



Transit and job accessibility: an empirical study of access to competitive clusters and regional growth strategies for enhancing transit accessibility



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ARTICLE INFO

Available online 13 March 2014

Keywords:

Transit
Accessibility
Industry clusters
Scenario analysis

ABSTRACT

This study looks at questions of regional transit job accessibility in an urban area making significant changes to its transit system. The study area is the Minneapolis–St. Paul (MSP) metropolitan region, which also has several initiatives to build/expand different *competitive economic clusters*—export-oriented, interconnected firms in the region. We analyze current transit accessibility to the existing clusters in the region and find significant sector to sector differences that highlight both the poor level of transit access to some economic sectors and the need of automobile ownership to be able to reliably access these jobs. Further, given changes that are being made to the transit system, we conduct scenario analyses and ask which population and employment growth patterns the region should follow to maximize transit accessibility for its residents. The results suggest that a strategy which focuses growth along transitways, particularly the growth of jobs along transitway corridors, will achieve the best regional transit accessibility gains. The research helps to bridge the separate bodies of literature on competitive clusters and transit, tests alternative land use scenarios to enhance accessibility, and investigates the importance of transit for jobs in regional competitive clusters.

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1. Introduction

The idea of using policy to build or strengthen what are called *competitive economic clusters* in regional economies has received increasing attention since the 1990s. Clusters refer to "...a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by commonalities and complementarities" (Porter, 2000). They are seen as drivers of regional economies; they pay higher wages relative to the general economy, have faster wage growth, higher levels of creativity, and bring positive externalities to their regions (Porter, 2003). Many areas have pursued strategies to attract, create or expand these interacting sectors with an eye toward advancing their economic growth and competitiveness. The Minneapolis–St. Paul Metropolitan area, for example, has several initiatives currently underway that either work to expand clusters or further the interests of cluster industries.¹

While the successful development of clusters is a win for a region, unequal access to jobs in these industries can have direct implications on who benefits from these successes. Discussions of cluster development however seldom address the question of equitable transportation access from the perspective of residents. Specifically, if cluster development is not informed by regional access considerations, those who are car-less or other disadvantaged groups can end up with significantly diminished opportunities in these industries. Coordinating cluster development efforts with efforts to concentrate these industries near transit accessible locations may help lessen the potential access gap that can be created when clusters are promoted without regional multimodal accessibility in mind.

This study looks at the questions of job accessibility by transit in a regional context where a transit system is undergoing several changes. The study area is the Minneapolis–St. Paul (MSP) metropolitan region. Given the advantages of cluster industries, the study starts by identifying the region's competitive clusters. We evaluate how jobs in general and cluster jobs in particular are served under the existing transit system. Further, given changes that are being made to the transit system, we conduct scenario analyses and ask which population and employment growth patterns the region should follow to maximize transit accessibility

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¹ Some examples include the MSP Regional Cluster Initiative, BioBusiness Alliance, High Technology Council, Robotics Alley, and Defense Alliance.

for its residents. We draw implications from the scenario analyses that are broadly applicable to other regions as well. This research helps to bridge the separate bodies of literature on competitive clusters and transit, tests alternative urban growth scenarios to enhance accessibility, and investigates the importance of transit for jobs in regional competitive clusters.

The relationship between transit and jobs has been a ripe area of policy and study. Transit has been suggested as one of the key solutions to problems of spatial mismatch between job opportunities and residences of disadvantaged population groups. Policies at the federal level have tried to address the needs of families moving from welfare to work through programs such as the Job Access and Reverse Commute (JARC) program, which funded fixed-route and demand responsive services that connect those seeking opportunities with jobs. The evolving urban growth patterns which have come to favor suburban environments also present challenges for connecting workers and jobs and this has reinforced the need for a private vehicle to ensure access to broader metropolitan opportunities. Policy efforts to attract and grow regional economies (such as the cluster approaches) offer opportunities for planning futures that can better address the worker–job connection through integrated land use and economic development initiatives. By influencing location decisions one can ensure better transit access choices, especially for disadvantaged and car-less households to sectors whose locations have thus far favored the automobile.

While research on transit and jobs rarely focuses on jobs in competitive clusters – in part due to the close association of clusters to high skilled workers – the concept of clusters can be made expansive to incorporate the variety of sectors that are linked through supply chains, knowledge sharing, and industrial class to the core industries of a region. Our approach is to focus on the regions' most competitive sectors while adopting a broad grouping definition for clusters that includes both export-oriented as well as local-serving sectors based on their existing trading relationships. Analyses that are based on all job categories are also performed.

The paper is organized as follows. The next section reviews the existing literature on jobs, workers and transit. That is followed in [Section 3](#) by a discussion of the local context in the Twin Cities region which discusses the changes the transit system is undergoing and identifies the regional competitive clusters. In [Section 4](#) we look at the location of cluster jobs and their current transit accessibility. That is followed in [Section 5](#) by a future scenario analysis to look at how accessibility may be enhanced in the region through land use and housing/population location strategies given a changing transit system. [Section 6](#) provides a summary and discussion of the findings.

2. Literature review

The literature on transit and jobs has largely evolved into three separate—yet related—bodies of research: one focuses on how transit services may provide workers' access to jobs, another on how transit may influence business location choice, and the third on how spatial distribution of jobs may influence transit use and transit system planning. Key findings from these bodies of research are summarized below.

2.1. Transit and workers' access to jobs

Whether public transit is an important mode of transportation getting people to work is an arguable question in the literature. Workers in the U.S. predominately (almost 90% of the workers) travel to work in privately owned vehicles, and the proportion of

workers who usually commute by transit has remained at about 5% since 1983 ([Santos et al., 2011](#)). However, public transit proponents have argued that these statistics could be misleading as they do not account for the fact that many locations in the U.S. offer no public transit services and thereby do not supply a public transit travel choice for workers ([Belzer et al., 2011](#); [Tomer et al., 2011](#)). In places with enhanced transit systems such as the cities in the San Francisco Bay Area, transit's share of the commute trip ranges from 10% to 40%—significantly higher than the national average of 5%. More generally, transit ridership is typically higher in urban regions with a strong CBD and more centralized development patterns ([Hendrickson, 1986](#); [Mierzejewski and Ball, 1990](#); [Meyer and Gomez-Ibanez, 1981](#)).

Public transit is also recognized as a much more important mode of transportation for low-income workers who do not have access to reliable private cars. Many researchers agree that public transit serves a key component in addressing poverty, unemployment, and uneven access to job opportunities ([Blumenberg and Manville, 2004](#); [Fan, 2012](#); [Rast, 2004](#); [Sen et al., 1999](#)). However, in reviewing the literature on transit's impact on employment outcomes of disadvantaged groups, only a few empirical studies find positive effects of transit accessibility on employment outcomes ([Kawabata, 2003](#); [Ong and Houston, 2002](#)), and many find little or no association between transit availability/quality and employment participation ([Bania et al., 2008](#); [Cervero et al., 2002](#); [Sanchez, 1999](#); [Sanchez et al., 2004](#); [Thakuriah and Metaxatos, 2000](#)).

When explaining the inconsistent evidence on transit's impact on employment, some researchers cite difficulties in determining the effectiveness of transit programs for influencing employment outcomes of disadvantaged groups, including no accepted performance measures and the inability to control for intervening factors affecting employability ([Sanchez, 2008](#)). Further, as low-wage workers benefit from increased job access, many purchase automobiles, ending their transit-dependency and increasing the difficulty of assessing the employment outcome impacts of transit systems ([Sanchez et al., 2004](#)). Many researchers also concede that inconsistencies in the literature partially reflect the ineffectiveness of U.S. transit services in meeting the needs of disadvantaged groups for job access ([Blumenberg and Manville, 2004](#); [Fan, 2012](#)).

2.2. Employers' demand for transit

Businesses in different industries prioritize different location factors including the consideration of commute-sheds and labor supply ([Holl, 2006](#)). [Laulajainen and Stafford \(1995\)](#) suggest that employers outside New York- or Los Angeles-scale megaregions cannot reasonably hope to draw on an area beyond 45–60 min travel time for non-executive positions. In the Chicago metropolitan area, [Kawamura \(2001\)](#) finds that firms' average distance to freeway interchanges decreased from 1981 to 1999, and that distances between firm locations in the central city and rail transit stations decreased as well over the same period. In Madrid, [Mejia-Dorantes et al. \(2012\)](#) find that the opening of a new rail transit line connecting previously poorly served suburbs led businesses to quickly reorient their location choices towards the new transit stations, in spite of a previous non-transit oriented built form.

It has been suggested that a high-quality transit network can allow employers to benefit from the clustering and agglomeration of people and businesses ([Tomer et al., 2011](#)). Such benefits, although widely discussed in the literature, have rarely been empirically demonstrated. A related body of empirical research exists focusing on businesses' "willingness to pay" for locations near transit, using changes in commercial property values near transit as a proxy measure of employers' demand for transit. Much research has found premiums for commercial property in rail transit station

areas (Cervero et al., 2002; Debrezion et al., 2007; Fejarang, 1993; Ko and Cao, 2013; Nelson, 1999; Weinberger, 2001). A notable exception is a study of the San Diego area by Ryan (2005), which finds no premium for light rail access and a significant premium for highway access (Ryan, 2005). Overall, the evidence appears to suggest that employers perceive at least some benefits from locating near high-quality regional transit options.

2.3. *Employment locations and transit planning*

The connection between employment and transit is bidirectional. While transit plays a role in business location choice, employment locations can affect transit planning. This is especially true in the U.S. as 59% of all transit ridership is employment-related trips (Neff and Pham, 2007). Empirical evidence has linked weak transit ridership in U.S. cities to the suburbanization of jobs and the decline of traditional central business districts (Brown and Thompson, 2008; Cervero and Landis, 1992; Cervero and Wu, 1998). Additionally, in the field of urban form and travel behavior, extensive and consistent evidence shows that employment density and workplace proximity to transit are at least as important as residential patterns for achieving transportation goals and boosting transit ridership (Chan and Miranda-Moreno, 2013; Frank and Pivo, 1994; Guerra and Cervero, 2011; Kuby et al., 2004; Pushkarev et al., 1977).

The solid evidence on the relationship between employment patterns and transit ridership has led to various policy and planning recommendations to grow transit share. One stream of proposals focuses on shaping land use patterns and creating areas of significant employment near transit to encourage transit use (Barnes, 2005; Belzer et al., 2011; Cervero, 2006; Kolko, 2011). These proposals move beyond the traditional transit-oriented development (TOD) concept which emphasizes housing development with mixed-use retail development, and acknowledge the importance of commercial real estate development including retail, office, and industrial land uses in TOD planning.

Besides policy proposals promoting job creation and economic development near transit, there are also proposals promoting alternative transit route structures to serve dispersed employment locations. Considerations of such proposals were discussed as early as in 1977 by Thompson (1977). Transit systems in most U.S. urban regions were historically designed in a radial, hub and spoke pattern, connecting inner-city areas and more distant suburbs with a single central business district (CBD) of the region. Job suburbanization has made this transit system design no longer effective in serving work commute trips. While land use planners could promote economic development in central cities to re-centralize jobs and make the old transit system work (Bernick, 1997), a counter argument is that transit system effectiveness can be increased if transit routes are restructured to serve dispersed employment locations and provide a multi-destinational service orientation (Brown and Thompson, 2012; Thompson and Matoff, 2003). Note that the idea to use a multi-destinational approach to serve more dispersed employment locations does not mean services to all locations but locations with relatively dense employment regardless of being urban or suburban. Regarding these proposals, researchers have found supportive evidence in recent years that systems with a multi-destination service orientation perform better than radial systems that focus on a single CBD, including higher ridership, higher levels of service effectiveness, and better cost efficiency (Brown and Thompson, 2012, 2008; Thompson and Brown, 2006; Thompson and Matoff, 2003).

Overall the literature review above suggests relevant connections between transit and jobs. Although some of the connections are admittedly arguable, others are well-established including the impact of transit on job accessibility of disadvantaged groups, the

importance of transit services to the business community, as well as the importance of employment density and workplace proximity to transit in sustaining transit ridership. Although insightful, existing studies in the field has focused on jobs in general, with a few exceptions that focus on jobs of different wage groups or skill levels. However, we largely do not know whether the connections of transit to workers and businesses differ by industrial sectors. Some groups of jobs may be more critical to a region's economy than others and enabling broader transportation access to disadvantaged groups to these sectors can be an important policy consideration. Knowing transit's relationship to these jobs will help planners and policy makers strengthen these connections and foster integrated efforts in transit planning and economic development.

3. The local context

3.1. *Transit system changes*

Data from the American Community Survey (ACS) show that the Minneapolis–St. Paul MSA ranks among the top 15 regions in terms of public transportation mode share (McKenzi, 2010) despite the region having a concentration of jobs in central cities that is much lower than that at the national level. In 2000, only 29.9% of all workers living in the MSA worked inside a central city as compared to 46.9% nationally (United States Census Bureau, 2001). The 2005–2009 5-year ACS estimate for public transportation use among workers 16 years and over is at 4.4% for the MSA, 9.0% for the city of St. Paul and 13.5% for the city of Minneapolis.

The region has pursued significant long-range transit planning activities since the late 1990s to further strengthen the system. Recent changes to the area's transit system include the 9-year old Hiawatha light rail line, the Northstar commuter rail line, the phased implementation of bus rapid transit (BRT) on Cedar Avenue and I-35W, the Central Corridor light rail line that is now under construction, and several other transitways in planning and development stages. By 2030, the region plans to have a network of 14 transitways converging on the Minneapolis and St. Paul downtowns. This new system is expected to significantly improve regional mobility and accessibility by providing reliable and rapid services to major destinations. Parallel efforts at attracting different clusters and industries in the region are also on going. Over the next 20 years the region anticipates shifts in population and land use. Given these changes, an analysis of the capabilities and limitations of the current system as well as how forward looking policies can enhance the future systems access to a spectrum of jobs is necessary.

3.2. *Competitive clusters in the twin cities region*

The Twin Cities region is home to a diverse set of industries. Large firms engaged in finance, insurance, medical device manufacturing, food processing, printing and publishing call the region home. Eighteen Fortune 500 companies are also headquartered in the metropolitan area. The process of cluster identification focuses on the relationships between these industries. It seeks to identify those sectors which have dependence on each other—through supply chains, knowledge sharing, and market access. Several approaches exist in the literature for empirically identifying economic clusters (see for example Porter, 2000; Feser, 2005). A common starting point is to divide the regional industries into local serving and export oriented sectors. This may be done by using the economic base theory which divides regional industrial sectors into those that are export oriented (called basic sectors) and those that are local serving (or non-basic sectors) for the

region based on location quotients (LQ). This is followed by a statistical cluster analysis to group the basic sectors into groups sharing similarities along a defined set of dimensions.

The detailed process we used in identifying competitive clusters in the Twin Cities region is given in [Fan and Tilahun \(2012\)](#). We identified five broad, export oriented sectors that serve as anchors and have significant trading relationships with many other (often smaller) sectors. These anchor sectors are the medical equipment and supplies manufacturing sector, management of companies and enterprises, finance and insurance, book publishers and printing industries, and lessors of non-financial assets (companies primarily engaged in assigning rights to assets, such as patents, trademarks, brand names, and/or franchise agreements).

Once we identify the clusters based on the trading relationships among export oriented sectors (the basic cluster), we expand the definition of clusters by incorporating local serving (non-basic) sectors that have significant trading relationships with the anchor. We call these broader groupings the expanded clusters. This expanded definition allows us to capture all sectors that are closely tied to those central to the regions economy. It also allows us to consider a broader set of skill and education levels in the accessibility analysis than focusing only on the basic clusters would. The five clusters, which we refers to by their respective anchors and the proportion of regional employment they make up, are given in [Table 1](#).

3.3. Metropolitan distribution of cluster jobs

We map cluster locations using firm level data from Dunn and Bradstreet that we linked to the cluster data. This data provides details on 110,325 businesses in the metropolitan region including their primary activity (using NAICS codes), their locations, and how many employees that business has. Based on this analysis we find that 15.7% of the businesses in this data belong to at least one of the basic clusters, and an additional 50.49% belong to the expanded clusters defined around the anchor sectors. Firms in the basic clusters account for 18.9% of the jobs in the D&B data, and those only in the expanded cluster account for 43% of the jobs.

Our analysis finds that different clusters are distributed differently in the metropolitan area owing to the needs of the member firms. These may include the needs of space, movement of goods, labor access, and location prestige. In addition, complementary or competitive advantages from co-location may also play a role. The cumulative distribution of jobs in each of these clusters relative to downtown Minneapolis can be seen in [Fig. 1](#). As can be seen, clusters that are centered around office-centered anchors such as Management of Companies and Finance and Insurance sectors have a significant amount of their employment close to downtown

Table 1
Anchor sectors for the Twin Cities region and workforce as a percentage of regional employment.

Anchor sector	Percentage of regional employment	
	Basic cluster (%)	Expanded cluster (%)
1 Medical equipment manufacturing	4.4	7.0
2 Management of companies and enterprises	9.1	25
3 Finance and Insurance	11.1	46.9
4 Book publishers and Printing industries	6.2	12.8
5 Lessors of non-financial intangible assets	2.5	6.9

Note that some sectors are part of more than one cluster. Percentages should not be added.

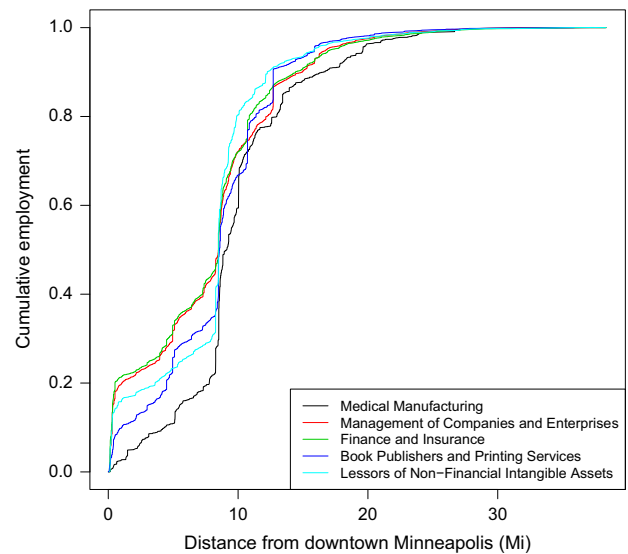


Fig. 1. Cumulative employment in basic clusters by distance from downtown Minneapolis.

Minneapolis. About a third of the jobs in the management, insurance, and monetary sectors are located within 5 miles of downtown, many of which are very close to the core. In contrast, much of the jobs in the Medical Manufacturing cluster are further from the downtown core with about 80% of the employment 7 miles or more away. As we will show next, these location patterns significantly affect the accessibility enjoyed to each of these clusters by the regional transit system.

4. Accessibility to cluster jobs

The core questions we seek to explore in this paper are whether current transit accessibility connects enough of the population to the cluster jobs. Second, given the changes in the transit system, in what ways will accessibility change. And third, what strategies can help increase accessibility of jobs looking out to 2030.

A simple way to evaluate whether current jobs in these clusters are well served by transit is to look at how many of them fall within a half mile of a high frequency transit station. We find variable amounts of nearness to high frequency transit service (service with headways of 15 min or less) among the clusters. Depending on the cluster between 60% and 90% of the jobs in the basic clusters are not within a half mile radius of high frequency transit. The Medical manufacturing anchored cluster, which contains many manufacturing type jobs, has the lowest levels of access to such stations. Sectors anchored around finance and insurance have the highest percentage within the same shed—largely on account of their location in the two CBDs and nearby areas. The summary for percentages within half mile of high frequency transit for the basic and expanded cluster is given in [Table 2](#). A more conservative buffer of quarter-mile would lead to even lower jobs in particular in suburban environments. Except for the clusters formed around medical manufacturing and Lessors of non-financial assets, the inclusion of the non-basic sectors drops the percentage of jobs near high frequency transit, which suggests that the non-basic sectors in these sectors are even less accessible than the basic sectors.

Measures of accessibility can range from those that count number of jobs within a given travel times (the so called cumulative opportunities measure) to those that are specified in gravity like functions and incorporate both attractiveness and cost

of travel as well as those which use the logsum from discrete choice models. For our purposes we employ the cumulative opportunities measure which is simple to calculate and intuitive. This measure simply counts the number of opportunities that are reachable at some travel time or travel cost. To determine the

Table 2
Percentage of jobs within a half mile radius of high frequency transit stop/stations.

Sector	Basic cluster	Expanded cluster
1 Medical manufacturing	9.6	13.8
2 Management of companies	33.8	28.1
3 Finance and Insurance	39.8	29.7
4 Book publishing and Printing	31.0	23.8
5 Lessors of non-financial intangible assets	25.3	30.6

Table 3
Average accessibility by metro blocks to cluster jobs within 60 and 30 min of transit time (expressed in terms of percentage of jobs in cluster).

Cluster	60 min		30 min	
	Basic (%)	Expanded (%)	Basic (%)	Expanded (%)
1 Medical manufacturing	3.4	3.9	2.4	2.7
2 Management of companies	10.9	8.1	6.8	5.2
3 Finance and Insurance	12.8	7.4	8.0	4.9
4 Book publishing and Printing	8.3	6.3	5.4	4.1
5 Lessors of non-financial intangible assets	9.3	10.0	5.9	6.3
6 All jobs	7.1	4.7		

accessibility for each of these clusters, total employment for each basic and expanded cluster is calculated at the census block level. This is then linked to data for block to block transit travel times using 2005 transit schedules. These travel times include walk access, egress, as well as wait times when connections are needed and use the closest transit station from block centroids to determine the different components of the transit travel time. The detailed procedure is presented in [Krizek et al. \(2007\)](#).

The cumulative opportunities measure is used to measure what percentage of jobs are accessible within a 30 and 60 min travel time from each census block. The analysis assumes that all jobs in a block are reachable if the block to block travel time meets the 30 or 60 min threshold. This makes the measure a bit more generous than reality especially for suburban census blocks that are relatively large in size. The analysis shows that the average transit accessibility to all jobs within 60 min in the metro area is 7.1% with some blocks having access to as much as 51.6% of jobs and others having no access to jobs by transit. The average accessibility (in terms of percentage of jobs accessed) to each of the clusters is given in [Table 3](#). The most accessible expanded clusters at 60 min are the lessors of non-financial assets, management of companies, and finance and insurance with average accessibility at the 60 min threshold ranging from 3.9% of jobs for medical manufacturing to 10% for lessors of financial services.

[Fig. 2](#) highlights the differences in transit accessibility in two sectors in the metropolitan region. Jobs in finance and insurance are relatively highly accessible as compared to the medical manufacturing cluster. The figures illustrate that access to particular types of jobs in the metropolitan area is not only a function of skills and idiosyncrasies of the usual search processes, but also

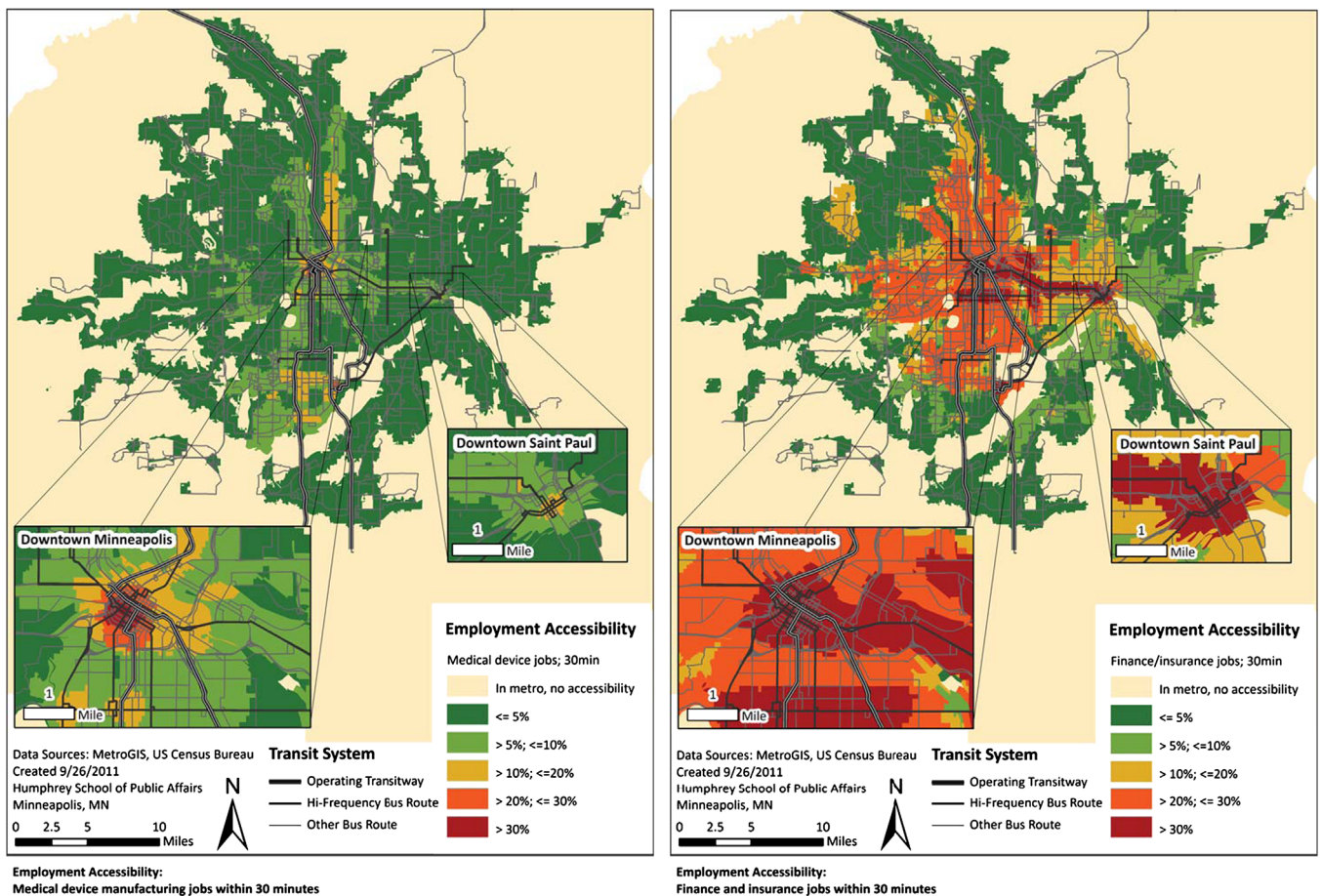


Fig. 2. Accessibility at 30 min travel time to the Medical Manufacturing Cluster (left) and the Finance and Insurance cluster (right).

of the availability of transport options. Short of relocating to the few blocks with better accessibility or vehicle ownership much of the jobs in the medical manufacturing cluster remain unreachable for transit dependent persons at reasonable cost. Relatively speaking better access is achieved to the Finance and Insurance cluster. The challenges of access are not only true for people who are without an automobile, but also for multi-worker households where the automobile needs to be shared.

Despite such differences in accessibility, current access levels are ordered in a manner that reflects the proportion of jobs in the metropolitan area that each cluster makes up. Fig. 3 shows the jobs in the cluster as a percentage of all the regions' jobs against the average percentage of cluster jobs that are accessible from the different blocks in the metropolitan area. This pattern changes somewhat when the expanded cluster is examined. Expanded clusters around the Finance and Insurance sectors and Management of companies sector make up 46.9% and 25% of all employment, respectively. In percentage terms, access to these clusters is around 8% of jobs, which is lower than that for Lessors of non-financial assets which make up around 8% of all regional jobs of which around 10% are accessible by transit. The implication is that the non-basic sectors which trade with the anchors are spread in a manner that is less served by transit than the basic sectors. To the extent basic sectors and non-basic sectors have a high-pay/low-pay or high-skill/low-skill dichotomy, the implication is that transit favors the former group.

5. Transit system changes and accessibility

As mentioned earlier, the current transit system in the metropolitan Twin Cities area is undergoing significant changes. The previous section showed that current levels of access to different types of industries are both limited and vary by cluster. The implications are that workers in car-less households or those in multi-worker households who need to share a vehicle may have their chances of employment in some sectors significantly reduced. The changes currently being made to the transit system and concurrent land use changes have the potential to increase accessibility broadly to these different sectors. In this section we imagine different scenarios that policy makers can pursue to increase accessibility by tying land use change to the planned changes in the transit system.

The starting point for our analysis is the forecasted land use and population for the metropolitan area by the regional planning agency. Alternative scenarios are built around these forecasts by

shifting population and jobs to different areas of the metropolitan area while keeping total population and job forecasts unchanged. The scenario patterns are similar to alternative scenarios developed by Anderson et al. (2013). The I-494/I-694 ring around the Twin Cities is used to delineate what we consider highly decentralized growth (when occurring outside the ring). The tested scenarios are

1. a transitway-focused centralization scenario where population and job growth follow the transitway lines at the expense of growth elsewhere;
2. a general centralization scenario where population and job growth favor inner-ring locations without a focus on transitway corridors;
3. a decentralization scenario that favors outer-ring population and job growth at the expense of inner ring growth;
4. a reference scenario that features transitway-focused job centralization coupled with population decentralization to outer-ring locations;
5. a reference scenario that features transitway-focused population centralization coupled with job decentralization to outer-ring locations.

Note: Scenario numbers refer to where results are reported in Table 6.

Each scenario reallocates jobs to defined locations from core to fringe or vice versa without changing total jobs or population in the metropolitan area from the 2030 forecasts. In the scenarios that feature transitway focused centralization, we assume the transitway type can affect what are achievable growth rates. For example, we assign higher concentrations of jobs along light rail transit than along Arterial BRTs or limited stop BRT service corridors. The additional growth at transitway corridors is assumed to come from locations that expect to see job growth in 2030. These locations will thus have less population/job growth than forecasted for 2030 but never lowering them below their 2010 levels. Places that are expected to lose population/jobs are left at their forecasted 2030 levels. The same logic is applied anytime reallocation is done (either to outer suburbs or inner city and inner suburbs). Locations where growth is not being tested but which were forecasted to have higher populations or jobs will see less than forecasted growth. Those expecting to lose population or jobs are not affected.

Rates of additional growth for the scenarios were chosen to be modest and achievable while recognizing that different target growth rates may have to be used based on the transitway type.

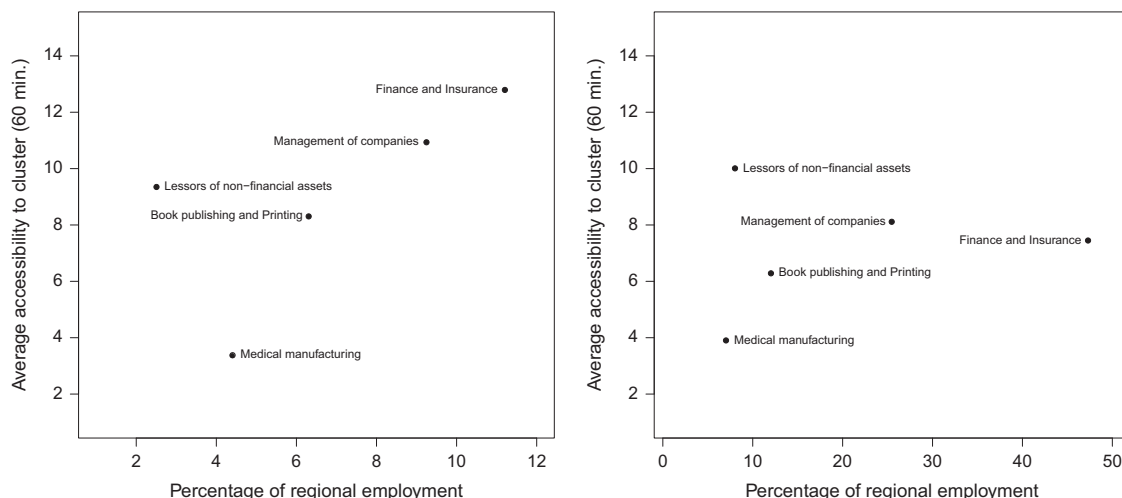


Fig. 3. Average 60 min metropolitan transit accessibility to basic (left) and expanded (right) cluster jobs plotted against cluster importance to region expressed as the percentage of all metro jobs a cluster accounts for.

The rates we use for the scenarios are given in Table 4. The most optimistic scenario is an additional 10% growth over that forecasted for 2030 in light rail corridors. We assign more optimistic growth rates to areas which will have light rail lines, followed by arterial BRT systems, then limited stop BRT systems. We do not increase concentrations along either commuter rail or express bus lines.

For the scenario analysis we use average population weighted accessibility as a basis for comparison. This is calculated as $\sum_i p_i A_i / P_t$, where i indexes traffic analysis zones (TAZ) in the metropolitan area, A_i and p_i are the accessibility (jobs reachable in a 30 min travel time) and population of a given TAZ, respectively, and P_t is the total metropolitan population which equals $\sum p_i$. The population weighted accessibility 2010 shows that a randomly chosen individual in the metropolitan area could access 117,611 jobs within a 30 min transit travel time. Under the forecasted population and job growth rates by the regional planning agency and with the planned transit system, the number of jobs reachable would be 126,419 in 2030—a gain of 7.5%. Under the scenario analysis, we evaluate how this measure changes under both a job centralization strategy and potential decentralization.

Similar numbers can be calculated for the cluster jobs as well. However some additional assumptions about location and growth need to be made since job growth forecasts are not available by sector. We make the simple assumption that in zones where cluster jobs are currently present, they will change (grow or decline) at the same rate that change occurs in the current zone they are located. Since these sectors are in general considered high growth sectors, the growth rates we assume based on all jobs are likely conservative. Further, because cluster jobs are counted from different data (the D&B data), there is a mismatch between the forecasts based on the regional planning agency and the D&B accessibility with the latter being about 80% of the former. Table 5 gives the current and future accessibilities based on this data for the Basic, Non-Basic and Expanded cluster jobs. The changes in person weighted accessibility under the do-nothing scenario suggest significant advantages to the Basic cluster (a 12.1% gain from about 20,500 jobs to approximately 23,000 jobs) and a 5% gain in accessibility when looking at only non-basic sectors in these clusters. Taken as a whole we estimate a 7.5% growth for the expanded clusters which matches the overall growth in accessibility for all jobs using the data from the metropolitan planning agency.

Table 4
Growth rate scenarios.

Transitway type	Growth percentage		
	Low (%)	Med (%)	High (%)
None	0	0	0
Light rail	3	5	10
Arterial BRT	2	3	6
Limited stop BRT	1	2	4
Commuter rail	0	0	0
Express bus	0	0	0

Table 5
Metropolitan accessibility to all, basic, non-basic, and expanded cluster jobs in 2010 and 2030.

Year	All jobs	Basic cluster	Non-basic cluster	Expanded cluster
2010 (Jobs)	117,611	20,497	37,671	58,168
2030 (Jobs)	126,419	22,974	39,551	62,525
Gains (%)	7.5	12.1	5.0	7.5

The scenario analysis evaluates how job accessibility in general will change under the different growth scenarios for all jobs. It tests different combinations of low, medium, and high centralization and decentralization combinations of jobs and population and takes the 2030 transit system as fixed. The results for the 63 different scenarios run are summarized in Table 6. The percentages report the changes in regional population weighed accessibility that decentralization or policies of centralization may bring relative to the 2030 levels under forecasted population and jobs.

Results from the scenario analysis show that the highest gains in accessibility result from a policy of concentrating both jobs and population along transitways. Given the current (and anticipated base) patterns of population and jobs, if one had to choose between centralizing population or jobs, the accessibility gains suggest that one should focus on centralizing jobs along transit ways. As can be seen from Scenario 1, a policy that does nothing to population but centralizes jobs aggressively along transitways would increase average accessibility by 4.5% while centralizing population only without affecting jobs would lead to a 2.2% increase. A combined effort at the most aggressive level tested would lead to gains of about 7%.

Second, an additional pattern that becomes clear from scenario 2 is that untargeted centralization (when centralization happens in the core but is not targeted to transitway corridors) has lower dividends in terms of transit accessibility as compared to targeted centralization efforts. This is true both for jobs and population. If the additional growth is concentrated in the inner cities and inner suburbs (inside the I-694/494 ring), then the highest gain one could anticipate at the most aggressive centralization of both jobs and population is 2.74%—only about 40% of the gains that could be had with targeted centralization.

Table 6
Scenario analysis: changes in population weighed average accessibility in the metropolitan area.

		Employment centralization			
		None	Low	Moderate	High
Scenario 1. Jobs and population centralization					
Population	None	126,419	+1.8%	+2.6%	+4.5%
	Low	+0.6%	+2.4%	+3.3%	+5.2%
Centralization	Moderate	+1.2%	+3.0%	+3.9%	+5.8%
	High	+2.2%	+4.0%	+4.9%	+6.9%
Scenario 2. Job and population centralization without a focus on transitways					
Population	None		+0.23%	+0.69%	+1.24%
	Small	+0.05%	+0.28%	+0.74%	+1.29%
Centralization	Moderate	+0.26%	+0.50%	+0.95%	+1.51%
	High	+1.48%	+1.71%	+2.18%	+2.74%
Scenario 3. Job centralization and population decentralization					
Population	None		+1.8%	+2.6%	+4.5%
	Small	-0.03%	1.74%	2.60%	4.48%
Decentralization	Moderate	-0.09%	1.67%	2.54%	4.42%
	High	-0.18%	1.58%	2.45%	4.32%
		Employment decentralization			
		None	Small	Moderate	High
Scenario 4. Job decentralization and population centralization					
Population	None		-0.21%	-0.63%	-1.29%
	Small	+0.6%	0.43%	0.01%	-0.66%
Centralization	Moderate	+1.2%	0.98%	0.56%	-0.11%
	High	+2.2%	2.0%	1.57%	0.89%
Scenario 5. Jobs and population decentralization					
Population	None		-0.21%	-0.63%	-1.29%
	Small	-0.03%	-0.24%	-0.66%	-1.32%
Decentralization	Moderate	-0.09%	-0.3%	-0.72%	-1.38%
	High	-0.18%	-0.39%	-0.81%	-1.47%

Third, even if population is decentralized further, a policy of centralizing jobs has positive impacts on regional accessibility. In scenario 3, under aggressive centralization of jobs and the highest decentralization of population tested, average accessibility gains of 4.3% are possible. However, if jobs were to decentralize to outer ring suburbs while population centralized to transitway corridors, a gain of less than 1% would be expected. This is shown in scenario 4.

Overall the scenario tests suggest that decentralization of housing/population at the tested levels will have relatively small effects on the regional measure of accessibility. The worst impact is when this is coupled with employment decentralization where a loss of 1.47% would be expected (scenario 5). Given an already relatively dispersed pattern of housing and population, the marginal impacts of population shifts are limited. Further, each job that is located in a transitway corridor has the potential to increase the opportunities accessible for many people; a household that centralizes on the other hand improves its own accessibility. Hence large shifts are needed in population to register higher gains in regional accessibility.

6. Summary

This paper looks into two interrelated accessibility issues in an area that is revamping its transit system. First, we look at job accessibility under the current transit system in metropolitan Minneapolis–St. Paul. We employ the idea of competitive clusters to create multi-sector groups of job opportunities that lend the region its economic strength and identified five clusters for the region that comprise 62% of total employment. The analysis highlights the sectoral differences that exist in reachability and accessibility by transit. The average census block can access 10% or less of the jobs depending on the clusters, and about 7% of all jobs at a 60 min transit travel time. The cluster to cluster variability in access suggests that some classes of jobs are not reachable without the use of a private automobile. For car-less households, this likely limits the choice set of employment opportunities they can pursue.

Second, we evaluate the changes that the region is making to the transit system by looking at the accessibility changes it will engender in combination with population and land use changes. We find that the region as a whole is moving towards higher accessibility under the population and land use scenarios forecasted for the year 2030. By 2030, we anticipate the regional measure of accessibility to increase by 7.5% above 2010 levels. We then evaluate several plausible scenarios where job growth and population growth may centralize into the core metropolitan area, centralize along transitway corridors, or decentralize further to outer suburban locations. Rates of centralization and decentralization were based on transitway type and were a simple reallocation of forecasted growth from one area of the metropolitan area to another.

Under these scenario analyses, we show that centralizing housing and jobs along transitway corridors is the best strategy to follow if increasing regional accessibility is the goal. Particularly a strategy that focuses on targeted jobs centralization along transitway corridors would have significant payoffs. With a joint population and jobs centralization along transitway corridors, increases in accessibility as large as 7% are possible; by focusing on jobs centralization alone gains of 4.5% can be achieved. Centralization of jobs and population that is not focused on transitway corridors, while leading to positive gains, does not achieve the level of gains that a focused growth along transitway corridors delivers. On the other hand, given the rather dispersed population pattern in the region, further decentralization of

population at the levels we tested does not appear to significantly alter regional accessibility. In most cases, the decline in average regional accessibility to jobs was on the order of 1% or less. Only when coupled with jobs decentralization does this number go above 1% and never exceeds 1.5%. Employment decentralization on its own also did not lead to large declines in accessibility.

We argue that understanding the connection between transit systems and a region's economic strength has important policy implications for access equity among residents. By integrating location decisions for firms with transit system deployment, regional policy makers can expand the types of opportunities that can be pursued by those who are not vehicle owners. While it is a given that transportation in itself will not translate into jobs, reliable access is also important to pursue these opportunities. Our approach used an expanded definition of economic clusters to ensure that jobs with different skill requirements are encompassed in our analysis while retaining the linkage to strong, generally more productive, better rewarding sectors in the region.

Further, as we noted earlier, the deployment of the transit system increases the accessibility of the basic cluster while the non-basic cluster sees modest growth by comparison (12% vs. 5%, see Table 5). Since the non-basic jobs may be better candidates for lower skilled workers, the centralization strategy can also choose to focus on such sectors to enhance access equity for the regions' car-less workers. Such an approach can lead to increased use of the transit system or at the very least make new opportunities available to those that do not have personal vehicles for every day mobility.

While our analysis focuses on the Minneapolis–St. Paul region, we believe the implications are broader. First, there is a broad focus on economic development through cluster initiatives in many regions. This research highlights the importance of coordinating such efforts with efforts to improve regional access to jobs. Secondly, the results of the scenario analysis highlight the importance that planners and policy makers should attach to centralizing jobs along transit corridors. By bringing jobs closer to public transportation corridors, higher accessibility gains can be achieved than can be by the provision of the transportation service alone. This can move forward broader access equity questions among the region's population by enhancing access to car-less or other transportation disadvantaged groups. In particular these lessons are likely important to regions of similar land use patterns—when Glaeser et al. (2001) classified the 100 largest metropolitan areas in the U.S. based upon the extent of job sprawl, the Minneapolis–St. Paul region fell in the middle category of regions which have fairly decentralized employment patterns. We expect that the results that highlight the strong impact of job concentration along transit corridors on transit accessibility would be replicated in similar metropolitan areas.

References

- Anderson, P., Levinson, D., Parthasarathi, P., 2013. Accessibility futures. *Trans. GIS* 17, 683–705.
- Bania, N., Leete, L., Coulton, C., 2008. Job access, employment and earnings: outcomes for welfare leavers in a us urban labour market. *Urban Stud.* 45 (11), 2179–2202.
- Barnes, G., 2005. The importance of trip destination in determining transit share. *J. Public Transp.* 8 (2), 1–16.
- Belzer, D., Srivastava, S., Wood, J., Greenberg, E., 2011. Transit-oriented development (TOD) and employment. Technical Report.
- Bernick, M., Cervero, R., 1997. *Transit villages in the 21st century*. McGraw-Hill, New York.
- Blumenberg, E., Manville, M., 2004. Beyond the spatial mismatch: welfare recipients and transportation policy. *J. Plan. Lit.* 19 (2), 182–205.
- Brown, J., Thompson, G.L., 2012. Should transit serve the CBD or a diverse array of destinations? A case study comparison of two transit systems. *J. Public Transp.* 15 (1).

- Brown, J.R., Thompson, G.L., 2008. The relationship between transit ridership and urban decentralisation: insights from atlanta. *Urban Stud.* 45 (5–6), 1119–1139.
- Cervero, R., 2006. Office development, rail transit, and commuting choices. *J. Public Transp.* 9 (5).
- Cervero, R., Landis, J., 1992. Suburbanization of jobs and the journey to work: a submarket analysis of commuting in the san francisco bay area. *J. Adv. Transp.* 26 (3), 275–297.
- Cervero, R., Sandoval, O., Landis, J., 2002. Transportation as a stimulus of welfare-to-work. *J. Plan. Educ. Res.* 22 (1), 50.
- Cervero, R., Wu, K.-L., 1998. Sub-centring and commuting: evidence from the San Francisco bay area 1980–90. *Urban Stud.* 35 (7), 1059–1076.
- Chan, S., Miranda-Moreno, L., 2013. A station-level ridership model for the metro network in Montreal, Quebec. *Can. J. Civil Eng.* 40 (3), 254–262.
- Debrezion, G., Pels, E., Rietveld, P., 2007. The impact of railway stations on residential and commercial property value: a meta-analysis. *J. Real Estate Finance Econ.* 35 (2), 161–180.
- Fan, Y., 2012. The planner's war against spatial mismatch lessons learned and ways forward. *J. Plan. Lit.* 27 (2), 153–169.
- Fan, Y., Tilahun, N.Y., 2012. Enterprising twin cities transitways: regional competitiveness and social equity in an integrated land use and transit context. Technical Report, Center for Transportation Studies, University of Minnesota, Report no. CTS-12-16.
- Fejarang, R.A., 1993. Impact on property values: a study of the los angeles metro rail. In *Public transport planning and operations*. In: Proceedings of Seminar held at the European Transport, Highways and Planning 21st Summer Annual Meeting (September 13–17, 1993).
- Feser, E., 2005. Benchmark value chain industry clusters for applied regional research. Regional Economics Applications Laboratory (REAL), University of Illinois at Urbana-Champaign.
- Frank, L.D., Pivo, G., 1994. Impacts of mixed use and density on utilization of three modes of travel: single-occupant vehicle, transit, and walking. *Transp. Res. Rec.* 1466, 44–52.
- Glaeser, E.L., Kahn, M.E., Chu, C., 2001. Job sprawl: employment location in US metropolitan areas. Brookings Institution, Center on Urban and Metropolitan Policy.
- Guerra, E., Cervero, R., 2011. Cost of a ride: the effects of densities on fixed-guideway transit ridership and costs. *J. Am. Plan. Assoc.* 77 (3), 267–290.
- Hendrickson, C., 1986. A note on trends in transit commuting in the United States relating to employment in the central business district. *Transp. Res. Part A: Gen.* 20 (1), 33–37.
- Holl, A., 2006. A review of the firm-level role of transport infrastructure with implications for transport project evaluation. *J. Plan. Lit.* 21 (1), 3–14.
- Kawabata, M., 2003. Job access and employment among low-skilled autoless workers in US metropolitan areas. *Environ. Plan. A* 35 (9), 1651–1668.
- Kawamura, K., 2001. Empirical examination of relationship between firm location and transportation facilities. *Transp. Res. Rec.: J. Transp. Res. Board* 1747 (1), 97–103.
- Ko, K., Cao, J., 2013. The impact of Hiawatha light rail on commercial and industrial property values in minneapolis. *J. Public Transp.* 16 (1).
- Kolko, J., 2011. Making the Most of Transit: Density, Employment Growth, and Ridership Around New Stations. Public Policy Institute, CA.
- Krizek, K., El-Geneidy, A., Iacono, M., Horning, J., 2007. Access to destinations: refining methods for calculating non-auto travel times. Technical Report.
- Kuby, M., Barranda, A., Upchurch, C., 2004. Factors influencing light-rail station boardings in the United States. *Transp. Res. Part A: Policy Pract.* 38 (3), 223–247.
- Laulajainen, R., Stafford, H.A., 1995. Corporate geography: business location principles and cases, vol. 31, Springer, Dordrecht.
- McKenzi, B.S., 2010, October. American Community Survey Briefs. Public Transportation Usage Among U.S. Workers: 2008 and 2009.
- Mejia-Dorantes, L., Paez, A., Vassallo, J.M., 2012. Transportation infrastructure impacts on firm location: the effect of a new metro line in the suburbs of madrid. *J. Transp. Geogr.* 22, 236–250.
- Meyer, J.R., Gomez-Ibanez, J.A., 1981. Autos transit and cities. Technical Report.
- Mierzejewski, E.A., Ball, W.L., 1990. New findings on factors related to transit use. *ITE (Instit. Transp. Eng.) J. (USA)* 60 (2).
- Neff, J., Pham, L., 2007. A profile of public transportation passenger demographics and travel characteristics reported in on-board surveys. American Public Transportation Association.
- Nelson, A.C., 1999. Transit stations and commercial property values: a case study with policy and land-use implications. *J. Public Transp.* 2 (3).
- Ong, P.M., Houston, D., 2002. Transit, employment and women on welfare 1. *Urban Geogr.* 23 (4), 344–364.
- Porter, M., 2000. Location, competition, and economic development: local clusters in a global economy. *Economic Development Quarterly*.
- Porter, M., 2003. The economic performance of regions. *Reg. Stud.* 37 (6), 545–546.
- Pushkarev, B.S., Zupan, J.M., et al., 1977. Public transportation and land use policy, vol. 977. Indiana University Press, Bloomington.
- Rast, J., 2004. Transportation equity and access to jobs in metropolitan milwaukee. Milwaukee, The University of Wisconsin-Milwaukee Center for Economic Development.
- Ryan, S., 2005. The value of access to highways and light rail transit: evidence for industrial and office firms. *Urban Stud.* 42 (4), 751–764.
- Sanchez, T.W., 1999. The connection between public transit and employment: the cases of portland and atlanta. *J. Am. Plan. Assoc.* 65 (3), 284–296.
- Sanchez, T.W., 2008. Poverty, policy, and public transportation. *Transp. Res. Part A: Policy Pract.* 42 (5), 833–841.
- Sanchez, T.W., Shen, Q., Peng, Z.-R., 2004. Transit mobility, jobs access and low-income labour participation in us metropolitan areas. *Urban Stud.* 41 (7), 1313–1331.
- Santos, A., McGuckin, N., Nakamoto, H.Y., Gray, D., Liss, S., 2011. Summary of travel trends: 2009 national household travel survey. Technical Report.
- Sen, A., Metaxatos, P., Sööt, S., Thakuria, V., 1999. Welfare reform and spatial matching between clients and jobs. *Papers Reg. Sci.* 78 (2), 195–211.
- Thakuria, P., Metaxatos, P., 2000. Effect of residential location and access to transportation on employment opportunities. *Transp. Res. Rec.: J. Transp. Res. Board* 1726 (1), 24–32.
- Thompson, G.L., 1977. Planning considerations for alternative transit route structures. *J. Am. Plan. Assoc.* 43 (2), 158–168.
- Thompson, G.L., Brown, J.R., 2006. Explaining variation in transit ridership in us metropolitan areas between 1990 and 2000: multivariate analysis. *Transp. Res. Rec.: J. Transp. Res. Board* 1986 (1), 172–181.
- Thompson, G.L., Matoff, T.G., 2003. Keeping up with the joneses: radial vs. multi-destinational transit in decentralizing regions. *J. Am. Plan. Assoc.* 69 (3), 296–312.
- Tomer, A., Kneebone, E., Puentes, R., Berube, A., 2011. Missed opportunity: transit and jobs in Metropolitan America.
- United States Census Bureau, 2001. Census 2000 summary file 3 (sf 3) – sample data, table p28. place of work for workers 16 years and over. (<http://factfinder.census.gov/>).
- Weinberger, R.R., 2001. Light rail proximity: benefit or detriment in the case of Santa Clara county, California?. *Transp. Res. Rec.: J. Transp. Res. Board* 1747 (1), 104–113.