ISCI
INSTITUTO
SISTEMAS COMPLEJOS
DE INGENIERÍA

CEDEUS
Centro de Desarrollo
Urbano Sustentable

DII
DEPARTAMENTO
INGENIERÍA INDUSTRIAL
UNIVERSIDAD DE CONCEPCIÓN

Understanding accessibility to education from the offer side:

(Spatial-rings analysis in Santiago, Chile)

International Choice Modelling Conference | Reykjavik, Iceland | May 23, 2022 Sebastian Astroza

Background image from https://www.emol.com/noticias/Nacional/2017/07/11/866292/El-22-de-los-escolares-chilenos-debe-trasladarse-a-otra-comuna-para-ir-al-colegio.html

Adrián Flores
Industrial Engineering
Universidad de Concepción

Daniela Robles
Industrial Engineering
Universidad de Concepción

Alejandra Rasse
School of Social Work
Pontificia Universidad Católica de Chile

Juan Antonio Carrasco
Civil Engineering
Universidad de Concepción

Felipe González-Espejo
Transport Engineering and Logistics
Pontificia Universidad Católica de Chile

Ricardo Hurtubia
Transport Engineering and Logistics
School of Architecture
Pontificia Universidad Católica de Chile

Presentation structure

- Motivation
- Data
- Methodology
- Results
- Conclusions

Background image from https://www.supermadre.net/furgon-escolar/

ISCI
INSTITUTO
SISTEMAS COMPLEJOS
DE INGENIERÍA

CEDEUS
Centro de Desarrollo
Urbano Sustentable

DII
DEPARTAMENTO
INGENIERÍA INDUSTRIAL
UNIVERSIDAD DE CONCEPCIÓN

Motivation

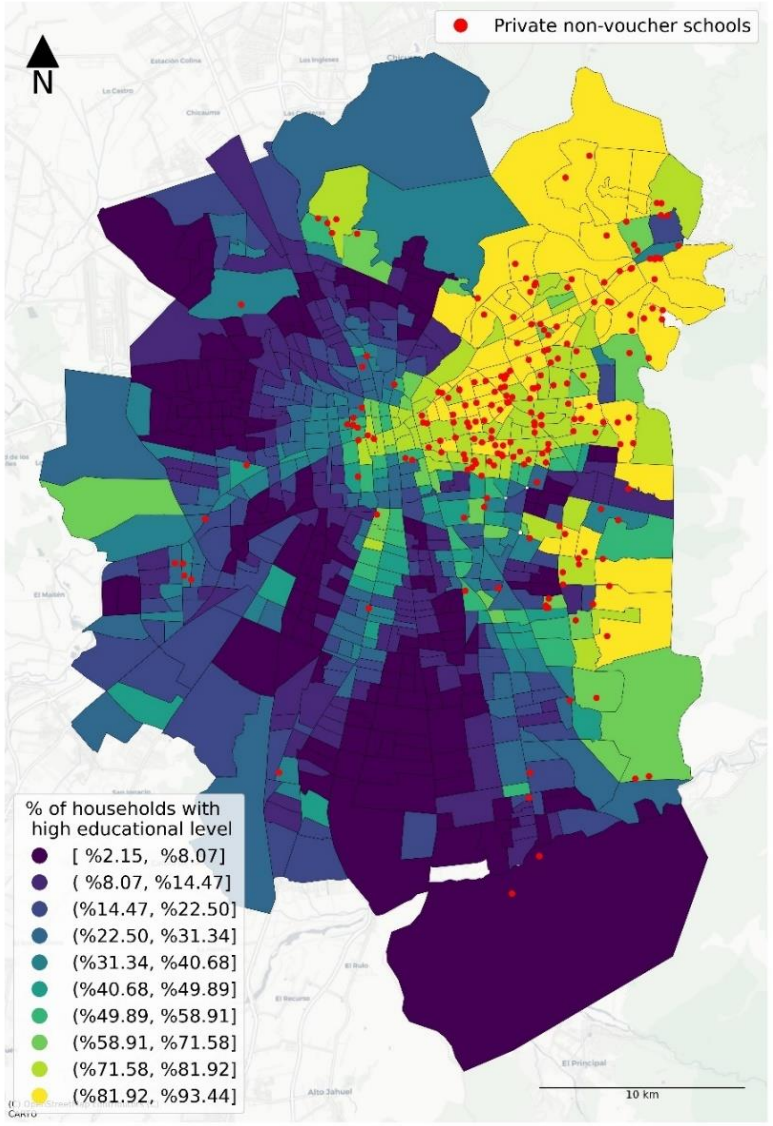
Education-voucher systems

- Provide better quality education and more efficient school systems (Friedman, 1962; Hoxby, 2007; Levin, 2002).
- Play a role on segregation mechanisms through education markets (Elacqua et al., 2006; Elacqua, 2012; Levin, 1998).
- Free school choice → parents' preferences and trade-offs become relevant (not restricted to geographical location's school assignment).

Chilean (and Santiago's) case

- Nationwide voucher system implementation in the 1980s (Villalobos and Quaresma, 2015).
- Recurrently criticized for its mechanisms that allow for discrimination and social segregation (Carrasco et al., 2021; Elacqua, 2012; Gayo et al., 2019; Valenzuela et al., 2014)
- Similar to Friedman's original work, no restrictions to the model in comparison to other countries' implementations (Hofflinger et al., 2020).

Figure 1: Private non-voucher school distribution and household's educational level distribution in Santiago, Chile.



Source: González-Espejo et al. (2022)

From the demand side

- Parents' role in the decision process vastly studied in the Chilean context.

- Academic and location attributes affect a household's preferences towards regarding school choice (Chumacero et al., 2011; Gómez et al., 2012)

- However, for several groups, socioeconomic aspects of the student body prevail over academic characteristics (Bellei et al., 2020; Elacqua et al., 2006), fostering social and spatial segregation dynamics.

From the demand side

There are families that “send” their kids to farther, more expensive, and lower quality schools only for the neighborhood that the school is located.

Screenshot from Chilean 90’s comedy sketch

From the demand side

- Spatially segregated city as income distribution strictly correlates with urban location (de Mattos, 1999).

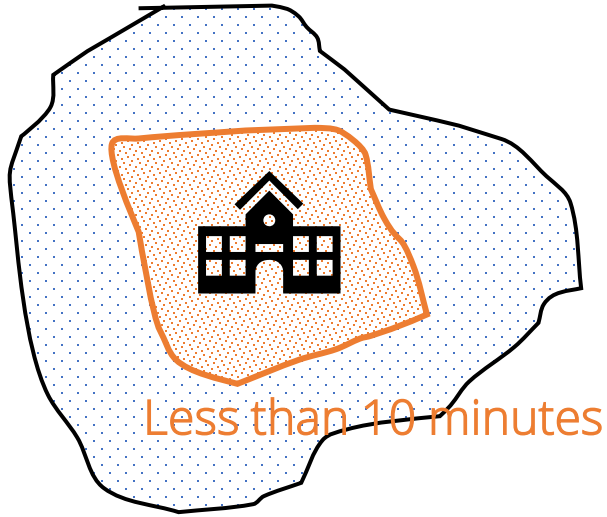
- School-related travel corresponds to 25% of the trips made at morning peak hour → half of them being made in motorized modes (SECTRA, 2014 : Origin-Destination Survey).

Our proposal

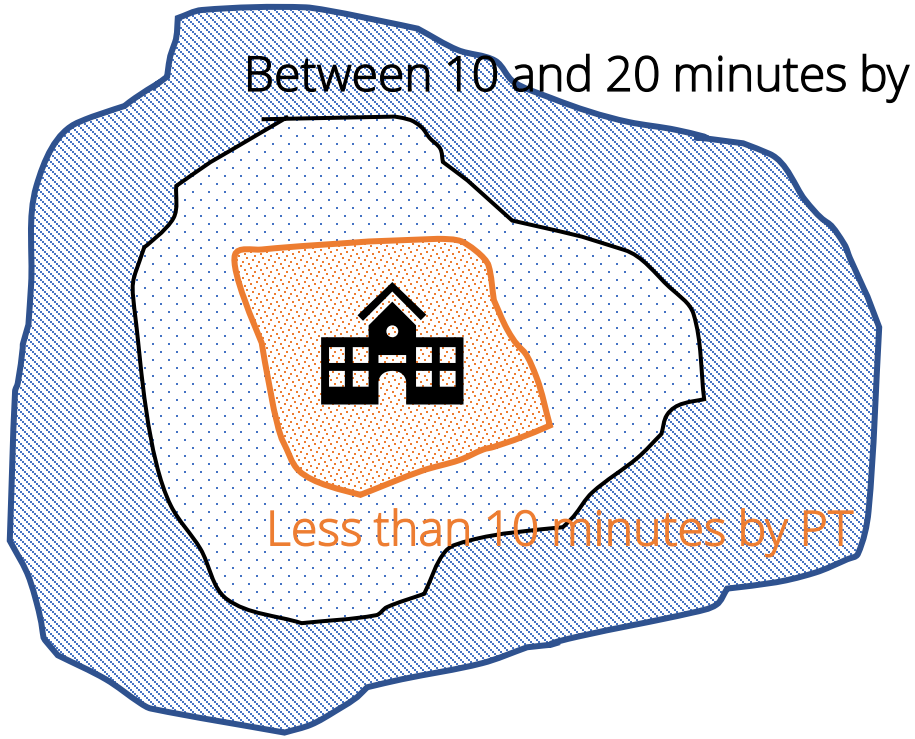
- Take a look “from the offer side.”
- Observation unit: school.
- Methodology: spatial (or time) rings (“isochrons”)

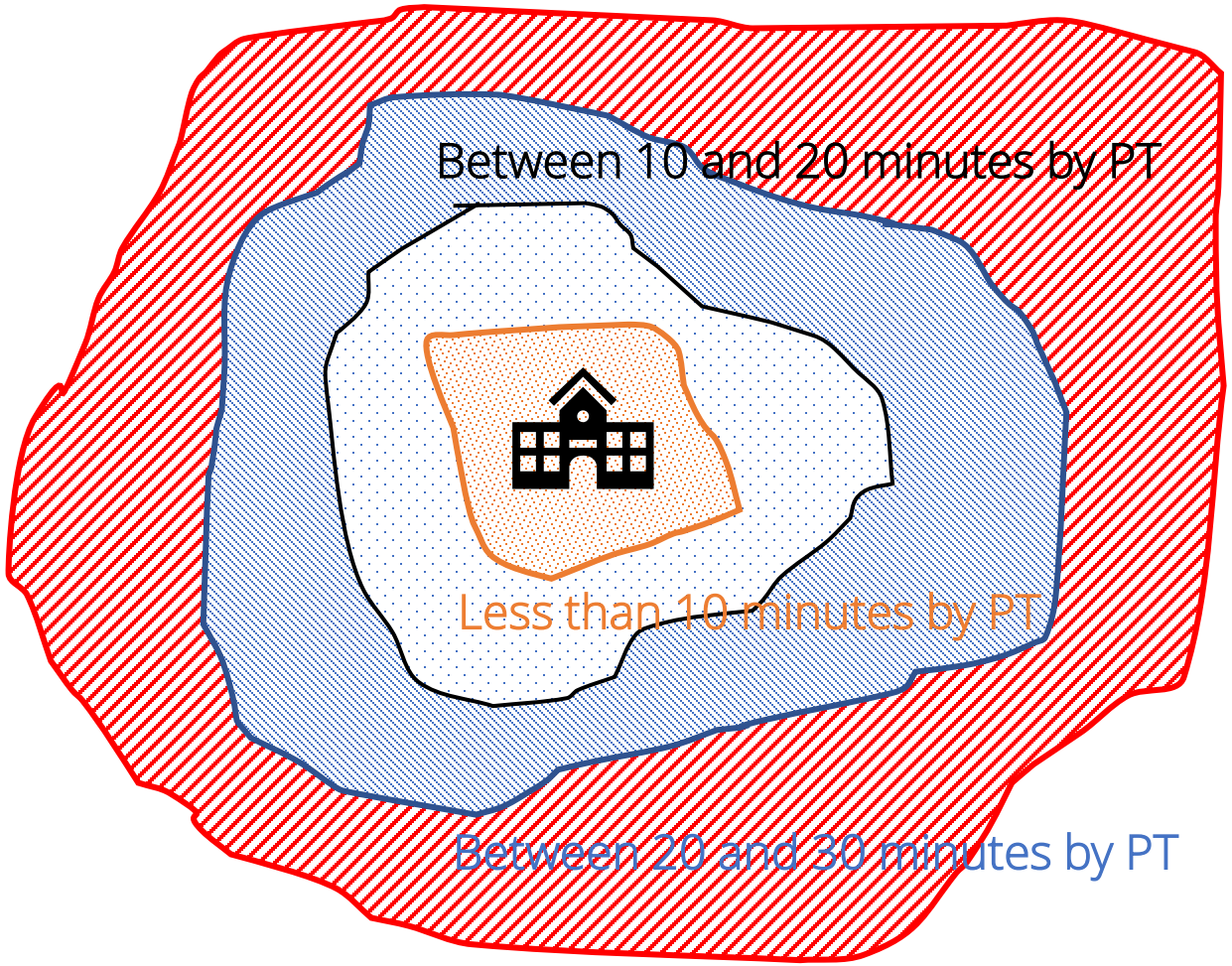
Less than 10 minutes by PT

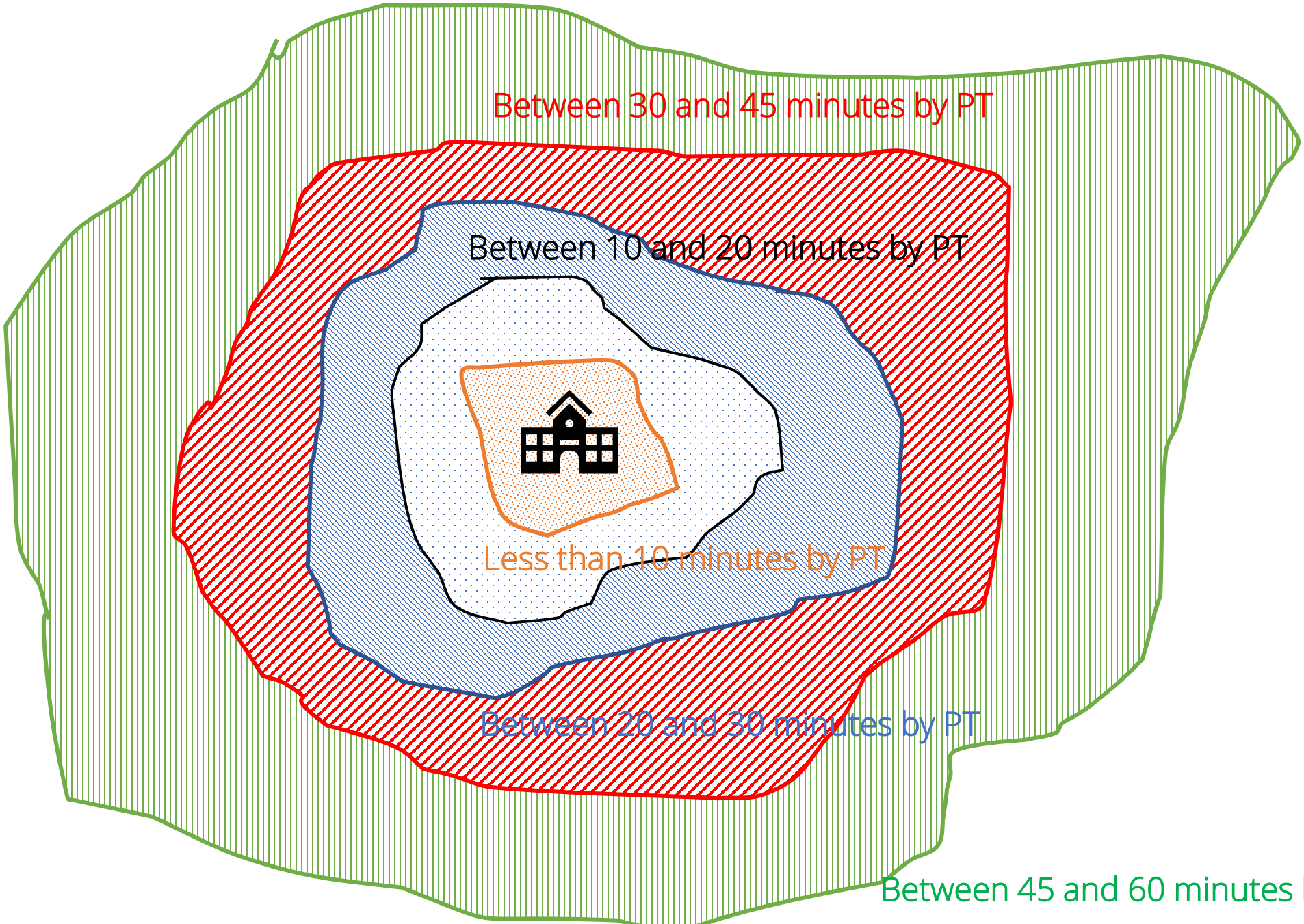
Between 10 and 20 minutes by PT

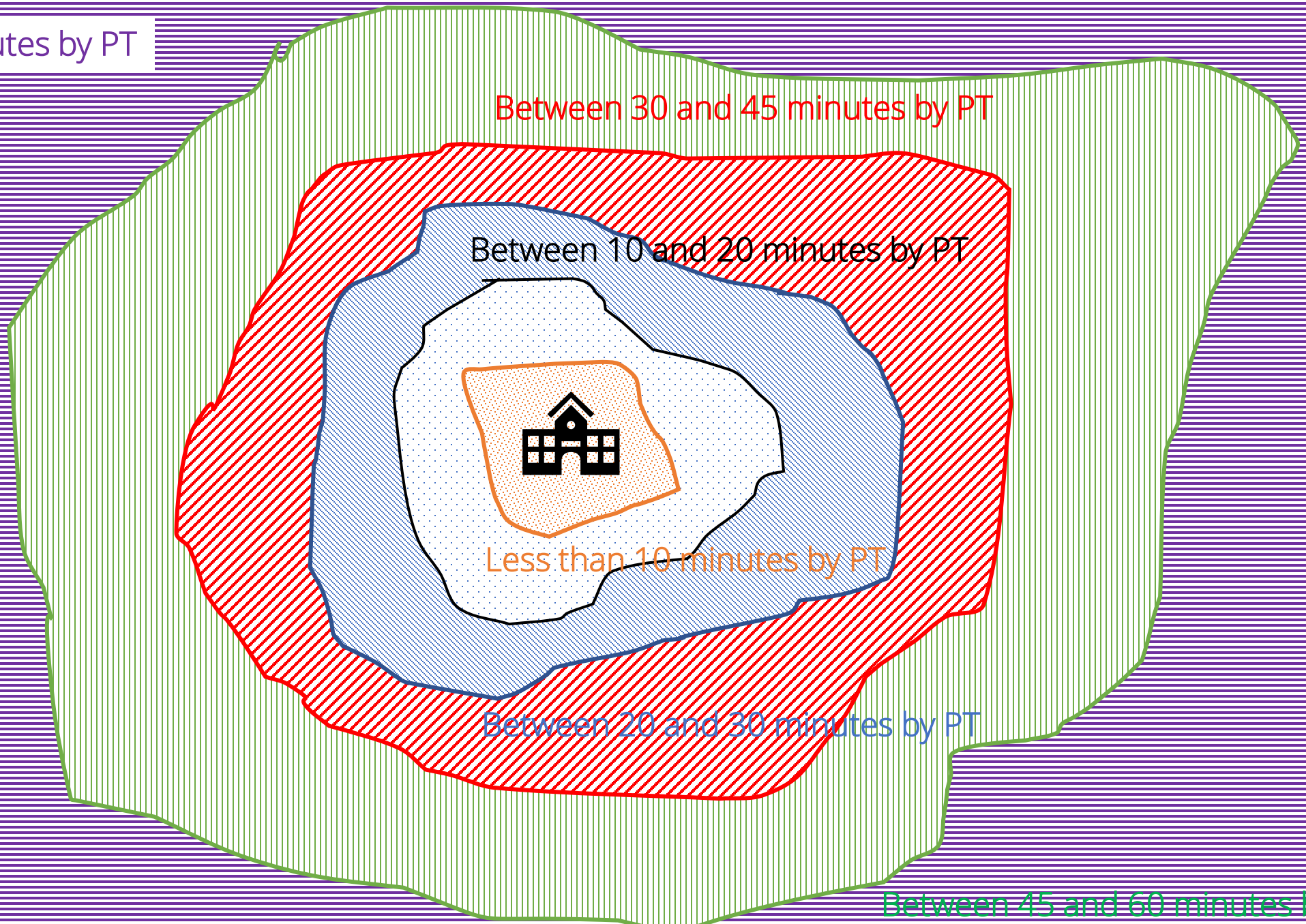


Less than 10 minutes by PT


Between 10 and 20 minutes by PT
Less than 10 minutes by PT
Between 20 and 30 minutes by PT


Between 30 and 45 minutes by PT
Between 10 and 20 minutes by PT
Less than 10 minutes by PT
Between 20 and 30 minutes by PT


Between 30 and 45 minutes by PT
Between 10 and 20 minutes by PT
Less than 10 minutes by PT
Between 20 and 30 minutes by PT
Between 45 and 60 minutes by PT


More than 60 minutes by PT
Between 30 and 45 minutes by PT
Between 10 and 20 minutes by PT
Less than 10 minutes by PT
Between 20 and 30 minutes by PT
Between 45 and 60 minutes by PT

Research questions

- Are there differences or patterns on the spatial distribution of the students' locations attending each school?
- What factors impact the spatial distribution of the students' locations for each school?

Background image from https://www.homeurbano.com/es/chile-santiago/transportes/

ISCI
INSTITUTO
SISTEMAS COMPLEJOS
DE INGENIERÍA

CEDEUS
Centro de Desarrollo
Urbano Sustentable

DII
DEPARTAMENTO
INGENIERÍA INDUSTRIAL
UNIVERSIDAD DE CONCEPCIÓN

Data

The sample

- 2016 enrollment data from the ministry of education.
- 456,817 students from 1,882 schools.

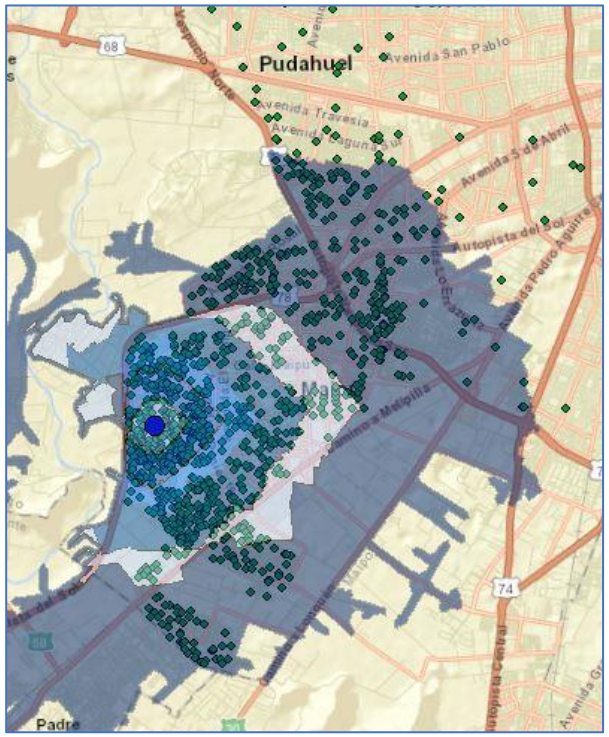
Type of institution	Sample	Real
Public	31.19%	21.17%
Private voucher	55.90%	61.93%
Private non-voucher	12.91%	16.90%

Table 1: Sample vs population distribution of schools by type

Enrollment	Sample	Real
Public	28.98%	25.44%
Private voucher	65.79%	61.27%
Private non-voucher	5.23%	13.29%

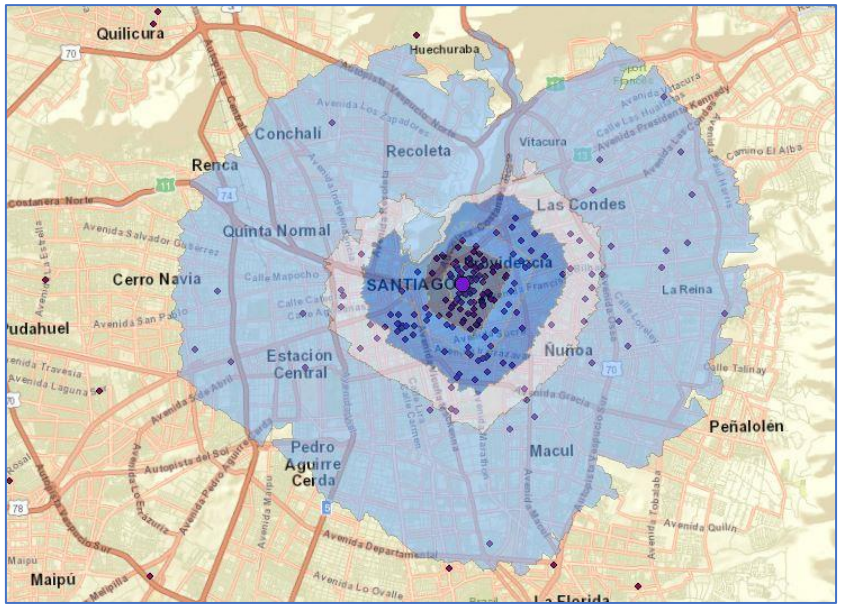
Table 2: Sample vs population distribution of enrollment by type

Examples



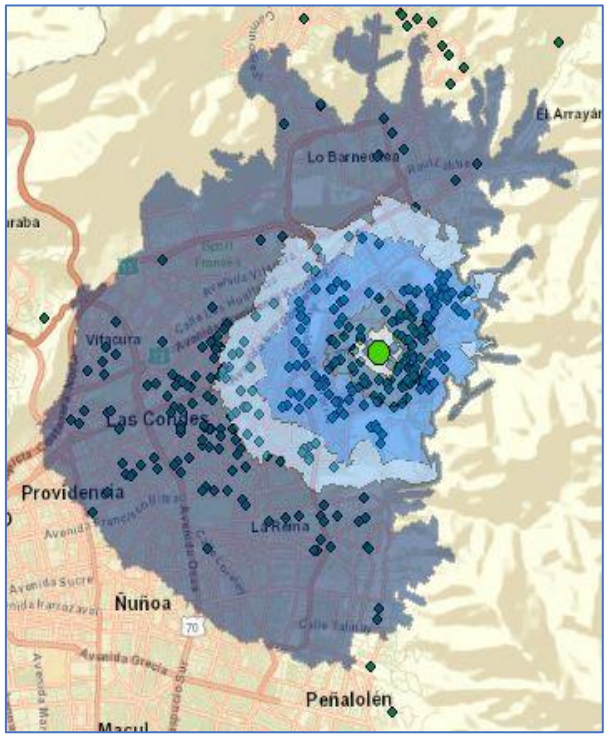
Liceo Nacional de Maipú

(public school)



Colegio Josefino Ssma Trinidad

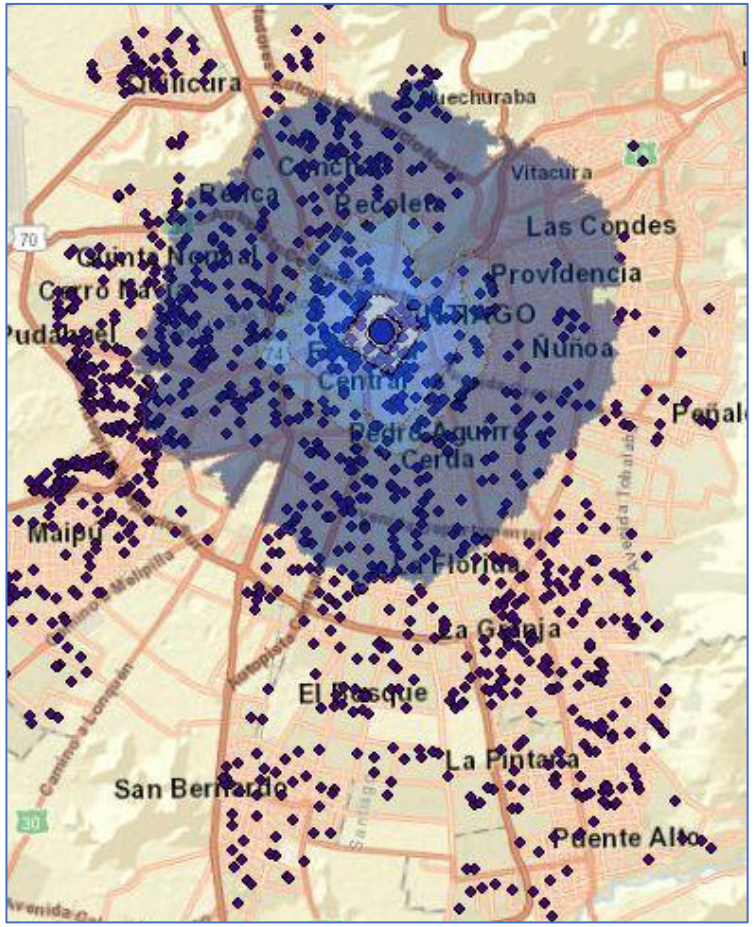
(private voucher)



Colegio Redland

(private non-voucher school)

Examples



Instituto Nacional

(traditional public school with high performance)

Variables

- Education level (elementary, secondary, both)
- Dependency type (public, private voucher, private non-voucher)
- Distance to city center.
- Municipality.
- School performance in SIMCE (Education Quality Measurement System)
- Built environment.
- Other school characteristics (number of teachers per student, religious status, extra-curricular infrastructure, etc.)

ISCI
INSTITUTO
SISTEMAS COMPLEJOS
DE INGENIERÍA

CEDEUS
Centro de Desarrollo
Urbano Sustentable

DII
DEPARTAMENTO
INGENIERÍA INDUSTRIAL
UNIVERSIDAD DE CONCEPCIÓN

Methodology

Multiple Discrete-Continuous Model

$$\max U(\boldsymbol{x}) = \sum_{k=1}^{K} \frac{\tau_k}{\alpha_k} \psi_k \left(\left(\frac{x_k}{\tau_k} + 1 \right)^{\alpha_k} - 1 \right)$$

$$s.t. \sum_{k=1}^{K} x_k = 1$$

K: number of rings (6 in our case)

x_k: % of student enrollment with residence in ring k

τ_k, ψ_k and α_k : parameters to estimate (with response heterogeneity and error)

Reference: Bhat (2008)

Spatial Multiple Discrete-Continuous Probit (S-MDCP) Model

$$\max U(\boldsymbol{x}) = \sum_{k=1}^{K-1} \tau_{qk}\psi_{qk} \ln\left(\frac{x_{qk}}{\tau_{qk}} + 1\right) + \psi_{qK} \ln(x_{qk})$$

$$s.t. \sum_{k=1}^{K} x_{qk} = 1$$

K: number of rings (6 in our case)

x_k: % of student enrollment with residence in ring k

τ_k and ψ_k : parameters to estimate

q: index for school (or educational institution)

Spatial Correlation

$$\bar{\psi}_{qk} = \bar{\psi}^{*}_{qk} - \bar{\psi}^{*}_{qK} = \boldsymbol{\beta}'_{\boldsymbol{q}}\boldsymbol{z}_{\boldsymbol{qk}} + \delta_k \sum_{q'} w_{qq'}\,\bar{\psi}_{q'k}, \quad \text{for } k = 1,\ 2,\ \ldots,\ K-1$$

$$\bar{\psi}_{qK} = 0 \text{ for } k = K.$$

$$w_{qq} = 0\ ,\ \sum_{q'} w_{qq'} = 1 \quad \text{and} \quad 0 < \delta_k < 1$$

Reference: Bhat *et al.* (2015)

ISCI
INSTITUTO
SISTEMAS COMPLEJOS
DE INGENIERÍA

CEDEUS
Centro de Desarrollo
Urbano Sustentable

DII
DEPARTAMENTO
INGENIERÍA INDUSTRIAL
UNIVERSIDAD DE CONCEPCIÓN

Results

Preliminary estimation

- Schools with elementary education tend to have students more concentrated and near (less than 10 minutes)
- Private non-voucher schools have less students living nearby (less than 20 minutes)
- Providencia is a particular case: attract students from far away (many farther tan 60 minutes)

Preliminary estimation

- Coed schools attract more students from nearby tan single-gender schools.
- Schools with higher scores in SIMCE (Education Quality Measurement System) attract more students from farther rings.
- Schools with betters acces to public transport (metro and buses) attract more students from farther rings.

Preliminary estimation

- Spatial correlation is statistically significant and equal to 0.217
- Proximity measure: 1 divided by distance (in km)

ISCI
INSTITUTO
SISTEMAS COMPLEJOS
DE INGENIERÍA

CEDEUS
Centro de Desarrollo
Urbano Sustentable

DII
DEPARTAMENTO
INGENIERÍA INDUSTRIAL
UNIVERSIDAD DE CONCEPCIÓN

Conclusions

Conclusions

- We can characterize the coverage area of each school.
- It is possible to determine precisely the impact of each school and built environment characteristic.
- There is evidence of a segregated city, even after controlling for many other factors.

Further Research

- Testing different definitions of rings.
- Expanding the model to other cities in the country.
- Panel version of the model.
- Other measures of “proximity” (competition)

Journal of Transport Geography 102 (2022) 103359

Contents lists available at ScienceDirect

Journal of Transport Geography

journal homepage: www.elsevier.com/locate/jtrangeo

On the relation between school and residential location choice: Evidence of heterogeneous strategies from Santiago de Chile

Felipe González-Espejo [a], Sebastian Astroza [b,d,e], Ricardo Hurtubia [a,c,d,e,*]

[a] Department of Transport Engineering and Logistics, Pontificia Universidad Católica de Chile, Chile
[b] Department of Industrial Engineering, Universidad de Concepción, Chile
[c] School of Architecture, Pontificia Universidad Católica de Chile, Chile
[d] Centro de Desarrollo Urbano Sustentable (CEDEUS), Chile
[e] Instituto Sistemas Complejos de Ingeniería (ISCI), Chile

SCAN ME

ISCI
INSTITUTO
SISTEMAS COMPLEJOS
DE INGENIERÍA

CEDEUS
Centro de Desarrollo
Urbano Sustentable

DII
DEPARTAMENTO
INGENIERÍA INDUSTRIAL
UNIVERSIDAD DE CONCEPCIÓN

Questions?

ISCI
INSTITUTO SISTEMAS COMPLEJOS DE INGENIERÍA

CEDEUS
Centro de Desarrollo Urbano Sustentable

DII
DEPARTAMENTO INGENIERÍA INDUSTRIAL
UNIVERSIDAD DE CONCEPCIÓN

Understanding accessibility to education from the offer side:

(Spatial-rings analysis in Santiago, Chile)

International Choice Modelling Conference | Reykjavik, Iceland | May 23, 2022

Sebastian Astroza

Background image from https://www.emol.com/noticias/Nacional/2017/07/11/866292/El-22-de-los-escolares-chilenos-debe-trasladarse-a-otra-comuna-para-ir-al-colegio.html