Examining Changes in Commuting Metrics Across Two Decades with LEHD Data.

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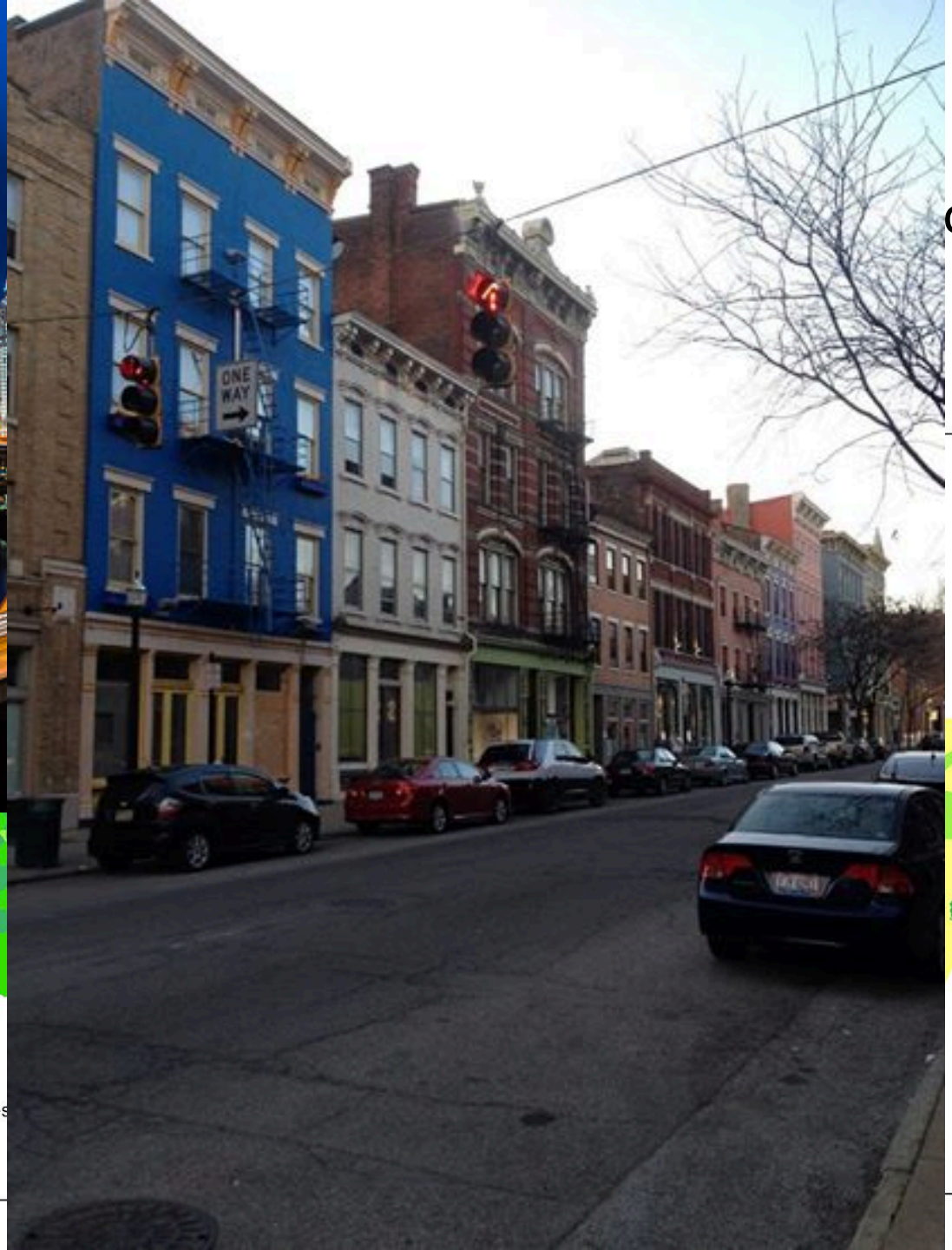
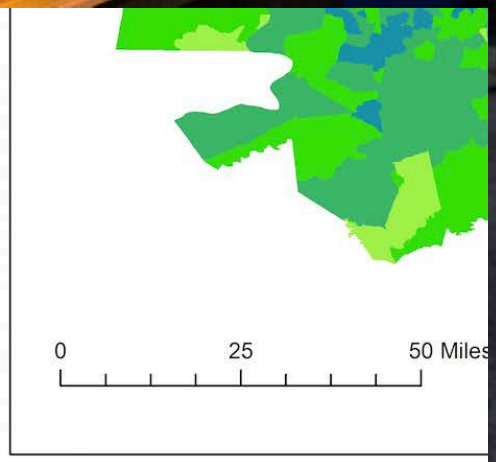




Background

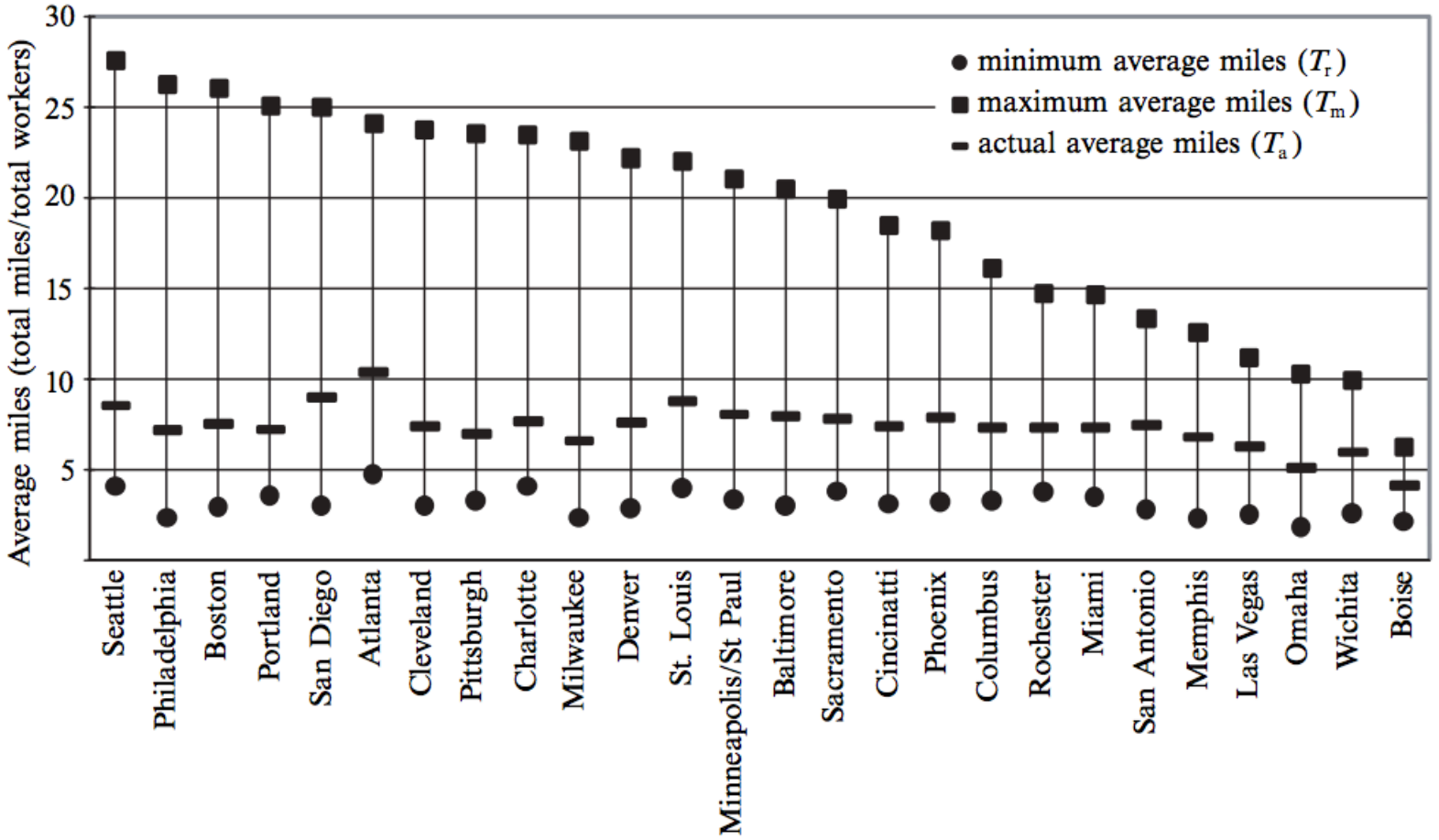


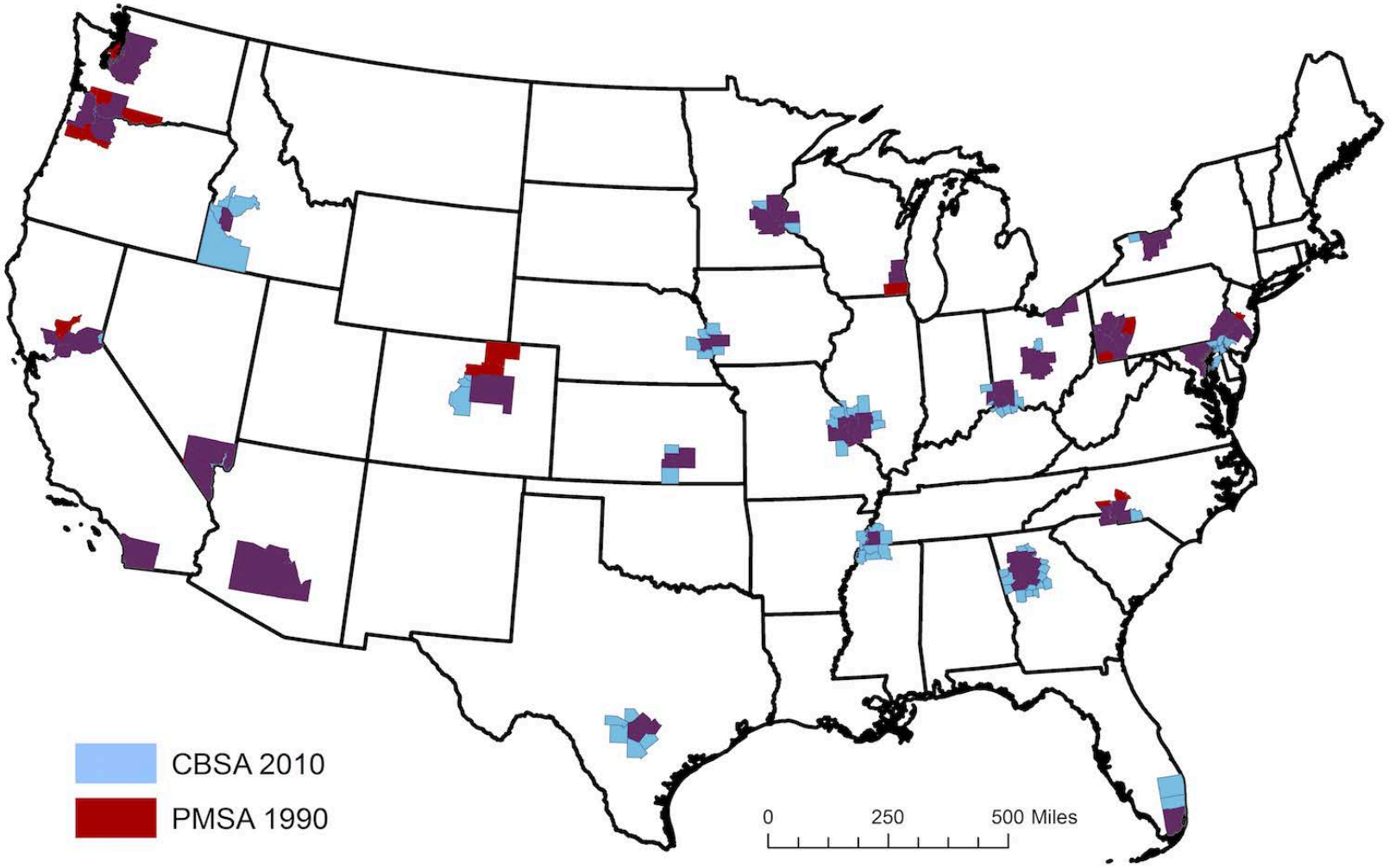
Figure 3. Composite commuting analysis results.

Horner, M. W. (2002) Extensions to the concept of excess commuting. *Environment and Planning A,* 34**,** 543-566.

Commuting Measures

- Observed Commutes (*Tobs*)
  - The average commute distance
- Theoretical Minimum Commute (*Tmin*)
  - Measure of jobs-housing balance
- Theoretical Maximum Commute (*Tmax*)
  - Measure of overall dispersion or sprawl
- Excess Commuting (*EC*)
  - (*Tobs – Tmin*) / *Tobs*
- Commuting Range (*R*)
  - *Tmax – Tmin*
- Capacity Used (*CU*)
  - (*Tobs – Tmin*) / *R*

Metro Locations



Considerations for the analysis

- 25 metro regions
- 2 years (2002 & 2011)
- 2 geographic extents (the 1990 metro definition and the 2010 metro definition)
- Road network distance used as the commuting cost.
- Scaling the underlying geography to be computationally feasible.

LEHD Data

- Published by the census bureau with almost complete national coverage
  - Massachusetts missing, some states missing 2002, 2003
- Created from state unemployment insurance records
- Consists of per block counts of residents and workers
- Available from 2002-2011 currently
- Already aggregated to 2010 blocks for 02-09
- Some workers are not included in the data
  - Migrant workers, uniformed military, and self-employed

Table 3: CBSA commuting efficiency results for 2011 (2010 boundaries)

CBSA	# of trips	T_{min}	T_{obs}	T_{max}	*EC*	Range	*CU*
Atlanta	1,881,590	6.71	17.84	39.95	62.37%	33.24	33.48%
Baltimore	898,483	3.85	12.58	25.27	69.37%	21.41	40.75%
Boise	219,143	4.77	11.04	19.95	56.80%	15.18	41.32%
Charlotte	573,404	4.85	12.84	26.45	62.26%	21.60	37.02%
Cincinnati	746,787	4.50	12.28	27.19	63.38%	22.69	34.29%
Cleveland	722,073	4.12	11.28	27.72	63.47%	23.60	30.34%
Columbus	652,899	4.04	12.17	23.88	66.84%	19.84	41.01%
Denver	984,890	3.97	11.91	21.80	66.71%	17.83	44.56%
Las Vegas	709,739	4.46	10.33	16.72	56.79%	12.26	47.86%
Memphis	456,140	5.22	12.52	23.08	58.29%	17.86	40.87%
Miami	1,893,259	3.48	14.36	45.50	75.77%	42.02	25.90%
Milwaukee	609,035	3.01	10.16	20.62	70.40%	17.61	40.62%
Minn/St.Paul	1,423,266	5.54	13.34	28.69	58.48%	23.15	33.70%
Omaha	352,311	3.12	9.01	16.82	65.38%	13.70	43.00%
Philadelphia	2,142,436	3.04	11.23	34.05	72.95%	31.02	26.42%
Phoenix	1,463,675	6.68	15.92	30.43	58.04%	23.75	38.90%
Pittsburgh	912,395	4.14	13.12	32.92	68.41%	28.78	31.18%
Portland	826,803	3.65	10.69	21.88	65.83%	18.23	38.63%
Rochester	373,326	4.05	10.91	23.36	62.85%	19.31	35.51%
Sacramento	586,121	4.39	12.71	27.12	65.48%	22.74	36.59%
San Antonio	654,012	4.52	12.72	23.36	64.48%	18.85	43.52%
San Diego	941,124	4.37	12.77	28.11	65.75%	23.74	35.37%
Seattle	1,330,856	5.52	13.65	33.84	59.55%	28.32	28.70%
St.Louis	1,072,666	5.85	14.80	34.38	60.50%	28.53	31.39%
Wichita	222,400	3.47	10.12	18.58	65.71%	15.11	44.02%

Table 3: CBSA commuting efficiency results for 2011 (2010 boundaries)

CBSA	# of trips	T_{min}	T_{obs}	T_{max}	*EC*	Range	*CU*
Atlanta	1,881,590	6.71	17.84	39.95	62.37%	33.24	33.48%
Baltimore	898,483	3.85	12.58	25.27	69.37%	21.41	40.75%
Boise	219,143	4.77	11.04	19.95	56.80%	15.18	41.32%
Charlotte	573,404	4.85	12.84	26.45	62.26%	21.60	37.02%
Cincinnati	746,787	4.50	12.28	27.19	63.38%	22.69	34.29%
Cleveland	722,073	4.12	11.28	27.72	63.47%	23.60	30.34%
Columbus	652,899	4.04	12.17	23.88	66.84%	19.84	41.01%
Miami	1,893,259	3.48	14.36	45.50	75.77%	42.02	25.90%
Minn/St.Paul	1,423,266	5.54	13.34	28.69	58.48%	23.15	33.70%
Omaha	352,311	3.12	9.01	16.82	65.38%	13.70	43.00%
Portland	826,803	3.65	10.69	21.88	65.83%	18.23	38.63%
San Antonio	654,012	4.52	12.72	23.36	64.48%	18.85	43.52%
San Diego	941,124	4.37	12.77	28.11	65.75%	23.74	35.37%
Seattle	1,330,856	5.52	13.65	33.84	59.55%	28.32	28.70%
St.Louis	1,072,666	5.85	14.80	34.38	60.50%	28.53	31.39%
Wichita	222,400	3.47	10.12	18.58	65.71%	15.11	44.02%

Table 1: CBSA commuting efficiency results for 2011 (1990 boundaries)

CBSA	# of trips	T_{min}	T_{obs}	T_{max}	*EC*	Range	*CU*
Atlanta	1,650,428	6.11	16.47	35.16	62.89%	29.05	35.65%
Baltimore	883,664	3.72	12.31	24.54	69.74%	20.82	41.22%
Boise	137,148	3.48	7.83	11.71	55.60%	8.23	52.92%
Charlotte	629,680	4.88	13.27	28.95	63.25%	24.07	34.85%
Cincinnati	709,105	3.98	11.54	25.23	65.49%	21.24	35.58%
Cleveland	722,073	4.12	11.28	27.72	63.47%	23.6	30.34%
Columbus	646,165	3.9	12.05	22.19	67.65%	18.29	44.55%
Denver	1,183,277	4.29	13.37	28.86	67.90%	24.57	36.94%
Las Vegas	709,739	4.46	10.33	16.72	56.79%	12.26	47.86%
Memphis	311,859	4.13	10.14	16.13	59.24%	12	50.07%
Miami	709,513	4.02	9.8	18.22	59.02%	14.21	40.72%
Milwaukee	609,035	3.01	10.16	20.62	70.40%	17.61	40.62%
Minn/St.Paul	1,371,759	5.22	12.93	27.32	59.65%	22.11	34.88%
Omaha	315,347	2.39	7.75	12.23	69.12%	9.84	54.46%
Philadelphia	1,984,858	2.93	11.02	30.94	73.44%	28.01	28.90%
Phoenix	1,463,675	6.68	15.92	30.43	58.04%	23.75	38.90%
Pittsburgh	960,479	4.28	13.77	35.68	68.90%	31.4	30.20%
Portland	1,016,423	5.72	12.72	33.27	55.04%	27.55	25.40%
Rochester	359,899	3.89	10.6	21.99	63.31%	18.1	37.07%
Sacramento	628,604	4.63	13.46	30.19	65.58%	25.55	34.54%
San Antonio	596,646	3.75	11.26	20.64	66.68%	16.89	44.45%
San Diego	941,124	4.37	12.77	28.11	65.75%	23.74	35.37%
Seattle	1,411,699	5.46	13.96	34.22	60.91%	28.76	29.56%
St.Louis	987,506	5.19	13.74	30.38	62.23%	25.2	33.93%
Wichita	200,559	3.1	9.22	15.63	66.39%	12.53	48.90%

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Denver	1,183,277	4.29	13.37	28.86	67.90%	24.57	36.94%
Las Vegas	709,739	4.46	10.33	16.72	56.79%	12.26	47.86%
Memphis	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Miami	709,513	4.02	9.8	18.22	59.02%	14.21	40.72%
Minn/St.Paul	1,371,759	5.22	12.93	27.32	59.65%	22.11	34.88%
Omaha	315,347	2.39	7.75	12.23	69.12%	9.84	54.46%
Philadelphia	1,984,858	2.93	11.02	30.94	73.44%	28.01	28.90%
Pittsburgh	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Portland	1,016,423	5.72	12.72	33.27	55.04%	27.55	25.40%
Sacramento	628,604	4.63	13.46	30.19	65.58%	25.55	34.54%
San Antonio	596,646	3.75	11.26	20.64	66.68%	16.89	44.45%
San Diego	941,124	4.37	12.77	28.11	65.75%	23.74	35.37%
Seattle	1,411,699	5.46	13.96	34.22	60.91%	28.76	29.56%
St.Louis	987,506	5.19	13.74	30.38	62.23%	25.2	33.93%
Wichita	200,559	3.1	9.22	15.63	66.39%	12.53	48.90%

Rank Order Comparison Tmin

metro	numJobs90	Tmin90	Tobs90	Tmax90	EC90	R90	CU90
Omaha	274058	1.85	5.14	10.32	0.6400	8.47	0.3887
Boise	87382	2.16	4.15	6.26	0.4807	4.11	0.4856
Memphis	360631	2.32	6.84	12.61	0.6604	10.29	0.4386
Milwaukee	775000	2.36	6.62	23.11	0.6437	20.75	0.2052
Philadelphia	2133136	2.36	7.21	26.24	0.6721	23.88	0.2029
Las Vegas	356452	2.55	6.3	11.22	0.5957	8.67	0.4329
Wichita	198394	2.6	5.99	9.94	0.5669	7.35	0.4625
San Antonio	506666	2.81	7.47	13.38	0.6244	10.57	0.4411
Denver	941325	2.88	7.63	22.2	0.6222	19.32	0.2457
Baltimore	1022450	3	7.99	20.47	0.6244	17.47	0.2855
Cleveland	886944	3.02	7.42	23.76	0.5930	20.74	0.2123
San Diego	1126712	3.03	9.04	25.03	0.6651	22	0.2733
Cincinnati	684950	3.12	7.43	18.5	0.5799	15.38	0.2804
Phoenix	919386	3.24	7.93	18.21	0.5907	14.96	0.3129
Pittsburgh	832049	3.3	6.99	23.58	0.5274	20.28	0.1817
Columbus	563061	3.31	7.35	16.11	0.5498	12.8	0.3156
Minneapolis	1221765	3.38	8.08	21.08	0.5819	17.7	0.2656
Miami	826175	3.5	7.36	14.69	0.5249	11.19	0.3450
Portland	687845	3.57	7.24	25.11	0.5062	21.54	0.1701
Rochester	395118	3.78	7.34	14.73	0.4853	10.95	0.3251
Sacramento	595168	3.82	7.86	19.96	0.5135	16.14	0.2500
St Louis	1026857	3.98	8.81	22.05	0.5488	18.07	0.2676
Charlotte	423873	4.09	7.69	23.52	0.4675	19.42	0.1851
Seattle	1156219	4.1	8.57	27.57	0.5217	23.48	0.1904
Atlanta	1279104	4.75	10.42	24.09	0.5443	19.34	0.2934

2002	num. of jobs	ave. tmin	ave tobs	ave tmax	EC	Range	CU
Omaha	333969	2.54	7.79	15.64	0.6745	13.10	0.4010
Milwaukee*	633373	2.66	9.27	20.10	0.7126	17.44	0.3787
Philadelphia	2084789	2.83	10.29	33.43	0.7247	30.60	0.2439
Cleveland*	801105	3.47	10.46	27.05	0.6680	23.58	0.2965
Wichita	231563	3.50	9.25	17.69	0.6214	14.19	0.4048
Denver	962901	3.51	10.99	20.38	0.6803	16.86	0.4432
Baltimore	870674	3.51	11.95	24.09	0.7061	20.58	0.4102
San Antonio	610070	3.52	11.20	21.89	0.6861	18.38	0.4183
Portland	780492	3.60	10.14	21.87	0.6451	18.27	0.3581
Sacramento	522762	3.64	11.62	27.59	0.6871	23.95	0.3333
Pittsburgh	909491	3.80	12.03	33.06	0.6840	29.26	0.2811
Miami	1899790	3.82	13.41	44.95	0.7150	41.12	0.2332
Las Vegas*	631740	3.93	8.86	15.16	0.5561	11.22	0.4389
Cincinnati	793861	3.98	11.40	26.28	0.6511	22.30	0.3328
San Diego*	927454	4.18	12.21	27.56	0.6575	23.38	0.3433
Rochester	404394	4.30	10.13	22.36	0.5756	18.06	0.3231
Charlotte	528978	4.32	11.45	26.11	0.6226	21.79	0.3272
Memphis (04	490734	4.64	11.76	22.47	0.6054	17.82	0.3996
Boise	204119	4.87	10.49	19.94	0.5355	15.07	0.3729
Minneapolis	1397314	5.04	12.27	27.31	0.5888	22.26	0.3244
St Louis	1108567	5.16	13.11	32.52	0.6065	27.36	0.2906
Phoenix* (04	1417688	5.33	13.95	27.63	0.6178	22.30	0.3865
Columbus	573065	5.42	12.79	25.90	0.5759	20.47	0.3598
Seattle	1256034	5.52	13.10	33.69	0.5786	28.16	0.2692
Atlanta	1812148	6.39	16.71	38.32	0.6176	31.93	0.3232

2011	num. of jobs	ave. tmin	ave tobs	ave tmax	EC	Range	CU
Milwaukee*	609035	3.01	10.16	20.62	0.7040	17.6147933	0.4062
Philadelphia	2142436	3.04	11.23	34.05	0.7295	31.0159817	0.2642
Omaha	352311	3.12	9.01	16.82	0.6538	13.6995414	0.4300
Wichita	222400	3.47	10.12	18.58	0.6571	15.1068606	0.4402
Miami	1893259	3.48	14.36	45.50	0.7577	42.0232254	0.2590
Portland	826803	3.65	10.69	21.88	0.6583	18.2258746	0.3863
Baltimore	898483	3.85	12.58	25.27	0.6937	21.4136492	0.4075
Denver	984890	3.97	11.91	21.80	0.6671	17.8292728	0.4456
Columbus	652899	4.04	12.17	23.88	0.6684	19.8420659	0.4101
Rochester	373326	4.05	10.91	23.36	0.6285	19.3083797	0.3551
Cleveland*	722073	4.12	11.28	27.72	0.6347	23.599548	0.3034
Pittsburgh	912395	4.14	13.12	32.92	0.6841	28.7798881	0.3118
San Diego*	941124	4.37	12.77	28.11	0.6575	23.7355838	0.3537
Sacramento	586121	4.39	12.71	27.12	0.6548	22.738116	0.3659
Las Vegas*	709739	4.46	10.33	16.72	0.5679	12.2565105	0.4786
Cincinnati	746787	4.50	12.28	27.19	0.6338	22.6949509	0.3429
San Antonio	654012	4.52	12.72	23.36	0.6448	18.8468613	0.4352
Boise	219143	4.77	11.04	19.95	0.5680	15.1822146	0.4132
Charlotte	573404	4.85	12.84	26.45	0.6226	21.6005176	0.3702
Memphis	456140	5.22	12.52	23.08	0.5829	17.8593001	0.4087
Seattle	1330856	5.52	13.65	33.84	0.5955	28.3193559	0.2870
Minneapolis	1423266	5.54	13.34	28.69	0.5848	23.1468946	0.3370
St Louis	1072666	5.85	14.80	34.38	0.6050	28.5278377	0.3139
Phoenix*	1463675	6.68	15.92	30.43	0.5804	23.7539187	0.3890
Atlanta	1881590	6.71	17.84	39.95	0.6237	33.2372606	0.3348

Table 6: Tmin, Tobs, and Tmax comparison between 2002 and 2011 (2010 boundaries)

CBSA	2002 *Tmin*	2011 *Tmin*	% change	2002 *Tobs*	2011 *Tobs*	% change	2002 *Tmax*	2011 *Tmax*	% change
Atlanta	6.39	6.71	5.07%	16.71	17.84	6.77%	38.32	39.95	4.27%
Baltimore	3.51	3.85	9.68%	11.95	12.58	5.23%	24.09	25.27	4.88%
Boise	4.87	4.77	-2.10%	10.49	11.04	5.25%	19.94	19.95	0.06%
Charlotte	4.32	4.85	12.18%	11.45	12.84	12.19%	26.11	26.45	1.30%
Cincinnati	3.98	4.50	13.07%	11.40	12.28	7.71%	26.28	27.19	3.48%
Cleveland	3.47	4.12	18.63%	10.46	11.28	7.81%	27.05	27.72	2.47%
Columbus	5.42	4.04	-25.57%	12.79	12.17	-4.82%	25.90	23.88	-7.79%
Denver	3.51	3.97	12.94%	10.99	11.91	8.43%	20.38	21.80	6.97%
Las Vegas	3.93	4.46	13.42%	8.86	10.33	16.63%	15.16	16.72	10.33%
Memphis*	4.64	5.22	12.51%	11.76	12.52	6.44%	22.47	23.08	2.74%
Miami	3.82	3.48	-8.94%	13.41	14.36	7.12%	44.95	45.50	1.24%
Milwaukee	2.66	3.01	12.95%	9.27	10.16	9.66%	20.10	20.62	2.59%
Minn/St.Paul	5.04	5.54	9.80%	12.27	13.34	8.73%	27.31	28.69	5.05%
Omaha	2.54	3.12	22.97%	7.79	9.01	15.63%	15.64	16.82	7.53%
Philadelphia	2.83	3.04	7.22%	10.29	11.23	9.10%	33.43	34.05	1.87%
Phoenix*	5.33	6.68	25.31%	13.95	15.92	14.13%	27.63	30.43	10.15%
Pittsburgh	3.80	4.14	9.00%	12.03	13.12	9.05%	33.06	32.92	-0.42%
Portland	3.60	3.65	1.51%	10.14	10.69	5.46%	21.87	21.88	0.06%
Rochester	4.30	4.05	-5.78%	10.13	10.91	7.64%	22.36	23.36	4.49%
Sacramento	3.64	4.39	20.65%	11.62	12.71	9.35%	27.59	27.12	-1.68%
San Antonio	3.52	4.52	28.49%	11.20	12.72	13.55%	21.89	23.36	6.72%
San Diego	4.18	4.37	4.66%	12.21	12.77	4.64%	27.56	28.11	2.01%
Seattle	5.52	5.52	-0.03%	13.10	13.65	4.15%	33.69	33.84	0.46%
St.Louis	5.16	5.85	13.33%	13.11	14.80	12.90%	32.52	34.38	5.71%
Wichita	3.50	3.47	-0.85%	9.25	10.12	9.45%	17.69	18.58	5.00%

Table 6: Tmin, Tobs, and Tmax comparison between 2002 and 2011 (2010 boundaries)

CBSA	2002 Tmin	2011 Tmin	% change	2002 Tobs	2011 Tobs	% change	2002 Tmax	2011 Tmax	% change
Boise	4.87	4.77	-2.10%	10.49	11.04	5.25%	19.94	19.95	0.06%
Charlotte	4.32	4.85	12.18%	11.45	12.84	12.19%	26.11	26.45	1.30%
Columbus	5.42	4.04	-25.57%	12.79	12.17	-4.82%	25.90	23.88	-7.79%
Las Vegas	3.93	4.46	13.42%	8.86	10.33	16.63%	15.16	16.72	10.33%
Memphis*	4.64	5.22	12.51%	11.76	12.52	6.44%	22.47	23.08	2.74%
Miami	3.82	3.48	-8.94%	13.41	14.36	7.12%	44.95	45.50	1.24%
Milwaukee	2.66	3.01	12.95%	9.27	10.16	9.66%	20.10	20.62	2.59%
Minn/St.Paul	5.04	5.54	9.80%	12.27	13.34	8.73%	27.31	28.69	5.05%
Omaha	2.54	3.12	22.97%	7.79	9.01	15.63%	15.64	16.82	7.53%
Philadelphia	2.83	3.04	7.22%	10.29	11.23	9.10%	33.43	34.05	1.87%
Phoenix*	5.23	6.68	25.31%	13.05	15.03	14.13%	37.63	39.43	10.15%
Portland	3.60	3.65	1.51%	10.14	10.69	5.46%	21.87	21.88	0.06%
Sacramento	3.64	4.39	20.65%	11.62	12.71	9.35%	27.59	27.12	-1.68%
San Antonio	3.52	4.52	28.49%	11.20	12.72	13.55%	21.89	23.36	6.72%
San Diego	4.18	4.37	4.66%	12.21	12.77	4.64%	27.56	28.11	2.01%
Seattle	5.52	5.52	-0.03%	13.10	13.65	4.15%	33.69	33.84	0.46%
St.Louis	5.16	5.85	13.33%	13.11	14.80	12.90%	32.52	34.38	5.71%
Wichita	3.50	3.47	-0.85%	9.25	10.12	9.45%	17.69	18.58	5.00%

Table 3: Tmin, Tobs, and Tmax comparison between 2002 and 2011 (1990 boundaries)

CBSA	2002 *Tmin*	2011 *Tmin*	% change	2002 *Tobs*	2011 *Tobs*	% change	2002 *Tmax*	2011 *Tmax*	% change
Atlanta	5.76	6.11	6.05%	15.54	16.47	6.00%	33.53	35.16	4.88%
Baltimore	3.37	3.72	10.40%	11.70	12.31	5.16%	23.37	24.54	5.02%
Boise	3.55	3.48	-1.94%	7.62	7.83	2.72%	11.14	11.71	5.12%
Charlotte	4.48	4.88	8.93%	12.00	13.27	10.51%	29.82	28.95	-2.91%
Cincinnati	3.48	3.98	14.61%	10.72	11.54	7.70%	24.23	25.23	4.10%
Cleveland	3.47	4.12	18.63%	10.46	11.28	7.81%	27.05	27.72	2.47%
Columbus	5.29	3.90	-26.36%	12.65	12.05	-4.74%	26.25	22.19	-15.49%
Denver	3.76	4.29	14.14%	12.12	13.37	10.27%	27.03	28.86	6.79%
Las Vegas	3.93	4.46	13.53%	8.86	10.33	16.63%	15.16	16.72	10.33%
Memphis*	3.55	4.13	16.50%	9.59	10.14	5.77%	15.69	16.13	2.81%
Miami	4.19	4.02	-4.17%	9.40	9.80	4.24%	17.68	18.22	3.05%
Milwaukee	2.66	3.01	12.95%	9.27	10.16	9.66%	20.10	20.62	2.59%
Minn/St.Paul	4.80	5.22	8.77%	11.95	12.93	8.17%	26.14	27.32	4.52%
Omaha	2.01	2.39	18.99%	6.82	7.75	13.70%	17.22	12.23	-28.95%
Philadelphia	2.76	2.93	6.18%	10.17	11.02	8.38%	30.19	30.94	2.49%
Phoenix*	5.33	6.68	25.31%	13.95	15.92	14.13%	27.63	30.43	10.15%
Pittsburgh	3.86	4.28	10.79%	12.50	13.77	10.09%	35.51	35.68	0.49%
Portland	3.87	5.72	47.71%	11.74	12.72	8.33%	33.82	33.27	-1.64%
Rochester	4.09	3.89	-4.91%	9.83	10.60	7.85%	21.14	21.99	4.00%
Sacramento	3.76	4.63	23.14%	12.10	13.46	11.24%	30.85	30.19	-2.16%
San Antonio	3.04	3.75	23.38%	10.12	11.26	11.26%	19.37	20.64	6.59%
San Diego	4.18	4.37	4.66%	12.21	12.77	4.64%	27.56	28.11	2.01%
Seattle	5.43	5.46	0.41%	13.37	13.96	4.41%	34.01	34.22	0.60%
St.Louis	4.85	5.19	7.06%	12.49	13.74	10.00%	29.02	30.38	4.70%
Wichita	3.12	3.10	-0.76%	8.47	9.22	8.86%	14.68	15.63	6.43%

Table 3: Tmin, Tobs, and Tmax comparison between 2002 and 2011 (1990 boundaries)

CBSA	2002 Tmin	2011 Tmin	% change	2002 Tobs	2011 Tobs	% change	2002 Tmax	2011 Tmax	% change
Boise	3.55	3.48	-1.94%	7.62	7.83	2.72%	11.14	11.71	5.12%
Charlotte	4.48	4.88	8.93%	12.00	13.27	10.51%	29.82	28.95	-2.91%
Columbus	5.29	3.90	-26.36%	12.65	12.05	-4.74%	26.25	22.19	-15.49%
Memphis*	3.55	4.13	16.50%	9.59	10.14	5.77%	15.69	16.13	2.81%
Miami	4.19	4.02	-4.17%	9.40	9.80	4.24%	17.68	18.22	3.05%
Milwaukee	2.66	3.01	12.95%	9.27	10.16	9.66%	20.10	20.62	2.59%
Minn/St.Paul	4.80	5.22	8.77%	11.95	12.93	8.17%	26.14	27.32	4.52%
Omaha	2.01	2.39	18.99%	6.82	7.75	13.70%	17.22	12.23	-28.95%
Philadelphia	2.76	2.93	6.18%	10.17	11.02	8.38%	30.19	30.94	2.49%
Portland	3.87	5.72	47.71%	11.74	12.72	8.33%	33.82	33.27	-1.64%
Sacramento	3.76	4.63	23.14%	12.10	13.46	11.24%	30.85	30.19	-2.16%
San Antonio	3.04	3.75	23.38%	10.12	11.26	11.26%	19.37	20.64	6.59%
San Diego	4.18	4.37	4.66%	12.21	12.77	4.64%	27.56	28.11	2.01%
Seattle	5.43	5.46	0.41%	13.37	13.96	4.41%	34.01	34.22	0.60%
St.Louis	4.85	5.19	7.06%	12.49	13.74	10.00%	29.02	30.38	4.70%
Wichita	3.12	3.10	-0.76%	8.47	9.22	8.86%	14.68	15.63	6.43%

Discussion

- We recalculated all of the commuting measures from Horner's 2002 paper for 25 metro regions.
- Understand how the urban forms are changing over time.
  - Miami's results support a polycentric urban form being able to facilitate shorter commutes
  - Overall metros remain fairly consistent
    - Especially with 1990 boundaries preserved
    - Columbus the only metro to decrease in Tmin, Tobs, and Tmax from 2002 to 2011.

Appendix

The Transportation Problem

Minimize ($T_{\min}$)

$$T_{\min} = \sum_{i=1}^{n}\sum_{j=1}^{m} c_{ij}x_{ij} \qquad [1]$$

subject to

$$\sum_{i=1}^{n} x_{ij} = D_j \qquad \forall j = 1,\ldots,m, \qquad [2]$$

$$\sum_{j=1}^{m} x_{ij} = O_i \qquad \forall i = 1,\ldots,n, \qquad [3]$$

$$x_{ij} \geq 0 \qquad \forall i, j, \qquad [4]$$