CENTRO DE INVESTIGACIÓN Y DOCENCIA ECONÓMICAS, A.C.

THE IMPACT OF COMMERCIAL SIDEWALK USE ON REAL ESTATE PRICES IN MEXICO CITY

TESINA

QUE PARA OBTENER EL GRADO DE

MAESTRO EN ECONOMÍA

PRESENTA

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CIUDAD DE MÉXICO JUNIO, 2017

Para Andrea y toda la mishpoje: Adela, Pepe, Rosana y todos los primos, primas, tías y tíos.

Agradecimientos

Gracias a mi asesor David Heres, mi profesora del seminario Sonia Di Giannatale, mi lector Hernan Bejarano, el profesor Florian Wendelspiess y la directora de la maestría Maite Guijarro por guiarme y apoyarme durante la realización de este trabajo, y a todos los otros profesores con los que tuve la suerte de tomar clases durante la maestría, especialmente David Strauss. También quiero agradecer a mis compañeros de la maestría mis otros maestros que me enseñaron tanto como los profesores o más: Joaquín, Karla, Julio, Christian y todos los demás. Gracias a Adela, Pepe, Rosana y Andrea por todos los años de apoyo incondicional. Finalmente, quiero agradecer a mis socios mi otra familia Manuel, Guillermo y Ricardo; Muebles para uso público, el proyecto que inspiró este trabajo, fue una colaboración con ellos, Tania Osorio y José Esparza, y ni mi maestría ni esta tesis hubieran sido posibles sin su apoyo.

Abstract

Urbanists, journalists, and activists have long argued that street life is beneficial for urban communities. In economic terms, there is a positive externality to having commercial activity on the street. However, in the case of sidewalk cafés and restaurants, a common resource (the sidewalk) becomes semi-privatized; there is a clear cost for the inhabitants of the city and a benefit for private shop owners.

In this study, I use a cross-sectional hedonic pricing econometric model to isolate the effects of placing furniture on the sidewalk on real estate rent prices using data from Mexico City. I find that rent prices can increase by up to around 3% when furniture can be placed on the sidewalk on or near a parcel.

Regarding policy implications, this suggests that city governments could charge a higher tax for the commercial use of sidewalks. These findings also suggest that urban planners, designers and city governments can add value to properties by allowing and incentivizing commercial activities on the sidewalk.

Keywords: Property values; Hedonic price analysis
JEL classification: R31; R33.

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Introduction

Urbanists, journalists, and activists have long argued that street life is beneficial for urban communities. Two of the most vocal proponents of these ideas are Jacobs (1961), who finds that streets with commercial activity are safer in her seminal book *The Death and Life of Great American Cities*, and more recently Solnit (2001), who claims that bustling public streets are essential for political empowerment. In economic terms, one could say that there is a positive externality to having a commercial activity on the street.

However, in the case of cafés and restaurants that also have tables and chairs on the sidewalk, a common resource (the sidewalk) becomes semi-privatized; there is a clear cost for the inhabitants of the city as well and a benefit for private shop owners. City governments have solved this conflict by charging a tax for the right to place furniture on the sidewalk, which works more or less like a rent, but is usually much cheaper that actual market rents[1]. There are plenty reasons for this fee to be less that commercial rents: shops can only occupy sidewalk space during certain hours, and it usually has no protection from the weather, for example. However, it also seems like the way in which government officials set these taxes is arbitrary, and cities could benefit from understanding the actual market value of this good and whether it adds value to its inhabitants through rent prices.

Although I have found no research on how the possibility of commercial activity on the

[1] A brief review of the legal regulation reveals that the laws and permits for commercial activity on the street are similar in many cities. In Mexico City, the relevant regulation for this research project dictates that restaurants, cafes, and bars will pay a yearly fee that is calculated per square meter using a price that applies to the whole city, plus a variable part that depends on the area where the shop is. Similarly, New York City charges a flat fee, plus a variable per square foot amount based on the region of the city, plus a security deposit. The city of San Francisco charges an annual per seat fee. Interestingly, in the case of San Francisco, the price is independent of the part of the town where the furniture is placed.

sidewalk affects property values either on rent or sale prices, Song and Knaap (2004) look at the impact of mixed land uses on housing values, while Duncan (2010) identifies the impact of transit-oriented development on housing prices. More generally, some of the first efforts to estimate the effects of environmental characteristics on real estate prices can be found in Ridker and Henning (1967), who measure the impact of air pollution on prices. Later, in his seminal paper on hedonic pricing, Rosen (1974) develops a theoretical model for analyzing classes of differentiated goods such as homes.

In this study, I use a cross-sectional hedonic pricing econometric model to isolate the effects of placing furniture on the sidewalk on real estate rent prices using data from Mexico City. I find that, although it is difficult to establish causation unequivocally and not merely correlation due to possible endogeneity issues, rent prices can increase by up to around 3% when furniture can be placed on the sidewalk on or near a parcel.

In terms policy implications, if we interpret this as an effect on rent prices for parcels with commercial use, this can translate to the shop owners' willingness to pay for having the possibility of using the sidewalk. Thus, it is possible that the government could charge a higher tax for the semi-privatization of this good, which could then be transferred back to citizens. On the other hand, if we look at these results as an effect on housing rents or rents in general, it can be seen as a measure of some of the positive externalities of street life. These finding would suggest that urban planners, designers and city governments can add value to properties by allowing and incentivizing commercial activities on the sidewalk, either by writing zoning laws or by designing sidewalks that physically allow these activities.

The rest of this thesis is organized as follows: In Chapter 1, I review the literature on the topic of externalities from street life and hedonic pricing models; in Chapter 2, I describe the model and the econometric specification used in this work, as well as a discussion of possible endogeneity issues; in Chapter 3, I describe the data that will be used in the regressions; in Chapter 4, I provide descriptive statistics for the data; in Chapter 5, I show the results from the regressions; I conclude in Chapter 6.

Chapter 1

Literature review

(Although there is not much economic literature on the positive externalities on conducting business on the sidewalk, journalists, activists, and urban planners have written extensively about this topic. One of the first authors to treat these subject was activist and writer Jane Jacobs, who attributed many of the positive qualities of older urban centers to commercial activity on the sidewalk in her book *The Death and Life of Great American Cities* Jacobs (1961). There, she developed two concepts that have been significantly influential in urban design in the last fifty year: (1) the "ballet of the sidewalk", where there is a positive impact of a broad range of activities happening on the sidewalk at the same time, and (2) "eyes on the street", the idea that when there is activity on the street, there is less need for surveillance since people are less likely to commit a crime in a crowd where everybody knows everyone else. Regarding urbanism, perhaps no school of thought has incorporated these ideas into planning more firmly than the New Urbanists, who argue that suburban sprawl has been detrimental to city life and advocate the creation of walkable neighborhoods with a wide variety of commercial spaces that encourage street life. Leccese and McCormick (2000) compiles the ideas of the various authors related to this movement. Finally, in Solnit (2001), the author argues for the importance of an active, public street life for political empowerment, another positive externality. Note that although most of these authors are referring to storefronts in general, sidewalk cafes, restaurants, and bars are

part of these activities, and perhaps the most problematic instance of it, where these positive externalities (safety, collective action, political empowerment, etc.) usually come at a cost for citizens: the privatization of a common resource.) There have also been proposals from designers to deal with this conflict. Hernández Chong Cuy et al. (2014) propose an alternative to this regulation based on the intuition that these externalities could be generating without privatizing sidewalk space. Instead of allowing business owners to pay for obtaining semi-exclusive rights on the sidewalk area, they imagine a project where anybody could place concrete furniture on his or her sidewalks through a public-private program with the goal of actively contributing to the use of public space at a local scale.

Although I have found no research on how the possibility of commercial activity on the sidewalk affects rent or property values specifically, much work has been done using hedonic pricing models to evaluate the effects of urban design and spatial characteristics on property values. Some of the first authors to do this kind of work, laying the foundations for hedonic pricing models were Ridker and Henning in 1967 Ridker and Henning (1967), where they explore the impact of air pollution on property values. A basic hedonic property value model is provided in Freeman III et al. (2014), which is itself based on Freeman (1974) and Rosen (1974). Later, mixed results were found on the evaluation of the impact of the construction of new TrasMilenio bus stations in Bogotá Rodriguez and Mojica (2008), for example. On a different study for San Diego, California, authors found that the effect of proximity to a public transportation station on house prices was stronger on neighborhoods that were more pedestrian-oriented Duncan (2010), and Song and Knaap (2004) found that housing values are higher in neighborhoods with mixed land uses. Bartholomew and Ewing (2011) contains a more extensive review of the literature regarding hedonic price effects of pedestrian- and transit-oriented development.

Chapter 2

Model

An econometric regression will be performed to estimate the effect of the possibility of placing furniture on the sidewalk on the per square meter rent of commercial space. This chapter contains a discussion of the possibility of an endogeneity problem, which will be ruled out, and a proposed econometric model.

2.1 Theoretical background

The theoretical framework for this work is the basic hedonic pricing model in Rosen (1974). In this seminal paper, the author analyses markets where "a class of differentiated products is completely described by a vector of objectively measured characteristics" Rosen (1974)[1] that cannot be unbundled, instead of a single homogeneous commodity. This is the case of the housing market, for example, where each home has a different location and specific characteristics, as opposed to the wheat market, where every bushel of the commodity is interchangeable.

This conjecture, derived from empirical observations, has two interesting implications. First, since the attributes of a product cannot be unbundled one cannot buy a house with an 80 square-meter garden and sell a quarter of the yard to a property owner in another part of town the no-arbitrage law does not hold. Second, as a result of this, there is no reason to believe that prices

[1]This idea is itself based on the definition of utility first presented by Lancaster (1966).

will be linear each additional square meter of land might be priced lower than the previous one.

In this model, a class of differentiated goods is described by n objectively measured characteristics, and each point on the plane is represented by a vector of coordinates $z = (z_1, z_2, \ldots, z_n)$, with z_i measuring the amount of the i^{th} characteristic contained in each good. There is a great variety of alternative packages, and there is a price $p(z) = P(z_1, z_2, \ldots z_n)$ for each point, which guides both consumers and producers. The market clears, and prices are determined when there is a perfect match of producers and consumers at each point.

Specifically, I use a cross-sectional hedonic price model to identify the impact of sidewalk use on real estate rent prices statistically. The model described in this thesis intends to predict the sales or rent price of properties based on measures of the possibility to place furniture on the sidewalk. This framework is well-suited for analyzing the impact of sidewalk use on prices of both housing and commercial properties[2].

2.2 Specification

The specification to be estimated is the following, based on standard hedonic pricing model literature, specifically Duncan (2010) and Song and Knaap (2004), who use cross-sectional data to measure the impact on prices of transit-oriented development and mixed land uses, respectively:

$$P = f(sidewalk, U, N, F), \tag{2.1}$$

where *sidewalk* is the variable of interest, U is a vector of unit-specific characteristics, N is a vector of characteristics of the neighborhood surrounding the lot, and F is a dummy per neighborhood to control for zonal fixed effects.

More specifically, I will use the following ordinary least squares (OLS) specification:

$$\widehat{price_i} = \alpha + \gamma \cdot sidewalk_i + \beta_U \cdot U_i^T + \beta_N \cdot N_i^T + \beta_F \cdot F_i^T + \varepsilon_i, \tag{2.2}$$

[2] "Goods do not possess final consumption attributes but rather are purchased as inputs into self-production functions for ultimate characteristics. Consumers act as their own 'middle-men', so to speak." Rosen (1974)

where the unit of observation i is a city block. Two separate sets of regressions will be run using the variable of interest both as a continuous variable, where $sidewalk_i$ equals the total sidewalk area that has been granted to shops for use since 2011[3], and as a categorical variable where $sidewalk_i = 1$ if the has been any positive amount of sidewalk area in use by shops since 2011 and $sidewalk_i = 0$ otherwise. The independent variable $\widehat{price_i}$ is per-square-meter rent. Note that the dependent variable is denoted as $\widehat{price_i}$ instead of $price_i$ because the price is estimated by calibrating a normalized price index using commercial rent prices. Further discussion of the data utilized for this calibration can be found on Chapter 3, and the full calibration is shown in Appendix B. The estimated parameter of interest would be $\hat{\gamma}$. Under the continuous specification, the interpretation would be that for every additional square meter of possible sidewalk use, the rent would increase by $\hat{\gamma}$ monetary units. Under the categorical specification, the interpretation would be that the existance of furniture on the sidewalk anywhere on the block increases rents by $\hat{\gamma}$.

2.3 Endogeneity

Perhaps the most sound strategy for choosing between an OLS and an instrumental variables (IV) econometric model is to start by looking at the possible sources of endogeneity, which would introduce a bias in the parameters and call from something other than a simple OLS specification. If there are no endogeneity problems, a linear regression can be performed to isolate this effect. The usual sources for endogeneity are reverse causality, omitted variable, and measurement error. Note that this discussion was focused on *the posibility* of placing furniture on the sidewalk, which is most likely exogenous and, one could argue, very highly correlated to the actual placement of furniture. However, the difference between the possibility of placing furniture on the sidewalk due to the physical qualities of the space and the law that governs this permit and the actual location of furniture on the sidewalk, which is the data set that is available, is not trivial. In this

[3]Specifically, the data set was constructed by removing all but the most recent observation for each street address. This leaves only the area that was granted the last time that a permit was requested.

thesis, I will make the rather strong assumption that within the past six years, every possible license that a person can obtain due to exogenous physical characteristics has in fact been granted. Thus, the possibility of placing furniture and the actual placement of furniture are assumed to me the same, and the terms are used interchangeably. This limitation is further discussed in Chapter 6.

If we look at the legal requirements for placing furniture on the sidewalk described in Appendix A, it is evident that having the possibility of obtaining this permission is almost certainly exogenous. Conditions 1 and 5 are limitations on the characteristics of the furniture and the behavior of businesses that apply to any shop: (1) the objects must be contiguous to the establishment and demountable, without being fixed to the sidewalk, and (5) they cannot be used to prepare drinks or foods. On the other hand, conditions 2, 3, 4, and 7 depend strictly on the physical shape of the city, which cannot be modified by a shop owner: (2) a free area at least two meters wide must be left between the installation of the furniture and the street, (3) the furniture can not occupy the surface for the vehicular circulation, nor green areas, nor any area where elements of accessibility for people with disability are placed, (4) its installation can not prevent the operation of pre-existing businesses, and (5) the equipment or installations can not be used to prepare drinks or foods. Finally, condition 6 depends on exclusively zoning laws, which are also determined by city authorities: the furniture can not be placed in urban zones destined mainly for housing.

There would be reverse causality if shop rent prices affected the possibility of placing furniture on the sidewalk. Looking at the requirements for the permit, it is evident that this cannot happen directly. However, one could argue that rent prices could affect the possibility of placing sidewalk furniture through changes in zoning laws or the city's design decisions. For example, a residential neighborhood where rents are higher might attract more business than a less wealthy one, and its zoning use could eventually be modified. Alternatively, as property prices increase in an area, the city could decide to extend the sidewalks. However, these changes would alter the possibility of placing furniture on the sidewalks at a much later time, ruling out any possible reverse causality.

Regarding a possible omitted variable, the question is whether any unobservable variables affect both the independent and the dependent variables. Here, again, one could think of zoning changes and urban design decisions. However, many of these characteristics land use and many physical traits of the city are observable and can be controlled for in the regression[4]. Note that although market trends and people's preferences are not observable, these variables would only affect rent prices and not the possibility of placing equipment on the sidewalk which is mostly determined by the physical shape of the city. If that is the case, it is unlikely that there would an omitted variable bias. Finally, as one can see in the specification outlined in the previous section, one dummy variable per neighborhood will allow us to control for any unobservable characteristics that do not vary within each area.

[4]See Table 3.2 for a complete list of control variables

Chapter 3

Data

This chapter contains a description of the data used for the regressions in this work and is divided into four subsections. In the first three, I describe the data for the explanatory, explained, and control variables, respectively. In the last one, I provide a summary of all variables.

3.1 Explanatory variable

The explanatory variable for this project is the possibility of using the sidewalk in front of a store. One possible way of obtaining this information is looking at many storefronts, taking measurements, and evaluating whether the city can grant a sidewalk furniture permit or not, which would be extremely time-consuming. Another way of obtaining an approximation of this information was to find a list of every one of these permits that the city has granted in the last few years. As I stated earlier, under the rather strong assumption that a few years, every possible sidewalk furniture permit that a person can obtain due to exogenous physical characteristics has in fact been requested and received, this information can be used as an exogenous indicator of whether a storefront can have sidewalk furniture.

A request for public information done through the online transparency portal for the INAI (*Instituto Nacional de Transparencia, Acceso a la Información y Protección de Datos Personales*) was submitted to each municipality (*Delegación*) in Mexico City. Of the sixteen *Delegaciones*,

two did not send any information, twelve provided only some information, and the last two, Cuauhtémoc and Miguel Hidalgo, sent all the requested information for permits granted since 2011: license date, commercial activity, name, full address, private area, and sidewalk area. Since Cuauhtémoc and Miguel Hidalgo are the municipalities for which there is more information, and there is enough heterogeneity in their land uses and rent prices, this study will be limited to limited to these two districts. See Chapter 4 on descriptive statistics for more detailed information on the information provided by each *Delegación*.

3.2 Explained variable

For the explained variable, an estimated per-square-meter rent price was obtained for each city block by calibrating a price index using information from real estate listings.

For the price index, the Mexican big data firm OPI generously provided a confidential per-block dataset. The OPI price index is a national indicator of real estate prices for all uses (commercial, residential, office, etc.) built with data from online real estate listings, the cadastral value, and appraisals from the *Sociedad Hipotecaria Federal*. Their methodology takes into account the price distributions for each source, weighed by block, and returns a normalized continuous variable that ranges from zero to one. This index can also be interpreted as the probability of a block being the most expensive in the county. In order to have a per-square-meter rent price in Mexican pesos for each city block, this index will be calibrated using for commercial rent price information from Delegación Cuauhtémoc[1]. The advantage of using this database are that there is information for every block in the city. The disadvantage is that the price heterogeneity of lots in the same block will be lost.

The per-lot dataset was built manually by looking at real estate listings and contacting the agencies or owners when the information on the listing is incomplete. This information will be used to calibrate the per-block index. Using this dataset directly in the model would have the

[1] Although this is only relevant for the interpretation in terms of Mexican pesos, the fact that the price index is calibrated using data from commercial spaces from Delegación Cuauhtémoc could make the interpretation slightly less accurate.

significant advantages of allowing to separate the effects of sidewalk activities on commercial and residential rent values and of taking into account the within-block heterogeneity. However, the number of observations was too small to provide any valuable results. This is further discussed in Chapter 5, and the results are included in Appendix E.

3.3 Control variables

To control for the physical characteristics of each unit, other exogenous variables were added on a per-lot and a per-block level. The information for the per-lot control variables comes from the real estate listings that were used to build the price database and it includes the logarithm of lot area in square meters, a categorical variable for lots located in a shopping mall, the floor on which the lot is located, a categorical variable for lots that are on a street, the number of parking spots for lot, and the number of restrooms per lot. The per-block information was obtained from the *Censo de Población y Vivienda* conducted by INEGI in 2010, and it includes information on pavement availability, sidewalk availability, sidewalk trim availability, trees availability, wheelchair ramp availability, public lighting availability, street name sign availability, public telephone availability, storm drain availability, public transportation availability, access for persons, access for automobiles, semi-fixed vending presence, and street vending presence.

Finally, one dummy variable per neighborhood also helps to control for any unobserved characteristics that to not vary within each area.

3.4 Summary of variables

The following tables are provided as a summary of per-lot and per-lot dependent, independent, and control variables.

Table 3.1: Summary of per-lot variables

Variable	Description	Source
Dependent variable		
Price	Total price rent for unit i	Real estate listings
Variable of interest		
Sidewalk	Sidewalk square meters in use in lot i since 2011	Delegaciones Cuauhtémoc and Miguel Hidalgo
Unit characteristics (U)		
Log area	Logarithm of lot area in square meters	Real estate listings
Mall	Lot in shopping mall (0, 1)	Real estate listings
Floor	Floor in which the lot is located	Real estate listings
Corner	Lot in street corner (0, 1)	Real estate listings
Parking	Number of parking spots for lot	Real estate listings
Bathrooms	Number of restrooms per lot	Real estate listings
Fixed effects (F)		
Multiple dummy variables	Series of 127 dummy variables, one per neighborhood (colonia)	INEGI: Información Vectorial de Localidades Amanzanadas y Números Exteriores

Table 3.2: Summary of per-block variables

Variable	Description	Source
Dependent variable		
Price	Per-square-meter rent price in block i	OPI price index
Variable of interest		
Sidewalk	Sum per block of sidewalk square meters in use in lot i since 2011	Delegaciones Cuauhtémoc and Miguel Hidalgo
Unit characteristics (U)		
Pavement	Pavement availability (1-3)	INEGI: Censo de Población y Vivienda 2010
Sidewalk availability	Sidewalk availability (0,1)	INEGI: Censo de Población y Vivienda 2010
Trim	Sidewalk trim availability (0-4)	INEGI: Censo de Población y Vivienda 2010
Trees	Trees availability (0-3)	INEGI: Censo de Población y Vivienda 2010
Wheelchair	Wheelchair ramp availability (0-2)	INEGI: Censo de Población y Vivienda 2010
Lighting	Public lighting availability (0,1)	INEGI: Censo de Población y Vivienda 2010
Street name	Street name sign availability (0-2)	INEGI: Censo de Población y Vivienda 2010
Public telephone	Public telephone availability (0-3)	INEGI: Censo de Población y Vivienda 2010
Storm drain	Storm drain availability (0,1)	INEGI: Censo de Población y Vivienda 2010
Public transportation	Public transportation availability (0,1)	INEGI: Censo de Población y Vivienda 2010
Access for persons	Access for persons (0,1)	INEGI: Censo de Población y Vivienda 2010
Access for automobiles	Access for automobiles (0,1)	INEGI: Censo de Población y Vivienda 2010
Semi-fixed vending	Semi-fixed vending presence (0,1)	INEGI: Censo de Población y Vivienda 2010
Street vending	Street vending presence (0,1)	INEGI: Censo de Población y Vivienda 2010
Fixed effects (F)		
Multiple dummy variables	Series of 127 dummy variables, one per neighborhood (colonia)	INEGI: Información Vectorial de Localidades Amanzanadas y Números Exteriores

Chapter 4

Descriptive Statistics

This chapter contains the descriptive statistics for the data used in this work. First, I show statistics on the information provided by each *Delegación*. Then, I show statistics and maps on the amount of sidewalk area granted by the city. Finally, I provide some descriptive statistics on the OPI price index, as well as on the price information collected from real estate listings that I used to calibrate this index.

4.1 Explanatory variable: sidewalk area

Table 4.1 shows a summary of the quality of the information that was submitted by each *Delegación*.

Figure 4.1 shows the number of observations per *Delegación*. It is evident simply by the number of reported registered permits per municipality that, except for Benito Juárez, for which there is no information, the most centric districts have more information. (Note that Centro Histórico, the historical center of the city, is located in Cuauhtémoc.) The reason for this could be that central municipalities are more likely to have activity on the sidewalk, and thus more permits are granted. It could also be that the city pays more attention to these central districts that have more commercial activities, which forces them to have better record-keeping policies and

Table 4.1: *Delegación* data availability

Delegación	Observations
Álvaro Obregón	48
Azcapotzalco	18
Benito Juárez	N/A
Coyoacán	729
Cuajimalpa de Morelos	0
Cuauhtémoc	1,736
Gustavo A. Madero	N/A
Iztacalco	30
Iztapalapa	3
La Magdalena Contreras	7
Miguel Hidalgo	1,202
Milpa Alta	0
Tláhuac	2
Tlalpan	15
Venustiano Carranza	37
Xochimilco	16

capacities and makes it harder for the municipalities to incur in informality and corruption.

As noted before, this study will be limited to limited to these two distrcits, Cuauhtémoc and Miguel Hidalgo. The following table shows the information on occupied sidewalk area from 2011 to 2016. Since shop owners have to renovate this permit on a yearly basis, each observation in the original data set represents one permit, either the original one or the renovation. Thus, if a shop has had the permit for three years, for example, there will be one observation for this location for every year. The data is presented per year as well as the accumulated permits. For the accumulated permits, all observations for each street address were discarded except for the most recent one, providing an approximation of every street address where it is possible to place furniture on the sidewalk. The first two columns in the table show the number of lots (unique street addresses), and the number of blocks through which they are distributed. The other columns show the sum, minimum, maximum, mean and median for the sidewalk surface per lot, measured in meters.

Figure 4.2 shows the total area of sidewalk in use by shops, for the latest observation, accumulated and plotted by city block. The rest of the figures can be found in Appendix C.

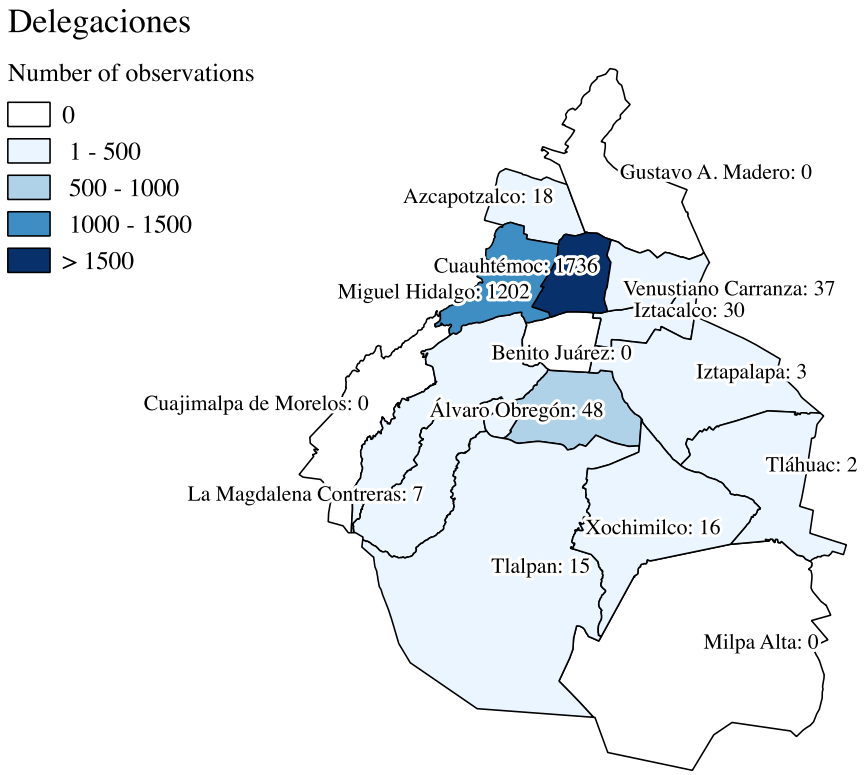

Figure 4.1: Number of observations per *delegación*

Table 4.2: Sidewalk permits area (Cuauhtémoc and Miguel Hidalgo)

	Observations		Surface				
Year	Lots	Blocks	Sum	Min	Max	Mean	Median
2011	223	168	4,886.28	1.28	321.00	29.09	18.85
2012	238	186	4,809.64	1.42	141.50	25.86	15.00
2013	312	236	6,080.32	1.42	205.00	25.76	15.09
2014	319	230	5,988.13	1.50	148.64	26.04	16.14
2015	344	256	7,304.78	1.00	203.62	28.53	16.75
2016	418	303	7,383.32	1.50	164.40	24.37	15.00
Latest	594	370	12,771.52	1.20	180.00	25.65	15.00

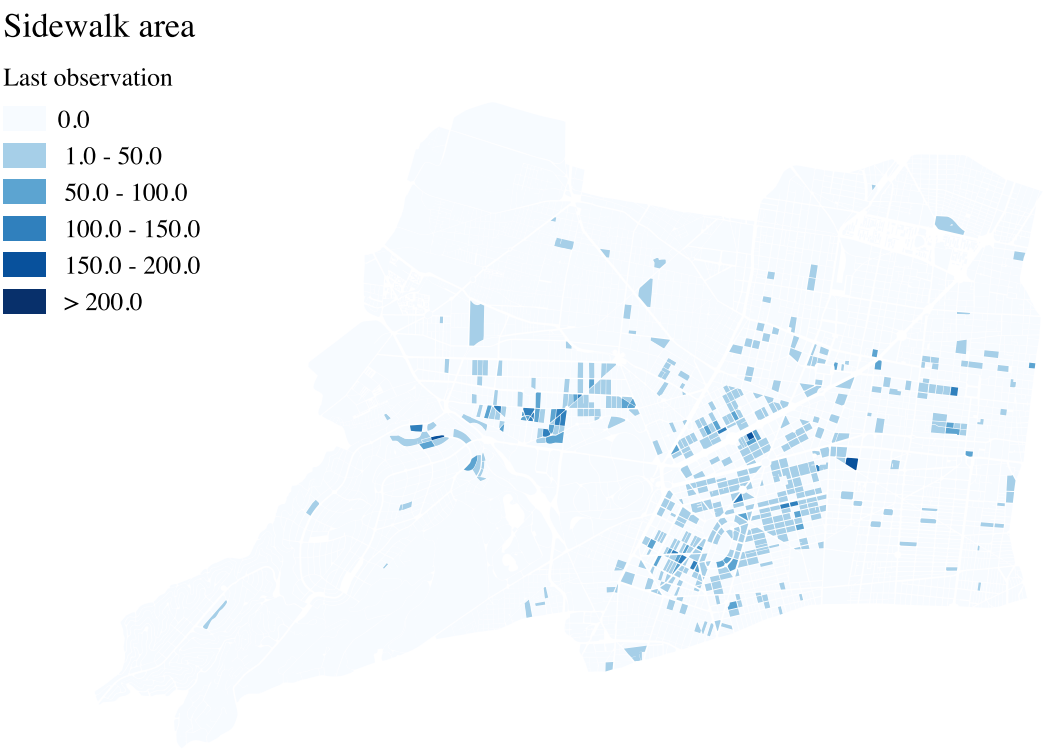

Figure 4.2: Sum per block of sidewalk area in use, last observation.

One can see from the table and the images that, by all measures, there has been a steady increase in sidewalk use: More lots have received the permit, distributed over a more broad area of the city, and the total number of square meters has increased. Some possible explanations for this tendency could be an increase in commercial real estate prices (where sidewalk space becomes comparatively cheaper), an increase in the population density or demand for this kind of use (there are more people, or they prefer seating outdoors), or merely an improvement in policy and its implementation (better record keeping or less informal use of the sidewalks by shops).

Some of the features of the map can be explained in broad terms by urban design decisions, where a decision to broaden the sidewalk results in more permits being granted. For instance, on Madero, Regina, and San Jerónimo, which were turned into pedestrian streets before 2011, there is a relatively high density of sidewalk surface in use, especially compared to the surrounding blocks where there is virtually none.

4.2 Explained variable: prices

Figure 4.3 shows the OPI real estate price index by deviation from the mean for the 2,704 city blocks in Cuauhtémoc.

Table 4.3 shows descriptive statistics for the price information that was gathered from real estate price listings. A total of 193 ads were scraped for online real estate listings, but the information was only complete for 83 observations.

Table 4.3: Price per square meter

Min	Max	Mean	Median	Std. dev.
62.5	2,500.00	500.61	333.33	473.90

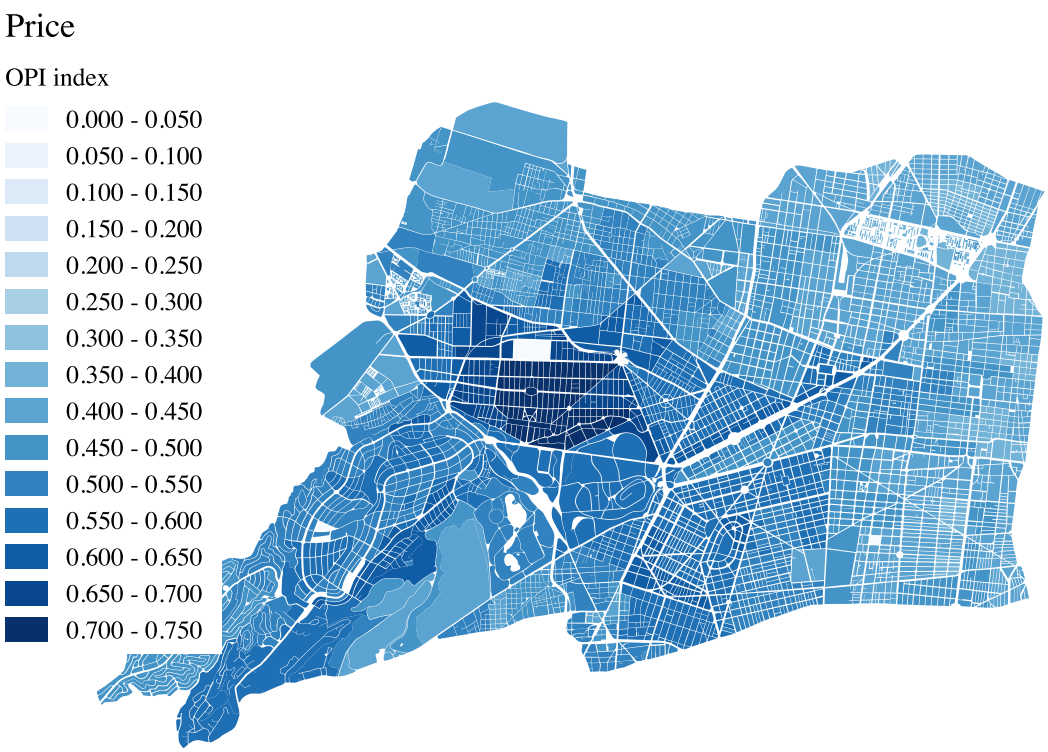

Figure 4.3: OPI price index.

Chapter 5

Results

This chapter contains the results of this thesis. The effect of the possibility of placing furniture on the sidewalk was estimated using the following specification:

$$\widehat{price_i} = \alpha + \gamma \cdot sidewalk_i + \beta_U \cdot U_i^T + \beta_F \cdot F_i^T + \varepsilon_i, \tag{5.1}$$

As specified in Chapter 2. Again, $\widehat{price_i}$ is per-square-meter estimated price[1], $sidewalk_i$ is the sidewalk area in use, U_i^T are per-block control variables, and F_i^T is a group of dummy variables, one per neighborhood (Colonia). Four regressions were run, using the combinations of the two calibration models (linear and quadratic), and two different versions $sidewalk_i$, one as the total area that was granted by the city per block since 2011, and another as a dummy variable that equals one when some sidewalk area was allowed and zero otherwise. The results are presented in Table 5.1.

Under this specification, the parameter of interest $\hat{\gamma}$ is statistically significant at an $alpha$ level of 0.10 in all regressions. Looking at columns (1) and (3), one can conclude that each additional square meter of sidewalk use on the block where a lot is located adds $\hat{\gamma} = 0.04$ and $\hat{\gamma} = 0.09$ Mexican pesos to the per-square-meter rent price under the linear and quadratic price calibrations, respectively. How big is this effect? Considering the block with the largest sidewalk area used for

[1] See Appendix B for details on the calibration.

Table 5.1: Effect of sidewalk space on prices.

	(1)	(2)	(3)	(4)
	Linear price calibration		Quadratic price calibration	
Sidewalk area	0.0399*		0.0941*	
	(0.0242)		(0.0481)	
Sidewalk dummy		2.066*		4.118*
		(1.071)		(2.128)
Constant	420.3***	420.3***	415.4***	415.3***
	(9.050)	(9.049)	(17.98)	(17.98)
Observations	5067	5067	5067	5067
Adjusted R^2	0.914	0.914	0.923	0.923

Standard errors in parentheses

Coefficients for control variables and dummies not displayed. See Appendix D for full regressions.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

furniture, for example, going from no sidewalk furniture to its current condition would increase per-square-meter rent prices by 16.4 Mexican pesos. If we consider that the average rent price is \$500 per square meter, this change would translate approximately to a 3% increase in the rent price, which is not insignificant.

Columns (2) and (4) show the regressions using dummy variables for $sidewalk_i$. In this case, having any amount of sidewalk furniture on the block where a lot is located adds $\hat{\gamma} = 2.07$ and $\hat{\gamma} = 4.12$ Mexican pesos to the per-square-meter rent price under the linear and quadratic price calibrations, respectively. Again, the quadratic price calibration shows a much larger effect. Looking again at the average rent price of \$500, a \$4.12 increase amounts approximately to a 0.8% increase on rent prices.

It is also worth noting that since there is time-series data for the variable of interest $sidewalk_i$, an instrumental variables specification was also tested using $sidewalk_i^{2011}$ as an instrument for $sidewalk_i$, where $sidewalk_i^{2011}$ is the sidewalk area per block granted in 2011. One could argue that the sidewalk space used five years ago is highly correlated to the area awarded in the following years, while it only has an effect on current prices through the latest sidewalk area granted to shops. However, after running an endogeneity test[2] it is found that the null hypothesis

[2]The endogeneity test that was used was the one implemented in the Stata command *ivreg2*, which is defined "as

"$sidewalk_i$, which is assumed to be endogenous, can be treated as exogenous cannot" cannot be rejected[3], and the simpler OLS regression is preferred[4].

Finally, a similar per-lot regression was also tested. However, the original sample size of 83 was reduced to 33 when one limited the study to the neighborhoods where sidewalk furniture was placed on at least on one of the lots contained in the sample. Under this specification, the p-value for the t-statistic of the variable of interest $sidewalk_i$ was 0.3, most likely due to the sample size. The results of this regression are included in Appendix E.

the difference of two Sargan-Hansen statistics: one for the equation with the smaller set of instruments, where the suspect regressor(s) are treated as endogenous, and one for the equation with the larger set of instruments, where the suspect regressors are treated as exogenous." Baum et al. (2007)

[3]"Under the null hypothesis that the specified endogenous regressors can actually be treated as exogenous, the test statistic is distributed as chi-squared with degrees of freedom equal to the number of regressors tested." Baum et al. (2007). The chi-squared score for this specification is 0.012, which under one degree of freedom corresponds to a p-value of 0.9116.

[4]This result is only true if the instrument is valid, which cannot be tested statistically if we only have one instrument.

Chapter 6

Conclusions

Although the effect of having the possibility to place sidewalk furniture on rents is not very high, and it is hard to rule out a bias from reverse causality entirely, there is at least some correlation between sidewalk furniture and real estate prices. In this chapter, I add some concluding comments regarding possible policy implications and discuss some possible improvements that could me made to this work.

6.1 Policy implications

Summarizing the findings from the previous chapters, real estate rent prices can increase by up to around 3% when furniture can be placed on the sidewalk on or near a parcel. Since the calibrated OPI price index contains information about rent prices for all uses (commercial, housing, office, etc.), the only thing that can be said is that there is a net positive effect on prices.[1] For this analysis, the results will be interpreted as if this positive effect is present in both commercial and housing uses.

This result has policy implications along two lines: the way in which the city sets the tax for using the sidewalk and the ways in which government planners and designers develop new towns

[1] That is, this effect could be in opposite directions for different kinds of use, but when they are netted, a positive effect is found. As an example, home rents could *decrease* with sidewalk use, and if the increase in commercial rents is high enough, the net effect would be positive.

and neighborhoods.

If we focus on commercial spaces and interpret this effect on the price as the renters' willingness to pay for having the possibility of using the sidewalk, it is likely that the government could charge a higher tax for the semi-privatization of this good, which could then be transferred back to citizens. In other words, if city officials made a more thorough analysis than similar to this thesis, they could raise the tax until there is no premium for the possibility of placing furniture in front of a shop. Theoretically, that would be the case where shop owners would be indifferent between renting a space where they can have seating outside and an identical one where they cannot, both for the same price. In this scenario, only one shop would pay the sidewalk tax, which would equal its earnings from the sidewalk seating. Additionally, if city officials did a more thorough analysis, they could redesign this tax to maximize the amount that can be extracted and transferred back to citizens. This could be done with non-linear pricing schemes or by differentiating which shop owners would be willing to pay a higher tax depending on the neighborhood where they are located or other characteristics.

Considering the effect of sidewalk use on housing rents or real estate rents in general, the findings suggest that people prefer to be near this kind of activities, and value can be added to properties by allowing commercial life to take place on the sidewalk. Urban planners, city officials, and designers could increase the value of cities by writing zoning laws that incentivize this kind of use and by designing sidewalks that physically allow these activities.

6.2 Further improvements

This work could be improved in some ways. Finding a good instrument to get rid of possible endogeneity problems could make the results more convincing regarding causality. However, this can be particularly challenging in works that look at housing values. For example, Song and Knaap (2004) use each lot's distance to a central general commercial space as an instrumental variable, as well as the proportion of the perimeter of the neighborhood commercial lot that is

facing a major road. Although these variables are exogenous, it is hard to argue that they do not have an effect on prices directly: many people possibly value living near or far a central general commercial use, for instance. For this work, some possible instruments that would have allowed to test an IV specification could have been total sidewalk area per block or sidewalk width per parcel or block[2]. Unfortunately, this information could not be found.

Although using the OPI index significantly increases the number of observations, it has the disadvantage of being constructed from the aggregate of all real estate prices. Thus, it is impossible to separate the effects that placing furniture on the sidewalk can have on rent prices for commercial spaces from the impact that it could have on home rents, for example. In this sense, by using the OPI price index, one cannot rule out the fact that the effect of sidewalk furniture could go in opposite directions for commercial space and home prices, which would have very different policy implications than the ones described above. Furthermore, a per-lot specification could help control for additional characteristics more precisely (number of bathrooms and windows in a unit instead of whether a city block has wheelchair ramps, for example). Thus, this work could be vastly improved by a larger per-lot data set for prices. This information could be obtained from gathering more real estate listings, which is very time consuming, or from the microdata from the economic census, which is mostly inaccessible.

[2]Note that these variables could have similar problems to the ones used in Song and Knaap (2004)

Appendix A

Legislation

This section contains an overview of the legislation regarding the *Notice for the placement of equipment and installations on the sidewalk*. Two aspects of this information will be useful for the setup of the econometric model and the interpretation of the results. First, the definition of the possibility of placing equipment on the sidewalk comes from from the conditions that the law requires for this permit. Second, the pricing structure for this license will serve to explain the motivation for this work and will possibly help interpret the results.

The *Notice for the placement of equipment and installations on the sidewalk* has its legal basis in the articles 2 (fractions X, XI, XV, XXII, and XXVI), 14, 15, 16, and 17 of the *Ley de Establecimientos Mercantiles del Distrito Federal* Gobierno del Distrito Federal (b); on the articles 32,33, 34, 35, 39, 40, 41, 42, 44, 49, 74, and 89 of the *Ley de Procedimiento Administrativo del Distrito Federal* Gobierno del Distrito Federal (c); on the articles 20 and 191 (fraction III and antepenultimate paragraph) of the *Código Fiscal del Distrito Federal* Gobierno del Distrito Federal (a); and on the Second (fractions II, VII, X, XVI, and XVIII), Third, Thirteenth, Fourteenth, and Fifteenth of the *Lineamientos Generales para la Operación del Sistema Electrónico de Avisos y Permisos de Establecimientos Mercantiles del Distrito Federal* Gobierno del Distrito Federal (d).

The following conditions are necessary for a shop to place furniture on the sidewalk in Mexico

City Gobierno del Distrito Federal (b):

1. That they are contiguous to the establishment and demountable, without being fixed to the sidewalk;
2. That a free width of at least two meters is left, between the installation of the furniture and the street, for pedestrians to walk;
3. That they do not occupy the surface for the vehicular circulation, nor green areas, nor any area where elements of accessibility for people with disability are;
4. That its installation does not prevent the operation of pre-existing businesses;
5. That the equipment or facilities are not used to prepare drinks or foods;
6. That they are not placed in urban zones destined for housing; and
7. The furniture may never cover an area of more than 50% of the total area of the commercial establishment.

The price for the annual *Notice for the placement of equipment and installations on the sidewalk* is calculated using the formula

$$permit\ cost = (\$2,882.50 + 0.12 \cdot cadastral\ value) \cdot area$$

for "high-impact" businesses (*impacto vecinal* and *impacto zonal*), such as bars and night clubs, and

$$permit\ cost = (\$1,451.20 + 0.12 \cdot cadastral\ value) \cdot area$$

for "low-impact" businesses (*bajo impacto*) such as cafes and restaurants that do not serve alcohol. The cadastral value is based on an estimated real estate value per square meter calculated by the government, which ranges from $3,100 to $9,100 pesos in the Cuauhtémoc municipality, for example. The 0.12 factor corresponds to "a monthly fee per occupied square meter equivalent to

1% of the land value". This calculation is specified in the articles 191 and 260 of the Mexico City fiscal code Gobierno del Distrito Federal (a).

Appendix B

OPI index calibration

To be able to interpret the results from the per-block regression in monetary terms, I calibrated the OPI index using the information from real estate listings as suggested by OPI. I used the following two specifications for the calibration:

$$price_i = \beta \cdot OPI_i + \varepsilon_i, \tag{B.1}$$

and

$$price_i = \beta \cdot OPI_i^2 + \varepsilon_i, \tag{B.2}$$

where $OPI_i \in [0, 1]$ is the OPI price index. The results of the calibration regressions are shown in the following table:

These specifications were chosen over other similar ones with a constant or with both linear and quadratic terms due to the fact that they had higher values for their adjusted R^2, and they forced the prices to be positive and strictly increasing. Both calibrations are used in the following section.

Note that this calibration is only necessary to give an interpretation of $\hat{\gamma}$ in monetary units, and under the linear calibration, the results from the following section would be identical except for the units of the parameter of interest. For this work, the calibration was done using commercial

Table B.1: OPI price index calibration.

	(1) Linear price calibration	(2) Quadratic price calibration
OPI index	850.0***	
	(59.15)	
OPI index squared		1693.5***
		(106.0)
Observations	60	60
Adjusted R^2	0.774	0.809

Standard errors in parentheses

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

rent prices, but since the OPI price index contains information about all kinds of real estate prices, this work could also be further extended by calibrating the price index using housing prices, for instance.

Appendix C

Sidewalk area maps

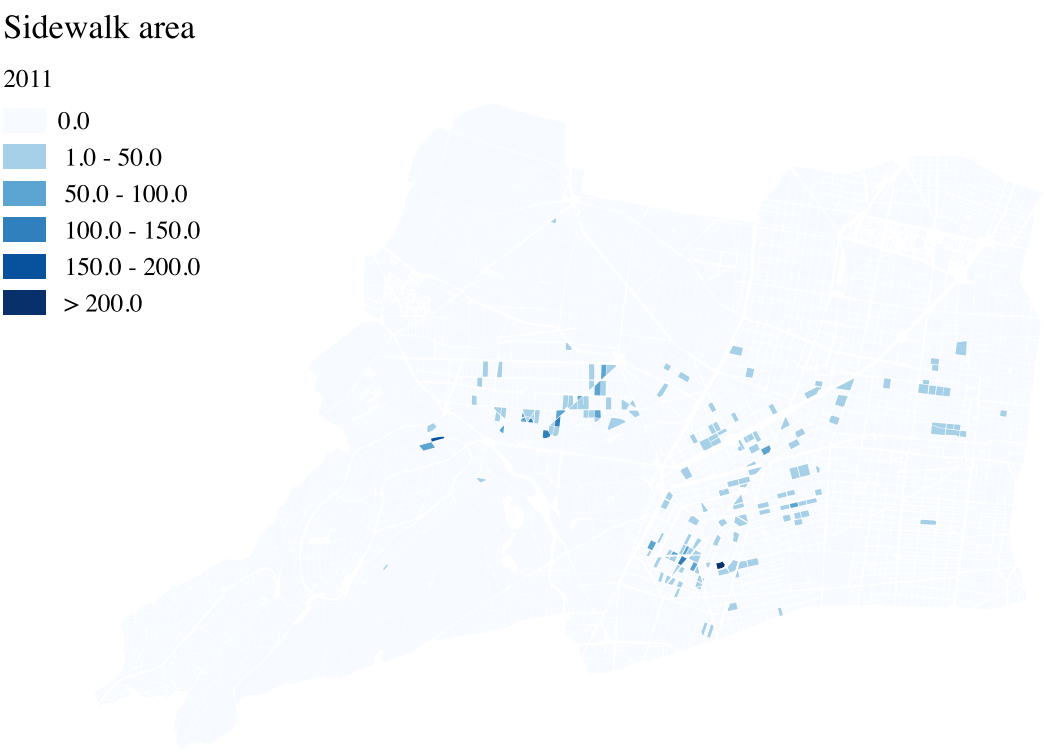

Figure C.1: Sum per block of sidewalk area in use, 2011.

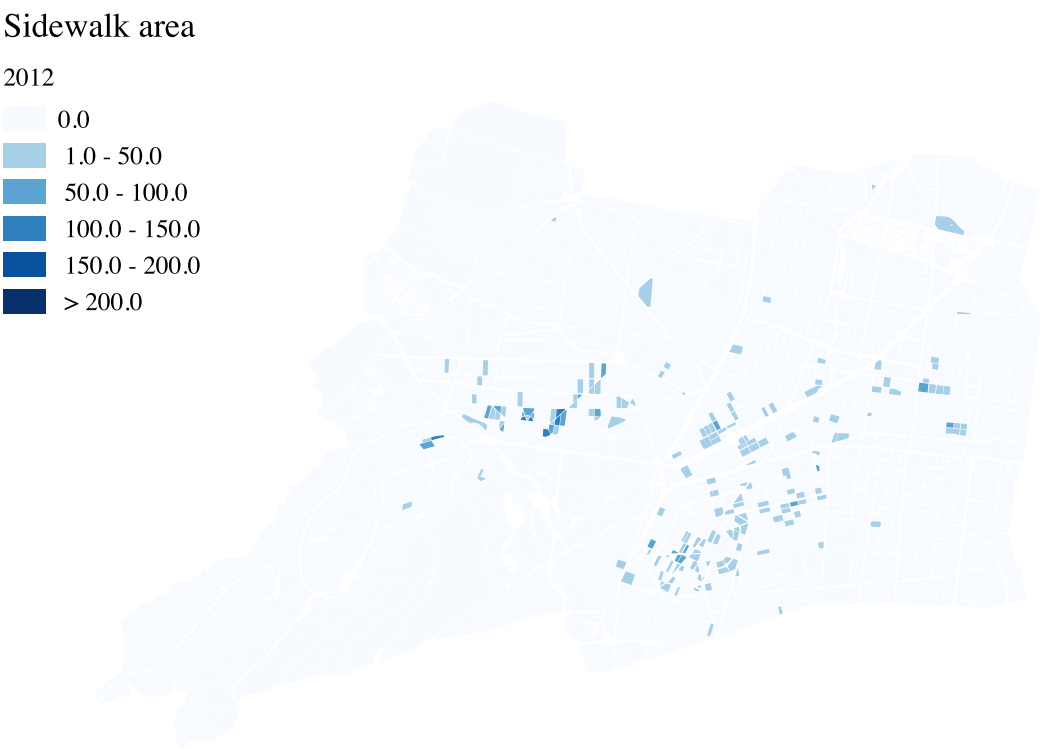

Figure C.2: Sum per block of sidewalk area in use, 2012.

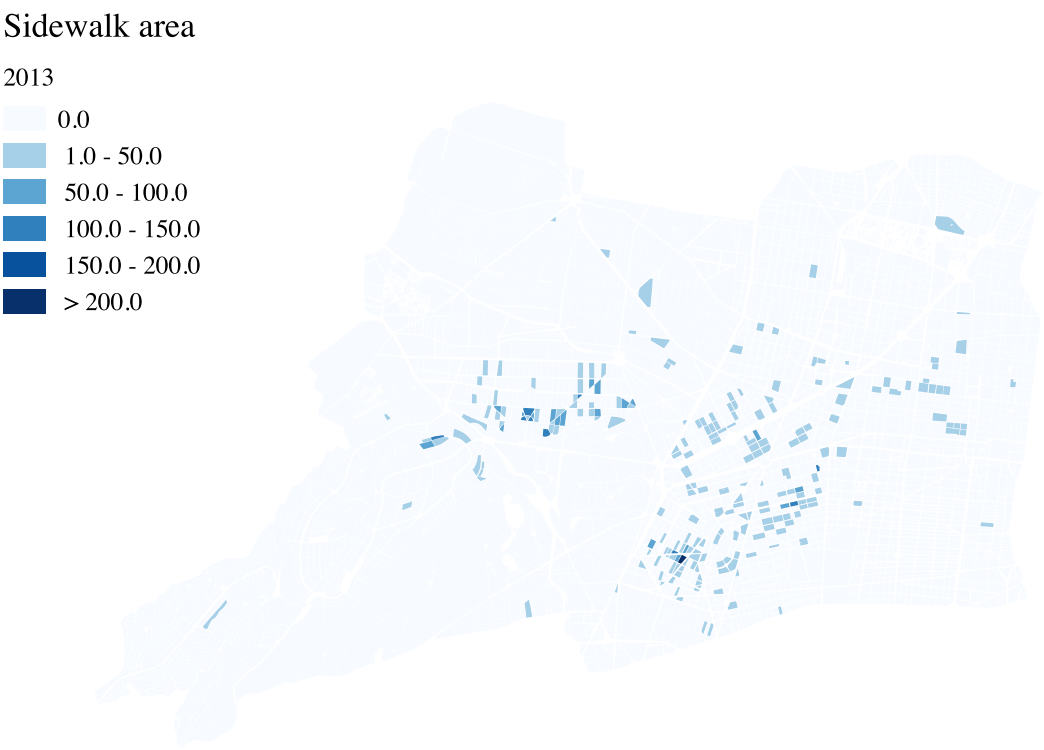

Figure C.3: Sum per block of sidewalk area in use, 2013.

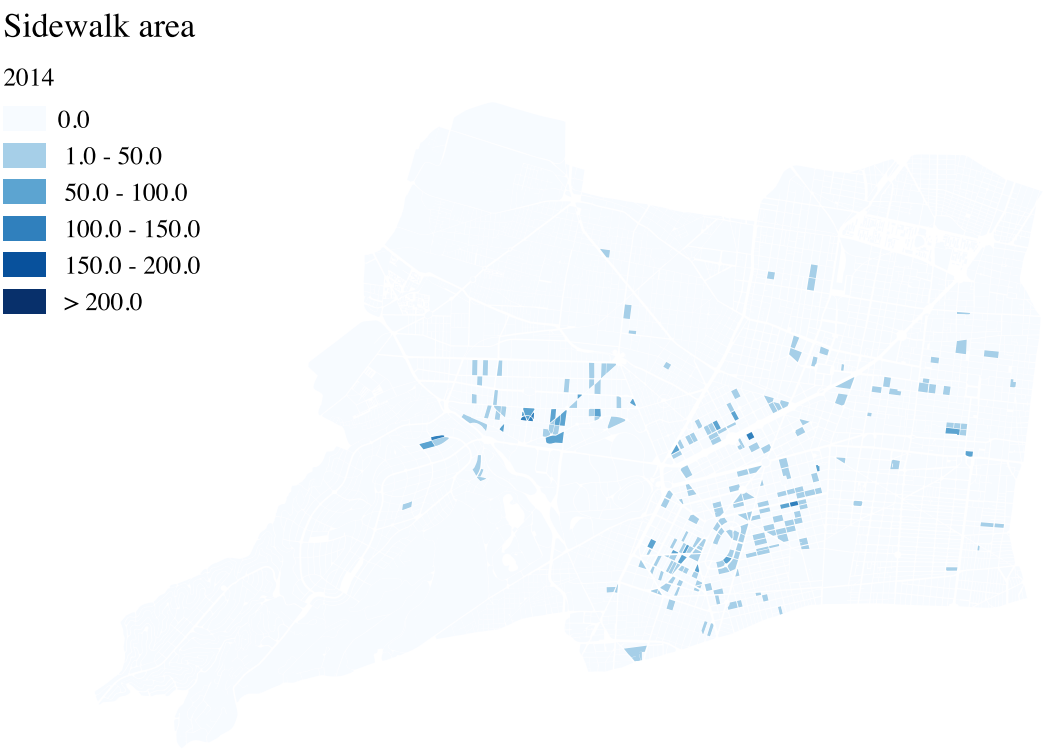

Figure C.4: Sum per block of sidewalk area in use, 2014.

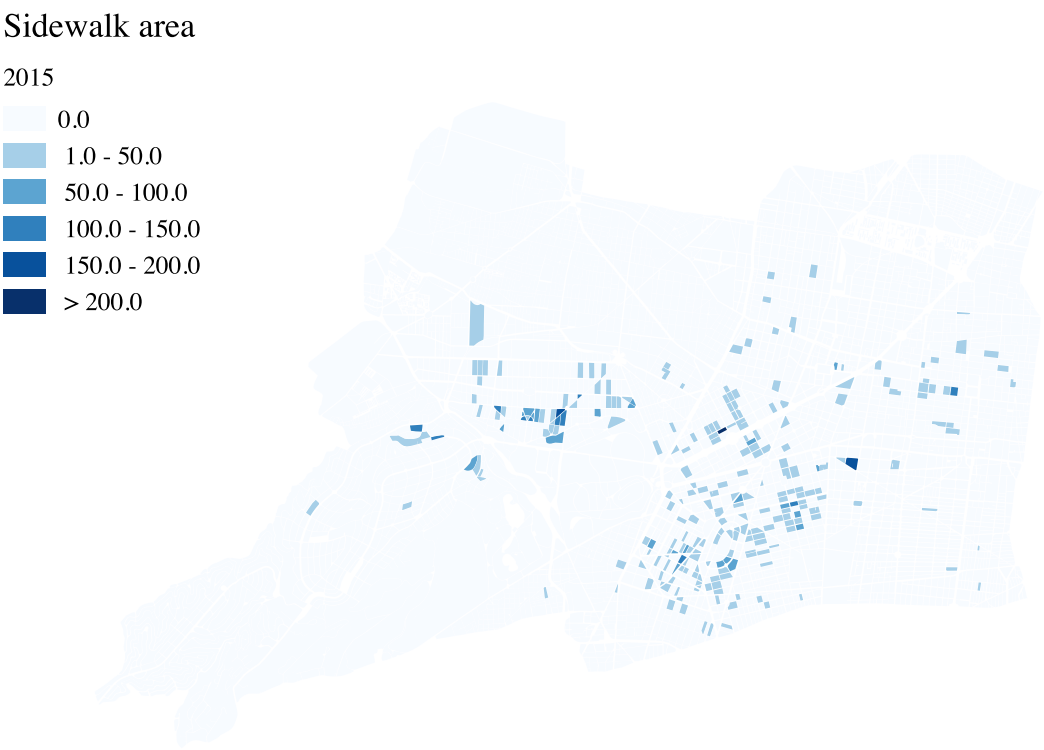

Figure C.5: Sum per block of sidewalk area in use, 2015.

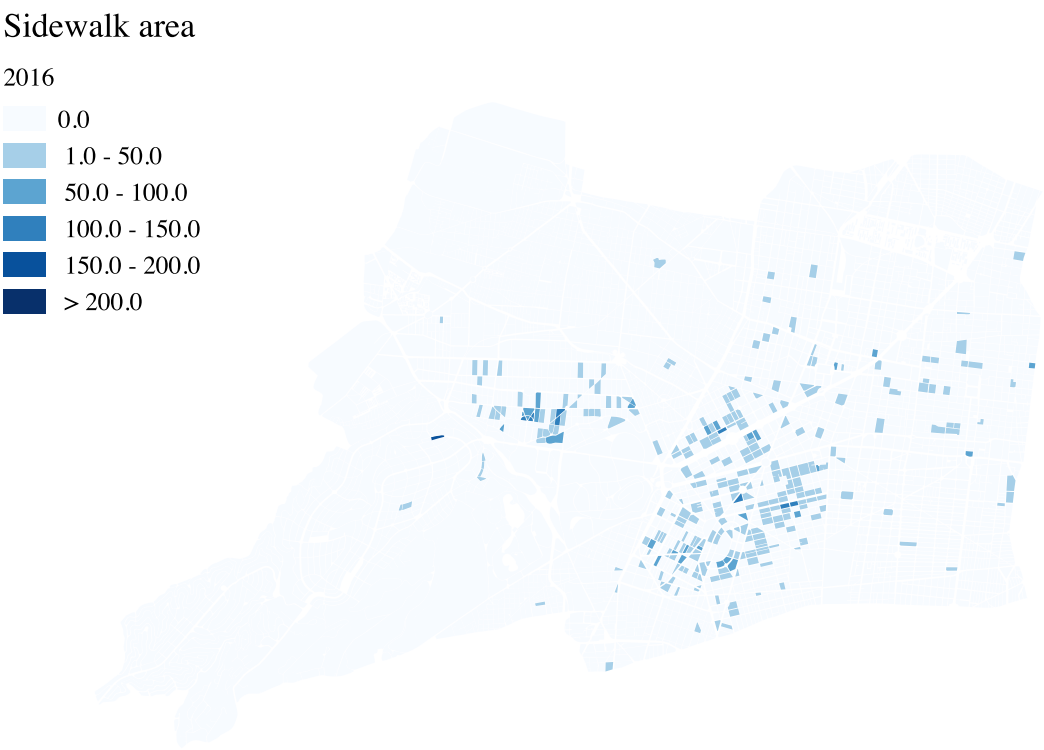

Figure C.6: Sum per block of sidewalk area in use, 2016.

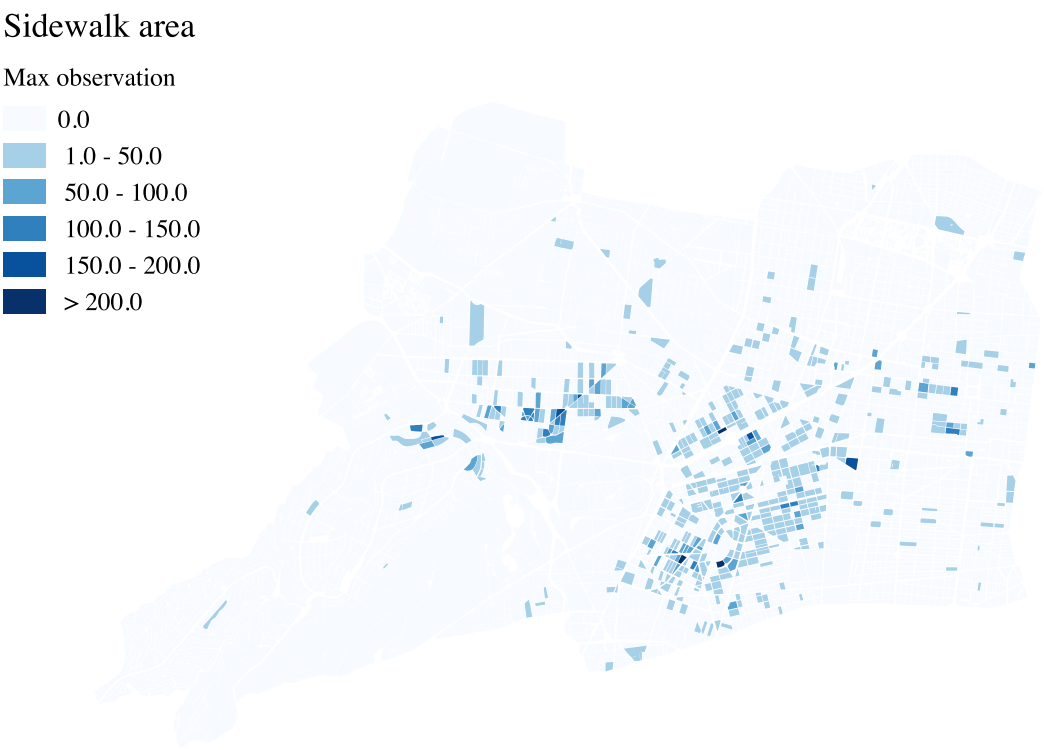

Figure C.7: Sum per block of sidewalk area in use, max of observations.

Appendix D

Performance of control variables

Table D.1: Effect of sidewalk space on prices.

	(1)	(2)	(3)	(4)
	Linear price calibration		Quadratic price calibration	
Sidewalk area	0.0399*		0.0941*	
	(0.0242)		(0.0481)	
Sidewalk dummy		2.066*		4.118*
		(1.071)		(2.128)
Constant	420.3***	420.3***	415.4***	415.3***
	(9.050)	(9.049)	(17.98)	(17.98)
Sidewalk type	0.503	0.492	0.991	0.965
	(0.508)	(0.508)	(1.009)	(1.009)
Disponibilidad de pavimento	-1.234	-1.242	-2.278	-2.278
	(1.103)	(1.103)	(2.192)	(2.192)
Sidewalk availability	-7.058***	-7.030***	-12.80***	-12.72***
	(1.438)	(1.437)	(2.856)	(2.855)
Trim	8.208***	8.176***	14.82***	14.75***
	(0.992)	(0.992)	(1.970)	(1.971)
Trees	0.00583	0.00684	-0.113	-0.118
	(0.852)	(0.852)	(1.692)	(1.692)
Wheelchair	-1.129**	-1.108**	-1.942**	-1.897*
	(0.490)	(0.490)	(0.973)	(0.973)
Lighting	4.235***	4.211***	7.905***	7.850***
	(1.038)	(1.038)	(2.063)	(2.062)
Street name	3.154***	3.189***	6.173***	6.249***
	(0.773)	(0.773)	(1.535)	(1.536)
Public telephone	1.102*	1.151**	2.509**	2.598**
	(0.567)	(0.568)	(1.126)	(1.128)
Storm drain	-3.196***	-3.201***	-5.858***	-5.871***
	(0.882)	(0.882)	(1.752)	(1.752)
Public transportation	-2.936***	-2.966***	-6.045***	-6.089***
	(0.634)	(0.635)	(1.260)	(1.261)
Access for persons	1.157	1.102	2.000	1.866
	(1.232)	(1.231)	(2.447)	(2.446)
Access for automobiles	-5.042***	-5.027***	-9.626***	-9.597***
	(1.010)	(1.010)	(2.007)	(2.007)
Semi-fixed vending	-0.501	-0.491	-1.434	-1.439
	(0.649)	(0.649)	(1.290)	(1.289)
Stret vending	1.681***	1.697***	3.075**	3.114**
	(0.616)	(0.616)	(1.225)	(1.225)
Observations	5067	5067	5067	5067
Adjusted R^2	0.914	0.914	0.923	0.923

Standard errors in parentheses

Coefficients for dummies per not neighborhood not displayed.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix E

Per-lot regression

The effect of the possibility of placing furniture on the sidewalk was estimated using the following specification:

$$price_i = \alpha + \gamma \cdot sidewalk_i + \beta_U \cdot U_i^T + \beta_F \cdot F_i^T + \varepsilon_i \tag{E.1}$$

Two versions of this regression were performed, and the results are presented in tables E.1 and E.2. For the first one, $sidewalk_i$ was defined as the number of square meters granted on the last time this permission was granted in a parcel, based on the information provided by each municipality. However, very few of the lots found in real estate listings have a positive value for $sidewalk_i$. A second regression was made where $sidewalk_i$ is the total sidewalk area granted in the block where the i^{th} lot is located. The results, which are discussed below, are similar for both regressions.

It is clear that the parameter of interest $\hat{\gamma}$ is not statistically significant in either regression. This is most likely because the number of observations is reduced from a total of 83 to 33 when the observations from neighborhoods with a low concentration of sidewalk furniture are dropped. Additionally, since this is a dataset that I constructed, it is likely that the sample is not random and there is some selection bias. Furthermore, $sidewalk_i$ is only positive for five observations in the first regression and eight in the second regression. Thus, this work could be further improved by adding more observations to the data set. This is further discussed in Chapter 6. Although the

Table E.1: Per lot sidewalk area

	Coefficient	t	P>|t|
Interest variable			
sidewalk (per lot)	3,617.30	1.06	0.300
Unit characteristics (vector U)			
u_log_superficie	17,807.58	3.19	0.004
u_banos	3,371.40	0.47	0.645
u_estacionamientos	-13.91	0.00	0.999
u_esquina	4.92	0.00	1.000
u_nivel	-27,933.89	-0.86	0.399
u_plaza	-671.18	-0.04	0.970

Number of obs. = 33, R-squared = 0.5989

Table E.2: Sum of block lot sidewalk area

	Coefficient	t	P>|t|
Interest variable			
sidewalk (sum per block)	1,390.25	1.03	0.315
Unit characteristics (vector U)			
u_log_superficie	16,901.26	3.07	0.006
u_banos	2,835.19	0.38	0.706
u_estacionamientos	2,047.22	0.12	0.904
u_esquina	-1,144.01	-0.09	0.931
u_nivel	-16,313.66	-0.62	0.544
u_plaza	609.29	0.03	0.973

Number of obs. = 33, R-squared = 0.5977

more general specification in Chapter 2 also calls for control variables at the neighborhood level, this regression was performed controlling for neighborhood characteristics merely by adding a dummy per neighborhood.

Looking over the fact that $\hat{\gamma}$ is not statistically significant, some observations could be made. Note that in this case, the commercial rent price interpretation is the only valid one. In the first regression, $\hat{\gamma} = \$3,617$. Thus, for each additional square meter of sidewalk that can be used, the owner of a parcel can charge an additional $\$3,617$ per month in rent. Although the direction of the effect is the expected one, the magnitude seems to be quite off, considering that the average rent price is $\$590$ per square meter.: one could argue that sidewalk space is even more valuable than inside space, but it is probably not six times more valuable.

For the second regression $\hat{\gamma} = \$1,390$, which would imply that each additional square meter of sidewalk that can be used *anywhere on the block* where the storefront is located adds $\$1,390$ to the rent price. Again, although the direction of the effect is the expected one, it seems unlikely that the effect would be that big.

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