Urban transportation, land use, and household greenhouse gas production

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Reseach Questions

- What is the effect of urban form on GHG emissions from driving?
- Can we estimate GHG emissions across US metros?
- Can planning that fosters a vibrant urban core lower GHG emissions?
- How do the above factors influence pub transit use?

Data Sources

- 2001 and 2009 NHTS
- 1994, 2001, 2009 Zip code Business Patterns (ZBP)
- 1995, 2000, 2005 Crime in the US (CIUS)
- 2000 Census
- 2007 City County Databook

The NHTS doesn't report GHG emissions

- We use conversion factors
  - A gallon of gasoline produces 19.564 lbs of CO2 (standard Dept of Energy conversion factor)
  - To capture the indirect emissions associated with using a gallon of gas (e.g. Refining, transporting gas to pump), we use a factor that is 20% higher (23.46 lbs)

Table 1a: Summary statistics, 2001 NHTS

Variable	Obs	Mean	Std. Dev	.	Min	Max
gsyrgal	14096	1204.26	816.30		0.34	4885.65
regionmidwest	37494	0.40	0.49		0	1
regionsouth	37494	0.21	0.41		0	1
regionwest	37494	0.10	0.30		0	1
distance	37494	17.03	28.85		0	1518.21
density	37494	6335.00	16659.32		0	229712.60
msadensity	37494	644.68	767.75		6.25	2724.27
middenintact	37492	2.79	3.54		0	11.29
southdenintact	37492	1.57	3.14		0	10.73
westdenintact	37492	0.79	2.43		-0.49	11.48
hhsize	37492	2.73	1.36		1	14
hhr_age	37492	43.45	11.94		18	65

Table 1b: Gallons of gasoline consumed per year, 2001

VARIABLES	household annual gasoline consumption (gallons)
regionmidwest	49.77
	(86.19)
regionsouth	176.1**
	(86.75)
regionwest	-252.2***
	(89.45)
lndistance	59.46***
	(9.10)
lndensity	-88.15***
	(8.00)
lnmsadensity	-55.30***
	(13.25)
middenintact	10.98
	(11.50)
southdenintact	-5.145
	(11.98)
westdenintact	40.39***
	(11.70)
hhsize	156.4***
	-5.509
hhr_age	-1.462**
	-0.585
Constant	1,536***
	-84.66
Observations	13,289
R-squared	0.231
income fixed effects?	yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 2a: Summary statistics, 2009 NHTS

Variable	Obs	Mean	Std. Dev	Min	Max
gsyrgal	70800	1223.07	773.32	1	4332
regionmidwest	73869	0.10	0.30	0	1
regionsouth	73869	0.52	0.50	0	1
regionwest	73869	0.24	0.43	0	1
distance	73869	20.18	20.86	0	1517.49
density	73869	3894.85	9958.54	0	212000
msadensity	73869	548.95	658.09	6.25	2724.27
middenintact	73867	0.68	2.10	0	11.08
southdenintact	73867	3.56	3.57	0	10.96
westdenintact	73867	1.93	3.48	-1.33	11.50
hhsize	73869	2.67	1.32	1	13
hhr_age	73869	49.48	10.91	18	65

Table 2b: Gallons of gasoline consumed per year, 2009

VARIABLES	household annual gasoline consumption (gallons)
regionmidwest	107.9
	-65.58
regionsouth	196.8***
	-65.65
regionwest	-207.0***
	-72.62
lndistance	42.92***
	-6.251
lndensity	-80.31***
	-9.216
lnmsadensity	-42.10***
	-9.999
middenintact	2.026
	-10.36
southdenintact	-2.328
	-10.33
westdenintact	41.52***
	-10.88
hhsize	185.1***
	-3.913
hhr_age	2.799***
	-0.368
Constant	1,060***
	-77.2
Observations	66,751
R-squared	0.238
income fixed effects?	yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Estimating Average Emissions by MSA

- We take our coefficient estimates and predict gasoline usage for a family with an income of 62,500 dollars and 2.62 members for each census tract located within 366 major metropolitan areas.

- Intuitively, we are predicting what the average gasoline consumption would be for a standardized household if it lived in each of census tracts within the 366 metropolitan areas.

- We then form metropolitan area aver-ages by aggregating up from the tract level weighting by the tract's household count.

Table 3: Gallons of gasoline, 2009, fixed effect model

VARIABLES	household annual gasoline consumption (gallons)
hhsize	184.1***
	(3.84)
hhr_age	2.689***
	(0.35)
lndistance	59.28***
	(5.96)
lndensity	-62.77***
	(3.85)
Constant	795.0***
	(47.94)
Observations	66,751
R-squared	0.248
income fixed effects?	yes
CBSA fixed effects?	yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

ranking of MSAs (pop > 1,000,000) by aggregate gasoline consumption

e	cbsaname	Freq.	est_gas	popmsa
0	New York-Northern New Jersey-Long Island, NY-N	3844	591.85	18323002
0	Washington-Arlington-Alexandria, DC-VA-MD-WV	996	733.95	4796183
0	San Jose-Sunnyvale-Santa Clara, CA	842	744.02	1735819
0	San Francisco-Oakland-Fremont, CA	2153	745.67	4123740
0	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	361	774.05	5687147
0	Las Vegas-Paradise, NV	134	793.67	1375765
0	Chicago-Joliet-Naperville, IL-IN-WI	609	818.04	9098316
0	Portland-Vancouver-Hillsboro, OR-WA	148	819.63	1927881
0	Boston-Cambridge-Quincy, MA-NH	251	831.34	4391344
0	Hartford-West Hartford-East Hartford, CT	94	845.36	1148618
0	Los Angeles-Long Beach-Santa Ana, CA	4053	857.39	12365627
0	Buffalo-Niagara Falls, NY	660	858.08	1170111
0	Phoenix-Mesa-Glendale, AZ	4396	868.21	3251876
0	Seattle-Tacoma-Bellevue, WA	180	873.52	3043878
0	Miami-Fort Lauderdale-Pompano Beach, FL	2801	890	5007564
0	Columbus, OH	96	891.43	1612694
0	Pittsburgh, PA	149	891.67	2431087
0	Minneapolis-St. Paul-Bloomington, MN-WI	192	895.91	2968806
0	Sacramento--Arden-Arcade--Roseville, CA	1132	900.99	1796857
0	Milwaukee-Waukesha-West Allis, WI	393	905.56	1500741
0	Rochester, NY	665	907.33	1037831
0	Kansas City, MO-KS	129	912.96	1836038
0	Tampa-St. Petersburg-Clearwater, FL	2014	914.96	2395997
0	San Diego-Carlsbad-San Marcos, CA	5345	919.46	2813833
0	Providence-New Bedford-Fall River, RI-MA	277	920.57	1582997
0	Baltimore-Towson, MD	162	932.4	2552994

San Diego-Carlsbad-San Marcos, CA	53
Providence-New Bedford-Fall River, RI-MA	27
Baltimore-Towson, MD	16
Austin-Round Rock-San Marcos, TX	147
St. Louis, MO-IL	16
Houston-Sugar Land-Baytown, TX	347
Denver-Aurora-Broomfield, CO	12
Orlando-Kissimmee-Sanford, FL	109
Cleveland-Elyria-Mentor, OH	13
Dallas-Fort Worth-Arlington, TX	470
Indianapolis-Carmel, IN	79
Detroit-Warren-Livonia, MI	19
Virginia Beach-Norfolk-Newport News, VA-NC	250
Atlanta-Sandy Springs-Marietta, GA	80
San Antonio-New Braunfels, TX	195
Jacksonville, FL	104
Riverside-San Bernardino-Ontario, CA	114
Charlotte-Gastonia-Rock Hill, NC-SC	54
New Orleans-Metairie-Kenner, LA	6
Louisville/Jefferson County, KY-IN	18
Oklahoma City, OK	7
Cincinnati-Middletown, OH-KY-IN	15
Nashville-Davidson--Murfreesboro--Franklin, TN	55
Richmond, VA	234
Memphis, TN-MS-AR	30
Birmingham-Hoover, AL	6

Table 3, Summary Statistics, all MSAs

Variable	Obs	Mean	Std. Dev .	Min	Max
gas	364	1045.67	172.93	474.10	1633.55
lninc	366	9.86	0.17	9.20	10.55
lnpop	366	12.58	1.05	10.82	16.72
pct_jobs_dwntwn_08	361	0.42	0.22	0.00	1.36
jan_temp	366	37.42	14.38	4.30	70.3
july_temp	366	76.30	5.97	57.30	95.2
job_grth_dwntwn_08	361	-0.02	0.23	-0.90	1.33
cc_crate_05	321	733.27	450.21	60.56	2717.75
cc_crate_growth	296	-0.07	0.84	-0.85	11.95
pct_collegdwntwn_00	362	0.24	0.10	0.08	0.66
pc_resta_dwntwn_08	361	177.32	90.03	0	961.75
pc_hotel_dwntwn_08	361	45.32	41.97	0	415.30
pc_bars_dwntwn_08	361	46.00	33.29	0	218.46
pc_bowling_dwntwn_08	361	3.95	4.62	0	35.83
pc_museum_dwntwn_08	361	5.83	8.99	0	120.92
pc_music_dwntwn_08	361	5.19	17.27	0	237.53

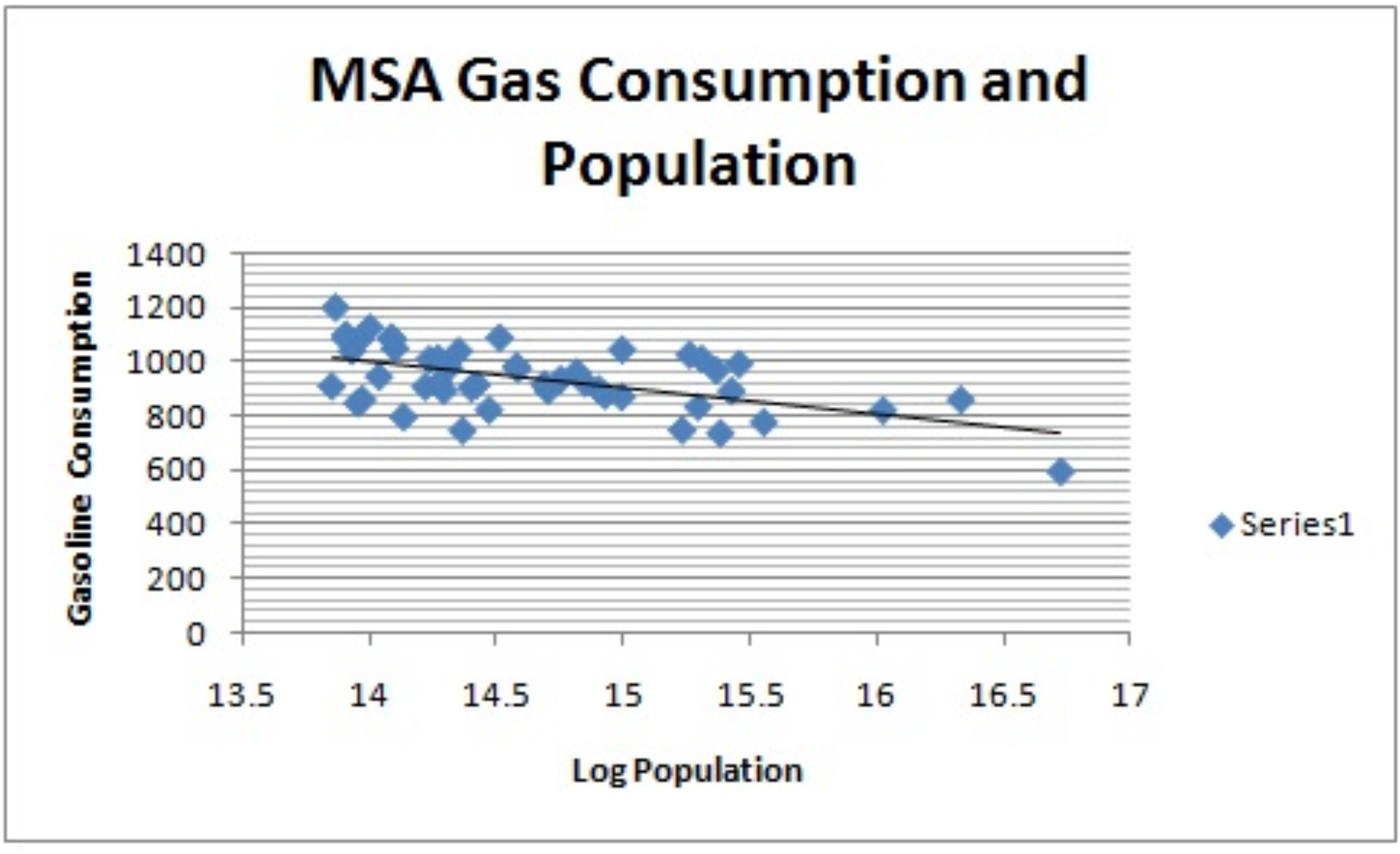
MSA Gas Consumption and Population
Gasoline Consumption
1400
1200
1000
800
600
400
200
0
13.5
14
14.5
15
15.5
16
16.5
17
Log Population
Series1

Table 3a: MSA emissions per capita, 2009, and urban form and vibrancy

VARIABLES	gas	gas	gas	gas	gas	gas	gas	gas	gas	gas	gas
lninc	-260.0***	-247.1***	-238.2***	-264.2***	-212.9***	-247.8***	-259.7***	-252.9***	-263.1***	-263.6***	-264.3***
	(54.45)	(54.36)	(57.56)	(56.19)	(55.82)	(55.48)	(54.50)	(54.14)	(55.14)	(54.62)	(54.73)
lnpop	-46.52***	-45.51***	-59.58***	-44.45***	-47.73***	-48.36***	-45.04***	-45.40***	-45.35***	-45.14***	-45.27***
	(9.53)	(9.47)	(10.91)	(10.15)	(9.44)	(9.66)	(9.82)	(9.47)	(10.04)	(9.66)	(9.65)
jan_temp	0.0011	-0.185	0.021	0.279	0.132	-0.00401	-0.0144	-0.0227	0.0144	0.00463	-4.68E-05
	(0.63)	(0.63)	(0.66)	(0.64)	(0.62)	(0.63)	(0.63)	(0.62)	(0.63)	(0.63)	(0.63)
july_temp	-2.587*	-2.431	-4.059**	-3.662**	-2.32	-2.448	-2.711*	-2.627*	-2.598*	-2.693*	-2.681*
	(1.50)	(1.49)	(1.61)	(1.55)	(1.49)	(1.50)	(1.51)	(1.49)	(1.50)	(1.50)	(1.50)
pct_jobs_dwntwn08	-1.543	19.42	19.97	36.27	-4.252	-8.241	1.239	12.89	-1.476	5.562	6.424
	(41.36)	(42.01)	(46.93)	(46.23)	(42.06)	(41.77)	(41.64)	(41.48)	(41.41)	(42.15)	(42.51)
job_grth_dwntwn08		-89.96**									
		(37.56)									
cc_crate_05			0.0730***								
			(0.02)								
cc_crate_growth				-6.055							
				(10.17)							
pct_college_dwntwn					-268.2***						
					(83.68)						
pc_resta_dwntwn08						-0.106					
						(0.09)					
pc_hotel_dwntwn08							0.128				
							(0.21)				
pc_barss_dwntwn08								-0.613**			
								(0.25)			
pc_bowli_dwntwn08									0.706		
									(1.89)		
pc_museu_dwntwn08										0.825	
										(0.93)	
pc_music_dwntwn08											0.401
											(0.49)
Constant	4,391***	4,236***	4,390***	4,464***	3,982***	4,305***	4,373***	4,333***	4,404***	4,410***	4,420***
	(513.60)	(514.30)	(535.50)	(519.90)	(524.00)	(519.00)	(514.90)	(510.50)	(515.50)	(514.20)	(515.10)
Observations	360	360	315	290	359	360	360	360	360	360	360
R-squared	0.207	0.22	0.243	0.263	0.23	0.21	0.208	0.221	0.208	0.209	0.209

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3b: MSA emissions per capita, 2009, and urban form and vibrancy (msa pop > 500,000)

VARIABLES	gas	gas	gas	gas	gas	gas	gas	gas	gas	gas	gas
lninc	-290.6***	-263.3***	-264.8***	-285.7***	-303.0***	-267.5***	-292.5***	-283.1***	-289.1***	-290.4***	-289.6***
	(58.27)	(58.71)	(55.88)	(55.96)	(60.81)	(55.93)	(59.19)	(57.61)	(58.67)	(58.56)	(57.96)
lnpop	-57.54***	-59.86***	-65.76***	-61.86***	-59.84***	-67.55***	-57.95***	-60.37***	-60.11***	-57.06***	-58.41***
	(14.81)	(14.58)	(14.70)	(15.17)	(15.18)	(14.46)	(15.01)	(14.69)	(16.05)	(14.93)	(14.75)
pct_jobs_dwntwn08	-407.1***	-413.3***	-336.9***	-419.4***	-429.5***	-482.8***	-411.6***	-394.5***	-411.4***	-394.2***	-404.5***
	(98.26)	(96.43)	(95.17)	(92.53)	(103.10)	(96.67)	(100.80)	(97.14)	(99.27)	(103.10)	(97.75)
jan_temp	1.119	1.089	0.722	1.119	1.113	1	1.121	1.061	1.096	1.114	1.26
	(0.77)	(0.76)	(0.75)	(0.74)	(0.78)	(0.74)	(0.78)	(0.76)	(0.78)	(0.78)	(0.78)
july_temp	-4.100**	-3.196*	-5.418***	-4.495**	-3.916**	-3.768**	-4.074**	-4.077**	-4.070**	-3.925**	-4.208**
	(1.82)	(1.84)	(1.76)	(1.75)	(1.84)	(1.74)	(1.84)	(1.80)	(1.83)	(1.88)	(1.81)
job_grth_dwntwn08		-94.14**									
		(46.28)									
cc_crate_05			0.0762***								
			(0.02)								
cc_crate_growth				-1.344							
				(36.54)							
pct_college_dwntwn					87.11						
					(117.70)						
pc_resta_dwntwn08						-0.472***					
						(0.15)					
pc_hotel_dwntwn08							-0.0941				
							(0.41)				
pc_barss_dwntwn08								-0.654*			
								(0.36)			
pc_bowli_dwntwn08									-1.902		
									(4.45)		
pc_museu_dwntwn08										1.641	
										(3.76)	
pc_music_dwntwn08											1.14
											(0.83)
Constant	5,036***	4,731***	4,910***	5,083***	5,163***	5,027***	5,063***	5,031***	5,061***	5,003***	5,035***
	(564.00)	(573.20)	(536.80)	(535.60)	(591.10)	(536.50)	(579.00)	(556.20)	(569.90)	(571.90)	(561.00)
Observations	86	86	81	79	86	86	86	86	86	86	86
R-squared	0.47	0.496	0.538	0.528	0.473	0.526	0.47	0.491	0.471	0.471	0.482

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3c: MSA emissions per capita, 2009, and urban form and vibrancy (msa pop < 500,000)

VARIABLES	gas	gas	gas	gas	gas	gas	gas	gas	gas	gas	gas
lninc	-255.7***	-244.6***	-232.6***	-254.9***	-199.1***	-231.2***	-244.6***	-229.7***	-239.1***	-243.8***	-243.7***
	(70.25)	(75.63)	(77.22)	(75.49)	(71.96)	(75.80)	(77.04)	(76.86)	(77.25)	(77.09)	(77.11)
lnpop	-60.24***	-64.89***	-71.45***	-67.68***	-63.65***	-56.40***	-60.84***	-53.82**	-62.07***	-60.13***	-60.29***
	(19.94)	(21.79)	(22.66)	(22.00)	(19.78)	(21.58)	(21.95)	(22.02)	(22.07)	(21.97)	(22.09)
pct_jobs_dwntwn082	8.202	-20.06	54.69	50.38	18.84	33.15	8.923	28.91	5.53	1.691	1.089
	(58.79)	(63.82)	(70.64)	(69.58)	(58.55)	(63.30)	(64.66)	(64.68)	(63.73)	(63.99)	(64.09)
jan_temp	-0.492	-0.503	-0.405	-0.257	-0.342	-0.402	-0.356	-0.404	-0.415	-0.414	-0.408
	(0.76)	(0.81)	(0.82)	(0.80)	(0.76)	(0.81)	(0.83)	(0.82)	(0.83)	(0.83)	(0.83)
july_temp	-1.733	-1.921	-3.094	-2.583	-1.27	-0.992	-1.946	-1.648	-1.943	-2.045	-2.035
	(1.85)	(1.91)	(2.06)	(1.98)	(1.84)	(1.95)	(1.95)	(1.95)	(1.95)	(1.96)	(1.95)
job_grth_dwntwn082		31.37*									
		(17.02)									
cc_crate_05			0.0638**								
			(0.03)								
cc_crate_growth				-7.081							
				(11.30)							
pct_college_dwntwn2					-258.9***						
					(87.15)						
pc_resta_dwntwn082						-0.236***					
						(0.08)					
pc_hotel_dwntwn082							-0.132				
							(0.21)				
pc_barss_dwntwn082								-0.424*			
								(0.22)			
pc_bowli_dwntwn082									-0.967		
									(1.29)		
pc_museu_dwntwn082										0.00845	
										(0.35)	
pc_music_dwntwn082											-0.0217
											(0.42)
Constant	4,466***	4,439***	4,429***	4,600***	3,965***	4,151***	4,381***	4,137***	4,344***	4,371***	4,371***
	(700.70)	(744.90)	(758.70)	(741.40)	(712.30)	(749.60)	(759.50)	(763.80)	(759.80)	(759.80)	(759.90)
Observations	277	251	237	214	274	249	249	249	249	249	249
R-squared	0.103	0.114	0.123	0.135	0.131	0.128	0.097	0.109	0.098	0.096	0.096

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9: public transit use, 2009

VARIABLES	ptused
regionmidwest	0.270**
	(0.12)
regionsouth	0.19
	(0.12)
regionwest	0.240*
	(0.12)
lndistance	-0.0415***
	(0.01)
lndensity	0.0629***
	(0.02)
lnmsadensity	0.0716***
	(0.02)
middenintact	-0.0573***
	(0.02)
southdenintact	-0.0475**
	(0.02)
westdenintact	-0.0424**
	(0.02)
hhsize	0.0172***
	(0.00)
hhr_age	-0.00137***
	(0.00)
Constant	-0.463***
	(0.13)
Observations	69,500
R-squared	0.128

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: public transit use, urban form and vibrancy, 2009

VARIABLES	ptused	ptused	ptused	ptused	ptused	ptused	ptused	ptused	ptused	ptused
pct_jobs_dwntwn08	0.0022									
	(0.05)									
job_grth_dwntwn08		0.102								
		(0.10)								
cc_crate_05			0.374							
			(1.86)							
pct_college_dwntwn				0.498***						
				(0.10)						
pc_resta_dwntwn08					7.206					
					(15.82)					
pc_barss_dwntwn08						14.4				
						(43.16)				
pc_hotel_dwntwn08							4.695			
							(27.62)			
pc_bowli_dwntwn08								108.3		
								(261.40)		
pc_music_dwntwn08									66.69	
									(79.43)	
pc_museu_dwntwn08										106.2
										(103.20)
Constant	-0.465***	-0.451***	-0.463***	-0.568***	-0.473***	-0.473***	-0.466***	-0.475***	-0.458***	-0.473***
	-0.144	-0.123	-0.127	-0.102	-0.129	-0.124	-0.127	-0.128	-0.124	-0.126
Observations	69,500	69,500	69,500	69,500	69,500	69,500	69,500	69,500	69,500	69,500
R-squared	0.128	0.131	0.129	0.143	0.129	0.129	0.129	0.129	0.129	0.129
income fixed effects?	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
control variable supressed?	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Future Plans

- Create a vibrancy index
- Instrument for density