Access Across America

Report 13 in the series
Access to Destinations Study

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Accessibility is the ease of reaching valued destinations. It can be measured across different times of day (accessibility in the morning rush might be lower than the less-congested midday period). It can be measured for each mode (accessibility by walking is usually lower than accessibility by transit, which is usually lower than accessibility by car). There are a variety of ways to measure accessibility, but the number of destinations reachable within a given travel time is the most comprehensible and transparent as well as the most directly comparable across cities. This report focuses on accessibility to jobs by car. Jobs are the most significant nonhome destination, but it is also possible to measure accessibility to other types of destinations. The automobile remains the most widely used mode for commuting trips in the United States.

This study estimates the accessibility to jobs by automobile in the 51 largest metropolitan areas in the United States for 2010, and compares results with 2000 and 1990.

Rankings are determined by a weighted average of accessibility, giving a higher weight to closer jobs. Jobs reachable within ten minutes are weighted most heavily, and jobs are given decreasing weight as travel time increases up to 60 minutes. Based on this measure, the ten metro areas that provide the greatest average accessibility to jobs are Los Angeles, San Francisco, New York, Chicago, Minneapolis, San Jose, Washington, Dallas, Boston, and Houston.

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Final Report

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Executive Summary

Accessibility is the ease of reaching valued destinations. It can be measured across different times of day (accessibility in the morning rush might be lower than the less-congested midday period). It can be measured for each mode (accessibility by walking is usually lower than accessibility by transit, which is usually lower than accessibility by car). There are a variety of ways to define accessibility, but the number of destinations reachable within a given travel time is the most comprehensible and transparent as well as the most directly comparable across cities. This report focuses on accessibility to jobs by car. Jobs are the most significant nonhome destination, but it is also possible to measure accessibility to other types of destinations. The automobile remains the most widely used mode for commuting trips in the United States.

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Job accessibility has changed over time. In the past two decades, Las Vegas, Jacksonville, Austin, Orlando and Phoenix have seen the largest percentage gains in job accessibility while Cleveland, Detroit, Honolulu and Los Angeles have seen the largest percentage drops.

Key findings

1. In 2010, the average American living in the top-51 metro areas could reach slightly fewer jobs by automobile than in 1990, but more jobs than in 2000.
2. Automobile speeds were faster in 2010 than in 2000 (and about where they were in 1990).
3. Overall job losses in these 51 areas have limited accessibility gains associated with faster networks.
4. The average American city is slightly more circuitous in 2010 than in 1990 because roads in newer areas (suburban growth) are not as well connected as those in older areas of the metropolitan region.
5. The overall most accessible metropolitan areas in 2010 were (in order): Los Angeles, San Francisco, New York, Chicago, Minneapolis, San Jose, Washington, Boston, Dallas, and Houston.

6. There have been significant changes among accessibility leaders since 1990, when New York, Philadelphia, Chicago, Miami, Los Angeles, Boston, Cleveland, Detroit, Washington, and Dallas made up the top 10.

7. People living in many smaller metropolitan areas can reach as many jobs by car as people living in much larger areas within both the 10- and 20-minute time frames. For instance New Orleans, Salt Lake City, and Jacksonville are all among the top 10 for number of jobs that can be reached within 10 minutes. Jacksonville, Milwaukee, and Las Vegas are among the top 10 for number of jobs that can be reached within 20 minutes.

There are two ways for cities to improve accessibility—by making transportation faster and more direct or increasing the density of activities, such as locating jobs closer together and closer to workers. While neither of these things can easily be shifted overnight, they can make a significant impact over the long term.

Chapter 1

Introduction

The average American spends about four years of life in motion. The amount of time individuals spend depends on who they are, what they do, where they live, and how they choose to travel. Most Americans live in metropolitan areas that enable people to engage in the activities they care about efficiently, by bringing activities and people close together for trade, commerce, social interaction, education, and many other purposes. This proximity must provide advantages, otherwise cities would not exist. But not all cities are equally efficient. They vary in size and scope, they vary in their density and location of activities, and they vary in their internal systems that enable people to move between places. As the United States and the world continue to urbanize, even small gains in urban efficiency will lead to large gains as a whole.

Accessibility is the ease of reaching valued destinations. It can be measured across different times of day (accessibility in the morning rush might be lower than the less-congested midday period). It can be measured for each mode (accessibility by walking is usually lower than accessibility by transit, which is usually lower than accessibility by car). There are a variety of ways to define accessibility, but the number of destinations reachable within a given travel time is the most comprehensible and transparent as well as the most directly comparable across cities. This report focuses on accessibility to jobs by car. Jobs are the most significant nonhome destination, but it is also possible to measure accessibility to other types of destinations. The automobile remains the most widely used mode for commuting trips in the United States.

Accessibility is not a new idea,[1] but this is the first systematic comparison using consistent cumulative opportunity measurements conducted for these cities.[2]

Accessibility has been shown to be associated with:

- Commuting times: A 1-percent increase in accessibility to jobs reduces average metropolitan commute times by about 90 seconds each way.[3]
- Mode shares: A 1-percent increase in accessibility to jobs results in a 0.0575-percent drop in auto mode share.[4]

[1] See Hansen (1959) for its origins, and Geurs and van Eck (2001); Handy and Niemeier (1997) for reviews.

[2] Previous comparative accessibility studies include Allen et al. (1993), Levine et al. (2012) which uses a gravity based measure, Tomer et al. (2011) which examines relative transit accessibility.

[3] See Levinson (2012).

[4] See Levinson (2012).

- Property values: A 1-percent increase in accessibility to jobs raised the sale price of a home by about 0.23 percent.[5]
- Economic productivity: Doubling accessibility to jobs leads to an increase in real average wages of 6.5 percent.[6]

This report compares morning peak period accessibility to jobs by automobile across 51 US metropolitan areas for 1990, 2000, and 2010 by combining publicly available data and some new measures of network efficiency (circuity) that were recently computed.

The results tell us not only which metro areas are performing well now but also which areas have seen the greatest change. Some cities gained accessibility and others lost as land-use patterns, network connectivity, and travel speeds changed.

Chapter 2 describes the accessibility scores of various metropolitan areas and ranks metropolitan areas by accessibility. Chapter 3 examines changes in accessibility across metropolitan areas. Chapter 4 discusses the results, and chapter 5 details the methodology for calculating accessibility used here.

[5] See Iacono and Levinson (2011).

[6] See Graham et al. (2012).

Chapter 2

Accessibility Today

Table 2.1 gives the accessibility scores for each metropolitan area in 2010. The columns represent the number of jobs within that metropolitan area that a typical individual located in the city can reach in 10, 20, 30, 40, 50, and 60 minutes respectively. Some cities are small and fast, and have higher accessibilities in the 10- and 20-minute time frames, but find that a commuter quickly reaches the city edge.[1] Larger cities tend to be more congested, though denser. The congestion may outweigh the density for short distances, but overall size results in the cities having higher accessibilities at longer travel times.

The rankings of accessibility across US cities for 2010 are shown in Table 2.2. The final column provides a weighted average, where the jobs reachable within each threshold are given a decreasing weight as travel time increases. A job reachable within 10 minutes counts more than a job reachable within 20, and so on. The 10 metro areas whose residents can, on average, reach the most jobs are Los Angeles, San Francisco, New York, Chicago, Dallas, Minneapolis, Washington, Houston, San Jose, and Phoenix. Within the specific time thresholds, the rankings vary.

The results may be surprising. Why are some large cities (e.g., Philadelphia and Boston) not ranked higher? Keep in mind what is being represented here: the number of jobs reachable from an average point in the metro area by automobile, with more weight given to jobs reachable within 10 minutes than 20 minutes, and more weight given to jobs reachable in 20 minutes than 30 minutes and so on. Small cities show prominently in the 10-minute accessibility threshold. When these cities are both fast and compact, their employment can be reached quickly. Travelers interested in how many jobs can be reached within 10 minutes of driving would be better off in Riverside, California than New York, since they can get to many of Riverside's jobs readily, but relatively few of New York's.

Within a 60-minute threshold, this list looks very much like the list of employment by metro area (within 60 minutes, almost everyone can reach (nearly) every job in every metro). But within 30 minutes, the density of jobs and the speed of the network are both quite important. While the number and density of jobs tends to increase as cities become more populous (and most of the top-51 cities were growing during this period), speeds on the road network tend to decline as traffic growth outpaces network investment. Whether job density is growing faster than speed is declining depends on the case, and as can be seen by comparing various cities by year, there is a wide dispersion.

[1] A few large cities like New York and Los Angeles have jobs more than 60 minutes from the core, the data are included in the rankings and weighted averages, but not shown in Table 2.1 for space reasons.

Table 2.1: Number of Jobs Reachable by Number of Minutes in 2010

	Minutes					
Area	**10**	**20**	**30**	**40**	**50**	**60**
Atlanta	59,477	264,942	635,155	1,178,230	1,902,208	2,003,047
Austin	89,629	394,995	640,563	640,563	640,563	640,563
Baltimore	107,845	480,844	1,059,610	1,059,610	1,059,610	1,059,610
Boston	104,250	460,666	1,091,487	1,998,786	2,902,747	2,902,747
Buffalo	94,459	408,301	455,704	455,704	455,704	455,704
Charlotte	73,878	335,340	727,384	727,384	727,384	727,384
Chicago	115,890	509,755	1,194,136	2,197,286	3,514,244	3,797,772
Cincinnati	76,612	342,081	810,459	874,547	874,547	874,547
Cleveland	85,324	374,192	870,158	870,158	870,158	870,158
Columbus	115,723	521,782	750,329	750,329	750,329	750,329
Dallas	108,325	472,326	1,125,361	2,077,955	2,510,280	2,510,280
Denver	99,069	403,946	926,327	1,038,146	1,038,146	1,038,146
Detroit	86,091	376,309	881,386	1,500,978	1,500,978	1,500,978
Grand Rapids	100,659	318,367	318,367	318,367	318,367	318,367
Virginia Beach	82,458	362,557	593,797	593,797	593,797	593,797
Hartford	79,708	348,096	529,323	529,323	529,323	529,323
Honolulu	99,156	335,934	335,934	335,934	335,934	335,934
Houston	98,662	437,845	1,035,579	1,908,705	2,176,567	2,176,567
Indianapolis	78,645	344,408	742,919	742,919	742,919	742,919
Riverside	163,148	659,561	957,326	957,326	957,326	957,326
Jacksonville	134,776	561,077	860,640	860,640	860,640	860,640
Kansas City	116,871	503,402	928,617	928,617	928,617	928,617
Las Vegas	130,714	527,875	731,876	731,876	731,876	731,876
Los Angeles	237,203	1,052,716	2,458,111	4,467,004	4,852,354	4,852,354
Louisville	88,446	387,515	515,000	515,000	515,000	515,000
Memphis	78,516	342,608	509,166	509,166	509,166	509,166
Milwaukee	127,254	552,165	737,279	737,279	737,279	737,279
Minneapolis	145,052	639,314	1,514,330	1,572,381	1,572,381	1,572,381
Nashville	84,487	373,578	652,935	652,935	652,935	652,935
New Orleans	146,521	446,087	446,087	446,087	446,087	446,087
New York	150,849	654,932	1,537,458	2,795,655	4,432,204	6,438,456
Oklahoma City	82,314	344,821	452,754	452,754	452,754	452,754
Orlando	98,774	418,126	855,864	855,864	855,864	855,864
Philadelphia	81,951	366,181	851,638	1,554,466	2,421,591	2,421,591
Phoenix	101,446	412,770	968,631	1,453,359	1,453,359	1,453,359
Pittsburgh	68,891	305,792	725,251	1,030,938	1,030,938	1,030,938
Portland	81,313	342,382	789,545	870,794	870,794	870,794
Providence	76,318	335,624	590,501	590,501	590,501	590,501
Raleigh	72,550	325,464	410,617	410,617	410,617	410,617
Rochester	103,745	415,085	415,085	415,085	415,085	415,085
Sacramento	105,441	441,574	621,068	621,068	621,068	621,068
Salt Lake City	136,060	526,157	526,157	526,157	526,157	526,157
San Antonio	97,780	425,275	718,175	718,175	718,175	718,175
San Diego	132,348	552,996	1,101,324	1,101,324	1,101,324	1,101,324
San Francisco	283,549	1,161,558	1,767,793	1,767,793	1,767,793	1,767,793
San Jose	237,929	857,032	857,032	857,032	857,032	857,032
Seattle	77,483	307,266	716,341	1,302,873	1,435,764	1,435,764
Miami	97,778	424,737	986,066	1,791,014	1,820,909	1,820,909
St. Louis	64,089	272,800	638,031	1,169,641	1,169,641	1,169,641
Tampa Bay	74,682	322,792	752,040	932,231	932,231	932,231
Washington	108,988	481,675	1,160,713	2,135,912	2,370,531	2,370,531

Table 2.2: Rank of Accessibility by Metropolitan Area in 2010

			Minutes				
Rank	**10**	**20**	**30**	**40**	**50**	**60**	**Weighted Average**
1	San Francisco	San Francisco	Los Angeles	Los Angeles	Los Angeles	New York	**Los Angeles**
2	San Jose	Los Angeles	San Francisco	New York	New York	Los Angeles	**San Francisco**
3	Los Angeles	San Jose	New York	Chicago	Chicago	Chicago	**New York**
4	Riverside	Riverside	Minneapolis	Washington	Boston	Boston	**Chicago**
5	New York	New York	Chicago	Dallas	Dallas	Dallas	**Minneapolis**
6	New Orleans	Minneapolis	Washington	Boston	Philadelphia	Philadelphia	**San Jose**
7	Minneapolis	Jacksonville	Dallas	Houston	Washington	Washington	**Washington**
8	Salt Lake City	San Diego	San Diego	Miami	Houston	Houston	**Dallas**
9	Jacksonville	Milwaukee	Boston	San Francisco	Atlanta	Atlanta	**Boston**
10	San Diego	Las Vegas	Baltimore	Minneapolis	Miami	Miami	**Houston**
11	Las Vegas	Salt Lake City	Houston	Philadelphia	San Francisco	San Francisco	**Riverside**
12	Milwaukee	Columbus	Miami	Detroit	Minneapolis	Minneapolis	**Miami**
13	Kansas City	Chicago	Phoenix	Phoenix	Detroit	Detroit	**San Diego**
14	Chicago	Kansas City	Riverside	Seattle	Phoenix	Phoenix	**Philadelphia**
15	Columbus	Washington	Kansas City	Atlanta	Seattle	Seattle	**Phoenix**
16	Washington	Baltimore	Denver	St. Louis	St. Louis	St. Louis	**Baltimore**
17	Dallas	Dallas	Detroit	San Diego	San Diego	San Diego	**Jacksonville**
18	Baltimore	Boston	Cleveland	Baltimore	Baltimore	Baltimore	**Kansas City**
19	Sacramento	New Orleans	Jacksonville	Denver	Denver	Denver	**Detroit**
20	Boston	Sacramento	San Jose	Pittsburgh	Pittsburgh	Pittsburgh	**Milwaukee**
21	Rochester	Houston	Orlando	Riverside	Riverside	Riverside	**Denver**
22	Phoenix	San Antonio	Philadelphia	Tampa Bay	Tampa Bay	Tampa Bay	**Las Vegas**
23	Grand Rapids	Miami	Cincinnati	Kansas City	Kansas City	Kansas City	**Columbus**
24	Honolulu	Orlando	Portland	Cincinnati	Cincinnati	Cincinnati	**Orlando**
25	Denver	Rochester	Tampa Bay	Portland	Portland	Portland	**Seattle**
26	Orlando	Phoenix	Columbus	Cleveland	Cleveland	Cleveland	**Cleveland**
27	Houston	Buffalo	Indianapolis	Jacksonville	Jacksonville	Jacksonville	**Salt Lake City**
28	San Antonio	Denver	Milwaukee	San Jose	San Jose	San Jose	**Atlanta**
29	Miami	Austin	Las Vegas	Orlando	Orlando	Orlando	**San Antonio**
30	Buffalo	Louisville	Charlotte	Columbus	Columbus	Columbus	**Cincinnati**
31	Austin	Detroit	Pittsburgh	Indianapolis	Indianapolis	Indianapolis	**Portland**
32	Louisville	Cleveland	San Antonio	Milwaukee	Milwaukee	Milwaukee	**Sacramento**
33	Detroit	Nashville	Seattle	Las Vegas	Las Vegas	Las Vegas	**Tampa Bay**
34	Cleveland	Philadelphia	Nashville	Charlotte	Charlotte	Charlotte	**Pittsburgh**
35	Nashville	Virginia Beach	Austin	San Antonio	San Antonio	San Antonio	**New Orleans**
36	Virginia Beach	Hartford	St. Louis	Nashville	Nashville	Nashville	**St. Louis**
37	Oklahoma City	Oklahoma City	Atlanta	Austin	Austin	Austin	**Indianapolis**
38	Philadelphia	Indianapolis	Sacramento	Sacramento	Sacramento	Sacramento	**Austin**
39	Portland	Memphis	Virginia Beach	Virginia Beach	Virginia Beach	Virginia Beach	**Nashville**
40	Hartford	Portland	Providence	Providence	Providence	Providence	**Charlotte**
41	Indianapolis	Cincinnati	Hartford	Hartford	Hartford	Hartford	**Virginia Beach**
42	Memphis	Honolulu	Salt Lake City	Salt Lake City	Salt Lake City	Salt Lake City	**Louisville**
43	Seattle	Providence	Louisville	Louisville	Louisville	Louisville	**Buffalo**
44	Cincinnati	Charlotte	Memphis	Memphis	Memphis	Memphis	**Providence**
45	Providence	Raleigh	Buffalo	Buffalo	Buffalo	Buffalo	**Rochester**
46	Tampa Bay	Tampa Bay	Oklahoma City	Oklahoma City	Oklahoma City	Oklahoma City	**Hartford**
47	Charlotte	Grand Rapids	New Orleans	New Orleans	New Orleans	New Orleans	**Memphis**
48	Raleigh	Seattle	Rochester	Rochester	Rochester	Rochester	**Oklahoma City**
49	Pittsburgh	Pittsburgh	Raleigh	Raleigh	Raleigh	Raleigh	**Honolulu**
50	St. Louis	St. Louis	Honolulu	Honolulu	Honolulu	Honolulu	**Raleigh**
51	Atlanta	Atlanta	Grand Rapids	Grand Rapids	Grand Rapids	Grand Rapids	**Grand Rapids**

Note: **Weighted Average** is an average of accessibility rankings, giving a higher weight to closer jobs. This is defined in Equation 5.3.

Chapter 3

Accessibility Over Time

One of the key questions is how accessibility has changed over time. Using data from 1990, 2000, and 2010 enables examination of changes in accessibility, which are the result of changes in network speeds, circuity, and employment density. There are a number of caveats to this analysis, in particular the changes in methodologies associated with all of the inputs (as discussed in Chapter 5) as well as changes in metropolitan geographies over time. This research uses consistent geographies when possible and employment density rather than total employment to control for these effects. In this analysis we use "donuts," so we look at the gains (or losses) in accessibility for a particular ring around the representative traveler, excluding the inner rings. Figure 3.1 shows the national average accessibility over time.

Table 3.1 shows the percentage changes in accessibility over the two decades between 1990 and 2010. The largest percentage gainers are in Las Vegas, Jacksonville, Austin, Orlando and Phoenix. The largest drops are seen in Cleveland, Detroit, Honolulu and Los Angeles. Smaller cities may see larger percentage changes if they are fast growing.

The past decade's results are shown in Table 3.2. The largest percentage gainers are in Jacksonville, Miami, and Houston. The largest drops are seen in Grand Rapids, Raleigh, Boston, and Detroit.

The cities where absolute accessibility increased included large and fast-growing metropolitan areas (Dallas, San Francisco, and Los Angeles), smaller but very fast-growing areas (Jacksonville, Las Vegas and Phoenix), and growing areas that saw improvements to their transportation networks (Minneapolis). The accessibility losers in this period tended to be older northeastern metropolitan areas that saw minimal or negative job growth, and faster-growing cities with major congestion problems (Seattle and Atlanta).

The Appendix shows more detailed tables.[1]

[1]Table A.1 shows the changes in accessibility over the two decades between 1990 and 2010. Table A.2 shows the changes in accessibility rank between 1990 and 2010. In the past decade, Table A.3 shows the changes in accessibility between 2000 and 2010. Table A.4 shows the changes in accessibility rank between 2000 and 2010.

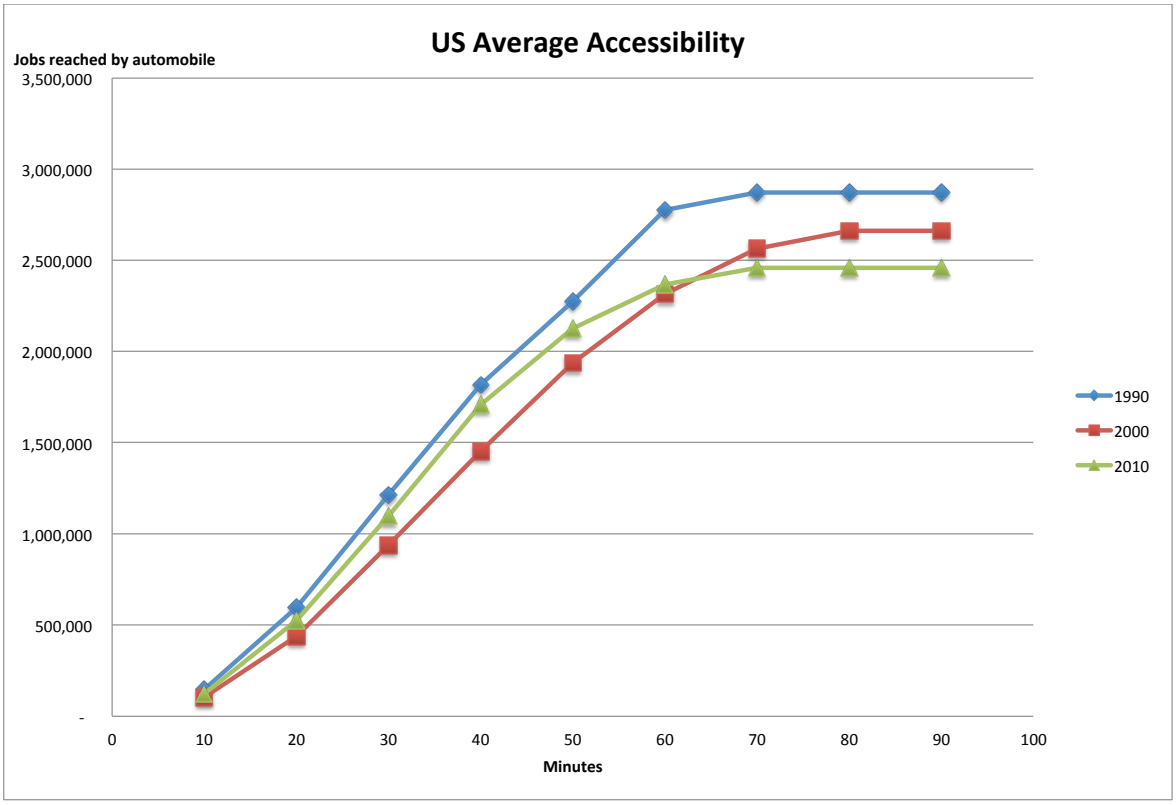

Figure 3.1: U.S. national average accessibility over time (1990-2010)

Table 3.1: Percentage Changes in Accessibility by Metropolitan Area: 1990 to 2010

			Minutes		
Area	**Total**	**Weighted**	**0 to 10**	**10 to 20**	**20 to 30**
Atlanta	35.18	(23.25)	(32.07)	(30.67)	(29.36)
Austin	58.55	14.66	(9.22)	0.03	
Baltimore	(11.09)	(17.82)	(21.45)	(17.61)	(3.83)
Boston	35.53	(34.49)	(40.26)	(40.91)	(40.51)
Buffalo	(14.20)	(45.96)	(56.30)	(0.36)	
Charlotte	20.26	(41.72)	(63.55)	(34.99)	
Chicago	(1.13)	(34.99)	(31.35)	(30.66)	(31.38)
Cincinnati	7.60	(24.73)	(39.39)	(37.18)	77.55
Cleveland	(29.94)	(83.67)	(57.55)	(57.41)	36.69
Columbus	10.69	(16.53)	(34.08)	(19.16)	
Dallas	27.00	6.23	1.18	1.91	1.72
Denver	7.59	(24.79)	(36.63)	(36.76)	60.00
Detroit	(27.83)	(48.05)	(35.26)	(34.69)	(34.51)
Grand Rapids	(5.62)	(16.26)	(29.99)	12.48	
Virginia Beach	(15.05)	(5.26)	4.61	7.65	(35.76)
Hartford	(5.81)	(60.30)	(65.50)	(18.90)	
Honolulu	(23.22)	(51.33)	(52.30)	3.10	
Houston	23.68	6.04	(1.14)	2.66	2.10
Indianapolis	18.87	(12.56)	(31.05)	(31.72)	227.47
Riverside	24.82	21.08	31.31	25.07	21.14
Jacksonville	93.89	57.51	183.08	187.01	20.92
Kansas City	20.39	26.71	56.16	53.18	(0.20)
Las Vegas	97.20	35.64	22.54	50.18	
Los Angeles	(19.69)	36.12	66.35	84.75	80.03
Louisville	15.24	(2.00)	(11.10)	(11.81)	1,444.21
Memphis	13.59	(9.52)	(22.28)	(19.97)	868.09
Milwaukee	(4.59)	(4.01)	(3.83)	(2.83)	(8.87)
Minneapolis	20.25	31.98	56.28	61.12	60.98
Nashville	31.72	20.49	17.38	23.83	46.81
New Orleans	(13.34)	(7.93)	11.86	(21.93)	
New York	(14.94)	(25.61)	(22.38)	(20.94)	(19.95)
Oklahoma City	0.58	12.10	24.17	26.38	(38.72)
Orlando	53.53	24.83	15.18	16.97	120.33
Philadelphia	(13.36)	(95.99)	(58.14)	(57.11)	(57.85)
Phoenix	45.85	12.10	4.14	(0.03)	5.16
Pittsburgh	7.82	(18.59)	(24.21)	(23.56)	(23.23)
Portland	20.19	(12.99)	(30.26)	(32.31)	101.21
Providence	8.41	(39.66)	(56.42)	(29.83)	
Raleigh	2.73	(43.63)	(64.50)	29.47	
Rochester	(13.79)	(38.06)	(52.41)	18.17	
Sacramento	(9.46)	(12.60)	(14.77)	(9.95)	(5.01)
Salt Lake City	9.77	5.08	(6.52)	16.87	
San Antonio	26.18	11.57	1.44	5.19	81.46
San Diego	(10.49)	11.42	26.20	29.67	2.62
San Francisco	(10.28)	43.47	155.98	166.33	6.38
San Jose	(9.44)	16.05	51.33	31.25	(100.00)
Seattle	9.74	(31.70)	(35.25)	(34.80)	(35.14)
Miami	23.36	(67.69)	(63.14)	(62.39)	64.41
St. Louis	2.21	(45.44)	(41.20)	(43.39)	(43.49)
Tampa Bay	1.92	(9.03)	(13.57)	(10.97)	(11.28)
Washington	7.05	(6.63)	(12.98)	(9.38)	(9.28)

Note (parenthesis) indicates negative. All numbers in percent. **Total** is the total percentage change in unweighted accessibility over all rings (i.e. employment). **Weighted** is the percentage change in weighted accessibility over all rings using Equation 5.3. **0 to 10** indicates the nearest 10 minute ring, **10 to 20** indicates the ring between 10 and 20 minutes, and **20 to 30** indicates the ring between 20 and 30 minutes.

Table 3.2: Percentage Changes in Accessibility by Metropolitan Area: 2000 to 2010

			Minutes		
Area	**Total**	**Weighted**	**0 to 10**	**10 to 20**	**20 to 30**
Atlanta	(5.92)	10.68	13.12	15.04	15.45
Austin	10.35	7.25	0.47	11.15	13.41
Baltimore	(0.38)	8.13	13.90	16.50	2.14
Boston	(5.61)	(15.99)	(16.02)	(15.78)	(16.34)
Buffalo	(4.19)	(2.46)	(2.17)	(0.44)	(25.77)
Charlotte	(10.37)	(20.76)	(24.77)	(23.40)	5.39
Chicago	(9.36)	23.39	35.96	38.60	36.12
Cincinnati	(6.46)	(8.27)	(7.34)	(9.03)	(7.22)
Cleveland	(19.26)	(38.67)	(36.05)	(36.79)	1.79
Columbus	(3.00)	(10.99)	(16.61)	(12.81)	35.21
Dallas-Fort Worth	(3.49)	(0.19)	(2.48)	1.60	2.10
Denver	(3.92)	(1.39)	(3.12)	0.44	2.41
Detroit	(23.16)	3.31	10.58	14.24	13.06
Grand Rapids	(40.04)	(55.27)	(20.35)	(46.19)	
Virginia Beach	3.51	21.98	58.74	57.37	(28.29)
Hartford	(6.80)	(23.90)	(27.62)	(27.00)	101.03
Honolulu	4.83	(3.20)	(19.86)	20.36	
Houston	16.35	26.54	31.68	47.66	43.74
Indianapolis	(8.67)	(3.84)	1.47	2.23	(14.33)
Riverside	9.10	19.35	35.56	41.59	(26.76)
Jacksonville	73.09	49.71	125.32	127.33	19.88
Kansas City	4.17	3.96	2.81	5.35	3.50
Las Vegas	5.78	8.42	11.20	12.49	(7.80)
Los Angeles	(8.43)	35.81	67.94	78.83	74.04
Louisville	(0.20)	9.50	17.87	21.57	(34.62)
Memphis	(5.27)	(0.09)	2.77	6.21	(21.58)
Milwaukee	(5.68)	6.80	19.30	18.89	(41.71)
Minneapolis	(4.26)	20.91	42.42	42.45	42.64
Nashville	2.86	2.21	(0.86)	4.24	2.62
New Orleans	(17.59)	(16.36)	(3.83)	(22.98)	
New York	(7.75)	20.29	29.98	29.54	27.64
Oklahoma City	2.57	(4.14)	(7.43)	(8.72)	66.27
Orlando	4.61	22.63	46.30	46.92	15.18
Philadelphia	(5.06)	4.15	6.50	7.87	3.82
Phoenix	3.60	10.82	16.26	16.24	19.16
Pittsburgh	(0.74)	(1.80)	(0.94)	(2.77)	(3.04)
Portland	(0.75)	4.69	3.69	11.10	5.30
Providence	(6.17)	(13.76)	(18.50)	(15.71)	11.78
Raleigh	(33.19)	(66.93)	(44.49)	(43.68)	144.25
Rochester	(8.81)	(11.29)	(14.24)	(6.84)	
Sacramento	6.13	22.88	51.85	59.37	(41.12)
Salt Lake City	(13.93)	0.86	12.19	9.11	(100.00)
San Antonio	13.02	10.71	9.25	12.90	14.47
San Diego	1.81	37.90	101.57	109.71	58.16
San Francisco	(13.70)	4.85	25.67	29.31	(47.00)
San Jose	(17.83)	8.72	44.16	18.92	(100.00)
Seattle	(3.10)	(12.89)	(14.27)	(15.20)	(10.13)
Miami	22.54	11.10	8.48	7.15	7.41
St. Louis	(4.18)	(14.52)	(15.88)	(17.20)	(18.90)
Tampa Bay	(10.61)	18.34	40.88	41.52	40.42
Washington	4.03	23.59	38.93	41.01	38.52

Note (parenthesis) indicates negative. All numbers in percent. **Total** is the total percentage change in unweighted accessibility over all rings (i.e. employment). **Weighted** is the percentage change in weighted accessibility over all rings using Equation 5.3. **0 to 10** indicates the nearest 10 minute ring, **10 to 20** indicates the ring between 10 and 20 minutes, and **20 to 30** indicates the ring between 20 and 30 minutes.

Chapter 4

Discussion

This research provides a new methodology and dataset to enable inter-metropolitan comparisons of accessibility in a way that is clearly understood and explainable, tracks with our experience and the available evidence, and does not require complex mathematical calculations.

Comparison of accessibility between cities is useful, but accessibility also varies within each metropolitan area. New data sources make it increasingly feasible to calculate accessibility within each city using detailed network and land-use information rather than metropolitan averages. This requires considerably more data (an accurate estimate of travel times between points throughout each city) and computation, but the results allow comparison of accessibility between neighborhoods or even individual blocks. While this level of analysis has been successfully implemented for individual cities, variations in methodology and data availability make consistent application across cities challenging.

Not all jobs are the same. Some are higher paying, some are lower skilled, some are for transportation professors, and some for typesetters, so one could differentiate accessibility by breaking down jobs by type and get different results. Accessibility to nonwork destinations (shopping, schools, medical care, etc.) also matters. People with higher accessibility tend to travel shorter distances because things are closer together.

Computing accessibility for other modes[1] is also a natural extension. Accessibility to jobs is not the only thing people care about. If it were, cities would be situated on a minimum amount of space so people could live on top of their jobs, or everyone would work from home. Measuring (and then valuing) accessibility to other opportunities and considering the trade-off between accessibility and living space are central problems of urban economics, regional science, and planning. Considering multiple modes is also important, especially for urban centers that have, or hope to have, large transit mode shares. While being more accessible is generally better, there are costs as well as benefits associated with accessibility. If the price of land is higher, a purchaser can afford less. Streets in places with more activities are inherently more crowded, and car trips are less pleasurable. Transit travelers have less privacy than those traveling by car, and so on.

The policy implications of these results are informative. There are two broad avenues to increasing accessibility: improving transportation by making it faster and more direct; and increasing the density of activities, so that, for instance, more jobs are located closer together, and closer to workers. Neither of these things can be easily shifted overnight, but over the longer term, they do change.

[1] See e.g., Tomer et al. (2011).

There are many ways to make transportation faster, some more viable than others. Adding capacity at bottlenecks, managing traffic flow effectively, and implementing peak road-user fees all would tend to increase road speeds. Adding connections in the transportation network would reduce the distances travelers must cover to reach their destinations.

On the land-use side, adding density depends on both market forces and public policy. In some cases market forces are constrained in the density they would provide, either due to zoning restrictions (height restrictions, maximum floor-area ratios, and so on) or minimum parking requirements. Similarly, the market responds to incentives. The tax code, which taxes buildings and land at equal rates, discourages construction.[2]

[2]See Junge and Levinson (2012)

Chapter 5

Methods

This report uses the Urban Macroscopic Network Accessibility Indicator. It is macroscopic, in that it reports a single value for each metropolitan area, and network-based, estimated using observed network speeds and measured network circuities. It differs from microscopic accessibility measures that have been used in other reports.[1]

In general, the method used here is to identify a *representative traveler* facing a series of rings around his or her location (see e.g., Figure 5.1 illustrating what this looks like in a microscopic analysis). The rings (sometimes called time bands or isochrons) are the amount of distance that can be covered in a fixed amount of time given observed network speeds and observed network circuities. The employment of the region is averaged and spread evenly across these areas. The accessibility is the number of jobs that can be reached in each subsequent ring, constrained by total employment in the city.

This averaging method compares with accessibility computed using much more detailed methods as shown in Figure 5.2, which illustrates 20-minute accessibility by automobile to jobs in 2010 in the Minneapolis-St. Paul region. The worker-weighted 20-minute accessibility to jobs by county for the Minneapolis-St. Paul region for 2010 is given in Figure 5.3.[2]

The 20-minute macroscopic value from Table 2.1 above for the Minneapolis-St. Paul region in 2010 was 639,314 and is consistent with the numbers from the microscopic analysis: smaller than the average value for Hennepin County (the region's largest and most central county), but larger than the other six counties.

[1] See El-Geneidy and Levinson (2007); Fan et al. (2012); Levinson (1998).

[2] See Owen and Levinson (2012).

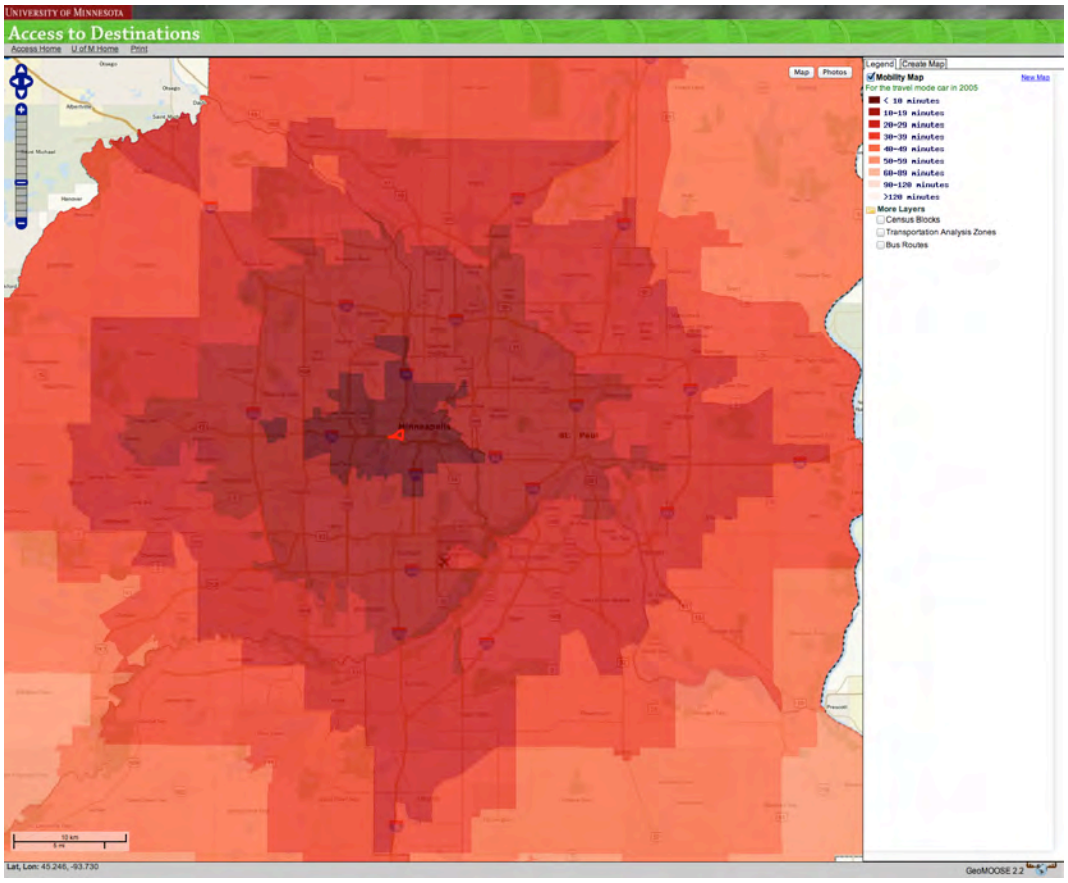

Figure 5.1: Mobility map of the Minneapolis-St. Paul region illustrates rings of travel from a single point

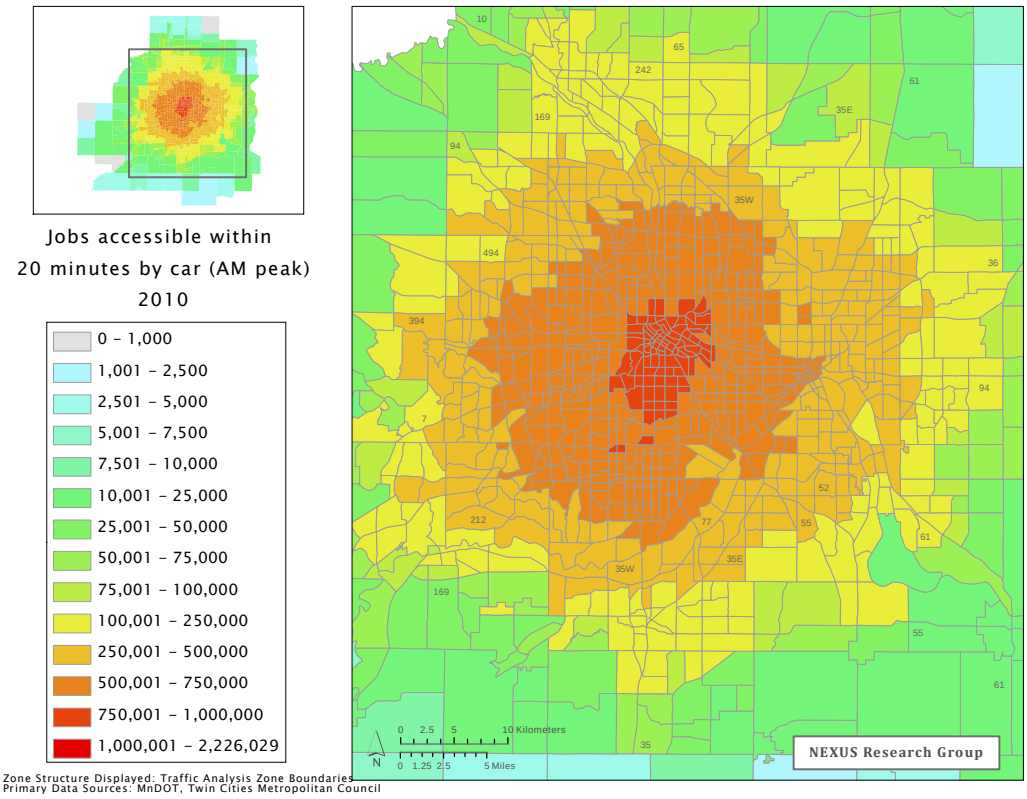

Figure 5.2: Accessibility map (20 minutes to jobs) of the Minneapolis - St. Paul region illustrates how microscopic accessibility varies by location in 2010

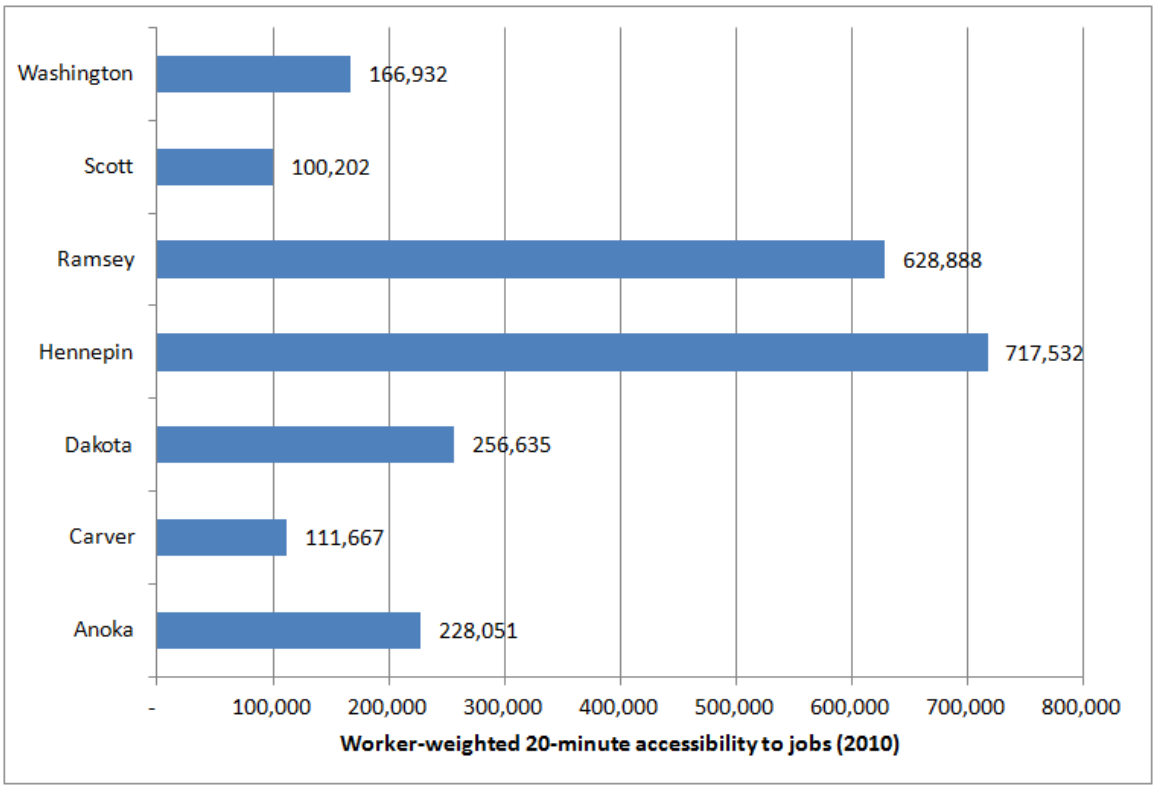

Figure 5.3: Worker-weighted accessibility by county in the Minneapolis - St. Paul region

5.1 Accessibility Equations

The cumulative opportunity measure of accessibility a_t estimates the number of destinations that can be reached in a given time threshold (t) [3]. Accessibility is calculated as:

$$a_t = \pi * \left[\frac{V_n \cdot t}{C_t}\right]^2 * \rho_{emp} \tag{5.1}$$

where:

- ρ_{emp} = Urban area employment density ($jobs \cdot km^{-2}$).
- t = time threshold.
- V_n = Average network velocity in $km \cdot h^{-1}$
- C_t = Average circuity of trips in time threshold (ex: 20-min threshold measures circuity of trips 0-20min).

Accessibility a_t was estimated for each study area using a combination of the above estimated circuity, the employment density of the urbanized area in (persons/km^2), and network speed, but is constrained not to exceed the actual employment of each metropolitan area (E):

$$a_c = \min\left[a_t, E\right] \tag{5.2}$$

In the weighted average of accessibility, destinations reachable in shorter travel times are given more weight. Here time is differenced by thresholds to get a series of donuts (e.g., jobs reachable from 0 to 10 minutes, from 10 to 20 minutes, etc.).

$$a_w = \sum_t (a_t - a_{t-10}) * e^{-b*t} \tag{5.3}$$

where:

- b = -0.08 based on previous work [4], and
- $t - 10$ denotes the next smaller 10-minute time threshold.

5.2 Circuity Equations

Network circuity is defined as the ratio of the shortest path network distance to the Euclidean or straight-line distance between an origin and destination and captures the spatial efficiency of the network in connecting two points.

$$c = \frac{d_n}{d_e} \tag{5.4}$$

where:

[3] See El-Geneidy and Levinson (2006).
[4] See Levinson and Kumar (1995).

- c = Circuity
- d_n = Network distance ,
- d_e = Euclidean distance.

This report requires not just the circuity between two points but also the average circuity for a metropolitan area as a whole. Computing this for every origin-destination pair for the 51 metropolitan areas for three decades would be computationally intensive, so a sampling procedure was used.

Two samples were generated for each city. The first sample of 200 origins and the second sample of 1000 destinations were generated using GIS. The points were randomly sampled from the network. The network distance and the Euclidean distance were calculated for each of the $200 \cdot 1000 = 200,000$ OD pairs.

We estimate circuity for 5 km intervals (0 to 5 km, 5 to 10 km, and so on). The OD pairs from the 200,000 random OD matrix in each metropolitan area were classified by interval. The average circuity for the subsample of OD pairs in each area was then estimated as:

$$C_i = \frac{D_{n,i}}{D_{e,i}} \tag{5.5}$$

where:

- C_i = Average circuity for distance interval i
- $D_{n,i}$ = Sum of the network distance between all OD pairs in the subsample,
- $D_{e,i}$ = Sum of the euclidean distance between all OD pairs in the subsample.

With speed data from each MSA, these are converted to functions of time.

$$C_t = \frac{D_{n,t}}{D_{e,t}} \tag{5.6}$$

where:

- C_t = Average circuity for time threshold t (e.g., 0 to 20 minutes)
- $D_{n,t}$ = Sum of the network distance between all OD pairs in the subsample,
- $D_{e,t}$ = Sum of the euclidean distance between all OD pairs in the subsample.

and then fed into Equation 5.1. The 0 to 10-minute circuity ratio for each area is summarized in Table 5.1. The circuity varies by length of trip.

Table 5.1: Changes in 10-minute Circuity by Metropolitan Area: 1990 to 2010

Area	1990	2000	2010	2010 - 1990	2010 - 2000
Atlanta	1.352	1.379	1.381	0.029	0.002
Austin	1.426	1.397	1.440	0.014	0.044
Baltimore	1.342	1.355	1.382	0.041	0.027
Boston	1.326	1.322	1.322	(0.003)	0.000
Buffalo	1.248	1.278	1.273	0.025	(0.006)
Charlotte	1.365	1.385	1.355	(0.010)	(0.030)
Chicago	1.316	1.327	1.324	0.007	(0.003)
Cincinnati	1.389	1.422	1.410	0.021	(0.012)
Cleveland	1.272	1.287	1.279	0.007	(0.009)
Columbus	1.315	1.321	1.325	0.010	0.004
Dallas	1.371	1.349	1.382	0.012	0.034
Denver	1.384	1.359	1.396	0.012	0.037
Detroit	1.296	1.308	1.303	0.006	(0.005)
Grand Rapids	1.335	1.333	1.321	(0.014)	(0.012)
Virginia Beach	1.377	1.449	1.404	0.027	(0.045)
Hartford	1.300	1.319	1.329	0.029	0.010
Honolulu	1.399	1.390	1.417	0.018	0.027
Houston	1.390	1.370	1.411	0.022	0.041
Indianapolis	1.313	1.349	1.331	0.017	(0.018)
Riverside	1.384	1.368	1.373	(0.011)	0.005
Jacksonville	1.382	1.421	1.392	0.011	(0.029)
Kansas City	1.350	1.347	1.348	(0.002)	0.001
Las Vegas	1.316	1.337	1.329	0.012	(0.008)
Los Angeles	1.297	1.320	1.349	0.053	0.029
Louisville	1.446	1.410	1.415	(0.031)	0.005
Memphis	1.367	1.396	1.384	0.016	(0.012)
Milwaukee	1.264	1.289	1.259	(0.005)	(0.030)
Minneapolis	1.343	1.363	1.368	0.025	0.005
Nashville	1.396	1.468	1.430	0.033	(0.038)
New Orleans	1.387	1.395	1.416	0.029	0.021
New York	1.329	1.355	1.316	(0.013)	(0.040)
Oklahoma City	1.311	1.356	1.333	0.022	(0.023)
Orlando	1.385	1.373	1.407	0.022	0.034
Philadelphia	1.284	1.317	1.291	0.007	(0.026)
Phoenix	1.338	1.365	1.344	0.007	(0.021)
Pittsburgh	1.396	1.423	1.412	0.015	(0.011)
Portland	1.513	1.497	1.530	0.017	0.033
Providence	1.318	1.325	1.341	0.024	0.017
Raleigh	1.331	1.372	1.360	0.029	(0.012)
Rochester	1.297	1.287	1.305	0.009	0.019
Sacramento	1.456	1.478	1.434	(0.022)	(0.045)
Salt Lake City	1.361	1.417	1.397	0.036	(0.020)
San Antonio	1.452	1.444	1.432	(0.020)	(0.012)
San Diego	1.420	1.416	1.452	0.032	0.036
San Francisco	1.412	1.426	1.453	0.041	0.027
San Jose	1.410	1.450	1.399	(0.011)	(0.050)
Seattle	1.446	1.400	1.473	0.027	0.072
Miami	1.320	1.335	1.337	0.017	0.002
St. Louis	1.433	1.442	1.444	0.010	0.002
Tampa Bay	1.354	1.368	1.363	0.010	(0.004)
Washington	1.436	1.441	1.428	(0.007)	(0.013)
Average	1.36	1.37	1.37	0.01	0.00

5.3 Street Network Data

The street networks for the 51 metropolitan areas used in this analysis were extracted from the Census TIGER/line files.

The extracted networks for the metropolitan areas were cleaned to include just the road features based on the Feature Class Codes (FCC) for the line segments provided in the Census TIGER/Line files. They were further cleaned using TransCAD software to eliminate nodes that served no topological purpose, and to combine the resulting links.

5.4 Travel Speed Data

Travel data from the Texas A&M Transportation Institute's Urban Mobility Report[5] provides information on the long-term congestion trends and the most recent congestion comparisons for 90 urban areas across the U.S. Within that document are data on travel speeds in metropolitan areas on freeways and arterials (shown in Table 5.2). To compute accessibility, we need an estimate of overall network speed (V_n), and so compute a weighted average of freeway (V_f) and arterial (V_a) speeds using the vehicle travel on each class of facility: freeways (Q_f) and arterials (Q_a). The vehicle travel by facility type comes from the Highway Performance Monitoring System.[6] An important methodological change in speed estimation came with the 2010 data, when the Urban Mobility Report began using speeds from Inrix, a GPS-data provider, rather than from loop detectors. While the GPS-based data are far more accurate, it makes comparisons with previous years more tenuous.

$$V_n = \frac{Q_f + Q_a}{(Q_f/V_f) + (Q_a/V_a)} \tag{5.7}$$

[5] See Schrank and Lomax (2009, 2012).

[6] See http://www.fhwa.dot.gov/policyinformation/statistics/2010/hm71.cfm

Table 5.2: Changes in Speeds (km/h) by Metropolitan Area: 1990 to 2010

Area	1990	2000	2010	2010 - 1990	2010 - 2000
Atlanta	60.38	52.32	66.7	6.31	14.37
Austin	63.48	53.20	67.1	3.65	13.93
Baltimore	60.38	57.56	64.3	3.95	6.77
Boston	61.54	60.29	59.1	(2.46)	(1.20)
Buffalo	73.28	60.08	61.5	(11.75)	1.45
Charlotte	66.91	54.74	64.1	(2.86)	9.31
Chicago	59.83	47.50	62.3	2.43	14.75
Cincinnati	67.52	59.70	63.8	(3.70)	4.11
Cleveland	70.27	62.78	60.6	(9.67)	(2.18)
Columbus	67.73	60.80	64.0	(3.68)	3.25
Dallas	66.03	56.96	66.0	(0.04)	9.03
Denver	65.00	50.87	60.7	(4.30)	9.83
Detroit	59.74	50.51	62.1	2.41	11.63
Grand Rapids	70.94	56.84	67.8	(3.15)	10.95
Virginia Beach	64.90	54.52	64.7	(0.18)	10.20
Hartford	70.55	68.57	63.8	(6.72)	(4.74)
Honolulu	61.85	58.40	54.7	(7.14)	(3.69)
Houston	61.87	53.77	66.7	4.83	12.93
Indianapolis	66.18	53.34	62.7	(3.52)	9.33
Riverside	65.10	57.82	72.1	7.01	14.29
Jacksonville	55.54	54.40	69.1	13.59	14.73
Kansas City	63.22	63.34	67.8	4.59	4.47
Las Vegas	58.29	50.76	62.5	4.16	11.69
Los Angeles	48.12	47.97	67.7	19.60	19.75
Louisville	62.49	57.96	69.8	7.28	11.80
Memphis	65.31	57.32	66.0	0.70	8.69
Milwaukee	64.49	57.26	66.6	2.09	9.32
Minneapolis	63.56	55.30	72.4	8.79	17.05
Nashville	63.73	60.80	66.5	2.77	5.70
New Orleans	62.64	56.71	70.1	7.48	13.40
New York	59.43	51.87	60.6	1.21	8.77
Oklahoma City	69.71	59.52	62.7	(6.97)	3.23
Orlando	58.78	45.74	63.7	4.89	17.94
Philadelphia	63.18	52.87	57.6	(5.59)	4.72
Phoenix	62.03	52.44	65.5	3.49	13.08
Pittsburgh	65.43	58.55	59.8	(5.62)	1.26
Portland	65.14	53.09	58.3	(6.81)	5.24
Providence	70.34	62.48	61.3	(9.01)	(1.15)
Raleigh	68.78	61.63	70.9	2.11	9.26
Rochester	70.51	62.09	64.0	(6.47)	1.96
Sacramento	61.56	53.30	69.9	8.29	16.55
Salt Lake City	65.14	52.23	64.5	(0.61)	12.30
San Antonio	68.13	59.61	70.3	2.20	10.72
San Diego	59.33	53.17	74.2	14.88	21.04
San Francisco	53.94	53.33	72.5	18.61	19.22
San Jose	57.59	50.66	67.9	10.33	17.25
Seattle	57.75	58.19	59.2	1.49	1.05
Miami	57.27	59.83	59.4	2.13	(0.43)
St. Louis	65.03	56.50	55.9	(9.08)	(0.56)
Tampa Bay	57.77	47.58	65.0	7.26	17.46
Washington	57.17	49.56	60.6	3.48	11.09
Average	63.23	55.82	64.66	1.42	8.84

5.5 Employment Data

The socio-demographic data was obtained for 1990, 2000, and 2010 from the U.S Census Bureau for the 51 metropolitan areas considered in the analysis.[7] As seen in Table 5.3, there are large changes in some metropolitan areas. There are several factors at play. First, economic conditions were not as robust in 2010 as in 2000 (or 1990) in many metropolitan areas, which still have relatively high unemployment rates. Second are changes in demographics which affect workforce participation. Third are structural economic changes that affected a few areas very hard (e.g., Detroit and New Orleans). Fourth are differences in geographical areas affecting some metropolitan areas (which generally would lead to an expansionbut in a few cases splits). In particular, note significant geographic changes in metropolitan Boston, Los Angeles, and San Francisco. Fifth are methodological differences in the collection of employment statistics, particularly between 1990 and 2000.

[7] 2010 and 2000 MSA Business Patterns (NAICS) Censtats Database http://censtats.census.gov. 1990 Employment from US Journey to Work Data by Metropolitan Area 2000 and 1990 http://publicpurpose.com/ut-jtw2000metro.htm

Table 5.3: Changes in Employment by Metropolitan Area: 1990 to 2010

Area	1990	2000	2010	2010 - 1990	2010 - 2000
Atlanta	1,481,781	2,129,188	2,003,047	521,266	(126,141)
Austin	404,016	580,485	640,563	236,547	60,078
Baltimore	1,191,813	1,063,684	1,059,610	(132,203)	(4,074)
Boston	2,141,717	3,075,331	2,902,747	761,030	(172,584)
Buffalo	531,122	475,627	455,704	(75,418)	(19,923)
Charlotte	604,856	811,507	727,384	122,528	(84,123)
Chicago	3,841,337	4,189,789	3,797,772	(43,565)	(392,017)
Cincinnati	812,766	934,953	874,547	61,781	(60,406)
Cleveland	1,242,099	1,077,676	870,158	(371,941)	(207,518)
Columbus	677,859	773,508	750,329	72,470	(23,179)
Dallas	1,976,606	2,601,083	2,510,280	533,674	(90,803)
Denver	964,912	1,080,509	1,038,146	73,234	(42,363)
Detroit	2,079,880	1,953,268	1,500,978	(578,902)	(452,290)
Grand Rapids	337,335	530,965	318,367	(18,968)	(212,598)
Virginia Beach	698,999	573,634	593,797	(105,202)	20,163
Hartford	561,969	567,921	529,323	(32,646)	(38,598)
Honolulu	437,518	320,461	335,934	(101,584)	15,473
Houston	1,759,796	1,870,780	2,176,567	416,771	305,787
Indianapolis	624,971	813,465	742,919	117,948	(70,546)
Riverside	766,953	877,495	957,326	190,373	79,831
Jacksonville	443,882	497,222	860,640	416,758	363,418
Kansas City	771,309	891,412	928,617	157,308	37,205
Las Vegas	371,128	691,875	731,876	360,748	40,001
Los Angeles	6,042,090	5,298,837	4,852,354	(1,189,736)	(446,483)
Louisville	446,876	516,026	515,000	68,124	(1,026)
Memphis	448,237	537,466	509,166	60,929	(28,300)
Milwaukee	772,752	781,664	737,279	(35,473)	(44,385)
Minneapolis	1,307,624	1,642,398	1,572,381	264,757	(70,017)
Nashville	495,717	634,772	652,935	157,218	18,163
New Orleans	514,726	541,312	446,087	(68,639)	(95,225)
New York	8,550,473	7,884,550	7,273,295	(1,277,178)	(611,255)
Oklahoma City	450,122	441,416	452,754	2,632	11,338
Orlando	557,448	818,126	855,864	298,416	37,738
Philadelphia	2,794,917	2,550,674	2,421,591	(373,326)	(129,083)
Phoenix	996,495	1,402,830	1,453,359	456,864	50,529
Pittsburgh	956,154	1,038,641	1,030,938	74,784	(7,703)
Portland	724,532	877,359	870,794	146,262	(6,565)
Providence	544,668	629,305	590,501	45,833	(38,804)
Raleigh	399,701	614,595	410,617	10,916	(203,978)
Rochester	481,467	455,184	415,085	(66,382)	(40,099)
Sacramento	685,945	585,187	621,068	(64,877)	35,881
Salt Lake City	479,338	611,285	526,157	46,819	(85,128)
San Antonio	569,149	635,453	718,175	149,026	82,722
San Diego	1,230,446	1,081,762	1,101,324	(129,122)	19,562
San Francisco	1,970,387	2,048,499	1,767,793	(202,594)	(280,706)
San Jose	946,363	1,042,998	857,032	(89,331)	(185,966)
Seattle	1,308,338	1,481,715	1,435,764	127,426	(45,951)
Miami	1,476,085	1,485,934	1,820,909	344,824	334,975
St. Louis	1,144,336	1,220,621	1,169,641	25,305	(50,980)
Tampa Bay	914,711	1,042,912	932,231	17,520	(110,681)
Washington	2,214,350	2,278,636	2,370,531	156,181	91,895
Average	1,257,805	1,344,353	1,287,985	30,180	(56,367)

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Appendices

Appendix A

Additional Tables

Table A.1: Changes in Accessibility by Metropolitan Area: 1990 to 2010

		Minutes					
Area	**Total**	**0 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 50**	**50 to 60**
Atlanta	**521,266**	-28,083	-90,900	-153,869	-30,699	723,978	100,839
Austin	**236,547**	-9,100	78	245,568	0	0	0
Baltimore	**-132,203**	-29,445	-79,703	-23,055	0	0	0
Boston	**83,105**	-70,259	-246,730	-429,488	603,546	903,961	0
Buffalo	**-75,418**	-121,693	-1,128	47,403	0	0	0
Charlotte	**122,528**	-128,788	-140,728	392,044	0	0	0
Chicago	**-43,565**	-52,923	-174,167	-312,986	-456,186	669,169	283,528
Cincinnati	**61,781**	-49,790	-157,097	204,579	64,088	0	0
Cleveland	**-371,941**	-115,670	-389,395	133,124	0	0	0
Columbus	**72,470**	-59,819	-96,258	228,547	0	0	0
Dallas	**533,674**	1,258	6,823	11,047	82,221	432,325	0
Denver	**73,234**	-57,254	-177,233	195,901	111,819	0	0
Detroit	**-578,902**	-46,885	-154,168	-266,129	-111,719	0	0
Grand Rapids	**-18,968**	-43,129	24,161	0	0	0	0
Virginia Beach	**-105,202**	3,636	19,904	-128,742	0	0	0
Hartford	**-32,646**	-151,318	-62,554	181,227	0	0	0
Honolulu	**-101,584**	-108,699	7,115	0	0	0	0
Houston	**416,771**	-1,140	8,782	12,277	128,990	267,862	0
Indianapolis	**117,948**	-35,410	-123,458	276,816	0	0	0
Riverside	**190,373**	38,898	99,515	51,960	0	0	0
Jacksonville	**416,758**	87,166	277,770	51,821	0	0	0
Kansas City	**157,308**	42,030	134,196	-844	-18,075	0	0
Las Vegas	**360,748**	24,040	132,707	204,001	0	0	0
Los Angeles	**-1,189,736**	94,611	374,098	624,732	892,036	-1,056,196	-1,711,573
Louisville	**68,124**	-11,046	-40,059	119,230	0	0	0
Memphis	**60,929**	-22,508	-65,916	149,353	0	0	0
Milwaukee	**-35,473**	-5,061	-12,390	-18,022	0	0	0
Minneapolis	**264,757**	52,234	187,501	331,448	-306,427	0	0
Nashville	**157,218**	12,509	55,631	89,078	0	0	0
New Orleans	**-68,639**	15,534	-84,173	0	0	0	0
New York	**-1,277,178**	-43,487	-133,477	-219,920	-302,781	-435,373	-544,123
Oklahoma City	**2,632**	16,022	54,798	-68,188	0	0	0
Orlando	**298,416**	13,021	46,331	239,064	0	0	0
Philadelphia	**-373,326**	-113,836	-378,404	-666,254	-81,957	867,125	0
Phoenix	**456,864**	4,033	-106	27,295	425,641	0	0
Pittsburgh	**74,784**	-22,002	-72,998	-126,895	296,679	0	0
Portland	**146,262**	-35,276	-124,636	224,926	81,249	0	0
Providence	**45,833**	-98,802	-110,242	254,877	0	0	0
Raleigh	**10,916**	-131,801	57,564	85,153	0	0	0
Rochester	**-66,382**	-114,244	47,862	0	0	0	0
Sacramento	**-64,877**	-18,274	-37,133	-9,470	0	0	0
Salt Lake City	**46,819**	-9,488	56,307	0	0	0	0
San Antonio	**149,026**	1,387	16,149	131,490	0	0	0
San Diego	**-129,122**	27,479	96,259	14,003	-266,864	0	0
San Francisco	**-202,594**	172,778	548,338	36,360	-789,391	-170,677	0
San Jose	**-89,331**	80,699	147,409	-317,439	0	0	0
Seattle	**127,426**	-42,178	-122,654	-221,633	381,000	132,891	0
Miami	**344,824**	-167,519	-542,406	219,906	804,948	29,895	0
St. Louis	**25,305**	-44,899	-159,968	-281,049	511,221	0	0
Tampa Bay	**17,520**	-11,727	-30,572	-54,589	114,408	0	0
Washington	**156,181**	-16,262	-38,574	-69,496	45,894	234,619	0

Table A.2: Rank of Changes in Accessibility Rank by Metropolitan Area: 1990 to 2010

Rank	Minutes 0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	Weighted Average
1	San Francisco	San Francisco	Los Angeles	Los Angeles	Boston	Chicago	**Los Angeles**
2	Los Angeles	Los Angeles	Charlotte	Miami	Philadelphia	Atlanta	**San Francisco**
3	Jacksonville	Jacksonville	Minneapolis	Boston	Atlanta	Austin	**Jacksonville**
4	San Jose	Minneapolis	Indianapolis	St. Louis	Chicago		**Minneapolis**
5	Minneapolis	San Jose	Providence	Phoenix	Dallas		**Las Vegas**
6	Kansas City	Kansas City	Austin	Seattle	Houston		**Kansas City**
7	Riverside	Las Vegas	Orlando	Pittsburgh	Washington		**Riverside**
8	San Diego	Riverside	Columbus	Houston	Seattle		**San Jose**
9	Las Vegas	San Diego	Portland	Tampa Bay	Miami		**Orlando**
10	Oklahoma City	Raleigh	Miami	Denver	Austin		**Nashville**
11	New Orleans	Salt Lake City	Cincinnati	Dallas			**San Diego**
12	Orlando	Nashville	Las Vegas	Portland			**Phoenix**
13	Nashville	Oklahoma City	Denver	Cincinnati			**Austin**
14	Phoenix	Rochester	Hartford	Washington			**San Antonio**
15	Virginia Beach	Orlando	Memphis	Austin			**Dallas**
16	San Antonio	Grand Rapids	Cleveland				**Houston**
17	Dallas	Virginia Beach	San Antonio				**Oklahoma City**
18	Houston	San Antonio	Louisville				**Salt Lake City**
19	Milwaukee	Houston	Nashville				**Louisville**
20	Austin	Honolulu	Raleigh				**Virginia Beach**
21	Salt Lake City	Dallas	Riverside				**Milwaukee**
22	Louisville	Austin	Jacksonville				**Memphis**
23	Tampa Bay	Phoenix	Buffalo				**New Orleans**
24	Washington	Buffalo	San Francisco				**Tampa Bay**
25	Sacramento	Milwaukee	Phoenix				**Grand Rapids**
26	Pittsburgh	Tampa Bay	San Diego				**Washington**
27	Memphis	Sacramento	Houston				**Indianapolis**
28	Atlanta	Washington	Dallas				**Sacramento**
29	Baltimore	Louisville	Grand Rapids				**Portland**
30	Portland	Hartford					**Pittsburgh**
31	Indianapolis	Memphis					**Columbus**
32	Seattle	Pittsburgh					**Baltimore**
33	Grand Rapids	Baltimore					**Atlanta**
34	New York	New Orleans	Kansas City				**Cincinnati**
35	St. Louis	Atlanta	Sacramento				**Denver**
36	Detroit	Columbus	Milwaukee				**Raleigh**
37	Cincinnati	Providence	Baltimore				**Rochester**
38	Chicago	Seattle	Tampa Bay				**Providence**
39	Denver	Indianapolis	Oklahoma City				**Seattle**
40	Columbus	Portland	Washington				**Honolulu**
41	Boston	New York	Pittsburgh				**Buffalo**
42	Providence	Charlotte	Virginia Beach				**Charlotte**
43	Honolulu	Detroit	Atlanta	Kansas City			**St. Louis**
44	Philadelphia	Cincinnati	New York	Atlanta			**Hartford**
45	Rochester	St. Louis	Seattle	Philadelphia			**Detroit**
46	Cleveland	Chicago	Detroit	Detroit			**Boston**
47	Buffalo	Denver	St. Louis	San Diego			**New York**
48	Charlotte	Boston	Chicago	New York			**Chicago**
49	Raleigh	Philadelphia	San Jose	Minneapolis	San Francisco		**Cleveland**
50	Hartford	Cleveland	Boston	Chicago	New York	New York	**Miami**
51	Miami	Miami	Philadelphia	San Francisco	Los Angeles	Los Angeles	**Philadelphia**

Table A.3: Changes in Accessibility by Metropolitan Area: 2000 to 2010

		Minutes					
Area	**Total**	**0 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 50**	**50 to 60**
Atlanta	**-126,142**	6,896	26,859	49,551	74,035	103,305	-386,788
Austin	**60,078**	419	30,627	29,031	0	0	0
Baltimore	**-4,074**	13,163	52,821	12,132	-82,189	0	0
Boston	**-850,510**	-19,891	-66,769	-123,237	-168,584	205,895	0
Buffalo	**-19,924**	-2,092	-1,380	-16,453	0	0	0
Charlotte	**-84,123**	-24,324	-79,865	20,067	0	0	0
Chicago	**-392,017**	30,650	109,681	181,604	275,559	355,306	-908,400
Cincinnati	**-60,406**	-6,068	-26,348	-36,447	8,457	0	0
Cleveland	**-207,518**	-48,103	-168,158	8,743	0	0	0
Columbus	**-23,179**	-23,046	-59,654	59,521	0	0	0
Dallas-Fort Worth	**-90,804**	-2,750	5,716	13,423	18,028	-125,220	0
Denver	**-42,364**	-3,195	1,332	12,310	-52,811	0	0
Detroit	**-452,290**	8,240	36,170	58,337	-25,120	-529,917	0
Grand Rapids	**-212,598**	-25,724	-186,874	0	0	0	0
Virginia Beach	**20,162**	30,511	102,109	-91,230	-21,228	0	0
Hartford	**-38,598**	-30,412	-99,263	91,077	0	0	0
Honolulu	**15,473**	-24,575	40,048	0	0	0	0
Houston	**305,786**	23,736	109,477	181,891	266,138	-275,457	0
Indianapolis	**-70,546**	1,140	5,806	-66,640	-10,852	0	0
Riverside	**79,830**	42,801	145,808	-108,779	0	0	0
Jacksonville	**363,417**	74,960	238,774	49,683	0	0	0
Kansas City	**37,205**	3,197	19,633	14,375	0	0	0
Las Vegas	**40,002**	13,171	44,084	-17,253	0	0	0
Los Angeles	**-446,482**	95,960	359,489	597,863	865,439	-1,101,300	-1,263,933
Louisville	**-1,025**	13,406	53,071	-67,503	0	0	0
Memphis	**-28,300**	2,115	15,431	-45,846	0	0	0
Milwaukee	**-44,385**	20,585	67,517	-132,487	0	0	0
Minneapolis	**-70,017**	43,203	147,294	261,573	-522,086	0	0
Nashville	**18,163**	-731	11,768	7,126	0	0	0
New Orleans	**-95,225**	-5,834	-89,391	0	0	0	0
New York	**-611,256**	34,795	114,936	191,124	271,244	336,769	389,570
Oklahoma City	**11,338**	-6,605	-25,078	43,020	0	0	0
Orlando	**37,739**	31,260	101,985	57,698	-153,204	0	0
Philadelphia	**-129,084**	5,001	20,735	17,842	32,147	-8,693	-196,117
Phoenix	**50,529**	14,188	43,502	89,364	-96,525	0	0
Pittsburgh	**-7,702**	-657	-6,755	-13,171	12,881	0	0
Portland	**-6,565**	2,895	26,084	22,508	-58,052	0	0
Providence	**-38,805**	-17,330	-48,332	26,857	0	0	0
Raleigh	**-203,979**	-58,148	-196,120	50,290	0	0	0
Rochester	**-40,099**	-17,226	-22,873	0	0	0	0
Sacramento	**35,881**	36,004	125,224	-125,347	0	0	0
Salt Lake City	**-85,128**	14,781	32,576	-132,485	0	0	0
San Antonio	**82,722**	8,276	37,431	37,015	0	0	0
San Diego	**19,562**	66,690	220,062	201,637	-468,827	0	0
San Francisco	**-280,706**	57,928	199,003	-537,637	0	0	0
San Jose	**-185,965**	72,885	98,497	-357,347	0	0	0
Seattle	**-45,951**	-12,895	-41,188	-46,109	-59,894	114,136	0
Miami	**334,975**	7,647	21,804	38,702	236,927	29,895	0
St. Louis	**-50,979**	-12,097	-43,351	-85,112	89,582	0	0
Tampa Bay	**-110,681**	21,670	72,791	123,551	-258,083	-70,610	0
Washington	**91,895**	30,537	108,395	188,843	258,806	-494,686	0

Table A.4: Rank of Changes in Accessibility Rank by Metropolitan Area: 2000 to 2010

			Minutes				
Rank	**0 to 10**	**10 to 20**	**20 to 30**	**30 to 40**	**40 to 50**	**50 to 60**	**Weighted Average**
1	Los Angeles	Los Angeles	Los Angeles	Los Angeles	Chicago	New York	**Los Angeles**
2	Jacksonville	Jacksonville	Minneapolis	Chicago	New York	Austin	**Jacksonville**
3	San Jose	San Diego	San Diego	New York	Boston		**San Diego**
4	San Diego	San Francisco	New York	Houston	Seattle		**New York**
5	San Francisco	Minneapolis	Washington	Washington	Atlanta		**Chicago**
6	Minneapolis	Riverside	Houston	Miami	Miami		**Houston**
7	Riverside	Sacramento	Chicago	St. Louis	Austin		**Washington**
8	Sacramento	New York	Tampa Bay	Atlanta			**Minneapolis**
9	New York	Chicago	Hartford	Philadelphia			**Riverside**
10	Orlando	Houston	Phoenix	Dallas-Fort Worth			**Orlando**
11	Chicago	Washington	Columbus	Pittsburgh			**Sacramento**
12	Washington	Virginia Beach	Detroit	Cincinnati			**Virginia Beach**
13	Virginia Beach	Orlando	Orlando	Austin			**Tampa Bay**
14	Houston	San Jose	Raleigh				**Miami**
15	Tampa Bay	Tampa Bay	Jacksonville				**San Jose**
16	Milwaukee	Milwaukee	Atlanta				**Phoenix**
17	Salt Lake City	Louisville	Oklahoma City				**San Francisco**
18	Phoenix	Baltimore	Miami				**Atlanta**
19	Louisville	Las Vegas	San Antonio				**San Antonio**
20	Las Vegas	Phoenix	Austin				**Baltimore**
21	Baltimore	Honolulu	Providence				**Las Vegas**
22	San Antonio	San Antonio	Portland				**Milwaukee**
23	Detroit	Detroit	Charlotte				**Louisville**
24	Miami	Salt Lake City	Philadelphia				**Austin**
25	Atlanta	Austin	Kansas City				**Philadelphia**
26	Philadelphia	Atlanta	Dallas-Fort Worth				**Kansas City**
27	Kansas City	Portland	Denver				**Portland**
28	Portland	Miami	Baltimore				**Detroit**
29	Memphis	Philadelphia	Cleveland				**Nashville**
30	Indianapolis	Kansas City	Nashville				**Salt Lake City**
31	Austin	Memphis	Grand Rapids				**Memphis**
32	Pittsburgh	Nashville					**Dallas-Fort Worth**
33	Nashville	Indianapolis					**Denver**
34	Buffalo	Dallas-Fort Worth					**Pittsburgh**
35	Dallas-Fort Worth	Denver	Pittsburgh				**Buffalo**
36	Denver	Buffalo	Buffalo				**Honolulu**
37	New Orleans	Pittsburgh	Las Vegas				**Oklahoma City**
38	Cincinnati	Rochester	Cincinnati				**Indianapolis**
39	Oklahoma City	Oklahoma City	Memphis	Indianapolis			**Cincinnati**
40	St. Louis	Cincinnati	Seattle	Virginia Beach			**Rochester**
41	Seattle	Seattle	Indianapolis	Detroit			**Providence**
42	Rochester	St. Louis	Louisville	Denver			**Columbus**
43	Providence	Providence	St. Louis	Portland			**St. Louis**
44	Boston	Columbus	Virginia Beach	Seattle			**Seattle**
45	Columbus	Boston	Riverside	Baltimore	Philadelphia		**New Orleans**
46	Charlotte	Charlotte	Boston	Phoenix	Tampa Bay		**Charlotte**
47	Honolulu	New Orleans	Sacramento	Orlando	Dallas-Fort Worth		**Hartford**
48	Grand Rapids	Hartford	Salt Lake City	Boston	Houston	Philadelphia	**Boston**
49	Hartford	Cleveland	Milwaukee	Tampa Bay	Washington	Atlanta	**Grand Rapids**
50	Cleveland	Grand Rapids	San Jose	San Diego	Detroit	Chicago	**Cleveland**
51	Raleigh	Raleigh	San Francisco	Minneapolis	Los Angeles	Los Angeles	**Raleigh**