Use of Accessibility Measures in Analysis of Wider Economic Impacts of Transportation Improvements:
An Analytic Review

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ACCESSIBILITY – WHAT IS IT?

No single dominant definition:
1. Broadest Measure - Effective Density
2. Market Access
   - labor
   - other market
3. Knowledge spillovers
   - Inter-industry and intra-industry
4. Labor market pooling: “Thick networks” of specialization – network size matters and is non-linear

Is there a way to measure the general accessibility of a region?
ACCESSIBILITY – MEASUREMENT

Effective market size
Zone to zone travel time
Zone to zone generalized cost
Transportation outcomes
  • congestion reduction
  • transportation capacity
  • Travel time benefits
Access to major activity centers
What does enhanced accessibility effect?

• Directly
  – Knowledge Spillovers
  – Labor market access
  – Labor market matching
  – Producer access to intermediate inputs
  – Producer / retailer access to intermediate and final consumer markets
  – Consumer access to retail opportunities
  – Consumer access to services, culture, education, etc.

• Indirectly
  – Labor productivity
  – Industry output
  – Labor force participation
  – Wage levels
Modeling Approaches

1. “Full” gravity model (constrained, unconstrained)
2. “Modified” gravity model
   - Gravity models do not posit relationships between accessibility and productivity
3. Agglomeration models
4. Labor market access models
   1. access within a given commute time
   2. transportation capacity as a direct growth limitation to central cities – “jobs through a straw”
5. Labor market participation
Key Question

• Question: Does any accessibility model/method address inter-regional competition?
GRAVITY MODELS
BASICS

- Allocation of a fixed growth total – NO NET CHANGE ACROSS THE REGION
- Every zone is ultimately assigned an attraction weight
- Strength of attraction of a given zone to all other zones a function of impedance, opportunities, impedance parameter
- Zone to zone impedances – generalized cost
- Socioeconomic data by zone represent opportunities
- Attraction parameters – the strength of the “gravitational attraction -- are calibrated mathematically
- Structurally similar to 4 step travel demand models
- Can include land use characteristics
- **Does not posit a relationship between accessibility and economic productivity of a zone**
EXAMPLE APPLICATIONS

• Many, including many attempts to construct integrated transportation and land use models
• Recent is application to the proposed Illiana Corridor highway project
“MODIFIED” GRAVITY MODEL

• A lower cost alternative to full calibration
• Assumes that the current zonal distributions of activity reflect accessibility, impedance factors, as well as all other market and land use factors
• Thus, changes in accessibility in a given zone relative to all other zones can be used directly to redistribute activities - if composite accessibility score in a given zone increases by a given percent, activities also increase by the same percentage in that zone
EXAMPLE APPLICATION

- Hirschman and Henderson, Rochester NY
AGGLOMERATION MODELS:

- Pioneered in UK, Daniel Graham and others
- Currently utilized in the UK for transportation investment evaluation, via its WebTag methodology guidelines
- Explicitly posits a relationship between accessibility, effective density, and economic productivity
- Accessibility improvements result in increased effective density, which in turn yield changes in “GDP” of producers in an area
- Focus is on the industry structure of a zone
- Inter industry and intra industry relationships captured primarily through formal trip interactions
- Assumes that benefits from increased effective density decay fairly rapidly with effective distance – implicit then is the idea that labor market effects are most determinative
EXAMPLE APPLICATION

• Application examples: no formal applications in US I could find, but PB PRISM test is underway to incorporate into its modeling framework

• Some early results applied to the Illiana Project – major new highway connecting Chicago area to Northern Indiana
Agglomeration Impacts

- Weighted Generalized Costs
- Effective Densities
- Sector & Zone Agglomeration
- Convert to Employment
- Zone Agglomeration Impacts GDP & Employment
- Total Impacts
Step 1: Weighted Generalized Costs

Calculate for each Zone Pairing, Build and No Build.
Zones: Study Area, Southern Corridor, Other CMAP
Base Year and Forecast Year
Step 2: Effective Density Calculations

Study Area to Study Area; Manufacturing, Build

Total Employment
(Avg. Generalized Costs)^Decay Parameter

Study Area to Southern Corridor; Manufacturing, Build

Total Employment
(Avg. Generalized Costs)^Decay Parameter

Study Area to Other CMAP Area; Manufacturing, Build

Total Employment
(Avg. Generalized Costs)^Decay Parameter

Study Area, Manufacturing Effective Density Build

Calculate for each Sector-Zone Pairing, Build and No Build.
Sectors: Manufacturing, Construction, Consumer Services, Business Services
Zones: Study Area, Southern Corridor, Other CMAP
Base Year and Forecast Year
Step 3: Sector/Zone Agglomeration Impact

Calculate for each Sector-Zone Pairing.
Sectors: Manufacturing, Construction, Consumer Services, Business Services
Zones: Study Area, Southern Corridor, Other CMAP
Base Year and Forecast Year
Step 3a: Interpolation

Calculate for each Sector-Zone Pairing.
Sectors: Manufacturing, Construction, Consumer Services, Business Services
Zones: Study Area, Southern Corridor, Other CMAP
Step 4: Converting to Employment

Calculate for each Sector-Zone Pairing.
Sectors: Manufacturing, Construction, Consumer Services, Business Services
Zones: Study Area, Southern Corridor, Other CMAP
All Analysis Years
Step 4a: Zone Agglomeration GDP Impacts

Study Area Agglomeration GDP Impacts

- Study Area Business Services Agglomeration Impact
- Study Area Construction Agglomeration Impact
- Study Area Manufacturing Agglomeration Impact
- Study Area Consumer Services Agglomeration Impact

Calculate for each Zone
Zones: Study Area, Southern Corridor, Other CMAP
Step 4b: Zone Agglomeration Employment Impacts

Calculate for each Zone
Zones: Study Area, Southern Corridor, Other CMAP
Step 5: Total Impacts

- Study Area Employment Impacts
- Southern Corridor Employment Impacts
- Other CMAP Employment Impacts

Total Agglomeration Employment Impacts

- Study Area GDP Impacts
- Southern Corridor GDP Impacts
- Other CMAP GDP Impacts

Total Agglomeration GDP Impacts
LABOR MARKET MODELS OF ACCESSIBILITY
COMMUTER SHED - BOUNDARIES

- Accessibility improvement = larger effective labor market size
- Commute time boundaries established and the size of the labor market expands when travel times decrease
EXAMPLE APPLICATION

- Hartgen et al, Gridlock and Growth: The Effect of Traffic Congestion on Regional Economic Performance, 2009
- Asks how improving accessibility to different parts of a region would effect economic performance
- Five key destination zones are the focus: CBD, major mall, large suburbs, university, airport.
- Accessibility measured as the size of labor force within 25 minute drive time – normalized for metro size
- Study correlates accessibility across a number of metro areas with GDP per capita, for different access nodes
- Finds positive elasticities of GDP per capita with respect to accessibility ranging from 0.1 or more.
- Finds higher elasticities outside of CBD, with suburban job centers assuming greater importance in many metro areas.

- Basic relational structure
  - Labor productivity = f(labor market accessibility)
  - Labor productivity proxy is wages
  - Accessibility measured as number of jobs within a given drive time; controlled also for industry structure (which effects wages)

- Key findings
- Doubling employment density within close drive time (e.g., <20 minutes, can increase wages by more than 4%
- Impacts decay rapidly and in non-linear fashion with time-distance parameter
TRANSPORTATION CAPACITY LIMITATION

“Jobs through a straw”

Example: New York City Strategic Investment Study
LABOR MARKET PARTICIPATION RATES


• Accessibility of a zone measured statistically by five components: weighted monetary cost of travel (weights are mode share, travel time, time of departure, car ownership, income level
• Labor supply function estimated simultaneously with accessibility function
• Findings: on average, a 10% improvement in measured accessibility will stimulate about a 1% increase in new labor market entries, in low income areas and for selected occupations only
• Overall, accessibility positively effects labor supply but for selected occupations only
• Retail, wholesale and service occupations show little impact from improved accessibility
Where we are?

- Not close to a “general theory” of accessibility
- Definitions vary from application to application
- Relationships vary – different aspects of accessibility are thought to impact economic performance in different ways
- Model purposes and outcomes vary
Applicability of Accessibility to Economic Analysis

• Accessibility measures may be most suitable tool for comparing the long term wider economic impacts of transportation improvements

• Accessibility indices provide a convenient ranking and scoring measure, in the absence of complete modeling analysis

• Can utilize relatively simple to compute measures, avoiding in many cases the complexity of model calibration