Land Use
Transport
Access, and
Value

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Access = Land Use × Transport
Accessibility_i = \sum_j (Opportunities_j \times f(Cij))
We can make this as simple or complicated as we like
Which opportunities?
Which cost *(C_{ij})*?
Which function \((f)\)
We don’t need to decide arbitrarily

The market tells us
The only reason to locate anywhere in particular is:

- to possess resources (mining, farming, etc.)
- to be near something(s)
- to be far from something(s)
Since few of us own mines, especially in the city
The value of land is determined by its proximity to everyone and everything else.
Access creates Value
We measure that value by looking at the price of land.
Price per $m^2 = f(\text{Access, Quality, Structures})$

Structures = f(\text{Price})
Hedonic models let us decompose this
e.g. Each additional job within 20 minutes adds $0.25 to price of a single family home on average in the Twin Cities (all else equal).

- additional job = Opportunity$_j$
- within 20 minutes = f(C$_{ij}$)
Cities are positive feedback loops in space
Figure 4: Transportation and the Montgomery County Growth Management System
Transportation and Land Use are Interdependent Shapers of Urban Form
London Borough Names

1: Barking and Dagenham
2: Barnet
3: Bexley
4: Brent
5: Bromley
6: Camden
7: City of London
8: Croydon
9: Ealing
10: Enfield
11: Greenwich
12: Hackney
13: Hammersmith and Fulham
14: Haringey
15: Harrow
16: Havering
17: Hillingdon
18: Hounslow
19: Islington
20: Kensington and Chelsea
21: Kingston upon Thames
22: Lambeth
23: Lewisham
24: Merton
25: Newham
26: Redbridge
27: Richmond upon Thames
28: Southwark
29: Sutton
30: Tower Hamlets
31: Waltham Forest
32: Wandsworth
33: Westminster

Data Sources:
Boundary: UK National Statistics
Projection: British National Grid

Generated By: NEXUS
Background

1836 London and Greenwich Railway
1846 Royal Commission on Railway Termini
1854 Metropolitan Railway chartered
1863 Metropolitan Railway opens
1884 “Circle” closed
1890 City and South London Railway (first tube)

Railways not permitted to be developers except Metropolitan Railway --> Metro-Land

Post-World War II: Greenbelt constrains Underground network
Population Density (persons per km$^2$)
Correlation between Rail Station Density Rank and Population Density Rank

- Increasing misfit between network and land use
- Initial good fit between network and land use

(including City of London) (excluding City of London)
Correlation Between Underground Station Density Rank & Population Density Rank (including City of London) & (excluding City of London)
Network connections to suburbs depopulate core
# Leads and Lags

<table>
<thead>
<tr>
<th>Developed Area</th>
<th>Transport Leads Land Use</th>
<th>Transport Follows Land Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(B) Development densifies in urban area after construction of new transport infrastructure</td>
<td>(A) Constructing new (higher speed) mode in existing urbanized area (e.g. London Transport in early years)</td>
</tr>
</tbody>
</table>

| Undeveloped Area | (C) Constructing new (higher speed) mode in greenfields, to promote development | Still waiting ... |
Model

$$D_{i,t} = D_{i,t-1} \varphi + W D_{t-1} \rho + X_{i,t-1} \beta + W X_{t-1} \chi + Z_i \zeta + T_{t-1} \psi$$

Where:

- \(D_{i,t}\) is the density (population, Underground station, surface rail station) of area \(i\) at time \(t\),
- \(W\) is a matrix of spatial interaction weights,
- \(X_{i,t-1}\) is a vector of variables that change with both time and area,
- \(Z_i\) is a vector of area-specific variables that do not change with time,
- \(T_{t-1}\) is a vector of time-specific variables that do not change with area,
- \(\varphi, \rho, \beta, \psi, \chi\) and \(\zeta\) are parameters to be estimated.
Modeling Issues

- Stratification: Core vs. Periphery
- Time Period: 1841 (1871) - 2001
- Lag Structure (10 years)
- Log Transformation (tested)
- Neighbor Definitions (neighbor nearest London)
- Statistical Techniques (cross-section/time series (OLS/PWR with PCSE))
<table>
<thead>
<tr>
<th></th>
<th>Log(PopDens)</th>
<th>Surface Rail Station Density</th>
<th>Underground Density</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Periphery</td>
<td>Core</td>
<td>Periphery</td>
</tr>
<tr>
<td>Surface Density (L10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underground Density (L10)</td>
<td></td>
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<tr>
<td>∆Population Density (L10)</td>
<td></td>
<td></td>
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<tr>
<td>∆Regional Surface Rail Stations (L10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>∆Regional Underground Stations (L10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log(Population Density) (L10)</td>
<td>+S</td>
<td>+S</td>
<td></td>
</tr>
<tr>
<td>Log(Population Density) (L20)</td>
<td>-S</td>
<td>-S</td>
<td></td>
</tr>
<tr>
<td>∆Regional Population</td>
<td>+S</td>
<td>+S</td>
<td></td>
</tr>
<tr>
<td>∆Surface Rail Density (L10)</td>
<td>+S</td>
<td>NS</td>
<td></td>
</tr>
<tr>
<td>∆Underground Density (L10)</td>
<td>+S</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>∆Neighbor Surface Rail Density (L10)</td>
<td>+S</td>
<td>+S</td>
<td>NS</td>
</tr>
<tr>
<td>∆Neighbor Underground Density (L10)</td>
<td>-S</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Neighbor Log(Population Density) (L10)</td>
<td>+S</td>
<td>-S</td>
<td>NS</td>
</tr>
<tr>
<td>∆Neighbor Population Density (L10)</td>
<td></td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>Distance to City of London</td>
<td>NS</td>
<td>+S</td>
<td>-S</td>
</tr>
<tr>
<td>North of River Thames</td>
<td>NS</td>
<td></td>
<td>NS</td>
</tr>
<tr>
<td>Constant</td>
<td>NS</td>
<td></td>
<td>NS</td>
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+S - positive and statistically significant at 10% level or better
-S - negative and statistically significant at 10% level or better
NS - not statistically significant at 10% level or better
Qualitative Model

Rail first inter-city: connects outside -> in

Underground first connects termini, then other points in developed area, and finally connects to new suburbs: inside -> out

Has a decentralizing effect for residences, lowering population density in center, increasing it in suburbs.

Other factors; entrepreneurs, construction costs, South vs. North (income, rail embeddedness, geology, competition, south already more local than north (London in south of England))
In London

Rail causes (precedes and is positively and statistically related to) suburban residential development. *Induced Demand*

Development causes (precedes and is positively and statistically related to) rail infrastructure. *Induced Supply*
In Minnesota

Transportation creates access.

Access creates value.

Landowners receive value.

Insufficient funds for capital investment in transportation.

Landowners receive less value.
Value can be used to fund Transport
Twin Cities Streetcars
Closing the feedback loop in Minnesota

Transportation creates access.
Access creates value.
Landowners receive value.
Fraction of value is captured by infrastructure funding organizations to fund transportation.
Landowners receive more value.
## Models of Provision

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<tr>
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<th>Government built</th>
<th>Developer Built</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publicly Funded</td>
<td>Traditional “free roads”, gas tax</td>
<td>“free roads” with shadow tolls, gas tax</td>
</tr>
<tr>
<td>Developer Funded</td>
<td>Impact fees, special assessment, exactions, proffers land value tax</td>
<td>Road clubs, joint development</td>
</tr>
<tr>
<td>User Funded</td>
<td>Toll roads</td>
<td>Private toll roads (PPP)</td>
</tr>
</tbody>
</table>
Questions?

Planning for Place and Plexus

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The Transportation Experience

Access to Destinations

nexus.umn.edu