Modelling urban economic segregation:

a **theoretical** and **quantitative** quest for causal processes

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SEGUE

ECTQG - Braga - September 2023

Urban economic segregation

The process through which different social groups end up residing in distinct cities as well as in distinct urban neighbourhoods, intentionally or not. More specifically, the spatial differentiation of urban societies along economic lines (income and wealth levels).

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Why does urban economic segregation deserve a quest?

1. Urban economic **segregation** is socially harmful (cohesion, health, education)
2. Urban economic **segregation** is linked to economic **inequality** & Economic **inequality** is on the rise
3. **Policies** fail at reducing urban economic segregation

› But why?

Why does urban economic segregation deserve a quest?

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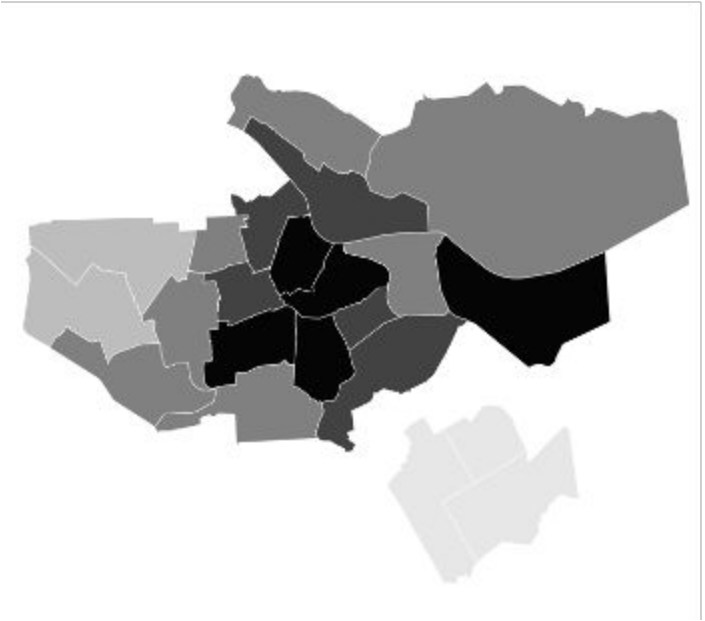
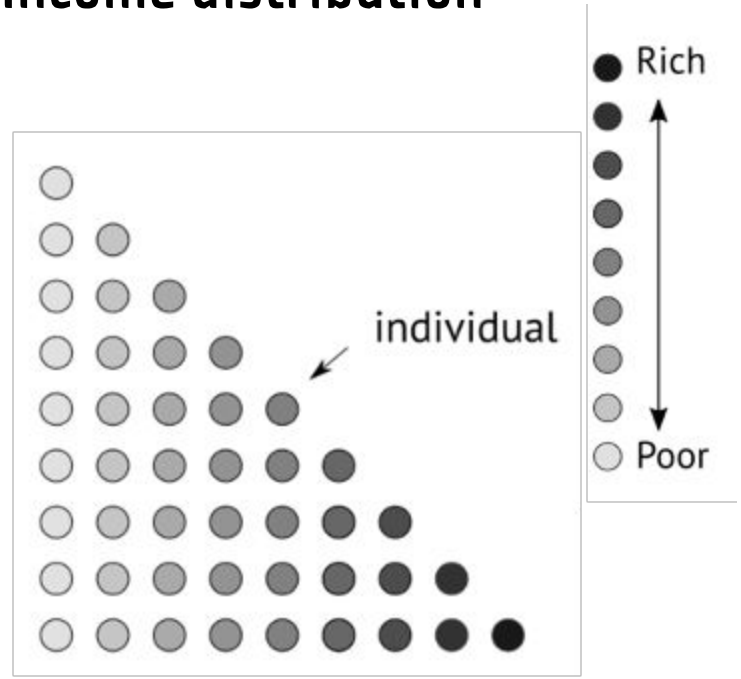
2. Urban economic **segregation** is linked to economic **inequality** & Economic **inequality** is on the rise
3. **Policies** fail at reducing urban economic segregation

› But why? Lack of consideration for the link between Inequality and segregation

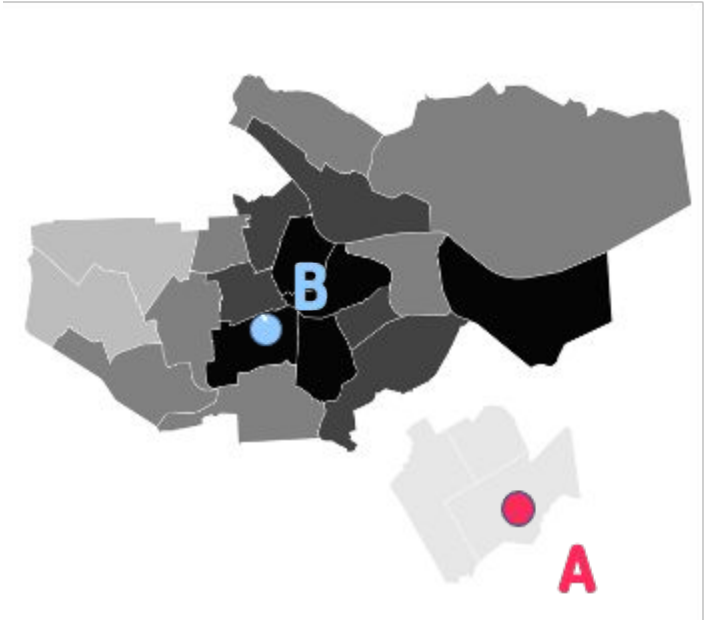
Spatial distribution



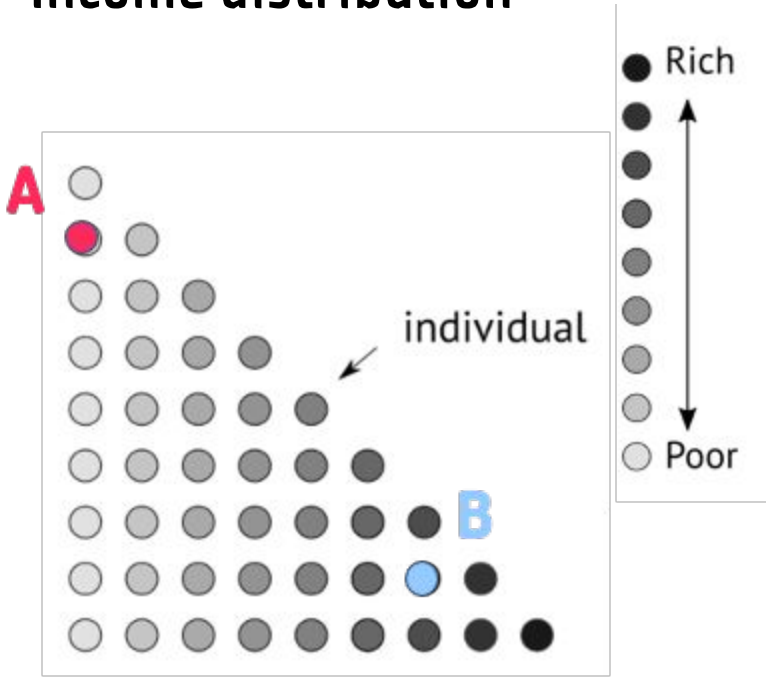
Income distribution



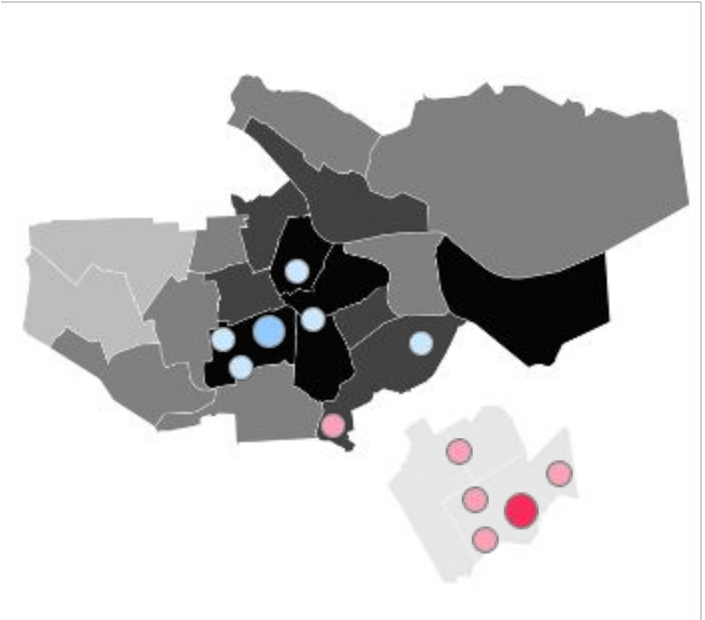
Spatial distribution



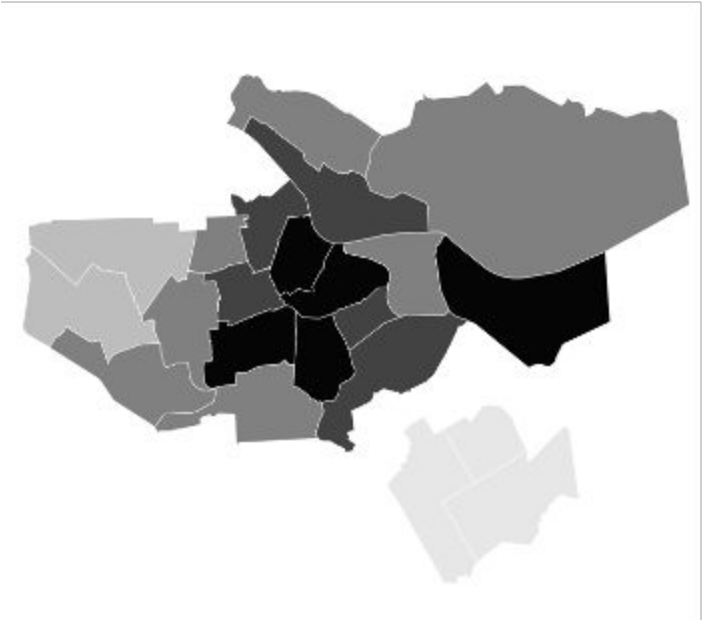
Income distribution

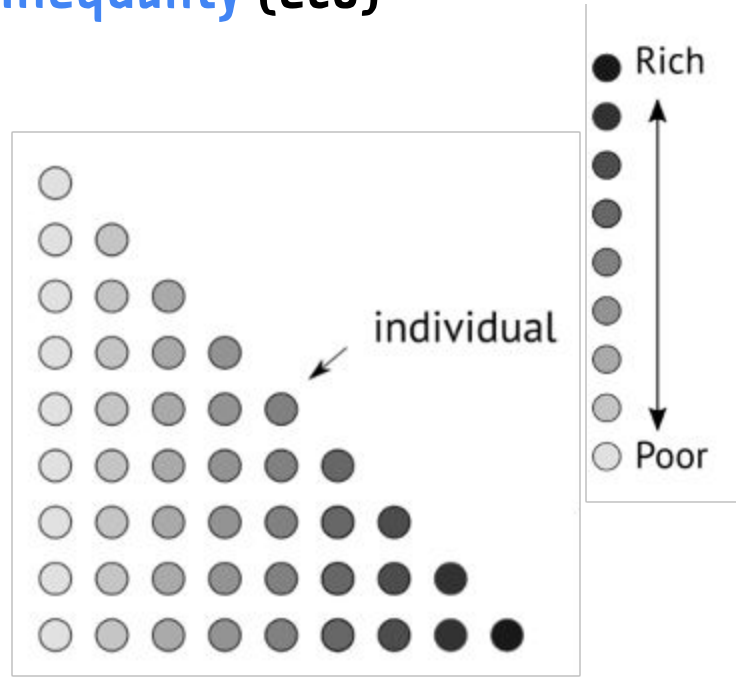


Spatial distribution ⇄ Income distribution



Segregation (Geo/socio) ⇄ Inequality (eco)



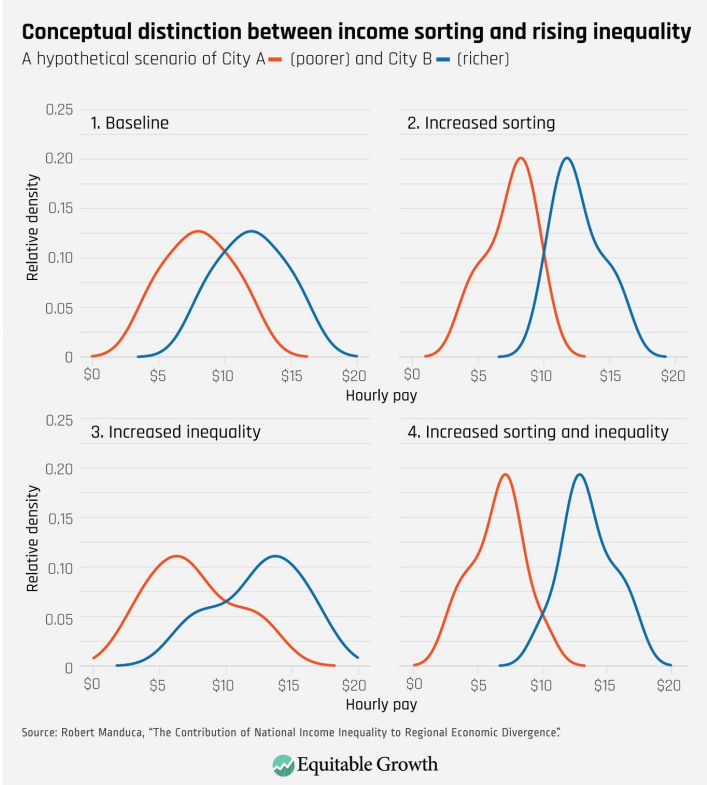


Two big literature fields are disconnected and misaligned

1. Misaligned **scales**: urban segregation vs. national inequality

> What about the **spatial distribution** of national individuals in cities?

> What about the **interactions** between cities of the same system?



Two big literature fields are disconnected and misaligned

1. Misaligned **scales**: urban segregation vs. national inequality
2. Misaligned **actors**: local communities vs. floating individuals

> What about actors who move and settle in space?
> What about local heterogeneity of communities?

8-10% of individuals (>1.5 million) move houses each year (CBS, 2022), mostly between 17 and 40 years old and >90.
46% of them from one municipality to another (CBS, 2022)

Two big literature fields are disconnected and misaligned

1. Misaligned **scales**: urban segregation vs. national inequality
2. Misaligned **actors**: local communities vs. floating individuals
3. Different disciplinary traditions for **explanation**:

   Location and characteristics of housing and social networks
   Circulation of money between people (taxation, return to education, intergenerational mobility)

Two big literature fields are disconnected and misaligned

1. Misaligned **scales**: urban segregation vs. national inequality
2. Misaligned **actors**: local communities vs. floating individuals
3. Different disciplinary traditions for **explanation**
4. Misaligned **methodologies**: descriptive studies vs. econometrics

Consequences of misalignment

1. Not enough knowledge about the **connection** between economic inequality and economic segregation

" There are only **a handful** of empirical studies of income inequality as a driver of residential segregation (Mayer, 2001; Watson, 2009; Reardon and Bischoff, 2011; Chen et al., 2012)."
(Xu & Liang, 2021, p. 520)

› Actually: how many?

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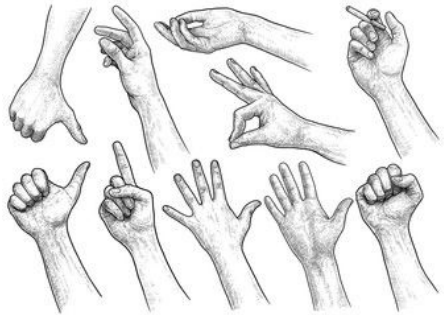
- (Xu & Liang, 2021, p. 520)

› Actually: how many?

2-3 handful
= 10-15 empirical studies



Consequences of misalignment

1. Not enough knowledge about the **connection** between economic inequality and economic segregation
2. It makes it harder to find **adequate** AND **comparable** study design

> right scale for **theoretical framework**
> adequate **measurement** for economic inequality and segregation
> robust conceptualisation and operationalisation of **time lag**
> consistent **data** sources for comparative work (cf. Tammaru et al, 2020)

Consequences of misalignment

1. Not enough knowledge about the **connection** between economic inequality and economic segregation
2. It makes it harder to find **adequate** AND **comparable** study design
3. It makes it harder to integrate **mechanistic explanations**

"Mechanist explanations are the most appropriate type of explanation for the social sciences. The core idea behind the mechanism approach is to explain a social phenomenon by referring to a constellation of events and activities, typically **actors** and their **actions**, that are linked to one another in such a way that they regularly bring about the phenomenon we seek to explain."

(Hedström, 2005, p. 2)

How are economic inequality and segregation connected?

› Through which channels / causal path / mechanisms ?

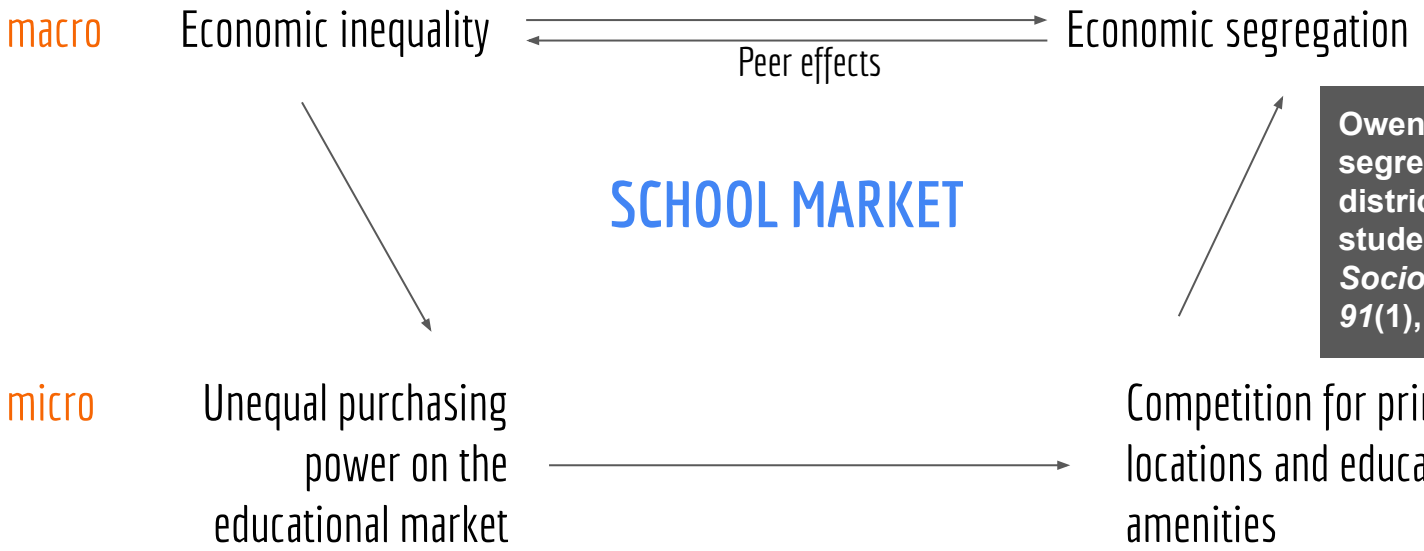
Mechanistic explanations of urban economic segregation

Tiebout C. (1956). A pure theory of local expenditures. *Journal of political economy*, *64*(5), 416-424.

Mechanistic explanations of urban economic segregation

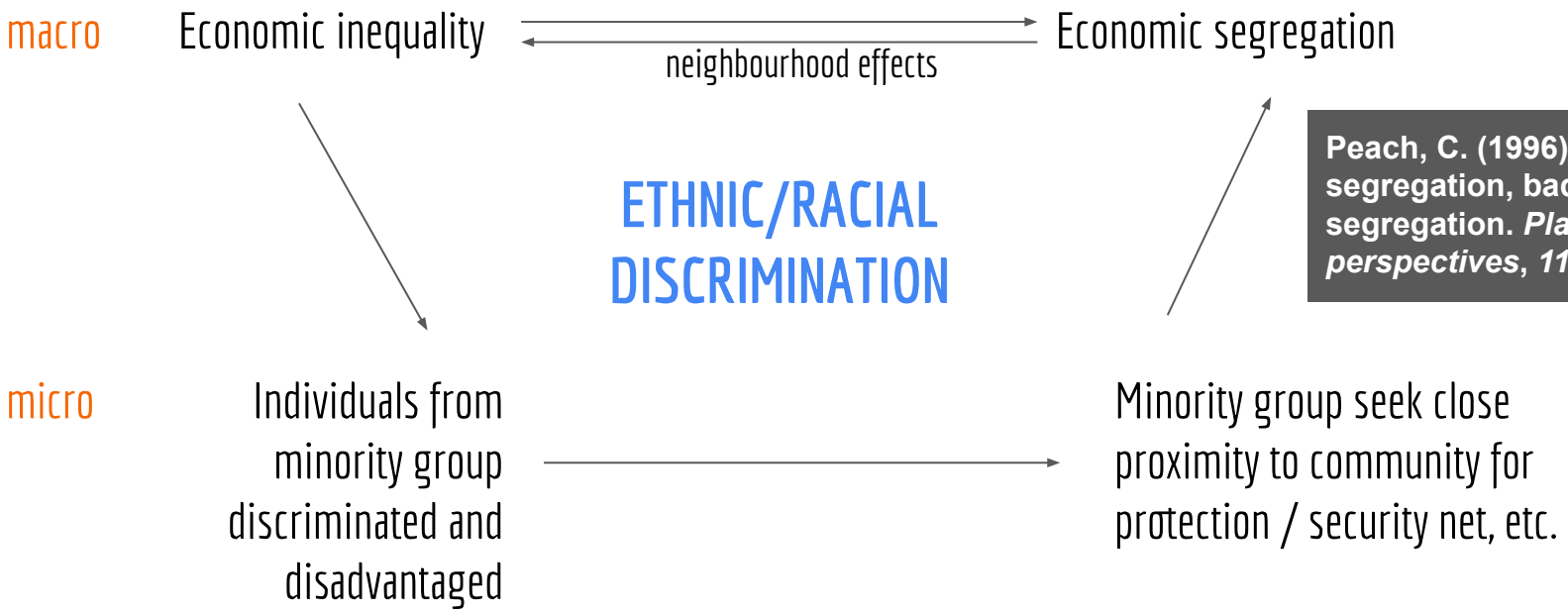
Keuschnigg, M., Mutgan, S., & Hedström, P. (2019). Urban scaling and the regional divide. *Science advances*, *5*(1)

Mechanistic explanations of urban economic segregation



Owens, A. (2018). Income segregation between school districts and inequality in students' achievement. *Sociology of education*, *91*(1), 1-27.

Mechanistic explanations of urban economic segregation



Peach, C. (1996). Good segregation, bad segregation. *Planning perspectives*, *11*(4), 379-398.

Research questions:

How are economic inequality and segregation connected?

› Through which channels / causal path / mechanisms ?
› To which extent do their analysis belong to distinct literature sets?
› What are the consequences of this misalignment in the existing literature?

SEGUE: Urban **E**conomic **SEG**regation | ERC-StG-2022-2027

4 strategies to deal with the complexity in segregation modelling:

- **Reviewing** the factors of urban economic segregation across disciplines
- Using multidimensional longitudinal spatial interactional **microdata**
- Empirical modelling with causal inference **statistical** methods
- Generative modelling of mechanisms of segregation: **ABM**

How are economic inequality and segregation connected?

SYSTEMATIC LITERATURE REVIEW

EMPIRICAL ANALYSIS OF SOCIAL › INDIVIDUAL LINK

GENERATIVE MODELLING OF INDIVIDUAL › SOCIAL LINK

SEGUE - Review

WOS / Articles only / Language = EN, FR, ES, RU, NL

((TS= segregation AND (TS=income OR TS=wealth OR TS=economic)) OR (TS=inequality AND (TS=income OR TS=wealth OR TS=economic)))

AND (ALL="mechanis*" OR ALL="explain*" OR ALL="explanation" OR ALL="effect*" OR ALL="caus*" OR ALL="relation*" OR ALL="process*")

AND (AB="segregation" OR AB="inequality") NOT (AB="spatial inequality")

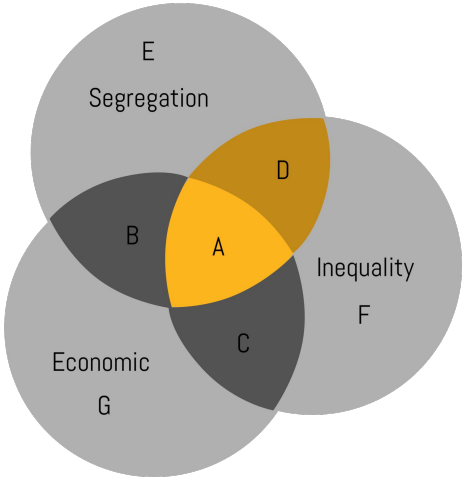
= 20 369 references as of March 2023

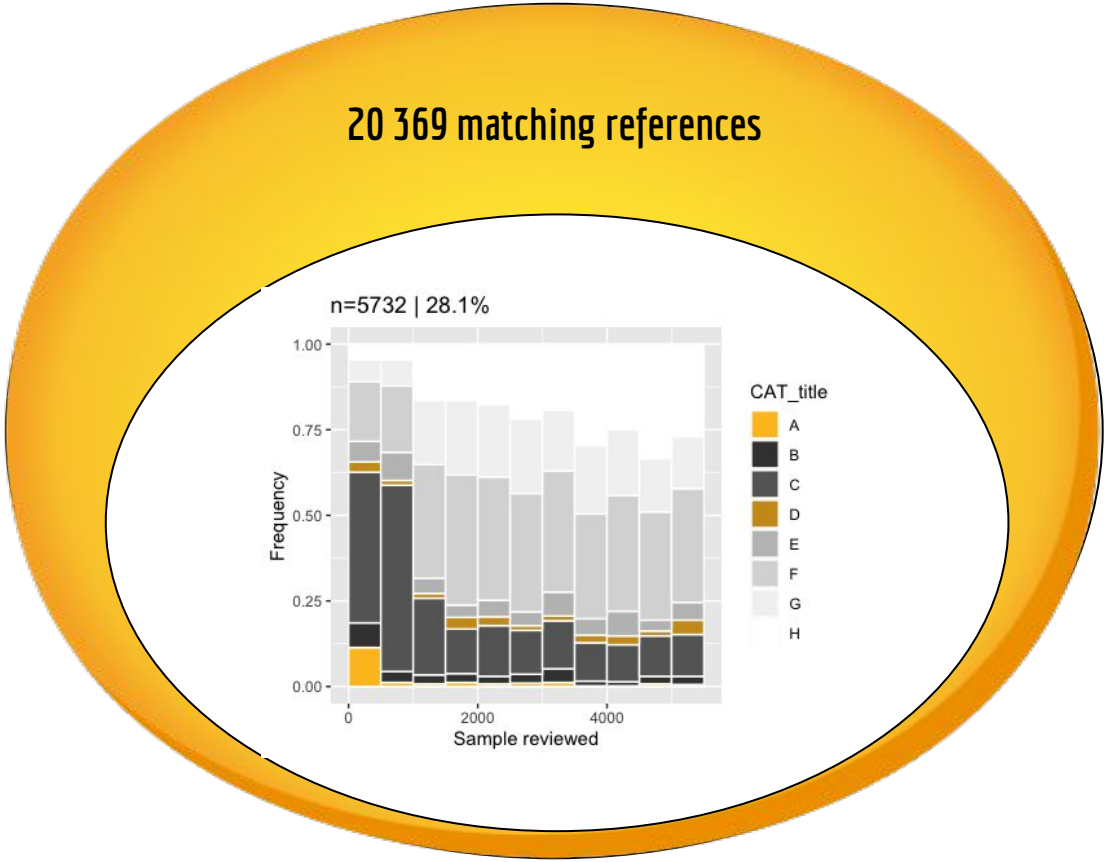
Screening Process:

1. Manual screening

Screening Process:

1. Manual screening





Screening Process:

1. Manual screening
2. Active learning

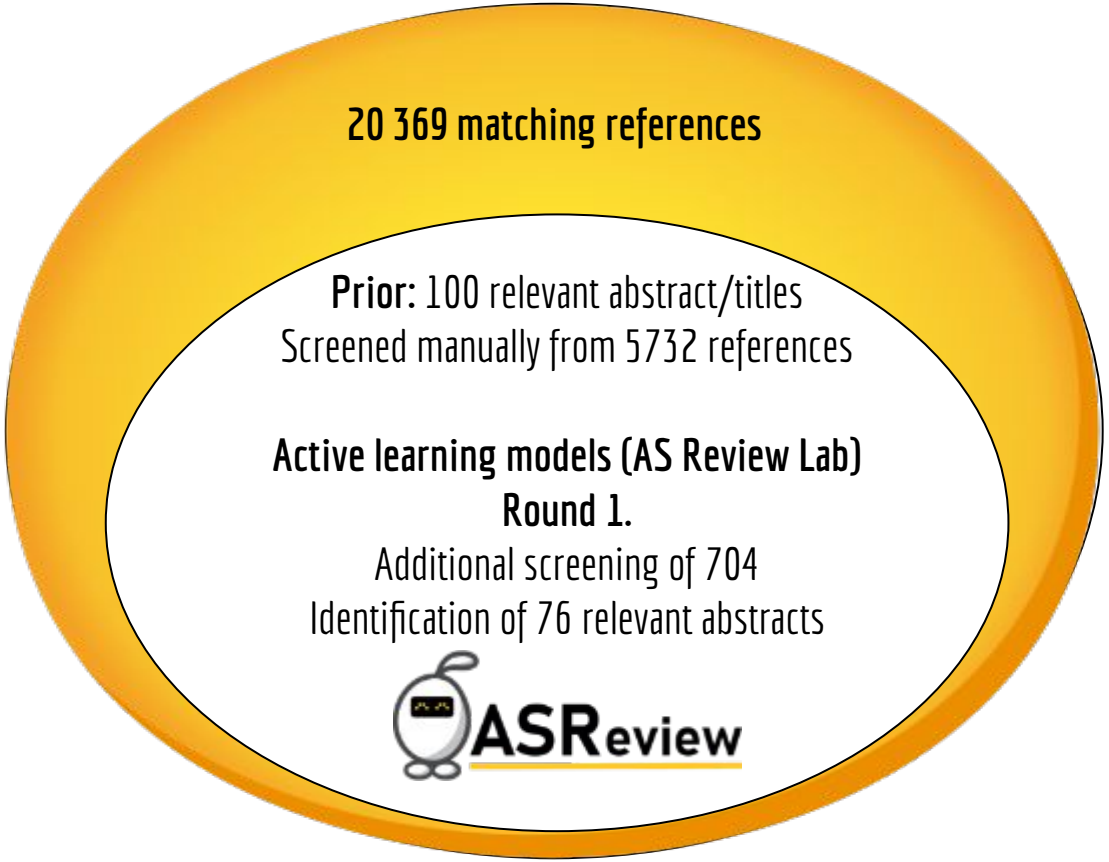
1st model:

Feature extraction technique
TF-IDF

Classifier
Naive Bayes

Query strategy
Maximum

Balance strategy
Dynamic resampling (Double)



Screening Process:

1. Manual screening
2. Active learning

2nd model:

Feature extraction technique
Sentence BERT

Classifier
Logistic regression

Query strategy
Maximum

Balance strategy
Dynamic resampling (Double)

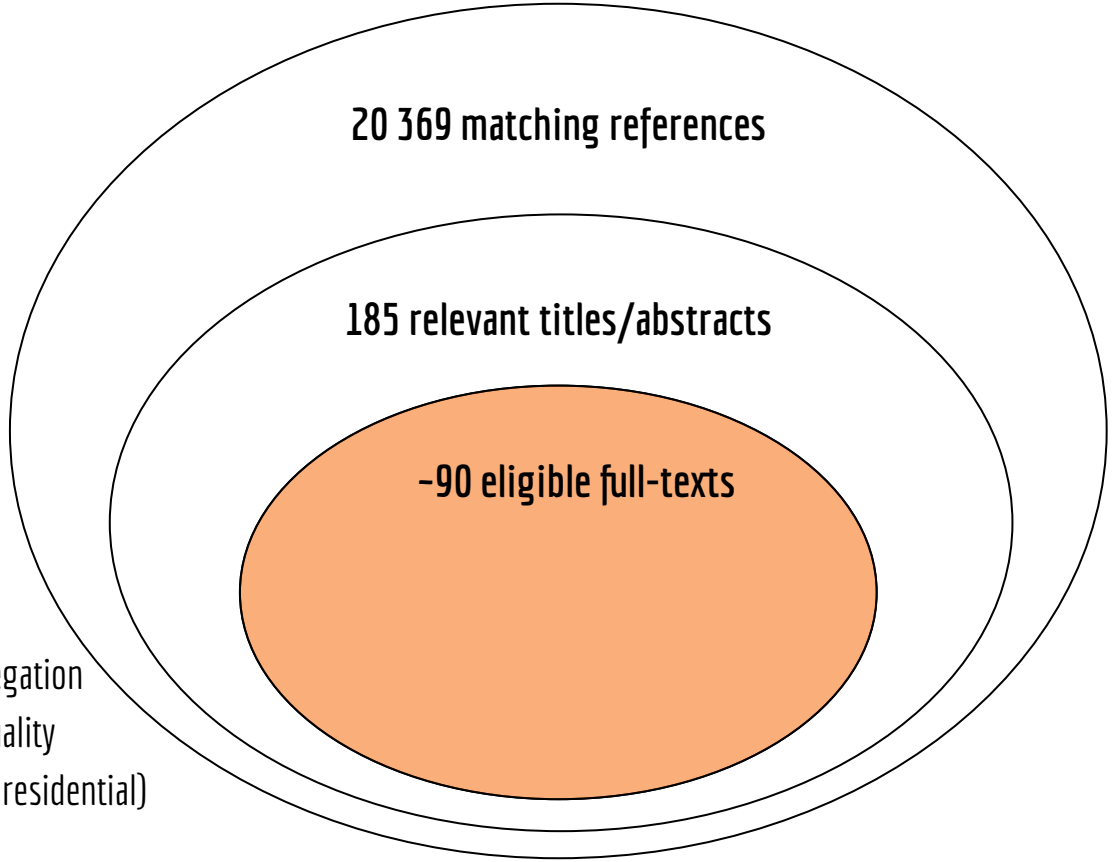
20 369 matching references

Prior: 100 relevant abstract/titles
Screened manually from 5732 references

Active learning models (AS Review Lab)
Round 1.
Additional screening of 704
Identification of 76 relevant abstracts
Round 2.
Additional screening of 100
9 relevant abstracts

Screening Process:

1. Manual screening
2. Active learning
3. Full-text reading for eligibility

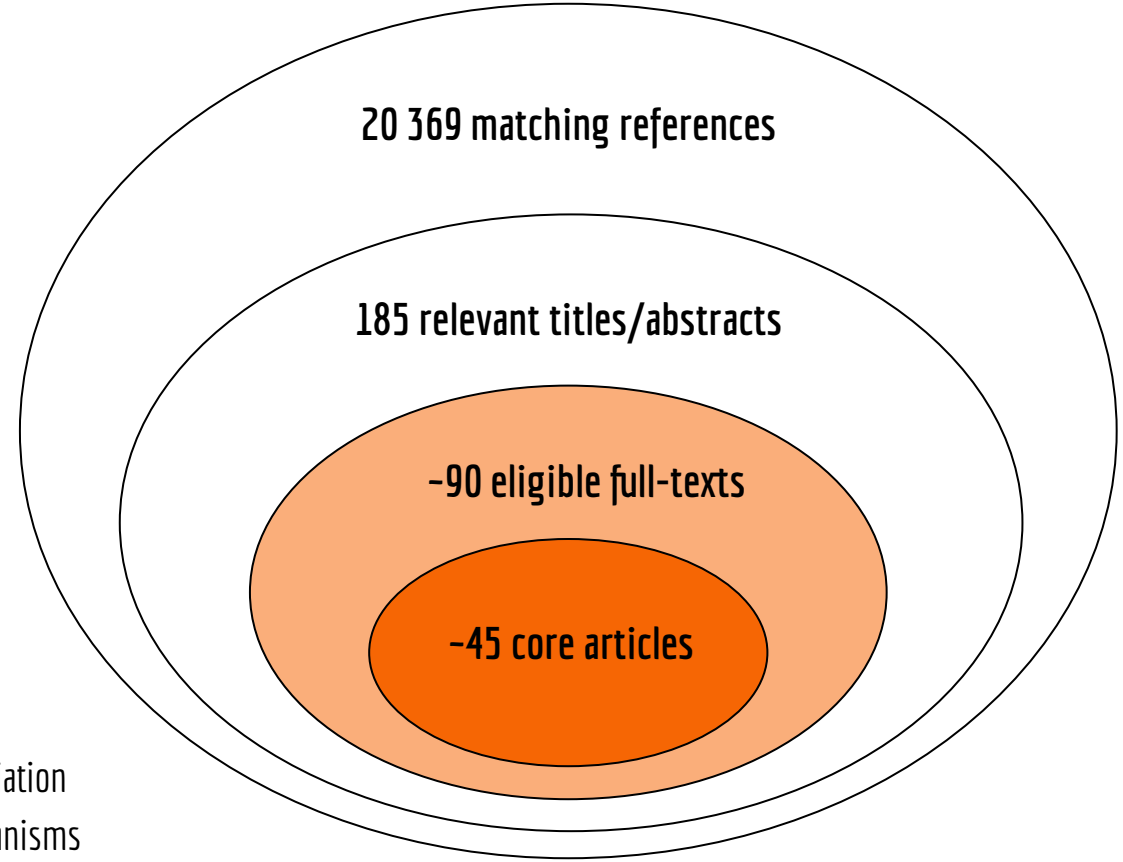


Exclusion criteria

- No mention of economic segregation
- No mention of economic inequality
- Occupational segregation (not residential)
- Unavailable full-text

Screening Process:

1. Manual screening
2. Active learning
3. Full-text reading for eligibility
4. Identification of core articles

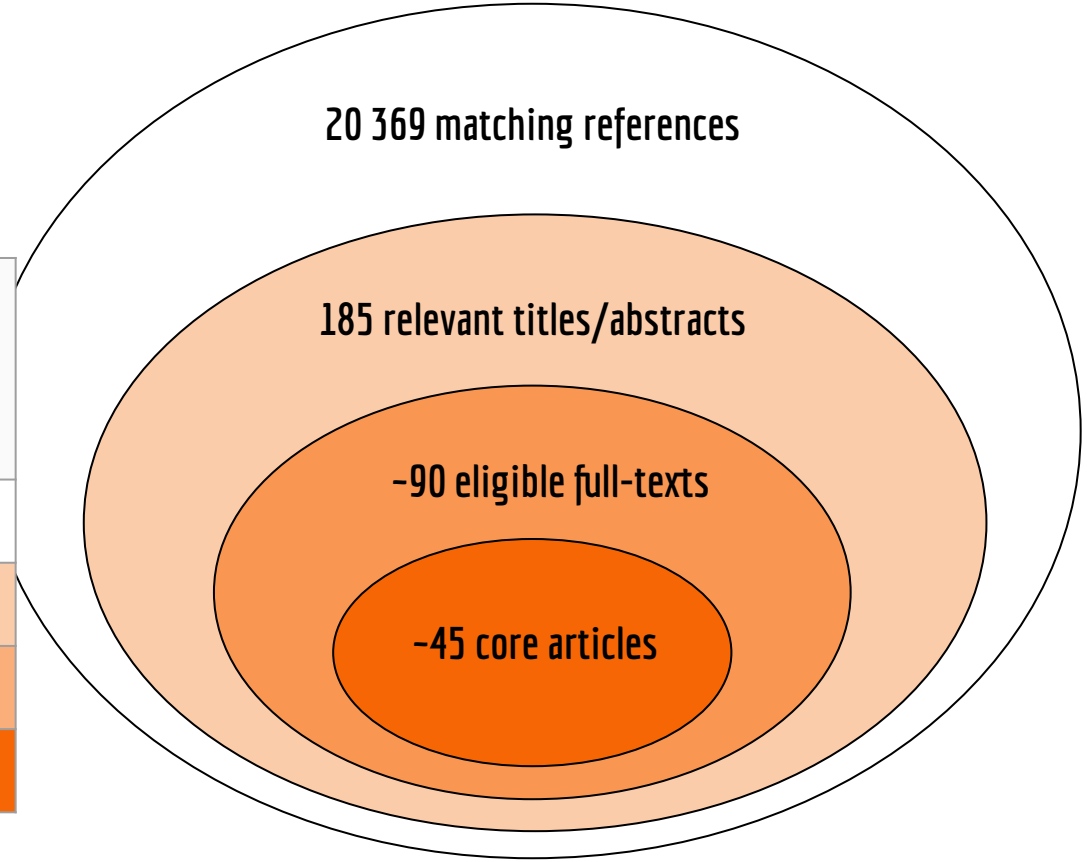


Inclusion criteria

- Empirical estimation of covariation
- Theoretical model with mechanisms

Screening Process:

n	Average year of publi-cation	Average number of refs	Average citations
20184	2015	52	22
95	2016	54	19
45	2015	67	28
45	2016	43	53



SEGUE - Scoping review

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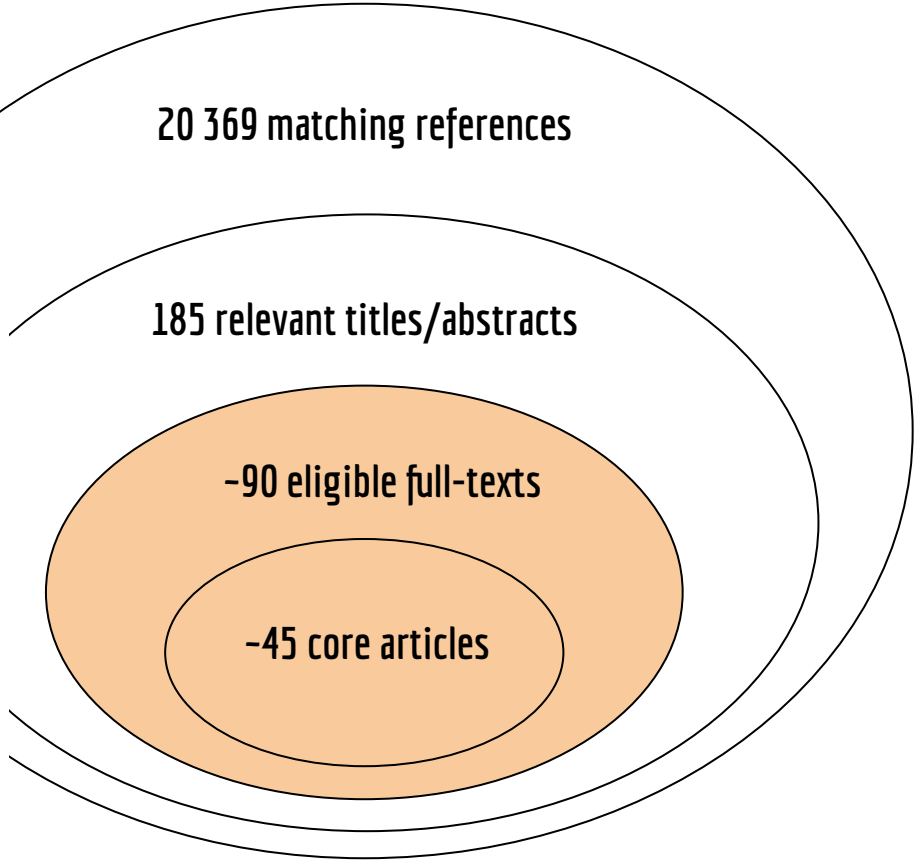


SEGUE - Scoping review

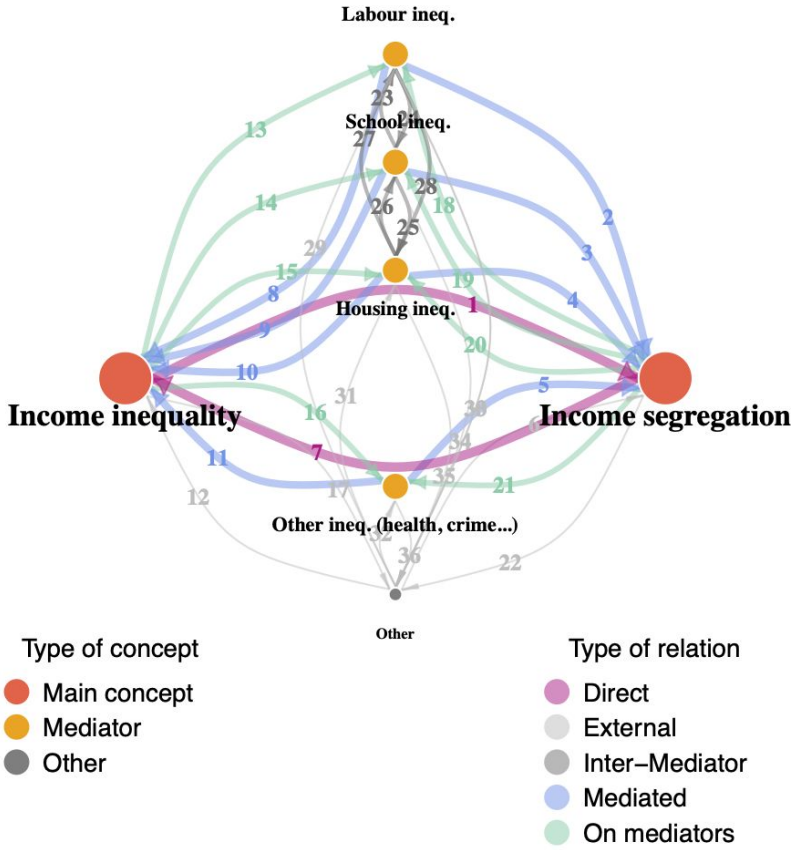
Relationship between economic inequality and segregation =

- **Direct**: higher inequality produce higher income segregation “through the influence of high-income households who tend to be the most segregated”

  Veneri et al., 2021

- **Mediated**: higher inequality creates higher competition on housing market. For instance, exclusion from homeownership is “widespread among young adults with a low income, while more spatially concentrated among those with a high income”

  Hochstenbach & Arundel, 2021



SEGUE - Scoping review

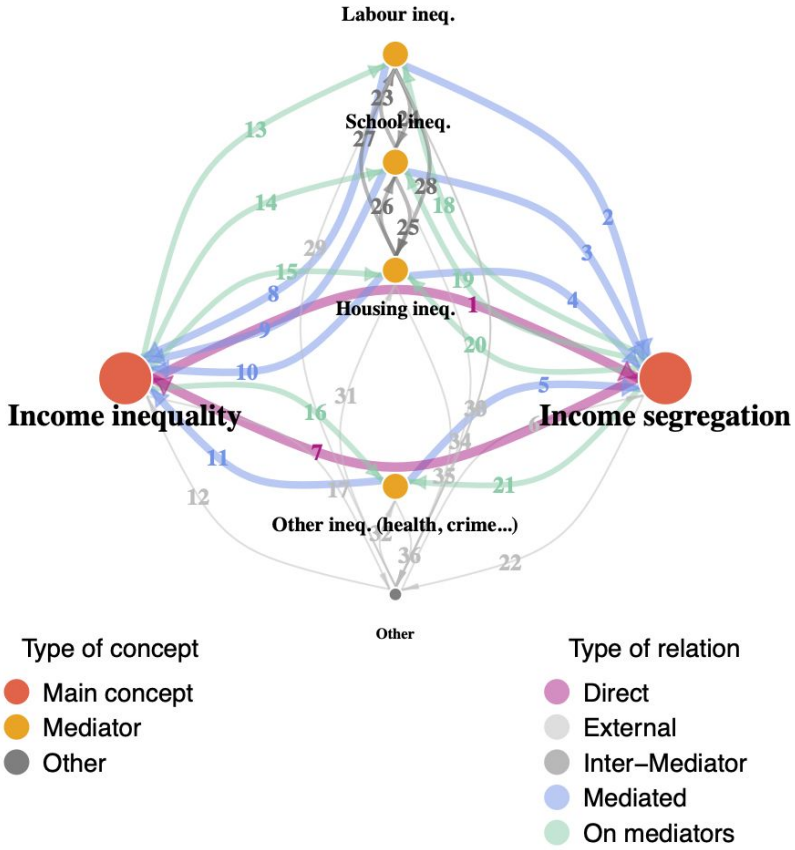
Relationship between economic inequality and segregation =

edu.nl/7bt77

Vevox.app

179-908-291

https://tudelft.display.vevox.com/#/present/475771/AAFKX0SD36QHNXKM0SGR



SEGUE - Scoping review

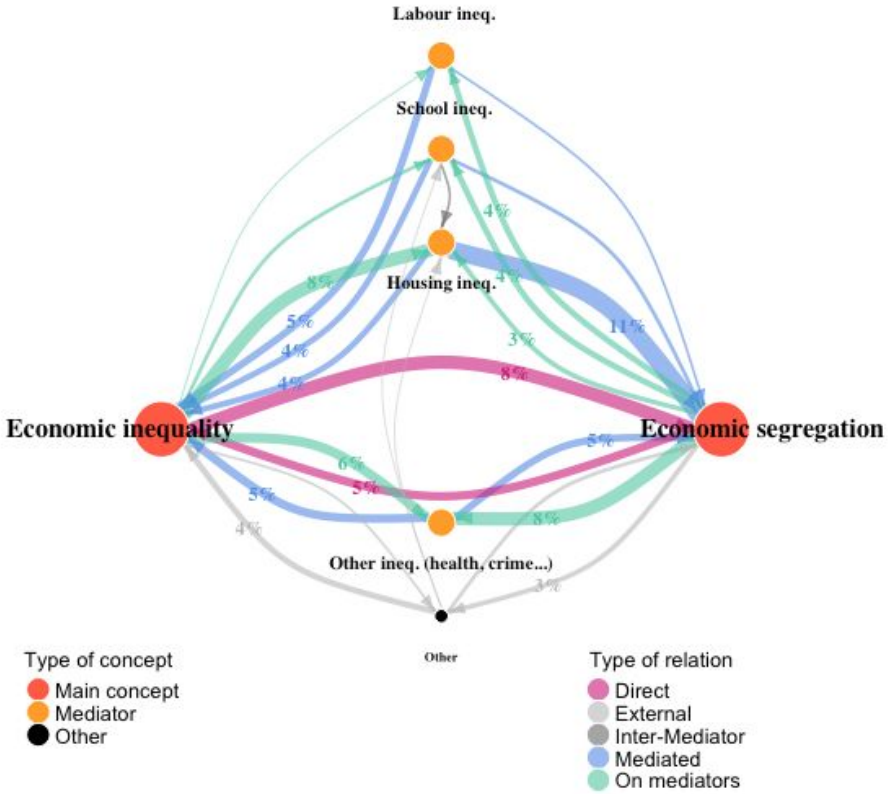
Relationship between economic inequality and segregation =

8 % **Direct** from inequality to segregation
5% **Direct** from segregation to inequality

1st mediator = housing (I›S)
11% from housing inequality to economic segregation
8 % from economic inequality to housing inequality

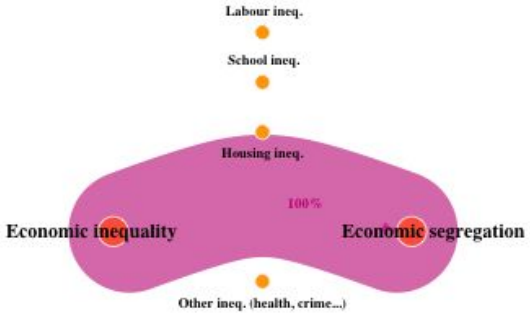
2nd mediator = education and schooling (mostly S›I)
3rd mediator = labour market (mostly S›I)

Other factors: tax system, voting system, crime inequality, Health inequality, discrimination, natural disasters

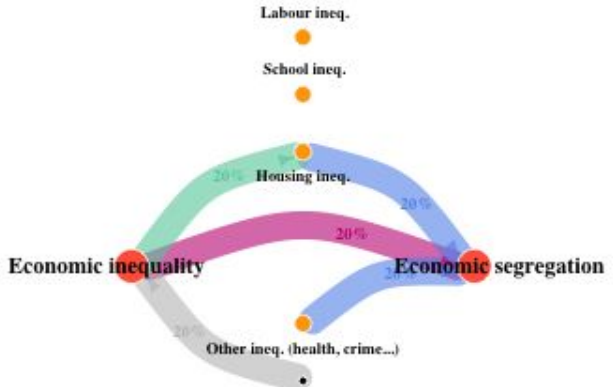


SEGUE - Scoping review

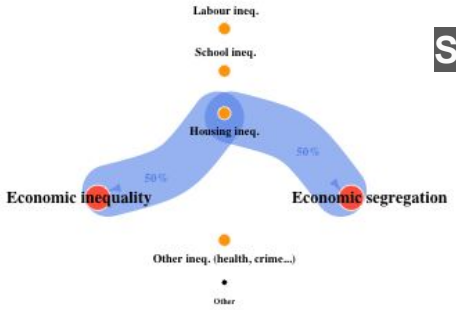
Article = Cauvain, J; Long, G; Whiteley, T; Farcot, E, 2022



Article = Marcinczak, S; Musterd, S; van Ham, M; Tammaru, T, 2016

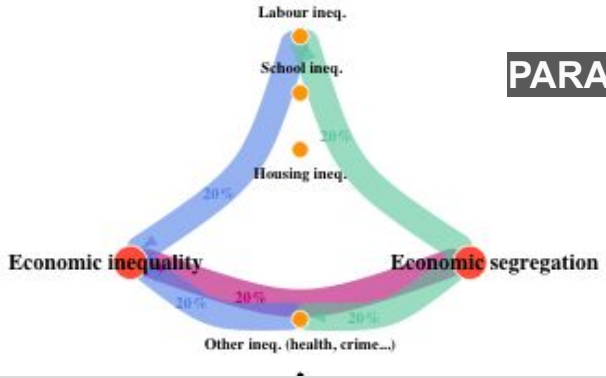


De la Cruz-Viesca, M; Ong, PM; Comandon, A; Darity, WA; Hamilton,



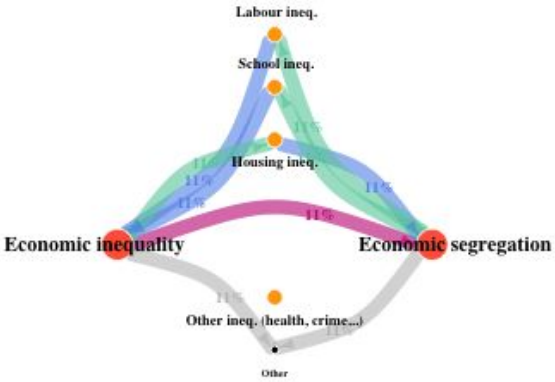
SIMPLE

Article = Galaskiewicz, J; Anderson, KF; Thompson-Dyck, K, 2021

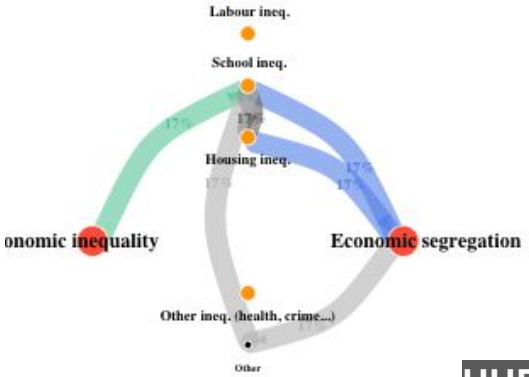


PARALLEL

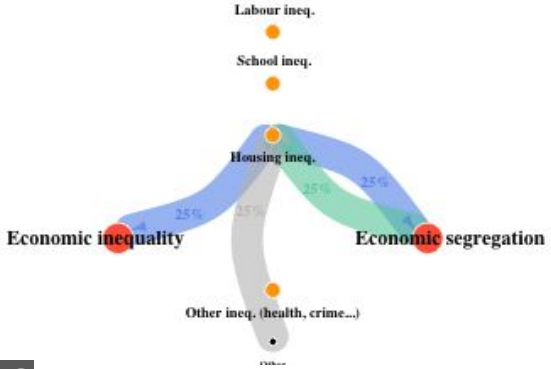
Article = Tuttle, J, 2022



Article = Melindi-Ghidi, P, 2018



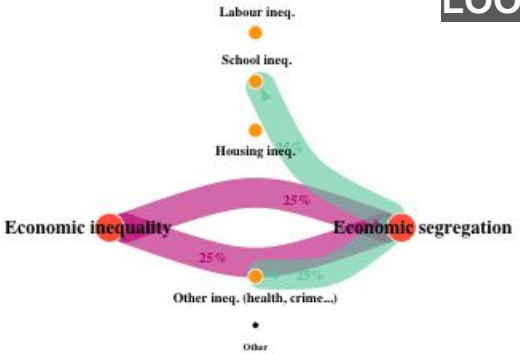
Article = Gordon, C; Bruch, SK, 2020



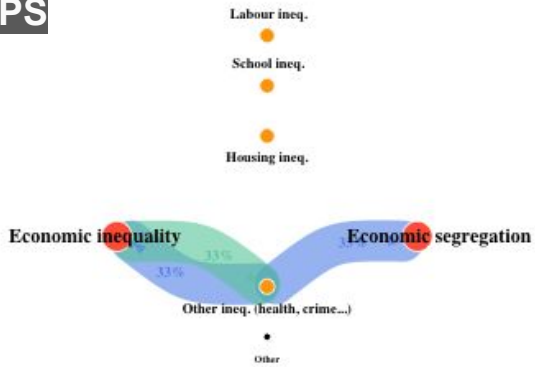
HUBS

Article = Chen, WH; Myles, J; Picot, G, 2012

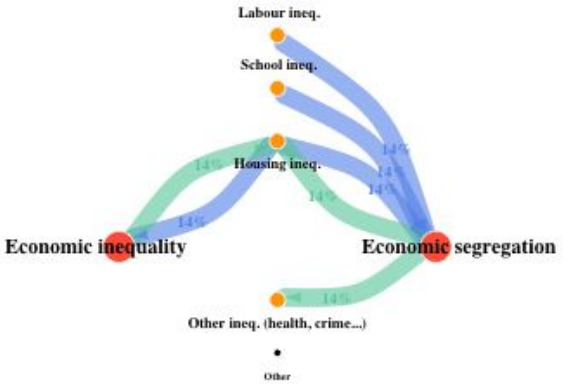
LOOPS



Article = Ananat, EO, 2011



Article = Dwyer, RE, 2007



SEGUE - Scoping Review

Typical study looks at...

- **Income** as economic concept -› 86%
- **Residential** segregation -› 88%
- **Skewed distribution** as inequality -› 61%

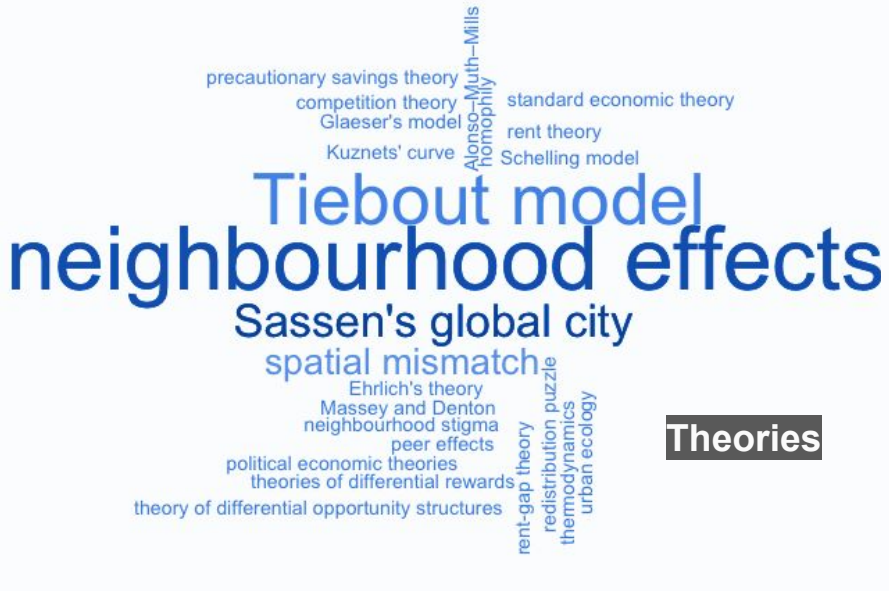
Cluster of papers consider **income gap** between population groups -› 16%

A minority of papers look at **wealth,** sometimes together with income -› 19%

Dominant cases analysed: **USA** (43%), **Sweden** (14%) & **Norway** (8%)

SEGUE - Scoping review

› Few consistent theories



Theories

Actors

› Many different actors

SEGUE - Scoping Review

Dominant **method** of analysis is econometrics/**regression** -› 53%

Theoretical and Methodological variations correlates with **disciplinary traditions**

> Most **economics** and **sociology** papers use **statistical regression/econometrics**

> **Analytical models (8%)** are mostly published in **economics** journals

› They are the main consumers of Tiebout as a theoretical reference

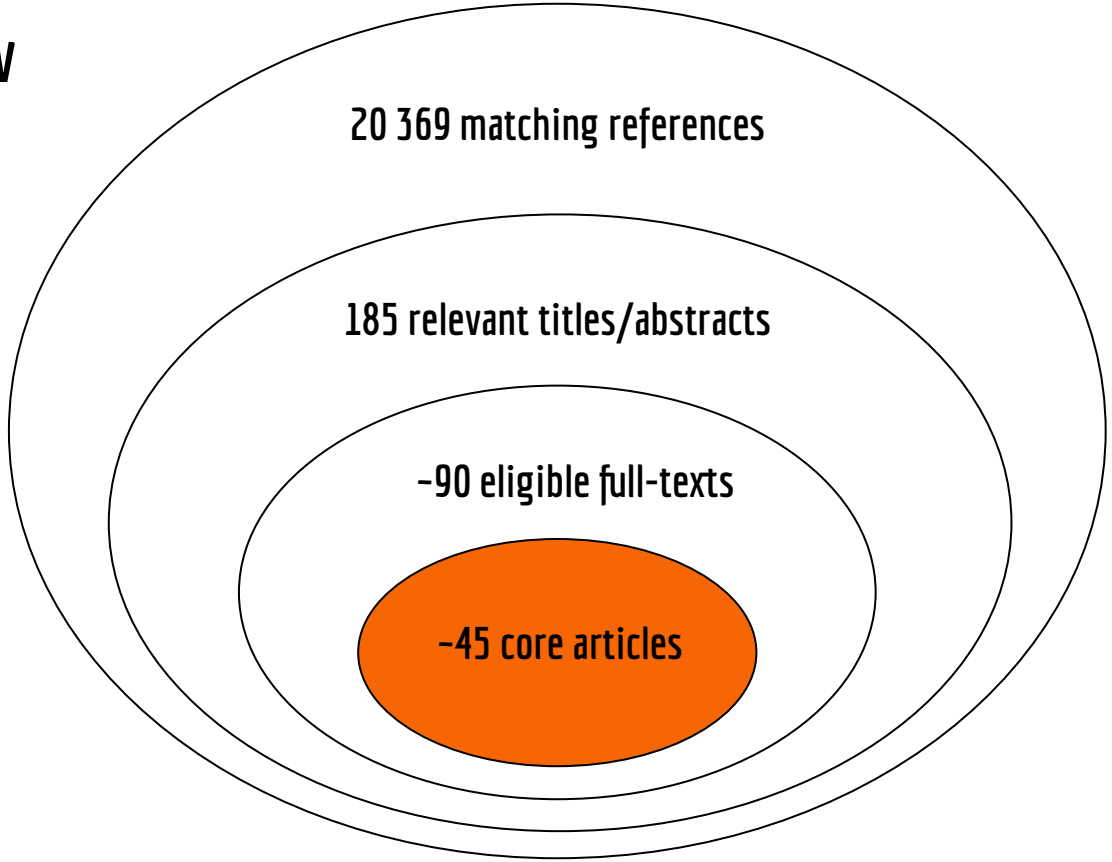
> **Comparative studies (8%)** are dominated by **geography** and **urban/regional studies**

› Same for articles citing Saskia Sassen as a theoretical reference

> **Historical analyses (25%)** dominated by **sociology** and **urban/regional studies**

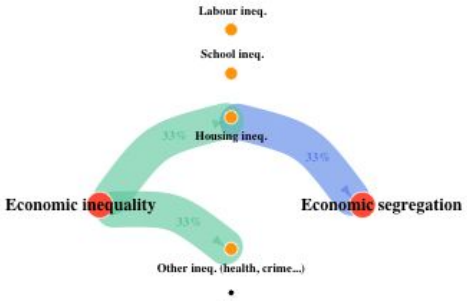
› Same for articles citing neighbourhood effects as a theoretical reference

SEGUE - Core review



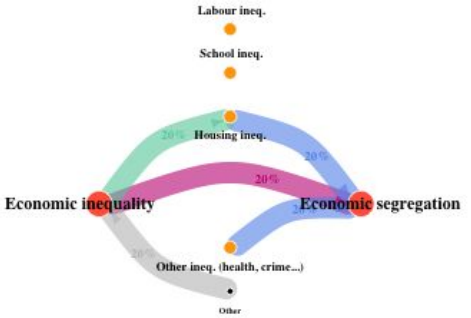
SEGUE - Main results... on causal pathways

Article = Watson, T, 2009

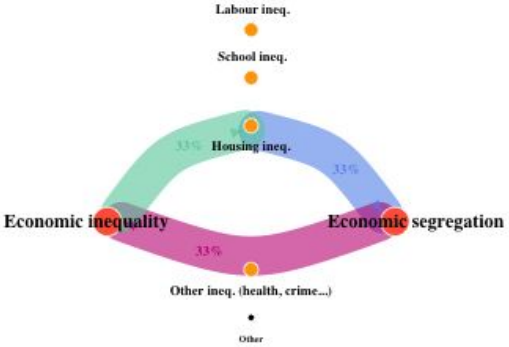


HOUSING AS THE MOST FREQUENT SINGLE COMPLETE PATHWAY

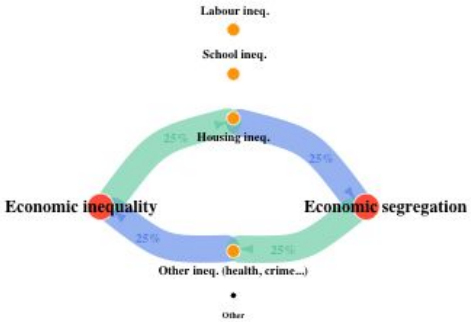
Marcinczak, S; Musterd, S; van Ham, M; Tammaru



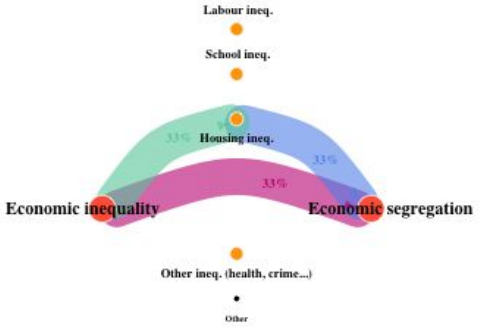
Article = Hochstenbach, C, 2018



Article = Bjorvatn, K; Cappelen, AW, 2003

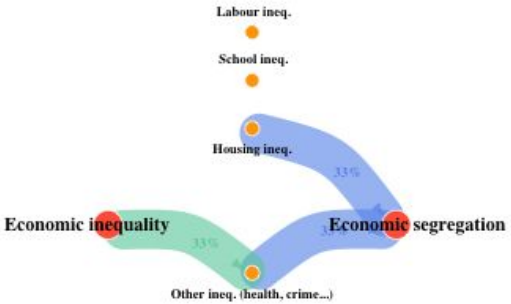


Article = Rodriguez, GM, 2020

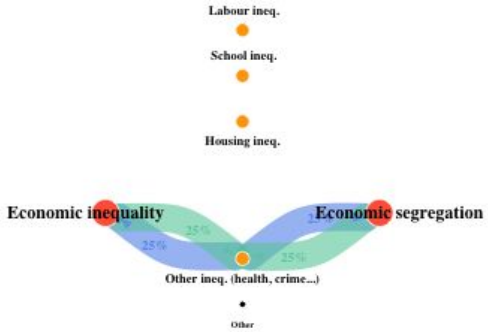


SEGUE - Main results... on causal pathways

Article = Reardon, SF; Bischoff, K, 2011

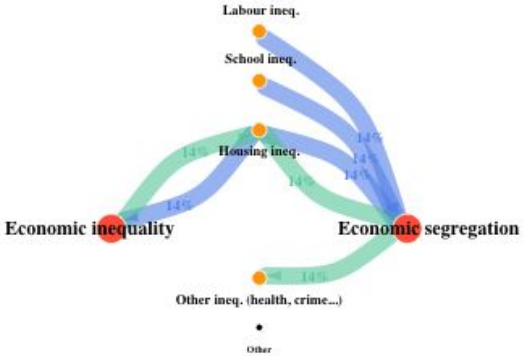


Article = Fernandes, L; Tempere, J, 2020

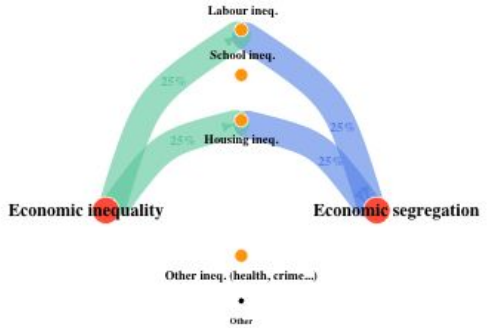


OTHER COMPLETE PATHWAYS (CAN ALSO INCLUDE HOUSING)

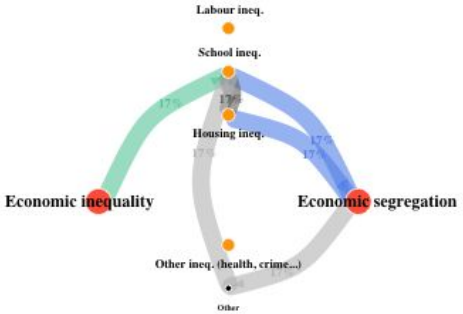
Article = Dwyer, RE, 2007



Tammaru, T; Marcinczak, S; Aunap, R; van Ham, M; Jar

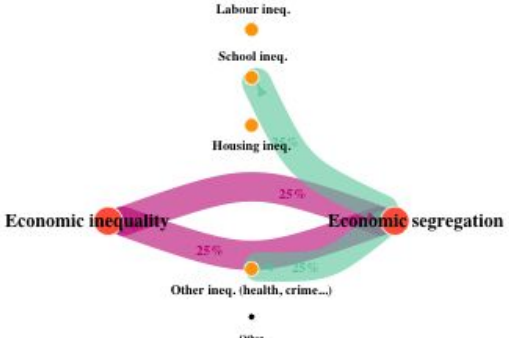


Article = Melindi-Ghidi, P, 2018

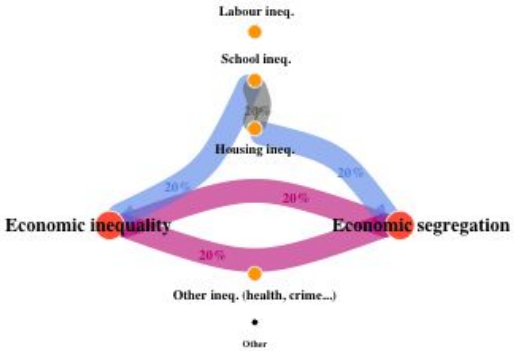


SEGUE - Main results... on causal pathways

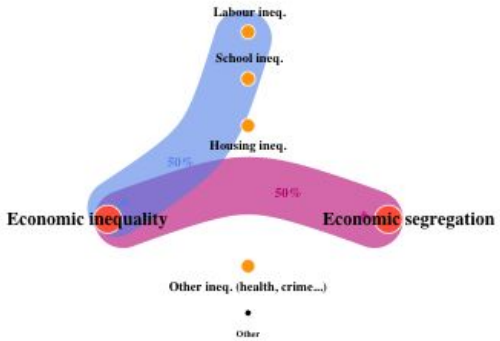
Article = Chen, WH; Myles, J; Picot, G, 2012



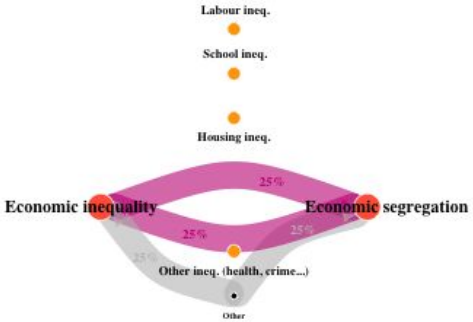
Article = Hu, X; Liang, CY, 2022



Article = Scarpa, S, 2015

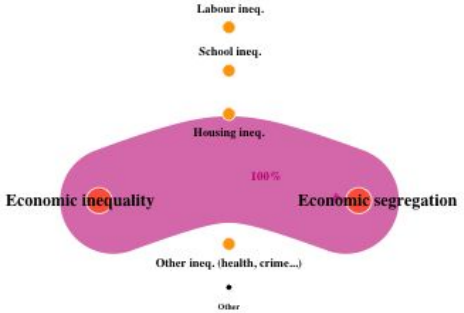


Article = Serna, MP; Mora, FG, 2017



EMPIRICAL PAPERS LACKING THEORETICAL GROUNDING

Article = Cauvain, J; Long, G; Whiteley, T; Farcot, E, 2022



SEGUE - Main results…

… on study design

› Larger **diversity** of locations

Dominated by **register countries:** SE, NO, NL

Time frames ranging from single-year (**11%**) to census-snapshots (**42%**) longitudinal series (**16%**), up to 30 years.

› 37% without temporal definition (theoretical, analytical)

SEGUE - Main results... on study design

Dominant measure of **Inequality** is **Gini coefficient** (53% papers)

› for **35%**, it's the **only measure**

Other measures: income ratio (29%), entropy (12%), dispersion (12%)

› suited for continuous variables in 87% cases

Dominant measure of **Segregation** is (still) **Dissimilarity index** (41% papers)

› for **29%**, it's the **only measure**

Other measures: Neighbourhood sorting index (NSI) (18%), inter-zone inequality (18%), Rank-order information theory index (6%)

› suited for continuous variables in (only) 54% cases

SEGUE - Main conclusions

50% papers do not / cannot conclude significant effects

44% papers conclude on significant effect of inequality on segregation

Examples: Watson, 2009; Reardon & Bischoff, 2011; Chen et al., 2012; Hu & Liang, 2022, Hochstenbach, 2018

6% papers conclude on significant effect of segregation on inequality

Example: Gabrieli, 2016

SEGUE - Main conclusions

44% papers conclude on significant effect of inequality on segregation

"a change of one point in a group's income inequality is associated with a change of roughly half a point in income segregation." Reardon & Bischoff, 2011, p. 1128

USA, survey data 100 metropolitan areas

"A striking finding in the study is that income inequality exerts a weak to moderate impact on income segregation." (Wessel, 2022, p.482)

(0.0454 with one year lag model, 0.112 with five year lag, 0.2266** with ten year lag)

Norway, register, 3 cities

"en el año 2010, los niveles de la SRS y desigualdad del ingreso (Gini) mantienen, en efecto, una correlación positiva y significativa: a mayor desigualdad mayor segregación. El coeficiente r de Pearson entre ambas variables alcanza un valor de 0,497 (significativo al nivel de 0,003) y un coeficiente de regresión R2 de 0,247." (Rodriguez, 2020, p. 14)

Argentina, census, 34 cities

SEGUE - Main conclusions

6% papers conclude on significant effect of segregation on inequality

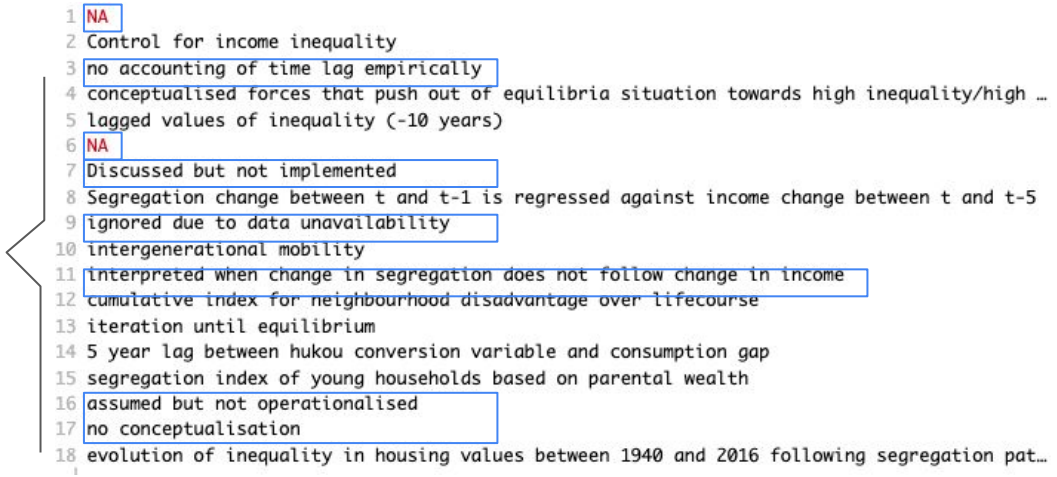
"Moving from no segregation (λ = 0.5) to maximum segregation (λ = 1) would increase the ideal tax rate τ (·, 1) of someone leaving in the poorer community, i.e. some with expected productivity θ1, from 0 to 25%" (Gabrieli, 2016, p.71)

Analytical model

SEGUE - Main problems

- Low **comparability/replication** between studies
- Poor **operationalisation of concepts.** Ex: time lag
  - › ignored in 30% cases mentioned in theory!

Among the ones who assume delayed effect in theory, about half do not operationalise it empirically:



SEGUE - Where does that lead us?

SYSTEMATIC LITERATURE REVIEW

EMPIRICAL ANALYSIS OF SOCIAL › INDIVIDUAL LINK

GENERATIVE MODELLING OF INDIVIDUAL › SOCIAL LINK

SEGUE - Where does that lead us?

How are economic inequality and segregation connected?

› Through which channels / causal path / mechanisms ?
› To which extent do their analysis belong to distinct literature sets?
› What are the consequences of this misalignment in the existing literature?

IC LITERATURE REVIEW

IS OF SOCIAL › INDIVIDUAL LINK

ING OF INDIVIDUAL › SOCIAL LINK

SEGUE

SEGUE - Where does that lead us?

SYSTEMATIC LITERATURE REVIEW

EMPIRICAL ANALYSIS OF SOCIAL › INDIVIDUAL LINK

GENERATIVE MODELLING OF INDIVIDUAL › SOCIAL LINK

SEGUE - Microdata

CBS Microdata allows to follow **longitudinally** and **spatially** (Gbaadresbus):

- **Individuals** - GBAPERSOONTAB
- In **households** (› assortative mating) - GBAHUISHUIDENBUS
- With **economic** characteristics (› income/wealth) - IHI, INHATAB, Vehtab...
- Proxies for other factors:
  - **Housing** : EIGENDOMTAB
  - **Migration**: MIGMOTIEFBUS
  - **Social** status: toeses
  - etc.

SEGUE - Statistical inference

Measuring **economic segregation** as:

- **Spatial** phenomenon with **ordered** variable:
  - › Rank-order information theory index (Reardon, 2009)
  - › Gini index + share of top incomes
- Household income vs. personal income

Javier San Millàn Tejedor

Effect of economic inequality as:

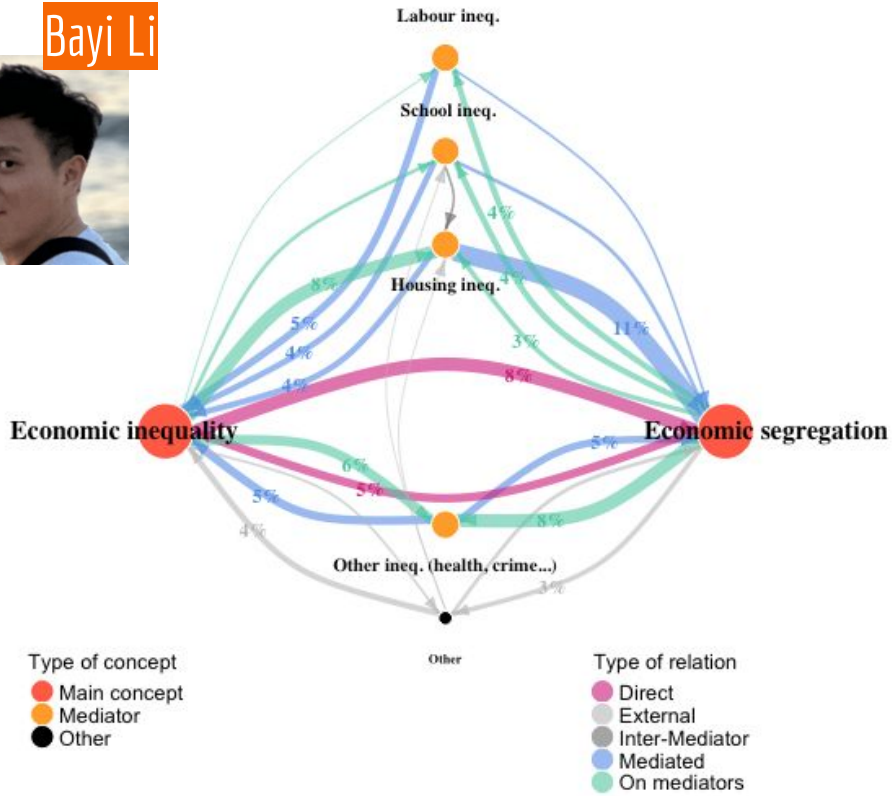
- Potentially **delayed** (10-15year of income data)
- Potentially higher **scale** (region, country)
- **Causal** (path analysis)

SEGUE - ABM

Agents as individuals/actors
Rules translate mechanisms

Simulate residential decision-making, mating strategies, inheritance, peer effects, etc.

...As **blocks** of modular model.



SEGUE - ABM

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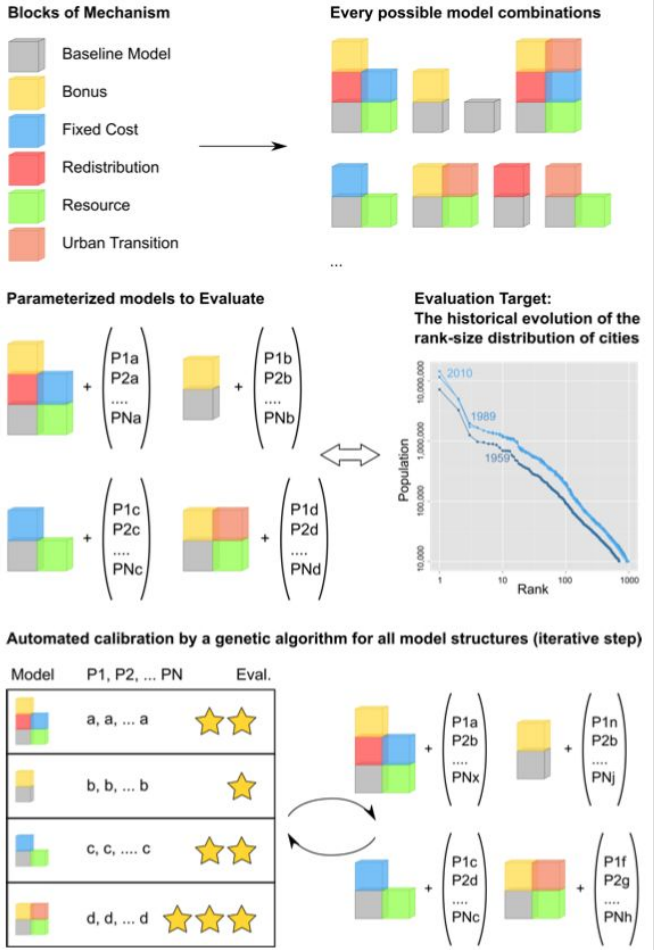

Source: Cottineau et al., 2015

SEGUE - Policy scenarios

Opportunity to compare **policy scenarios at different scales** & assess side effects (at low cost because in silico) of:

- Mixing policies at **local** scale
- **Meso**-level education policies
- **National** taxes on inheritance
- **Infrastructure** and social **housing** projects

SEGUE - Policy scenarios

postdoctoral position

Opportunity to compare **policy scenarios at different scales** & assess side effects (at low cost because in silico) of:

- Mixing policies at **local** scale
- **Meso**-level education policies
- **National** taxes on inheritance
- **Infrastructure** and social **housing** projects

edu.nl/ymdvw

Conclusion

- Economic inequality and spatial segregation are processes connected through multiple channels, at different **scales** of **time** and **space**
- Main causal path in the literature = **housing** market
- Other paths include: **labour** market, **school** and **health** systems, **racial** discrimination, **environmental** injustice, organisation of the **welfare** state, etc.
- No simple solution to reduce it, but also many opportunities to tackle it!

Conclusion

- Economic inequality and spatial segregation are two ways of projecting the same process
- Lack of knowledge due to **disconnected** fields of research
- Need for **systematic** analysis and integration
- Need for **replication** (transparent, cumulative)
- Need for better and more integrated **data infrastructure**

Project in progress...

Clémentine Cottineau
Javier San Millán Tejedor
Bayi Li

Public GitHub repo

PS: We are looking for **postdoctoral researcher**
More info on **erc-segue.nl** and **@ERC_SEGUE**

SEGUE

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European Research Council
Established by the European Commission