Unaffordable Fare:
The cost of public transportation for low-income commuters working at three airports

By

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Submitted to the Department of Urban Studies and Planning
in partial fulfillment of the requirements for the degree of

Master in City Planning

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

February 2015

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ABSTRACT

For airport employers, making sure the many low-income people they employ as baggage handlers and retail salespeople, amongst others, can get to work ensures the continued efficient operations of the airport and the prosperity of the regional economy. However high and increasing costs coupled with low-wages make commutes unaffordable and constrain employees' ability to get to their job. Using case studies of Chicago Midway International Airport (MDW), Denver International Airport (DEN), and San Diego International Airport (SAN), this research measures the extent to which low-income employees commuting to work at the airport by public transportation can afford their commute in 2011. The results of this analysis suggest that the cost of commuting on public transportation is beyond the means of a low-income budget. Furthermore, fewer low-income commuters take public transportation as the affordability of public transportation declines, suggesting that affordability contributes to outcomes of spatial mismatch. These results promote interventions to increase affordability and expand accessibility to public transportation for low-income commuters to the airport.

Thesis Supervisor: Amy Glasmeier
Title: Professor of City Planning

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CHAPTER 1: Introduction

In 2014, the incomes of at least 19 million families are not high enough to cover the costs of their basic needs *(1)* and their cost of living is only expected to rise *(2)*. By most accounts, families need to earn more than the federally mandated minimum wage of $7.25 per hour to get by in 2014 *(1,3)*, but there are more and an increasing number of jobs that do not pay enough following the Recession *(4)*. Amidst an economy of high costs and less opportunity to keep up, the working poor may struggle to find and sustain employment that pays for their expenses including, but not limited to, the cost of getting to and from work *(5-7)*.

Public transportation is the means by which many low-income workers get from their homes to work *(6)*. When making decisions about where to live, low-income workers consider the availability of public transportation *(8)* and they are more likely to use public transportation than other income groups to get from home to work *(9)*. This holds true, even though low-income workers have lower levels of service and infrequent availability of public transportation *(10,11)*. For many low-income commuters who are unable to afford to purchase and maintain a vehicle, public transportation is the only means to get to work *(12-14)*.

Of employers well connected to public transit, airports supply many jobs for low-skill and low-wage workers, predominantly as baggage handlers and in retail shops *(15,16)*. And at airports, these positions pay more than other comparable low-skilled infrastructure occupations *(17)*. By providing for business travel, tourism, and trade, airports are also regional economic assets. They create new business that expands commerce and wealth even beyond their physical footprint *(18)*.

Building from research previously in siloes of spatial mismatch analysis and basic needs budgeting, I establish a method to measure whether low-income employees can afford to commute by public transportation to work at the airport in 2011. The results of this analysis demonstrate that the cost of public transportation to three case study airports in Chicago, Denver, and San Diego is unaffordable for employees who are commuting on a low-income budget by public transportation. Furthermore, the least affordable public transportation commutes have fewer commuters on average than other commutes, suggesting that affordability contributes to spatial mismatch. Ultimately, the results of this paper support policies that make jobs more accessible and commutes more affordable for low-income employees.

CHAPTER 2: Why Might Low Income People Not Be Able to Get to Work?

Over the last 50 years, researchers have identified persistent disadvantages associated with the inability of low-income workers' ability to access work. In the 1960s, after observing the problem of concentrated unemployment in inner-city, black neighborhoods, John Kain's work showed that a discontinuity exists between the home location of workers and their proximity to job opportunities. As the distance from home to jobs increased, the likelihood of employment declined *(19)*.

From the early 1990s onwards, studies expanded the scope and replicated the findings of Kain's spatial mismatch theory for different types of people by race *(20-24)*, gender *(25)*, income *(26)*, skill-level *(27-30)*, and commuting origin *(31)*. Subsequent researchers reinforced these early findings and concluded that physical distance, time spent commuting, and absolute costs of transportation to suburban labor markets adversely affected poor, inner city, and, in particular, minority labor market participation *(32-42)*.[1]

Since 2000, in research spanning disciplines of economics, geography, anthropology, and sociology, researchers focused not only on characterizing spatial mismatch, but also on identifying its root causes *(64)*. Thus far, researchers pinpoint factors including metropolitan size *(28,65)*, relocation of households *(66-70)*, relocation and dispersion of jobs *(21,71-74)*, vehicle *ownership (9,14,29,55,75,76)*, as well as the availability, organization, and extent of the road *(77)* and public transportation network *(30,78,79)* as contributing factors to spatial mismatch.

Together, these studies have identified and characterized many facets of spatial mismatch and explained their contribution to poor labor market outcomes such as concentrated unemployment in poor neighborhoods and available employment positions left unfilled. Yet, poor labor market outcomes persist. This truth points to the possibility that there may be factors contributing to spatial mismatch, such as the affordability of commutes, not fully explored.

In the next section, I review the challenges facing low-income workers when it comes to affording the high costs of living on a constrained budget. In response to insufficient wages, I

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[1] Researchers have also sought alternate explanations, evaluating the mediating effects of a-spatial factors such as discrimination in housing *(43-54)* and hiring *(55-57)* as well as skill and information mismatches *(58,59)*, whereby workers do not have the requisite information *(60)*, qualifications *(29, 39, 61)*, or social networks *(62,63)* to find and gain employment.

acknowledge municipalities along with other large employers, including airports, which have made progress towards ensuring wages are high enough to meet their workers basic needs while continuing the efficient operations of their business.

CHAPTER 3: What Can Low-Income Workers Afford?

From the 1960s onwards, the federal poverty threshold was used to establish eligibility for income supports from government agencies. However the poverty measure falls short of measuring the extent to which low-income people can achieve financial self-sufficiency. In particular, poverty thresholds take into consideration only the cost of a basic food budget, excluding costs like childcare and health care that not only draw from a family's income but also influence a family's ability to work. Poverty thresholds also do not account for geographic variation in the calculation of cost.[2]

3.1 Municipalities use Basic Needs Budgeting to Assess Needs

In order to determine whether families were meeting self-sufficiency goals on their existing wages, as set out in welfare reform legislation such as the Personal Responsibility and Work Opportunity Reconciliation Act *(3)*, in the late 1990s, a number of municipalities began to construct an alternate measures of a family's basic needs *(10,81-86)*. Basic needs budgets determine the minimum employment earnings necessary to meet a family's basic needs, without risking food and housing insecurities. Unlike the poverty measure and minimum wage, basic needs budgets are adjusted for local conditions, inflation, and family characteristics including the number of working adults and the number of children in a family (15).

Basic needs budgets are constructed using a market-based approach, compiling known or predicted expenditures for families' food, childcare, housing, transportation, healthcare, and other basic necessities *(1,87-90)*. Notably, a basic needs budget does not include money for meals eaten out of the home, entertainment, vacations or holidays, savings, investment, or capital purchases such as purchasing a home. Thus a basic needs budget can be considered a minimum threshold of self-sufficiency.

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[2] The supplemental poverty measure, developed in 2010, includes more expenses and adjusts for geographic variability in the cost of housing. However, the supplemental poverty measure is not used to qualify families for federal assistance. Rather it is only used as an alternative measure of well-being *(80)*.

3.2 Living Wage Laws are Enacted

After finding that wages were in fact too low for self-sufficiency, municipalities mandated higher wages to compensate for basic needs. Since the first 'living wage' law to legislate wages that compensate for a family's basic needs went into effect in Baltimore City in 1994, more than one hundred municipalities have implemented living wage ordinances *(91-95)*. Also, the Economic Policy Institute and Massachusetts Institute of Technology created basic needs budgeting tools to support new legislation with consistent estimates of the budget for low-income families' needs and comparisons to the minimum wage *(1,96)*.

3.3 Wages are Increasing at Airports

More recently large employers, including airports, are introducing living wages for their employees *(16,97)*. These wage ordinances come as a result of observations that low wages at airports were resulting in low employee productivity, high employee turnover, low service quality and unacceptable security standards *(16)*. For example, amongst 19 major airports, pre-board security screeners, who are often paid near minimum wage salaries, averaged an annual turnover of 110% in 2003, costing an estimated $4,275 in turnover costs to airport employers per worker *(16)*.

Two prominent examples of airports implementing wage ordinances are San Francisco International Airport and Seattle-Tacoma International Airport. In 1998, a living wage ordinance at San Francisco International Airport mandated a minimum wage of $9 with benefits or $10.25 without benefits for all workers in security areas or performing security functions at the airport *(16)*. Following the lead of San Francisco, in 2014, the City of SeaTac passed the Proposition One ballot measure, raising the minimum wage at Seattle-Tacoma International Airport to $15 per hour *(97)*.

3.4 The Effects of Living Wage Laws at Airports

After the implementation of the living wage laws, most of the negative externalities of low-wages were erased. At San Francisco International Airport, wage increases coincided with increases in employee productivity, morale, and customer service along with reductions in

employee turnover and disciplinary issues *(16)*. When cost savings from productivity gains were factored in, airport employers generated revenue from making an investment in higher employee wages *(16)*.

As this paper focuses on the ability of commuters to access jobs at the airport, I now turn to a discussion of the role of airports in regional economies. In addition, I explore the nature of public transportation at airports including both the length and cost of commutes for employees.

CHAPTER 4: Airports are an Asset to Metropolitan Economies

Airports are a large and increasingly important part of the metropolitan economies in which they are embedded. Beyond their most obvious function of providing for travel, tourism, and trade, airports supply much needed jobs for low-skill and low-wage workers, predominantly as baggage handlers and in retail shops *(16)*. These positions also on average pay more than other low-skilled infrastructure occupations *(17)* and the need for employees is growing at one of the fastest rates amongst infrastructure occupations; the replacement rate of air traffic controllers and airfield operation specialists, for example, is over 44.1% from 2012 to 2022 *(17)*.

The physical asset of the airport has also shown to attract commerce, creating more jobs and wealth in regions *(98,99)*. Airports further economic growth by promoting trade and connecting communities to a broader range of resources including telecommunications, education, and hospitals *(18)*. In this way, airports create jobs for more workers, even beyond their geographic boundaries.

4.1 Public Transportation Connects Employees to the Airport

Airports are often served by more than one mode of public transportation *(15)*. In airport planning documents, the road and public transportation networks to airports are explicitly considered, although not necessarily for employees *(15,100)*. This suggests that airports may perhaps be accessible work destinations for public transportation commuters.

Commutes to Airports are Long

While airports may be well connected to existing public transportation infrastructure, they are often located far from downtown and require a long commute *(15)*. For example, when Denver International Airport relocated from its downtown Stapleton location in 1994, to a new location 27 miles outside of the city center. In the planning documentation for the new, Denver International Airport, the commission cited both a desire to expand and to reduce noise complaints from neighbors as primary considerations for the selection of a new site. Ultimately, residential development nearby the new location was explicitly prohibited *(101)*. For employees commuting to airport destinations, the 31-minute commute to Denver International Airport from downtown Denver is not uncommon *(15)*.

Commutes to Airports are Expensive

In addition to long commutes, some public transportation agencies charge a surcharge for those commuting by public transportation to the airport. For example, the Chicago Transit Authority (CTA) charges a $2.75 surcharge for commutes on the CTA Blue Line to Chicago O'Hare International Airport. This surcharge more than doubled the total fare of other commutes ($2.25) on the same public transportation system and line. In the absence of employee exemptions, which notably were later enacted in the Chicago O'Hare example, surcharges on public transportation to airports make airport commutes more expensive than the standard fare for commutes by public transportation *(102)*.

CHAPTER 5: Establishing a New Methodology

As the previous discussion suggests, spatial mismatch between workers and job sites can lead to higher unemployment of specific groups *(19,32)* and can result in lost productivity of employers *(16)*. Such a mismatch can arise due to a lack of transportation to and from the work place. Absent car ownership, low-income workers must rely upon friends or, if available public transportation *(6)*.

When the working poor cannot afford to get to their job at the airport, this generates issues for commuters, employers, airline passengers, and the regional economy. The lack of an efficient, timely and ready workforce at airports leads to higher costs, less certainty and lower productivity for airport employers. And ample evidence suggests inefficiencies due to labor shortages and unproductive workforces have resulted in record delays and higher costs to consumers *(103)*. Importantly, interruptions in airport operations, such as security screening and baggage handling, may place passenger security at risk *(16)*.

5.1 An Overview of the Four Stages of Analysis

In this paper, I examine the extent to which public transportation is affordable for low-income employees commuting to the airport. To do so, I undertake four stages of analysis. First, I identify three case study airports as the focus for the remainder of this paper. For each case study, I then determine who commutes to the airport for work and how many are low-income commuters. Once the pool of commuters is established, I narrow the focus to identify only those who could reasonably use public transportation to get to and from work, based on the availability and accessibility of public transportation. Finally, for those commuters that remain, I ask how affordable is the commute?

Select Case Studies

In this section, I describe the case study selection process and the resulting characteristics of selected airports. The use of case studies follows in the tradition of spatial mismatch and basic needs budgeting research *(104)*. Economists, sociologists, and geographers, for example use case studies to evaluate the effect of housing vouchers that moved employees closer to work

in select cities *(105)*. Similarly, economists and public policy analysts evaluate the effects of municipal living wage ordinances on local labor market outcomes *(81-86)*.

Starting with an original list of 35 commercial airports accessible by public transportation, I chose three airports as cases for this paper: Chicago Midway, Denver International, and San Diego International Airports. I selected these airports based on the availability of data and the consistency of geographic boundaries that enabled the compilation of datasets from multiple sources. I define the airports selected using a variety of characteristics including geographic size, number of commuters, distance from downtown, and the availability of public transportation (See Table 1).

TABLE 1. Comparison of Case Study Airports in 2011.

	Airport Size *(106)*	**Commuters** *(107)*	**Public Transportation Systems** *(108)*	**Distance from Downtown** *(15)*
Chicago Midway International	1.3 sq miles	6,456	Chicago Transit Authority (bus and rail) and PACE (suburban bus)	11.8 miles
Denver International	35.7 sq miles	12,151	Denver Regional Transportation District (Skyride express bus)	27 miles
San Diego International	1.0 sq miles	2,996	Metropolitan Transit System (local bus)	3 miles

Of the case studies, Denver International airport is the largest airport, in terms of geographic size and number of commuters *(106,107)*. It is the furthest of the three case studies from downtown *(15)* and has only one option for public transportation, the Skyride express bus operated by the Denver Regional Transportation District *(108)*. San Diego International is the smallest airport case in terms of geographic size and number of commuters *(106,107)*. Only one local bus route services the airport, however the airport is located in the heart of downtown San Diego *(15, 108)*. Chicago Midway International is smaller than Denver but larger than San Diego International Airports in terms of geographic size and the number of commuters *(106,107)*. It also ranks in the middle in terms of distance from downtown *(15)*. Unlike the other two airport cases, Midway can be accessed by multiple, highly trafficked systems of public

transportation including the Chicago Transit Authority (CTA) rail as well as the PACE suburban bus *(108)*.

Identify Commuters to the Airport

In the first stage, I determine who commutes to the airport from within the same metropolitan area using the Longitudinal Employment-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES), a dataset published annually by the US Census Bureau. Unlike surveys that use estimation techniques to model commuter flows, LODES data reports the home origin and work destination of 90% of all commuters in the US from federal administrative records linked by employee social security numbers and employer identification numbers *(109)*.[3]

For later comparison, I also identify commuters to the airport from within the same metropolitan area who earn low-incomes, between $15,000 and $39,996, using the LODES data. I select this wage band because it approximates what families need to afford their basic expenses in 2011 for housing, food, transportation, health care, childcare, and other necessities according to the MIT Living Wage Calculator estimate of basic needs *(1)*.

In summary, this step processes LODES data to identify a subset of workers who commute to the airport from within the same metropolitan area. It excludes those who do not commute, those who commute to work destinations other than the airport, and those whose homes fall outside of the metropolitan area where the airport is located. Furthermore, it subsets commuters by their income level, differentiating low-income commuters from all commuters.

Identify Public Transportation Commuters

In the next stage of this analysis, I identify commuters that might use public transportation to get to and from work. To do so, I exclude commuters to the airport who do not have public transportation nearby and those for whom it might take too long to get to work using this mode. To confirm that public transportation is available, I search for an existing route from a commuter's home to the airport using Google Transit. Then, using data created by the

[3] Social Security numbers and employer ID numbers are compiled from wage records, employer reports, administrative demographic information, and economic censuses *(110)*.

Brookings Institution, I determine whether a commuter in the LODES data can access the airport from their home in an average of less than 60 minutes one-way by public transportation. I summarize the characteristics of these commuters by the number of commuters who can commute in less than 60 minutes and their average commute time by public transportation.

Previous analysis has attempted to isolate the number of public transportation commuters from all commuters, most frequently using the Census Transportation Planning Products (CTPP) *(111)*, which reports commuters by mode. For this paper, LODES was preferred to CTPP for three reasons. First, LODES data was available in 2011, consistent with the remainder of the data in this paper, whereas CTPP was only available through 2010. In addition, LODES uses counts of commuters, not estimates compiled from surveys, and therefore has a smaller margin of error in reported values. Lastly, LODES characterizes commuters by their level of income, whereas CTPP does not. These characteristics of income vitally helped determine which of all commuters might have difficulty affording the costs of public transportation.

Evaluate the Affordability of Public Transportation

For the identified commuters – those who commute to the airport from within the metropolitan area and for whom public transportation is an available and accessible option - in the final stage of this paper, I generate a "ratio of affordability" of public transportation. The ratio of affordability is constructed by comparing the share of a low income spent on public transportation fares to the share of a basic needs budget set aside for public transportation, as per the MIT Living Wage Calculator in each of the metropolitan areas in which the case studies are contained in 2011.

In addition to the base fare, the time commuters spend commuting costs them money in foregone productivity and wages *(6,112)*. Therefore, I re-calculate an alternative ratio of affordability that takes into account the estimated average time employees spend commuting. In comparison to the ratio of affordability that only takes fares into consideration, this alternate measure of the ratio of affordability shows that longer commute times are less affordable than shorter commutes.

In the next section of this paper, I elaborate on each of the stages of the method introduced here. Because my method of determining affordability is novel, this section provides

detailed descriptions of sub-steps, data sources, geographic transformations, and other methodological decisions made prior to reporting the results of this analysis and their implications for policy.

CHAPTER 6: Stage 1 - Selecting Case Studies

The case study site selection was first informed by existing research on travel patterns to and from airports *(15,113, 114)*. From this literature, I compiled a list of 35 commercial airports about which research on travel patterns had previously been conducted.

I narrowed the list of 35 public transit-accessible airports based on three criteria. First, data must be available to describe the commuting patterns in the metropolitan area of each airport. Second, data on commuting patterns and average commute times must be reported in comparable geographies, or be able to be transformed to comparable geographies. Lastly, publically available data about the number of commuters must be a reliable proxy for the number of employees working at airports. Only three case study locations of the initial 35 met all three of these criteria. These cases are: Denver International Airport (DEN), Chicago Midway International Airport (MDW), and San Diego International Airport (SAN).

CHAPTER 7: Stage 2 - Identify Commuters to the Airport

After selecting case studies, I establish the number and origin of people who commuted to the airport in 2011 using the annual US Census Bureau's Longitudinal Employment-Household Dynamics (LEHD) Origin-Destination Employment Statistics (LODES) *(107)*. LODES, unlike other counts of employees, includes geographic linkages between home origins and work destinations for those who commute.[4] It does not however differentiate commuters based on their mode of transportation to work or whether they are full-time or part-time workers.

7.1 Transform LODES Data

Unfortunately 2011 LODES data is reported using geographies that are inconsistent with all of the other datasets I employ in this paper. Therefore, before proceeding, I transform the LODES data in two ways, namely into geographies that are consistent with the unit size (Census Tracts) and vintage (2008 Census geographic definitions) of the remainder of the data. It is vital to take this step in order to avoid false comparisons between different units of analysis.

Transform Into Consistent Census Tract Unit

First, I transform the size of the geographies to report the number of commuters from Census Tract origins, instead of Census Blocks. Luckily, Census Blocks are smaller units and contained entirely within Census Tracts, and this transformation is easily accomplished by summarizing the number of commuters who originate in Census Blocks to the higher order of Census Tracts.

[4] In order to assess the affordability of public transportation commutes, this paper starts with a population of commuters, rather than a population of employees. This is because a count of employees includes teleworkers, off-site workers, and contractors that do not commute to the airport *(15)*.

Transform Boundary Definitions into Consistent Year

For the second transformation, I convert the vintage of the Census Tract boundaries from 2010 Census geographic definitions into 2008 Census geographic definitions.[5] The two different vintages are artifacts of the US Decennial Census. With each Decennial Census, the Census Bureau evaluates and redraws the boundaries of Census Tracts to adjust for shifts in population over the course of the previous ten years.[6] While most Tracts remain unchanged from 2008 to 2010, some are split, combined, or redrawn entirely.

For those Tracts that were split or redrawn entirely from 2008 to 2010, I accomplish a vintage transformation using the Longitudinal Tract Database (LTD). The LTD is an open-source statistical programming script created to help facilitate research that uses data collected before and after the Census Bureau's Decennial Census, when geographic boundaries may be redrawn. The LTD creates consistent comparisons across geographic vintages by apportioning population values using population- and area-based weighting *(116).*[7] For the vast majority of Tracts that were either combined or remained unchanged from 2008 to 2010, it was not necessary to transform the vintage using weighting techniques. Instead, the values reported were either summed or transferred directly.

7.2 Narrow to Airport Commuters Only

Thus far, I compiled and transformed data for all commuters, thereby establishing the number of commuters in 2011. Next, I narrow the focus, isolating only those who commuted to

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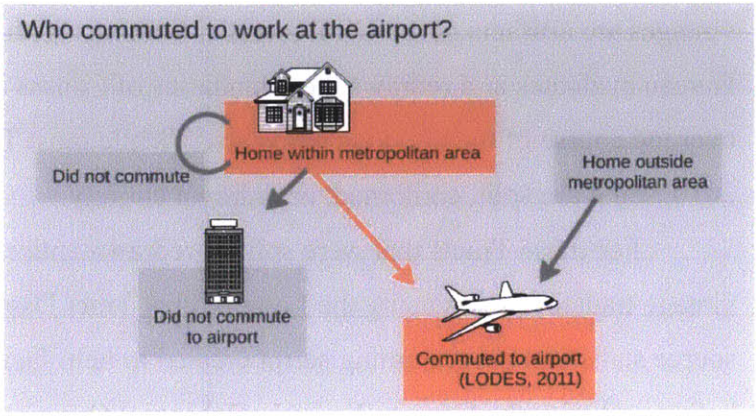
[5] It was necessary to convert the LODES data into an older version of geographic boundaries because Brookings Institution data used in this paper could not be brought forward into contemporary geographic definitions without rerunning an expensive, proprietary model. While it makes sense to have the analysis completed in the most contemporary boundaries if possible, the vintage does not significantly change the results in the aggregate.

[6] In each iteration, the Census Bureau aims to apportion approximately the same number of people in each Tract, this equated to between 1,500 and 8,000 people with an optimum size of 4,000 people in the contiguous US in 2008 *(115).*

[7] The impact of Tract transformation on the results of this paper is almost negligible for two reasons. First, the number of impacted Tracts is small; most Tract boundaries remain unchanged from 2008 to 2010. Second, in selecting the case studies, I excluded airports that were located in a Tract that required a transformation. This choice avoids compounding error in estimation of both the origin and destination Tract.

the airport. Then I characterize these commuters to the airport by income, keeping all commuters and those who earn low-incomes for comparison.

This paper considers only those who commuted from home to work at the airport from within the same metropolitan area[8] and excludes those who commuted to other work destinations, those who did not commute, and those who commuted to the airport from other metropolitan areas. To facilitate this narrowing, I identify the Census Tract(s) in which the airport is predominantly contained (See Figure 1) and keep only those observations of commuters in the LODES 2011 survey of commuters that had this Tract(s) as their destination.



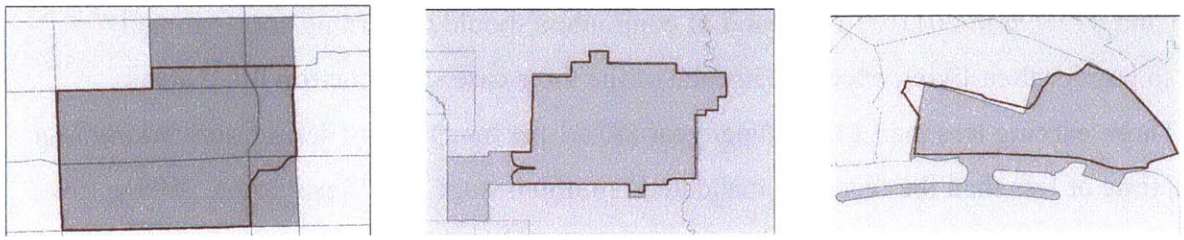
I make the methodological leap that the Census Tract could be considered the equivalent of the airport only after overlaying the geographic boundaries of the airports on Census Tracts boundaries and confirming that the airport footprint conforms very closely to the Census Tract in which they are contained (See Figure 1).[9] In Chicago and Denver, the airport footprint is contained entirely within the Census Tract used as a proxy. In Chicago, the airport Tract used as a proxy for Chicago Midway International Airport is 1.65 square miles, of which the airport comprises 77% of the land area. Similarly in Denver, the geographic footprint of Denver International Airport comprises 84% of the airport proxy Tract's 42.29 square miles. In San Diego, the geographic footprint of San Diego International Airport overlaps the Census Tract Boundary. The airport Tract and airport are ultimately about the same size – the geographic

[8] For this paper, I also require commuters to have originated from within the metropolitan area because Brookings Institution data is only available for commutes within metropolitan boundaries.

[9] This qualification led to the exclusion of airports that did not fall neatly within a few Census Tracts and those that were located in Census Tracts that were much larger and perhaps contained multiple employers. For example, the geographic footprint of Chicago O'Hare International Airport overlapped portions of seven different Census Tracts, making it ineligible for inclusion in this paper.

footprint of the airport is approximately one square mile, whereas the Tract used as a proxy is slightly larger at 1.27 square miles (See Figure 1).

FIGURE 1. Geographic Consistency of Airport to Tract Boundaries *(79,131).*



Chicago Midway *Denver International* *San Diego International*

Airport geographic boundary (2011)
Census Tracts used to approximate airport (2008)

While it is possible that this method falsely includes those who work very nearby to the airport and excludes those commuters who may work for an employer at the airport but not work on the airport grounds, informal interviews with airport administrators at each of the case study airports confirmed that the number of commuters reported in LODES data approximates employment at the airport very closely.

Airport Commuters that are Low-Income

After narrowing the focus to include only airport commuters, I characterize which of the airport commuters may be commuting on a low-income budget and might have difficulty paying for public transportation. To accomplish this narrowing, I make an assumption about how much working families need to earn to get by and then exclude commuters to the airport who earn more, work only part-time, or earn less than the federally mandated minimum wage.

In order to keep only commuters who earn low incomes that are enough to get by, I first need to establish how much is enough. To do so, basic needs budgeting and living wage calculators help to establish how much a working family would need to pay for their family's expenses of food, housing, childcare, healthcare, transportation, and other basic necessities. In

2011, according to the MIT Living Wage Calculator, the cost of living in the metropolitan area in which each case study airport was contained was approximately $15,000 for a family of one and $40,000 for a family of three.

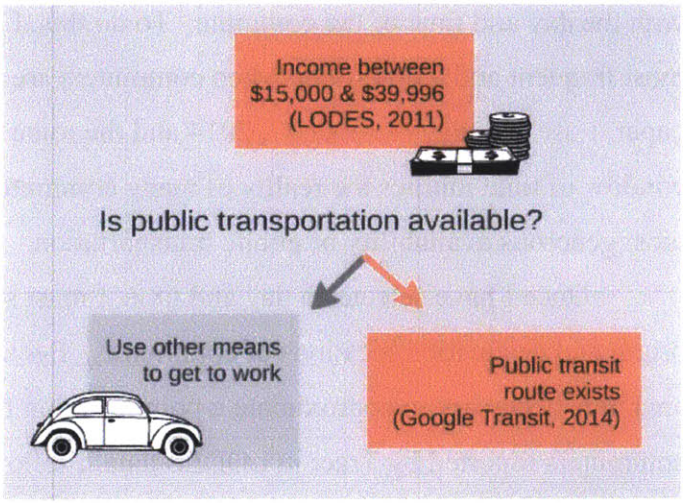
Given this approximation of the cost of living in each of the case study metropolitan areas, I then selected, within the LODES data, commuters who reported earnings between $15,000 and $39,996 in 2011.[10] This band of commuters should be earning approximately enough to pay for their living expenses in each of the three case study metropolitan areas.

Those earning less than $15,000 per year ($7.21 per hour) are by definition working less than full time or less than the federally mandated minimum wage ($7.25 per hour). While technically also low-income, these workers are not included in this paper because it is not possible to accurately measure or estimate the number of commutes they undertake or their budget for public transportation.

[10] LODES data reports the income of commuters at three bandwidths: those earning less than $15,000, those earning between $15,000 and $39,996, and those earning more than $39,996.

CHAPTER 8: Stage 3 - Extract Potential Public Transportation Commuters

After narrowing the pool of commuters to those who commute to the airport and identifying those who earn low incomes, I transition to the next phase of the paper. In the next phase, I determine which commuters get to work at the airport on public transportation. Unfortunately, LODES data does not differentiate commuters by their mode of transportation. With this information alone, it is impossible to exclude those who do not use public transportation to get to work. Instead, as a proxy for the number of commuters who actually used public transportation, I approximate how many commuters use public transportation. To do so, I keep only those commuters for whom public transportation is available by using Google Transit to confirm the existence of a route and for whom public transportation is accessible by using Brookings Institution data of the average commute times on public transportation.



8.1 Identify Commuters for Whom Public Transportation is Available

In this paper, I set out to confirm the availability of public transportation from every Census Tract with commuters to the airport in 2011. Because routes were separated by system and not always digitized, I used Google's 2014 General Transit Feed Specification (GTFS) and Google Transit tool to identify routes *(117)*.[11,12] GTFS feeds incorporate public transportation

[11] To check that the routes are comprehensive of most systems and that the results are comparable with data by the Brookings Institution that is used later in this paper, I confirm that the transit systems incorporated in the GTFS of Google Transit is consistent with those included in the 2011 National Transit Database (NTD), a list of public transportation systems operating in 2011 that receive federal funding or voluntarily report to the Federal Transit Administration *(108)*.

[12] Unfortunately for each of the public transportation systems operating in Chicago, Denver, and San Diego GTFS feeds are published for 2014 and may no longer accurately reflect the public transportation options available to commuters in 2011. Because this is the case, I review whether any of the systems operating in the case study metropolitan areas expanded their

routes, schedules, and stop location information from individual transit agencies into a consistent format. This consistent format enables programs like Google Transit to model routes that include transfers across public transportation systems.

Identify a precise route to the airport

In order to use the Google Transit tool to identify a precise route to the airport Census Tract from other Tracts throughout the region, first I needed to provide the Google Transit tool with the day and time of the commute. To do this, I selected a weekday when public transit is most frequent and a timeframe when commuters are most likely to be commuting *(101)*. For this paper, I use Monday October 27, 2014 and the route that left soonest after 9 am and 5 pm. This window of time mimics the reality of many commuters getting to work and also generates the most generous availability of public transportation.

Once I have selected a day and time, I must supply the Google Transit tool with precise origin and destination locations of commuters. Because Census Tracts are representative of an area, it is necessary to approximate a point location for the likely origin and destination of commuters reported by Tract in LODES data. I follow the methodology of the Brookings Institution estimates employed later in this paper and decide to average the probable origins and destination of Census Tract residents. To do so, I use geographic analysis software to identify the central most location of each Census Tract. Then, for origins only, I adjust the location of this point on a map to favor more populated areas. This adjustment corrects for the reality that people are unevenly distributed across the Tract and, on average, originate from a location that may be different than the geographic center. For destination Tracts, I do not adjust the geographic centroid, because data was not available to know how evenly employment is distributed across Census Tracts.

Instead of using the geographic centroid of the airport destination Census Tract, I could have used the location of the airport terminal, as this is where most employees are likely to work.

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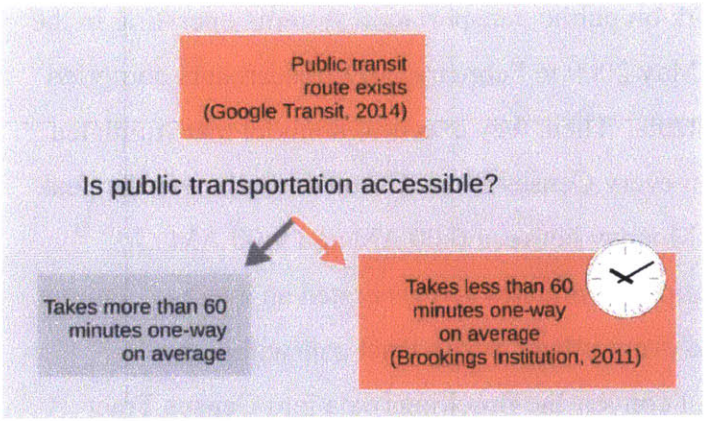
infrastructure or substantially reorganized routes between 2011 and 2014. The only case where this occurred was in Denver, which undertook an expansion of the Denver Regional Transportation District in 2013. Fortunately in Denver, the routes (and prices) to and from the airport remained unchanged from 2011 to 2014, eliminating the influence of additional infrastructure on the affordability of commutes *(123)*.

However, even if this information were publically available for each of the case studies, the presence of multiple terminals would complicate the determination of a precise destination location. Alternatively, I could have used the centroid of the airport's actual geographic footprint. Making this adjustment however, would most likely not change the route, as the geographic footprint of the case study airports are nearly analogous with the Census Tracts used as a proxy and there are only a limited number of public transportation stops at the airport anyways (See Figure 1).

8.2 Identify Commuters for Whom Public Transportation is Accessible

In this paper, I make the assumption that commuters will not use public transportation if their commute is greater than 60 minutes each way. I exclude those who commute more than 60 minutes one way because in the LODES data there are commuters that commute very long times that I do not reasonably expect to use public transportation. For example, airline employees including pilots and flight crew may commute over ten hours from other airports and most probably do not use local public transportation systems in this commute. The less than 60-minute restriction ensures that later calculations of the affordability of public transportation are made only for those who are not reliant on other modes to get to work.



Establishing a Threshold for Commute Times

While there is no established threshold of a reasonable commute time, other evaluations have used varying thresholds of 30, 60, and 90 minutes *(30)*. For this paper, I selected 60 minutes because it closely approximated the behaviors of a majority, nearly two-thirds (64%), of public transportation commuters in 2011 in each of the metropolitan areas *(118)*. However, this threshold may be too low if people are willing to take longer commutes for reasons such as their housing preferences, housing availability, union membership, a narrow labor market for

specialized skills and few other labor market opportunities closer by where they live *(6,119, 120)*. To account for this at Denver International Airport, where the airport is far from most residential areas, I increased the threshold to 90 minutes.

At this point in the analysis, I turn to determining which of the previously identified available routes are accessible. That is, which Census Tracts contain commuters who can travel to the airport in less than 60 minutes each way by public transportation? In order to do so, I employ a Brookings Institution original dataset that estimates the average commute time from each Census Block Group to every Census Tract pair within a metropolitan area.

Determining how long it takes to commute

In 2011, researchers at the Brookings Institution developed a model to simulate the lived experience of commuters trying to get to work on public transportation systems operating in the largest metropolitan areas. Over a period of May 2009 to February 2011, researchers compiled GTFS feeds of 371 public transportation systems. Then, they executed a model that simulated the randomized departure of commuters from every Census Block Group to work over the peak period of public transportation commutes, a Monday between 6:00 AM and 9:00 AM *(30)*.[13] Lastly, they cataloged the length of every journey in minutes and generated an average commute time between every Census Block Group and every other Census Tract pair within the metropolitan area. As with the LODES data, I convert the Brookings data into Census Tract geographic pairs for comparability. In this case, I sum the values of Block Groups, which are themselves broken into Blocks, into the higher order Census Tracts and end up with Census Tract origin and destination pairs.

In summary, commuters in those Census Tract pairs that connect a home origin to the airport destination and can be traversed in less than 60 minutes each way are kept for the remainder of the analysis. For all subsequent analysis, only commuters for whom public

[13] The model assumes that the commuter begins their commute at the population-weighted centroid of a Block Group, walks no more than ¾ of a mile to the nearest public transportation stop, transfers if necessary to a stop within ¾ of a mile (up to eight possible options), departs public transportation, and walks the remainder of the way to work at the geographic centroid of a Census Tract *(30)*.

transportation is available, in that they are serviced by public transportation, and accessible, in that the average commuter can reach the airport in a reasonable amount of time, remain.

CHAPTER 9: Stage 4 - Evaluate the Affordability of Public Transportation

Up until this point in the paper, I have not yet considered the cost of the available public transportation routes, only that there are commuters and that they can reach the airport in a reasonable amount of time, on average. In this next stage of the paper, I consider the cost of public transportation commutes and whether low-income commuters can afford to use public transportation for the identified available route.

In order to determine whether public transportation is affordable on a low-income budget, first, I establish the share of income set aside for public transportation in 2011 using the MIT Living Wage Calculator *(1)*. Then I create an original database of the cost of public transportation using publically available 2011 transit agency fare charts. Lastly, I compare the share of actual costs to budgeted costs for public transportation on a basic needs budget.

9.1 Define a Low-Income Public Transportation Budget

In the first step of determining the affordability of public transportation, I calculate the share of a low-income basic needs budget set aside for public transportation. In this paper, I employ a basic needs budget that estimates the minimum cost of living expenses based on local costs and family size *(3)*.

Of the many available calculators, the MIT Living Wage Calculator method of calculating a basic needs budget[14] is preferred for four reasons. First, it draws from publically available data sources, making it freely replicable. Second, the calculation methodology can be repeated for different geographies, enabling comparisons across case studies. Next, it includes expenses for public transportation, unlike other calculations that assume that the working poor

[14] The cost of food was estimated from the national average low-cost food plan for nutritionally adequate food published by the US Department of Agriculture; childcare from state-level estimates of the lowest cost option for family child care or child care center for infant and school age children reported by the National Association of Child Care Resource and Referral Agencies; and housing using county HUD Fair Market Rent values. National expenditure estimates by household size and region from the Bureau of Labor Statistics Consumer Expenditure Survey estimated expenses for transportation (used cars, gasoline, and motor oil, other vehicle expenses, and public transportation), health care (medical services, drugs, and medical supplies), and other necessities (apparel, housekeeping supplies, personal care products, reading, and other miscellany). Lastly, health insurance costs were added from the Health Insurance Component Analytical Tool for single, employee, and family plans *(1)*.

use only cars due to inadequate access to public transportation *(3,81,82,88)*. Lastly, the MIT Living Wage Calculator is constructed using previous years' expenditures for families. Using previous years' expenditures assumes that the amount families previously spent was sufficient to meet their basic needs. Since this is likely not the case in resource constrained low-income household, the MIT Living Wage Calculator is probably a conservative measure of basic needs *(3)*.

According to the MIT Living Wage Calculator, in 2014, the budget for all transportation costs including used vehicle expenses, gasoline, other vehicle expenses and public transportation ranged from 17.9% to 19.4% for families of three and one respectively (*1*). In 2011, the share of a low-income budget set aside for public transportation expenses alone in each case study metropolitan area was 0.6% in Chicago, 0.6% in Denver, and 0.5% in San Diego.

9.2 The Cost of Public Transportation Fares for Low-Income Commuters

After compiling the share of budget set aside for public transportation on a low-income basic needs budget, I next set out to determine the actual costs for comparison. To do so, I compile an original database of fares for the available public transportation routes identified earlier, excluding Tracts from which, based on the previous calculations, it was not reasonable to commute by public transportation using 2011 published fares *(121-123)*. Alternatively, I could have determined the cheapest or average fare for all possible routes and generated different results. However available data is disaggregated across agencies and does not allow for the efficient and accurate calculation of these metrics.

In calculating the fares, I assume that a commuter would obtain a transit pass to pay for the public transportation fare, but not use cash or a monthly booklet or other package deals. This is because I thought that a resource-constrained commuter might not have the funds to pay the upfront cost of a monthly pass or other deals that require pre-payment *(124)*. Also, transit passes offer a modest discount for each ride, whereas multi-ride discounts accrue benefits to the rider only if they are using public transportation regularly, which may not be the case for part-time employees *(113)*.

I also assumed commuters would not opt for airport or employer offered public transportation subsidies. This is because according to the most recent Bureau of Labor Statistics'

Employee Benefits survey, only five percent of employees in private industry were offered such transportation subsidies *(125)*. In addition, the most recent survey of employee commuting patterns at the only airport in this study to offer an airport-wide public transportation subsidy, San Diego International Airport, most employees (98%) did not use the subsidy *(113,126)*. Employers within the airport might provide other transit subsidies, but data about the availability and uptake of these offers is not regularly evaluated by the airport or otherwise publically available for use in this analysis.[15]

9.3 Share of Low Incomes Spent on Public Transportation

Once a database of fares was compiled for every Tract to airport Tract pair that had commuters who could access the airport within 60 minutes or less one-way by public transportation in 2011, I calculate the proportion of a basic needs budget spent on public transportation. To do so, I sum the cost of morning and evening commutes, multiply by 260 (the number of workdays in a year), and then divide by $39,996, the approximate basic needs budget for a family of three *(127)*. This estimate of the share of wages spent on public transportation represents the best-case scenario, the lowest share of wages spent on public transportation for commuters who reported incomes between $15,000 and $39,996 in the LODES database.

9.4 Cost of Transportation Fares and Time Spent Commuting

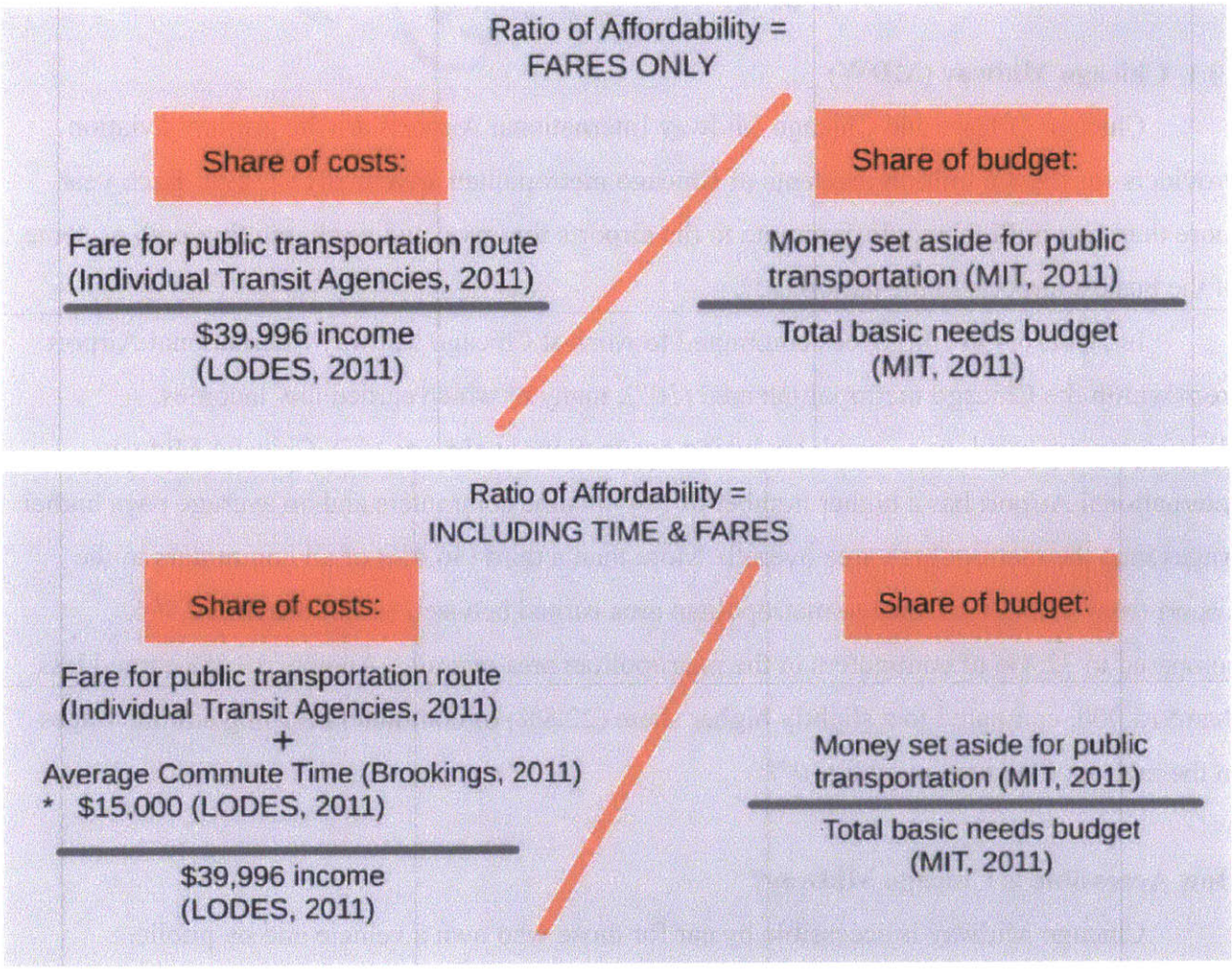
In addition to calculating the cost of fares for public transportation commuters, I use a method employed by economists and transportation planners to estimate the value of a commuter's time *(128)*. I do so by multiplying the average commute time from each Tract by the per-minute wage an employee earning $15,000 (12 cents per minute) to estimate what that employee would earn had they not been commuting. This monetized cost of commuting in dollars estimates the lowest possible value of time for those with wages between $15,000 and $39,996 and therefore is the most modest estimate of the cost of commuters' time. To estimate the share of wages spent on both fares and time spent commuting, I sum the fares of morning and

[15] After speaking with the ground transportation administrators at each case study airport, I was not able to confirm a coordinated airport-wide policy at the case study airports. If there are subsidies, they are provided by specific employers and not monitored by the airport.

evening commutes with the monetized estimate of a commuters time and then I follow the same process as I completed for fares alone – I multiply by 260 and then divide by $39,996.

9.5 How Does the Cost Compare to the Budget for Public Transportation?

Lastly, I compared the share of the basic needs budget set aside for public transportation to the share spent on a commute and the share spent on a commute plus commuting time. The resultant ratio of affordability is expressed for each of the three following case studies.



CHAPTER 10: Case Studies of Select Airports

Now that the data to enable an analysis is prepared, I proceed with three case study investigations of the affordability of public transportation. For each case study, I briefly introduce the airport and characterize the number of commuters. Then, I describe the state of public transportation to the airport and the share of commuters for whom the airport is accessible in less than 60 minutes each way by public transportation. Lastly, I calculate the costs of commutes by public transportation and determine for whom they are affordable.

10.1 Chicago Midway (MDW)

Chicago O'Hare and Chicago Midway International Airports are the primary aviation providers for the 8.6 million residents of Chicago metropolitan area in 2011 *(129)*. Each year more than two million people commute to the airports for travel and work, ranking both as some of the busiest airports in the nation *(15)*.

In 2011, 6,456 employees commuted to work at Chicago Midway International Airport from within the Chicago metropolitan area *(107)*, many of which earned low incomes. Consistent with previous research analyzing occupations at airports *(17)*, Chicago Midway International Airport has a higher number of low-income commuters and on average pays higher wages than the metropolitan area overall. More than a third (36.4%) of all commuters to the airport from within the Chicago metropolitan area earned between $15,000 and $39,996, compared to 32.4% of commuters in the metropolitan area overall. Another 19.3% earned less than $15,000, compared to a slightly higher share (22.8%) of commuters earning similar wages in the metropolitan area overall *(107)*.

How Accessible is Chicago Midway?

Chicago Midway is accessible by car for those who own a vehicle and by public transportation for those who do not. For commuters to the airport, it takes approximately 19 minutes on average to drive from downtown Chicago the 11.8 miles to Chicago Midway *(15)*. However, in 2011, 11.5% of all households, or 399,927 households, in the Chicago metropolitan area did not own a vehicle and were therefore reliant on other modes, including public transportation, to get to work *(9)*. For employees commuting by public transportation to the

airport, the Chicago Transit Authority (CTA) bus and orange rail line and the PACE suburban bus directly connects to the airport *(108)*.

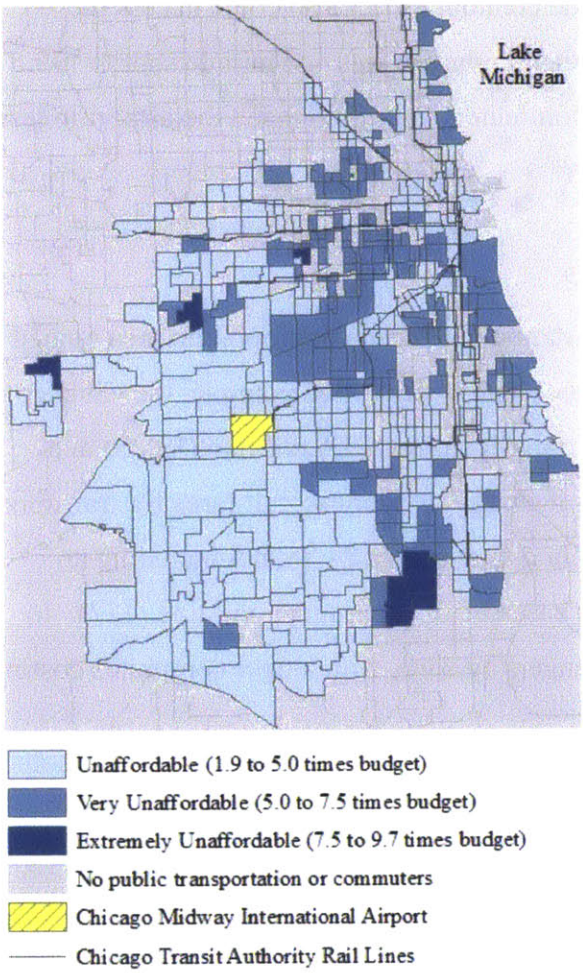
Over half of commuters in 2011 (50.1%) could access the airport by public transportation in less than 60 minutes one-way, on average. Relative to all commuters, low-income commuters were slightly better off, a higher share of low-income commuters (53.3%) could access the airport in the same amount of time and on average their commute was one minute shorter (39.5 compared to 40.5 minutes) per commuter of those commuters that could reach the airport in less than 60 minutes each way on average *(30)*.

How Costly is Public Transportation in Chicago?

In 2011, the cost of riding on public transportation in Chicago metropolitan area ranged based on mode and order of transfers, even within the same system. For example, the Chicago Transit Authority (CTA) allows riders to execute a transfer from a CTA rail line ($2.25) to a CTA bus for $0.25 and total fare of $2.50, however it charges a rider two full fares for transfers from a CTA bus ($2.00) to a CTA rail line ($2.25) for a total fare of $4.25, not including an additional transfer fee of $0.25 if the rider transfers buses before boarding a rail line *(121)*. In comparison, the Metra commuter rail charges passengers by zone, with longer commutes costing more *(130)*.

The average cost of public transportation was broadly unaffordable for low-income commuters in 2011, but the severity varied based on geographic location. In 2011, on average, fares cost $4.83 (3.1% of a $39,996 income) for commuters earning between $15,000 and $39,996 to complete a round-trip commute by public transportation in less than 60 minutes each way, compared to $4.88 for all commuters on average. These cost of fares for commuters earning between $15,000 and $39,996 were between 1.9 and 9.7 times the low-income budget in the Chicago metropolitan area. Some of the very unaffordable commutes (between 5 and 7.5 times a low-income budget for public transportation) clustered to the northeast of the airport (See Figure 2).

FIGURE 2. Affordability of Public Transportation Fares to Chicago Midway International Airport from Tracts with Average Commute Time of Less than 60 Minutes One-Way and Commuters with Annual Wages between $15,000 and $39,996 in 2011 *(114, 146)*.



The affordability of public transportation fares has not yet considered the cost of a commuter's time on public transportation, in terms of lost wages. If the cost of time spent commuting is factored in, the cost of public transportation is three times as much as the cost of fares alone at $14.31 (9.3% of a $39,996 income) for low-income commuters and $14.61 for all commuters. For commuters earning between $15,000 and $39,996 in the Chicago metropolitan area, this cost is between 5.0 and 23.5 times the low-income budget.

Who Accesses Chicago Midway Airport on a Low-Income Budget?

The average number of commuters per Tract, reported by the Tracts' level of affordability, is revelatory of commuting tendencies. In Chicago, commuters to the airport earning between $15,000 and $39,996 were least likely (1.7 commuters per tract) to commute to the airport if they originated from Tracts that were very unaffordable (5.0 to 7.5 times budget). These trips most often required a transfer from a bus to the Metra on the way to work. In comparison, twice as many commuters per Tract commuted from Tracts with the lowest levels of unaffordability (3.4 commuters per Tract) and the highest levels of unaffordability (3.5 commuters per Tract). These results suggest that although the availability and timeliness of public transportation favors low-income commuters

compared to all commuters on average, the cost of public transportation may play a role in determining whether low-income commuters can chose to work at the airport.

10.2 Denver International Airport (DEN)

The recent history of the Denver International Airport begins in 1994. At that time, the Denver regional airport relocated from its Stapleton location, proximate to downtown Denver, to Denver International Airport, 27 miles outside of the city *(15)* in order to expand the airport capacity and "increase economic opportunity" *(101)*. In following with the legislation that founded the Denver International Airport, few residences were located nearby the airport to reduce the number of noise complaints from neighbors.

As of 2011, Denver International Airport is the only large commercial airport that services the 2.5 million residents of the Denver metropolitan area *(94)*, making it the fifth-busiest airport in North America and tenth in the world *(100)*. In the same year, 12,151 employees commuted to work at the airport from within the Denver metropolitan area *(107)*, most of which (71%) worked in the terminal area or concourse *(100)*.

Consistent with previous research analyzing occupations at airports *(17)*, the Denver International Airport has a higher number of low-income commuters than the metropolitan area overall. Nearly half (46.5%) of all commuters to the airport in 2011 earn between $15,000 and $39,996, and another 23.4% earn less than $15,000. This compares to the Denver metropolitan area, in which only about a third (34.1%) of commuters earned between $15,000 and $39,996, and another 21.4% earned less than $15,000 *(107)*.

How Accessible is Denver International?

Denver International Airport is accessible by car for those who own a vehicle, but for those that do not, there is only one public transportation option. To drive to the Denver International Airport takes about 31 minutes without traffic from the city of Denver *(15)*. However, in 2011, 6.9% of all households, approximately 68,523 households, in the Denver metropolitan area did not own a vehicle and were therefore reliant on other modes, including public transportation, to get to work *(9)*. The only public transportation option to the airport for

these commuters is the SkyRide public express bus operated by the Denver Regional Transportation District *(108)*.[16]

Given only one option and an airport located far from the city center, zero public transportation commuters to the airport could commute in less than 60 min one way on average. However, about a quarter of commuters (25.6%) could access the airport by public transportation in less than 90 minutes one-way, on average. Relative to all commuters, low-income commuters were slightly better off. In 2011, 29.0% of low-income commuters could access the airport in less than 90 minutes one-way. Additionally, the time that low-income commuters who could commute in less than 90 minutes each way on average spent on public transportation was nearly identical to the overall population, 79 minutes each way on average per commuter *(30)*.

How Costly is Public Transportation in Denver?

The cost of riding Skyride, the only public transportation system operating at the airport, went up at the start of 2011. Denver Regional Transportation District (RTD) increased fares by an average of 12.5% across the system in order make up for revenue shortfalls during the Recession *(122)*. A one-way ticket on the SkyRide to the airport went up one dollar to $9, $11, or $13, depending on the origin of the commuter *(122)*.

The average cost of public transportation is unaffordable for low-income commuters in 2011, but the severity varied based on geographic location. Following the fare hikes, on average, fares cost $18.07 (11.8% of a $39,996 income) for commuters earning between $15,000 and $39,996 and $18.09 for all commuters on average to complete a round-trip by public transportation in less than 90 minutes each way. The costs for commuters earning between $15,000 and $39,996 are between 20.6 and 25.2 times the low-income budget in the Denver metropolitan area, with distant locations to the far west and south of Denver International Airport having the most extremely unaffordable commuting costs by public transportation (See Figure 3).

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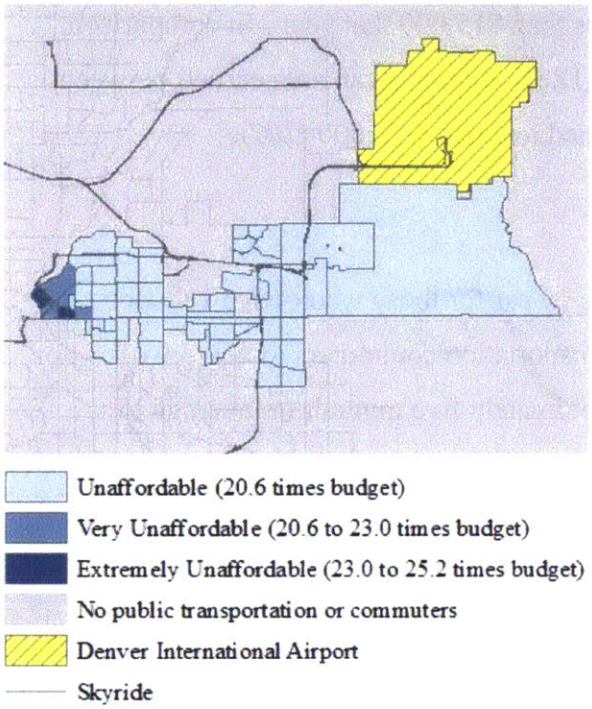
[16] In 2013, the Denver Regional Transportation District opened the first of a multi-stage, multi-billion dollar planned expansion of the transit system, including a new rail line to the airport. If seen to fruition, the FasTracks plan could change the results of this analysis by adding 122 miles of new commuter and light rail, 18 miles of bus rapid transit, 57 new transit stations over the next 20 years *(131, 132)*.

FIGURE 3. Affordability of Public Transportation Fares to Denver International Airport from Tracts with Average Commute Time of Less than 90 Minutes One-Way and Commuters with Annual Wages between $15,000 and $39,996 in 2011*(79, 147)*.



The reported affordability of public transportation fares has not yet considered the cost of a commuter's time on public transportation, in terms of lost wages. If the cost of time spent commuting is factored in, the cost of public transportation balloons to three times as much as the cost of fares alone, or $37.14 for low-income commuters (24.1% of a $39,996 income) and $37.13 for all commuters on average. These costs for commuters earning between $15,000 and $39,996 are between 39.1 and 49.9 times the low-income budget in the Denver metropolitan area.

Who Accesses Denver International Airport on a Low-Income Budget?

The average number of commuters per Tract, reported by the Tracts' level of affordability, is revelatory of commuting tendencies. In Denver, commuters that earned between $15,000 and $39,996 per year were five times less likely on average to commute from Tracts with the highest levels of unaffordability (6.3 commuters per Tract) compared to the lowest levels of unaffordability (33.2 commuters per Tract). This suggests that low-income commuters may consider the cost of commuting when deciding where to live and whether to work at the airport.

10.3 San Diego International Airport (SAN)

San Diego International Airport is a large regional airport, servicing over 3 million people living in the San Diego metropolitan area *(128)*. The airport also provides many jobs to

residents. In 2011, 2,996 employees commuted to work at the airport from within the San Diego metropolitan area *(107)*.

Consistent with previous research analyzing occupations at airports *(17)*, the San Diego International Airport has a higher number of low-income commuters and on average pays higher wages than the metropolitan area overall. Nearly half of all commuters (46.6%) earned between $15,000 and $39,996, and another 17.8% earned less than $15,000 that year. In comparison, only about a third (33.6%) of commuters in the San Diego metropolitan area earned between $15,000 and $39,996 but slightly more (23.7%) earned less than $15,000 *(107)*.

How Accessible is San Diego International?

San Diego International Airport is accessible by car for those who own a vehicle; otherwise there is only a single option for public transportation commuters to get to work. For those commuting to the airport by car, it takes approximately five minutes on average to commute from downtown San Diego, three miles away *(78)*. However, in 2011, over 6.2% of all households, or 67,715 households, did not own a vehicle and were therefore reliant on other modes, including public transportation, to get to work *(9)*. For employees commuting on public transportation, route 992 of the Metropolitan Transit System (MTS) stops outside the terminal area where an estimated 97% of employees work *(81, 92)*.

In 2011, less than one-in-three commuters (29.2%) could access the airport by public transportation in less than 60 minutes one way, on average. However, relative to all commuters, a higher share of low-income commuters (33.1%) could access the airport in the same amount of time. The time low-income commuters spent on public transportation was nearly identical to the overall population, 49 minutes each way on average per commuter for those that could reach the airport in less than 60 minutes each way on average *(30)*.

How Costly is Public Transportation in San Diego?

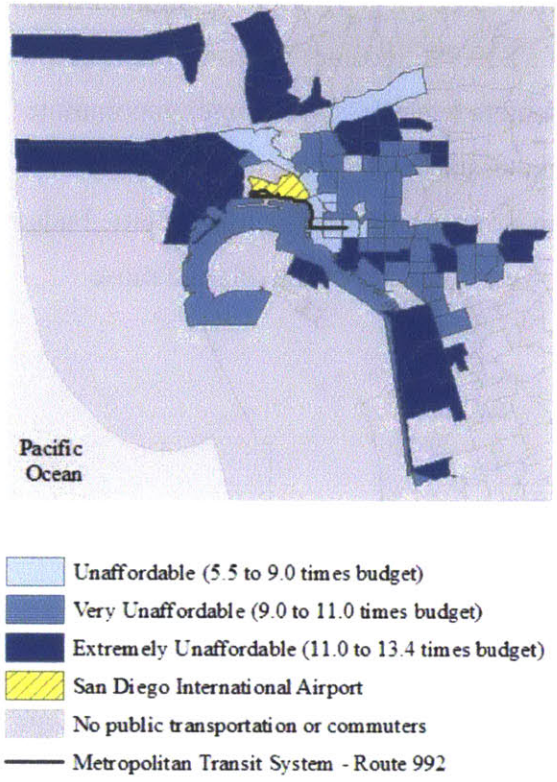
In 2011, the cost of riding the MTS varies based on the mode and number of transfers, even within the same system. A commute on the MTS in 2011 costs $2.50 for a trolley, $2.25 for a local or urban bus, and $2.50 or $5.00 for express bus routes. There is no discount for transfers between modes and commuters pay full fares for transfers within and between the

systems *(109)*.[17] For example a trip from the local bus ($2.25) to another local bus ($2.25) to a trolley ($2.50) costs the commuter $7.00.

The average cost of public transportation in San Diego in 2011 is unaffordable for low-income commuters to the airport, but the severity varies based on geographic location of their home. In 2011, on average, fares cost $8.92 (5.8% of a $39,996 income) for commuters earning between $15,000 and $39,996 and $8.91 for all commuters regardless of income, to commute round-trip by public transportation in less than 60 minutes each way. For commuters earning between $15,000 and $39,996, their costs are between 5.5 to 13.4 times the low-income budget in the San Diego metropolitan area, with areas to the west of the airport having the most unaffordable commutes (See Figure 4).

[17] San Diego fares last increased in January, 2009 *(133)*.

FIGURE 4. Affordability of Public Transportation Fares to San Diego International Airport From Tracts with Average Commute Time of Less than 60 Minutes One-Way and Commuters with Annual Wages between $15,000 and $39,996 in 2011 *(79, 148).*



The affordability of public transportation fares has not yet factored in the cost of a commuter's time on public transportation, in terms of lost wages. If the cost of time spent commuting is factored in, the cost of public transportation is more than twice as much as the cost of fares alone; $20.64 for both low-income commuters (13.4% of a $39,996 income) and all commuters on average. For commuters earning between $15,000 and $39,996 in the San Diego metropolitan area, these costs are between 11.3 and 29.4 times the low-income budget.

Who Accesses San Diego International Airport on a Low-Income Budget?

The average number of commuters per Tract, reported by the Tracts' level of affordability, is revelatory of commuting tendencies. Fewer commuters earning between $15,000 and $39,996 commuted from Tracts with the highest level of unaffordability by public transportation than from Tracts with the lowest level of unaffordability (5.2 and 4.1 commuters per Tract respectively). These results may help to explain low levels of commuting to the airport by public transportation and low levels of uptake in the airport's public transportation subsidy.

CHAPTER 11: Discussion of Findings

Case studies of Chicago Midway, Denver International, and San Diego International Airports exposed across the board lack of affordability and an uneven distribution of accessibility for low-income workers commuting to work by public transportation. This paper also revealed that fewer low-income commuters took public transportation as the affordability of public transportation declined. Based on these findings, airport employers, municipal governments, and federal agencies should consider interventions to increase affordability and accessibility in order to ensure the continued efficient operations of airports, support the prosperity of the regional economy, and provide economic opportunities for low-income workers.

11.1 Modify the Low-Income Budget

Airport municipalities, working with union representation, can raise the wages of employees to meet their basic needs, including transportation to and from work. In doing so, airport municipalities would join the over 100 other municipalities *(91-93)* and airports including San Francisco International Airport (SFO) and Seattle-Tacoma International (SEA) *(16)* that pay their low-wage workers enough to provide for their family's basic needs, even when the cost of living rises *(3,87)*. Research investigating the effects of wage ordinances at airports suggests that the expense of these increased wages can actually benefit employers as well. The San Francisco International Airport wage hike for example generated savings for employers by increasing employee productivity, morale, and customer service as well as reducing employee turnover and disciplinary issues *(16)*.

In addition, sponsored transportation subsidies help low-income working families by providing discounts per fare, reimbursement of cost, and tax-free transportation savings accounts *(113)*. For example, Chicago, O'Hare International Airport coordinated with the Chicago Transit Authority (CTA) to eliminate an airport surcharge of $2.75 per ride for employees, on top of the existing base fare of $2.25. This measure ensured that the surcharge was appropriately targeted towards travelers taking advantage of convenient public transportation to airports and did not penalize employees *(102)*.

In the absence of living wages or subsidies for public transportation, income supports such as the Earned Income Tax Credit (EITC) and Supplemental Nutrition Assistance Program (SNAP), are important federal programs that help low-income families make ends meet *(3)*. These programs make sure that low-income people have a basic standard of living, even in the absence of earning enough wages or having low enough expenses to subsist.

11.2 Reorganize for Accessibility

In addition to making commutes more affordable, municipalities can play a role in making sure transportation is available and accessible to low-income commuters. At the local level, municipalities have realigned affordable housing development and expanded transportation to better connect employees to work *(134-138)*. For example, in Denver, a public-private partnership organized a $15 million transit-oriented development fund and invested in the acquisition of eight properties and the preservation or creation of 626 affordable homes near transit sites *(131)*. At the federal level, examples of targeted transportation realignment designed to increase employment accessibility include the Job Access and Reverse Commute Program *(139)*, National Infrastructure Investments *(140)*, and the Partnership for Sustainable Communities *(141)*.[18]

11.3 Expanding Car Ownership

In the absence of transit realignment or expansion, which is impractical and infeasible for all but the densest of metropolitan areas, reducing the number of zero vehicle households in areas with low or no access to reliable public transportation may be a viable means of connecting low-income workers to work *(142)*. According to research conducted in 2014, for low-income families, owning a car increases the likelihood of employment *(143)* and raises earnings *(14)*.

Expanding car ownership for low-income workers can be accomplished by revising policies that disqualify low-income car owners from receiving SNAP benefits or other assistance

[18] Alternatively, housing mobility programs, such as Moving to Opportunity for Fair Housing, seek to bring low-income people closer to jobs in the suburbs, however with few notable results on employment accessibility *(105)*.

(144) and preparing low-income families for the financial burden of car maintenance, insurance, gasoline, and parking. The negative externalities most often associated with car ownership, namely increased congestion and air quality degradation, can be offset by reductions in car ownership for those with multiple cars or high levels of transportation accessibility *(14, 145)*.

To incentivize driving, most airports already offer parking subsidies, particularly for those who carpool *(15)*. However, airports that have vehicle subsidy programs must be sure to target them appropriately so as to not divert those for whom public transportation is accessible into driving and make the effect of concurrent public transportation subsidies moot *(129)*.

CHAPTER 12: Conclusions

By establishing a method to evaluate the affordability of public transportation, this analysis of three commercial airports in Chicago, Denver, and San Diego, evaluated the affordability of public transportation on a low-income budget. Consistently unaffordable public transportation commutes suggest that commuters cannot access their jobs by public transportation and meet their families' basic needs on a low-income budget. Furthermore, unaffordability may result in spatial mismatch outcomes, as fewer low-income commuters took public transportation as the affordability of public transportation declined. These findings support policies that make jobs more accessible and commutes more affordable for low-income employees to ensure the continued efficient operations of airports, secure economic opportunities for low-skill workers, and support the prosperity of the regional economy.

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