NEREUS

Núcleo de Economia Regional e Urbana
da Universidade de São Paulo

The University of São Paulo
Regional and Urban Economics Lab

Aula 27: Acessibilidade e Mercados Urbanos

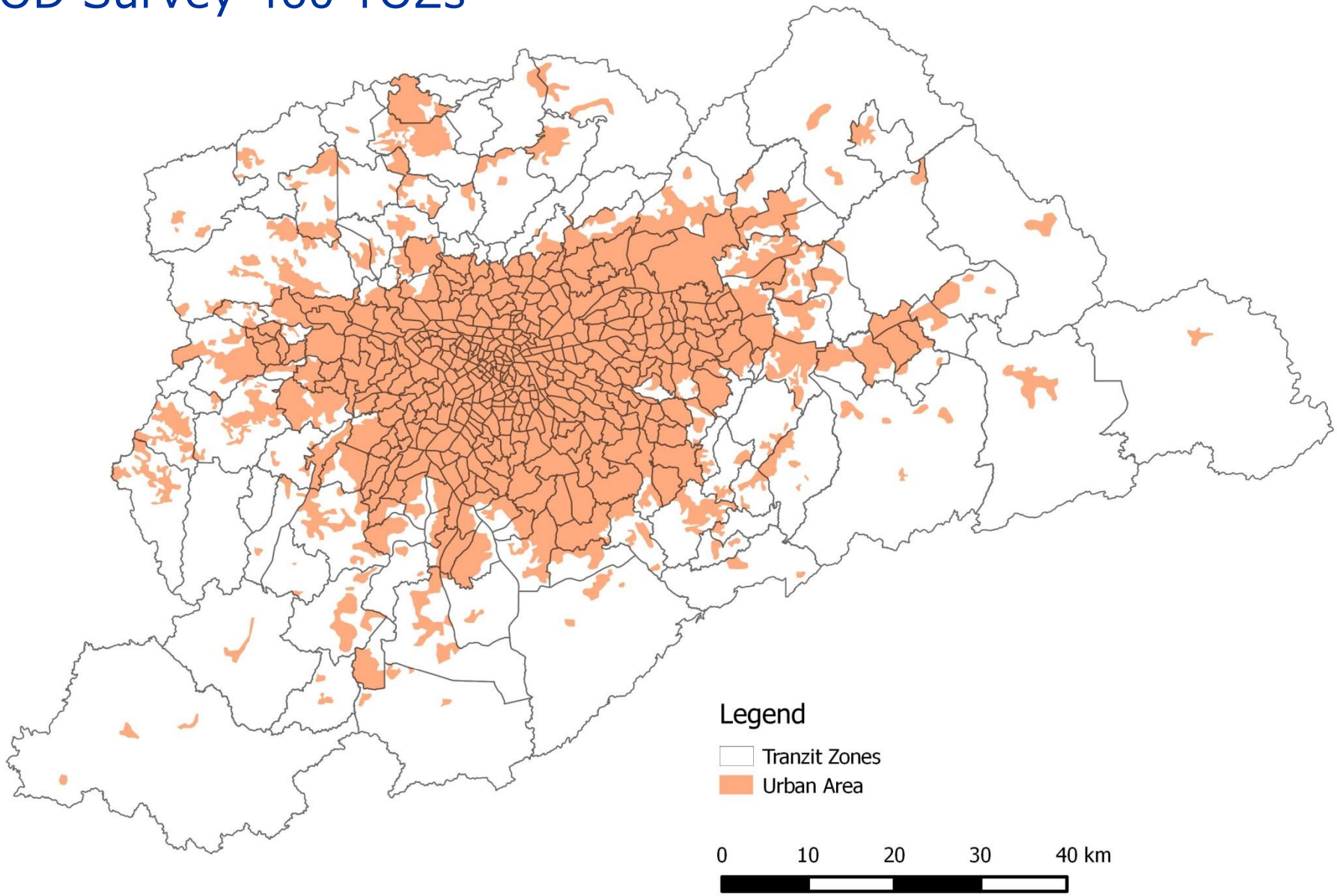
Prof. Eduardo A. Haddad

Data

OD - Household Survey

- Data on 30,000 households about all trips made during a whole weekday
- Includes mode, distance, time, purpose, o/d location, cost, etc
- Uses 460 zones for the Metropolitan Region of São Paulo

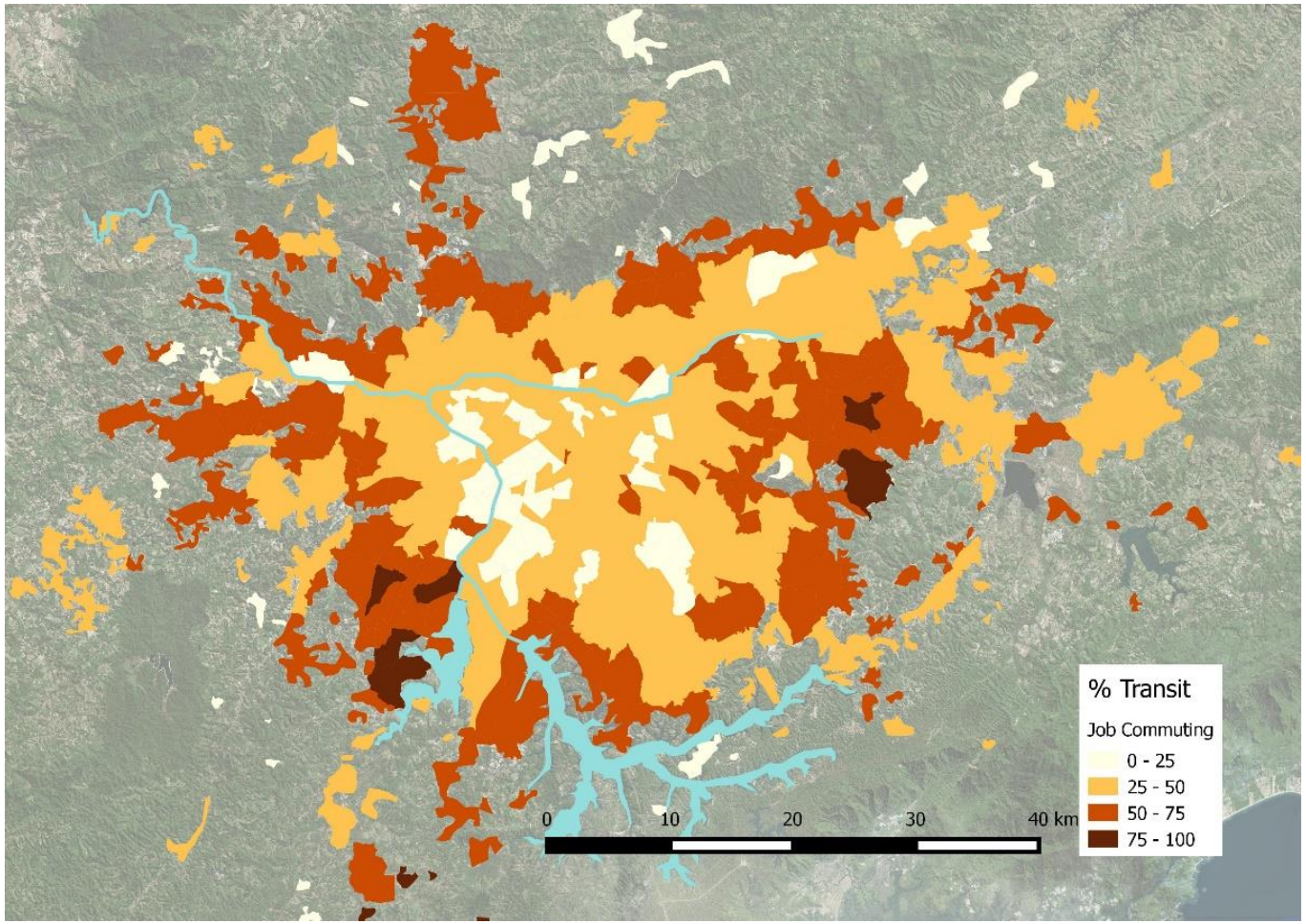
OD Survey 460 TOZs



Job-Commuting Patterns

	Nº of Trips	% of Trips	Average Trip Duration (minutes)
Transit	**7,393,206**	**58.6%**	**68.2**
Bus	6,872,412	43.8%	67.8
Subway	1,354,285	8.6%	66.0
Rail	969,525	6.2%	81.5
Private Vehicle	**4,548,993**	**32.3%**	**36.5**
Car Driver	3,682,845	23.5%	37.4
Car Passenger	834,739	5.3%	35.3
Táxi	31,409	0.2%	30.4
Motorcycle	519,916	3.3%	28.1
Other	**3,355,176**	**21.4%**	**16.3**
Walking	3,097,319	19.7%	16.2
Bicycle	214,416	1.4%	20.4
Other	43,441	0.3%	73.6
Total	**15,693,904**	100%	44.1

Transit Users



A fórmula de Hansen

$$A_{im} = \sum_{j=1}^{n} O_j f(t)$$

j = 460 zonas

Oj = Empregos em j

A = Acessibilidade

t = tempo de deslocamento

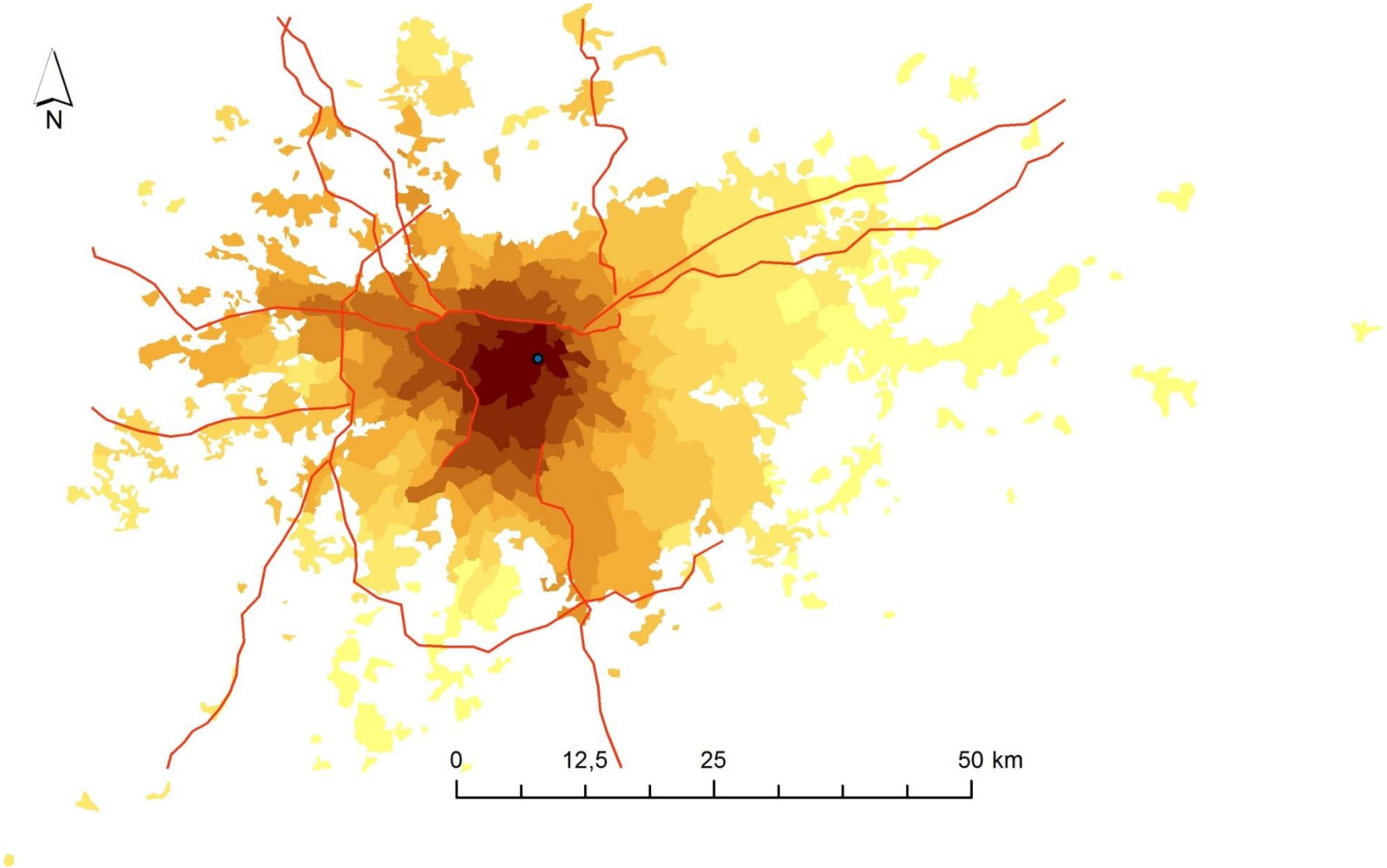
i = 460 zonas

Modos =
1 Veículo Privado
2 Transporte Público

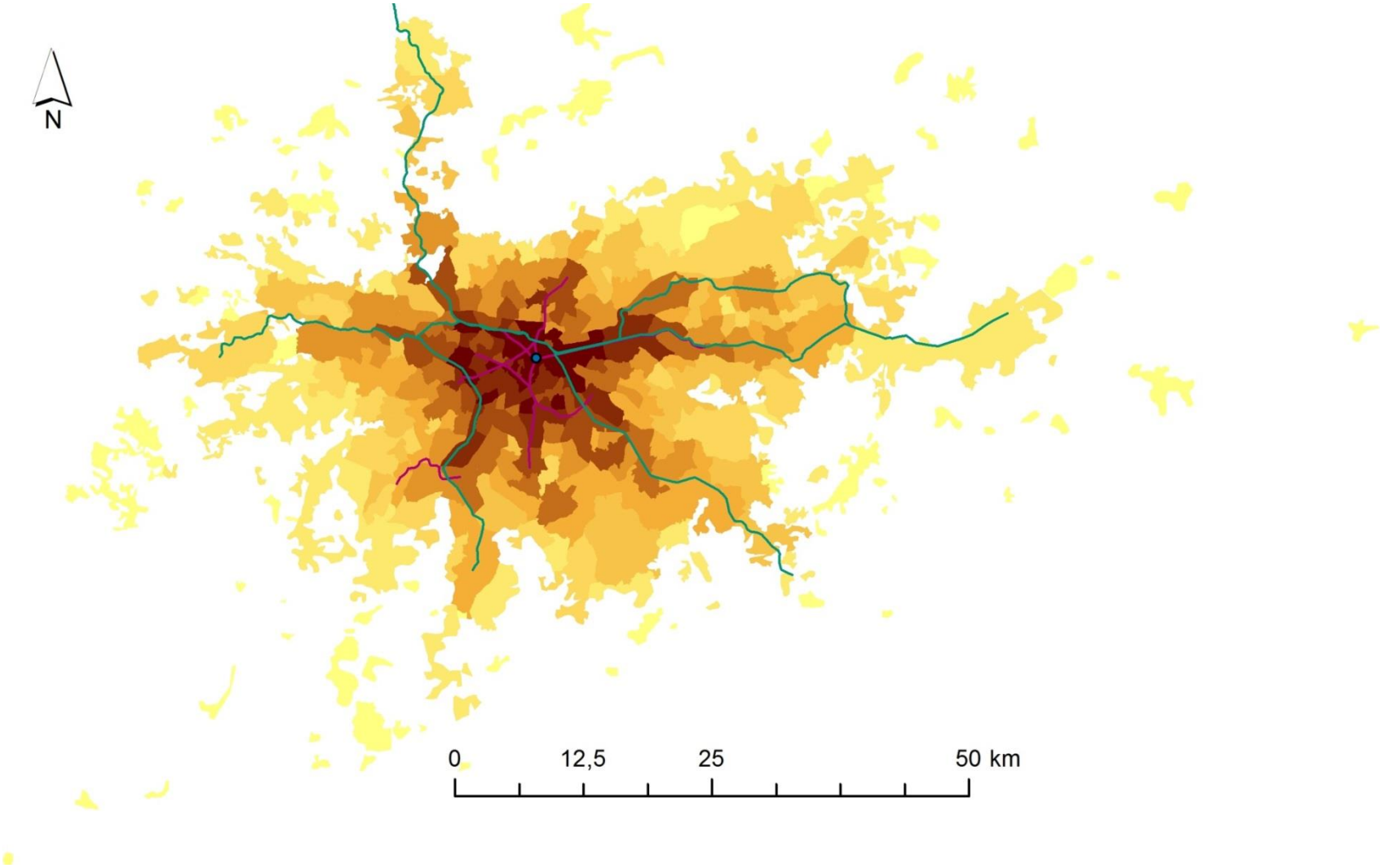
$f(t) = e^{-\alpha t}$

$\alpha = 0{,}01154$

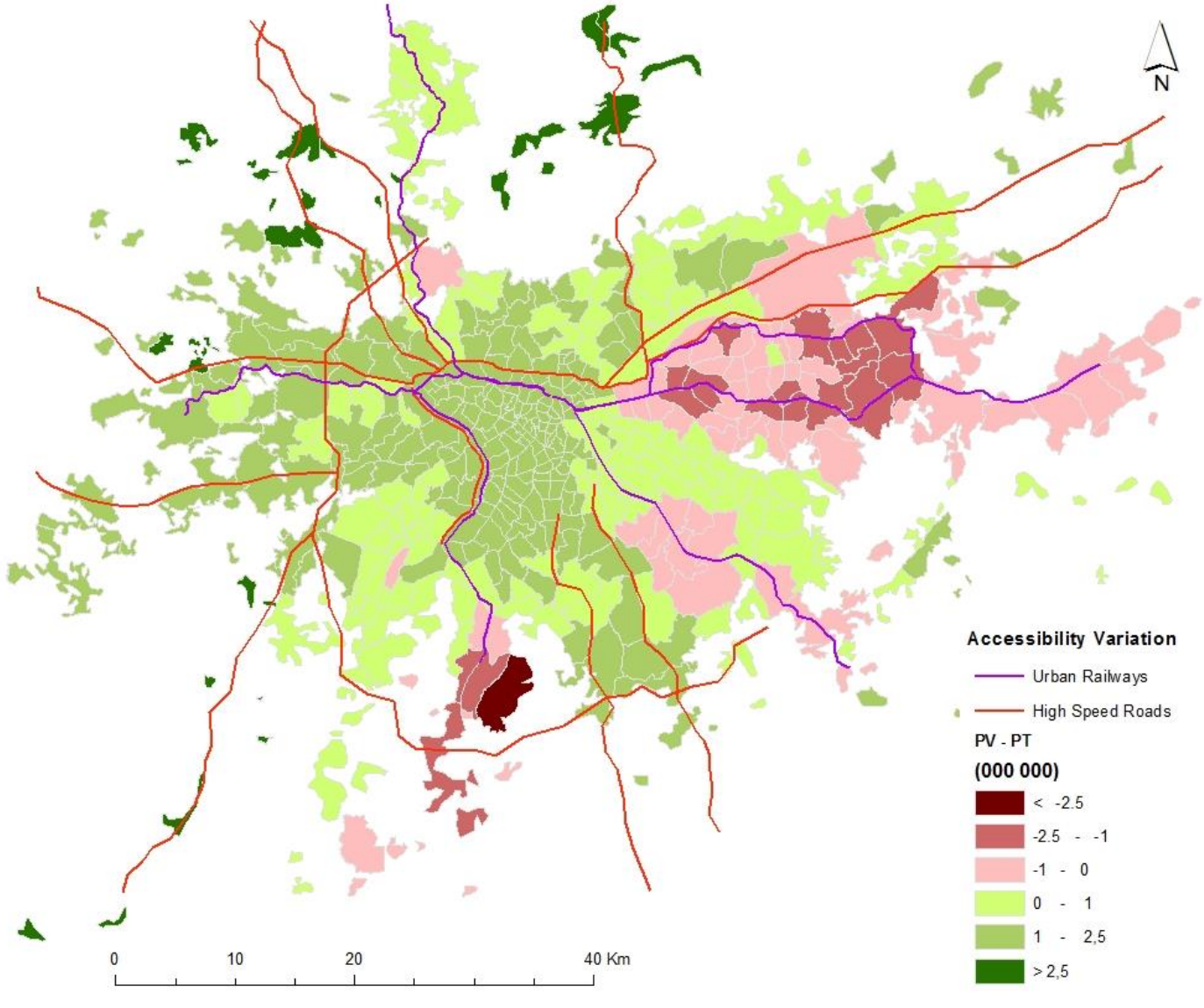
Índice de Acessibilidade via Veículo Privado na RMSP



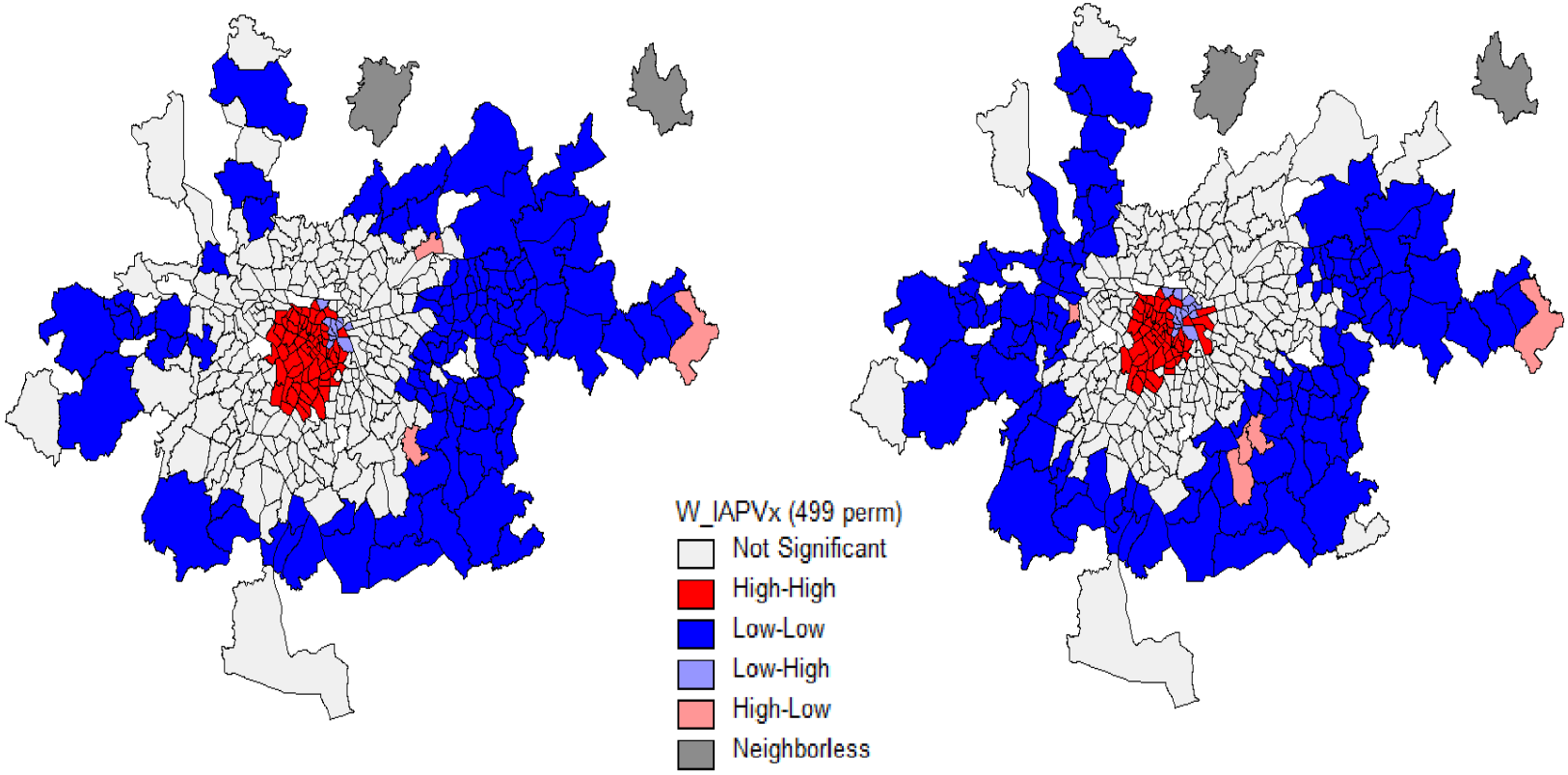
Índice de Acessibilidade via Transporte Público RMSP



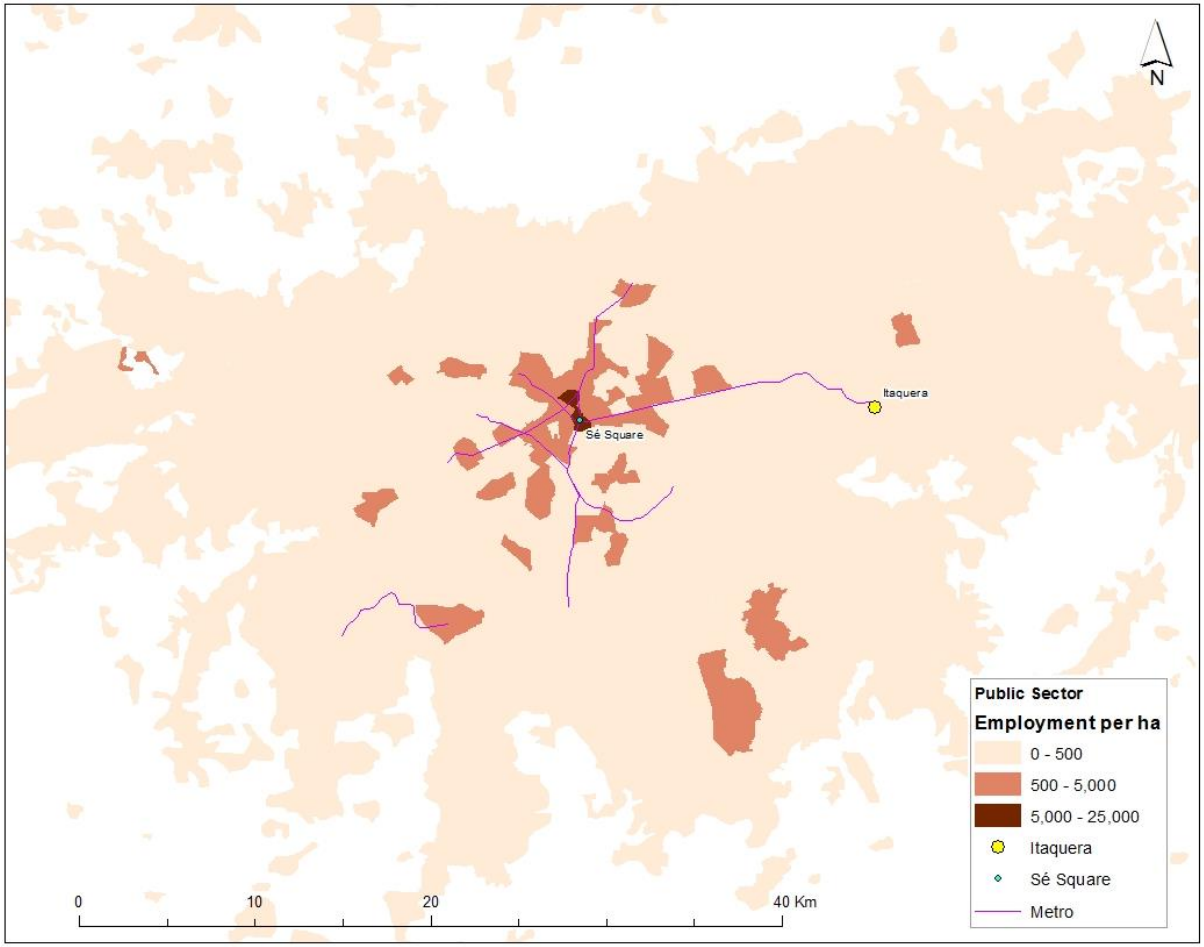
Diferença entre os modos



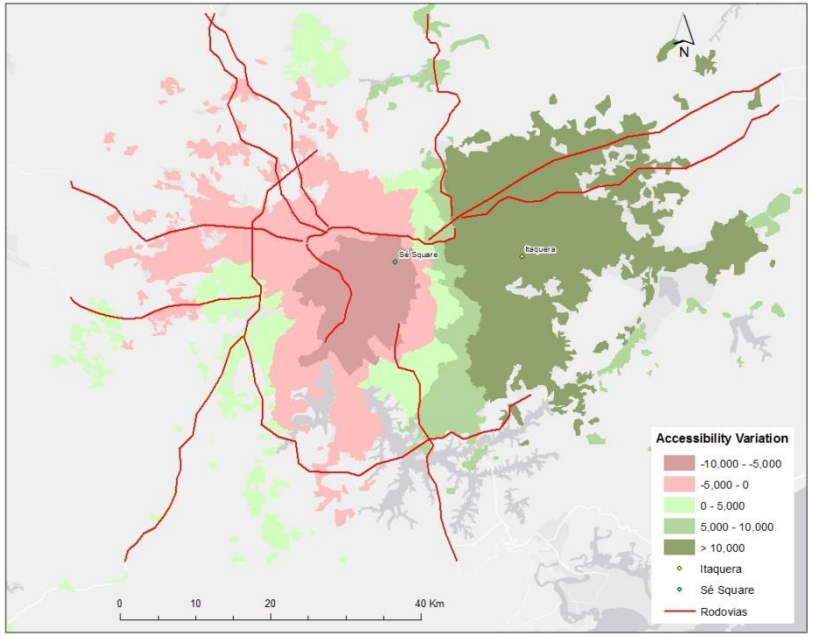
Correlação espacial entre acessibilidade e renda

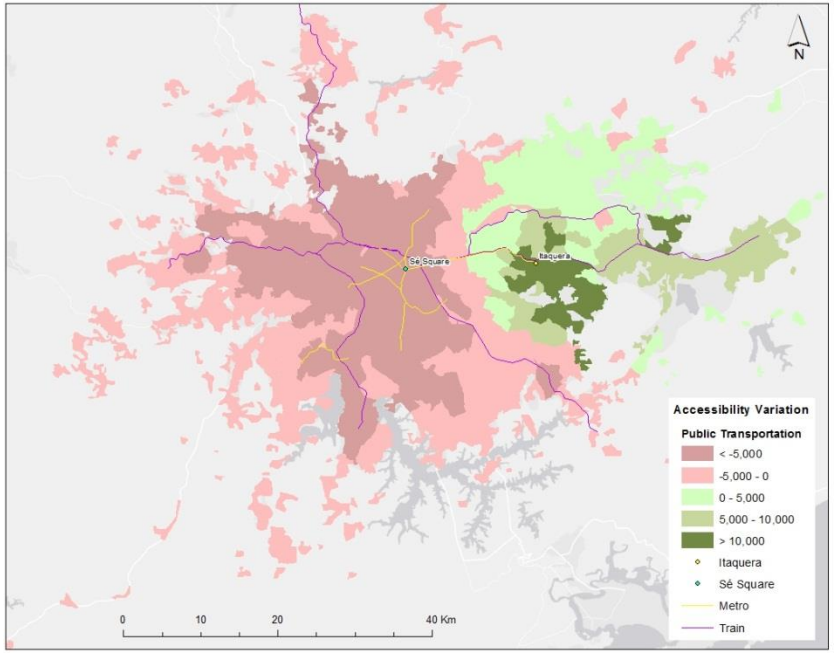


É possível analisar possíveis políticas urbanas que atuem tanto na distribuição de oportunidades quanto na estrutura de transportes



E se transferíssemos os empregos públicos (37,851) do centro antigo para Itaquera?





Modelo de preços hedônicos

<u>Preços hedônicos</u>: preços implícitos de atributos que são revelados pela observação de preços de bens heterogêneos e suas respectivas quantidades de características

$$P = f(Z_1, Z_2, \ldots, Z_I)$$

$$\frac{\partial P}{\partial Z_i} \equiv P_{Zi}$$

P preço do bem heterogêneo, Z_i quantidade do atributo i, P_{Zi} preço hedônico do atributo i

Modelo de preços hedônicos

Mercado de imóveis

$$P(S, L, E) = \alpha_0 + \alpha_1 S + \alpha_2 L + \alpha_3 E + u$$

S vetor de variáveis estruturais, *L* de localização e *E* ambientais

A fórmula de Hansen

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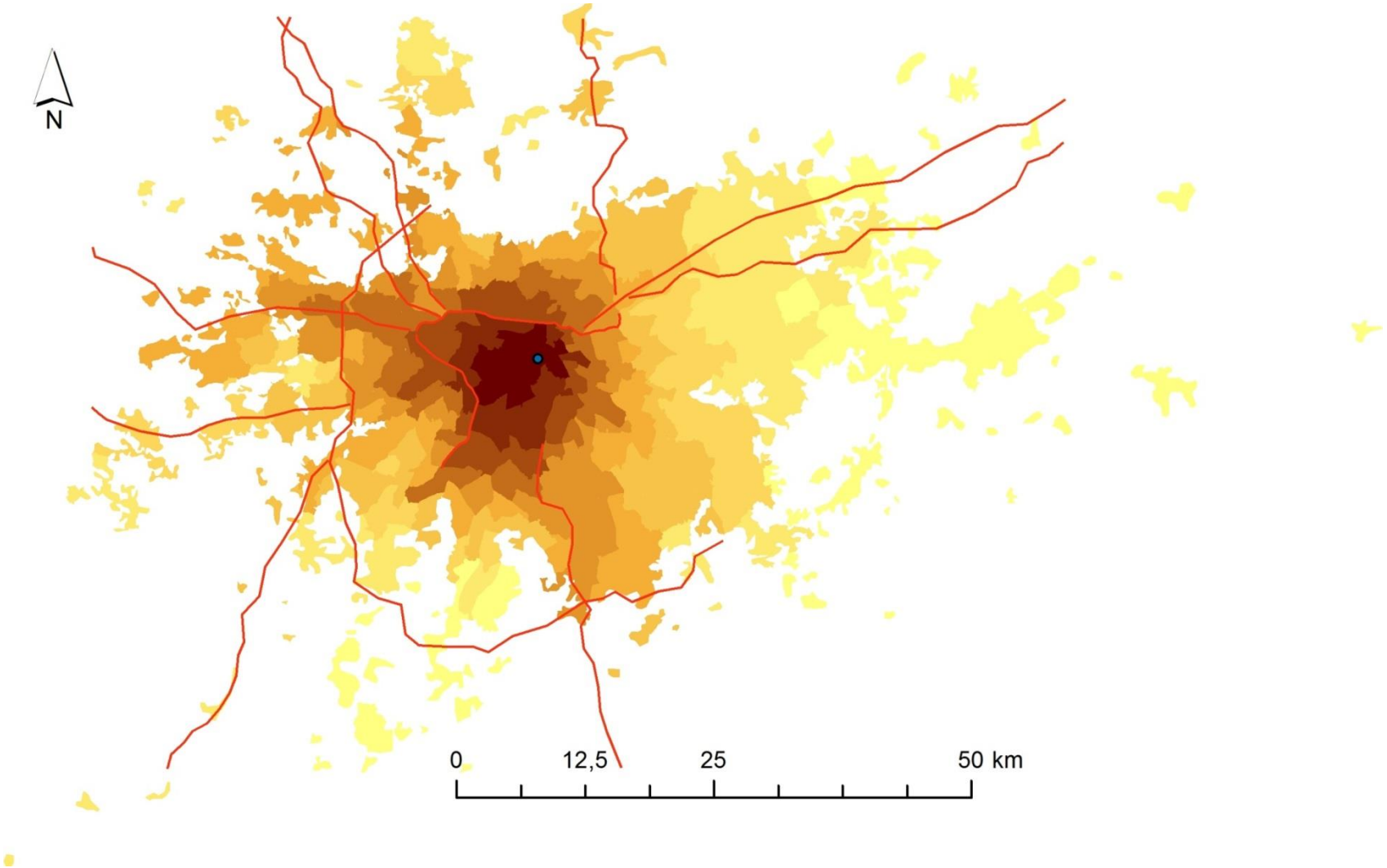
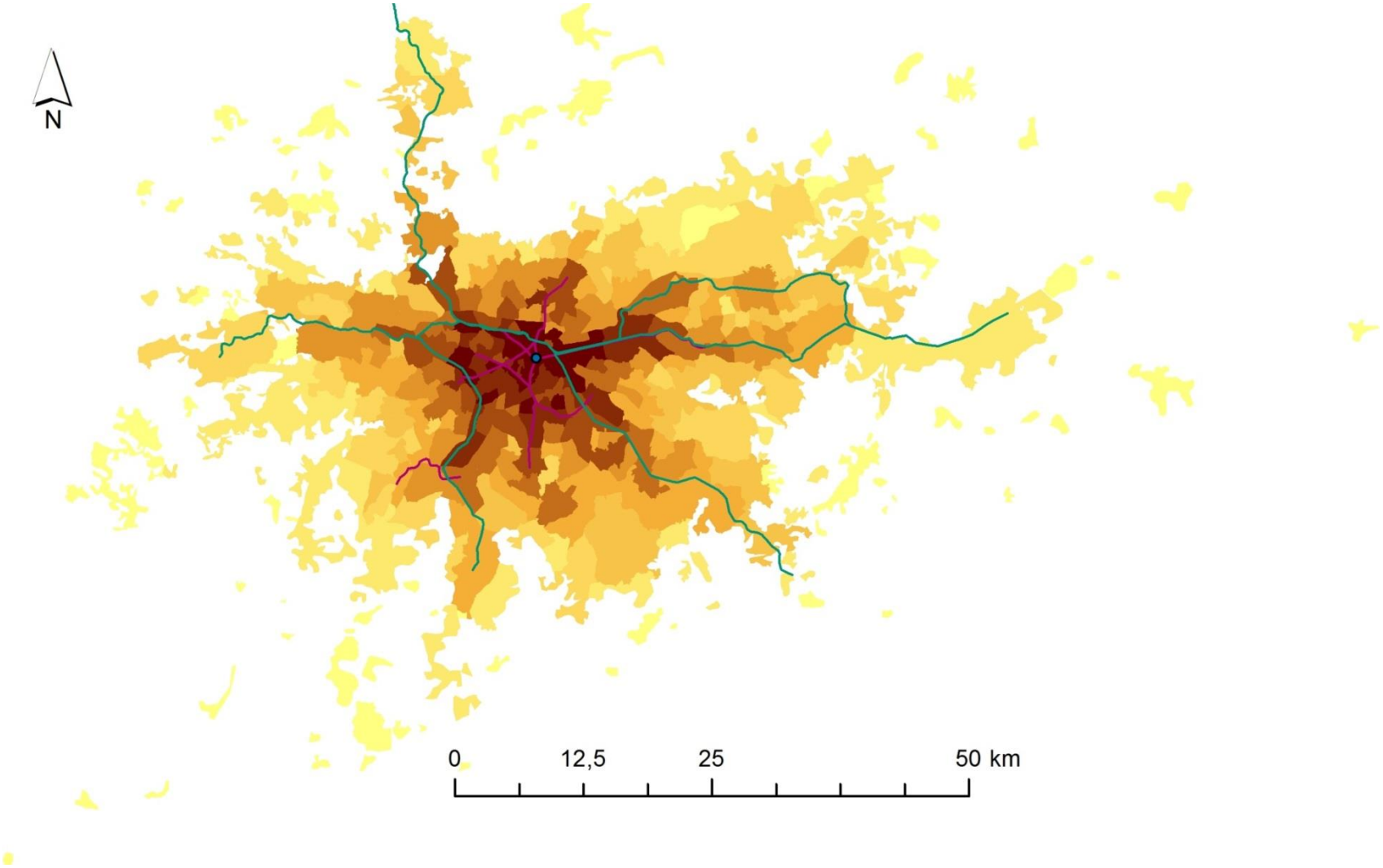
Índice de Acessibilidade via Veículo Privado na RMSP



Índice de Acessibilidade via Transporte Público RMSP



Objetivos

Isolar os **efeitos das condições de acessibilidade local** dos efeitos das características dos imóveis

Mensurar o impacto do metrô (medida pelos índices de acessibilidade) sobre os preços das residências

Autores: Faria, Haddad e Pereda

Forma log-linear

Cinco modelos diferentes foram estimados:

Modelo 0: $ln(p_i) = f(X, D1) + \varepsilon$

Modelo 1: $ln(p_i) = f(X, D1, ACESS1) + \varepsilon$

Modelo 2: $ln(p_i) = f(X, D1, ACESS2) + \varepsilon$

Modelo 3: $ln(p_i) = f(X, D1, DISTR) + \varepsilon$

Modelo 4: $ln(p_i) = f(X, D1, ZONA) + \varepsilon$

pi *= preços dos imóveis;*

X *= vetor de características dos imóveis;*

D1 *= dummy do ano;*

ACESS1 *= índice de acessibilidade do transporte privado;*

ACESS2 *= índice de acessibilidade do transporte público;*

DISTR *= dummy do distrito (137 distritos na RMSP);*

ZONA *= dummy da zona municipal (16 zonas da RMSP);*

Variáveis estruturais

O conjunto de variáveis representadas por X corresponde às seguintes características dos imóveis:

- número de quartos
- número de banheiros
- número de vagas para estacionamento
- número de elevadores
- número unidades residenciais por andar
- número de blocos no condomínio
- número de andares
- *dummy* para casa/apartamento

Dados

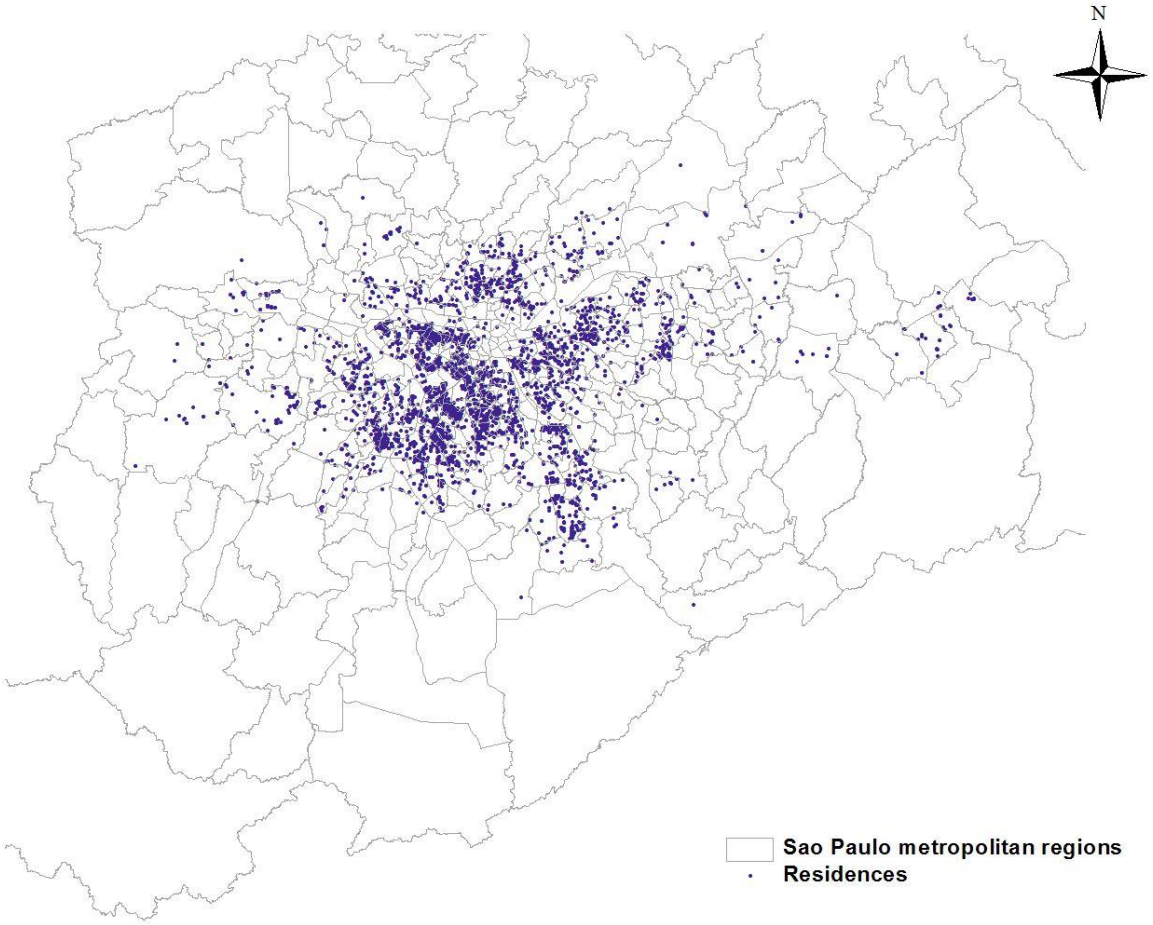
Empresa Brasileira de Estudos de Patrimônio (EMBRAESP):

Informação sobre os preços das residências e suas características entre os anos de 2001 e 2007 – Região Metropolitana de São Paulo

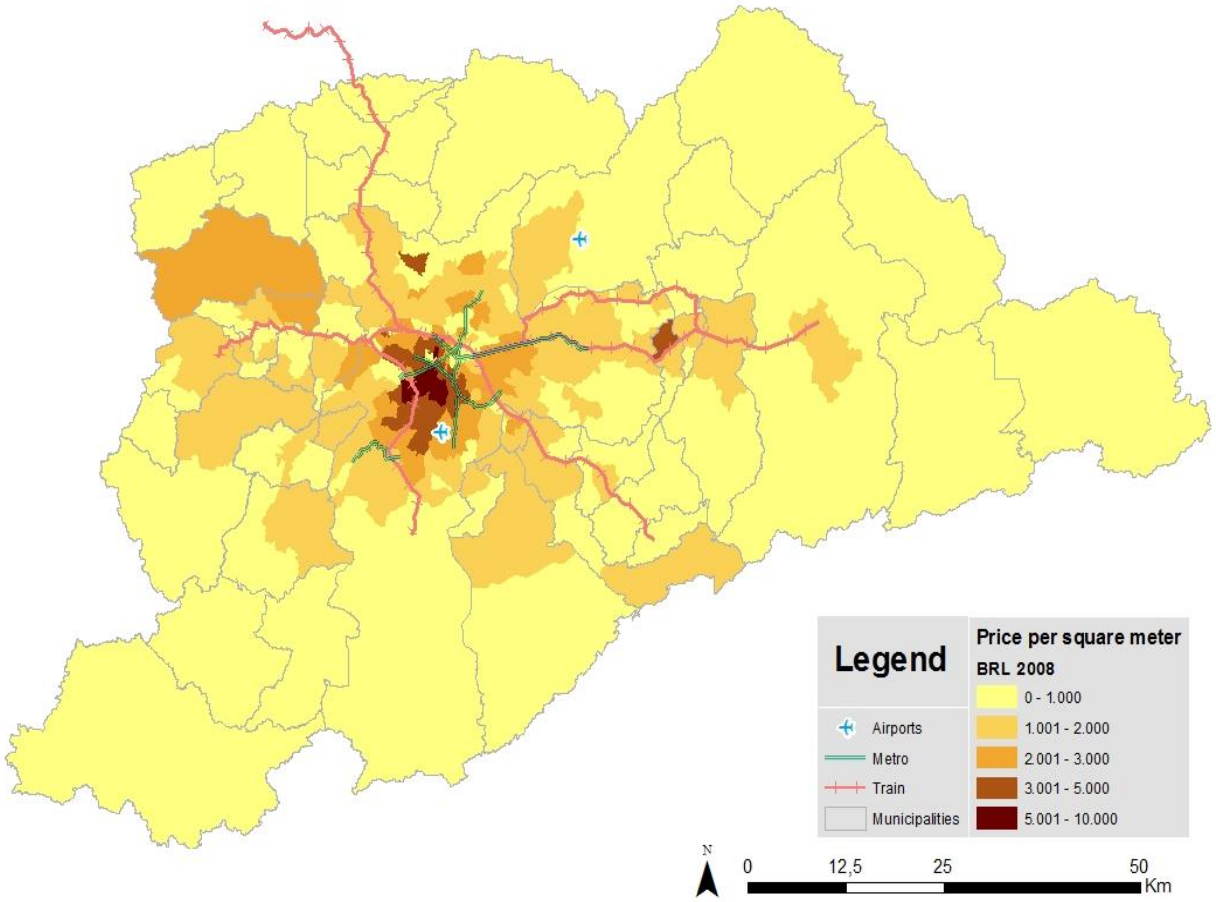
Dados EMBRAESP

Variáveis	Mínimo	Mediana	Média	Máximo	Desvio-padrão	Observações
1 quarto	0,00	0,00	0,06	1,00	0,25	4266
2 quartos	0,00	0,00	0,37	1,00	0,48	4266
3 quartos	0,00	0,00	0,31	1,00	0,46	4266
4 quartos	0,00	0,00	0,25	1,00	0,44	4266
5 quartos	0,00	0,00	0,00	1,00	0,06	4266
Número de banheiros	1,00	2,00	2,06	6,00	0,97	4266
Número de vagas de estacionamento	0,00	2,00	2,06	12,00	1,26	4266
Número de elevadores	0,00	2,00	1,93	22,00	2,04	4266
Número de unidades por andar	0,00	3,87	3,02	25,87	2,56	4266
Número de blocos	0,05	1,00	1,13	31,00	1,15	4266
Número de andares	0,00	13,00	12,37	38,00	8,14	4266
Dummy para casa	0,00	0,00	0,25	1,00	0,43	4266
ano = 2001	0,00	0,00	0,11	1,00	0,31	4266
ano = 2002	0,00	0,00	0,13	1,00	0,34	4266
ano = 2003	0,00	0,00	0,15	1,00	0,36	4266
ano = 2004	0,00	0,00	0,15	1,00	0,36	4266
ano = 2005	0,00	0,00	0,14	1,00	0,35	4266
ano = 2006	0,00	0,00	0,14	1,00	0,35	4266
ano = 2007	0,00	0,00	0,15	1,00	0,36	4266

Localização das residências na RMSP (amostra)



Preço médio por metro quadrado das residências na RMSP



Resultados

Variáveis	(0) MQO	(1) MQO (carro)	(2) MQO (púb)	(3) MQO (distrito)	(4) MQO (zonas)
Variáveis dependentes:	**ln(preço)**	**ln(preço)**	**ln(preço)**	**ln(preço)**	**ln(preço)**
1 quarto	1,172***	0,889***	1,177***	0,673***	1,211***
2 quartos	1,373***	0,773***	0,985***	0,534***	0,878***
3 quartos	1,321***	0,760***	0,949***	0,537***	0,863***
4 quartos	1,296***	0,719***	0,899***	0,531***	0,820***
5 quartos	1,117***	0,604***	0,737***	0,531***	0,659***
Número de banheiros	0,176***	0,123***	0,144***	0,087***	0,151***
Número de vagas de estacionamento	0,155***	0,119***	0,138***	0,096***	0,130***
Número de elevadores	0,005**	0,006***	0,003	0,005*	0,004
Número de unidades por andar	0,017***	0,012***	0,014***	0,014***	0,006
Número de blocos	-0,044***	-0,027***	-0,029***	-0,017***	-0,037***
Número de andares	0,010***	0,006***	0,005***	0,003***	0,009***
Dummy para casa	-0,138***	-0,079***	-0,124***	-0,087***	-0,202***
ano = 2001	0,052	0,065	0,068*	0,024	-0,031
ano = 2002	0,038	0,043	0,049**	0,012	-0,04
ano = 2003	0,002	0,009	-0,008	-0,031	-0,076***
ano = 2004	-0,012	-0,013**	-0,008	-0,055***	-0,110***
ano = 2005	-0,064**	-0,068***	-0,056**	-0,078***	-0,137***
ano = 2006	-0,075***	-0,036***	-0,040**	-0,057***	-0,113***
ano = 2007	-0,013	0,002	-0,002	-0,027	-0,022
Índice de acessibilidade (transporte privado)		**0,191*** **			
Índice de acessibilidade (transporte público)			**0,148*** **		
d1 a d137				#	
zona 1 a 16					##
Constante	5,834***	6,626***	6,357***	7,153***	6,369***
Observações	**4266**	**4266**	**4266**	**4266**	**4266**
R-quadrado	**63,89%**	**76,39%**	**72,16%**	**85,50%**	**72,50%**

*** p<0.01, ** p<0.05, * p<0.1

Dummies de distritos para a RMSP

Dummies de zonas coletadas pela EMBRAESP

Superfície da variação (%) dos preços médios estimados com e sem o sistema de metrô

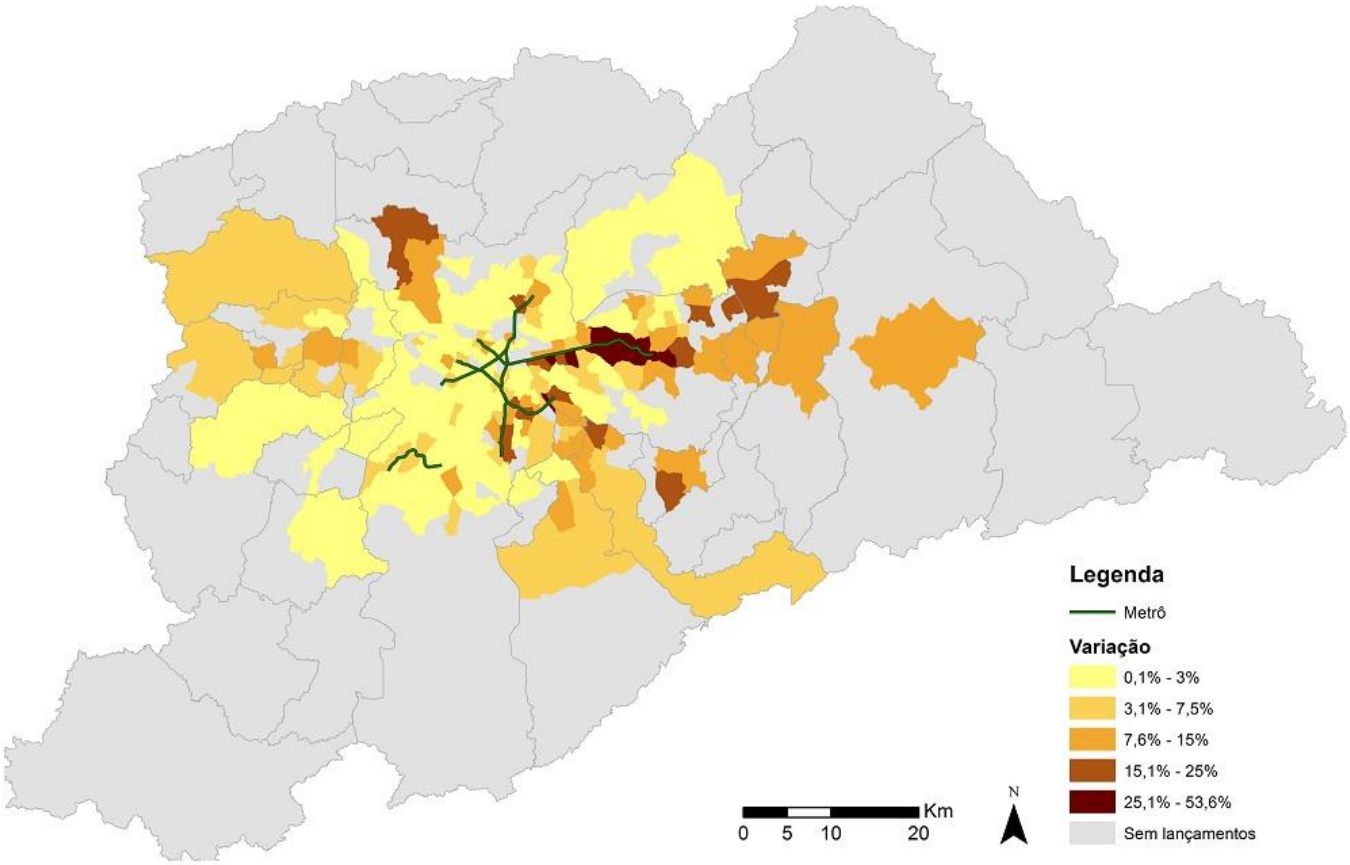
Como exemplo, foram simuladas as superfícies dos preços médios previstos dos imóveis com e sem a presença do sistema de metrô

No primeiro caso (com o metrô) os valores foram calculados com base nas estimativas do modelo (2)

Em seguida, foram simulados os preços após uma variação na acessibilidade em decorrência da remoção do metrô da malha viária, novamente utilizando os coeficientes estimados no modelo (2)

Por fim, foi calculada a variação percentual dos preços previstos entre as duas simulações

Resultados


Legenda
Metrô
Variação
0,1% - 3%
3,1% - 7,5%
7,6% - 15%
15,1% - 25%
25,1% - 53,6%
Sem lançamentos
Km
0 5 10 20
N

RH (2004)

There are two sources of gains from reducing commuting costs: a direct effect of agents paying less commuting costs per mile commuted and an indirect effect via the concentration of business areas. Policies like road construction, improving public transportation and parking space provision should consider this additional gain.

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From Rivers to Roads: Spatial Mismatch and Inequality of Opportunity in Urban Labor Markets of a Megacity

Prof. Eduardo A. Haddad

“São Paulo, a cidade dos rios invisíveis”

Fonte: https://aquipassaumrio.wordpress.com/

Introduction

Location decisions of firms and workers shape the spatial distribution of economic activity between and within cities

Conceptual framework: spatial general equilibrium model of land use with endogenous job locations in a circular city [Lucas and Rossi-Hansberg (2002)]

The theory determines the distribution of business and residential land together with employment and residential densities at all locations in the city, as well as urban prices (i.e. wages and land rents).

Given the general equilibrium nature of the theory, one should be aware of the **potential simultaneity bias in the empirical estimation of wage equations based on accessibility measures**.

General approach

In LRH approach, productivity is higher the higher is employment in neighboring locations.

The specification of the model considers such external effect of employment to decline exponentially with distance.

This arbitrary form of production externalities will prove to be very useful for our empirical work.

We will depart from reduced-form intra-urban prices equations based on accessibility to capture production externalities in the form proposed in LHR.

Lucas and Rossi-Hansberg (2002)

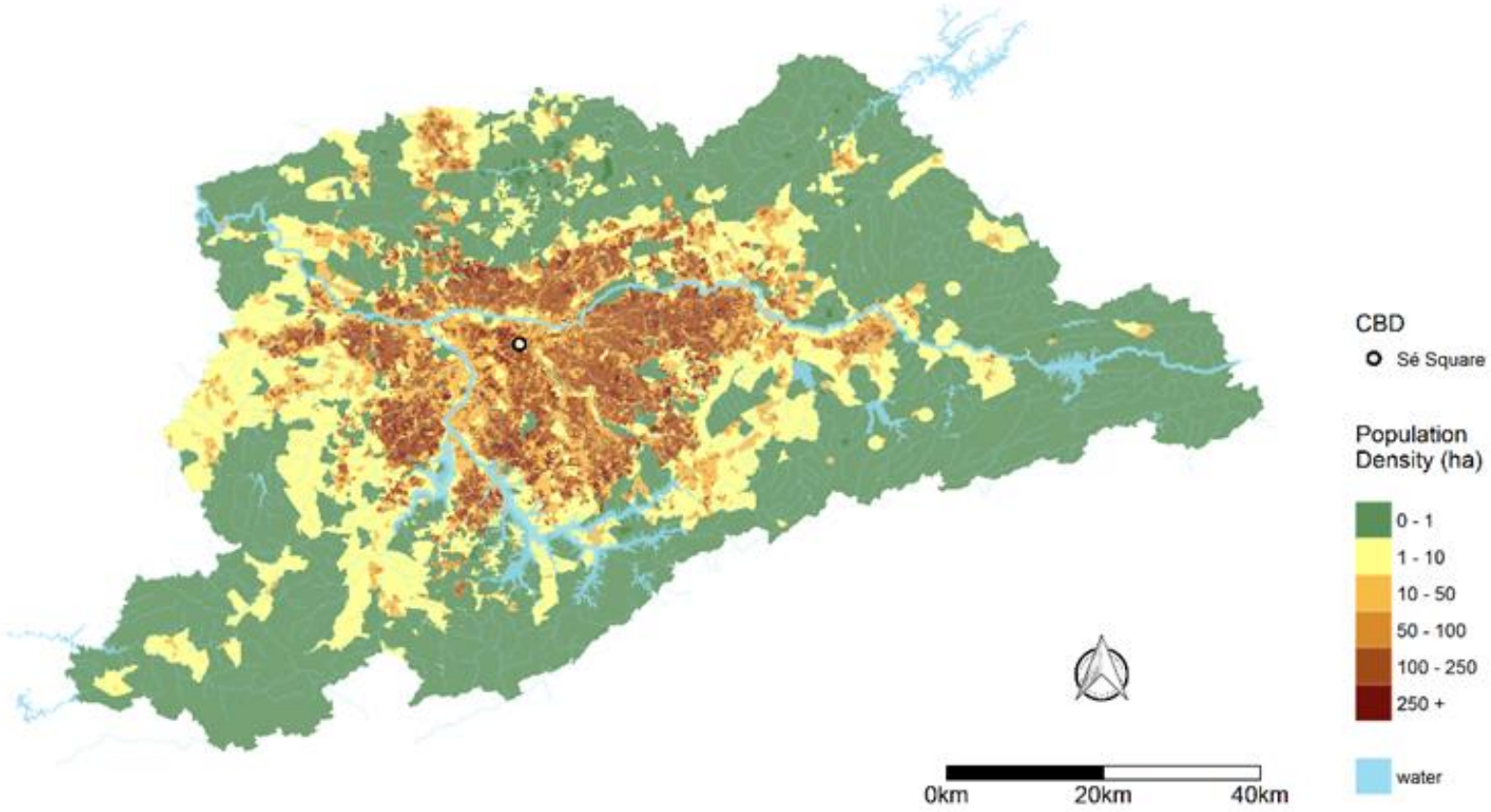
1. The model simultaneously determines the location of jobs and workers, as well as wages and land rents.

2. In equilibrium, wages within the city increase with employment density.

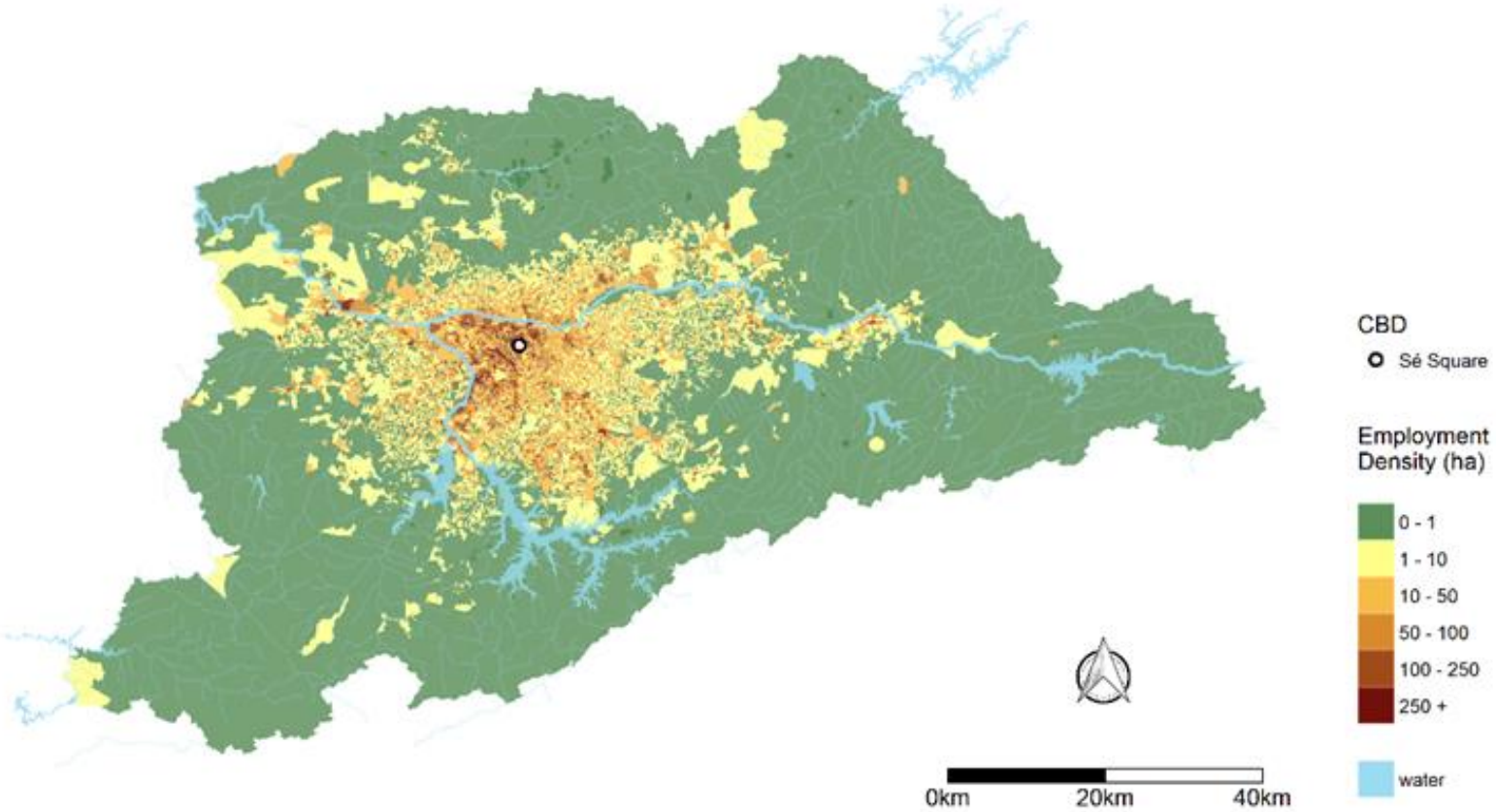
3. In equilibrium, land rents within the city also increase with density of workers.

4. As a consequence of (1)-(3), accessibility to jobs is also simultaneously determined, for any given commuting cost function.

Population Density in SPMR, 2010



Employment Density in SPMR, 2008



Econometric approach

Again: we depart from reduced-form <u>intra-urban prices</u> equations based on accessibility to capture production externalities in the form proposed in LHR.

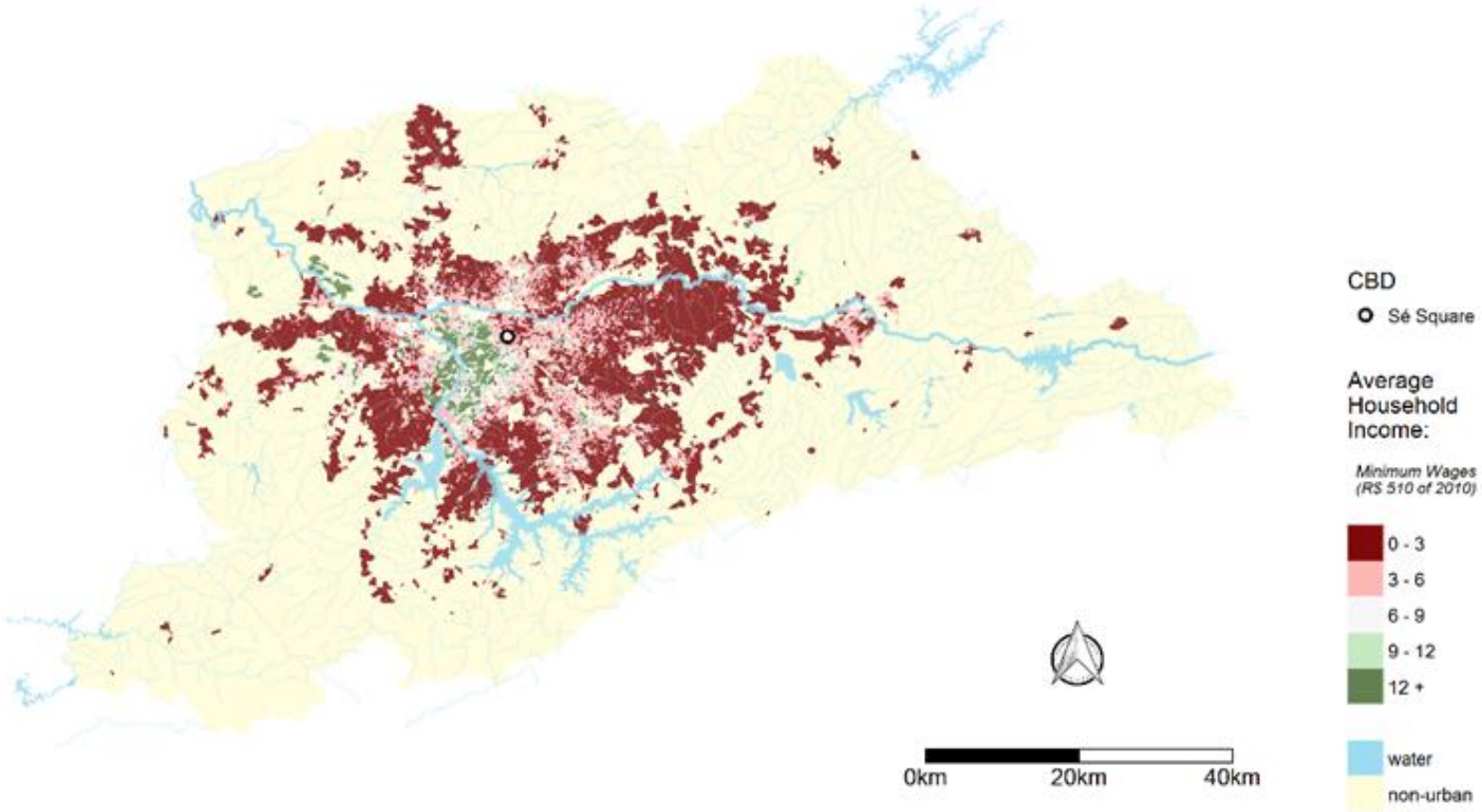
We estimate the empirical models related to wages determination:

$$\ln w_i = \alpha_0 + X_i\beta + WP\gamma + \theta A_r + \varepsilon_i$$

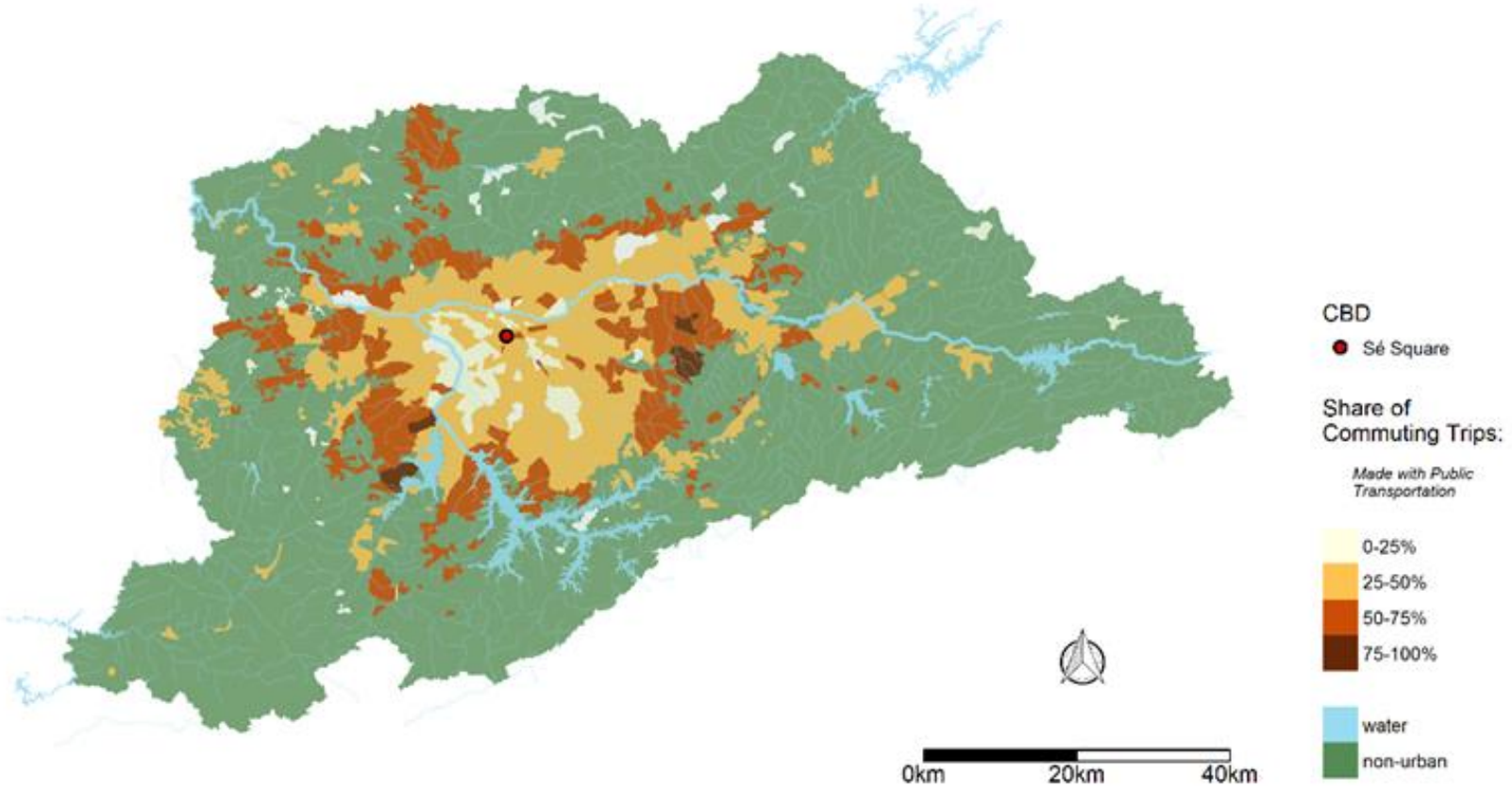
Need to find a suitable instrument for our accessibility measure

where the individual wage (w_i) is explained by a set of individual characteristics (X_i), attributes of the region of work (WP), the accessibility index (A_r), and the error term ε_i.

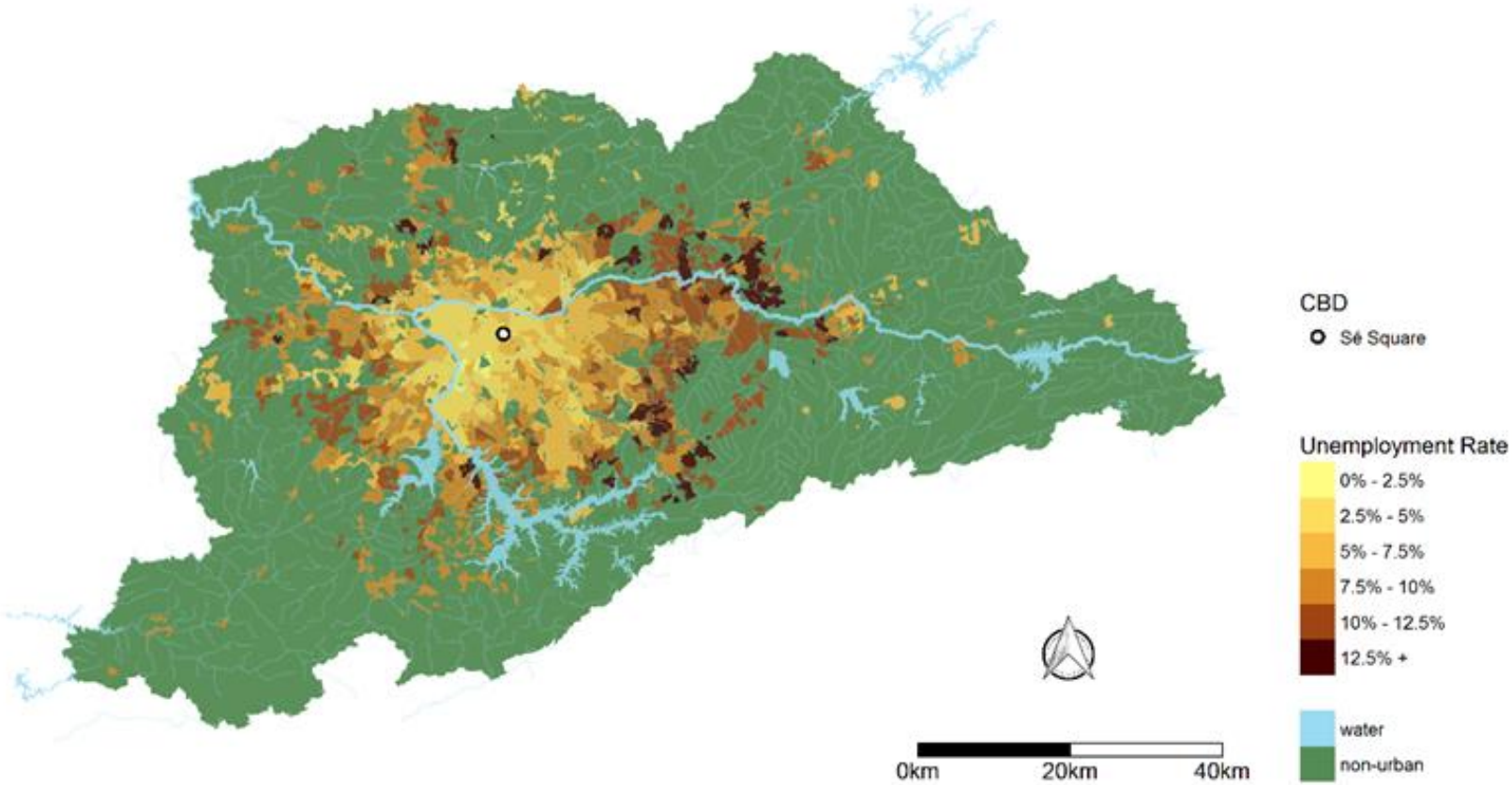
Average Household Income in SPMR, 2010



Share of Commuting by Public Transportation



Unemployment Rate in SPMR, 2010



Commuting time and productivity

Workers with longer daily commuting are less productive

- Theoretical support (Zenou and Smith, 1995; Zenou, 2002; Brueckner and Zenou, 2003; Ross and Zenou, 2008; Zenou, 2008)
- On-the-job effort is negatively related to commuting time
- Empirical support (Van Ommeren and Gutiérrez-i-Puigarnau, 2009; Porsse et al., 2012)
- Excessive commuting time may induce workers to arrive late or leave early; it also increases the frequency of absenteeism, reducing workers' productivity

Accessibility to jobs and productivity

Workers with higher accessibility to jobs are more productive

- Theoretical support ("matching")
- Effective size of labor market
  - Efficiency of transport system
  - Relative location of jobs and homes
  - Helps explaining labor productivity
- How many jobs can a worker access in, say, 60 minutes?
- Empirical support

Measuring accessibility to jobs

j = 460 zones

Oj = Jobs in j

A = Accessibility

$$A_{im} = \sum_{j=1}^{n} O_j f(t)$$

t = Commuting time

i = 460 zones

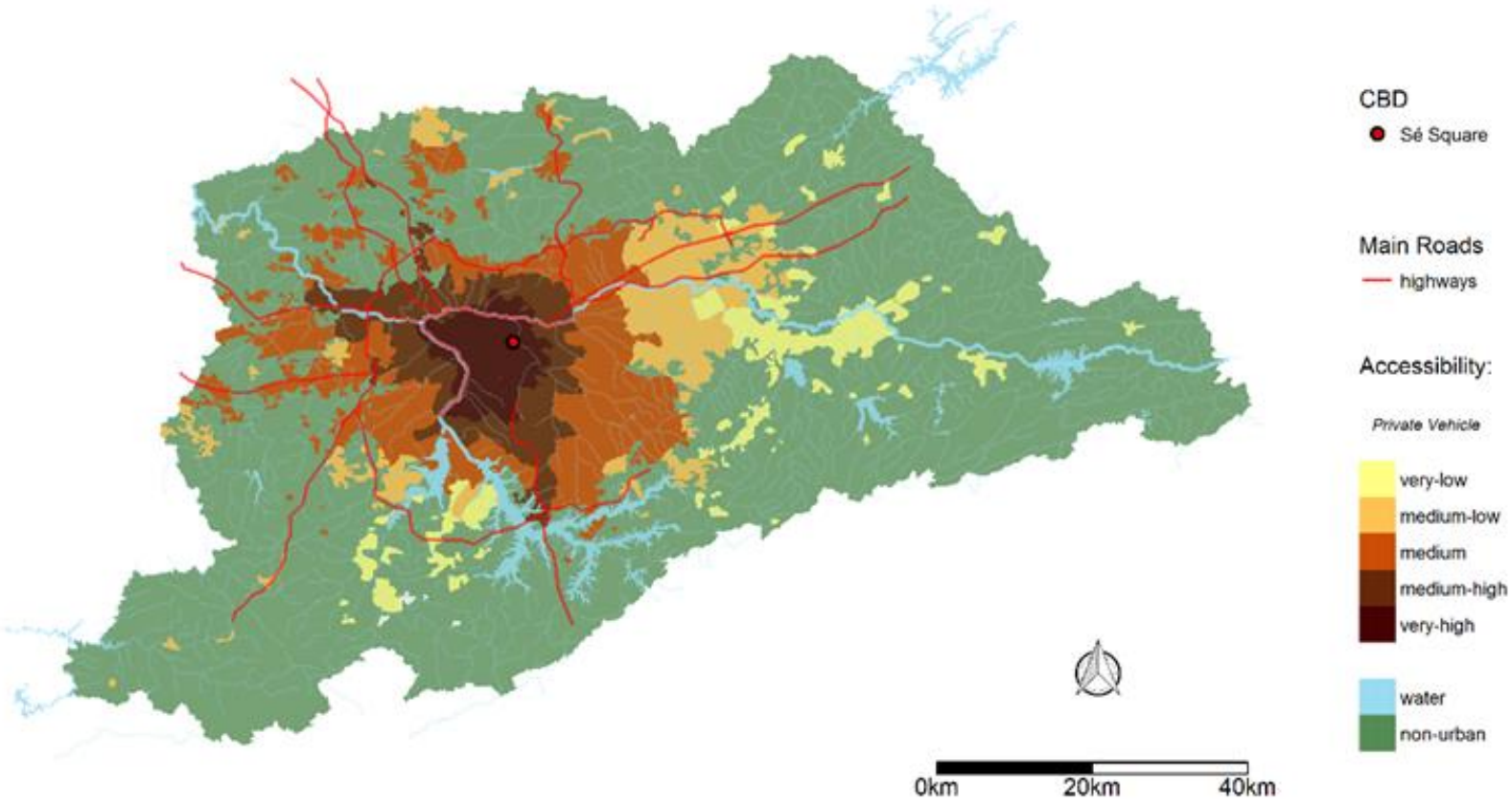
$f(t) = e^{-\alpha t}$

$\alpha = 0{,}01154$

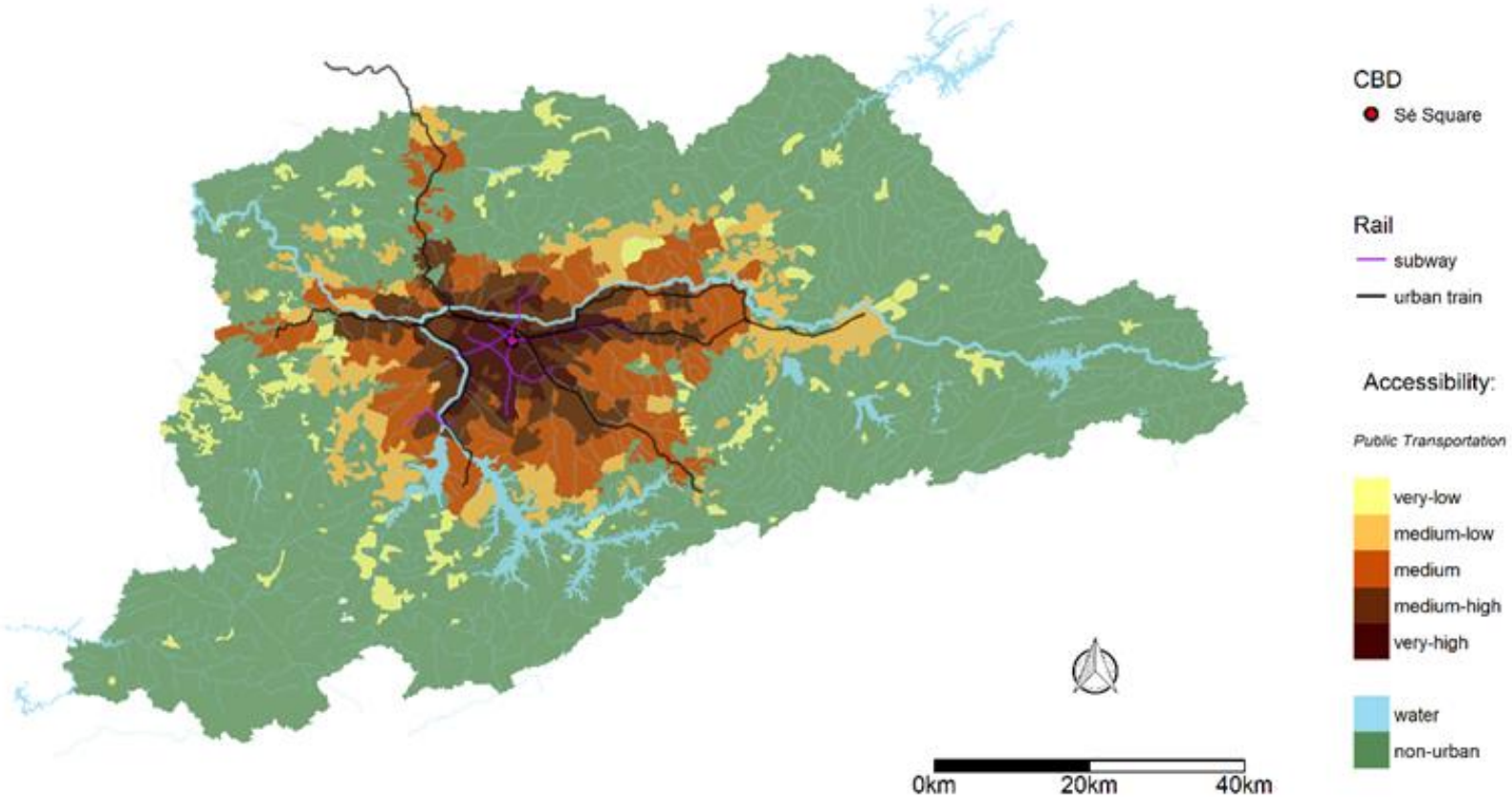
Defined such that f(60) = 0.5

Modes =
1 Private vehicle
2 Public transportation

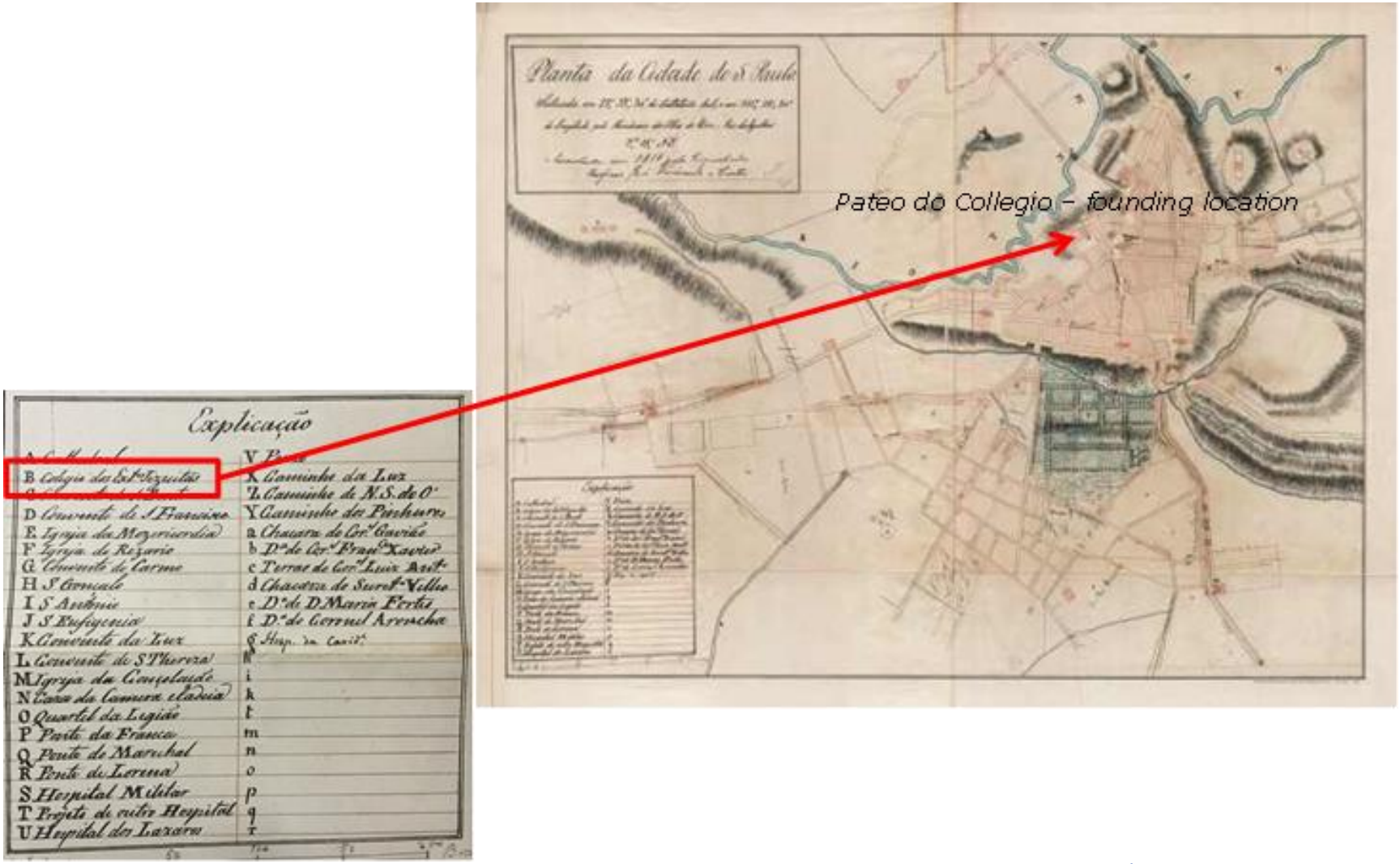
Spatial distribution of accessibility by private vehicle mode



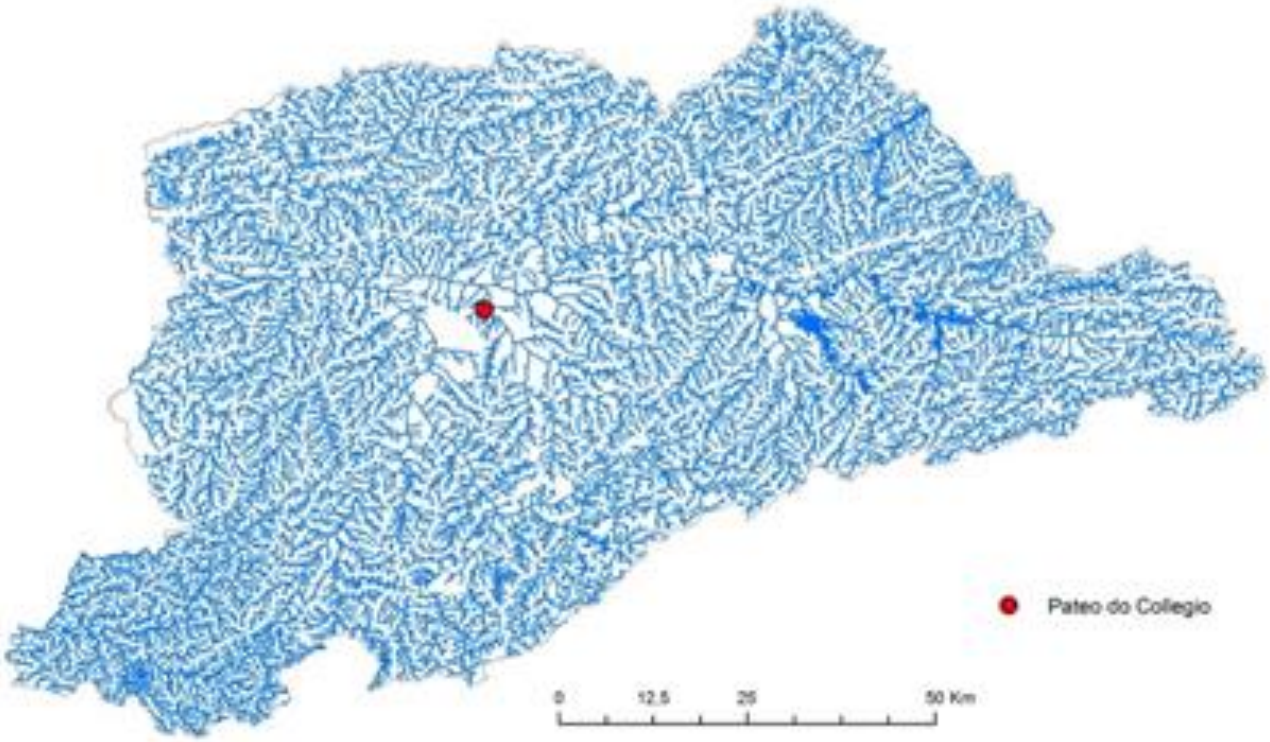
Spatial distribution of accessibility by public transportation mode



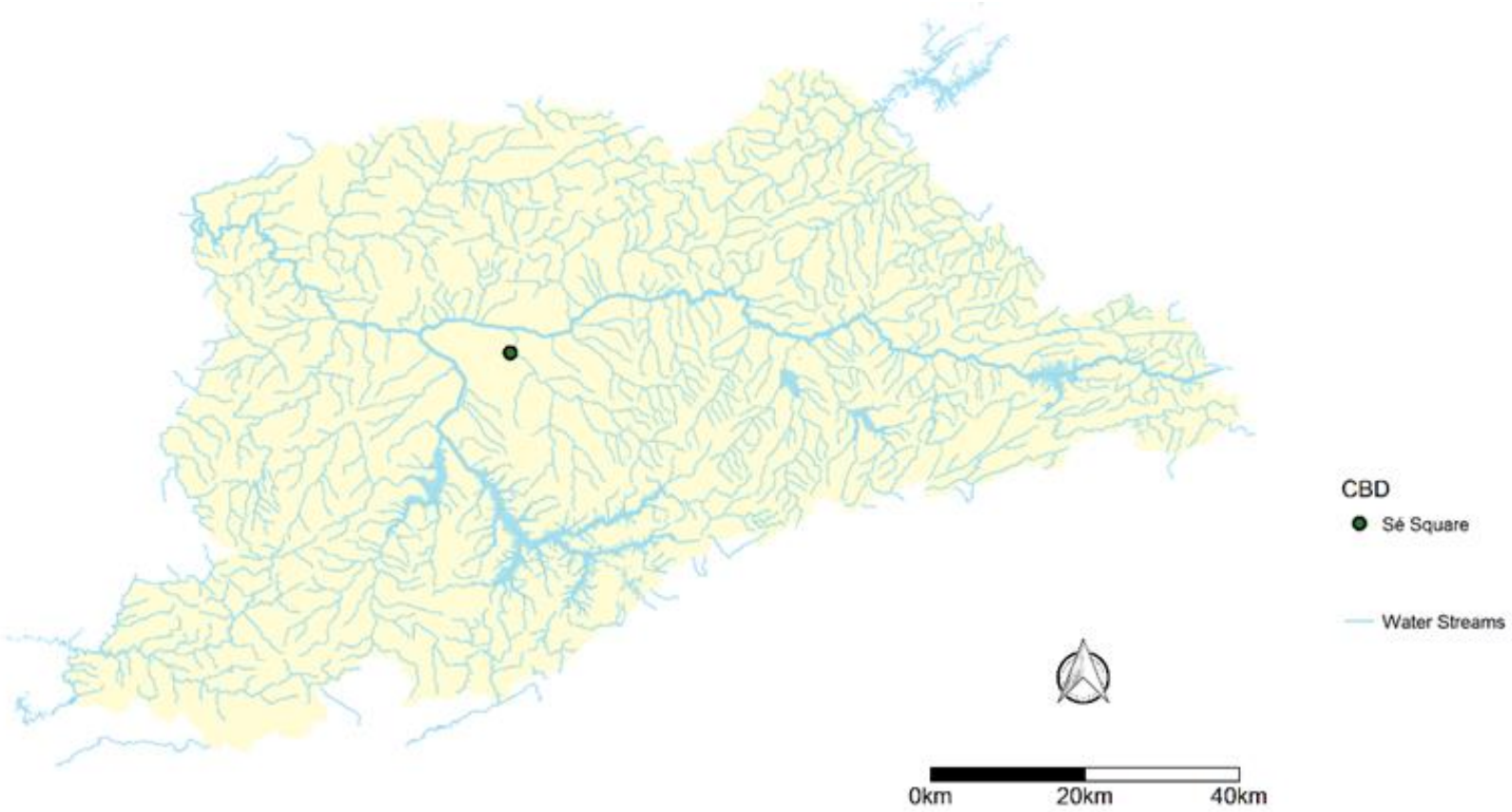
The “First” Map of São Paulo City – 1807-1810



Watershed in SPMR

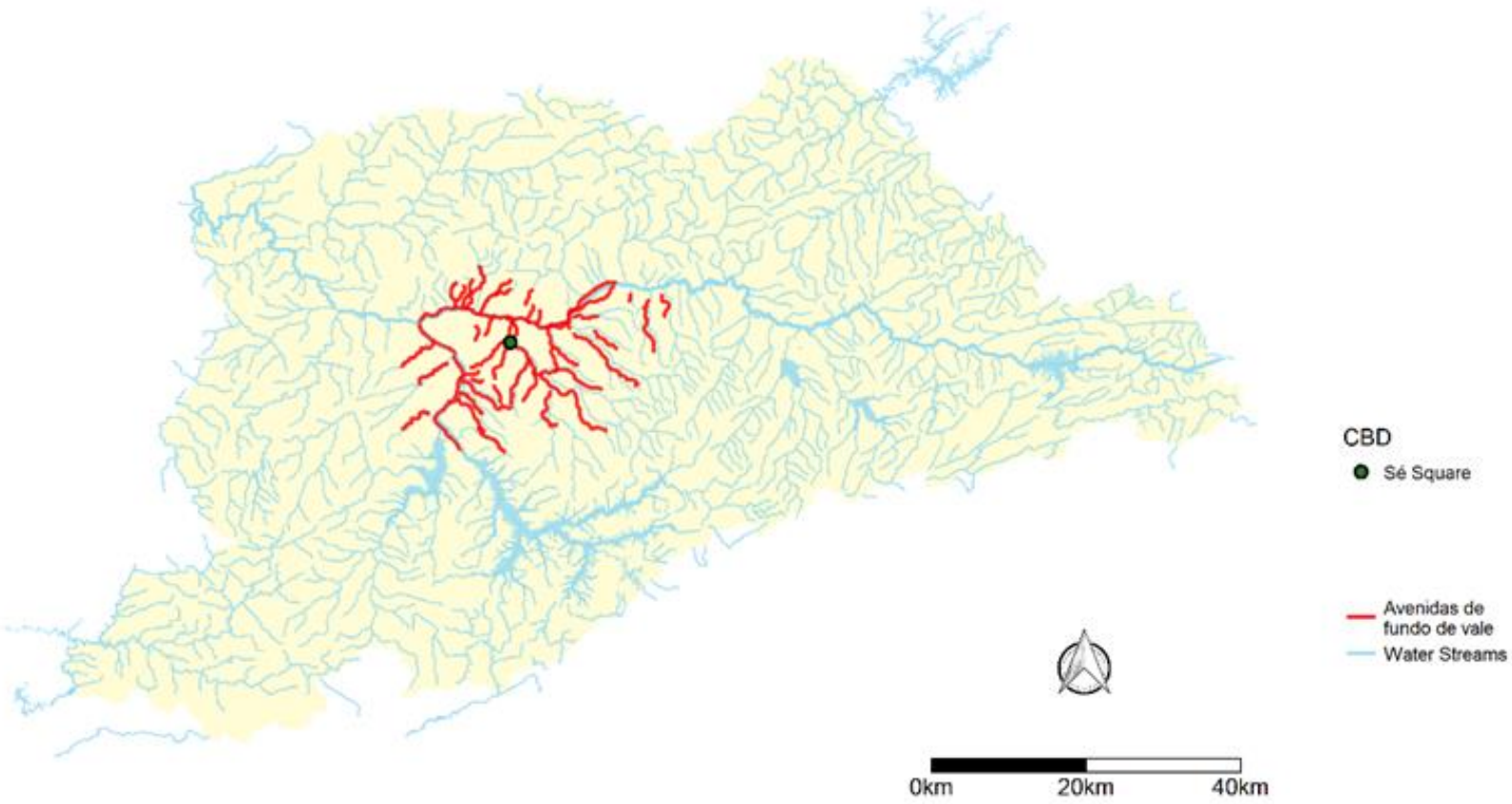


Watershed in SPMR

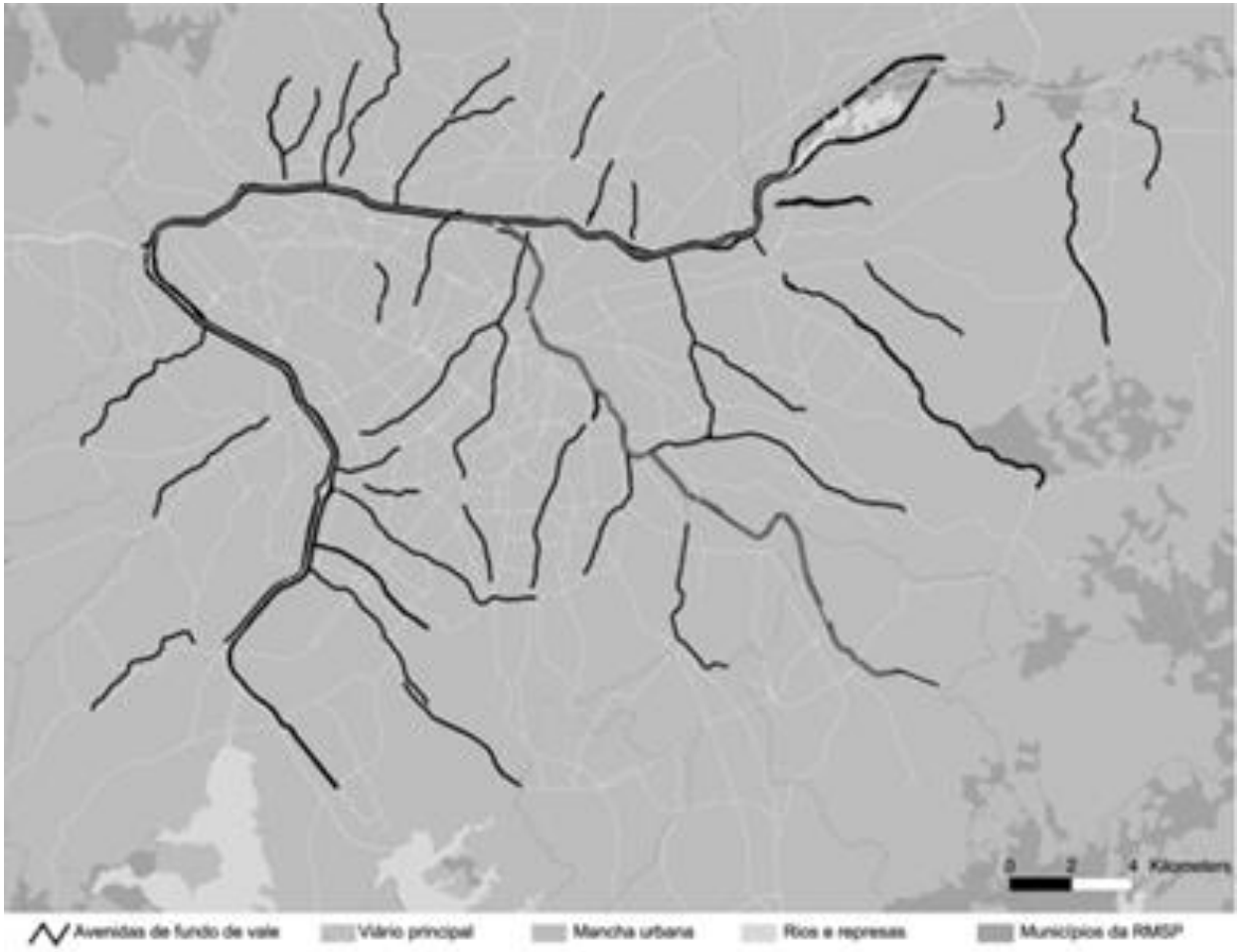


Urban Rivers Corridors in the City of São Paulo

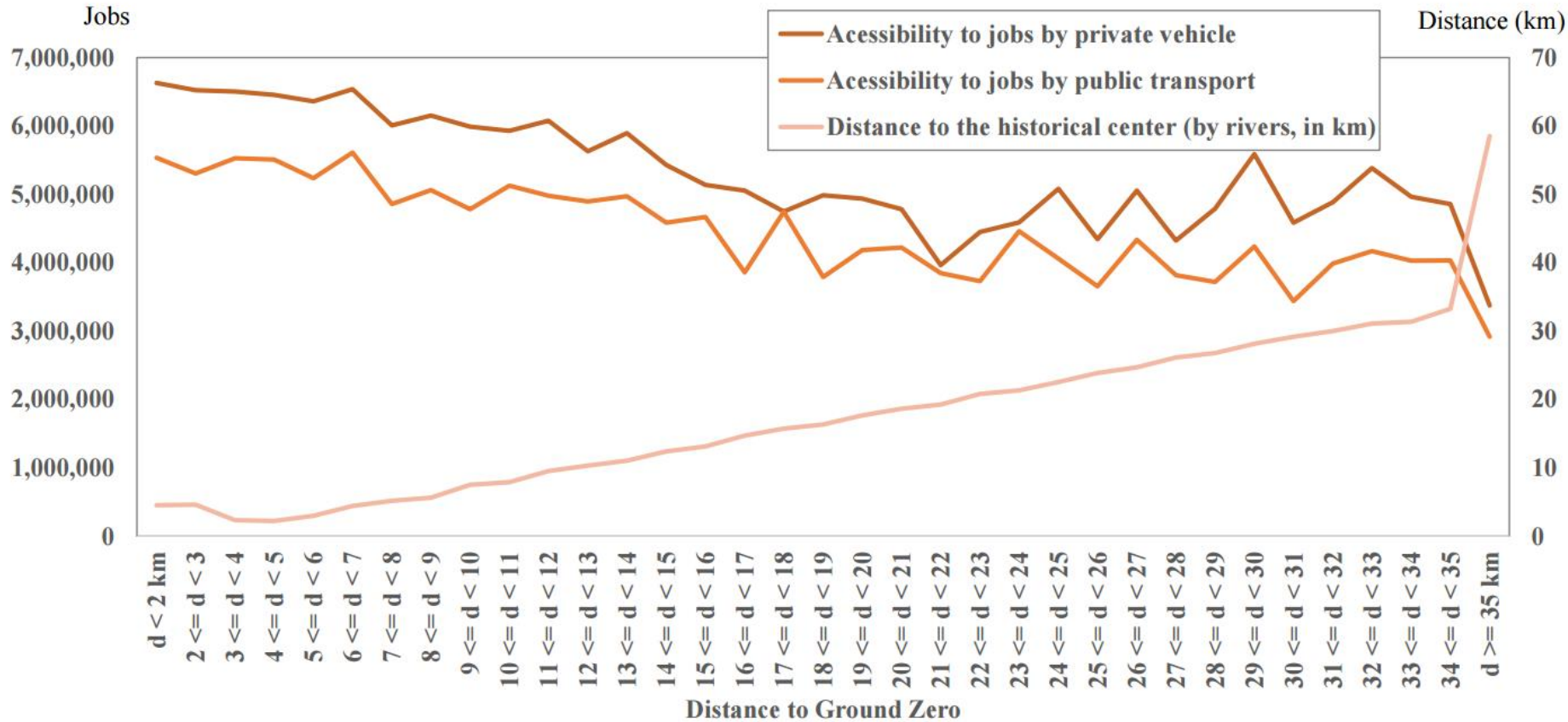
The conception of the use of floodplains as the preferential space for circulation prevailed in the development plans for the city, so that thalwegs avenues represent nowadays the main arteries of São Paulo



Urban Rivers Corridors in the City of São Paulo



Accessibility to jobs and Distance to *Pateo do Collegio* by Rivers



Source: Calculation by the authors

Descriptive statistics of the main variables for the OD Survey, 2007

	Private vehicle		Public transportation		Total	
	mean	s.d.	mean	s.d.	mean	s.d.
Wage (individual income)	R$ 2,036	R$ 2,035	R$ 982	R$ 909	R$ 1,316	R$ 1,455
Commuting time (min.)	39	29	76	40	64	41
Distance to Ground Zero (km)	34.6	21.5	39.8	21.1	38.1	21.4
Distance to Pateo do Collegio by rivers (km)	32.8	21.8	38.1	21.4	36.4	21.7
Accessibility to jobs through transportation	4,334,939	1,139,496	3,551,412	862,184		
	Individuals	**%**	**Individuals**	**%**	**Individuals**	**%**
Weighted sample	1,041,992	31.7%	2,247,343	68.3%	3,289,335	100.0%

*Sampling weights applied
Source: OD Survey

Estimation results for the wage equation

(Dependent variable – logarithm of wage)

	Model 1 Private vehicles OLS	Model 2 Public transp. OLS	Model 3 Private vehicles OLS	Model 4 Public transp. OLS	Model 5 Private vehicles OLS	Model 6 Public transp. OLS	Model 7 Private vehicles IV	Model 8 Public transp. IV
Ln(commuting time)	0.007	-0.058***						
	(0.016)	(0.015)						
Ln(Euclidean distance to Ground Zero)			-0.114***	-0.092***				
			(0.019)	(0.011)				
Ln(accessibility to jobs by car)					0.260***		0.466***	
					(0.068)		(0.073)	
Ln(accessibility to jobs by public transportation)						0.183***		0.418***
						(0.025)		(0.050)
Instrument								
Ln(distance to Pateo do Collegio by rivers)							Yes	Yes
Observations	5,730	8,564	5,730	8,564	5,730	8,564	5,730	8,564
R-squared	0.526	0.397	0.530	0.401	0.530	0.401	0.527	0.391

Robust t-statistics in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Obs.: Additional controls: age, age squared, gender, role in the household, schooling level, type of job, sector of activity, ln(time of departure from home), workplace zone dummies, constant term. Sampling weights are applied to the estimation.

Source: Calculation by the authors

Final remarks

Significant bias is generated by estimating directly the relationship between wages and accessibility

Instrument: exogenous geographical measure, of which economic agents are fully unaware ("invisible" rivers)

Complement the analysis by considering the other relevant urban price, namely the price of land (hedonic price model)

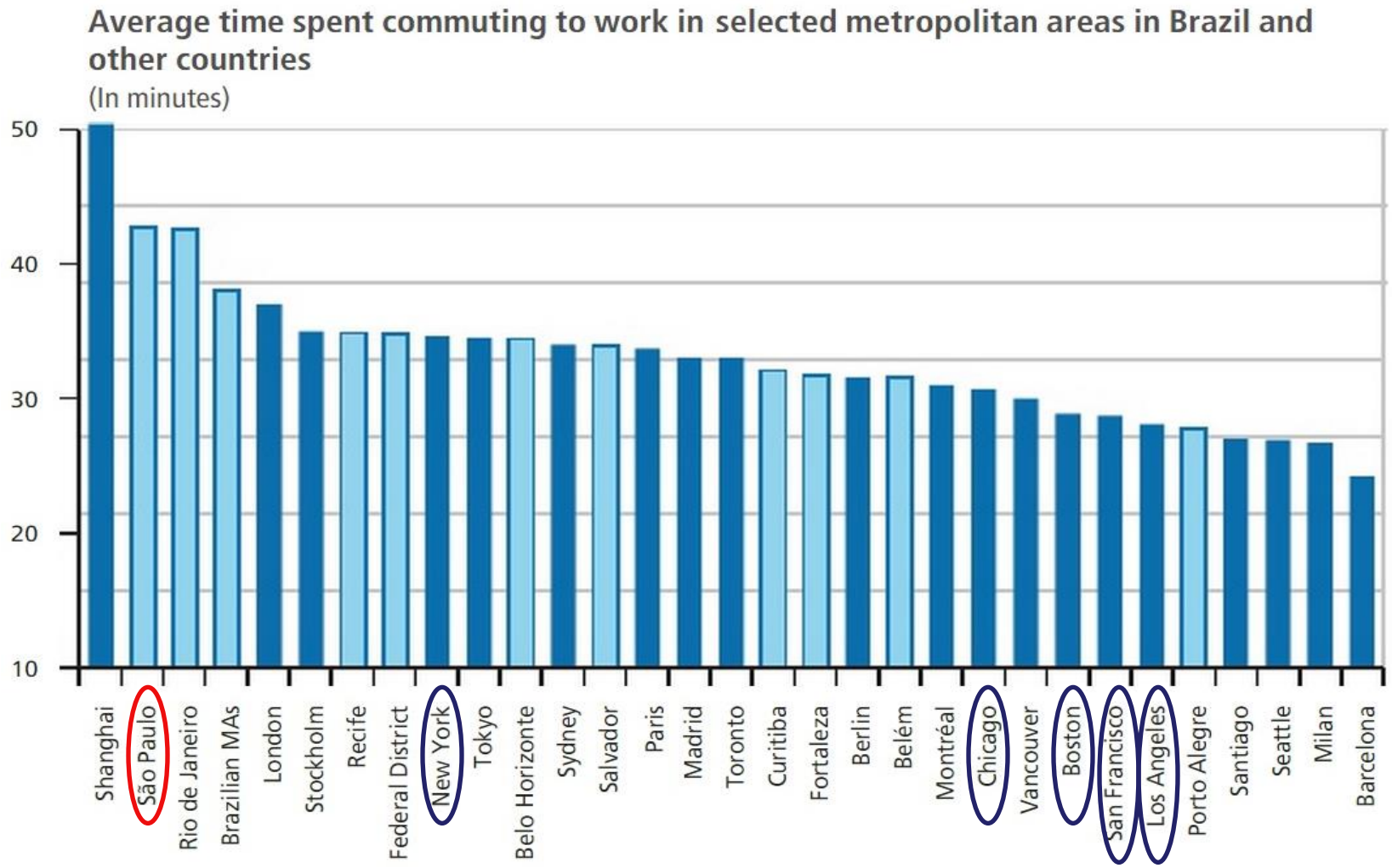
Our empirical analysis, despite being motivated by a theoretical general equilibrium framework, was based on partial equilibrium modelling strategies.

A complete structural model comprising the simultaneous determination of the housing and the labor markets can provide further insights on these relationships.

“From rivers to roads...”

Fonte: https://aquipassaumrio.wordpress.com/

International Comparison



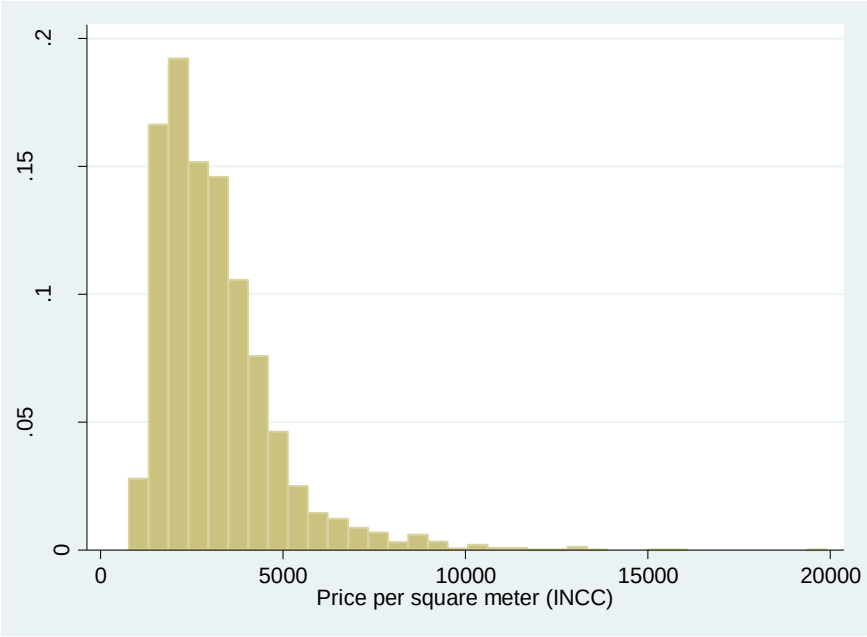
Source: (Pereira & Schwanen, 2013)

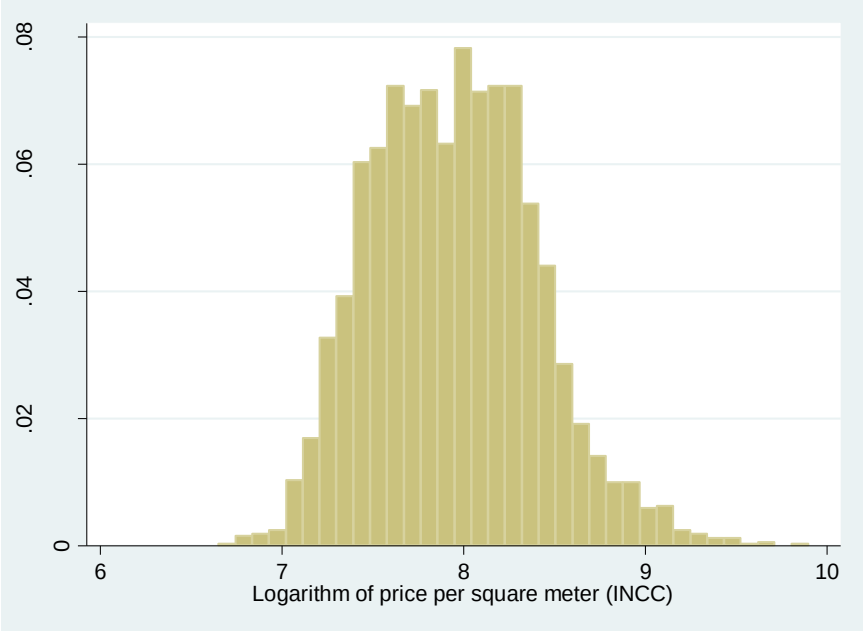
Especificação

Uma das principais dificuldades em estimar os modelos de preços hedônicos é definir a forma funcional das equações, uma vez que a teoria não apresenta uma especificação padrão a ser adotada

A vantagem da transformação Box-Cox é permitir que os próprios dados revelem a melhor especificação do modelo

Transformação Box-Cox





Resultado da transformação Box-Cox: preços dos imóveis em nível (esquerda) e em logaritmo (direita)