EFFECTIVE DENSITY MARKET ACCESS TOOLKIT: TOOL APPLICATIONS AND USAGE WHITE PAPER

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INTRODUCTION

This white paper provides additional background material on the application and usage of the Effective Density Market Access Tool for planning and evaluation. The document supplements and provides clarifications to the original tool guidance, which can be found on the SHRP C11 website.

The following topics are addressed:

- The key components comprising the market access measure.
- The use of different activity variables to assess various types of market access.
- The types of projects that can be examined using access measures.
- The uses of access measures within a planning agency’s business process.
- Different sources and causal factors underlying agglomeration economies, and how these relate to the selection of appropriate measures.

MARKET ACCESS MEASURES AND THEIR USE

The Effective Density Market Access Tool was designed both to enable estimates of productivity impacts from a change in the transportation network, and as a more general tool for assessing changes in accessibility, irrespective of their productivity implications. To calculate productivity impacts requires the use of the Effective Density measure and employment by place of work as the activity variable (following the methodology developed by Daniel Graham for the UK Department of Transport). The more general potential access measure (which does not include the scale factor approximating own-zone accessibility) can be used as an indicator of access, but is not currently recommended as an input to productivity calculations.

Both measures incorporate three factors that together provide a dynamic way of exploring changes in market access: 1) The weight or activity variable used for evaluation, 2) The corresponding decay factor, and 3) The impedance or transport cost matrix that provides the vital link between the transportation system itself and the origins and destinations (markets) that it connects (Figure 1). The activity variable represents the economic activities or opportunities for interaction to which access is provided by the transportation system. The impedance matrix


2 Please refer to the Accessibility Analysis Addendum document posted on the SHRP C11 website for more details.
represents the costs incurred accessing said activities. The decay factor captures the diminishing influence of activities, as travel time or cost increases.

**Figure 1 Measuring Incremental Change of a Region/Zone/Area in Access to Markets**

![Diagram](image)

**MEASURING DIFFERENT TYPES OF MARKET ACCESS**

Markets can be differentiated by both activity type and the user group that primarily requires access to the economic activities. Markets accessed by personal and commuting travel (most often via transit or automobile) include consumer sites such as shopping centers and places of work (among others). Market access for business travelers is enabled by linkages to work sites. Markets pertinent for freight movement and industries are sites where intermediate inputs, raw materials and labor are sourced from, as well as sites where goods are either distributed, transferred and/or sold. Essentially, the markets served by transportation in a region can be defined along the entire spectrum or value chain from production, through distribution and consumption (see Figure 2).

Table 1 demonstrates how given the appropriate impedance measures (associated with a trip type/purpose), different activity units can be used to measure access to a variety of markets applicable to passengers and/or freight movements.
Share my insights on the importance of transportation in the economy.

**Source:** Weisdorf et al. NCHRP Report 786. Transportation Research Board. Available at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_786.pdf

**Figure 2 Transportation Role in the Economy**

![Transportation Roles Diagram](image)

**Table 1 Destination Markets Defined by Activity Measure**

<table>
<thead>
<tr>
<th>Activity Measure</th>
<th>Market Accessed</th>
<th>Transportation Network User (e.g. Trip Type/Purpose)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment by place of residence or population</td>
<td>Available workforce / labor</td>
<td>Commuters</td>
</tr>
<tr>
<td>Firms / businesses of a specific type / related firms (Measured in terms of number of firms, or total employment by place of work*)</td>
<td>Buyers and/or suppliers</td>
<td>Commuters, business travelers, and goods movement</td>
</tr>
<tr>
<td>Firms / businesses of a specific type / related firms (Measured in terms of number of firms, or total employment by place of work*)</td>
<td>Other firms (for collaboration)</td>
<td></td>
</tr>
<tr>
<td>Households</td>
<td>Consumer markets</td>
<td>Commuters/Passengers</td>
</tr>
<tr>
<td>Sales (or other measure of economic activity)</td>
<td>Point of sale to final consumer (e.g. retail markets)</td>
<td>Goods movement to final demand</td>
</tr>
<tr>
<td>Landed activity at nodes (e.g. enplanements at airports / shipments at marine ports)</td>
<td>Port, airport</td>
<td>Passenger travel, goods movement</td>
</tr>
<tr>
<td>Logistics employment</td>
<td>Inland Port (Also a proxy for import/ export markets)</td>
<td>Goods movement</td>
</tr>
</tbody>
</table>

*Note: Agglomeration and productivity implications are more typically associated with scale of productive activity (as represented by total employment) than actual number of plants, firms, or businesses. However, the latter may still be used to as an access measure.*
When using employment as an activity variable, it is important to differentiate between employment by place of work, which is a measure of business activity in a zone, and employment by place of residence, which proxies for the working population or available labor pool. The spatial divergence of residential centers and employment centers is particularly important at smaller levels of geography (i.e. if zones are defined as Traffic Analysis Zones, as compared to entire counties).

In some cases, one may wish to measure access to specialized labor, rather than simply looking at the effect of access to all workers in a region. For this purpose, Drucker and Feser have developed a specialized measure (which we here call the Regional Labor Pool or RLP) in which the activity units are shares of occupational employment:

\[
RLP_{cj} = \sum_k \left( \frac{O_{kx}}{O_{kT}} \right) \left( \frac{1}{d_{cj}} \right)
\]

where \( j \) is the study industry, \( k \) indexes counties, \( c \) is the target establishment’s county, \( O_{kx} \) is county \( k \)’s residual workforce in the top 15 occupations employed by industry \( x \) nationally, \( O_{kT} \) is county \( k \)’s total workforce, and \( d_{cj} \) is the distance (or time impedance) between the county \( c \) county \( j \). Drucker and Feser apply a threshold such that the distance is input as zero beyond the expected size of a reasonable labor market (e.g. up to 75 miles). This effectively zeroes out the contribution of specialized labor in zones beyond the selected threshold.

The second C11 market access tool, the Fixed Threshold: Specialized Labor Market Access Tool provides an alternative threshold based measure. The fixed threshold tool calculates a cumulative opportunity type small scale measure that is the preferred measure of access when there are only a few key nodes in the impact area. Examples include locations of key employment centers (nodes) in a study area, distribution and delivery sites, and ports/inland ports.

**TYPES OF PROJECTS THAT MIGHT BE EXAMINED USING ACCESS MEASURES**

The toolkit is designed to measure changes in accessibility resulting from a change in transport costs. These costs can either be uni-modal or multi-modal, depending on the type of project being assessed. The selection of the study area should be based on the pertinent potential or existing O-D pairs. The selection of activity variable will reflect the type of access altered by the project (Table 1). The following are types of projects that might be assessed using access measures included in the toolkit:

1. **A highway or transit project that addresses passenger movement.** Such a project could be expected to improve accessibility between consumers and retail establishments, between workers and the businesses that employ them, or between employees at different

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4 For example, the Oak Ridge National Laboratory has developed highway-rail skim matrices between counties in the US. See: [http://cta.ornl.gov/transnet/SkimTree.htm](http://cta.ornl.gov/transnet/SkimTree.htm)
firms. From the firm’s perspective, improved connections have agglomerative implications, based on market size effects and knowledge-sharing.

2. **A highway project that addresses freight movement.** Such as project could be expected to reduce freight transport costs thus improving accessibility for firms to inputs (sourced from the location of relevant suppliers) and to markets (represented by the location of other firms that are downstream buyers, or by the location of retail centers). These access improvements also have agglomerative implications.

3. **A highway or transit project that addresses flows to and from gateway nodes such as ports or airports.** Certain projects improve access to and from nodes at which a user can transfer to another mode that connects to destinations/origins outside a region. These nodes include locations such as ports and airports. Because models do not usually consider all modes simultaneously, or connections that extend beyond a study region, access to a gateway node can be considered a proxy for a) access to import and export markets for firms moving goods, b) access to potential tourists, for firms that serve visitors to a region, or c) access to business partners outside a region. While conceptually similar to the market access concepts addressed by the Effective Density Market Access toolkit, the SHRP C11 Intermodal Connectivity Tool addresses this type of project more directly (also available on the SHRP C11 website).

**USES OF ACCESS MEASURES WITHIN THE PLANNING PROCESS**

The toolkit was developed to aid planners and analysts in a number of endeavors, beyond the calculation of productivity benefits based on changes in transportation system performance. Possible additional uses of accessibility measures calculated with the tool include:

1. Proactively, to help design transportation projects to maximize the potential relationship between transportation and economic development.

2. In exploration of the expected impacts of planned projects on one or more types of market access. This exploration can help support prioritization efforts, or provide supporting evidence when making the case for a project.

3. As a performance measure, to be used in benchmarking studies to assess connectivity and access to different markets in line with strategic goals, or to be used for spatial and temporal comparisons.5 There is significant empirical work that suggests that these measures may be useful performance measures.

4. In evaluative ex-post studies of transportation projects as explanatory variables subject to further empirical testing. With the development of historical transport network and impedance data, access measures may be developed and used as independent variables in

model estimation to isolate the role of market access in creating measured economic impacts.

PRODUCTIVITY GAINS FROM DIVERSITY AND SPECIALIZATION: DIFFERENTIATING BEHAVIORAL DRIVERS OF AGGLOMERATION

The effective density and productivity estimation methodology is designed to approximate external economies of scale derived from transport investments and associated productivity gains. “External” means that an increase in industry activity outside a firm results in productivity gains for the target firm. This class of impacts are referred to as agglomeration effects. Prior research on agglomeration has sought to differentiate between effects that are associated with a diversity of economic activity or inter-industry connections, and those that related more closely to the idea of specialization or intra-industry connections. Marshall’s seminal work on agglomeration pointed to the benefits of clustering businesses within the same industry, based on input sharing, labor pooling, and knowledge spillovers. These types of benefits are sometimes referred to as localization or Marshallian agglomeration economies. Others use the term localization more broadly to refer to business productivity benefits that occur from any localized clustering based on similar or complementary firm interactions. Since Marshall, others have acknowledged that there are also agglomeration economies available from greater concentrations of economic activities, across more than one industry. Jane Jacobs argued that diversity within cities leads to greater innovation, thus leading to the term “Jacobian diversification externalities.” In a slightly different vein, others have found that there are returns from greater market size, so that access to a broader and more diverse labor, supplier, or customer market can increase firm productivity. This is often referred to as an urbanization effect.

In principle, different activity measures can be used to explore the various sources and behavioral drivers of agglomeration economies. For example, one might use total population or employment to examine the benefits of returns to market scale across industries (including economies from diversity), while using specialized sector employment to explore knowledge spillovers within an industry. However, to actually estimate the agglomeration benefits of these different agglomerative forces requires both a decay parameter and a productivity elasticity estimated in an empirical study using the chosen activity variable (and controlling for other effects). There is still relatively limited empirical work on untangling the productivity responses from different underlying causes of agglomeration. Overlapping forces of urbanization and localization can “occur simultaneously in dense urban areas,” thus making them harder to


8 Transportation Research Board. NCHRP Report 786. Assessing Productivity Impacts of Transportation Investments.
Untangle. In addition, the untangling of causes will require modeling specifications that differentiate responses by industry sector. As explained by Edward Feser: “The focus on aggregate industries may be acceptable when the concern is with the role of urban and industry size on productivity… However, disentangling the influence of various sources of agglomeration economies requires the analysis of more narrowly defined sectors for which valid and defensible measures of specialized suppliers, labour pools and knowledge spillovers can be developed.”

Untangling the different underlying sources of agglomeration would also provide additional information on how the various causes attenuate with distance. There is evidence in the research literature that intra-industry and knowledge spillover effects decay quite rapidly with distance while effects based on diversity are more varied and do not decay as rapidly. Further research on the decay factor as it relates to sourcing decisions would also be helpful.

At present, estimation of productivity benefits within the toolkit is limited to using aggregate activity measures such as total employment. Nevertheless, the tool can be used to explore access to a variety of activity types (e.g. specialized employment), thus providing information on the potential drivers of agglomerative benefits, even if dollar value productivity impacts are not available. For regions with a high degree of economic specialization, performing differentiated analyses may prove particularly important. Absent sector-specific productivity elasticities, the analyst can at least measure accessibility for the inputs to which dominant industries in their region are most sensitive. For example, if a region is dominated by the automobile industry, one could specifically measure the effect of a project on access to parts suppliers. Similarly, if a region is dominated by the service sector, skilled labor may be a more important input to consider.

Future empirical work is undoubtedly needed to continue to refine our understanding and predictive modeling capabilities. Nevertheless, the Effective Density Market Access Tool provides a useful diagnostic approach that enables the consideration of market access effects not captured when measuring traditional traveler benefits such as savings in time or cost.

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