Transport and Mobility Segregation in Urban Spaces

Nandini Iyer¹, Prof. Ronaldo Menezes¹,², Dr. Hugo Barbosa¹

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[1] BioComplex Laboratory, Computer Science, University of Exeter, UK
[2] Computer Science, Federal University of Ceará, Brazil
Segregation

The Experience
Segregation

The Experience
Segregation

The Experience

The Estimation

EVENNESS

ISOLATION

EXPOSURE

CLUSTERING
Segregation

Residential

Income & Race
Segregation

Residential

Income & Race

Amenities

visitors’ SES
Segregation

Residential
Income & Race

Public Transport
travellers’ SES

Amenities
visitors’ SES

*assuming uniform usage
Data

Socioeconomic

2020 American Community Survey (Median Household Income)
Index of Concentration at the Extremes (ICE)

\[ \text{ICE}_i = \frac{H_i - L_i}{T_i} \]

for a region \( i \)…

- \( H_i \): high-income population
- \( L_i \): low-income population
- \( T_i \): total population
Residential Segregation

<table>
<thead>
<tr>
<th>City</th>
<th>Income-Race</th>
</tr>
</thead>
<tbody>
<tr>
<td>Houston</td>
<td>0.404***</td>
</tr>
<tr>
<td>Fort Worth</td>
<td>0.419***</td>
</tr>
<tr>
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<td>0.637***</td>
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<tr>
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***p<0.001
Residential Segregation

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<td>0.766***</td>
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</tbody>
</table>

***p<0.001

A)

B)

ICE_{income}  ICE_{race}
Segregation Groups

- Highly segregated, low-income
- Moderately segregated, low-income
- Less segregated
- Moderately segregated, high-income
- Highly segregated, high-income
Segregation Groups

highly segregated, low-income

moderately segregated, low-income

less segregated

moderately segregated, high-income

highly segregated, high-income
Data

Socioeconomic
2020 American Community Survey (Median Household Income)

Mobility
SafeGraph Weekly Patterns (2020-2021)

Amenities
Census Block Groups (CBGs)
Traveler Amenity Segregation (TAS)

Amenity Segregation

ICE_{amenity}
Traveler Amenity Segregation (TAS)

Amenity Segregation

$ICE_{amenity}$
Traveler Amenity Segregation (TAS)

Amenity Segregation

\[ ICE_{\text{amenity}} \]
Traveler Amenity Segregation (TAS)

Amenity Segregation

$ICE_{amenity}$

Traveler Amenity Segregation

TAS
Mobility Segregation

Residential Segregation

<table>
<thead>
<tr>
<th>$\Delta ICE_{TAS}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$ICE_{res}$</td>
</tr>
</tbody>
</table>

San Francisco

Dallas

New Orleans

Residential Segregation

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>low</td>
<td>high</td>
</tr>
</tbody>
</table>

Change in Segregation

(Residential $\rightarrow$ Mobility)

<table>
<thead>
<tr>
<th>-2</th>
<th>+2</th>
</tr>
</thead>
<tbody>
<tr>
<td>decreasing</td>
<td>increasing</td>
</tr>
</tbody>
</table>

$ICE_{res}$
Data

Socioeconomic
2020 American Community Survey (Median Household Income)

$ 
$$
$$$ 
$$$$

Mobility
SafeGraph Weekly Patterns (2020-2021)
Census Block Groups (CBGs)

Transport
OpenMobilityData (GTFS Feeds) & UrbanAccess (Transit Nx)
Transit Nx
Pedestrian Nx
Segregation of Accessible Neighbourhoods

San Francisco

Dallas

New Orleans

Travel Time (min)

ICE_{res}

HS – Highly Segregated
MS – Moderately Segregated
LS – Less Segregated
Lo – Low Income Concentration
Hi – High Income Concentration
Segregation of Accessible Neighbourhoods

San Francisco

- HS-Lo
- MS-Lo
- LS
- MS-Hi
- HS-Hi

Dallas

New Orleans

Travel Time (min)

- $\bar{ICE}_{res}$

Lo – Low Income Concentration
Hi – High Income Concentration

**Legend:**
- HS – Highly Segregated
- MS – Moderately Segregated
- LS – Less Segregated
Segregation of Accessible Neighbourhoods

San Francisco  
- HS-Lo  
- MS-Lo  
- LS  
- MS-Hi  
- HS-Hi  

Dallas  

New Orleans  

Travel Time (min)  
ICE_{res}  

- HS – Highly Segregated  
- MS – Moderately Segregated  
- LS – Less Segregated  
- Lo – Low Income Concentration  
- Hi – High Income Concentration
Segregation of Accessible Neighbourhoods

San Francisco  
Dallas  
New Orleans

Transit Access

<table>
<thead>
<tr>
<th>HS-Lo</th>
<th>MS-Lo</th>
<th>LS</th>
<th>MS-Hi</th>
<th>HS-Hi</th>
</tr>
</thead>
</table>

Driving Access

<table>
<thead>
<tr>
<th>HS-Lo</th>
<th>MS-Lo</th>
<th>LS</th>
<th>MS-Hi</th>
<th>HS-Hi</th>
</tr>
</thead>
</table>

Travel Time (min)

\[ \frac{ICE_{res}}{1.0} \]

HI – High Income Concentration
Lo – Low Income Concentration

HS – Highly Segregated
MS – Moderately Segregated
LS – Less Segregated
Segregation of Accessible Neighbourhoods

San Francisco | Dallas | New Orleans

**Transit Access**

- HS-Lo
- MS-Lo
- LS
- MS-Hi
- HS-Hi

**Driving Access**

- HS-Lo
- MS-Lo
- LS
- MS-Hi
- HS-Hi

**Travel Time (min)**

<table>
<thead>
<tr>
<th>ICE_res</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.0</td>
</tr>
<tr>
<td>-0.5</td>
</tr>
<tr>
<td>0.0</td>
</tr>
<tr>
<td>0.5</td>
</tr>
<tr>
<td>1.0</td>
</tr>
</tbody>
</table>

**Key**

- HS – Highly Segregated
- MS – Moderately Segregated
- LS – Less Segregated
- Lo – Low Income Concentration
- Hi – High Income Concentration
<table>
<thead>
<tr>
<th>Urban Segregation</th>
<th>San Francisco</th>
<th>Dallas</th>
<th>New Orleans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td><img src="#" alt="Graph" /></td>
<td><img src="#" alt="Graph" /></td>
<td><img src="#" alt="Graph" /></td>
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<tr>
<td>Transit</td>
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<tr>
<td>Mobility</td>
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*Low Income* | *High Income*
The Role of Destinations in Urban Segregation

Null Model Comparison

San Francisco  Dallas  New Orleans

Low Income  High Income

Transit Segregation with Empirical vs Uniform Destinations

-2 decreasing  +2 increasing

\( \Delta ICE_{\text{transit}} \)
Take-home Messages

- Mobility data plays a key role for defining **more dynamic forms of segregation**
- Mobility provides a means for **overcoming residential inequalities**
  - **inequalities in transport service** and the amenity landscape pose limitations
- Digital footprints can unveil differences in mobility patterns for various demographics
  - Distinguishing if differences are due to **choice vs. constraint**
\[ \Delta ICE(x, y) = \begin{cases} 
  x - y, & \text{if } x < 0 \\
  -(x - y), & \text{if } x \geq 0
\end{cases} \]

\[
x, y \in \{\text{residential, mobility, transit}\}
\]

**Change in Segregation**

(Dimension \( x \rightarrow \) Dimension \( y \))

-2 → +2

-2: decreasing

+2: increasing

\[ \Delta ICE(x, y) \]
Segregation

The Experience

The Estimation