municipality's expenditures on administration activities. These expenditures include wages of municipal's workers, transfers to Municipal Common Fund (MCF) and other expenditures used in order to cover the operations incorporated to municipal performance.	All population

Appendix B: Definition of variables affecting subsistence expenditures and discretional incomes

Variables Affecting Subsistence Expenditures		
Variable	Definition	Expected Result
Population share 6-13 years of age using public primary education services.	Share of the population between 6-13 years of age enrolled in municipalities schools.	(+) Demographic variable that can explain important variations in subsistence expenditures.
Population share 14-19 years of age using public education services.	Share of the population between 14-19 years of age enrolled in municipalities schools	(+) Demographic variable that can explain important variations in subsistence expenditures.
Dependency to MCF	Proxy of municipal efficiency. The MCF is a redistribution instrument of municipal incomes. All the municipalities give resources to this instrument and after, central government redistributes the resources given some requirements imposed by law. In general, the MCF represents in average 30% of municipality incomes. However, for the smallest or poorest municipalities the MCF can represent about 90% of their incomes	(+/-) Evidence for economies of scale. More dependency, more expenditure in services. In general, the smallest municipalities with lower opportunities for recollecting income from regular sources depend more of this instrument than other municipalities. However, this result depends on the degree of dependency to central government funding of each service.
Distance to urban centers	Distance in KM from commune to the main urban center	(+/-) Evidence for economies of scale affecting variations on subsistence expenditures. More distance to urban centers, more subsistence expenditure. However, this result can vary among services.
Density	Number of inhabitants for KM2	(+) Evidence for economies of scale. High density, higher expenditures on services.
Inverse Population	This variable assigns the population of smallest municipality to biggest municipalities.	(+) Evidence for economies of scale, unit costs are higher for small municipalities.
Dummy for agglomerations	Dummy variable that takes 1 when municipality has more 100.000 inhabitants.	(-) Evidence for economies of scale, small communes must spend more resources in public goods per inhabitant. Then, the unit costs are higher in comparison with biggest municipalities.
Dummy for small municipalities	Dummy variable for municipalities with less or equal 2000 inhabitants.	(+) Evidence for economies of scale. Then, the unit cost is higher for small municipalities because they use a large share of their resources providing local services.
Poverty rate	Proportion of population living belong poverty line by commune.	(+) Municipalities with more poor individuals might to spend more resources on services.
PSU's effectiveness	Proportion of students that performed selection test for universities by first time and was selected to study at the university. Proxy for education's quality.	(+) As the variable might reflect quality of education by commune, it means that municipalities spend more resources on education when it exhibits high rates.

Unemployment rate	Proportion of active population without labor but actively looking for a job. Proxy for poverty	(+) More unemployees, more efforts of municipalities to cover services , in special, health care services.
Variables Affecting Discretional Incomes		
Variable	Definition	Expected Result
Average education level for individuals 30-59 years	Variable that can influence in local discretional decisions in the provision of public goods.	(+/-) Educated individuals increase (decrease) the demand for public goods, then expenditures might increase.
Average income per capita	Disposable income average by commune.	(+/-)
Political participation of council	Proportion of municipal councilors sharing the same political membership as mayor.	(+/-)
Average housing rent	Housing rent by commune.	(+/-)

Appendix C: Bootstrapping results: Spatial decomposition of Income Inequality. Shared functions

Year	Type of income	Obs.	Std. Err.	z	P>|z|	Lower Bound	Upper Bound
Extended Autonomous Incomes							
2009	Within Communes	0,42062	0,00753	55,84	0,0000	0,40586	0,43538
	Between Communes	0,04825	0,00343	14,08	0,0000	0,04154	0,05497
	Between Provinces	0,00828	0,00088	9,37	0,0000	0,00655	0,01002
	Between Regions	0,02405	0,00170	14,13	0,0000	0,02071	0,02738
2011	Within Communes	0,45122	0,01459	30,92	0,0000	0,42262	0,47983
	Between Communes	0,06136	0,00304	20,17	0,0000	0,05540	0,06732
	Between Provinces	0,01167	0,00100	11,64	0,0000	0,00971	0,01364
	Between Regions	0,02882	0,00182	15,86	0,0000	0,02526	0,03238
2013	Within Communes	0,38140	0,00696	54,84	0,0000	0,36777	0,39503
	Between Communes	0,05862	0,00281	20,88	0,0000	0,05312	0,06413
	Between Provinces	0,01177	0,00088	13,43	0,0000	0,01005	0,01349
	Between Regions	0,02717	0,00133	20,49	0,0000	0,02457	0,02977
Autonomous Incomes							
2009	Within Communes	0,46324	0,00986	46,96	0,0000	0,44391	0,48257
	Between Communes	0,05319	0,00386	13,80	0,0000	0,04563	0,06074
	Between Provinces	0,01034	0,00101	10,22	0,0000	0,00836	0,01232
	Between Regions	0,02845	0,00199	14,26	0,0000	0,02454	0,03236
2011	Within Communes	0,48376	0,01705	28,38	0,0000	0,45035	0,51718
	Between Communes	0,06563	0,00362	18,13	0,0000	0,05854	0,07272
	Between Provinces	0,01329	0,00115	11,58	0,0000	0,01104	0,01554
	Between Regions	0,03214	0,00170	18,95	0,0000	0,02882	0,03546
2013	Within Communes	0,41219	0,00672	61,36	0,0000	0,39902	0,42536
	Between Communes	0,06400	0,00333	19,24	0,0000	0,05748	0,07052
	Between Provinces	0,01369	0,00094	14,54	0,0000	0,01185	0,01554
	Between Regions	0,03045	0,00167	18,21	0,0000	0,02717	0,03373
Extended Monetary Income							
2009	Within Communes	0,38727	0,00863	44,90	0,0000	0,37036	0,40417
	Between Communes	0,04493	0,00321	14,00	0,0000	0,03864	0,05122
	Between Provinces	0,00735	0,00074	9,93	0,0000	0,00590	0,00880
	Between Regions	0,02096	0,00128	16,42	0,0000	0,01846	0,02347
2011	Within Communes	0,43028	0,01528	28,15	0,0000	0,40033	0,46023
	Between Communes	0,05833	0,00300	19,45	0,0000	0,05245	0,06421
	Between Provinces	0,01115	0,00098	11,37	0,0000	0,00923	0,01307
	Between Regions	0,02715	0,00153	17,71	0,0000	0,02415	0,03016
2013	Within Communes	0,35343	0,00625	56,58	0,0000	0,34118	0,36567
	Between Communes	0,05485	0,00291	18,87	0,0000	0,04915	0,06055

	Between Provinces	0,01088	0,00079	13,73	0,0000	0,00933	0,01243
	Between Regions	0,02435	0,00124	19,62	0,0000	0,02192	0,02679
Monetary Incomes							
2009	Within Communes	0,42825	0,00939	45,60	0,0000	0,40985	0,44666
	Between Communes	0,04937	0,00311	15,90	0,0000	0,04328	0,05545
	Between Provinces	0,00920	0,00085	10,77	0,0000	0,00753	0,01088
	Between Regions	0,02525	0,00161	15,66	0,0000	0,02209	0,02841
2011	Within Communes	0,46168	0,01342	34,41	0,0000	0,43538	0,48797
	Between Communes	0,06229	0,00407	15,31	0,0000	0,05431	0,07026
	Between Provinces	0,01270	0,00106	11,96	0,0000	0,01062	0,01478
	Between Regions	0,03037	0,00177	17,13	0,0000	0,02690	0,03385
2013	Within Communes	0,38174	0,00744	51,32	0,0000	0,36716	0,39631
	Between Communes	0,05968	0,00296	20,19	0,0000	0,05389	0,06547
	Between Provinces	0,01258	0,00076	16,55	0,0000	0,01109	0,01406
	Between Regions	0,02742	0,00153	17,90	0,0000	0,02442	0,03042

Appendix D: Bootstrapping results. Spatial decomposition of income inequality. Exclusive functions

Year	Type of income	Obs.	Std. Err.	z	P>|z|	Lower Bound	Upper Bound
Extended Autonomous Incomes							
2009	Within Communes	0,42062	0,00753	55,84	0,0000	0,40586	0,43538
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	Between Regions	0,02435	0,00124	19,62	0,0000	0,02192	0,02679
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	Between Regions	0,02525	0,00161	15,66	0,0000	0,02209	0,02841
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	Between Communes	0,06229	0,00407	15,31	0,0000	0,05431	0,07026
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	Between Regions	0,02742	0,00153	17,90	0,0000	0,02442	0,03042

Chapter 2

Spatial accessibility to local public services and residential segregation: Evidence for Chile

Abstract

The study of the relationship between the provision of local public services and residential segregation takes a relevant significance when the latter is considered as the social manifestation of spatial income inequality. In this paper, we address this relationship by analyzing how the spatial accessibility to local public services is equitably distributed among different social and economic groups in the Metropolitan Area of Santiago, Chile (MR). For accomplishing this objective, we use accessibility measures to local public services such as transportation, public education, healthcare, kindergartens, parks, fire and police stations, and cultural infrastructure, information about housing prices and exempted housing units from local taxes by block, as well as, quantile regressions and bivariate local indicators of spatial association (LISA). Main results confirm the accessibility to local public services is unequally distributed among residents, however, it is affecting more to low-income groups who are suffering significant deficits on the provision of local public services. These groups are geographically located in the periphery of the MR, where poor municipalities and social housing projects are concentrated. In this scenario, poor residents face a double disadvantage due to their social exclusion from urban systems and their limited access to crucial services as education, healthcare or transportation. In particular, we found evidence confirming that social housing policies could be considered as one cause of residential segregation which is reinforced by the insufficient accessibility to local infrastructure that the poorest population should assume.

Keywords: Accessibility to local public services, residential segregation, spatial income inequality, local governments.

JEL-CODES: R14, R23, R58.

1. Introduction

Spatial income inequality – the unequal distribution of incomes across communities – has received a remarkable attention from the scientific literature. An important characteristic of this stylized fact is its multidimensional character, which penetrates several aspects of inequality with social, geographical, and political consequences. One of the most important manifestations of the spatial income inequality is observed on the rise of residential segregation, a concept that directly relates the location and characteristics of individuals with social equity issues. As Cheshire (2007) noted, residential segregation is the spatial articulation of income inequality at the society by arguing that neighborhoods in cities are more polarized if incomes are unequally distributed. However, the stratification of socioeconomic groups in the space cannot only be observed on the distinction of economic classes across neighborhoods. Also, segregated groups live in different local jurisdictions which can differ in fiscal and administrative capacities to provide local public services. Consequently, differences between socioeconomic status across neighborhoods are reinforced by disparities in the provision of local public services, which could differ in terms of quantity or quality against the poorest population.

As Tiebout (1956) argued in his famous sentence "people vote with their feet", individuals with more willingness to pay live in communities that provide high-quality local public services because these can be capitalized into housing prices. At the same time, local governments also can increase their revenues to provide better local public services, thereby creating a virtuous circle with more benefits for richer local governments due to their capacity to attract high-income individuals. Under this logic, residential segregation is view as a natural manifestation induced by market responses to local government fragmentations, generating an unequal distribution of local public services across communities, and reinforcing therefore, the relationship between housing prices and local public services. Then, negative social consequences of residential segregation can be only addressed by

redistributive policies from higher levels of government (Li H. , Wang, Shi, Deng, & Wang, 2015) (Li H. , Wang, Deng, Shi, & Wang, 2017). An important wave of criticism that comes from the social stratification-government inequality thesis (SSGI) refutes these arguments by highlighting that political incorporation by class and status is an important institutional mechanism for creating and perpetuating inequalities among residents in communities (Hill, 1974). Particularly, residential segregation arises influenced by the maximum control exerted for advanced or affluent groups over scarce resources with the purpose of maintaining the homogeneity into communities by increasing housing costs. In this way, SSGI involves social equity issues by arguing that fragmented jurisdictions and political governance could generate and exacerbate disparities in public service accessibility given the unequal distribution of income and social status, as well as, an unequal system of relationships into the urban housing market with important consequences in the accessibility to housing projects, better neighborhoods, and local public services.

According to this background, the objective of this paper is to address the relationship between the accessibility to local public services and residential segregation. In particular, this objective is assessed by analyzing how the accessibility to local public facilities is equitably distributed among different social and economic groups. This analysis follows the context of territorial justice (Davies, 1968), which determines the most appropriate distribution of local public services must be according to individuals' needs, regardless the place where they live. In this sense, we use accessibility measures to determine how the distribution of local public services is equitable by examining their spatial pattern provision considering the relationship between provision and needs. The analysis is conducted for the Metropolitan Area of Santiago, Chile (MR), that represents an interesting case of residential segregation. According to results found by Rodríguez (2001), the capital of MR – Santiago of Chile – is one of the most segregated cities around the world. However, the origin of its residential segregation is different in comparison to other cases. For instance, many studies of residential segregation in the US context are focused on the analysis of endogenous elements such as

preferences or characteristics of individuals that potentially cause residential segregation. In the Chilean case, it is well documented that the origin of the residential segregation into the MR is related to exogenous forces such as social housing public policies implemented by the State from the 1970s (Lambiri & Vargas, 2012). Despite these instruments accomplished their main objective of reducing poverty, new affordable neighborhoods were located far from the city center – mainly in the periphery of the MR – in places characterized by low land prices. This resettlement generated negative consequences to the poor whose suffered a deprivation of the locational advantages obtained in their former residences. Thus, new affordable housing faced important differences in terms of accessibility to local public services as well as, new social problems due to the increment of this spatial segregation. On the other hand, this resettlement also permitted to the richest municipalities be more careful about how to spend their tax-revenues within their communities, excluding public housing projects from their boundaries given the pressure exerted by high-income groups (Scarpaci, Infante, & Gaete, 1988). According to these evidences, the importance of studying how equitable is the accessibility to local public services is reinforced because the latter is recognized as the major source of people's real income, especially for the poorest population who must overcome more physical and financial barriers to reach better opportunities.

The empirical strategy used in this paper is twofold. First, we compute accessibility measures based on blocks to different local public services such as schools, transportation, urban parks, kindergartens, hospitals, fire and police stations, and cultural infrastructure. In particular, we use the spatial accessibility index proposed by H. Li (2015) which is able to reflect the ability of residents to reach a destination based on geographic distances by considering the number of local public services inside a buffer area. Second, the evaluation of the distribution of accessibility measures is carried out by using Quantile Regression Model (QRM) and Multivariate Local Indicators of Spatial Association (Multivariate LISA). Quantile Regression Model has the advantage to analyze all properties of the conditional distribution of a response variable by computing a function based on the conditional

mean. In this way, the method permits to examine the influence of determinants on the dependent variable at any point of its distribution. In this paper, we use the mean of housing prices by block to determine how it can affect the distribution of each indicator of accessibility. Even if we do not have information about a complete profile of household's needs, we use property's housing prices by block as a proxy of the social status of residents into communities. Also, we include other control variables such as the number of exempted housing units from local taxes by block and housing quality indices to obtain a better representation of households' economic status. Consequently, we can compare the distribution of local public services supply across different quantile groups for detecting how much equitable is the distribution of these facilities with respect to different income groups. Although QRM offers an interesting alternative to analyze the conditional distribution of accessibility indicators according to the economic status of residents, this method is not sufficient to reflect how the spatial distribution of local public services is affected by housing clustering. This element is crucial to analyze how residential sorting by housing prices is associated with the spatial distribution of local public services. For this reason, we use Bivariate LISA analysis to obtain a better representation of this association by complementing previous results with the spatial distribution of residents and local service infrastructure.

The remainder of this paper is organized as follows. In the next section, we describe important elements of the common framework used to relate accessibility to local public services, territorial justice, and social equity issues. Section 3 describes the case of study. Section 4 describes the data and methodology used. Section 5 shows and discusses the main results obtained using the methodology proposed. The last section concludes.

2. Framework

2.1. Provision of local public services, residential segregation and fragmentation of local governments.

The first argument to study the relationship between the provision of local public services and residential segregation comes from the public choice theory proposed

by Tiebout (1956). In this statement, the author describes that people choose where to live due to the match between their preferences for local public services and their willingness to pay for these services. For this reason, people "vote with their feet" and decisions about their location are based on the selection of the local government that best fit with their tastes for local public services and the package of taxes that they must pay for. Thereby, local government actions are dedicated to attracting or retaining more high-income individuals to live in their communities with the purpose of increasing their revenues and compete with other communities to attract and retain affluent people and businesses. As a result, a virtuous circle is created in favor of richer municipalities because they can offer high-quality services which are used to attract more high-income groups. In this way, local governments can increase their revenues which are used to offer more and better local public services and attract more affluent groups and so on. Under this logic, the manifestation of residential segregation is a natural consequence of housing market responses to local government differences on the provision of local public services. In other words, these local government fragmentations could improve the efficiency in the provision of local public services because competition between local governments must also improve their fiscal discipline to maximize their budgets to offer service packages. Finally, citizens choose their locations by evaluating the financial performance of their own local government with respect others excluding the inefficient ones (Jimenez, 2014).

An important body of criticism against the arguments about the benefits in efficiency that emerge from the fragmentation of local governments given residential decisions is provided by the social government-stratification inequality thesis (SSGI) (Hill, 1974) (Neiman, 1979). Under this context that concerns more equity issues than efficiency, urban problems arise from the differences in access of urban residents to scarce economic, social and political resources. In this case, political incorporation by class and status plays a relevant role in creating and perpetuating inequalities among residents in communities. Thus, residential segregation arises from the mismatch between service needs and fiscal capacities in local governments, where affluent groups exert a maximum control over scarce

resources by imposing exclusionary zoning, building codes and other regulations in order to maintain social homogeneity in communities by increasing housing costs and excluding low-income groups from their community limits. In this way, residential location is an important resource on the urban stratification system because decisions about to live in specific communities are not only based on citizen's service preferences. Also, these decisions are related to the desire of residents in living into communities with similar incomes or similar socioeconomic characteristics. Finally, the poor are isolated in local governments with limited fiscal capacities because the segregation by class and socioeconomic status can separate fiscal resources from needs.

Regardless of these different perspectives, the impact of residential segregation on accessibility to local public services has been relatively less explored by the empirical literature, particularly in cases which differ from the context of residential segregation in US metropolitan areas. Recently, Sun et Al (2016) showed for Chinese cities that disparities in the provision of local public services may emerge from the influence of residential market responses on income sorting, generating an unequal distribution of local public services across residential locations. For these authors, improving the accessibility to local public services is an effective tool to increase the opportunities for individuals to reach better job options, neighborhoods, education or medical facilities. In addition, individuals could match correctly their needs with the actual provision of local public services and eventually, reduce residential segregation and spatial income inequality, as well (Sun, Fu, & Zheng, 2016). Similarly, H. Li et Al (2015) showed for Shanghai that jurisdiction and fiscal autonomy of local governments influence on distributional patterns of local public service provision. In contrast to conclusions emerged from public choice theory, the results suggest that local governments could play an important role in shaping patterns of public service provision and addressing negative consequences associated with residential clustering and public service inequality. For these authors, fragmentation between local governments does not just mean fewer options for accessing to affordable housing. Also, it implies a limited accessibility to local public services, or a "double-disadvantage" with a

negative impact on well-being of low-income individuals (Li H. , Wang, Shi, Deng, & Wang, 2015).

2.2. Accessibility, territorial justice and social equity

Accessibility to local services has an important role in the definition of any indicator of living standard. This concept – which is understood as the ease with which a resident can reach a destination – is crucial to figure out how the spatial proximity between residents and facilities can help to satisfy their daily life needs, as well as, whether the distribution of local services can potentially match with their needs (Talen, 2002). Formally, accessibility is sometimes defined as the quality of interacting with a particular good, service or facility, which could or not involve a physical distance between residents and facilities. In fact, accessibility definition can reflect the travel behavior of individuals in a specific area, or instead, how social factors, cultural barriers or an ineffective planning design may be determinants to reach locations with better access (Talen & Anselin, 1998) (Talen, 2002). Even though in the literature does not exist a consensus about an exclusive definition of accessibility, it is recognized that this concept involves two important elements: the location of local services or facilities and the characteristics of a transport network (Vandenbulcke, Steenberghen, & Thomas, 2009). In addition, other approaches suggest that accessibility is determined by the spatial distribution of potential destinations, the ease of reaching a destination and the quality and character of activities that can be found there (Handy & Niemeier, 1997, pág. 1175). It implies that travel costs, destination choice, and means of transport can also affect patterns of accessibility, as well as, social and economic interactions. For these reasons, improving the accessibility to local public services is seen by policymakers as an effective tool to increase the opportunities of individuals to access to employment alternatives, education and medical facilities or recreational spaces as a mechanism of improving their welfare and promote an ideal urban form by reducing neighborhood segregation (Lynch, 1984) (Wei, Cabrera-Barona, & Blaschke, 2016).

The conception and measurement of accessibility to local services and its evaluation have a direct relation to the territorial justice concept. This framework is considered as a starting point to study how local public services are accessible to individuals. According to the proposition of Davies (1968), territorial justice claims that the most appropriate distribution of local public services must be according to needs of the population regardless their spatial position in a specific area (Boyne & Powell, 1991). Thus, this definition emphasizes that needs are the main criteria to allocate local public services by reflecting the concept of social equity, which highlights that local authorities must respond to potential conflicts by ensuring that individuals with similar needs receive similar services regardless where they live (Boyne & Powell, 1991). Moreover, social equity also involves the study of factors that are determinants in the spatial variation of local services, then accessibility is taken as a tool to reflect if these services are equitably distributed or not (Talen & Anselin, 1998).

Territorial justice implies equal standards of provision for equal needs and consequently, its measurement suggests a high correlation between indices of resource use and relative needs. Of course, this element adds more conceptual and methodological problems to the analysis. First, territorial justice needs a political consensus about the fairness or justice of the distributional effects of a public policy. This implies that the distribution of costs and benefits must be considered fair by the society which is almost impossible (Truelove, 1993).[18] On the other hand, territorial justice indicators require empirical measures of needs which also face problems because single or composed indices cannot capture their multidimensional nature. However, the scientific literature recognizes that measures of accessibility are crucial to account for distributional inequities, therefore, these indicators are commonly used to evaluate the actual pattern of local public service distributions with the purpose of recommending more equitable systems. For instance, Talen (1997) analyzed the spatial distribution of parks by defining equity in relation to the spatial location of population subgroups and

[18] Taking in consideration the definition of territorial justice, it is based on the value-judgement criteria which determines the allocation of local public services.

assuming that urban service distribution may be racially polarized and unjust. This approach follows the standard procedures adopted by different studies of spatial distribution of facility systems: in general, these are mapped and analyzed considering socioeconomic characteristics of population and different methods to analyze them (Knox, 1980) (Pacione, 1989) (Truelove, 1993) (Handy & Niemeier, 1997) (Lotfi & Koohsari, 2009). In most of these cases, accessibility measures are based on geographic distances between residents and potential destinations of local services, however, the construction and empirical application of these indicators depend on the nature of the case to study, reflecting analysis needs of every specific situation (Vandenbulcke, Steenberghen, & Thomas, 2009).

Irrespective of this, in the scientific literature is possible to find several empirical studies which allow distinguishing between two different waves of accessibility measures. First, the most traditional approaches include indicators related with the computation of facilities or local services contained within a given spatial unit of analysis (container measures), service buffer areas (coverage), minimum distances, travel cost or gravity model based-measures. This type of indicators can be found in the earliest empirical analyses of accessibility and spatial equity by using socioeconomic characteristics of the population at census tracts level and geolocations of urban facilities, which are summarized with more details in table 9. With the introduction of geographic information systems (GIS) and the availability of georeferenced data of individuals, housing or transportation systems, a new wave of indicators of accessibility emerged with more sophisticated applications which include spatial-temporal constraints, congestion levels of road networks or program daily activities of individuals. Table 10 summarizes these alternative approaches which are extensively discussed in Vandenbulcke, Steenberghen & Thomas (2009), highlighting four basic perspectives of accessibility measures: infrastructure-based measures, activity-based measures, person-based measures and utility-based measures. The most important constraints found in the implementation of these accessibility measures are related to their complexity to interpreting the results obtained. For instance, utility-based measures which are commonly used in economic studies include several variables such as the attractiveness of

destinations, travel impedance, socio-economic characteristics of individuals and their tastes and preferences into a maximization utility problem. In this sense, researchers must overcome different problems associated with the choice of an appropriate utility function; this decision can determine the interpretation of the evidence found. Moreover, these approaches are complex and computationally demanding and therefore, their operationalization should be evaluated with the objective of selecting the most appropriate methodology to study accessibility. This detail also constitutes an important challenge for researchers because involves finding a correct model able to balance accessibility measures with empirical and theoretical frameworks used to study every case. Finally, other aspects related to the empirical analysis of accessibility should be addressed and solved. For instance, the spatial level of disaggregation of the analysis must be selected with the objective of maintaining comparability between studies. Commonly, empirical studies of accessibility use census tracts (blocks) as unit of analysis (Talen, 2002). In addition, other important issues as the criteria for defining origin and destinations of local public services and population, different travel times (walking or car distances) or observable characteristics of destinations (used into the analysis as measures of attractiveness) should be chosen regardless to the measurement of accessibility.

3. Case of Study

This analysis is conducted for Metropolitan Area of Santiago, Chile (MR). This area is the most populated and densely region of the country with an area of 15.403 square kilometers and a population projected in 7.399.042 inhabitants (INE; Instituto Nacional de Estadísticas).[19] Administratively, this region is divided into 14 provinces and 52 municipalities and the nation's capital of Chile is located there. In the MR, social and economic activities are highly concentrated: more than 40 percent of the Chilean population is living there. This remarkable characteristic determines the emergence of a high attractiveness power of the MR over other regions for living there. For instance, it is possible to identify a spatial concentration of high-quality educational institutions in this region. During 2005, 15 of the best

[19] The density of the Metropolitan Region is estimated in 480,4 inhabitants per square kilometer.

universities of Chile were located there. This scenario motivates more talented students to move from regions to the MR with the purpose of accessing to universities with more prestige and international recognition. Until 2005, 47 percent of Chilean students were enrolled in universities of the MR, capturing more than 35 percent of the highest SAT scores of the country (Paredes, Iturra, & Lufin, 2014). On the other hand, the labor Chilean legislation permits to workers accessing to different labor systems given the economic sector in which they are employed. For example, the mining sector –concentrated in the extreme north of the country – permits to employees spend some days working in regions where firms are located and similar number of days resting at home. Considering the lack of amenities observed in extreme regions, the fly-to-fly-out system allows to many employees to work in extreme areas without to sacrifice their accessibility to high-quality amenities.[20] Thus, these factors contribute to the divergence of human capital between the MR and other regions, especially of high-skilled workers who prefer to live in places with high levels of recreational and cultural amenities (Aroca & Atienza, 2011).

Despite these important differences between MR with respect to the rest of the country, which could explain the high concentration of the population around the center, it is still possible to find differences in living standards within communes. According to the quality life index scores computed by the Center of Urban Studies of the Catholic University of Chile (PUC) for Chilean cities, only 8 communes located in the MR have indices of quality of life higher than the national average.[21] This means that 20.5 percent of inhabitants are living in communities that provide high-quality amenities (Las Condes, Vitacura, Providencia, Ñuñoa, Lo Barnechea, La Reina, Santiago, and Macul). In contrast, 12 communes that concentrate 35.9 percent of the population are living in communes with medium-quality amenities, and 20 communes with 43.6 percent of the population are living in communities

[20] In the literature, this process also is called long-distance commutation.

[21] This index measures the living conditions 93 communes which concentrate 85 percent of the Chilean population. Its computation considers indicators related to housing conditions, health and environment, sociocultural conditions, economic conditions, and transportation.

that offer low-quality amenities. As the same study highlights, the results evidence a high inequality in terms of urban life quality, which determine that 64.6 percent of the MR's inhabitants are living in places with low mobility and connectivity, and 43.6 percent in communities with low housing quality (Instituto de Estudios Urbanos y Territoriales, 2016). These arguments reinforce the importance of studying how equitable is the accessibility to local public services, not only because it is a prominent component of quality of life. Accessibility also can be recognized as a major source of people's real income especially for the poorest population, who must receive more benefits from local public services (Knox, 1980). Public policies must help to poorer individuals to overcome physical and financial barriers to increase their opportunities for accessing to better job options or better neighborhoods.

4. Data and Methodology

With the purpose to understand the relationship between residential segregation and accessibility to local public services, two important decisions must be considered before its implementation. First, we need to identify an indicator to reflect residential segregation. According to previous studies, residential segregation is analyzed by using housing prices as a proxy for the social and economic status of individuals within communities. Even though we do not have a complete profile about individual's needs for local public services by location, housing prices can be used to identify sectors with people economically more vulnerable. It implies that people living in low-income communities could demand more local public facilities such as education or healthcare services because their incomes are not sufficient to access to their private version. In this paper, we use information of property prices computed by the internal revenue service (SII; Servicio de Impuestos Internos) for the first semester of 2017. This price is computed following some criteria such as build's area, materials, age and use. From this dataset, we extract information of the mean of housing prices by every block of the MR which is the finer geographical scale used in the Chilean case. Figure 13 shows the spatial distribution of housing values by blocks using local indicators of spatial association (LISA) in order to

identify possible residential clustering.[22] We identify two different clusters which contain more than 61 percent of all housings in the MR. However, 60 percent of housing are clustered in places with lower housing values around lower-priced communities, which are located in the north-west and south part of the MR. The spatial distribution of housing is relatively segregated and localized in peripheral locations of the MR, reflecting in some sense the logic of Chilean housing policies implemented from the 1970s. For instance, social housings were built on the fringe of urban areas because lower-land prices can be found there, and the State owns significant proportions of land. This situation is reflected in the actual distribution of social housing in the MR where 80.7 percent of affordable housings are located in peripheral municipalities (Borsdorf, Hidalgo, & Zunino, 2013).

On the other hand, the selection of the most appropriate approach to measure accessibility constitutes an important challenge that researchers must overcome. In this sense, this decision needs to consider the different degrees of operationalization, interpretability, and communicability of each approach, as well as, their computational costs because also these applications are highly demanding in data (Vandenbulcke, Steenberghen, & Thomas, 2009). After to evaluate all these constraints, this study uses an accessibility indicator that captures new approaches such as activity-based measures, gravity-based measures, as well as, traditional ones such as container and distance measures to analyze the access of residents to local public services. This indicator is selected because is possible to include key elements into the analysis as the range of activities that can be reached by individuals in different locations and the degree of attractiveness of local public services which can be measured using observable characteristics. In addition, the spatial distribution of local public services and access profiles can be represented easily using geographical distances. In this paper, we analyze the spatial equity distribution of crucial local public services using accessibility measures to schools, hospitals, parks, kindergartens, transportation, fire and police stations, and cultural

[22] Significant positive values represent two possible situations: high housing values around high housing values (high housing communities) or low housing values around low housing values (low housing communities).

equipment. These services constitute a basic package of local public services that everyone must receive as fundamental human rights which are commonly managed by central government and municipalities. Also, these elements constitute the basic elements to compute indicators of quality of life and then, are continuously evaluated by citizens and policymakers.[23] The information about these local public services was collected from different sources which are summarized in table 11.

Index of spatial accessibility to local public services

Even though it is not possible to find in the literature a consensus about how to measure the accessibility to local public services, in this paper we adopt the approach proposed by H. Li et Al (2015). This index has the objective of measuring the spatial accessibility to local public services by considering the number of local public services and the linear distances between blocks and destinations. This index can be computed as:

$$F_d = \sum_{i=1}^{n} A\left(1 - \frac{d_i}{D}\right)^2$$

where n is the number of services located in a buffering area; d_i is the geographical distance from the ith local service to the community; D is the total buffering distance which is based on walk-access buffers to local public services, and A is defined as a constant to keep f_i stable within a reasonable boundary. This index has two important advantages with respect to other indicators. First, this measure captures the number of services that a resident can reach into a feasible radius of distance. Second, its computation and interpretability are fewer complexes than other indicators such as utility-based measures or person-based measures. Thus, this accessibility measure reflects correctly how much services are available for residents, as well as, how separated are these from residents.

[23] This package of services defined as basic human rights is declared by the Chilean political constitution.

For example, to compute the spatial accessibility to schools for a block, first, we need to identify the schools located in a buffering area D. In this case, we define D as a circle with a center located in a block and a radius of 2 kilometers (Li H. , Wang, Shi, Deng, & Wang, 2015). Then, the accessibility of the block to the i-th school is computed by $fi = A(1 - di/D)^2$ and its sum corresponds to the accessibility of all the schools in each block. The interpretation of the indicator reflects the ease with which residents can access to schools within a given distance: high values exist if in a block exists more schools or schools are closer to each census block, or both. Table 12 summarizes the criteria used for computing spatial accessibility to other local public services, which differ in the buffering areas used according to the characteristic of each local service.

Quantile Regression Model (QRM)

As it is well known, classical linear regression (LR) is generally the standard procedure used to measure the average of the relationship between a set of covariates with respect to a response variable. In particular, this method computes conditional mean functions, however, this does not consider the full conditional distributional properties of the outcome variable, and therefore LR only provides a partial picture about it. In other words, this method is limited to explain the mean of the dependent variable. An alternative method to consider these important properties is the Quantile Regression Model (QRM), which based on the minimization of weighted absolute deviation, computes conditional quantile functions. This model helps to analyze the full distributional properties of a response variable by computing a conditional median function. It means the method can be applied to explain the influence of determinant variables at any point of the distribution of the dependent variable. In our application, quantile regression can help us to analyze how housing prices by block affects in a different way the distribution of each indicator of accessibility to local public services. By doing so, we study this relationship using as dependent variable the accessibility to every local public service considered into the analysis, meanwhile our explanatory variable is the mean of housing prices by block to detect how different socio-economic groups can affect the distribution of local public services. Moreover, we

include some control variables such as the share of exempted housing from property taxes by block, and a housing quality index computed by the SII which help us to characterize socioeconomic conditions of residents.

Similar to the computation mechanism used in LR, Quantile Regression Model minimizes the weighted sum of absolute residuals. In this case, consider a sample of N observations for the computation of the accessibility to local public services model. Denote as y as a N vector of the accessibility index, and X is a vector of $N\ x\ K$ matrix with $K-1$ explanatory variables (in our case, housing prices, share of exempted housing from property taxes and housing quality index). Then, the minimization problem of a quantile regression can be expressed as,

$$\hat{\beta}_q = \min_{\beta_q \in \mathbb{R}^K} \sum_{n=1}^{N} \left| y_n - x_n \beta_q \right| h_n$$

where the nth observation's weight h_n is defined as:

$$h_n = 2q$$

if $y_n - x_n \beta_q > 0$, and

$$h_n = 2 - 2q$$

otherwise. For instance, if $q = 0.75$, the criterion is minimized when 75 percent of residuals are negative. Then, quantile regression indicates how the explanatory variables such as housing values by block influences on the accessibility measure to any local public service at the 75th percentile of the conditional accessibility distribution. Standard errors of the coefficient are estimated using bootstrapping and as result, standard errors are less sensitive to typical econometric problems such as truncation, outliers, heteroscedasticity and unobserved heterogeneity.

Bi-Variate LISA

Although QRM shows how socio-economic conditions of residents can affect the distribution of accessibility measures, this method cannot reflect if housing price clustering is associated with the provision of local public services. This last element is crucial to understand if the spatial distribution of local public services is related to residential segregation patterns. The simplest form to identify spatial clustering, local indicators of spatial association (LISA) are used to accomplish this objective. The LISA is computed for each observation and denotes to what extent similar values are clustered around that observation based on the concept of local Moran's I. Usually, this spatial statistic is computed as a univariate indicator, however, its measurement also can be extended to study the spatial association of two variables as well. In this paper, we introduce the Bi-variate LISA to study the association between housing prices and the accessibility to local public services. This statistic shows the degree of linear association which can be positive or negative between one variable in a given location i, and the average of another variable in neighborhood communities. In our approach, we seek to study the linear association between housing prices by block with respect to the average of accessibility to local public services. Bi-variable LISA is computed as follow,

$$I_{ha}^{i} = \left(\frac{X_h^i - \bar{X}_h^i}{\sigma_h}\right)\sum_{j=1}^{n} W_{ij}\left(\frac{X_a^i - \bar{X}_a^i}{\sigma_a}\right)$$

where X_h^i represents the housing price in the block i, and X_a^i is the accessibility to a local public service in block i, respectively. Also, $\bar{X}_h^i$ and $\bar{X}_a^i$ are the average values of both variables, meanwhile σ_h and σ_a are their variances. Finally, W_{ij} is the spatial weight matrix defined as a binary matrix where a neighbor set for each observation is identified with non-zero elements for neighbors and zero for others.

The interpretation of this indicator establishes that a positive association suggests a similar spatial clustering of both variables, and negative relations assumes the opposite result. Consequently, this measure provides a clear picture to understand how the spatial association between residential segregation and the provision of local public services is working by defining four distinctive groups: high housing

prices and high accessibility to local public services, low housing prices and low accessibility to local public services, high housing prices and low accessibility to local public services, and low housing prices and high accessibility to local public services.

5. Results and discussion

In this section, we show the main results of the analysis performed via Quantile Regression Method. As usual on these computations, the comparison between OLS and Quantile Regression is reported in Tables 14 – 28,[24] where the dependent variable is represented by the accessibility index computed for every local public service considered into the analysis, meanwhile the explanatory variables are represented by the mean of housing prices by block as well as, control variables about socioeconomic characteristics of housing. Also, figure 2 shows the panels that supports the behavior of coefficients computed. The language of the discussion concerns the conditional distribution, then, we always refer to the conditional mean or certain conditional quantiles. In this way, higher (lower) accessibility indexes by block are located at higher (lower) positions in the conditional accessibility index distribution, conditioned on the mean of housing prices by block.

As one would expect, on most of local public services their accessibilities are increasing when housing prices decrease. However, this behavior differs by every local public service. For instance, the effect of housing prices on the accessibility to public schools is negative, but it is less negative for the lowest and highest-income quantile groups. In this sense, a U-shaped coefficient behavior can be found, and it is observed in panel 1. It implies that middle-income groups are receiving more benefits because they have more access to local public schools in comparison with other income groups. Panel 2 shows the same analysis for public schools but only considering those with more than 250 points in SIMCE.[25] According to the

[24] Summary statistics are reported in table 13.

[25] SIMCE is a national standardized test used to measure the quality of education across students. This system has the purpose of improving the quality and equity of Chilean education by reporting information about student performances and their learning environment.

analysis, we can observe how high-quality educational public services are distributed by income groups. In this way, middle-income and high-income groups have better access to high-quality public schools than lower-income groups. In fact, this shape is likely to the influence of housing prices on the access to semi-private schools observed in panels 3 and 4. Thus, taking into consideration that semi-private schools have better performances in quality terms than public schools, this analysis reveals that high-quality educational services are still concentrated and closer to higher-income groups. It implies that poorer individuals are facing more disadvantages in access to public schools than richer individuals because the latter can compensate their lower access to these schools by increasing their access to private schools. This fact can be observed in panels 5 and 6 where a positive relationship between housing prices and the accessibility to private schools is found. Consequently, private schools are reserved for high-income groups and low-income groups are excluded from these services.

Panels 7 and 8 show the behavior of the quantile coefficients for the accessibility to public transportation: bus and subway stations. In this case, a U-shape is found in the accessibility to buses which is following the same pattern as public schools: lower and higher income groups are suffering a lack of the accessibility to these services. In particular, this shape could be explained by two facts. First, most of low-income and high-income households are located in outer areas of the MR and both groups could be suffering problems with respect to the insufficient route coverage that exists outside the city's central areas. However, only wealthy families have higher probabilities of possessing cars to benefit from highway systems. Higher-income groups can switch from public transportation to private vehicles overcoming the commuting constraints the poor must handle in order to access to central areas. On the other hand, medium-income groups have more access to subway stations. From this analysis, we can confirm that housing location is still relevant to determine the access to local public services: subway stations are designed to connect mainly the central area of the MR, where commercial activities are located. Considering that housing prices also response to the location of these

kinds of activities at the space, high-access to subway stations is expected due to high-housing prices.

A different behavior on the accessibility to urban public parks can be found in panels 9 and 10, respectively. In panel 9, it is possible to observe a homogeneous effect of housing prices on urban public parks. In terms of supply, urban public parks are more equitably distributed between income groups than other local public services. However, if we consider only urban public parks with a surface over 5750 square meters, the behavior of coefficients by quantile follows the same pattern as private services (e.g. private schools).[26] Therefore, the accessibility to bigger urban parks is still determined by housing prices which is higher when housing prices are higher as well, reflecting their unequal distribution against the poorest population. A possible explanation can be found at the current Chilean regulation of urban areas because it does not define a minimum size by a park, but only the obligation of using a percentage of urbanized land to this purpose. In this way, developers can assign small proportions of land to urban parks because there is not possible to build more affordable housing and therefore, small green areas proliferate without to consider the population density of locations (Reyes & Figueroa, 2010). Consequently, an unequal and insufficient supply of urban parks is provided across neighborhoods with few large parks concentrated and closer to high-income groups.

The remaining of local public services such as kindergartens, hospitals, fire and police stations, and cultural equipment are following the same U-shape pattern as other local public services. The behavior of coefficients is shown in Panels 11 to 15. In this sense, lower-income and higher-incomes quantiles are still receiving less access to kindergartens, hospitals, fire and police stations, respectively. An exception is found for culture services that present a fairer distribution between income groups. Moreover, we do not find significant coefficients for middle-income and higher-income groups and reflects that incomes are not affecting the access to culture services. Finally, we can conclude that income groups are still determinants on the accessibility to local public services and marked differences

[26] This surface represents the mean of green area size at the Metropolitan Region (MR).

are found between them. In this case, middle-income groups are receiving higher proportions of local public services than others. This detail converts to residents' location in the MR in a relevant element to shaping the spatial distribution of local public services. Notwithstanding, these results cannot reflect if housing prices clustering is associated with the provision of local public services.

For overcoming this problem, we use Bi-Variate LISA to determine whether the spatial distribution of income groups is also related to the spatial distribution of local public services. Figure 15 depicts the main results obtained from this analysis. LISA statistic shows that more than 50 percent of communities are highly clustered. Moreover, we observe a systematic concentration of higher levels of accessibility to local public services in the center and northeast areas of the MR, meanwhile, groups with insufficient levels of accessibility are mainly located in the outer areas of the MR. For instance, LISA for public schools evidences this behavior (panels 1 and 2). Higher levels of accessibility are located in the center part and groups with lower levels of accessibility are located in the eastern areas and some areas of the western part of the MR. Particularly, in the eastern area is possible to identify two different groups: lower-housing prices with lower accessibility and higher-housing prices with lower accessibility levels. These results confirm the evidence found by QRM methodology in which high-income and low-income groups are suffering important disparities in terms of accessibility to public schools with both groups mainly located in the eastern area of the MR. However, the spatial distribution of public schools with better performances in standardized test is still unequal and against to poorer communities. High-income groups that are receiving higher levels of accessibility to better schools are located in the center and northeast areas of the MR, where high-housing prices are located as well. By the contrary, low-income groups located in southern areas of the MR are suffering important disparities for accessing to high-quality public schools. Obviously, this situation determines that lower-income groups are excluded from these services and reduce their probabilities to access to better education opportunities than households located in the center and northeast areas. By considering that high-income groups are more likely to choose the private version of schools, which are characterized by high-

quality performances as well as, lower physical and financial barriers than the poorer, these results confirm that patterns of residential segregation are apparently reinforced by low accessibility levels to public schools, excluding to the poorest communities of high-quality public services. This situation reveals the urban space in the MR is not only segmented by the stratification of communities. Also, the unequal distribution of accessibility levels can exacerbate this shape with important differences in terms of well-being or capitalizations of public services into housing prices.[27]

A similar spatial distribution also is observed for urban parks. Panel 9 shows that high-income groups are receiving higher levels of accessibility to public urban parks than lower-income groups located in the southern areas of the MR. This situation is exacerbated when bigger parks are taking into account (panel 10). In this sense, higher levels of accessibility to urban parks are reserved to high-income areas, and lower-income groups located in the northwest and south part of the MR are marginalized from this type of urban parks. Finally, LISA maps for other local public services such as transportation, kindergartens, healthcare centers, fire stations, police stations, and culture infrastructure confirm that lower-income groups that are receiving fewer proportions of local public services are located mainly in the southern and northwest areas than other income groups in the MR. This evidence supports that residents' location is strongly associated with the spatial distribution patterns of local public services, which might have relevant consequences in migration decisions exerted by individuals. In this case, residential segregation patterns are marked and apparently exacerbated by the unequal distribution of local public services across the MR. This implies low access for the poorest population by excluding them from enjoying better living standards or opportunities in crucial services such as schools, hospitals or transportation. On the other hand, these results reveal that local governments could play an important role in shaping the spatial distribution of local public services into the MR, where

[27] Panels 5 and 6 in figure 15 show the bi-variate LISA for private schools. There clearly is observed higher levels of residential segregation where high-income groups are receiving more high-quality services than low-income groups.

apparently still persists high-income local governments providing better services to their communities and other local governments with an inefficient supply of local public services within poorer communities.

Discussion

Regardless that MR exerts an important attractiveness force of individuals or social and economic activities over other places of the country, the results confirm that within is still possible to observe differences in the accessibility levels to basic local public services between communities. In particular, the unequal distribution of local public services is affecting mainly to lower-income groups, who are suffering significant deficits in accessing to critical local public services such as transportation, schools or hospitals. This situation reduces dramatically their opportunities for finding better living conditions closer to their homes, assuming in some cases time and monetary costs for accessing to better local services in other communities. In contrast, middle-income and high-income groups are enjoying a higher provision of local public services, who are generally located in the central area of the MR. This fact constitutes an important advantage for these individuals in contrast lower income groups because socioeconomic activities, public and private services are located in the core areas of the MR. These benefits according to the spatial position of this groups and gains in terms of accessibility could explain some important urban renovation processes such as the gentrification, concept that explains why middle-income classes – due to their higher economic power – renew the central core of urban areas and excludes lower income groups to periphery areas. The low accessibility observed in the poorest groups reflects important losses in terms of human development due to their low probability of accessing to better opportunities for increasing their quality of life. Despite that the richest residents also suffer from the insufficient provision of education, transportation or health care services, they still have more advantages to overcome this problem by opting for the private version of these services, which are usually characterized by high-quality performances.

Geographically, low accessibility levels are located at the periphery of the MR, specifically, in the north-western and southern parts, which also coincide with the location of social housing projects implemented by the state during the 1970s. The main objective of the Chilean social housing policies was reducing the lack of affordable housing and increase the ownership by implementing different subsidies which were concentrated on households with incomes below US $400 per month. Apparently, these public policies were successful in the sense of reducing housing deficits. However, new neighborhoods were located in places with low land prices, far from the center and within communities with higher poverty levels and social problems such as crime or drug abuse. As Borsdorf et Al (2013) highlighted, this "new poverty" emerges due to the absence of a clear spatial dimension of public policies to include low-income residents into the urban system, reinforcing social segregation patterns and reducing living standards of the poorest population. In addition, this situation has important economic implications for hosting municipalities of social housing projects: social housing units are exempted from the payment of territorial taxes. Considering that these resources correspond to the most relevant source of income for municipalities, the presence of social housing units automatically reduces their budgets to provide local public services. For a better understanding of this fact, figure 16 shows the spatial distribution of healthcare and education per-capita expenditures by communes for the year 2016. There is possible to observe that higher per-capita expenditures in both services are mainly concentrated in the eastern area of the MR and it coincides with high-income groups and high levels of accessibility. By the contrary, lower per-capita expenditures are located in the southern and northwest areas of the MR where lower income groups with insufficient levels of accessibility are located as well. Apparently, this outcome is reflecting the fact that richer local governments are hosting high-income groups with higher willingness to pay for local public services. As a consequence, these local governments should respond to these demands providing high-quality local services which are used to attract higher-income residents. On the other hand, low expenditures in per-capita terms could reflect two situations. First, local governments with higher levels of exempted housing from local taxes are facing important income restrictions to provide local public services

and then, lower incomes are generated. Second, important deficits in terms of quantity and quality in local public services also could be found in poorer municipalities because also face a higher demand from their communities. As local infrastructure is not sufficient, households must assume commuting costs or overcome budget restrictions for accessing to more and better local public services or to the private version of the same local facilities. Therefore, results are reflecting in some sense the logic of housing policies which is recognized by the Chilean literature as one of the causes of residential segregation (Lambiri & Vargas, 2011), and apparently this lack on accessibility to local public services is reinforcing residential segregation with diverse consequences on living standards for the poorest population. Even if, we do not draw any conclusion about the causal relationship between the spatial distribution of local public services and residential segregation, these results provide a better understanding of this stylized fact and its consequences. Moreover, the comprehension of this new perspective can have important public policy implications, and most especially for local public governments because they could play a relevant role to address these problems.

6. Conclusions

The study of the relationship between the provision of local public services and residential segregation takes an important significance when the latter is considered such as the social manifestation of spatial income inequality. This means that the unequal distribution of income across communities also can be observed on the unequal distribution of local public services, which are seen as fundamental rights that everyone must receive from central governments. However, this relationship is still relatively unexplored by the empirical literature, especially in cases that differ from the US context. This paper wants to build a bridge between both concepts by analyzing the accessibility to local public services and residential segregation for the Metropolitan Region of Santiago, Chile (MR). In particular, this objective is addressed by studying how the spatial accessibility to local public services is equitably distributed among different social and economic groups, by using different measures of accessibility based on physical distances, quantile regression methods and local indices of spatial association LISA to understand how housing

prices by block – used as a proxy of socioeconomic conditions of people – can influence on the accessibility to crucial local public services such as schools, transportation, hospitals, parks, fire stations, police stations, and culture infrastructure.

Main results suggest the accessibility to local public services has an unequal distribution between housing units and economic classes. However, these differences are affecting more to lower income groups, who are suffering significant deficits on the provision of local public services. Geographically, low accessibility levels are concentrated at the periphery of the MR, where poor municipalities and housing social projects are located as well. This situation has important implications for lower-income residents and local governments. On one hand, these neighborhoods are located in places with low land prices and far from core areas, assuming several social problems such as crime or drug abuse due to their exclusion from urban systems. Therefore, the location of social housing projects at the fringe of the MR could increase residential segregation patterns with negative consequences for living standards of the poorest population. On the other hand, local governments also are suffering severe budget deficits to provide local public services due to the high number of housing units exempted from local taxes that are concentrated in their communities. Apparently, their budgets are not sufficient to satisfy the high demand for local public services, which can be observed on the insufficient infrastructure or in the low-quality performances. Under this scenario, poor residents are suffering a "double-disadvantage" due to their social exclusion from urban centers and their limited accessibility to local public services. We found evidence confirming that social housing public policies could be considered as one cause of residential segregation in which the latter is reinforced by the insufficient accessibility levels that poorest population must assume. Even if richer residents also face lower levels of accessibility to social public services still keep more advantages with respect to other social groups because they can access to the private version of them.

Overall, the findings from this study have important public policy implications, especially for local governments because they can play an important role in shaping the spatial accessibility to local public services. In this vein, important disparities in terms of provision of local public services are strongly associated with the concentration of municipal incomes across the MR. Moreover, this unequal pattern also reduces the opportunities for the poorest population to access to more and better local public services which are concentrated in places with higher-income residents. These results confirm that higher levels residential stratification by housing prices also are strongly associated with the unequal spatial distribution of local public services. Therefore, richer local governments have more opportunities to attract high-income individuals who are willing to pay more local taxes for accessing to high-quality local public services. As a result, these municipalities can generate a virtuous circle that permits to obtain more local taxes by reinforcing the relationship between public services and housing values. On the contrary, lower-income groups residing in communities with lower local revenues have fewer possibilities to improve their living standards because apparently, they are marginalized and excluded from high-quality local public services. Although we do not seek to explain the causal relationship between the spatial distribution of local public services and patterns of residential segregation, we recognize that local governments might play an important role in addressing these problems by reducing the severe differences that are still observed in the MR. Further research about how local government revenues and how institutional restrictions are affecting local response capacity to resolve these problems could be addressed in order to obtain a better understating of this stylized fact.

Figure 13: Map of Residential Communities by Housing Prices in the Metropolitan Region

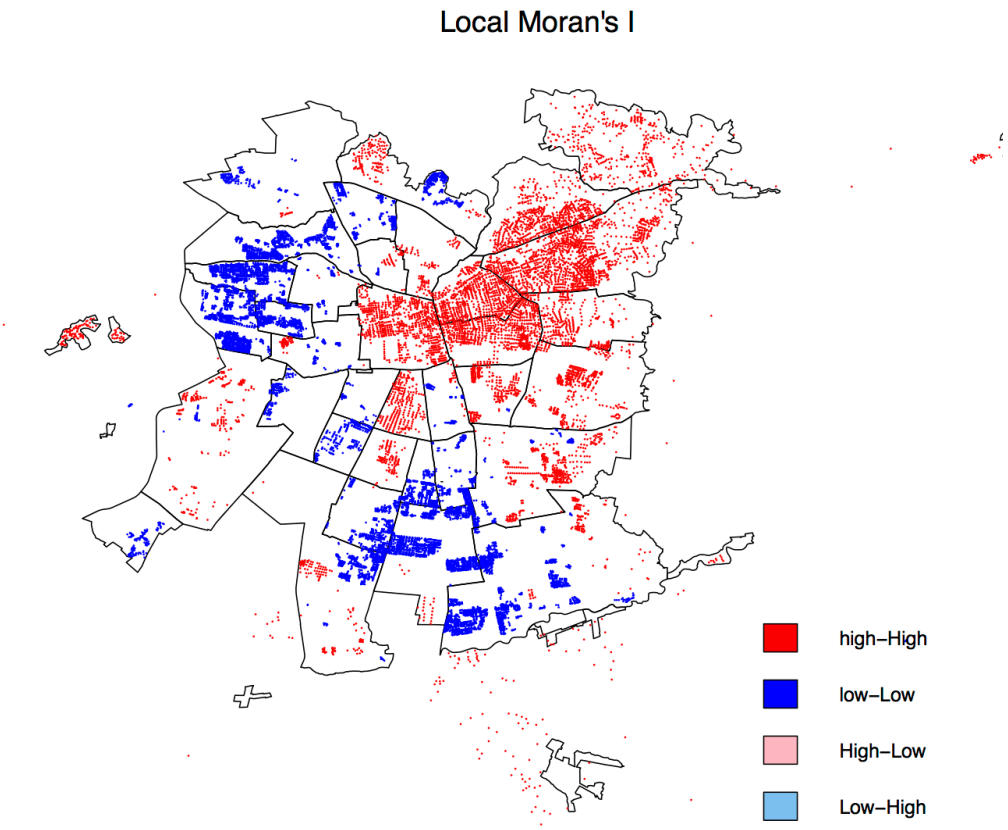
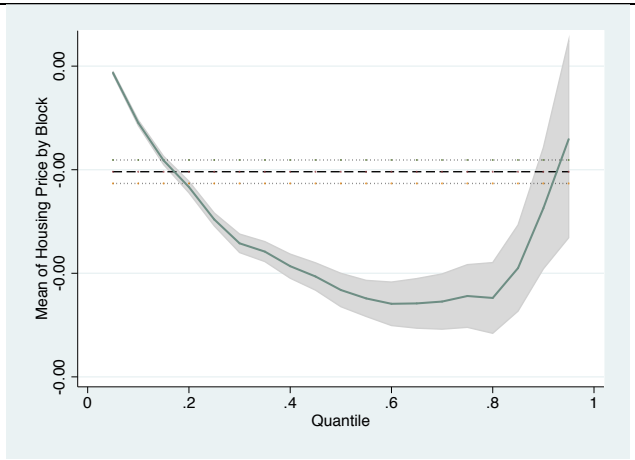
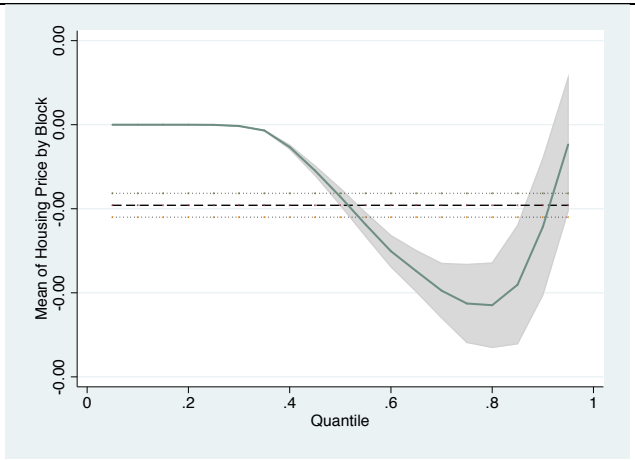
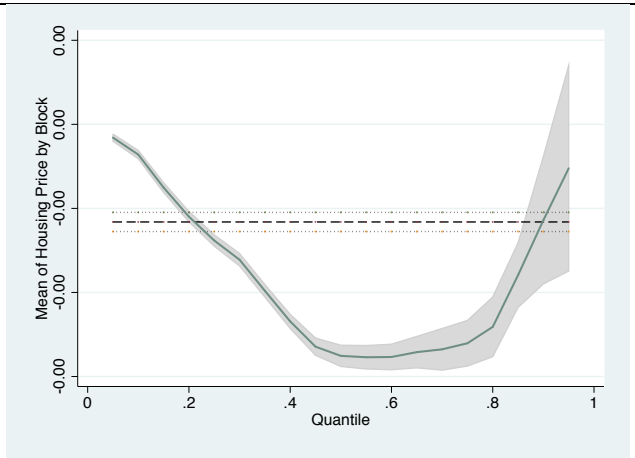
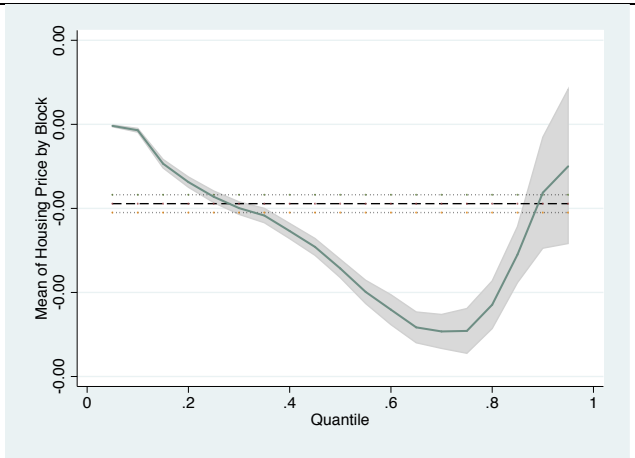
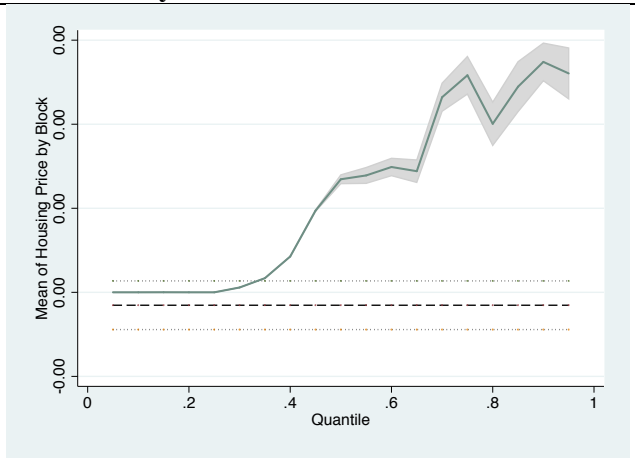
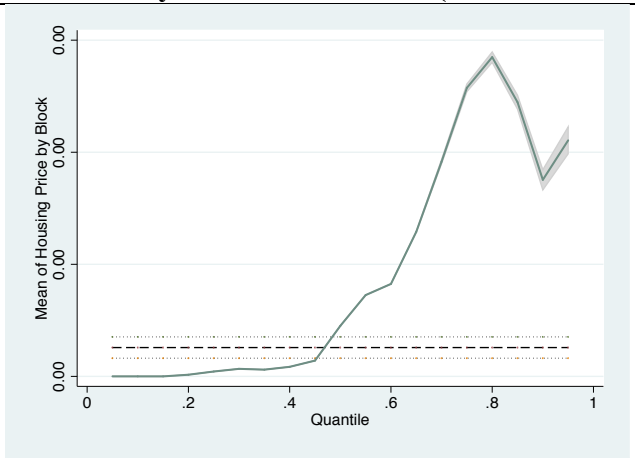
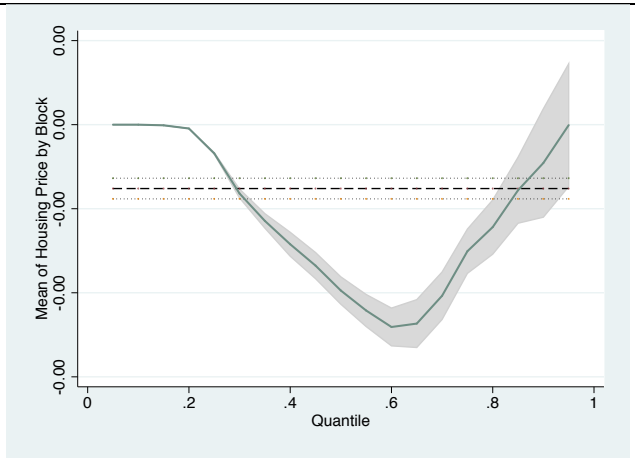
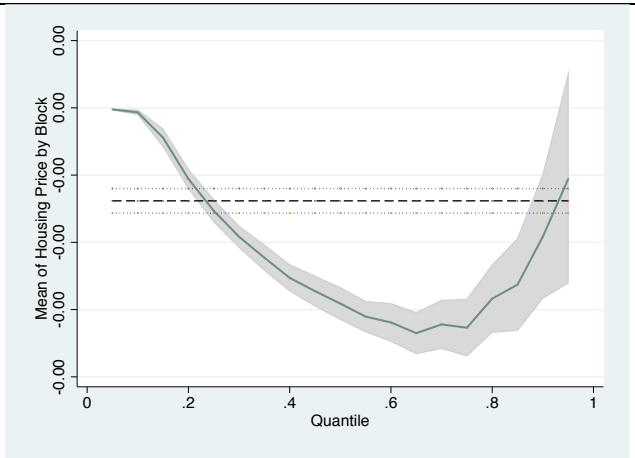
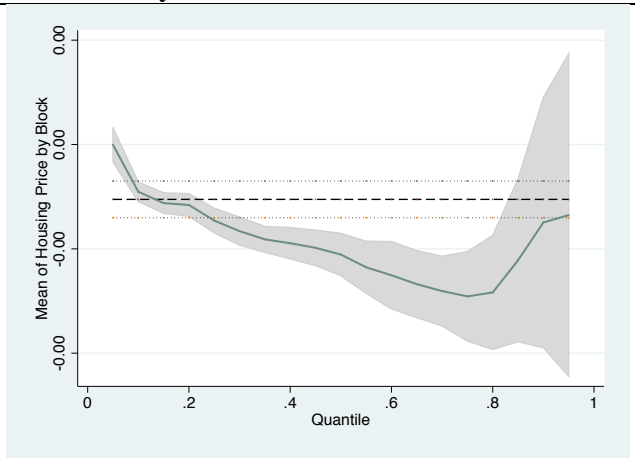
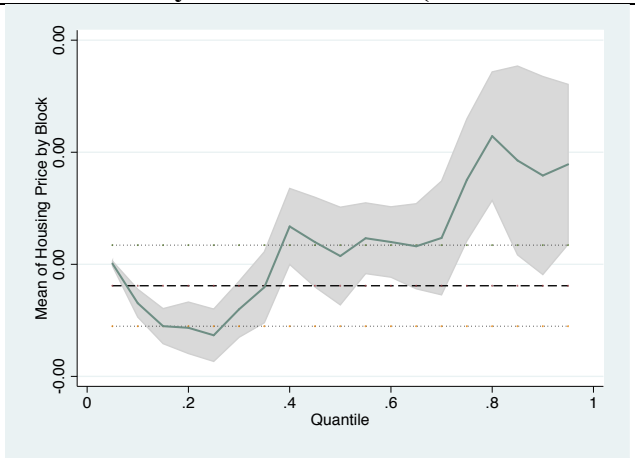
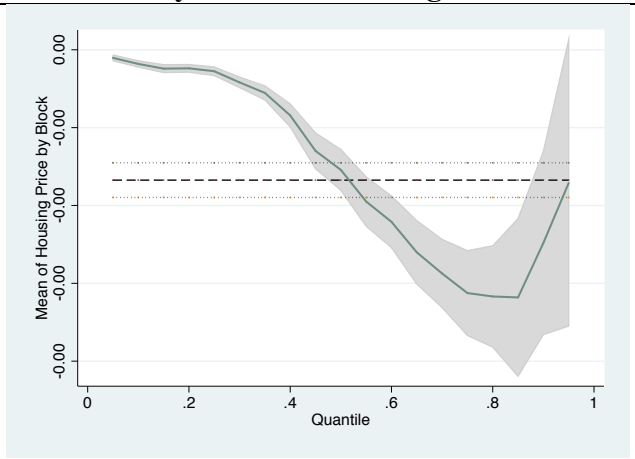
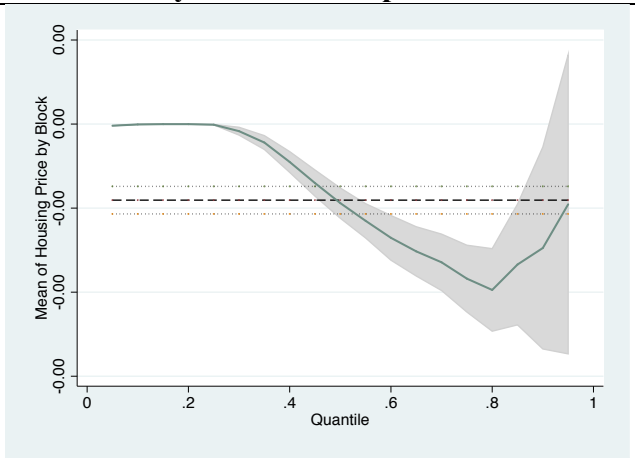


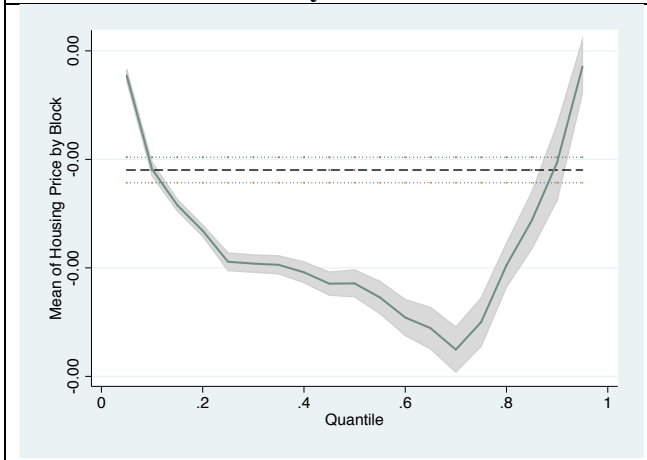
Figure 14: Quantile Regression Coefficient Estimates by Quantile

Panel 1: Accessibility to Municipal Schools	Panel 2: Accessibility to Public Schools (more 250 SIMCE)
	
Panel 3: Accessibility to Semi-Private Schools	**Panel 4: Accessibility to Semi-Private Schools (more 250 SIMCE)**
	

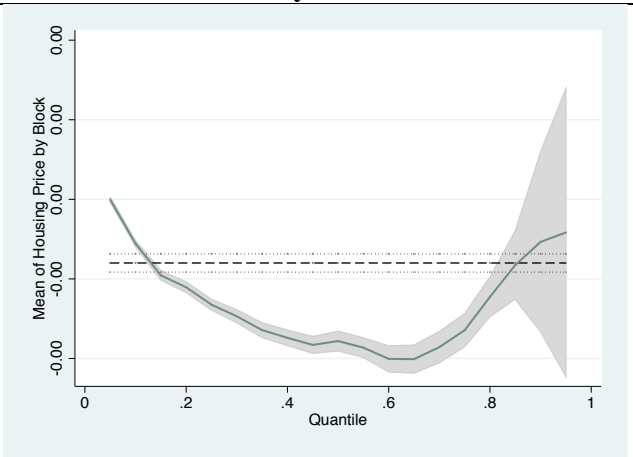
Panel 5: Accessibility to Private Schools	Panel 6: Accessibility to Private Schools (more 250 SIMCE)
	
Panel 7: Access to Public Transportation. Subway Stations	**Panel 8: Access to Public Transportation. Bus Stations**
	

Panel 9: Accessibility to Urban Parks	Panel 10: Accessibility to Urban Parks (more than 5750 mt2)
	
Panel 11: Accessibility to Public Kindergartens	**Panel 12: Accessibility to Public Hospitals**
	

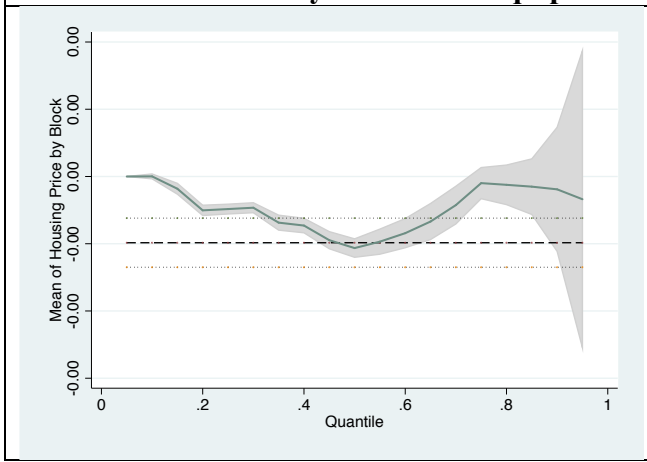
Panel 13: Accessibility to Fire Stations



Panel 14: Accessibility to Police Stations



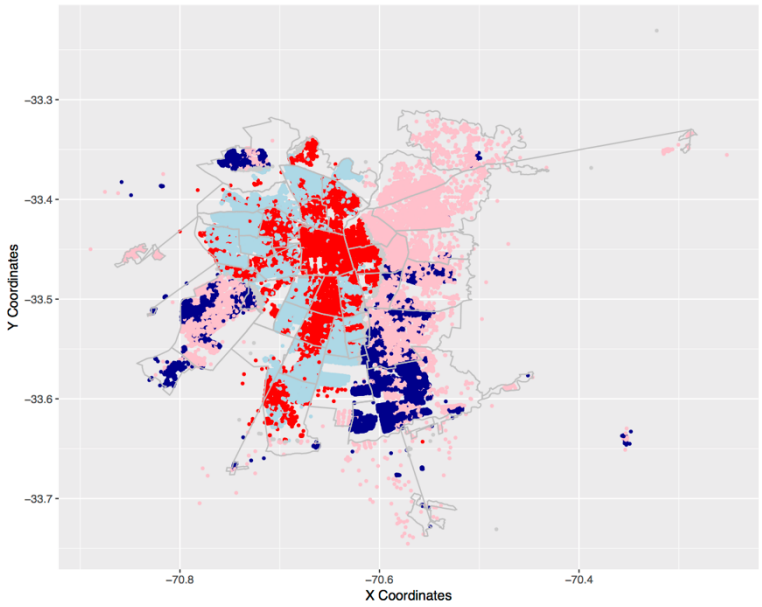
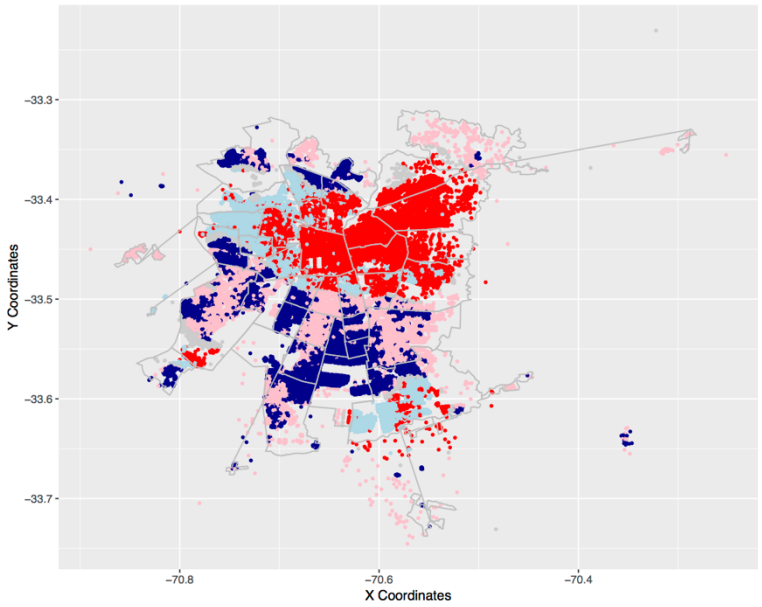
Panel 15: Accessibility to Culture Equipment

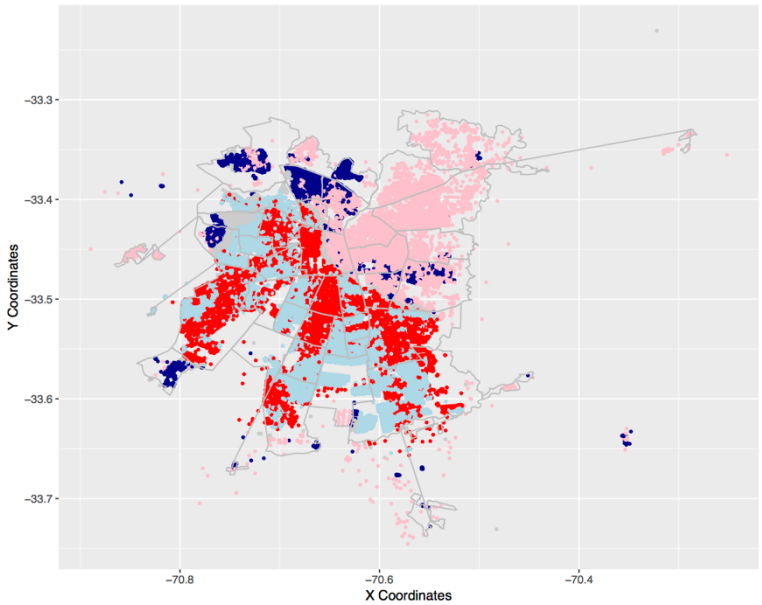
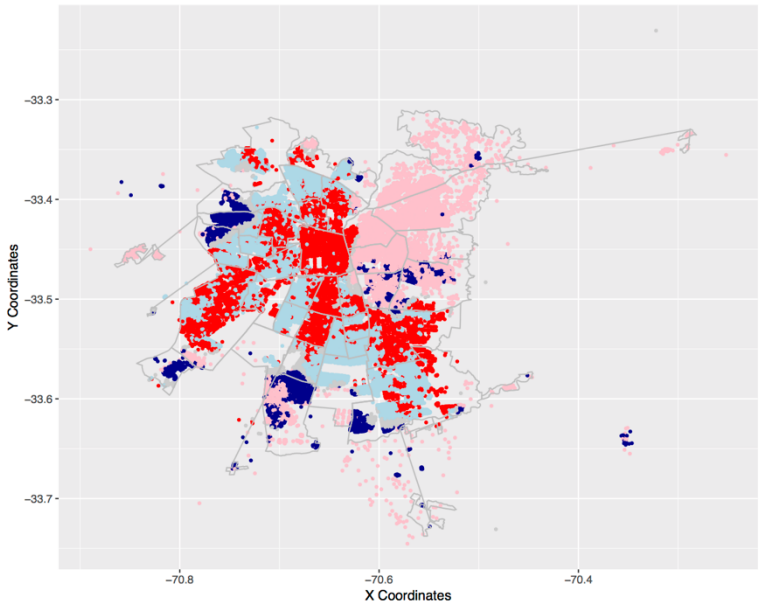


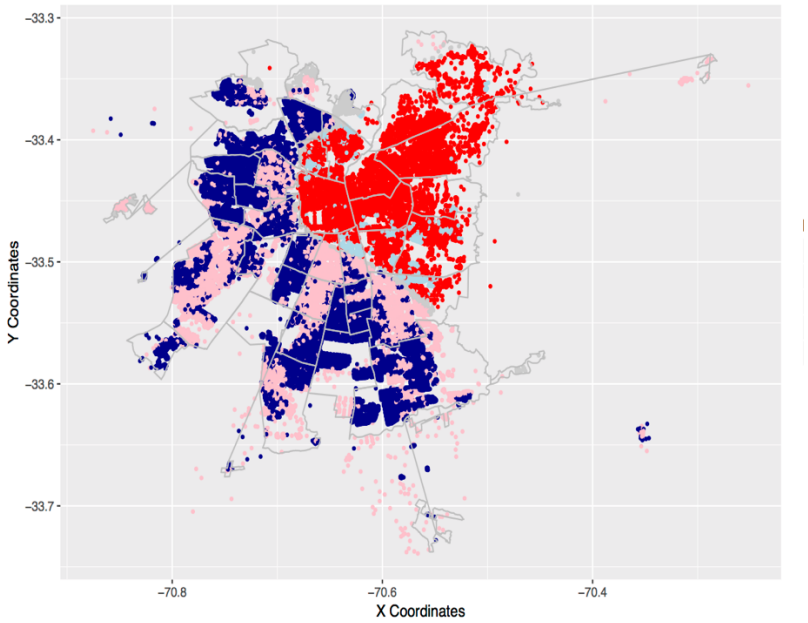
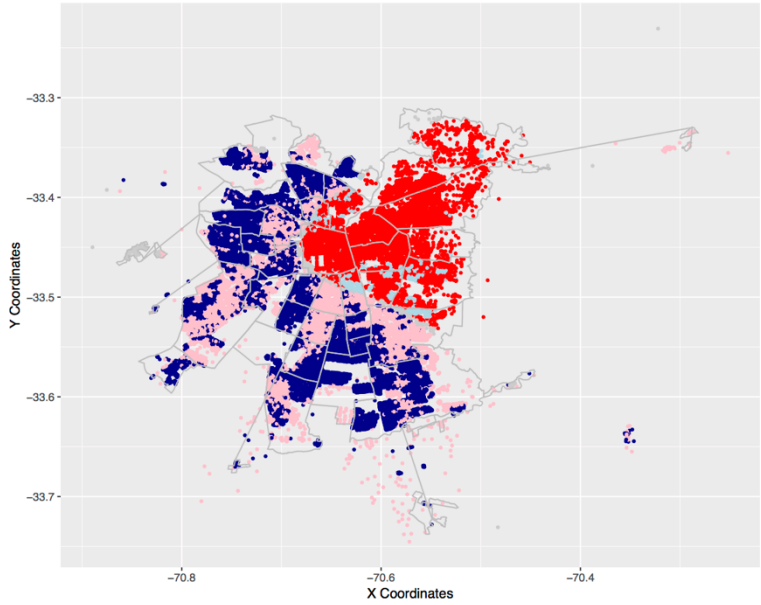
Quantile Estimates
95% CI of quantile estimates

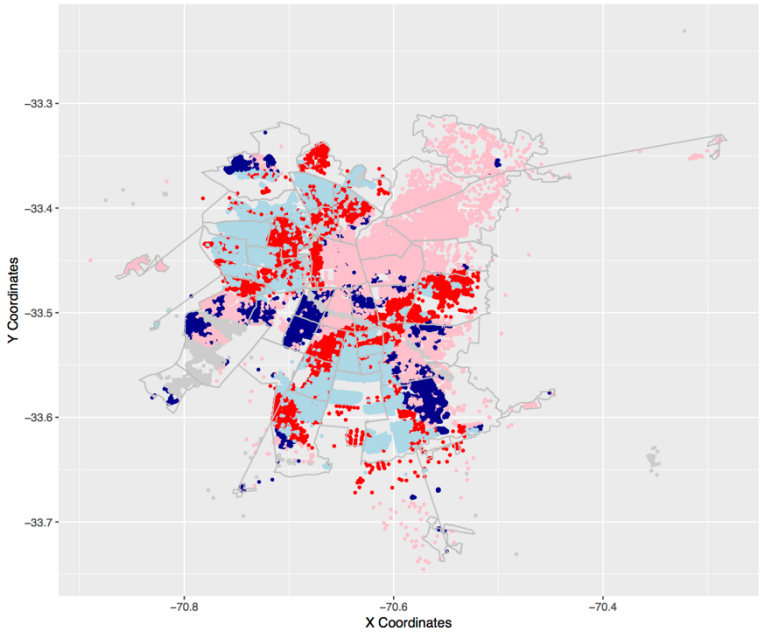
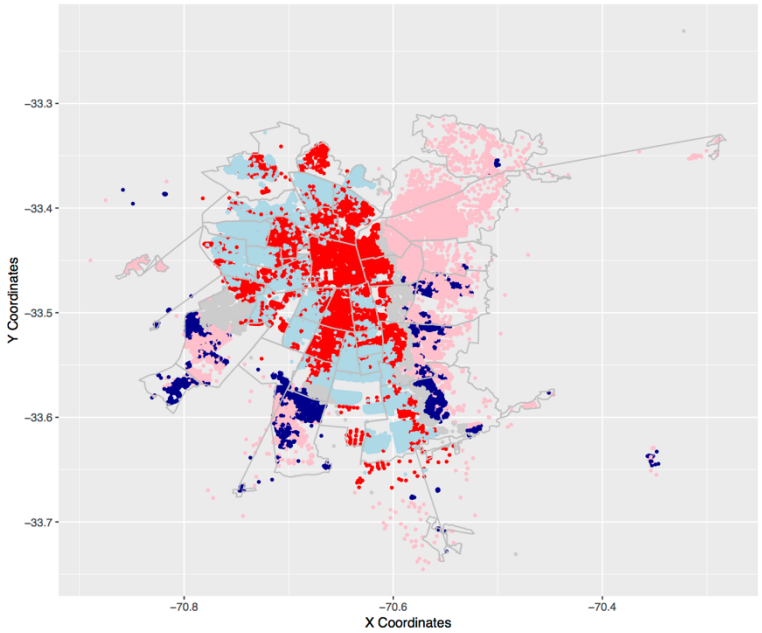
OLS estimates
95% CI of OLS est; upper bound
95% CI of OLS est; lower bound

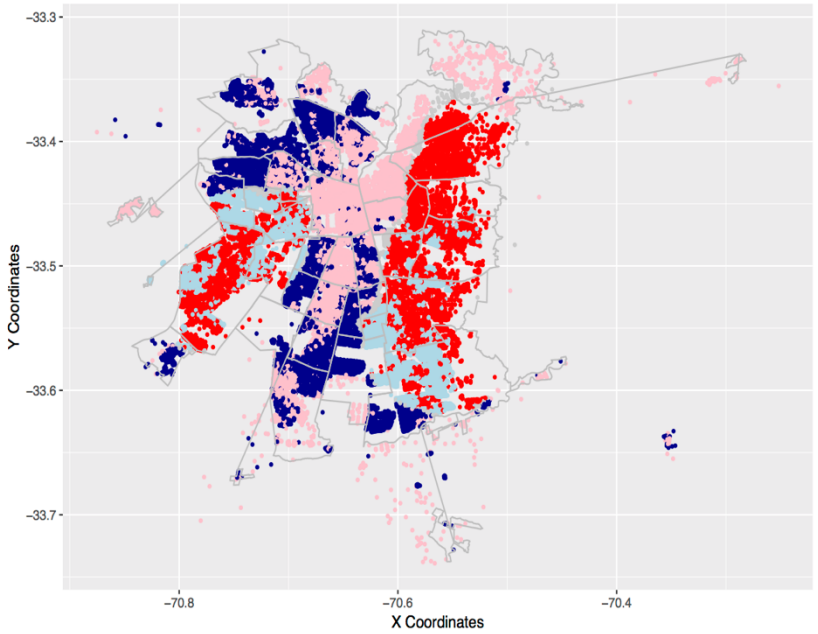
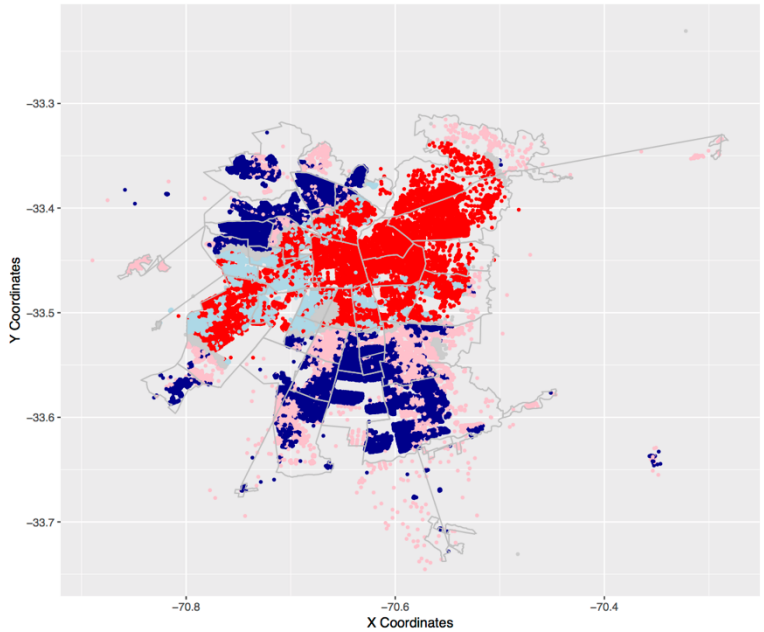
Figure 15: LISA Maps for bi-variate relation between housing prices and accessibility measures of local public services

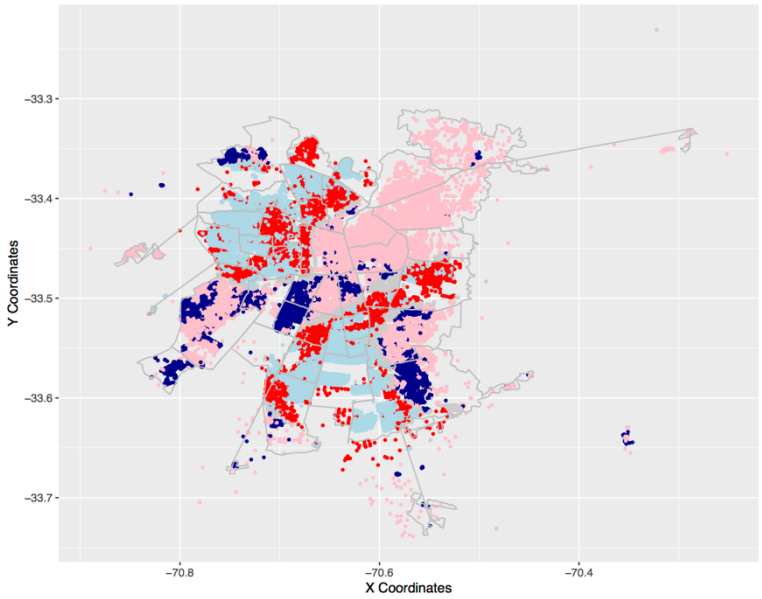
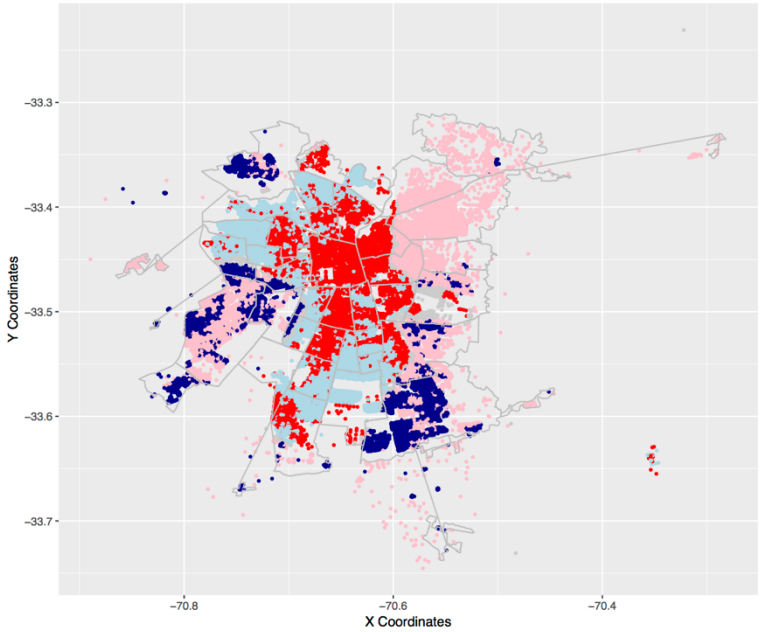
Panel 1: Accessibility to Public Schools	Panel 2: Accessibility to Public Schools with 250 SIMCE
	

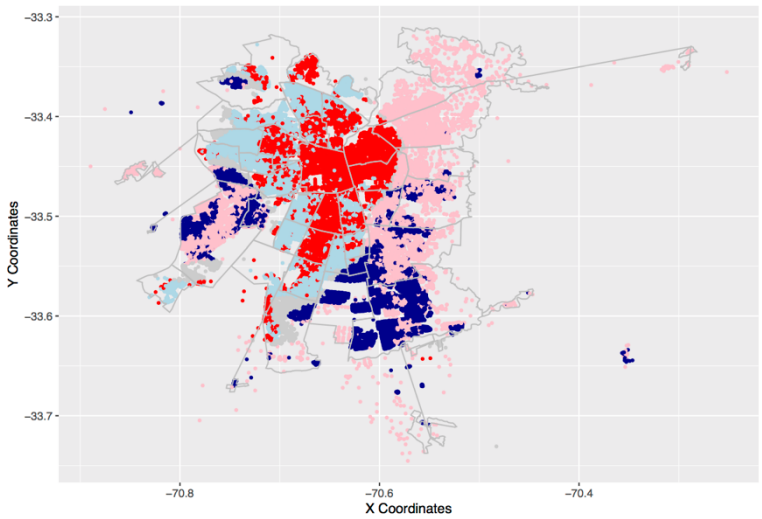
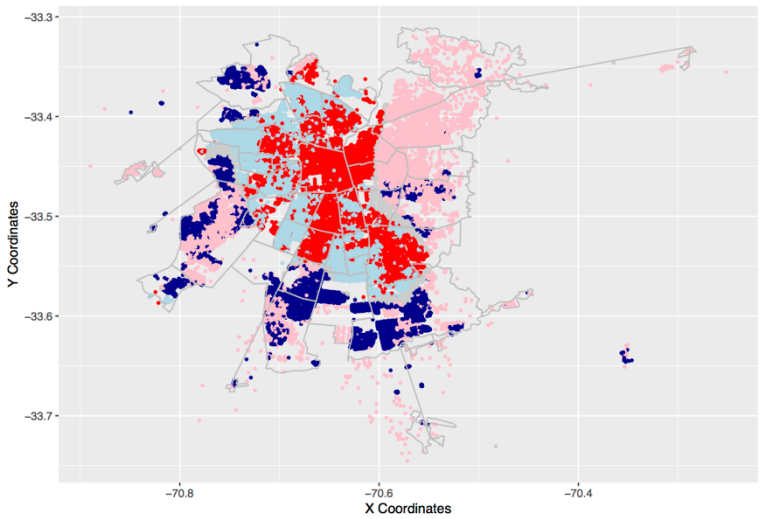
Panel 3: Accessibility to Semi-Private Schools	Panel 4: Accessibility to Semi-Private Schools with 250 SIMCE
	

Panel 5: Accessibility to Private Schools	Panel 6: Accessibility to Private Schools with 250 SIMCE
	

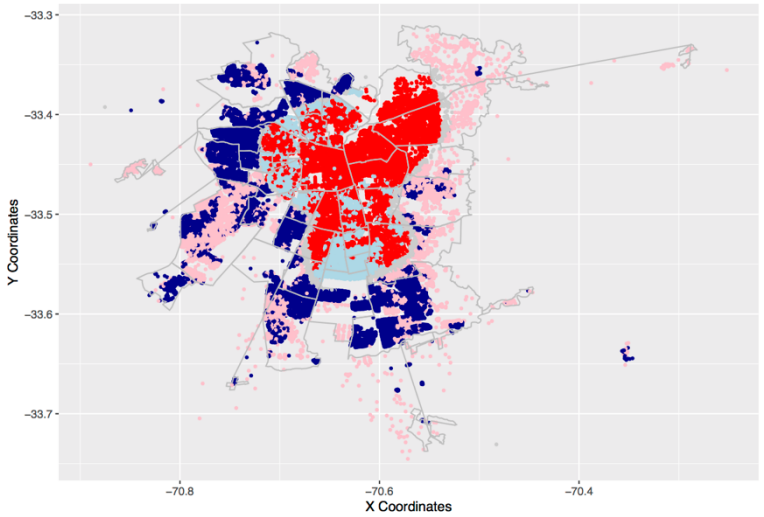
Panel 7: Accessibility to Subway Stations	Panel 8: Accessibility to Bus Stations
	

Panel 9: Accessibility to Urban Parks	Panel 10: Accessibility to Urban Parks (more than 5750 mt2)
	

Panel 11: Accessibility to Public Kindergartens	Panel 12: Accessibility to Public Hospitals
	

Panel 13: Accessibility to Fire Stations	Panel 14: Accessibility to Police Stations
	

Panel 15: Accessibility to Culture



Legend

- High income – High access gain
- High income – Low access gain
- Low income – High access gain
- Low income – Low access gain
- Not significant

Note: The significant level is 5%.

Figure 16: Spatial distribution of local government expenditures in education and healthcare by communes

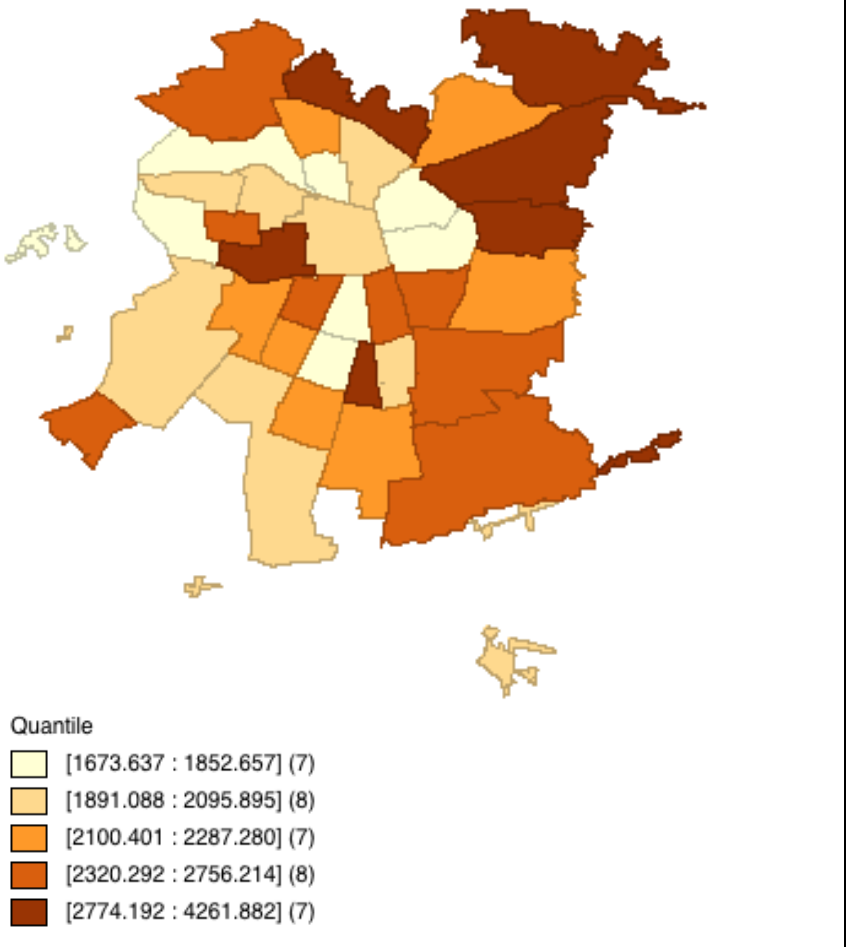
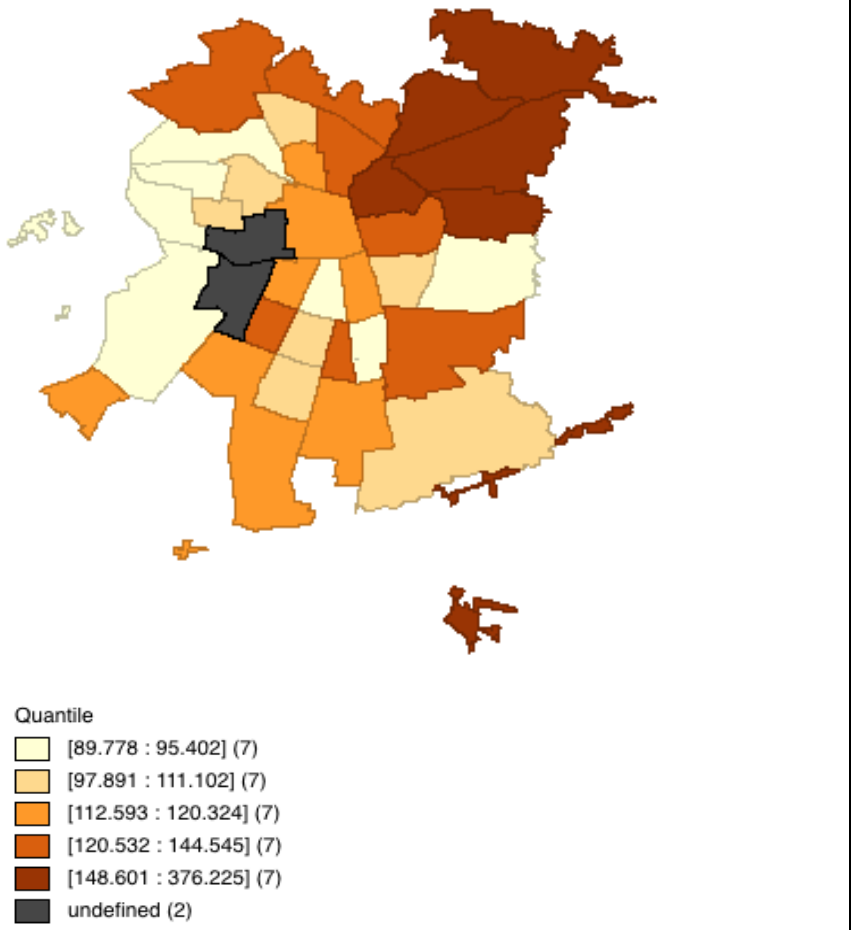
Panel 1: Local expenditure per-capita in education	Panel 2: Local expenditure per-capita in healthcare
	

Table 9: Accessibility Measures. Traditional approaches

Measurement Approach	Definition	Spatial Unit	Used in literature
Container	Number of facilities or services contained within a given unit.	Census tracts	Talen & Anselin (1998) Knox (1980)
Coverage	Number of households (or individuals) covered by service area buffer.	Household locations or location of facilities.	Knox (1978) Talen (1997) Radke & Mu (2000) Knox (1980) Wei, Cabrera-Barona & Blanschke (2016)
Minimum Distances	Minimum distance from the origin to the nearest local public service. In this case, more accessibility if a spatial unit is closer to every facility (Inverse approach)	Census tracts (centroids), spatial location of households.	Lotfi & Koohsari (2009) Knox (1980) Talen (2002) Talen (2003)
Travel cost	Average distance between census blocks and local services (Walkable distances, car distances, etc.)	Census tracts	Handy & Niemeier (1997) Vandenbulcke, Steenberghen & Thomas (2009)
Gravity Measures	Gradual decrease in accessibility as the travel time to destinations increases.	Census tracts or spatial location of households if it is available.	Pacione (1989) Truelove (1993) Talen & Anselin (1998)

Table 10: Accessibility measures. Alternative approaches

Measurement Approach	Definition
Infrastructure-based measures	These measures have the purpose to analyze the observed or simulated performed of the transport infrastructure. This approach includes the level of congestions of a road network.
Activity-based measures	This approach includes the analysis of accessibility given the range of activities that can be found in a destination. It can consider competition effects (based on gravity model measures). Finally, this analysis considers the degree of impedance or attraction given the quantity and quality of activities.
Person-based measures	This analysis assumes that accessibility applies to an individual at a particular time and place. In this sense, accessibility measures are used as an attribute of individuals, by evaluating how individual's abilities can affect the accessibility to opportunities given their program daily activities and spatial-temporal constraints. This approach uses different measures of accessibility which consider trip purposes, transport nodes, income, gender, age, occupational groups and activity types.
Utility-based measures	These measures compute accessibility at the individual level by considering not only user's characteristics. Also, this approach uses modal characteristics of transport system as the travel time. It is assumed that people face a cardinal utility and then, select the alternative that reports a maximum utility. Next, the utility function is represented by the sum of a deterministic component and a stochastic component. Finally, control variables are included into the function to account for attributes of each choice, attractiveness of destinations and travel impedance, as well as, socioeconomic characteristics of individuals (households), tastes and preferences.

Based on classification presented by Vandenbulcke, Steenberghen & Thomas (2009)

Table 11: Summary of information sources of local public services

Local facility	Source	Variables
Transport	Ministry of Transport (www.transantiago.cl) (www.mtt.gob.cl)	Location of bus stops and subways. Frequency: number of stops per day. (February 2017)
Schools	Ministry of Education (www.mineduc.cl)	Location of schools (incluying private and semiprivate schools). SIMCE scores from 2012-2015.
Hospitals	Ministry of Health (www.minsal.cl)	Location of hospitals
Parks	Municipal Council of Santiago (www.intendenciametropolitana.gov.cl)	Location of Parks Green area (surface).
Kindergartens	• National Board of Day-Care Centers; Junta Nacional de Jardines Infantiles (JUNJI). • INTEGRA Foundation (Fundación Integra)	Location of Kindergartens.
Fire Stations	National Board of Fire-fighters of Chile (http://www.bomberos.cl)	Location of Fire Stations.
Police	Police of Chile (Carabineros de Chile) (www.carabineros.cl)	Location of Police Stations.
Culture	IDE – OCUC (Observatory of cities Pontifical Catholic University of Chile; 2016).	Location of cultural centers, museums, libraries.

Table 12: Buffer areas and attractiveness measure for spatial accessibility index

Local public service	Buffer
Transportation	• Bus stops: 400 meters. • Subway stations:4000 meters.
Education (Also, it includes semi-private education and private education)	2000 meters
Hospitals	2000 meters
Parks	2000 meters
Kindergartens	2000 meters.
Fire Stations	4000 meters
Police Stations	4000 meters
Culture	4000 meters

Table 13: Summary statistics of variables

Variable	Observations	Mean	SD	Min	Max
Mean of Housing Price by Block	44170	22.700.000	62.100.000	1.300.000	7.190.000.000
Share of exempted housing	44170	1	0	0	1
Number of superior quality housing by block	44170	0	4	0	263
Number of medium-superior quality housing by block	44170	5	34	0	1.085
Number of medium quality housing by block	44170	17	61	0	1.601
Number of medium-low quality housing by block	44170	29	36	0	1.076
Number of low quality housing by block	44170	4	10	0	695
Accessibility to private schools	44170	558	1.114	0	8.025
Accessibility to semi-private schools	44170	6.545	3.650	0	22.946
Accessibility to public schools	44170	2.077	1.413	0	6.901
Accessibility to private schools with more than 250 SIMCE	44170	334	741	0	5.529
Accessibility to semi-private schools with more than 250 SIMCE	44170	1.984	1.302	0	8.539
Accessibility to public schools with more than 250 SIMCE	44170	281	446	0	3.400
Accessibility to subway stations	44170	1.345	1.560	0	9.736
Accessibility to bus stations	44170	1.788	1.125	0	8.024
Accessibility to parks	44170	15.675	10.585	0	55.210
Accessibility to parques with more than 5750 square meters	44170	1.242	1.146	0	8.095
Accessibility to public hospitals	44170	511	500	0	4.121
Accessibility to public kindergartens	44170	2.107	1.507	0	6.919
Accessibility to fire stations	44170	1.165	733	0	5.916
Accessibility to police stations	44170	1.033	701	0	4.301
Accessibility to culture	44170	2.742	4.787	0	44.132

Table 14: OLS and Quantile Regression Estimates for Public Schools

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.00000204**	-0.00000296***	-0.00000432***	-0.00000444***	-0.00000141***
	(-2.79)	(-26.67)	(-26.48)	(-22.30)	(-4.42)
Share of exempted housing from property taxes by block	869.9***	490.7***	756.5***	1202.1***	1113.3***
	(16.58)	(23.62)	(24.75)	(32.25)	(18.64)
Number of superior quality housing by block	-10.10***	2.441	2.411	-4.284	-16.68**
	(-3.83)	(1.35)	(0.91)	(-1.32)	(-3.21)
Number of medium-superior quality housing by block	0.0626	-0.898***	-0.627*	0.819*	0.771
	(0.24)	(-4.71)	(-2.24)	(2.40)	(1.41)
Number of medium quality housing by block	1.380***	0.313**	1.446***	1.809***	1.716***
	(10.88)	(2.92)	(9.18)	(9.42)	(5.58)
Number of medium-low quality housing by block	-0.0115	0.913***	-0.113	-0.868**	-0.606
	(-0.06)	(5.12)	(-0.43)	(-2.71)	(-1.18)
Number of low quality housing by block	13.55***	17.61***	27.08***	27.13***	3.148
	(6.82)	(27.82)	(29.10)	(23.90)	(1.73)
Constant	1356.6***	579.0***	1226.0***	1998.7***	3670.1***
	(23.18)	(30.24)	(43.54)	(58.20)	(66.69)
Observations	44170	44170	44170	44170	44170
R^2	0.085	0.065	0.058	0.0579	0.019

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 15: OLS and Quantile Regression Estimates for Private Schools

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-7.68e-08	-1.69e-20	0.000000673***	0.00000129***	0.00000130***
	(-0.47)	(-0.00)	(11.47)	(11.13)	(6.69)
Share of exempted housing from property taxes by block	-1636.1***	-329.9***	-1117.0***	-2249.8***	-4630.2***
	(-63.78)	(-71.69)	(-101.72)	(-103.57)	(-127.11)
Number of superior quality housing by block	-14.10***	-3.391***	-12.86***	-22.89***	-22.69***
	(-5.55)	(-8.46)	(-13.44)	(-12.10)	(-7.15)
Number of medium-superior quality housing by block	4.028***	3.088***	5.759***	8.938***	4.201***
	(11.27)	(73.15)	(57.16)	(44.85)	(12.57)
Number of medium quality housing by block	2.532***	0.838***	2.554***	3.843***	4.610***
	(18.59)	(35.35)	(45.14)	(34.33)	(24.55)
Number of medium-low quality housing by block	0.429***	1.04e-15	0.0756	0.571**	2.122***
	(4.31)	(0.00)	(0.80)	(3.06)	(6.79)
Number of low quality housing by block	-3.306***	-0.0294	-0.275	-3.921***	-4.835***
	(-4.98)	(-0.21)	(-0.82)	(-5.93)	(-4.36)
Constant	1804.7***	329.9***	1123.4***	2464.0***	5391.3***
	(69.55)	(77.80)	(111.03)	(123.10)	(160.63)
Observations	44170	44170	44170	44170	44170
R^2	0.399	0.051	0.182	0.317	0.537

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 16: OLS and Quantile Regression Estimates for Semi-Private Schools

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.00000581**	-0.00000691***	-0.0000138***	-0.0000130***	-0.00000262*
	(-2.74)	(-23.43)	(-43.60)	(-29.27)	(-2.31)
Share of exempted housing from property taxes by block	2956.4***	3572.8***	3160.4***	2971.1***	-360.9
	(19.41)	(64.69)	(53.45)	(35.67)	(-1.70)
Number of superior quality housing by block	-25.66***	4.687	17.32***	-12.39	-64.97***
	(-3.33)	(0.97)	(3.36)	(-1.71)	(-3.51)
Number of medium-superior quality housing by block	-5.795***	-1.967***	-5.965***	-5.089***	-7.551***
	(-8.87)	(-3.88)	(-11.00)	(-6.66)	(-3.88)
Number of medium quality housing by block	1.631***	1.213***	1.751***	1.769***	1.190
	(5.90)	(4.26)	(5.74)	(4.12)	(1.09)
Number of medium-low quality housing by block	-0.276	-1.131*	-0.832	-1.342	1.179
	(-0.53)	(-2.39)	(-1.64)	(-1.88)	(0.65)
Number of low quality housing by block	1.416	4.565**	-5.319**	-4.758	2.408
	(0.86)	(2.71)	(-2.95)	(-1.88)	(0.37)
Constant	4327.7***	1556.6***	3830.0***	6247.4***	13477.4***
	(25.35)	(30.59)	(70.30)	(81.40)	(68.91)
Observations	44170	44170	44170	44170	44170
R^2	0.131	0.162	0.094	0.043	0.005

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 17: OLS and Quantile Regression Estimates for Public Schools with scores over 250 in SIMCE

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.000000479*	-1.00e-09	-0.000000429***	-0.00000106***	-0.000000118
	(-2.52)	(-0.29)	(-11.72)	(-13.96)	(-0.81)
Share of exempted housing from property taxes by block	-247.1***	0.913	-123.8***	-342.9***	-1111.5***
	(-15.63)	(1.39)	(-18.08)	(-24.04)	(-40.76)
Number of superior quality housing by block	-5.521***	-0.0961	-1.678**	-4.553***	-8.335***
	(-5.69)	(-1.68)	(-2.81)	(-3.66)	(-3.51)
Number of medium-superior quality housing by block	0.673***	0.0165**	0.499***	1.479***	0.523*
	(5.23)	(2.74)	(7.94)	(11.30)	(2.09)
Number of medium quality housing by block	1.191***	0.182***	1.408***	1.708***	2.036***
	(18.72)	(53.95)	(39.91)	(23.23)	(14.49)
Number of medium-low quality housing by block	0.0116	-0.000109	-0.0562	-0.126	0.554*
	(0.20)	(-0.02)	(-0.96)	(-1.03)	(2.37)
Number of low quality housing by block	-3.030***	-0.00428	-1.386***	-6.005***	-4.070***
	(-7.09)	(-0.21)	(-6.65)	(-13.82)	(-4.90)
Constant	478.1***	-0.897	183.6***	717.3***	1978.5***
	(27.76)	(-1.49)	(29.12)	(54.58)	(78.74)
Observations	44170	44170	44170	44170	44170
R^2	0.098	0.0008	0.029	0.058	0.167

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 18: OLS and Quantile Regression Estimates for Private schools with scores over 250 in SIMCE

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	0.000000257*	4.33e-08*	0.000000451***	0.00000257***	0.00000211***
	(2.36)	(2.18)	(17.00)	(39.83)	(12.40)
Share of exempted housing from property taxes by block	-1120.4***	-209.9***	-733.6***	-1470.1***	-3073.5***
	(-67.11)	(-56.36)	(-147.83)	(-121.47)	(-96.67)
Number of superior quality housing by block	-6.946***	0.209	-4.186***	-13.29***	-15.69***
	(-4.54)	(0.65)	(-9.68)	(-12.61)	(-5.66)
Number of medium-superior quality housing by block	2.628***	1.764***	4.233***	6.527***	3.704***
	(10.00)	(51.64)	(92.98)	(58.79)	(12.70)
Number of medium quality housing by block	1.338***	0.348***	0.874***	1.972***	3.371***
	(15.38)	(18.14)	(34.18)	(31.61)	(20.57)
Number of medium-low quality housing by block	0.305***	0.000263	0.000712	0.157	1.657***
	(4.36)	(0.01)	(0.02)	(1.51)	(6.07)
Number of low quality housing by block	-1.932***	-0.0271	-0.0132	-0.749*	-4.089***
	(-5.04)	(-0.24)	(-0.09)	(-2.03)	(-4.22)
Constant	1185.7***	209.3***	730.8***	1493.6***	3492.1***
	(70.32)	(61.00)	(159.85)	(133.94)	(119.20)
Observations	44170	44170	44170	44170	44170
R^2	0.412	0.044	0.206	0.368	0.531

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 19: OLS and Quantile Regression Estimates for Semi-Private Schools with scores over 250 in SIMCE

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.00000189**	-0.00000172***	-0.00000343***	-0.00000492***	-0.00000100**
	(-2.72)	(-16.06)	(-28.02)	(-27.80)	(-2.86)
Share of exempted housing from property taxes by block	552.8***	753.7***	849.3***	372.5***	-618.3***
	(10.81)	(37.51)	(37.06)	(11.25)	(-9.46)
Number of superior quality housing by block	-9.560***	1.280	1.676	-3.402	-23.31***
	(-3.69)	(0.73)	(0.84)	(-1.18)	(-4.10)
Number of medium-superior quality housing by block	-1.952***	-0.763***	-1.431***	-2.968***	-2.153***
	(-7.24)	(-4.14)	(-6.80)	(-9.77)	(-3.59)
Number of medium quality housing by block	1.796***	1.260***	1.625***	2.305***	3.434***
	(14.40)	(12.17)	(13.76)	(13.51)	(10.20)
Number of medium-low quality housing by block	0.985***	0.512**	0.927***	1.414***	0.996
	(5.05)	(2.97)	(4.71)	(4.97)	(1.78)
Number of low quality housing by block	-3.876***	-1.848**	-3.144***	-6.744***	-9.387***
	(-6.98)	(-3.02)	(-4.51)	(-6.69)	(-4.72)
Constant	1552.9***	474.0***	1151.0***	2457.4***	4853.2***
	(27.27)	(25.61)	(54.50)	(80.56)	(80.59)
Observations	44170	44170	44170	44170	44170
R^2	0.054	0.075	0.054	0.022	0.016

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 20: OLS and Quantile Regression Estimates for Transportation. Buses

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.00000138**	-0.00000153***	-0.00000291***	-0.00000327***	-0.00000106***
	(-3.11)	(-12.51)	(-24.76)	(-24.36)	(-4.14)
Share of exempted housing from property taxes by block	644.8***	631.9***	575.8***	605.3***	852.3***
	(19.17)	(27.60)	(26.17)	(24.09)	(17.82)
Number of superior quality housing by block	-9.718***	-1.362	-5.103**	-5.823**	-13.76***
	(-4.88)	(-0.68)	(-2.66)	(-2.66)	(-3.30)
Number of medium-superior quality housing by block	0.945***	0.488*	0.717***	0.882***	1.830***
	(4.73)	(2.32)	(3.55)	(3.83)	(4.17)
Number of medium quality housing by block	0.369***	0.297*	0.204	0.199	0.522*
	(3.69)	(2.51)	(1.80)	(1.54)	(2.12)
Number of medium-low quality housing by block	-0.0620	0.494*	-0.0511	-0.439*	-2.005***
	(-0.41)	(2.52)	(-0.27)	(-2.03)	(-4.88)
Number of low quality housing by block	-0.494	-0.483	-1.522*	-0.709	-1.172
	(-0.92)	(-0.69)	(-2.27)	(-0.93)	(-0.80)
Constant	1299.9***	504.1***	1311.0***	2063.6***	3114.1***
	(35.25)	(23.90)	(64.66)	(89.13)	(70.66)
Observations	44170	44170	44170	44170	44170
R^2	0.058	0.043	0.0359	0.030	0.024

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 21: OLS and Quantile Regression Estimates for Transportation: Subway

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.00000152*	-0.000000683***	-0.00000395***	-0.00000301***	-1.18e-08
	(-2.06)	(-10.58)	(-21.41)	(-15.74)	(-0.02)
Share of exempted housing from property taxes by block	-656.1***	-136.8***	-880.0***	-1028.0***	-2278.5***
	(-11.59)	(-11.31)	(-25.49)	(-28.70)	(-21.00)
Number of superior quality housing by block	-19.10***	-3.204**	-8.764**	-15.79***	-29.92**
	(-5.60)	(-3.04)	(-2.92)	(-5.06)	(-3.17)
Number of medium-superior quality housing by block	3.519***	1.532***	4.283***	4.616***	4.320***
	(7.92)	(13.80)	(13.53)	(14.05)	(4.34)
Number of medium quality housing by block	6.418***	3.989***	6.908***	8.290***	11.09***
	(29.45)	(64.01)	(38.83)	(44.91)	(19.84)
Number of medium-low quality housing by block	0.816***	0.722***	3.197***	0.962**	-1.330
	(4.22)	(6.96)	(10.79)	(3.13)	(-1.43)
Number of low quality housing by block	-5.657***	-0.00328	-3.628***	-7.032***	-16.57***
	(-8.72)	(-0.01)	(-3.45)	(-6.45)	(-5.02)
Constant	1779.1***	139.0***	1529.5***	2907.1***	5885.7***
	(28.35)	(12.47)	(48.09)	(88.10)	(58.89)
Observations	44170	44170	44170	44170	44170
R^2	0.122	0.015	0.047	0.073	0.073

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 22: OLS and Quantile Regression Estimates for Urban Public Parks

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.00000526*	-0.00000729***	-0.0000105***	-0.0000146***	-0.00000676*
	(-2.23)	(-9.78)	(-9.57)	(-9.87)	(-2.36)
Share of exempted housing from property taxes by block	1164.7***	-400.7**	-465.2*	1407.7***	6200.4***
	(5.23)	(-2.87)	(-2.26)	(5.10)	(11.58)
Number of superior quality housing by block	-71.00***	-27.64*	-44.86*	-64.36**	-64.52
	(-5.41)	(-2.27)	(-2.50)	(-2.68)	(-1.38)
Number of medium-superior quality housing by block	-9.014***	3.670**	-6.019**	-12.41***	-20.92***
	(-9.64)	(2.87)	(-3.18)	(-4.90)	(-4.26)
Number of medium quality housing by block	-2.654***	2.985***	-2.420*	-8.821***	-19.40***
	(-4.69)	(4.15)	(-2.28)	(-6.20)	(-7.03)
Number of medium-low quality housing by block	-0.852	-2.360*	1.990	1.901	-10.29*
	(-0.57)	(-1.97)	(1.12)	(0.80)	(-2.24)
Number of low quality housing by block	-140.3***	-48.28***	-119.1***	-202.2***	-271.6***
	(-9.38)	(-11.36)	(-18.97)	(-24.06)	(-16.65)
Constant	15531.6***	8552.7***	14303.8***	21701.9***	33849.8***
	(68.81)	(66.52)	(75.29)	(85.34)	(68.59)
Observations	44170	44170	44170	44170	44170
R^2	0.022	0.024	0.050	0.068	0.140

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 23: OLS and Quantile Regression Estimates for Urban Public Parks with more than 5750 mts2

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-9.56e-08	-0.000000317***	3.69e-08	0.000000377**	0.000000446
	(-0.62)	(-4.06)	(0.34)	(2.65)	(1.46)
Share of exempted housing from property taxes by block	-751.5***	-380.5***	-709.4***	-811.1***	-1925.8***
	(-31.58)	(-26.06)	(-34.50)	(-30.53)	(-33.62)
Number of superior quality housing by block	-6.882**	-6.518***	-11.27***	-6.556**	-3.754
	(-3.21)	(-5.13)	(-6.29)	(-2.83)	(-0.75)
Number of medium-superior quality housing by block	1.979***	2.443***	2.732***	2.879***	1.317*
	(8.22)	(18.25)	(14.48)	(11.81)	(2.51)
Number of medium quality housing by block	2.460***	1.538***	2.338***	3.237***	5.973***
	(18.34)	(20.45)	(22.06)	(23.65)	(20.23)
Number of medium-low quality housing by block	-0.704***	-0.295*	-0.830***	-0.986***	-1.096*
	(-5.00)	(-2.35)	(-4.70)	(-4.32)	(-2.23)
Number of low quality housing by block	-3.991***	-0.647	-4.062***	-5.917***	-7.883***
	(-7.70)	(-1.45)	(-6.49)	(-7.31)	(-4.52)
Constant	1829.3***	724.5***	1578.8***	2386.5***	4777.0***
	(77.85)	(53.87)	(83.32)	(97.50)	(90.50)
Observations	44170	44170	44170	44170	44170
R^2	0.112	0.024	0.050	0.068	0.140

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 24: OLS and Quantile Regression Estimates for Public Healthcare centers

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.000000453**	-3.70e-09	-0.000000470***	-0.000000920***	-0.000000478**
	(-2.59)	(-0.10)	(-9.30)	(-13.87)	(-2.68)
Share of exempted housing from property taxes by block	175.5***	123.5***	264.8***	311.5***	-51.40
	(12.24)	(18.25)	(27.98)	(25.10)	(-1.54)
Number of superior quality housing by block	-2.082**	0.00323	0.170	-1.088	-4.691
	(-3.17)	(0.01)	(0.21)	(-1.01)	(-1.62)
Number of medium-superior quality housing by block	-0.0770	0.000774	-0.0774	0.172	-0.546
	(-1.05)	(0.01)	(-0.89)	(1.51)	(-1.79)
Number of medium quality housing by block	0.503***	-0.00113	0.328***	0.631***	1.586***
	(9.36)	(-0.03)	(6.71)	(9.86)	(9.23)
Number of medium-low quality housing by block	0.0219	0.0221	0.318***	0.114	0.00427
	(0.30)	(0.38)	(3.91)	(1.07)	(0.01)
Number of low quality housing by block	6.606***	8.404***	9.129***	11.08***	15.04***
	(7.45)	(40.79)	(31.67)	(29.31)	(14.82)
Constant	347.4***	0.416	145.3***	463.5***	1446.9***
	(22.55)	(0.07)	(16.66)	(40.53)	(47.12)
Observations	44170	44170	44170	44170	44170
R^2	0.046	0.047	0.053	0.038	0.022

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 25: OLS and Quantile Regression Estimates for Kindergartens

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.00000167**	-0.000000275*	-0.00000154***	-0.00000313***	-0.00000171***
	(-3.03)	(-2.27)	(-9.70)	(-19.14)	(-5.82)
Share of exempted housing from property taxes by block	1672.6***	1153.2***	1957.9***	2204.4***	2411.1***
	(41.33)	(50.76)	(65.75)	(72.10)	(43.79)
Number of superior quality housing by block	-1.857	0.318	3.293	1.239	-8.795
	(-1.05)	(0.16)	(1.27)	(0.47)	(-1.83)
Number of medium-superior quality housing by block	-0.723***	-0.0441	-0.755**	-0.851**	-1.352**
	(-4.92)	(-0.21)	(-2.76)	(-3.03)	(-2.68)
Number of medium quality housing by block	-0.989***	-0.313**	-0.794***	-0.789***	-0.515
	(-8.81)	(-2.67)	(-5.17)	(-5.01)	(-1.81)
Number of medium-low quality housing by block	0.439*	1.295***	0.883***	-0.251	0.478
	(2.32)	(6.64)	(3.46)	(-0.95)	(1.01)
Number of low quality housing by block	11.82***	20.32***	17.99***	10.77***	6.185***
	(6.58)	(29.38)	(19.84)	(11.57)	(3.69)
Constant	773.9***	36.65	387.0***	1242.1***	2588.5***
	(17.39)	(1.75)	(14.10)	(44.09)	(51.03)
Observations	44170	44170	44170	44170	44170
R^2	0.222	0.151	0.158	0.133	0.104

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 26: OLS and Quantile Regression Estimates for Fire Stations

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.00000110**	-0.00000194***	-0.00000214***	-0.00000250***	-0.000000146
	(-2.58)	(-33.19)	(-30.24)	(-29.37)	(-0.80)
Share of exempted housing from property taxes by block	33.10	159.4***	177.2***	-104.3***	-1375.6***
	(1.04)	(14.54)	(13.35)	(-6.54)	(-40.04)
Number of superior quality housing by block	-11.11***	-0.264	-2.908*	-6.821***	-15.93***
	(-5.47)	(-0.28)	(-2.52)	(-4.91)	(-5.32)
Number of medium-superior quality housing by block	1.666***	0.370***	0.710***	2.415***	3.058***
	(5.92)	(3.68)	(5.83)	(16.52)	(9.70)
Number of medium quality housing by block	3.274***	1.054***	2.578***	4.419***	7.182***
	(25.72)	(18.66)	(37.71)	(53.82)	(40.57)
Number of medium-low quality housing by block	0.00118	-0.0865	-0.186	0.0417	0.908**
	(0.01)	(-0.92)	(-1.63)	(0.31)	(3.08)
Number of low quality housing by block	1.402***	2.138***	4.177***	7.432***	-0.459
	(3.44)	(6.40)	(10.34)	(15.32)	(-0.44)
Constant	1097.1***	605.3***	916.4***	1561.9***	3217.8***
	(30.74)	(59.93)	(74.96)	(106.39)	(101.66)
Observations	44170	44170	44170	44170	44170
R^2	0.089	0.0354	0.027	0.042	0.226

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 27: OLS and Quantile Regression Estimates for Police Stations

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.000000800**	-0.00000132***	-0.00000178***	-0.00000164***	-0.000000416
	(-2.65)	(-22.63)	(-28.52)	(-22.11)	(-1.29)
Share of exempted housing from property taxes by block	206.0***	197.3***	176.3***	128.0***	222.0***
	(9.04)	(18.02)	(15.08)	(9.19)	(3.68)
Number of superior quality housing by block	-5.606***	0.344	-0.311	-3.602**	-9.321
	(-4.44)	(0.36)	(-0.31)	(-2.97)	(-1.77)
Number of medium-superior quality housing by block	-0.277	-0.665***	-0.912***	-0.499***	0.957
	(-1.59)	(-6.62)	(-8.50)	(-3.90)	(1.73)
Number of medium quality housing by block	1.282***	0.657***	1.053***	1.603***	1.976***
	(17.84)	(11.64)	(17.48)	(22.34)	(6.35)
Number of medium-low quality housing by block	0.739***	0.441***	0.541***	0.794***	1.760***
	(7.32)	(4.69)	(5.40)	(6.64)	(3.40)
Number of low quality housing by block	3.957***	4.490***	3.707***	4.418***	10.78***
	(5.83)	(13.46)	(10.41)	(10.42)	(5.87)
Constant	831.2***	397.5***	776.3***	1212.8***	2197.1***
	(33.12)	(39.39)	(72.07)	(94.51)	(39.52)
Observations	44170	44170	44170	44170	44170
R^2	0.038	0.043	0.028	0.019	0.015

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 28: OLS and Quantile Regression Estimates for Culture Equipment

	OLS	**Q(.25)**	**Q(.5)**	**Q(.75)**	**Q(.95)**
Mean of Housing Price by Block	-0.00000197*	-0.000000969***	-0.00000213***	-0.000000197	-0.000000677
	(-2.11)	(-8.35)	(-10.60)	(-0.57)	(-0.31)
Share of exempted housing from property taxes by block	-1881.0***	-139.1***	-882.9***	-1081.8***	-14762.7***
	(-15.71)	(-6.41)	(-23.47)	(-16.56)	(-36.12)
Number of superior quality housing by block	-38.22***	-11.52***	-26.22***	-12.97*	-98.24**
	(-4.67)	(-6.09)	(-8.00)	(-2.28)	(-2.76)
Number of medium-superior quality housing by block	15.89***	6.909***	14.60***	29.63***	21.51***
	(8.46)	(34.68)	(42.32)	(49.44)	(5.74)
Number of medium quality housing by block	24.15***	3.014***	11.01***	35.47***	66.31***
	(24.78)	(26.93)	(56.80)	(105.36)	(31.48)
Number of medium-low quality housing by block	-2.569***	0.846***	0.222	-0.365	-0.441
	(-4.82)	(4.54)	(0.69)	(-0.65)	(-0.13)
Number of low quality housing by block	7.940***	16.22***	23.78***	22.00***	52.82***
	(5.07)	(24.52)	(20.76)	(11.06)	(4.24)
Constant	3852.2***	650.6***	2042.4***	3358.2***	20208.5***
	(30.99)	(32.52)	(58.92)	(55.79)	(53.66)
Observations	44170	44170	44170	44170	44170
R^2	0.170	0.012	0.038	0.094	0.270

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Chapter 3

Capitalization of urban amenities into housing prices. Estimating the spatial relationships between urban amenities and property values for the Metropolitan Area of Santiago, Chile.

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Abstract

Urban amenities have received a great attention by the scientific literature because their spatial distribution can explain why some cities are more attractive than others. On the other hand, this stylized fact has important consequences on regional economic growth, urban population, as well as, labor and housing markets. In this paper, we explore the relationship between housing prices and urban amenities through a hedonic pricing model and 27 urban amenities for the main Chilean urban agglomeration, the Metropolitan Region of Santiago (MR). By doing so, we recognize that the capitalization of urban amenities into housing prices is spatially heterogeneous distributed and then, we study this relationship by using geographically weighted regression (GWR). Main results suggest that urban amenities play an important role in determining housing prices with a significant spatial heterogeneity on their capitalizations. However, clear differences between public and private local services are found. Particularly, private services such as schools, shopping centers, healthcare centers or restaurants have positive capitalizations on housing prices. By the contrary public schools, public hospitals or public kindergartens have negative valuations in housing prices, evidencing that living closer to these services is not advantageous for residents. Possible explanations for these results can be related to several administrative and financial restrictions that local governments face providing local public services. Finally, a

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correct land management is required for an optimal use of these amenities, especially in the poorest communities with higher demands for local public services.

Key words: Urban amenities, hedonic models, housing values, local governments.

JEL-CODES: H42, R23

1. Introduction

The reasons why some cities are more attractive than others have been extensively documented by urban economists and geographers (Glaeser, Gyourko, & Saks, 2006) (Glaeser, Kolko, & Saiz, 2000). Traditionally, internal and external economies of scale in the production process are used to explain why cities differ in terms of their size and economic structure (Garretsen & Marlet, 2017). However, more recent empirical studies in urban economics suggest that the reasons behind the attractiveness of cities go beyond the agglomeration benefits and intra-industry spillovers. Urban amenities, defined as location-specific goods and services that make some locations more attractive, are also relevant to explain why some cities attract more people and businesses than others (Nilsson, 2014). In this vein, when explaining urban growth and local development patterns, a large empirical body of research emphasizes that the spatial distribution of amenities matters, because they might stimulate regional economic growth, urban population, employment and the creative class (Li, Wei, Yu, & Tian, 2016). Recognizing that amenities affect household migration decisions is equivalent to state that both labor and housing markets depend on such people movements, which configures the stylized fact that wages and housing prices are heterogeneous across cities (Glaeser, Kolko, & Saiz, 2000) (Glaeser, Gyourko, & Saks, 2006)

Since housing is a composite good, its final price is not only determined by its structural characteristics, but also, by its neighborhood attributes such as the accessibility to transportation, labor markets, fire stations, local public services, cultural structure and other amenities (Li, Wei, Yu, & Tian, 2016). In this context,

a more attractive city due to its high-quality amenities implies an increased demand for housing, that is, amenities are capitalized into housing values (Roback, 1982, 1988). Consequently, individuals that consider site characteristics when making their location decisions might be willing to pay higher housing values to live in more attractive environments. This reasoning is also supported by the public choice theory which suggests that individuals are willing to pay more for living in communities with high-quality local public services provided by local governments (Tiebout, 1956). Accordingly, high-quality services can act as attracting forces of people willing to pay higher housing prices, which creates a virtuous circle for local governments by increasing their revenues to provide better services (Li H. , Wang, Shi, Deng, & Wang, 2017).

The aim of this paper is to study the relationship between urban amenities and housing prices in the main Chilean urban agglomeration, the Metropolitan Region of Santiago (MR). The MR is a conurbation that contains 37 communes and concentrates the most important public institutions, businesses, culture structure, and financial institutions. The case is selected mainly for two reasons. First, the MR agglomerates more than 40 percent of the Chilean population, becoming in the densest region of the country (National Institute of Statistics, 2017). Moreover, the MR concentrates more than 50 percent of high-skilled workers (Aroca & Atienza, 2011) (SUBDERE, 2012). Second, although it is well known the power that MR exerts over other regions to attract more talented people and firms, this scenario contrasts with marked differences in living standard measures within the MR. According to the results of the Quality Life Scores, only 20.5 percent of inhabitants are living in communities that provide high-quality amenities, meanwhile 79.5 of the MR population located in places that offer medium and lower quality amenities (Instituto de Estudios Urbanos y Territoriales, 2016). These characteristics make the MR an interesting scenario to analyze how a heterogeneous set of urban amenities are capitalized into housing prices.

To meet our objective, we recognize that the capitalization of urban amenities into housing prices is likely to be spatially heterogeneous across the MR. This is because

household location decisions, among other things, depends on their preferences to amenities, which in turn are strongly conditioned by their personal traits such as age, schooling, and marital status. For instance, while married people with children would locate in a commune because it offers a high variety of restaurants and recreational activities, meanwhile single individuals might prefer to be located near shopping centers. Consequently, an average estimated parameter will hide a potential heterogeneity between housing prices and the above-mentioned amenities. In doing so, this paper contributes to the growing literature in at least two aspects. First, a better understanding of the housing market is achieved by taking into account its local-spatial character. Second, this paper helps to interpret correctly the behavior of housing markets and urban amenities into developing country contexts. This is critical because public policies, urban regulations, institutional frameworks as well as urban services in developing countries differ from those in developed economies, and consequently, we contribute by enlarging the empirical evidence that provides valuable elements to both policymakers and scholars about the behavior of housing markets in less developed economies characterized by a higher urban primacy.

We use the geographically weighted regression (GWR) (Fotheringhan, Brunsdon, & Charlton, 2002) to test the relationship between average housing values by block in the MR and 27 urban amenities provided by official data sources and geographical information systems (GIS). Among our main findings, we observe that urban amenities play an important role in determining housing prices. Moreover, we confirm that the capitalization of urban amenities on housing prices is spatially heterogeneous across the MR. However, modern amenities show mixed results and make a clear distinction between public and private services. In this sense, private services have positive capitalizations into housing prices, meanwhile, public services have a negative valuation in housing prices. A possible explanation for these results can be found on the several administrative and financial restrictions that local governments face for providing local public services. Consequently, the spatial distribution of local public services could not be sufficient to satisfy all

resident's demand, as well as, a possible mismatch between local public supply and residential needs could be found in the MR context.

The rest of this paper is organized as follows. The next section reviews the existing literature and highlights the key elements to consider into the analysis. The third section devotes to explain the case of study and the fundamentals of GWR methodology. The four section discusses the main results along with their policy implications. Finally, the last section concludes.

2. Framework

Urban amenities are receiving a growing interest in the scientific research due to its important role in urban growth and urban developing patterns. A large empirical literature suggests that urban amenities can also help to explain why some cities are more attractive for workers and firms (Garretsen & Marlet, 2017). Urban amenities are defined as location-specific goods and services that make cities more attractive and are associated with positive externalities from agglomeration and intra-industry spillovers (Nilsson, 2014). In this way, the recognition of urban amenities as critical factors on urban development has started to change the conventional definition of cities. Traditionally, cities have been viewed as production centers and their growth is associated with agglomeration effects where internal and external economies of scale have a relevant participation in explaining why cities differ. An extensive body of literature starting by the seminal work proposed by Henderson (1974) explained how the exploitation of different economies of scale and production specialization in different traded goods can determine the city size and economic growth. Due to the recognition of the important role of amenities in urban growth, cities now can be viewed as consumer cities and their attractiveness depends also on urban amenities influencing directly on location decisions, lifestyle choices or quality of life (Roback, 1982) (Glaeser, Gyourko, & Saks, 2006) (Rappaport, 2008). Indeed, Roback (1988) and extending her previous work, studied the influence of local-specific amenities on wages and housing prices using the hedonic price model proposed by Rosen (1974). Main results suggest that wage differentials are produced by differences in amenities across regions which are exacerbated by the

inclusion of the cost of living. On the other hand, Gottlieb (1995) went far beyond by arguing that amenities also have impacts on the location decisions of firms and then, amenities not only attract people, also can attract firms given the concentration of workforce. Since these seminal studies, other empirical works explore different arguments to conclude that the spatial distribution of amenities affects urban growth, regional development, as well as, housing and labor markets.

Particularly, numerous papers have paid special attention to effects of urban amenities on housing markets. This crucial market is directly affected by urban growth, especially because the elasticity of housing supply could determine how productivity increments may create bigger cities or increment wages and housing prices (Glaeser, Gyourko, & Saks, 2006). The impact of urban amenities on housing prices has been extensively studied using the hedonic pricing model proposed by Rosen (1974) in which utility of composite goods, like housing, are valued according to their attributes or characteristics. First studies demonstrated how housing values are determined by structural characteristics of houses such as materials, age, surface, property's ownership, number of bedrooms and others. Over time, numerous studies have demonstrated how housing prices also are affected by the characteristics of neighborhoods. Under this logic, individuals could be willing to pay more for living in locations that provide better amenities around houses. If these amenities exist, residents can enjoy a favorable trade-off between amenities and commuting costs (Li, Wei, Yu, & Tian, 2016). According to empirical studies, urban amenities can be categorized into three different groups: natural, historical and modern amenities (Brueckner, Thisse, & Zenou, 1999). Natural amenities are referred to topological and climate characteristics of the area where a house is located. This set of amenities includes exogenous variables such as temperature, precipitation, proximity to rivers, cultivated landscapes, water resources, open spaces and other elements. Moreover, this group can contain dis-amenities that can affect inversely housing prices such as high levels of pollution or nuisance. Studies about the effect of natural amenities on housing prices show mixed evidence about the effect of these characteristics on housing prices. For instance, Spacescape (2011) show for Stockholm, Oslo and Copenhagen that access

to open spaces is highly valued by residents. In addition, access to forest or water areas also has a positive effect on the capitalization of housing prices (Nilsson, 2014) (Shultz & King, 2001) (Yoo & Wagner, 2016). In fact, studies suggest that forests have a positive effect on the willingness to pay of residents. However, their negative valuations were associated with the management of that area (Tyrväinen, 2001). With respect to air quality, studies performed for Jakarta, Indonesia and many cities on the United States reported a negative relationship between housing prices and pollution, and consequently negative elasticities (Brasington & Hite) (Kim, Phipps, & Anselin, 2003).

On the other hand, historical amenities are composed of architectural amenities such as monuments, cultural infrastructure, parks or any other well-preserved building past centuries. Brueckner et Al. (1999) proved that historical amenities played an important role in attractiveness differences across European Cities. As a result, centers have a strong advantage in comparison with outer areas due to their better access to historical (exogenous) amenities where their valuations increase with household's incomes. One key to understanding this result is provided by government investments in city-center infrastructure which is used to maintain historical amenities given their rapid depreciation. Thus, a signal to understand why high-income individuals seek to relocate outside of cities is because historical amenities could be suffering maintenance lacks (Brueckner, Thisse, & Zenou, 1999). Finally, modern amenities are referred to man-constructed amenities like local public services such as schools, transportation, fire and police stations, hospitals and so on. Moreover, private urban amenities also can be included in the list: private schools and hospitals, shopping centers, banks, restaurants, and others. In general, these urban amenities are endogenous because partially can reflect the current economic state of cities and these are associated with high-income areas. Mainly, empirical research in modern amenities has been concentrated on determining the impact of public schools and transportation on location decisions. For instance, studies have found a significant positive relationship between public school quality and housing prices. Providing a comprehensive survey, Nguyen-Hoang and Yinger (2011) determined that housing values rise by 1-4 percent for a

one-standard deviation increase in student test scores. Also, other results evidence that school-capitalization also can help to understand residential sorting by permitting that individuals locate across jurisdictions given their willingness to pay for school quality. On the other hand, accessibility to transportation also has a positive valuation on housing prices because constitutes a key factor for accessing to labor markets, education infrastructure, etc. Mulley et Al (2016) showed for Brisbane, Australia that being closer to Bus Rapid Transit (BRT) increases housing prices by about 0.14 percent for every hundred meters. However, this urban amenity could be associated with negative effects on quality of life due to its high concentration of pollution or noise associated with the delivery of this service.

Other Important challenges that empirical studies on urban amenities should face are associated with the inherent spatial character that housing markets exhibit. This feature violates the assumption that housing prices are spatially independent. Previous studies found that housing markets can be affected by two problems: spatial autocorrelation and heterogeneity. Housing prices are spatially auto-correlated because are affected by land regulations and other building restrictions and therefore, housing units can share similar structural characteristics. Moreover, the inclusion of urban amenities also contributes to increasing spatial autocorrelation because houses are sharing location-amenities and neighborhood effects also can be similar into communities (Basu & Thomas G., 1998) (Dubin, 1992). On the other hand, housing prices could be heterogeneously distributed across space. The most relevant consequence associated to this issue is related with the surge of multiple submarkets across cities (Basu & Thomas G., 1998) and therefore, differences in neighborhood characteristics across communities could generate different valuations of urban amenities. In this sense, demand for houses may impact on the spatial distribution of urban amenities and their associated premium could be not homogeneous across space. Not to consider these issues can lead inefficient coefficients on the estimates of hedonic pricing models. In this paper, we address these problems by using spatial econometric methods which are presented in the next section.

3. Methodology and Data

3.1. Case of Study and Data

The Metropolitan Area of Santiago (MR) is the main Chilean agglomeration. The MR is a conurbation of 37 communes which concentrates more than 40 percent of the Chilean population and the most important public institutions, businesses, culture structure, and financial institutions are located there. These characteristics make the MR in an attractive pole for Chilean population for accessing to better services. For instance, the MR concentrates more than 50 percent of high-skilled workers (Aroca & Atienza, 2011) (SUBDERE, 2012). Moreover, 15 of the best universities are located on the MR and this situation motivates to talented students to move to the MR to access to universities with more prestige and international recognition. As a result, 47 percent of Chilean students are enrolled in universities of the MR (National Education Council, 2017). However, although it is well known the power that MR exerts over other regions to attract more people and firms, this scenario contrast with disparities in living standards that still persist within the MR. Particularly, only 8 communes located in the MR have indices of quality of life higher than the national average. This implies that 20.5 percent of inhabitants are living in communities that provide high-quality amenities. By contrast, 79.5 percent of the population are living in communities with medium and lower quality amenities (Instituto de Estudios Urbanos y Territoriales, 2016). These results determine that 64.6 percent of inhabitants reside in places with low mobility and connectivity, as well as, 43.6 percent of inhabitants live in communities with low housing quality. This scenario makes the MR in an interesting case to explore how a heterogeneous set of urban amenities are capitalized into housing prices.

In this paper, we analyze the relationship between housing prices and urban amenities using property fiscal values for the year 2017. This data was obtained from the Chilean Internal Revenue Service (SII; Servicio de Impuestos Internos). These values are computed by considering some structural characteristics of houses such as property land, build area, construction materials, age and use. In addition, this information is used to compute the territorial tax as a percentage of property

fiscal value. In absence of home sales data, we use property fiscal values as a proxy for housing prices. From this dataset, we extract the mean of property values by block which is the finer geographical scale georeferenced by SII. Once all information is processed, a dataset with housing prices and structural characteristics such as quality, age, surface and the proportion of exempted housing from local taxes was obtained for 43,843 blocks of all MR. Also, we include on this dataset the location of each block on the space whose is crucial to obtain neighborhood characteristics of houses. More details about these variables are shown in table 29.

On the other hand, a dataset of urban amenities was created from different official sources that provide georeferenced data of services delivered by local governments and privates. Also, the data was complemented with information obtained from open sources such as Open Street Maps (OSM) and Geographically Information Systems (GIS). The set of urban amenities is shown in table 30 and it is composed of natural amenities (Nuisance), historical amenities such as monuments, cultural equipment, parks and typical areas; and modern amenities such as schools (public, semi-private and private), transportation (bus stops and subway stations), public kindergartens, healthcare centers (public and private), universities and bicycle circuits. On the other hand, a set of crucial private services are included in this typical set. We consider the proximity to shopping centers, pharmacies, fast food restaurants, restaurants and banks have a positive valuation for residents and eventually can increase housing values. Finally, a set of indicators such as accidents, nuisance, housing camps and crime (housing burglary) are included like dis-amenities. These variables represent the regular congestion problems that biggest cities face every day. Except for housing camps, dis-amenities variables were constructed using spatial interpolation techniques by identifying information from monitoring stations about the number of accidents, number of housing burglary and nuisance levels located into the MR. Using inverse distance weighting method of interpolation, the average level of these dis-amenities is assigned to each spatial unit.

3.2. Geographically Weighted Regression (GWR)

With the purpose of studying the relationship between housing prices and attributes, usually, global statistics are performed. For example, hedonic pricing models historically have been estimated via Ordinary Least Square (OLS), however, this method omits an important detail about the behavior of housing markets: housing prices are spatially auto-correlated. As Basu & Thomas G. (1998) explain, housing prices are spatially auto-correlated mainly for two reasons. First, neighborhoods have similar structure characteristics because these tend to be developed at the same period of time. Second, neighborhoods are sharing amenities due to their location, and then individuals are closer to the same schools, hospitals, green areas, etc. Considering this scenario, analyses performed via OLS present two disadvantages that reduce the possibilities of obtaining accurate parameters when we suspect that relationships between housing prices and amenities vary over space. On one hand, if errors are spatially auto-correlated, parameters are inefficient and will produce incorrect intervals for estimated parameters. On the other hand, global statistics such as OLS hides important characteristics about the local behavior of parameters, assuming that average values are equal in every place of the study region (Fotheringhan, Brunsdon, & Charlton, 2002). In particular, average values assume the capitalization of amenities on housing prices does not present differentials across the space. The last statement is crucial to understand that OLS under spatial autocorrelation is not adequate to represent local variations and therefore, the production of local statistics can generate a better representation of housing markets providing much more information of spatial relationships, and finally, a better understanding of the capitalization of amenities into housing prices.

An explicit local modeling approach that permits that parameters vary over the space is Geographically Weighted Regression (GWR). This method extends OLS regression by allowing that parameters vary locally rather globally. Under GWR, the local parameters can be modeled as,

$$y_i = \beta_0(u_i, v_i) + \sum_k \beta_k(u_i, v_i) x_{ik} + \varepsilon_i$$

Where (u_i, v_i) denotes the coordinates of the ith point in the space, meanwhile $\beta_k(u_i, v_i)$ is the realization of the continuous function $\beta_k(u, v)$ in every point i. In this setup, the model allows that observations near to location i have more influence in the estimation of $\beta_k(u_i, v_i)$ rather than data located farther from i (Bitter, Mulligan, & Dall' erba, 2007). In doing so, GWR weights an observation according to its proximity to location i and then, observations closer to location i are weighted more than other data observations located in other farther places. In matrix notation, parameters of the GWR model are computed such as,

$$\widehat{\boldsymbol{\beta}}_{(u_i,v_i)} = (\boldsymbol{X}^T \boldsymbol{W}(u_i, v_i)\boldsymbol{X})^{-1}\boldsymbol{X}^T \boldsymbol{W}(u_i, v_i)\boldsymbol{y}$$

where $\boldsymbol{W}(u_i, v_i)$ is a spatial weighting matrix. This matrix denotes an n by n matrix that on the off-diagonal elements are zero meanwhile diagonal elements denote the geographical weighting of each n observation for regression point i. In contrast to weighted least square regression, GWR weights vary according to the location of point i rather than a constant weighted matrix by allowing that points in closer proximity have more weight into the computation of model parameters for location i (Fotheringhan, Brunsdon, & Charlton, 2002). The spatial weighted matrix $\boldsymbol{W}(u_i, v_i)$ that captures the relationship between regression points and data points is represented by a Gaussian function such as:

$$\boldsymbol{W}(u_i, v_i) = \exp\left[-\frac{1}{2}\left(\frac{d_{ij}}{b}\right)^2\right]$$

where d_{ij} is the Euclidean distance between points i and j, and b is the spatial bandwidth. The choice of b is crucial for GWR's results for two reasons. First, as a weighting procedure that specifies a wide bandwidth and allows a minimal distance decay can produce results like a global model. Second, if the bandwidth selected is narrow only near points will be considered, which will produce high variances in the estimators (Bitter, Mulligan, & Dall' erba, 2007). In this approach, we use adaptive spatial kernel because permits that the bandwidth varies according to the density of housing prices by assuming that some data points are sparsely distributed

across space. Moreover, this procedure ensures that an equal number of observations will receive a non-zero weighting at all regression points. Finally, the cross-validation approach is selected to optimize the bandwidth selection.

4. Estimation Strategy and Results

4.1. Estimation Strategy

The computation of spatial econometric models is a high-demand computational task. For instance, invert a W matrix of 43,843 by 43,843 dimension is not supported by many operation systems or/and computational hardware. In this paper, we overcome this problem by designing a methodology strategy that permits to capture the spatial variability of housing prices without losing our objective. Particularly, we split the analysis into two stages. In the first stage, we compute the hedonic pricing model via OLS, where the dependent variable is the natural logarithm of the mean of housing prices by block. In this stage, explanatory variables are the structural characteristics of houses whose are shown in table 29. Assuming the existence of spatial autocorrelation in residuals, we include fixed effects by census districts into a second regression which have the purpose of capturing all the spatial variability that housing prices exhibit. A census district is a geographic unit greater than a block that divides one commune for census purposes. Here, we decrease dramatically the computational demand by reducing our sample from 43,843 blocks to 1,651 census districts. In this case, the system perfectly can invert a W matrix of 1,651 by 1,651, as well as fixed effects can summarize all the spatial autocorrelation contained in housing prices by block. In the second stage, fixed effect coefficients by census district are used in the hedonic housing model as,

$$y_i = \beta_0(u_i, v_i) + \sum_{k=1}^{27} \beta_k(u_i, v_i) x_{ik} + \varepsilon_i$$

where y_i is the fixed effect parameter by census district computed in the first stage, and x_{ik} represents the matrix of urban-amenities variables measured at the census

district level. Summary statistics of variables used at first and second stage are displayed on tables 31 and 32, respectively.

4.2. Results

The results of the global model performed at stage 1 are depicted in table 33. Both models show the hedonic pricing model considering only structural characteristics of houses by block. Model 1 represents the OLS regression without fixed effects meanwhile, model 2 shows coefficients for structural characteristics plus fixed effects by census district. All variables are significant at 1 percent and show the expected sign in both models. Global model 1 has a reasonable adjust by explaining 76 percent of the variability of housing prices at MR, with a standard error of 0.42. However, the inclusion of fixed effects by census district increases notably the explanation power of model 1 by capturing 93 percent of the housing price variability. Moreover, all fixed effects by census districts are significant at 5 percent level. As housing prices are apparently spatially auto-correlated, residuals of both models are mapped and tested using Moran's Index to determine the existence of spatial clustering of errors. Results are presented in figures 17 and 18, respectively. Results for model 1 confirm the presence of spatial autocorrelation: residuals are apparently clustered in the space, as well as Moran's index exceeds from 0.6. The inclusion of fixed effects by census district reduces largely the spatial autocorrelation of model 1 by about 70 percent and reflects that fixed effects are capturing the spatial autocorrelation of model 1. Figure 19 shows the spatial distribution of housing prices by block, as well as the spatial distribution of fixed effects by census district.

The results of stage 2 are depicted in table 34. In this stage, the dependent variable is the fixed effects by census district computed in stage 1 meanwhile, explanatory variables are urban-amenities. The first column of table 34 presents the average marginal effects using OLS which represents the traditional estimation of hedonic pricing models. The other columns display the same specification using GWR where estimates are described by the median, minimum and maximum values, as

well as their interquartile range. In comparison with the previous model, GWR specification shows a notable improvement in the explanatory power of the model, with a R-Square of over 88 percent. This result demonstrates that apparently housing prices are influenced by spatial effects localized inside the MR and consequently, geographical-based submarkets could emerge. The last column of table shows the p-values from randomization test to check for the significant spatial variability of GWR's coefficients. In this sense, we can determine that at least 20 urban amenities are significant at the 0.05 level. This result evidences that capitalization of these urban amenities on housing prices is not homogeneous and varies spatially across the MR. The exceptions are found on urban amenities such as public schools, parks of 5750 meters or more, bus stops, pharmacies, fire stations and accidents by census districts. In these cases, results could affirm that marginal prices are constant across the MR, but also can reflect that census districts are not the most suitable administrative level to reflect the relationship between these urban-amenities and housing prices. At least for cases such as public schools, parks of 5750 meters or more, and bus stops their coefficients of the global model are significant at 0.01 level. Finally, we cannot determine that these urban amenities do not have any influence on housing prices, neither the absence of spatial variability.

With respect to significant urban amenities, it is possible to observe clear differences between natural, historical and modern amenities. The set of natural amenities that includes the mean of nuisance by census districts – a dis-amenity – has a positive and significant effect on housing prices. A possible explanation for this counterintuitive result is related to the location of expensive houses in the MR. This kind of housing is found in northeast and central areas, closer to the core of the MR where Santiago – the country's capital – is located. As this core community concentrates a relevant number of public bodies, businesses, financial institutions, and other important services, generally, receives many commuters from their residences to place of works. Naturally, this process could generate congestion problems such as high levels of noise that, apparently, are not able to reduce housing prices. On the other hand, historical amenities such as monuments, and typical areas have a negative and significant effect on housing prices.

Consequently, houses located close to these amenities are positively capitalized on housing prices as theory predicts. However, we do not find the same effect for parks. An explanation is related to structural characteristics of parks, and especially, with their sizes. In this sense, individuals might be indifferent to small parks closer to their homes and the presence of this urban-amenity is not crucial in their location decisions. However, if parks are larger, households could positively valorize them on housing prices. Partially, this idea can be confirmed by the proximity of parks of 5750 meters or more, whose coefficient has the expected sign and a significant effect on housing prices in the global hedonic regression.

The set of modern amenities that includes schools, kindergartens, universities, healthcare centers, transportation, bicycle lines, shopping centers, pharmacies, restaurants, banks, fire and police stations, and housing camps shows mixed evidence about its influence on housing prices. In this case, we should do a clear distinction between public and private services. For instance, proximity to private or semi-private schools has a negative and significant effect on housing prices. However, proximity to public kindergartens or public healthcare centers has not a positive capitalization on housing prices. Therefore, living closer to these key services might not be advantageous for residents. Similar results are found for universities, bicycle circuits, bus stops and police stations that apparently have negative capitalizations on housing prices. On the contrary, proximity to private services such as healthcare centers, shopping centers, restaurants, and banks have negative and significant effects on housing prices. In this scenario, we can conclude that private services are more valued than public services and individuals could be willing to pay more for living in places with a large presence of private services. But also, these results can reflect the restrictions that local governments face to create more local public services and then, are not able to respond to community's demands. These implications are counterintuitive in comparison to other empirical evidence for developed countries. Finally, dis-amenities such as housing burglary or proximity to housing camps have a negative influence on housing prices as we expected.

An important advantage of GWR is that coefficients can be easily mapped and visualized. Figure 4 shows the spatial patterns of parameters for urban-amenities which confirm previous results. For natural amenities as nuisance, positive coefficients are located closer to central areas of MR confirming the previous argument to justify its counterintuitive behavior. In addition, historical amenities such as monuments have a positive capitalization on houses located in the central part of the MR and cultural equipment has positive valuations concentrated in the northeast of the MR. Both places coincide with the location of higher housing prices determining that these services are more appreciated by high-income groups. Interesting results are found for modern amenities, especially, for the distinction between public and private services. For instance, private and semi-private schools have positive valuations on housing prices mainly in the south part of the MR where lower housing prices are concentrated. In fact, it is the coefficient behavior that we expect for public schools or public kindergartens whose negative valuations are found in almost all the entire MR. An exception to this behavior is found in public schools that present positive housing valuations in central and northwest areas of MR. An explanation for this spatial distribution is because at the center are located public schools with better SAT results and therefore, public schools can have a positive valuation on housing prices. However, this special distribution is not reproduced in other communities. Finally, remarkable results are found for private services such as shopping centers and banks with positive capitalizations in higher and lower housing prices, respectively. In this sense, private services are highly valued by residents and consequently, these urban amenities can play a crucial role in location decisions of residents for living in certain places than others. Apparently, the public equipment is not an important variable for residents and put a lower weighting in their valuations motivated by quality's perceptions or by the low accessibility levels to these services.

5. Conclusions

A large empirical research supports that the spatial distribution of urban amenities matters for urban growth and local development patterns due to its influence on migration decisions exerted by households. As a consequence, wages and housing

prices are heterogeneous across cities because labor and housing markets are determined by such movements. In this paper, we explore the relationship between urban amenities and housing prices for the Metropolitan Area of Santiago (MR), Chile. By doing so, we recognize that the capitalization of urban amenities into housing prices is not constant across the MR and therefore, we use a geographically weighted regression (GWR) to explore this heterogeneity and information of 27 urban amenities provided by official data sources and Geographically Information System (GIS).

Main results suggest that urban amenities play an important role in determining housing prices as previous studies found. Individuals are not only interested in structural characteristics of houses, but also neighborhood effects are driving households' location decisions. Moreover, GWR's results confirm a significant spatial heterogeneity on the capitalization of urban amenities in housing prices. However, counterintuitive evidence is found in comparison with studies performed for developed countries. For instance, modern amenities show mixed results about their capitalizations on housing prices with a clear distinction between public and private services. In this case, proximity to local public services such as schools, kindergartens or healthcare centers has a negative and significant capitalization on housing prices. As a result, living closer to these key services apparently is not advantageous for residents. By contrast, private services such as schools, healthcare centers, shopping centers, restaurants, and banks have positive and significant valuations on housing prices. This means that individuals are willing to pay more for living in places with a large presence of these services and could be determinants on location decisions rather than public equipment which have not important weighting in resident's valuations.

These findings have a strong influence on public policy implementations, especially at local level. Results could reflect the restrictions that local governments have for providing local public services. On one hand, despite that local governments are the main providers of local services, their supply is determined by central government decision's. On the other hand, local government also face several financial

restrictions to provide local public services. Therefore, the supply of services could be not sufficient to cover all resident's demand. Also, the spatial distribution of local public services could be inefficient to match correctly the supply of local public services with its respective demand. In this sense, a correct land management is required for an optimal use of these amenities especially in poorer communities whose are facing a high demand for local public services. A local government is one of the nearest institutions to communities and easily can identify community needs due to this proximity, however, administrative and financial restrictions could undermine this comparative advantage. By contrast, developers with fewer restrictions to provide private services can generate efficiently more and better services by detecting the willingness to pay of residents. Thus, an important challenge for local governments consists in improving the provision of local public services in terms of quantity and quality to make their communities more attractive to live. Finally, resident's perceptions about quality of public and private services also can be crucial determinants in location decisions. Further research can help to detect the reasons why local public services have lower valuations on housing prices, as well as how urban amenities could be used efficiently to increment housing prices.

Figure 17: Residuals Stage 1

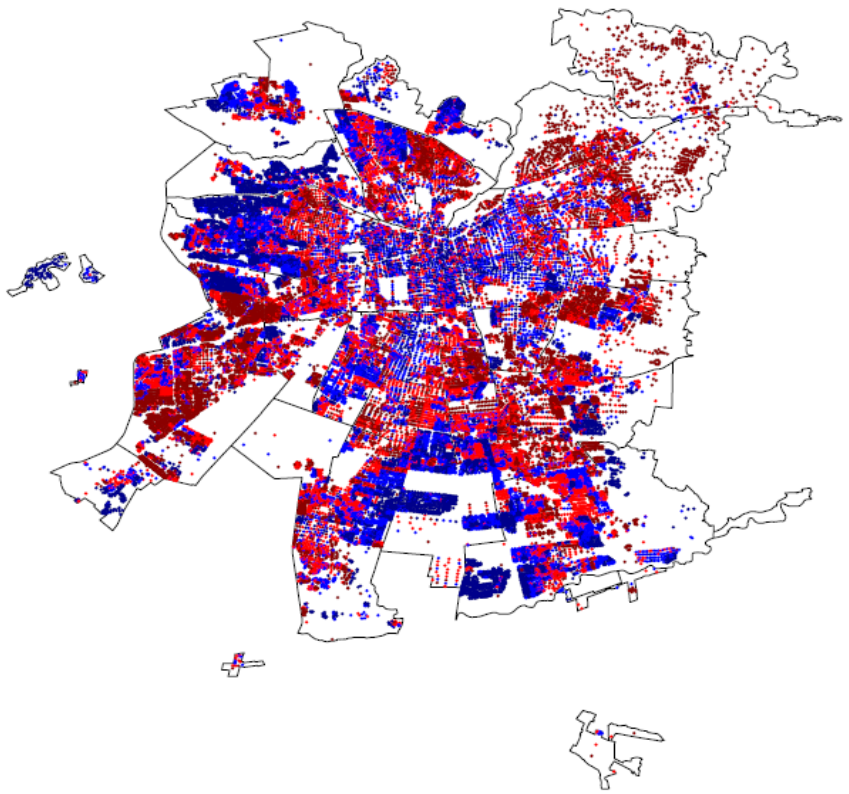
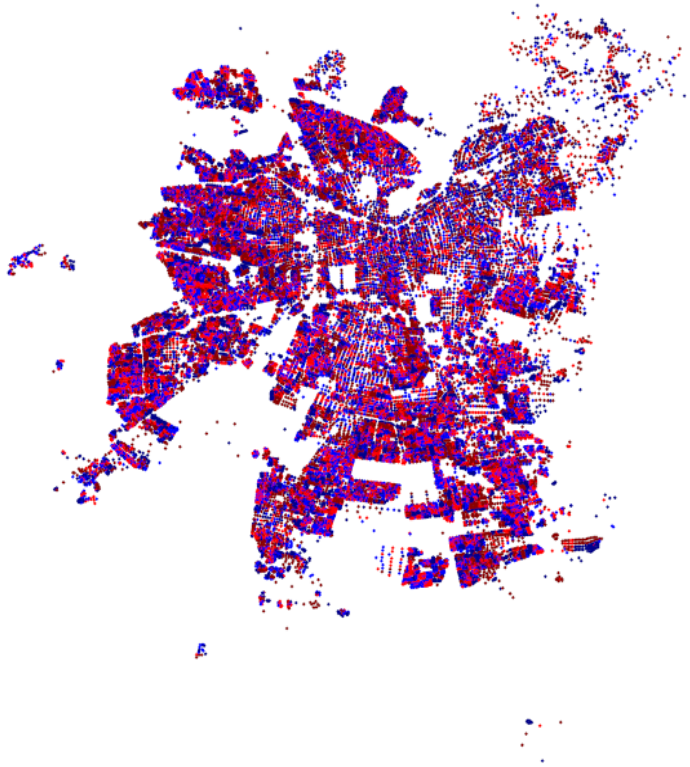
Model 1: Without Fixed Effects	Model 2: With Fixed Effects
	
[−8.476,−0.2818] (−0.2818,0.002855] (0.002855,0.3003] (0.3003,5.22]	[−3.907,−0.1004] (−0.1004,0.001398] (0.001398,0.104] (0.104,3.548]

Figure 18: Moran's Test Residuals Stage 1

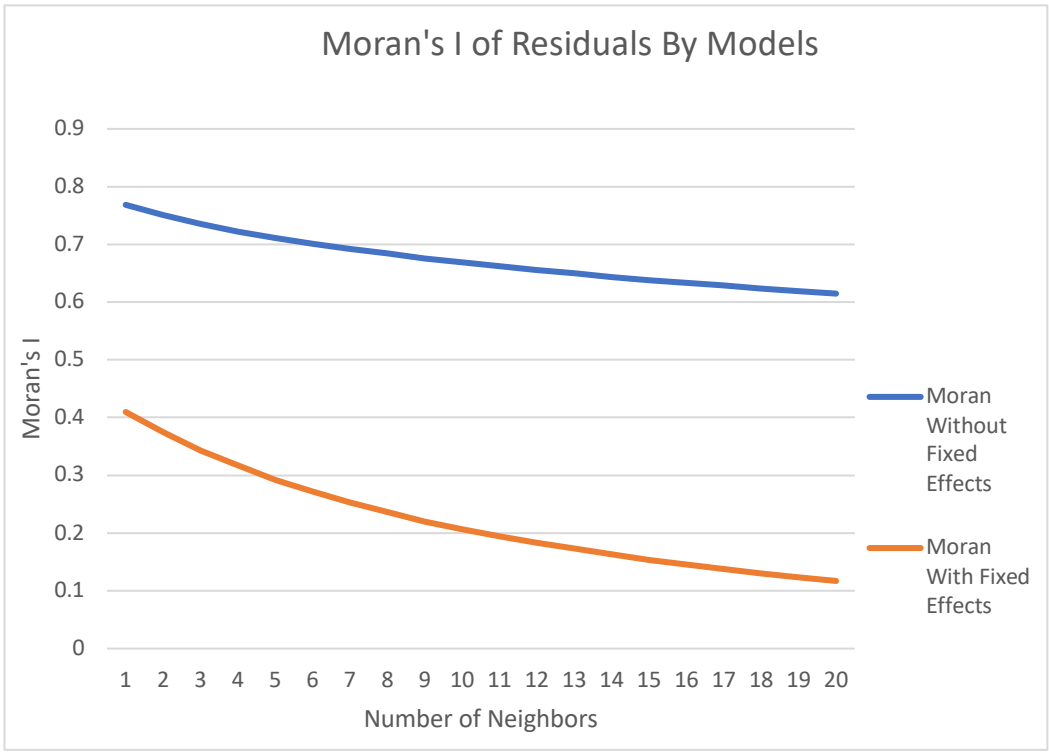


Figure 19: Spatial distribution of housing prices and fixed effects by census districts

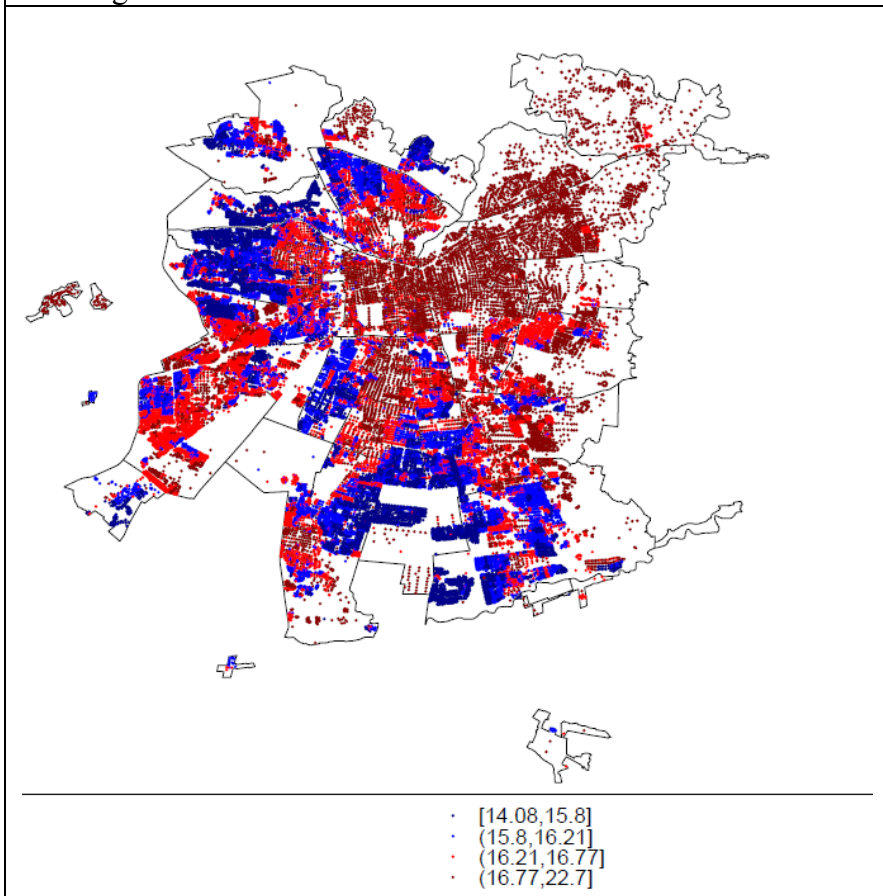
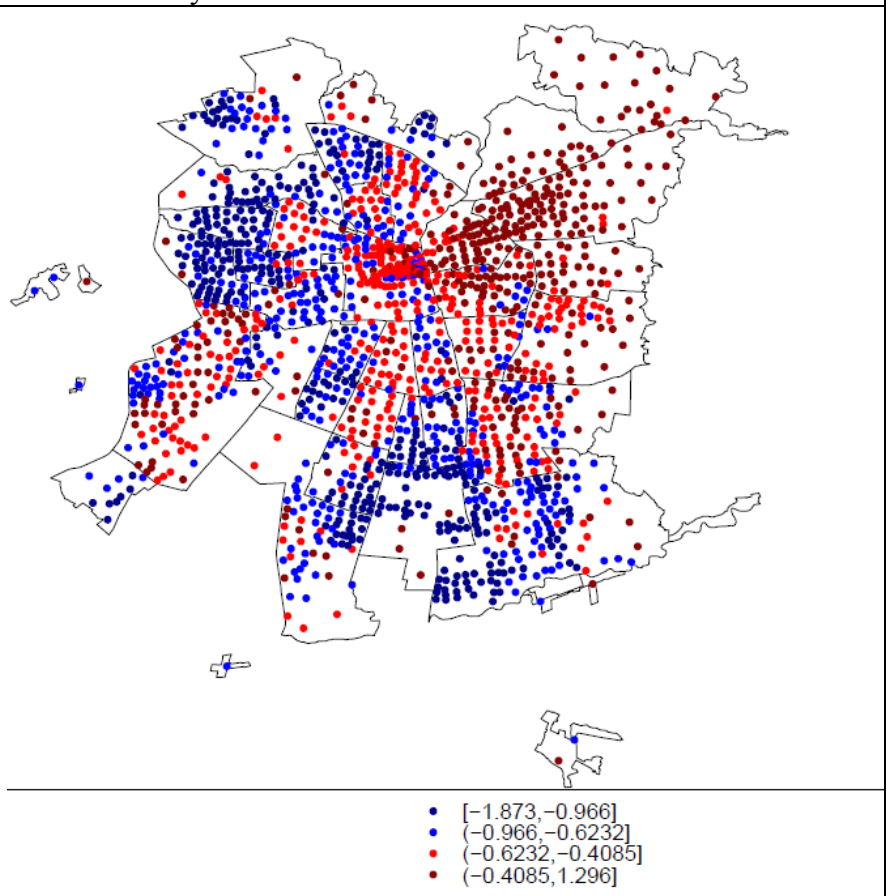
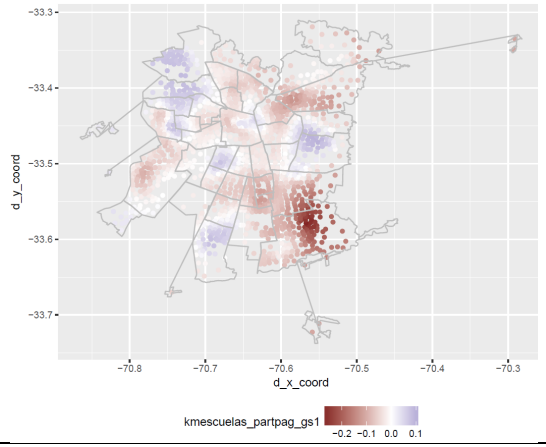
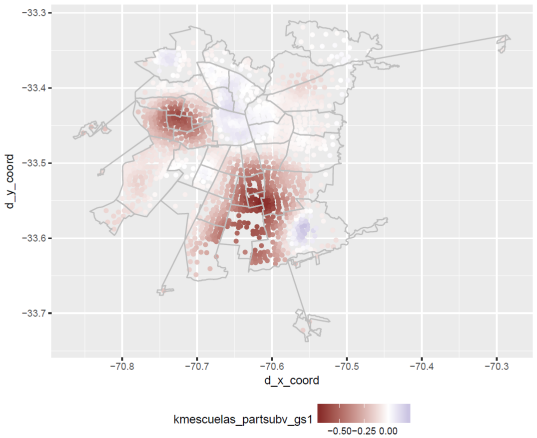
Housing Prices	Fixed Effects by census districts
	
[14.08,15.8] (15.8,16.21] (16.21,16.77] (16.77,22.7]	[−1.873,−0.966] (−0.966,−0.6232] (−0.6232,−0.4085] (−0.4085,1.296]

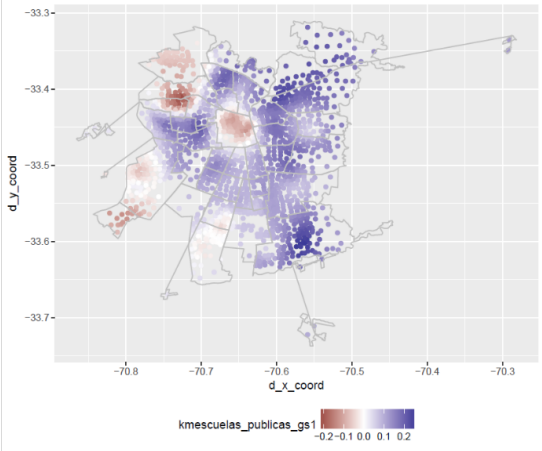
Figure 20: Spatial coefficient patterns of GWR by census districts



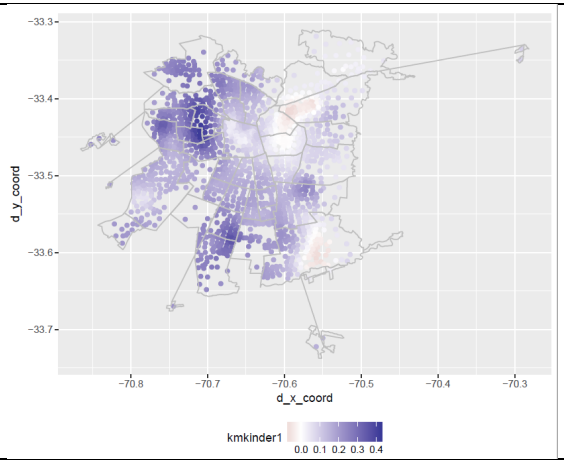
Proximity to Private Schools



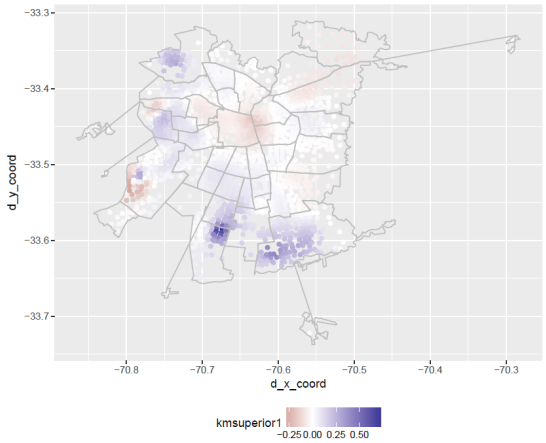
Proximity to Semi-Private Schools



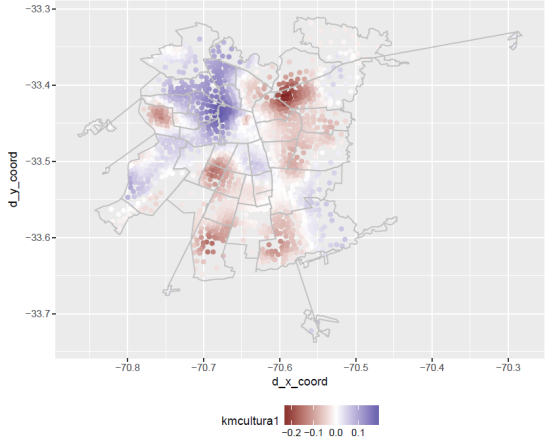
Proximity to Public Schools



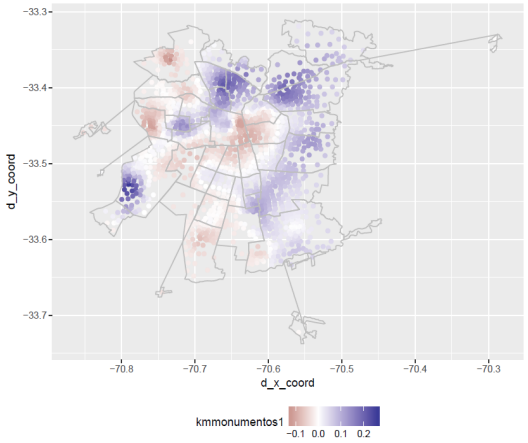
Proximity to Kindergartens



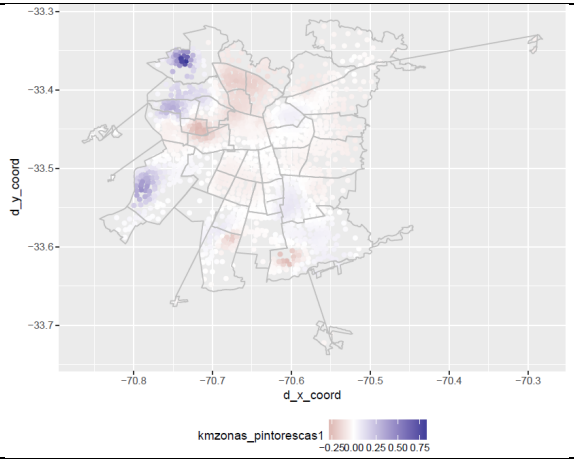
Proximity to Universities



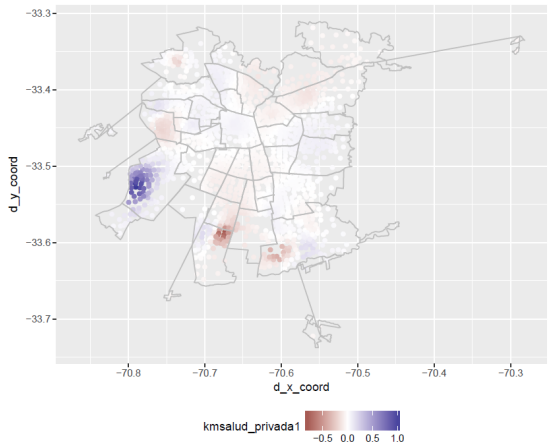
Proximity to Culture Equipment



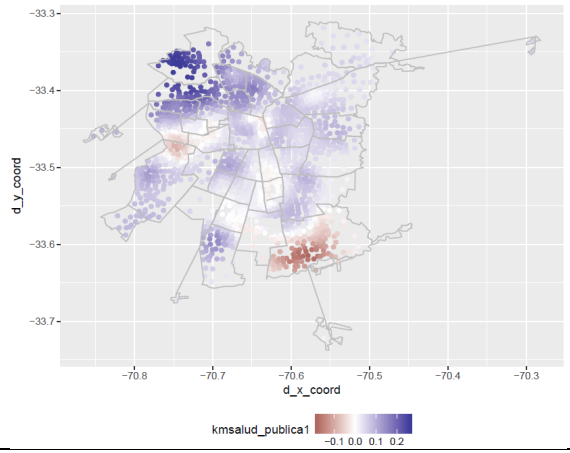
Proximity to Monuments



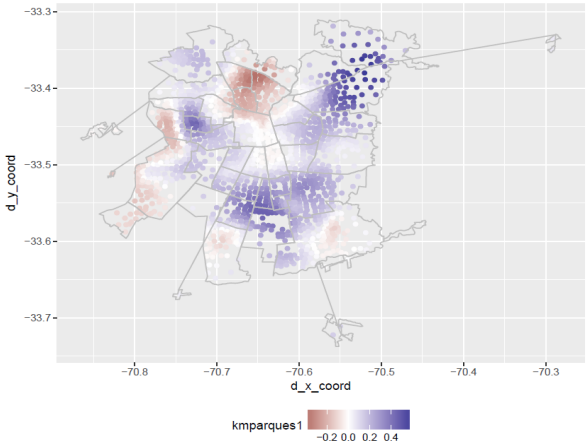
Proximity to Typical Areas



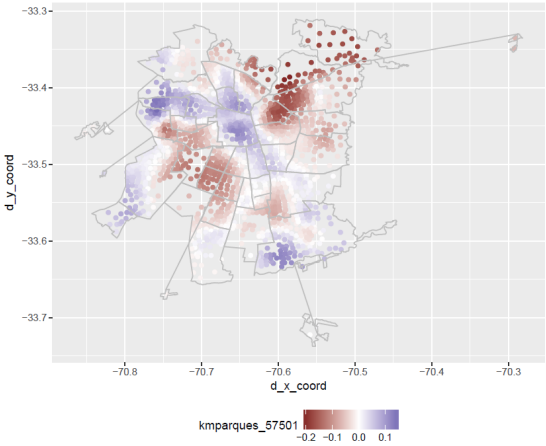
Proximity to Private Healthcare centers



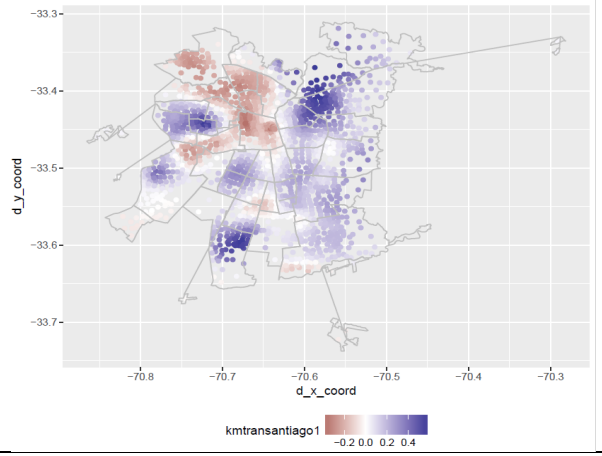
Proximity to Public Healthcare centers



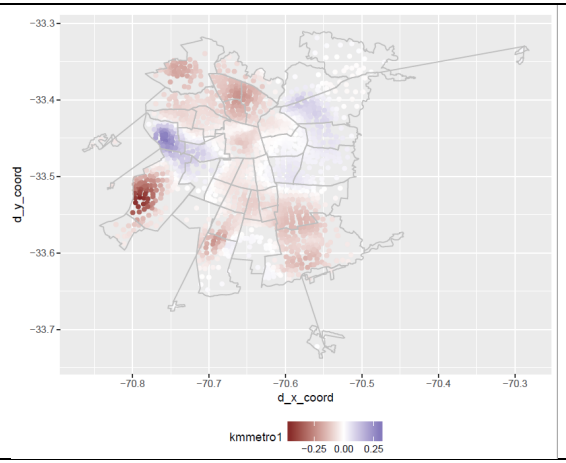
Proximity to Parks



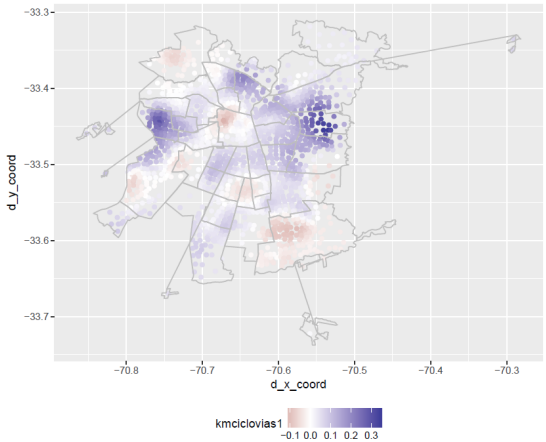
Proximity to Parks over 5750 meters



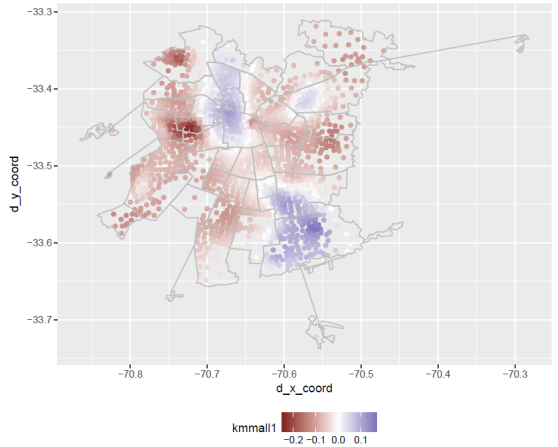
Proximity to Bus stops



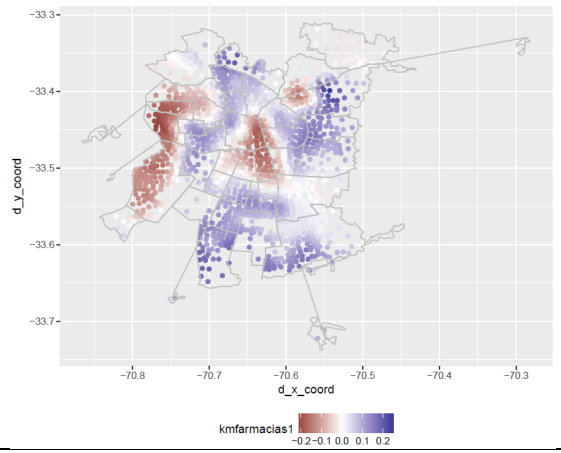
Proximity to Subways



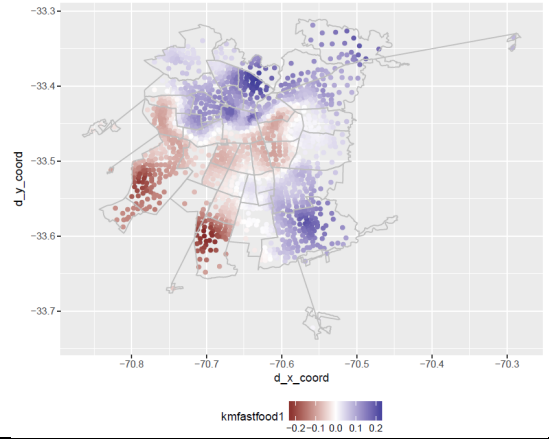
Proximity to Bicycle lines



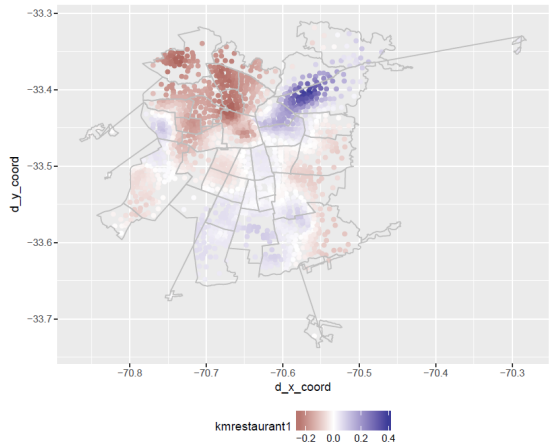
Proximity to Shopping Centers



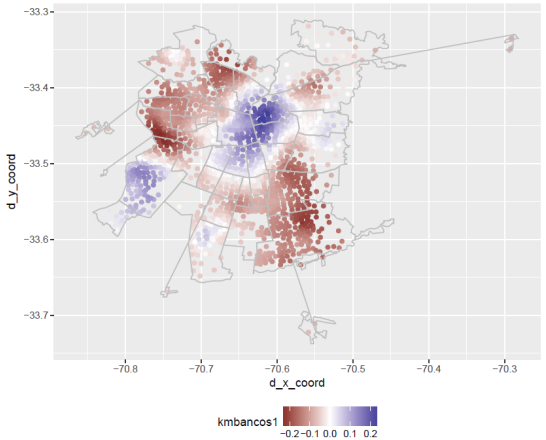
Proximity to Pharmacies



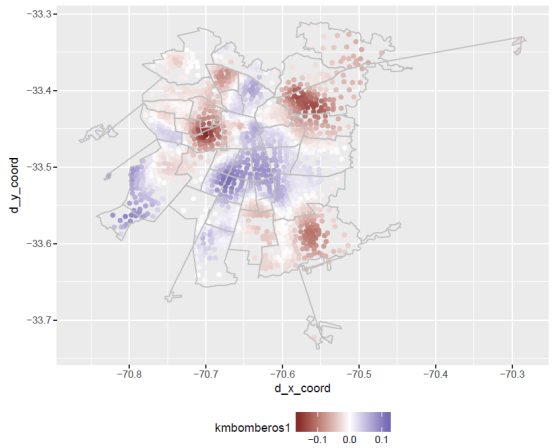
Proximity to Fast food Restaurants



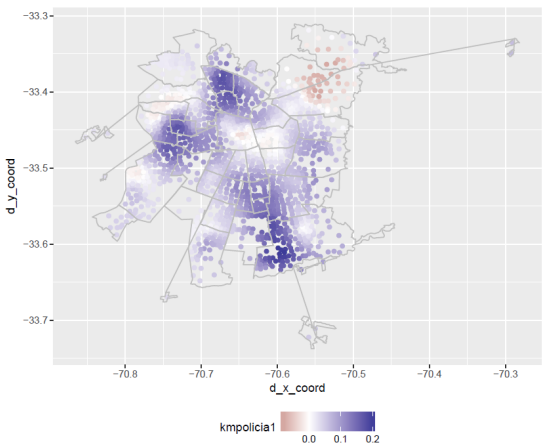
Proximity to Restaurants



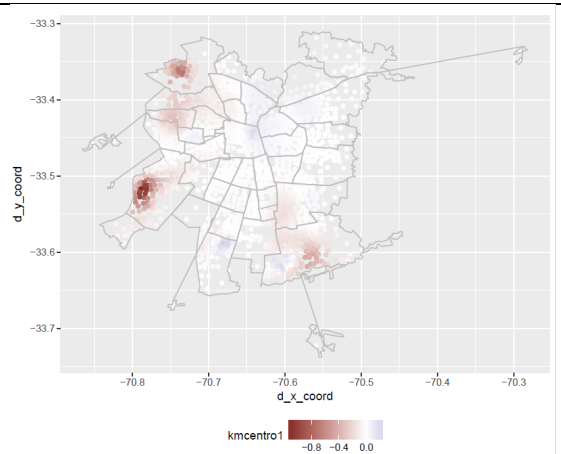
Proximity to Banks



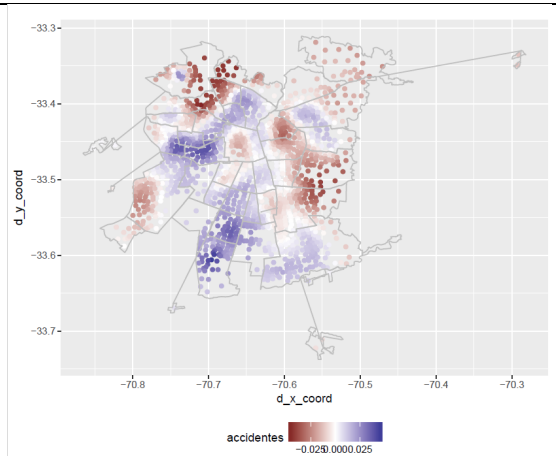
Proximity to Fire Stations



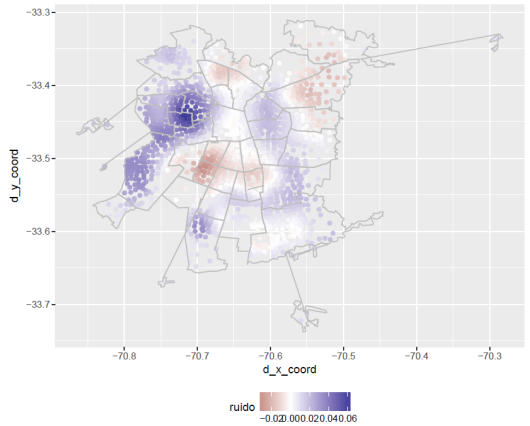
Proximity to Police Stations



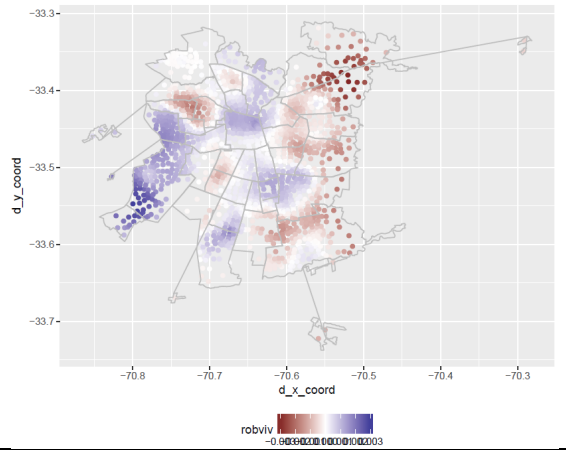
Proximity to CBD



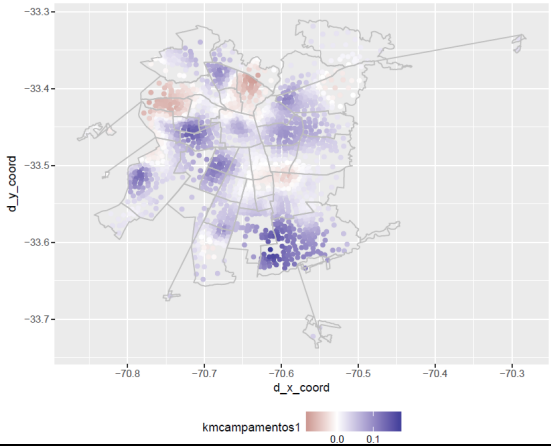
Mean of Accidents by Census District



Mean of Nuisance by Census District



Mean of Housing Burglary by Census District



Proximity to Housing Camps

Table 29: Housing Attributes Variables

Variable	**Definition**
Housing Values	Average of property values by block
Quality Housing	Number of housing by block with: • Superior quality • medium-superior quality • medium quality • medium-low quality • low quality. This classification is provided by SII.
Housing Size	Average of housing size by block. This measure only considers the constructed area.
Housing Age	Average of housing age by block.
Exempted housing from taxes	Proportion of housing that are exempted from housing taxation.

Table 30: Urban Amenities

Amenity	Measurement	Source
Schools (Public, Semi-Private, Private)	Proximity in kilometers to the nearest school.	Ministry of Education (2017).
Kindergartens (INTEGRA y JUNJI)	Proximity in kilometers to the nearest kindergarten.	• Junta Nacional de Auxilio y Becas (2013). • Fundación Integra (2016)
Universities	Proximity in kilometers to the nearest university.	Ministry of Education (2017)
Culture	Proximity in kilometers to the nearest cinema, theater, cultural center, art gallery, museums, concert halls and libraries.	IDE – OCUC (Observatory of cities Pontifical Catholic University of Chile; 2016).
Historic Monuments	Proximity in kilometers to the nearest monument.	National Monument Council (Consejo de Monumentos Nacionales; 2014).
Typical Areas	Proximity in kilometers to the nearest typical areas.	National Monument Council (Consejo de Monumentos Nacionales; 2014).
Health Care Centers (Public and Private)	Proximity in kilometers to health care centers.	Public healthcare centers: Ministry of Healthcare (2017). Private healthcare centers: IDE – OCUC (Observatory of cities Pontifical Catholic University of Chile; 2016).
Parks	Proximity in kilometers to the nearest park.	Ministry of Housing (2015).
Bus stops and Subways	Proximity in kilometers to the nearest station of buses or subway.	Ministry of Transport (2016).
Bicycle lines	Proximity in kilometers to the nearest bicycle route.	Metropolitan Government of Santiago (2016).
Shopping Centers	Proximity in kilometers to the nearest shopping center.	Representatives of shopping centers (2017).
Pharmacies	Proximity in kilometers to the nearest pharmacy.	Ministry of Healthcare (2017).
Fast Food Restaurants	Proximity in kilometers to the nearest fast food restaurants.	Open Street Maps (OSM; 2017).
Restaurants	Proximity in kilometers to the nearest restaurant.	Open Street Maps (OSM; 2017)
Banks	Proximity in kilometers to the nearest bank.	Superintendence of Banks (2013).
Proximity to CBD	Proximity in kilometers to the capital of Metropolitan Region (Santiago of Chile).	Open Street Maps (OSM; 2017).
Accidents	Average of accidents by spatial unit using critical points of accidents (interpolation techniques).	National Transit Security Council (2016).
Nuisance	Average of nuisance by spatial unit using monitoring stations (interpolation techniques).	Ministry of Environment (2011).

Crime	Average of housing burglary by spatial unit using critical points of housing burglary (interpolation techniques)	IDE OCUC (Observatory of cities Pontifical Catholic University of Chile; 2016).
Housing camps	Proximity in kilometers to the nearest housing camps.	Ministry of Housing (2016).

Table 31: Descriptive Statistics Variables First Stage

Variable	Obs	Mean	Std. Dev.	Min	Max
Mean of Housing Price by Block (Logarithm)	43.843	16,39208	0,8487138	14,07978	22,6959
Number of superior quality housing by block	43.843	0,185959	3,546786	0	263
Number of medium-superior quality housing by block	43.843	4,80161	34,30477	0	1085
Number of medium quality housing by block	43.843	16,94387	61,21488	0	1601
Number of medium-low quality housing by block	43.843	28,96433	35,98318	0	1076
Number of low quality housing by block	43.843	3,833839	9,810599	0	695
Mean of housing size by block	43.843	52,20041	33,33943	6	2575,667
Share of exempted housing from property tax by block	43.843	0,7998525	0,3600474	0	1
Mean of housing age by block	43.843	33,07619	14,7774	1	111,6667

Table 32: Descriptive Statistics Variables Second Stage

Variable	N	Mean	SD	Min	Max
Proximity to private schools	1651	1.56	1.33	0.01	17.85
Proximity to semi-private schools	1651	0.45	0.79	0.01	17.16
Proximity to public schools	1651	0.63	0.85	0.01	19.39
Proximity to public kindergartens	1651	0.82	1.06	0.00	19.51
Proximity to universities	1651	4.29	3.59	0.01	20.88
Proximity to culture centers	1651	1.56	1.56	0.02	20.18
Proximity to monuments	1651	2.26	1.82	0.02	20.41
Proximity to typical areas	1651	5.10	3.85	0.01	21.55
Proximity to private healthcare centers	1651	4.75	3.68	0.06	22.88
Proximity to public healthcare centers	1651	1.14	1.03	0.01	20.04
Proximity to parks	1651	0.33	0.81	0.00	17.49
Proximity to parks over 5750 square mts	1651	0.83	0.94	0.00	17.49
Proximity to buses stations	1651	0.24	0.77	0.00	19.04
Proximity to subway stations	1651	2.35	2.36	0.13	24.95
Proximity to bicycle lines	1651	0.88	1.18	0.00	20.17
Mean of accidentes by census district	1651	8.82	1.33	0.00	18.73
Mean of noise by census district	1651	64.34	4.28	0.00	74.11
Mean of home burglary by census district	1651	139.86	54.74	28.20	411.91
Proximity to housing camps	1651	2.26	1.56	0.08	20.16
Proximity to shopping center	1651	2.10	1.55	0.06	19.86
Proximity to pharmacies	1651	0.51	0.80	0.01	19.19
Proximity to fast food restaurants	1651	0.90	0.74	0.01	11.69
Proximity to restaurants	1651	0.61	0.59	0.00	9.70
Proximity to banks	1651	1.07	1.11	0.00	20.17
Proximity to CBD	1651	10.12	5.44	0.21	35.27
Proximity to fire stations	1651	1.22	1.04	0.01	21.03
Proximity to police stations	1651	1.35	0.91	0.02	9.96

Table 33: Results of Global Models (OLS) Stage 1

	Dependent variable:	
	Mean of Housing Values by Block	
	(1)	(2)
Number of superior high-quality units by block	0.012***	0.002***
	(0.001)	(0.0004)
Number of medium-superior quality units by block	0.001***	0.0001***
	(0.0001)	(0.00004)
Number of medium quality units by block	0.0003***	0.0002***
	(0.00003)	(0.00003)
Number of medium-low quality units by block	-0.0003***	-0.001***
	(0.0001)	(0.00004)
Number of low quality units by block	-0.004***	-0.001***
	(0.0002)	(0.0001)
Mean of housing size by block	0.006***	0.004***
	(0.0001)	(0.00005)
Mean of housing age by block	-0.0003**	0.001***
	(0.0001)	(0.0002)
Proportion of exempted property tax units by block	-1.648***	-0.979***
	(0.007)	(0.008)
Constant	17.421***	17.676***
	(0.009)	(0.095)
Fixed effects by census district	No	Yes
Observations	43,843	43,843
R^2	0.760	0.929
Adjusted R^2	0.760	0.926
Residual Std. Error	0.416	0.231
F Statistic	17,355.530***	331.795***
Note:		*p**p***p<0.01

Table 34: Results of Global Models (OLS) and Geographically Weighted Regression (GWR) Stage 2

	Dependent variable: Fixed Effect by Census District						
	OLS	Geographically Weighted Regression					
	Coeff (Std. Error)	Min	1st Qu.	Median	3rd Qu.	Max.	p-value
Proximity to private schools	-0.090***(0.009)	-0,27453	-0,06481	-0,03051	0,00899	0,10060	0,000
Proximity to semi-private schools	-0.114***(0.023)	-0,72690	-0,25148	-0,08549	-0,00893	0,21280	0,000
Proximity to public schools	0.100***(0.019)	-0,20678	0,01624	0,10066	0,14644	0,25820	0,140
Proximity to kindergartens	0.122***(0.015)	-0,07101	0,07958	0,15675	0,21235	0,42030	0,000
Proximity to universities	-0.001(0.006)	-0,27500	-0,02753	0,02009	0,07632	0,71930	0,000
Proximity to culture	0.036***(0.010)	-0,23808	-0,05010	-0,00925	0,03639	0,19410	0,000
Proximity to monuments	-0.022***(0.007)	-0,13033	-0,02342	0,02180	0,07268	0,26090	0,000
Proximity to typical areas	-0.054***(0.005)	-0,26893	-0,05063	-0,01567	0,02902	0,83930	0,000
Proximity to private healthcare centers	-0.046***(0.007)	-0,81446	-0,05138	-0,00037	0,04023	1,06840	0,000
Proximity to public healthcare centers	0.060***(0.012)	-0,18104	0,01813	0,05308	0,08126	0,26330	0,004
Proximity to parks	0.019(0.029)	-0,38697	-0,01836	0,09457	0,20237	0,59890	0,032
Proximity to parks over 5750 mts2	-0.062***(0.017)	-0,20876	-0,05605	-0,00852	0,03504	0,15000	0,163
Proximity to bus stops	0.054**(0.026)	-0,37462	-0,05580	0,10892	0,22600	0,58510	0,169
Proximity to subway stations	0.012*(0.006)	-0,46844	-0,09128	-0,04383	0,01328	0,30330	0,000
Proximity to bicycle lines	0.088***(0.012)	-0,11750	-0,00103	0,04262	0,08411	0,34920	0,004
Proximity to shopping centers	-0.048***(0.009)	-0,24387	-0,08661	-0,05372	0,01678	0,16040	0,000
Proximity to pharmacies	-0.003(0.023)	-0,21148	-0,03942	0,03740	0,09780	0,24440	0,649
Proximity to fast food restaurants	0.056***(0.013)	-0,23474	-0,05065	0,03213	0,09296	0,23730	0,000
Proximity to restaurants	0.023(0.017)	-0,29153	-0,09299	-0,01620	0,04199	0,40390	0,002
Proximity to banks	-0.085***(0.014)	-0,23410	-0,11675	-0,05643	0,02732	0,23970	0,000

Proximity to Fire stations	-0.021(0.014)	-0,16558	-0,03304	-0,00637	0,02727	0,12160	0,356
Proximity to police stations	0.058***(0.011)	-0,08048	0,02732	0,05945	0,10144	0,20560	0,038
Proximity to CBD	0.049***(0.004)	-1,16402	-0,06990	-0,00617	0,02379	0,26660	0,000
Accidents by census districts	-0.008(0.006)	-0,04610	-0,01018	0,00194	0,01322	0,04590	0,671
Nuisance by census districts	0.007***(0.002)	-0,03163	-0,00006	0,00846	0,01791	0,06350	0,005
Housing burglary by census district	-0.0005***(0.0002)	-0,00311	-0,00046	0,00010	0,00084	0,00300	0,000
Proximity to housing camps	0.028***(0.007)	-0,08205	0,01029	0,03534	0,06392	0,17890	0,000
Constant	-1.075***(0.175)	-5,52219	-1,69471	-1,15960	-0,54643	3,19560	0,000
Observations	1,651	1651					
R^2	0.666	0.877					
Adjusted R^2	0.661	0.820					
Residual Std. Error	0.271						
F Statistic	120.077***						
Note:	*p**p***p<0.01						

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