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Economic Development Impacts of Bus Rapid Transit



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Economic Development Impacts of Bus Rapid Transit

Final Report

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Contents

Introduction	1
Literature Review	2
1.1 Employment Decentralization.....	2
1.2 Economic Development and BRT	3
Research Approach	4
1.3 Peer Regions	4
1.4 Additional BRT Systems.....	6
1.5 BRT Feature Levels	6
1.6 Units of Analysis.....	7
1.6.1 Joining job data.....	7
1.7 Job Categories	7
Results	9
1.8 Variables	9
1.9 Models.....	11
1.10 Standardized Coefficients	14
Conclusions.....	17
References	19

LIST OF TABLES

- Table 3-1: Full list of BRT Systems 6
- Table 3-2: NAICS to Collar Color Crosswalk 8
- Table 4-1: Descriptive statistics 11
- Table 4-2: Ordinary least-squares regression models 13
- Table 4-3: Significant standardized coefficients, blue collar jobs 14
- Table 4-4: Significant standardized coefficients, pink collar jobs 15
- Table 4-5: Significant standardized coefficients, white collar jobs 15
- Table 4-6: Significant standardized coefficients, low wage jobs 15
- Table 4-7: Significant standardized coefficients, high wage jobs 16

LIST OF FIGURES

- Figure 3-1: Study regions and modes 5

EXECUTIVE SUMMARY

With next year's opening of the A Line, advancing plans for the Metro Gold Line and additional arterial bus rapid transit (BRT) lines, not to mention continued growth of the Metro Red Line, it is clear that BRT will play an increasingly important role in the Twin Cities transit system in the coming years. Transitways directly advance accessibility by offering shorter travel times, but employment accessibility benefits are greatest when the density of destinations is high: job growth in station areas will be necessary to achieve the greatest possible accessibility benefits from transitway implementation. As planned and proposed BRT projects look set to dramatically expand the number of transitway station areas in the Twin Cities in relatively short order, now is an opportune time to consider under what conditions station area job growth is most likely to be strong.

This research fills a gap in knowledge about the job growth impacts of BRT implementation, by directly comparing job change rates before and after implementation around dedicated guideway BRT stations (with an exclusive guideway), Arterial BRT stations and light rail transit (LRT) stations in 15 regions around the nation. (Due to the relative lack of regional experience with BRT, LRT stations are included to provide a convenient point of reference to compare BRT stations to.) This research is unique in employing a consistent, comparable, national sample of transitway stations and directly studying job growth and loss, as opposed to less direct measures of economic activity such as commercial property values.

The study regions include peer regions, as defined by the Metropolitan Council either for transit system performance or transit system investment comparison, with the addition of Eugene, Oregon and Las Vegas, Nevada to increase the number of dedicated guideway BRT stations considered. Figure E-1 shows the regions and modes included.

To account for the need for a balance of employment types in transitway station areas, we separately consider jobs paying an annual wage of less than \$40,000 and jobs paying an annual wage greater than or equal to \$40,000, as well as jobs in three sector categories defined roughly by skill level and type of work: blue collar (low-skilled, productive), pink collar (low-skilled, service) and white collar (high-skilled, professional).

Total street mileage (a measure of network density) is a significant, positive predictor of jobs after implementation in all but one of the models, and it is the strongest positive predictor in three of the models. This finding underscores the importance of fine-grained connectivity between BRT stations and their surroundings. This bodes well for the planned A Line, which primarily serves areas with a dense street grid. Providing street connections in suburban Metro Red, Orange and Gold Line station areas seems to be a critical step to attract jobs to these areas.

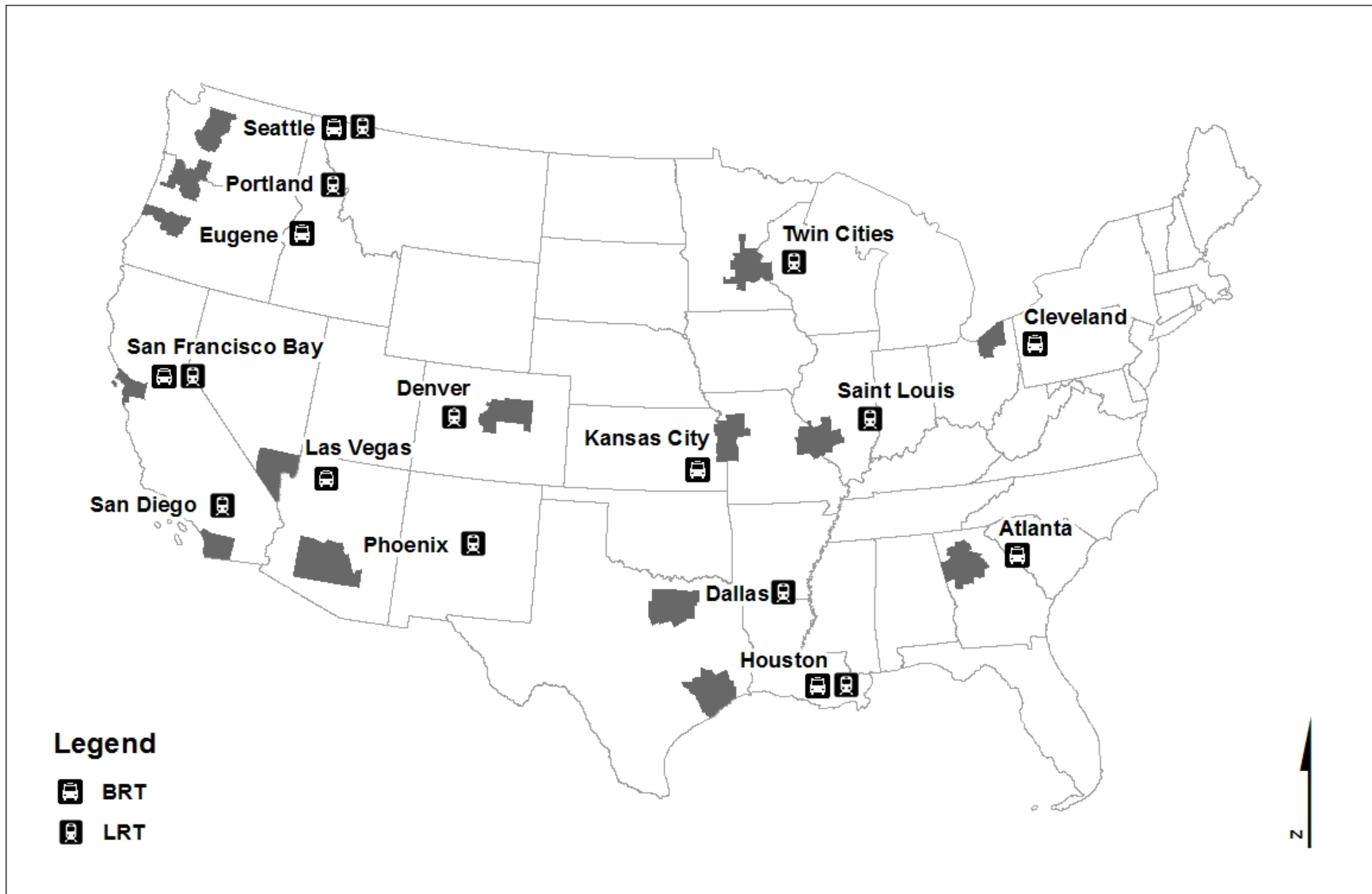


Figure E-1: Study Regions and Transitway Modes

Arterial BRT is a significant, negative predictor of station area job change; dedicated guideway BRT is negative for pink collar jobs. This indicates that transitway modes matter in determining economic impacts. In particular, fixed infrastructure matters. It appears, however, that the greatest difference is between some type of fixed infrastructure (wheel and propulsion technology notwithstanding) and no continuous fixed infrastructure. This finding indicates significant potential for attracting jobs to proposed dedicated guideway BRT stations, as on the Orange and Gold Lines. It also seems to highlight the importance of branding and marketing for Arterial BRT projects, with the aim of creating as strong a perceived corridor identity as possible

Distance from the central business district is a strong negative predictor of both white collar and high wage job growth. This fact seems to potentially reinforce a pattern of high status jobs in the urban core, juxtaposed against lower status jobs farther out. Twin Cities BRT projects have the potential to be social equity promoters, but it will be important to consider the types of jobs attracted to station areas in different parts of the region to maximize this benefit.

Regional factors—such as the metropolitan rate of job change after implementation—prove highly important in determining changes in station area jobs. This finding speaks to the importance of broad, regional policies that support economic growth, or which avert obstacles to it. To the extent a high-quality regional transit system supports the regional economy by improving labor supply access, supporting consumer demand through transportation cost savings and providing a hedge against (or at least an alternative to) gridlock, each new transitway station implemented can be said to play some role in supporting job growth in other transit station areas.

INTRODUCTION

With next year's opening of the A-Line, advancing plans for the Metro Gold Line and additional Arterial BRT lines, not to mention continued growth of the Metro Red Line, it is clear that bus rapid transit (BRT) will play an increasingly important role in the Twin Cities transit system in the coming years. According to the Arterial Transit Corridor Study, Metro Transit even sees Arterial BRT more as a new standard of service for the Primary Transit Network to be implemented in stages than as a special-purpose improvement for one or two corridors (SRF Consulting Group, 2012).

One of the central goals of transitway investments is the improvement of regional employment accessibility. Improving employment accessibility by transit can also have positive social equity implications, by opening up regional employment opportunities for the transit dependent and more generally transportation-disadvantaged. Transitways directly advance accessibility by offering shorter travel times (Fan, Guthrie, & Levinson, 2011), but employment accessibility benefits appear to be greatest when the density of destinations is high (Levine, Grengs, Shen, & Shen, 2012): job growth in station areas will be necessary to achieve the greatest possible accessibility benefits from transitway implementation. As planned and proposed BRT projects look set to dramatically expand the number of transitway station areas in the Twin Cities in relatively short order, now is an opportune time to consider under what conditions station area job growth is most likely to be strong.

While Light Rail Transit (LRT) has a proven track record for local economic development in the Twin Cities and elsewhere, the literature is all but mute on how BRT impacts station area employment. This report fills a gap in understanding by directly exploring the predictors of job growth in BRT station areas on a national scale, using LRT station area job growth to provide a ready reference point.

Chapter 2 synthesizes the need for the research, as established by the literature, and sets up current knowledge of BRT economic implications as a jumping-off point for the research. Chapter 3 explains the research approach and introduces the BRT and LRT systems studied. Chapter 4 presents the results of the research, while Chapter 5 draws conclusions from the results and discusses implications for Twin Cities BRT projects.

LITERATURE REVIEW

Transitways can be a powerful tool for increasing regional employment accessibility and, at the same time, promoting social equity (Fan et al., 2011; Tilahun & Fan, 2014). Accessibility benefits of transitways are contingent, however, on station areas with jobs in them. In fact, a high density of destinations appears more important in practice for promoting accessibility than high travel speeds (Levine et al., 2012). Early results following the implementation of the Metro Blue Line suggest a net trend of jobs moving into light rail station areas, and of increasing commutes with origins in transit-served areas and destinations in station areas (Fan, Guthrie, & Teng, 2010). Other existing research on station area employment and economics, however, tends to take a relatively narrow, case-study approach (Cervero, 1998; Cervero, 2006), or to focus on commercial property values (Cervero & Duncan, 2002; Debrezion, Pels, & Rietveld, 2007; Ko & Cao, 2010; Nelson, 1999). Both of these approaches offer valuable insight on transit's relationship to local economic development, but neither directly, broadly considers the most important outcome of it: jobs. As such, this research fills an important gap in knowledge by directly addressing station area job growth on a national scale.

1.1 Employment Decentralization

Popular conceptions of urban sprawl tend to focus on the uncoordinated, spatial expansion of residential development, the parallel decentralization of employment locations—"job sprawl"—has been underway for decades (Beauregard, 1995; Glaeser, Kahn, & Chu, 2001; Weitz & Crawford, 2012). Central cities generally retain more jobs than there are workers living in them—experiencing net inflows of commuters—but it is quite common for most of the workers in a given metropolitan areas to work in the suburbs: as long ago as 2001, Glaeser, et al found that only 22% of workers in the 100 largest U. S. regions worked within three miles of their respective city centers (Glaeser et al., 2001). In general, the farther from the central business district a job is, the less accessible by transit it is, and by a large margin. Recent research conducted by the Brookings Institution finds that, while roughly 76% of jobs in the 100 largest U. S. regions are in neighborhoods with at least some form of transit service, "The typical job is accessible to only about 27 percent of its metropolitan workforce by transit in 90 minutes or less" (emphasis added), finding low accessibility despite an exceptionally long cutoff time (Tomer, 2012).

"Smart growth" is ascendant in regional planning, but overly residential-focused urban revitalization can inadvertently exacerbate job sprawl by displacing productive industrial uses with upscale housing. This modern-day incarnation of urban revitalization can lead to especially severe job sprawl in one of the few sectors which still consistently pays living wages to non-college educated workers: though jobs in the manufacturing sector have undeniably declined in recent years, they continue to offer valuable work opportunities to less-educated workers (W. Curran, 2004; W. Curran, 2007; Leigh & Hoelzel, 2012), and contribute to a metropolitan economy supporting employment for a wide variety of skill levels (W. Curran, 2010). The common practice of aligning transitways in old rail corridors to reduce construction costs can constrain more upscale economic development opportunities (Cervero, 1984; Loukaitou-Sideris & Banarjee, 2000), but might offer opportunities for industrial employers to escape central-city land speculation without suffering a decline of the labor supply access that is a significant benefit of such locations (W. Curran, 2007).

Service to automobile dominated suburban employment centers tends to be slow, indirect and infrequent, due to low demand. The result is ineffective service to suburban jobs generally incapable of attracting any riders who have other travel options—or even many who do not. Even regarding Federally-funded Job Access and Reverse Commute (JARC) service designed for the transit-dependent unemployed, repeated studies find little impact on employment outcomes (Blumenberg & Manville, 2004; Fan, 2012; Grengs, 2010).

1.2 Economic Development and BRT

Research specifically on the economic development impacts (or any kind of development impacts) of bus rapid transit is much less common. In a study of the East Busway in Pittsburgh, Pennsylvania, Wohlwill finds over \$300 million in development within the busway corridor, despite overall population loss. In addition, development tended to cluster around busway stations (Wohlwill, 1996). Cervero finds strong station-area employment growth following full implementation of the OC Transpo BRT system in Ottawa, Ontario—as high as 73% of non-CBD office development in some years, speaking to the potential of transitways to act as the nuclei of new employment centers (Cervero, 1998). Resources such as these are the exceptions in the literature: articles on the economic development impacts of BRT overwhelmingly focus on Latin American and Asian systems which operate in very different economic circumstances and real estate markets (G. Currie, 2006; Levinson et al., 2003; Zhang, 2007). Existing research on North American BRT systems focuses heavily on transit planning and operations, providing little direct insight into economic development impacts (Bent, Hiatt, & Singa, 2008; Callaghan, 2008; G. Currie, 2005). This lack of knowledge is problematic, as so-called Arterial BRT services appear likely to take on an increasingly important role in transitway development in the coming years, often complementing more regionally-focused light rail lines to provide high-quality local service while extending the reach of transitways to many more areas.

All such research has a key problem, however: in focusing on commercial real estate development and/or land values, such studies hint at, but do not directly measure job growth (Adams & VanDrasek, 2007). Of course, it is an entirely reasonable assumption that 73% of all office development outside downtown, for instance, brings with it some growth in station area employment. Still, how much in net terms, in what sectors and at what wages are other matters, matters of considerable significance for equitable regional employment access.

Based on their behavior, employers appear to perceive at least some benefits from locating near high-quality regional transit options. There is a need for research that engages directly with those perceptions and the motivations they create in order to design strategies for promoting equitable station area job growth.

The following chapter describes how this research approaches the task of filling in the gap in knowledge about the economic development implications of BRT. It lays out the regions and time period studied, describes data sources and units of analysis, as well as the job categorization employed to allow consideration of social equity.

RESEARCH APPROACH

The approach of this research revolves around comparing before-implementation and after-implementation job growth and/or loss rates around transitway stations in regions similar to the Twin Cities. The following chapter describes the study regions, data collection approach and analysis methods.

1.3 Peer Regions

Exploring and predicting BRT's job-growth impacts in the Twin Cities region requires a broader focus than the Twin Cities region. Bus Rapid Transit (BRT) is a new transit technology in the Twin Cities, and the Metro Red Line—the region's only operating BRT service—opened after the most recent available Longitudinal Employer and Household Dynamics (LEHD) data were collected. United States metropolitan areas, however, are not economically interchangeable—substantial differences appear between regions in terms of per-capita and per-worker income (Rey & Janikas, 2005; Yamamoto, 2007) and regional competitiveness (Kitson, Martin, & Tyler, 2004); even economists who question competitiveness as a central measure of regional economic success call for a place-based focus to regional economic development (Bristow, 2010).

To obtain a sufficient sample of BRT services, while studying regions as broadly comparable to the Twin Cities as possible, we focus on peer regions—metropolitan areas used by the Metropolitan Council either for transit system performance comparisons or for transitway investment level comparisons (C. Hiniker, personal communication, July 31, 2013). To allow us to employ LEHD job data—the most fine geographic scale job data available at the national level—we restrict our analysis to peer regions which opened Bus Rapid Transit or Light Rail Transit (LRT) lines or extensions between 2003 and 2010. These standards yield a total of six BRT regions and nine LRT regions (Federal Transit Administration, 2013; National BRT Institute, 2014). Figure 3-1 shows the study regions which implemented LRT and/or BRT between 2003 and 2010.

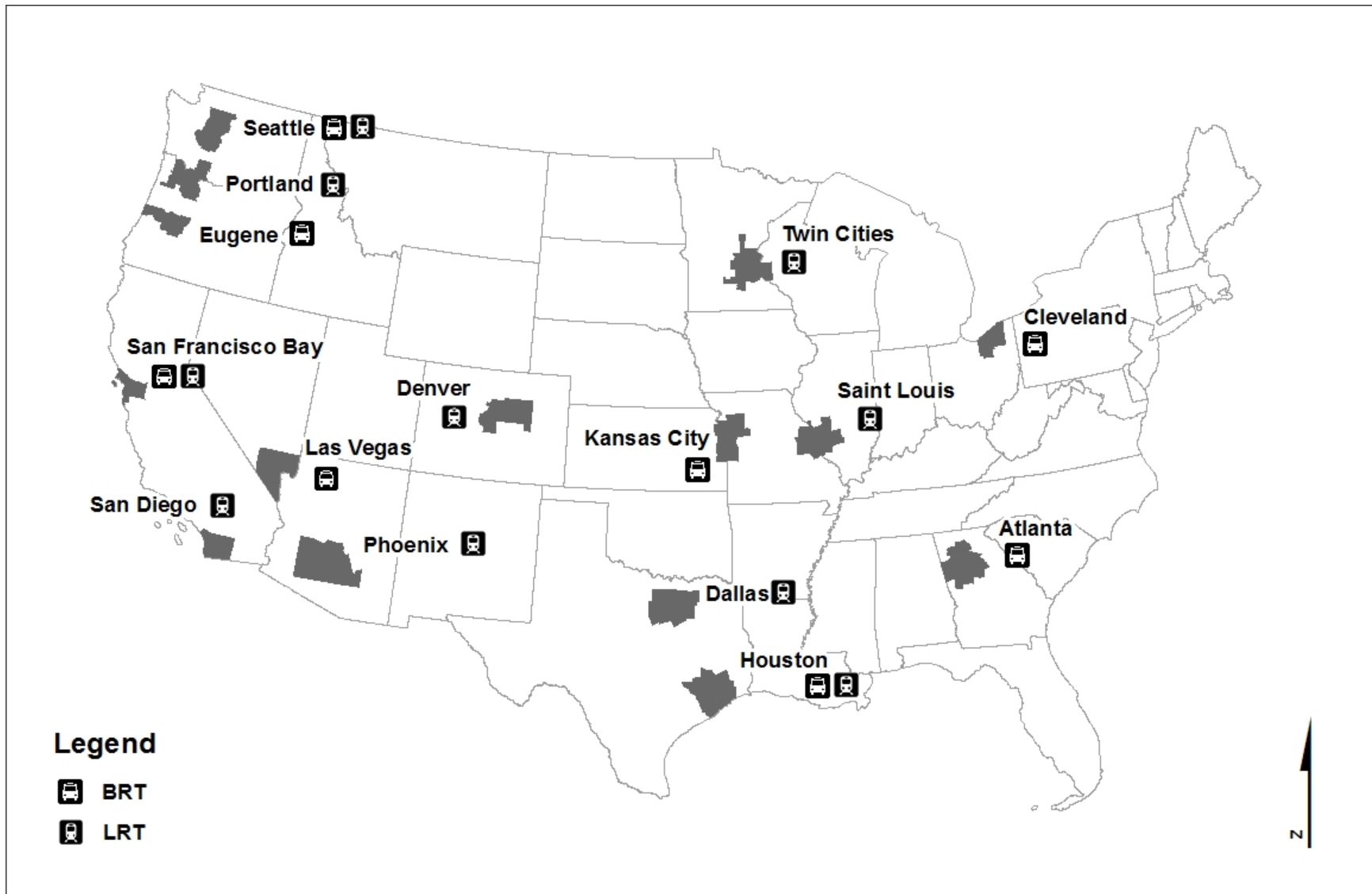


Figure 3-1: Study regions and modes

1.4 Additional BRT Systems

Due to the relatively small number of BRT systems available for analysis, we have decided to broaden the scope of the BRT portion of data collection beyond Twin Cities peer regions. (The unit of observation is the station, not the line, which increases sample size significantly; the inclusion of additional systems further broadens the sample.) Specifically, we include BRT lines in Eugene, Oregon (Lane Transit District, 2014), and Las Vegas, New Mexico (Regional Transportation Commission of Southern Nevada, 2014) to increase the number of our observations and equal the number of peer LRT regions.

1.5 BRT Feature Levels

Bus Rapid Transit can refer to a wide range of specific service features including (or not including) dedicated lanes, signal priority, off-board fare collection, high amenity stations, etc. This wide range of features makes BRT a highly versatile technology, but can complicate comparisons of one BRT service to another, as feature levels are likely related to impacts (Racehorse, Zhang, Sussman, Jian, & Parker, 2014).

Table 3-1: Full list of BRT Systems

Region	Service
<i>Dedicated Guideway—(Similar to proposed Metro Gold Line.)</i>	
Cleveland, Ohio	HealthLine
Eugene, Oregon	EmX
Las Vegas, Nevada	MAX
<i>Arterial—(Similar to planned A Line.)</i>	
Atlanta, Georgia	MARTA Q†
Houston, Texas	Quickline Bellaire
Kansas City, Missouri	MAX
San Francisco, California	AC Transit 1-Rapid & 72-Rapid
Seattle, Washington	RapidRide

†MARTA discontinued BRT branding in 2012 (after the “post-implementation” observation of this study) due to low ridership. The service continues to operate as a numbered, limited-stop route.

The Metropolitan Council draws a distinction between “Arterial BRT” (operating in mixed-traffic on primary, urban surface streets) such as the planned A Line and “Highway BRT” (operating with dedicated lanes or transit advantages) on regional major arterials and freeways such as the Metro Red Line (*2030 Transportation Policy Plan*.2010). With the exceptions of the HealthLine in Cleveland, Ohio and the EmX service in Eugene, Oregon, the BRT services included in the research most closely resemble Arterial BRT in terms of stop spacing and lack of dedicated lanes. (While the goals of specific arterial and dedicated guideway systems may differ, most of the U. S. transit services marketed as BRT most closely resemble the Council’s definition of arterial BRT; our analysis would be incomplete without them.) Data collection and regression modeling tasks will place special focus on differentiating the effects of varying BRT feature levels. Table 3-1 shows the final list of BRT lines included in the analysis.

1.6 Units of Analysis

Within each region, individual BRT and LRT stations implemented between 2003 and 2010 were identified. In addition BRT stations are divided into Arterial BRT and dedicated guideway BRT. The unit of analysis is the station area, defined by a half-mile, network distance buffer around each station, with limited access highways excluded from buffer generation, so as to base station areas only on streets generally offering at least some level of pedestrian access. The buffers generated are non-overlapping: any area within one half-mile network distance of more than one station is always assigned to the closest station.

1.6.1 Joining job data

The Census Bureau's Longitudinal Employer and Household Dynamics (LEHD) database provides annual, block-level job counts for 49 states and the District of Columbia from 2002 to 2011. The database also offers breakdowns by age, wage categories and two-digit NAICS codes. To protect employers' and employees' privacy, the Census Bureau employs a data swapping procedure, which holds total job counts constant at the block level, but may swap age, wage and particularly sector data within block groups. To allow this research to consider wage and sector, block-level jobs data are aggregated to the block group level.

Block groups intersecting station area buffers are then spatially joined to the buffers, using a "closest" merge rule to assign the jobs in a block group intersecting more than one block group to the station they are closest to. In addition, block group level built environment data from the Environmental Protection Agency's Smart Location Database and tract-level sociodemographic data from the American Community Survey are also spatially joined to the station area buffers.

1.7 Job Categories

Not every job is available to every job seeker, and not every job is equally beneficial. For example, extremely high transit accessibility to high-paying white collar jobs is not particularly helpful to a transit-dependent person with a high-school education, unless it comes along with access to jobs that person is more likely to be qualified for. To account for the need for a balance of employment types in transitway station areas, we separately consider jobs paying an annual wage of less than \$40,000 (the low- and medium-wage categories of the LEHD database) and jobs paying an annual wage greater than or equal to \$40,000 (the high-wage category of the LEHD database), and jobs in three sector categories defined roughly by skill level and type of work: blue collar (low-skilled, productive), pink collar (low-skilled, service) and white collar (high-skilled, professional). Slightly less common in the popular imagination than "blue collar" and "white collar", "pink collar" identifies a growing segment of the economy that is differentiated from traditional blue collar employment, and includes generally low wage jobs disproportionately filled by women. Table 3-2 shows a crosswalk from 2-digit NAICS codes to the broad "collar color" skill/work type categories (Fan, Allen, & Sun, 2014). The correspondence to skill levels of individual jobs is limited by the blunt instrument of 2-digit NAICS codes (the finest detail available); the skill categories represent the type of jobs primarily provided by each industry group. In addition, they tend to correspond to education requirements: a skilled, blue-collar trade tends not to require a college degree.

Table 3-2: NAICS to Collar Color Crosswalk

US-NAICS	Sector description	Low-skilled		High-skilled
		Production	Service	
11	Agriculture, Forestry, Fishing and Hunting	X		
21	Mining, Quarrying, and Oil and Gas Extraction	X		
22	Utilities	X		
23	Construction	X		
31-33	Manufacturing	X		
42	Wholesale Trade		X	
44-45	Retail Trade		X	
48-49	Transportation and Warehousing	X		
51	Information			X
52	Finance and Insurance			X
53	Real Estate and Rental and Leasing			X
54	Professional, Scientific, and Technical Services			X
55	Management of Companies and Enterprises			X
56	Administrative and Support and Waste Management and Remediation Services			X
61	Educational Services			X
62	Health Care and Social Assistance			X
71	Arts, Entertainment, and Recreation		X	
72	Accommodation and Food Services		X	
81	Other Services (except Public Administration)		X	
92	Public Administration			X

The following chapter describes the modeling approach used to explain station area job change based on these data. It then presents model results and identifies the strongest practical positive and negative predictors of station area job change.

RESULTS

The station area-level job change, built environment and sociodemographic data described in the previous chapter form the basis of a series of ordinary-least-squares regression models to explain post-implementation station area job change as a function of pre-implementation station area job change, station area jobs at implementation, overall change in the metropolitan job market, transitway mode, as well as built environment and sociodemographic controls. Five models result: one each to predict station area change in blue collar, pink collar and white collar, as well as low-medium and high wage jobs. The models are also clustered by region to account for regional idiosyncrasies unexplained by the region-level control variables.

1.8 Variables

Specifically, the models are based on the following variables:

- **Post-implementation station area job change per year**—The mean annual change in blue collar, pink collar, white collar, high wage or low wage jobs, as appropriate, in the station area from that station’s year of implementation to 2011. This is the response variable.
- **Pre-implementation station area job change per year**—The mean annual change in blue collar, pink collar, white collar, high wage or low wage jobs, as appropriate, in the station area from 2002 to that station’s year of implementation. Included as a measure of pre-implementation employment trends in the station area.
- **Station area jobs at implementation**—The total number of blue collar, pink collar, white collar, high wage or low wage jobs, as appropriate, in the station area in the year of implementation. Included as a measure of the base from which jobs either grow or shrink in the years after implementation.
- **Station area population density**—The gross population density in the station area in people per square mile.
- **Station area job density**—The gross job density in the station area in jobs per square mile.
- **Metropolitan population density**—The gross population density in the region in people per square mile.
- **Metropolitan job density**—The gross job density in the region in jobs per square mile.
- **Post-implementation metropolitan job change**—The mean annual change in metropolitan blue collar, pink collar, white collar, high wage or low wage jobs, as appropriate, from the station’s year of implementation to 2011. Included as a measure of overall regional economic trends.
- **Arterial BRT station**—Binary variable identifying stations served by arterial bus rapid transit, defined as bus service operating primarily or entirely in mixed traffic, but with features including high-amenity stops, off-board fare collection, signal priority, distinctive vehicles and differentiated branding. This category would include the planned A-Line.

- **Dedicated guideway BRT station**—Binary variable identifying stations served by dedicated guideway bus rapid transit, defined as bus service operating mostly or entirely in exclusive lanes and/or a dedicated busway, including high amenity stations, level boarding through multiple doors, and lengthened station spacings. This category would include the proposed Metro Gold Line. (Light rail transit is omitted as the reference category.)
- **Years since implementation**—The number of years elapsed from implementation to 2011. Included to control for potential change in the *rate* of annual job change after implementation (in other words: $\Delta\Delta y$).
- **Street mileage**—The aggregate mileage of streets (excluding limited access highways) in the station area. Included as a measure of the extent and density of the street system in the station area, and as a proxy for pedestrian connectivity to the station itself.
- **Distance from CBD**—The airline distance, in miles, from the station to the region's central business district. Included to account for differences in local economic conditions (and thus the opportunity for job change to occur) based on metropolitan radius.
- **Distance from next station**—The airline distance, in miles, from the station to the nearest other transitway station, whether that station was included in the study, or implemented previously. Included to account for the potential of closely spaced stations to compete with each other for job growth.
- **Poverty rate**—The percentage of station area families living below the Federal poverty line. Included as a measure of station area social conditions.
- **% minority residents**—The percentage of station area residents who do not identify as non-hispanic whites. Included as a measure of marginalized populations in station areas.

Table 4-1 shows descriptive statistics for the variables included in the five models. Mean station area job changes are nearly all negative, both before and after implementation. Consistently near zero medians, however, suggest the means are influenced by a relatively small number of strongly negative outliers, possibly representing areas hit particularly hard by the recession. Station area jobs at implementation skew towards white collar, but also slightly to low wages, reflecting the strong but imperfect correlation between broad sector categories and wage levels. Overall, metropolitan changes in jobs are considerably more positive than station area job changes, and have considerably more similar means and medians, likely reflecting the fact that region-level outliers are considerably less likely than station area level outliers.

Arterial BRT represents nearly half the sample, dedicated guideway BRT 14%. (Light rail, the reference category, accounts for 39% of the sample.) The median year of implementation is 2007, or four years prior to 2011. The mean of 4.26 years since implementation indicates a generally even distribution of station implementations during the study period.

Table 4-1: Descriptive statistics

	Mean	Median	Std. Dev.
"After" station area change in blue collar jobs/year	-11.40	-0.25	225.82
"After" station area change in pink collar jobs/year	-12.85	0.35	164.61
"After" station area change in white collar jobs/year	-6.97	0.83	902.93
"After" station area change in low wage jobs/year	-76.28	-2.50	431.97
"After" station area change in high wage jobs/year	24.90	1.39	575.74
"Before" station area change in blue collar jobs/year	-48.57	-0.75	226.48
"Before" station area change in pink collar jobs/year	-3.86	-0.25	181.46
"Before" station area change in white collar jobs/year	9.00	-0.71	392.51
"Before" station area change in low wage jobs/year	-163.78	-9.00	543.79
"Before" station area change in high wage jobs/year	140.51	1.50	532.46
Station area blue collar jobs at implementation	776.54	27.50	2,396.86
Station area pink collar jobs at implementation	1,163.05	255.00	2,486.43
Station area white collar jobs at implementation	2,738.92	194.00	7,516.17
Station area low wage jobs at implementation	2,400.85	477.00	5,114.03
Station area high wage jobs at implementation	2,155.35	188.50	5,281.32
Station area population density	250,477.10	17,347.47	2,205,579.00
Station area job density	164,976.90	3,708.93	1,366,599.00
Metro population density	621.61	541.79	376.94
Metro job density	279.73	249.65	170.18
"After" metropolitan change in blue collar jobs/year	-1,963.34	-4,862.14	13,452.68
"After" metropolitan change in pink collar jobs/year	9,015.32	2,606.08	15,502.96
"After" metropolitan change in white collar jobs/year	25,073.36	23,756.00	21,829.77
"After" metropolitan change in low wage jobs/year	2,415.04	-6,144.50	31,568.02
"After" metropolitan change in high wage jobs/year	29,524.88	33,255.83	19,553.22
Arterial BRT station	0.47	0.00	0.50
Dedicated guideway BRT station	0.14	0.00	0.35
Years since implementation	4.26	4.00	2.44
Total street mileage in station area	18.13	15.17	12.59
Distance from CBD	6.93	6.37	5.07
Distance from next station	0.50	0.23	0.90
Poverty rate	0.19	0.16	0.15
% minority residents	0.57	0.58	0.27

Mean and median station spacings are relatively short, reflecting the large number of arterial BRT stations. Station areas tend to have a significant, but moderate poverty rate, and tend towards high percentages of minority residents.

1.9 Models

Table 4-2 shows the regression results for all five models. The models have the highest explanatory power for blue and pink collar jobs, as well as low wage jobs, with R^2 values of 0.29, 0.39 and 0.34, respectively. This means the models perform especially well in terms of

predicting the change in entry level station area jobs—a type of employment crucial to improving social equity through transit accessibility.

For blue collar jobs, only pre-implementation station area annual job change, regional population density, regional job density and post-implementation regional annual job change are significant. As one would tend to expect, regional population density and post-implementation regional annual job change both have positive coefficients. However, pre-implementation station area annual job change and regional job density have negative coefficients, indicating that stations with less job growth/more job loss before implementation are expected to have more job growth/less job loss, and that station areas in regions with lower job densities are expected to have more job growth/less job loss. Neither modal variable is significant for blue collar jobs, indicating no significant difference between LRT and either type of BRT considered.

Pre-implementation station area annual job change, as well as total station area jobs at implementation are both significant and negative for pink collar jobs, indicating that low-skilled service jobs grew most (or shrunk least) in station areas that were not already strong centers of pink collar employment before implementation. In this model, both modal variables are significant and negative, indicating less growth/more loss of pink collar jobs in BRT station areas as compared with LRT station areas. Distance from the next station is also significant and negative, indicating that pink collar jobs grow more/shrink less in areas with closely spaced transit stations.

Arterial BRT is significant and strongly negative for white collar jobs; here, though, dedicated guideway BRT is insignificant: the difference seems to be more a function of dedicated guideway vs. mixed traffic as opposed to vehicle technology. Total street mileage is significant and positive, showing an extra 14 jobs for every additional centerline mile of streets, while distance from the central business district is significant and negative, showing roughly 31 fewer jobs for each additional mile away from the CBD.

Low wage jobs grow more/shrink less per year in station areas that had fewer low wage jobs at the time of implementation. However, low wage jobs also grow more/shrink less per year in regions with stronger overall job growth/less overall job loss. Once again, arterial BRT is significant and negative, while dedicated guideway BRT is insignificant. Total street mileage is also significant and positive.

Table 4-2: Ordinary least-squares regression models

<u>Response Variable: "After" station area change in job category/year</u>					
Model	Blue Collar	Pink Collar	White Collar	Low Wage	High Wage
N	452	452	452	452	452
R ²	0.29	0.39	0.19	0.34	0.17
<u>Explanatory Variables:</u>					
"Before" station area change in job category/year	-0.239578 *	-0.249334 **	-0.068258	0.060847	-0.022962
Station area job category at implementation	-0.047083	-0.031167 **	-0.003706	-0.034538 ***	0.007877
Station area population density	-0.000004	-0.000007	-0.00005	-0.000028	-0.000025
Station area job density	0.000007	0.000005	-0.000077	-0.000032	-0.000036
Metro population density	0.65252 *	-0.075136	0.397585	0.470306	1.671492
Metro job density	-1.415145 *	0.087602	-1.217109	-1.071993	-4.014436
"After" metro change in job category/year	0.002031 ***	0.000615	0.001898	0.001104 **	0.00359 **
Arterial BRT station	-21.62506	-60.65815 **	-239.9056 **	-96.5944 *	-173.5404 **
Dedicated guideway BRT station	-15.97912	-94.22882 *	-65.59411	-13.00526	-53.1281
Years since implementation	-7.10035	7.352733	15.661779	-0.959224	10.823119
Total street mileage in station area	1.849726	0.37162	13.867455 **	6.414003 **	8.743176 ***
Distance from CBD	0.172705	2.172807	-31.32611 **	-11.84071	-16.65769 **
Distance from next station	-12.34536	-18.65301 *	0.136604	10.113292	-35.28345
Poverty rate	-175.5977	-4.489162	-479.8767	-177.3435	-578.2333 *
% minority residents	-5.369403	26.78682	479.04102	163.04812	302.06956
Constant	57.389599	23.13144	-87.62029	-14.13271	-45.57067

*p<0.1; **p<0.05; ***p<0.01

High wage jobs grow more/shrink less per year in regions with more positive post-implementation employment trends. As with low wage jobs, arterial BRT is significant and negative, dedicated guideway BRT is insignificant, and total station area street mileage is significant and positive. Distance from the CBD is also significant and negative for high wage jobs, echoing the pattern found for white collar jobs. The station area poverty rate is significant and negative as well.

1.10 Standardized Coefficients

While OLS regression coefficients can be directly interpreted in terms of the change in post-implementation station area annual job change associated with one unit of change in each explanatory variable, the explanatory variables themselves have widely differing units and ranges. This fact makes interpretation of their relative practical importance difficult: whether one percentage point of poverty rate is “more” than one mile of street is not a question with a meaningful answer on its face. Standardized coefficients, however, which describe the change in the response variable associated with one standard deviation change in each explanatory variable, allow the significant variables in each model to be ranked in order of their practical importance.

Table 4-3: Significant standardized coefficients, blue collar jobs

Metro population density	245.96	Most positive
"After" metro change in blue collar jobs/year	27.328	↑
Total street mileage in station area	23.297	
"Before" station area change in blue collar jobs/year	-54.26	↓
Station area blue collar jobs at implementation	-112.85	
Metro job density	-240.829	Most negative

Table 4-3 shows standardized coefficients for significant explanatory variables from the blue collar jobs model. Metropolitan population density has by far the strongest impact on blue collar jobs, followed by overall blue collar job change after implementation and station area street mileage. Oddly, metropolitan job density is the strongest negative predictor, followed by total blue collar jobs in the station area at implementation and pre-implementation station area blue collar job change. Given the period of implementation, this pattern may partly be explained by a “bounce back” effect in the later years of the recession.

Table 4-4 shows standardized coefficients for significant explanatory variables from the pink collar jobs model. All are negative. The most strongly negative are pink collar jobs at implementation and the pre-implementation trend in pink collar jobs. Next, with very similar standardized coefficients, are both BRT modes, indicating that the most important modal difference in station area pink collar employment is simply between rail and bus, with little difference between the two BRT modes. Distance from the next other station is the weakest negative predictor of pink collar jobs.

Table 4-4: Significant standardized coefficients, pink collar jobs

		0
Distance from next station	-16.749	
Arterial BRT station	-30.296	↓
Dedicated guideway BRT station	-32.672	↓
"Before" station area change in pink collar jobs/year	-45.244	
Station area pink collar jobs at implementation	-77.494	Most negative

Table 4-5 shows significant standardized coefficients from the white collar jobs model. For white collar jobs, the total mileage of streets in the station area is the strongest positive predictor of white collar job change, followed by the percentage of minority residents in the station area. (In interpreting this result, it would seem important to bear in mind that both California and Texas, with two participating regions each, have majority minority populations and strong economies. This finding may not hold true for majority-white regions like the Twin Cities.) Distance from the central business district is the strongest negative predictor, likely reflecting centralization of high wage jobs, followed by arterial BRT.

Table 4-5: Significant standardized coefficients, white collar jobs

Total street mileage in station area	174.658	Most positive
% minority residents	130.881	↑
Arterial BRT station	-119.821	↓
Distance from CBD	-158.77	Most negative

Total station area street mileage in the station area is also the strongest positive predictor of low wage job change, as shown in Table 4-6, followed by the overall annual, metropolitan change in low wage jobs. The number of low wage jobs in the station area at the time of implementation, however, is the strongest negative predictor, followed by arterial BRT.

Table 4-6: Significant standardized coefficients, low wage jobs

Total street mileage in station area	80.783	Most positive
"After" metro change in low wage jobs/year	34.845	↑
Arterial BRT station	-48.244	↓
Station area low wage jobs at implementation	-176.629	Most negative

Once again, total station area street mileage is the strongest positive predictor of high wage job change, as shown in Table 4-7. The percentage of minority residents in the station area is the second strongest, echoing the similar finding for white collar jobs, followed closely by the overall, regional change in high wage jobs. The three negative predictors have nearly equal strength, with poverty rate the strongest by a thin margin, followed closely by arterial BRT and distance from the central business district.

Table 4-7: Significant standardized coefficients, high wage jobs

Total street mileage in station area	110.119	Most positive	
% minority residents	82.53		
"After" metro change in high wage jobs/year	70.197	↑	0
Distance from CBD	-84.426		
Arterial BRT station	-86.675	↓	
Poverty rate	-89.395	Most negative	

The following chapter presents the key conclusions that can be drawn from these results. It offers general recommendations for maximizing job growth in BRT station areas, and discusses implications of the results for specific Twin Cities BRT pr

CONCLUSIONS

The coincidence of the period studied and the Great Recession makes the forward projection of post-implementation trends problematic. This problem is exacerbated by the overall trend of job sprawl through the early 2000s and, to some extent, throughout the study period. The general trend of jobs shifting outward coupled with the fact that both BRT and LRT lines tend to be implemented primarily in central cities and inner suburbs means that metropolitan-wide economic controls may not provide as appropriate a baseline as initially hoped for the job impacts of transitway stations relative to otherwise similar areas without stations.

Despite these limitations, the models provide important insight into the conditions that lead to positive employment outcomes in station areas. These conditions are critical to understand, as they point to the most fruitful policy interventions for promoting station area job growth. The most important local strategies for encouraging station area job growth appear to fall into two general categories: the form taken by the transitway itself and “last mile” access within the station area.

The finding of station area street mileage as a significant, positive predictor of jobs after implementation for all but one of the models and as the strongest positive predictor in three of five underscores the importance of fine-grained connectivity between BRT stations and their surroundings. (Bear in mind that the models control for distance from the central business district; this finding is not merely a result of concentrated downtown employment.) This appears to bode well for the planned A Line, which primarily serves areas with a dense street grid. While transit providers have no direct control of station-area street systems, the cities they work with to implement BRT projects do. Streetscape improvements along corridors themselves are a common feature of BRT projects; it seems street system improvements in station areas may be important features to consider as well. It is important to note that only streets are considered in the model, due a lack of national data on paths and trails. Our hypothesis for the importance of station-area street mileage is that it serves as a measure of pedestrian connectivity within station areas, as well as to and from stations. As such, it is entirely possible that the addition of trails, pedestrian cut-throughs, etc. in suburban station areas with a sparser, less connected street system may have a similar effect as the addition of street mileage. This may be important for many highway BRT lines in the Twin Cities serving already-developed suburban areas. Providing street connections in Metro Red, Orange and Gold Line station areas seems to be a critical step in attracting jobs.

The consistent finding of Arterial BRT as a significant, negative predictor of station area job change, as well as the finding of dedicated guideway BRT (as compared with LRT) as a negative for pink collar jobs indicates that transitway modes matter when determining economic impacts. In particular, fixed infrastructure matters. It appears, however, that the greatest difference is between some type of fixed infrastructure (wheel and propulsion technology notwithstanding) and no continuous fixed infrastructure. This finding indicates significant potential for attracting jobs to proposed dedicated guideway BRT stations, as on the Orange and Gold Lines, by taking advantage of the lure of a fixed guideway. It also seems to highlight the importance of branding and marketing for Arterial BRT projects, with the aim of creating as strong a perceived corridor identity as possible. A worthy goal for the A Line might be for the words “Snelling Avenue” to conjure up an image of a rapid bus as reliably as the words “University Avenue” conjure up an image of a train.

The strength of distance from the central business district as a negative predictor of both white collar and high wage job growth seems to potentially reinforce a pattern of high status jobs in the urban core, juxtaposed against lower status jobs farther out. This pattern raises the specter of spatial mismatch—a common tendency for jobs located closest to the homes of poor, minority and transportation-disadvantaged workers to require qualifications they are unlikely to have. Of course, transitway implementation in and of itself can act as a powerful countermeasure against spatial mismatch by offering affordable, convenient regional mobility to marginalized populations. However, these social equity benefits will be strongest in instances where transitway implementation actually helps lessen spatial mismatch, as opposed to merely mitigating its effects. Twin Cities BRT projects have the potential to be social equity promoters, but it will be important to consider the types of jobs attracted to station areas in different parts of the region to maximize this benefit.

The importance of regional factors—such as the metropolitan rate of job change after implementation—in determining changes in station area jobs demonstrate that the power of transit providers, cities and station area plans is far from absolute. In one sense, this result might be seen as putting some aspects of station area economies beyond the reach of transit planning stakeholders to influence. In another sense, however, it speaks to the importance of broad, regional policies that support economic growth, or which at least avert obstacles to it. In addition, the fact that station area employment in blue collar, low wage and high wage jobs does significantly better in regions with stronger overall job growth indicates job growth around transitways is not merely a case of station areas cannibalizing other employment centers but one of station areas participating in a pattern of general growth. Finally, to the extent a high-quality regional transit system supports the regional economy by improving labor supply access, supporting consumer demand through transportation cost savings and providing a hedge against (or at least an alternative to) gridlock, each new transitway station implemented can be said to play some role in supporting job growth in other station areas.

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