Urban Development and Carbon Dioxide Emissions

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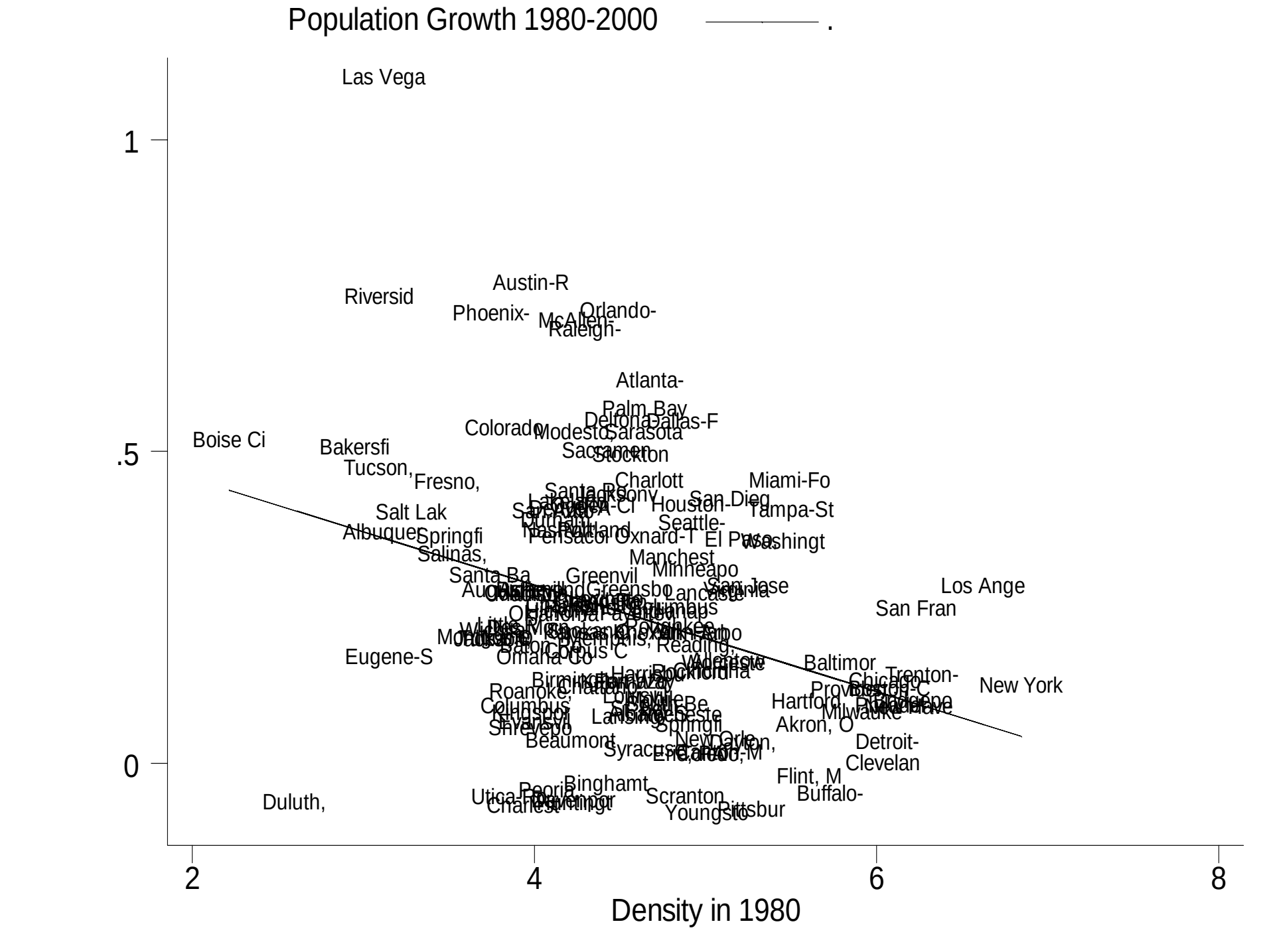
Overview of Discussion

- Basic Question: How should concerns about carbon dioxide emissions impact urban development?
- Preliminary Facts
- The economics of land use decisions in the presence of an environmental externality
- What are the external effects of building different cities?
- How do these line up with current growth?

Metropolitan statistical area	Change, 2000 to 2006	
	Number	Percent
Atlanta-Sandy Springs-Marietta, GA	890,211	21.0
Dallas-Fort Worth-Arlington, TX	842,449	16.3
Houston-Sugar Land-Baytown, TX	824,547	17.5
Phoenix-Mesa-Scottsdale, AZ	787,306	24.2
Riverside-San Bernardino-Ontario, CA	771,314	23.7
Los Angeles-Long Beach-Santa Ana, CA	584,510	4.7
New York-Northern New Jersey-Long Island, NY-NJ-PA	495,154	2.7
Washington-Arlington-Alexandria, DC-VA-MD-WV	494,220	10.3
Miami-Fort Lauderdale-Miami Beach, FL	455,869	9.1
Chicago-Naperville-Joliet, IL-IN-WI	407,133	4.5
Las Vegas-Paradise, NV	401,801	29.2
Orlando-Kissimmee, FL	340,292	20.7
Tampa-St. Petersburg-Clearwater, FL	301,718	12.6
Sacramento--Arden-Arcade--Roseville, CA	270,260	15.0
Austin-Round Rock, TX	263,802	21.1
Charlotte-Gastonia-Concord, NC-SC	252,613	19.0


Population Growth 1980-2000
Las Vega
Riversid
Austin-R
Phoenix-
Orlando-
McAllen-
Raleigh-
Atlanta-
Palm Bay
Colorado
Modesto
Sarasota
Boise Ci
Bakersfi
Sacramen
Stockton
Tucson,
Fresno,
Charlott
Miami-Fo
Houston-
San Dieg
Tampa-St
Salt Lak
Albuquer
Springfi
Seattle-
Pensacol
Oxnard-T
El Paso,
Washingt
Salinas,
Manchest
Santa Ba
Greenvil
Minneapo
San Jose
Los Ange
San Fran
Eugene-S
Omaha Co
Reading,
Baltimor
Trenton-
New York
Roanoke,
Columbus,
Hartford,
Milwauke
Akron, O
Beaumont
Detroit-
Clevelan
Flint, M
Binghamt
Buffalo-
Scranton
Duluth,
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.5
0
2
4
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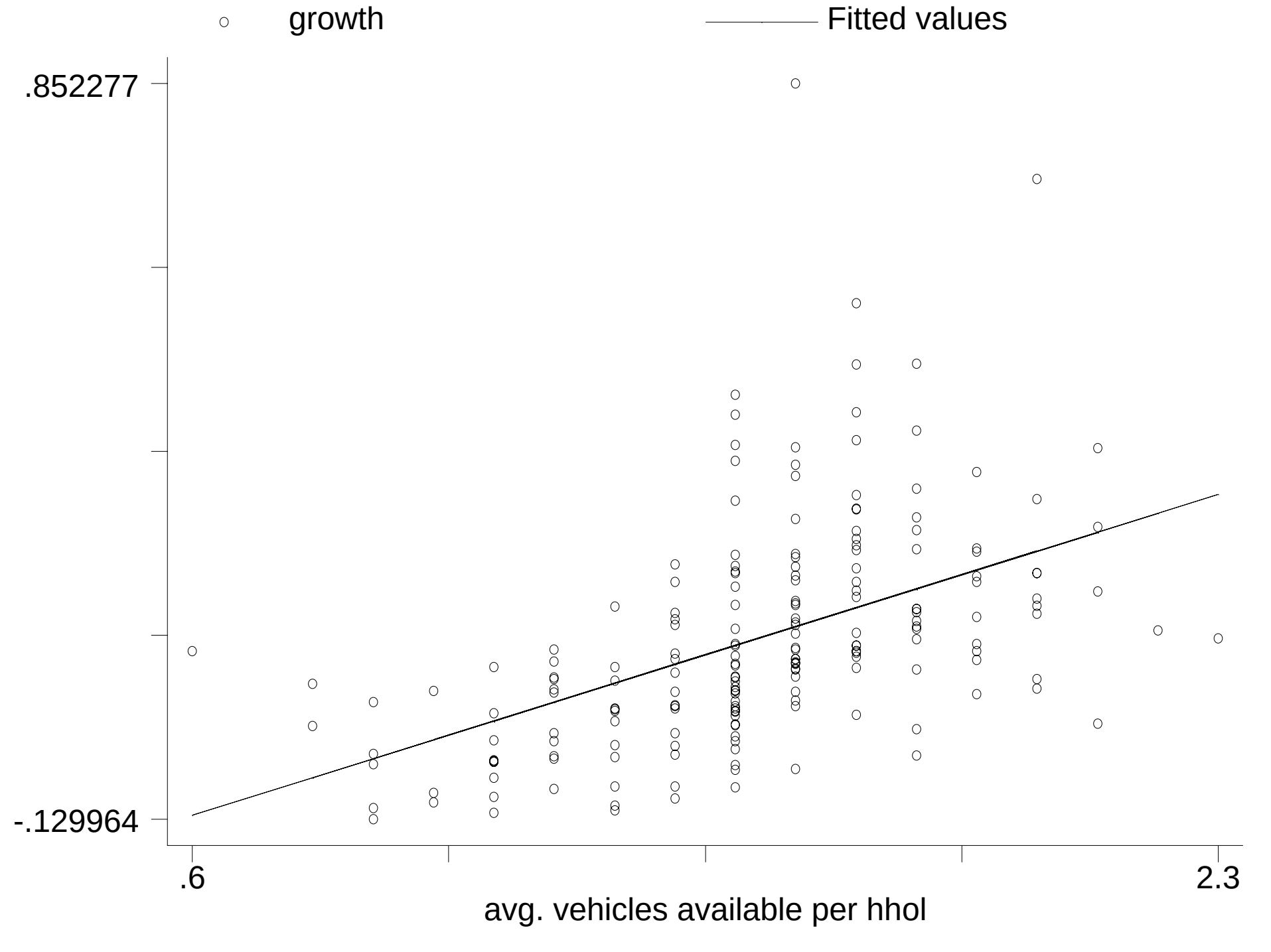
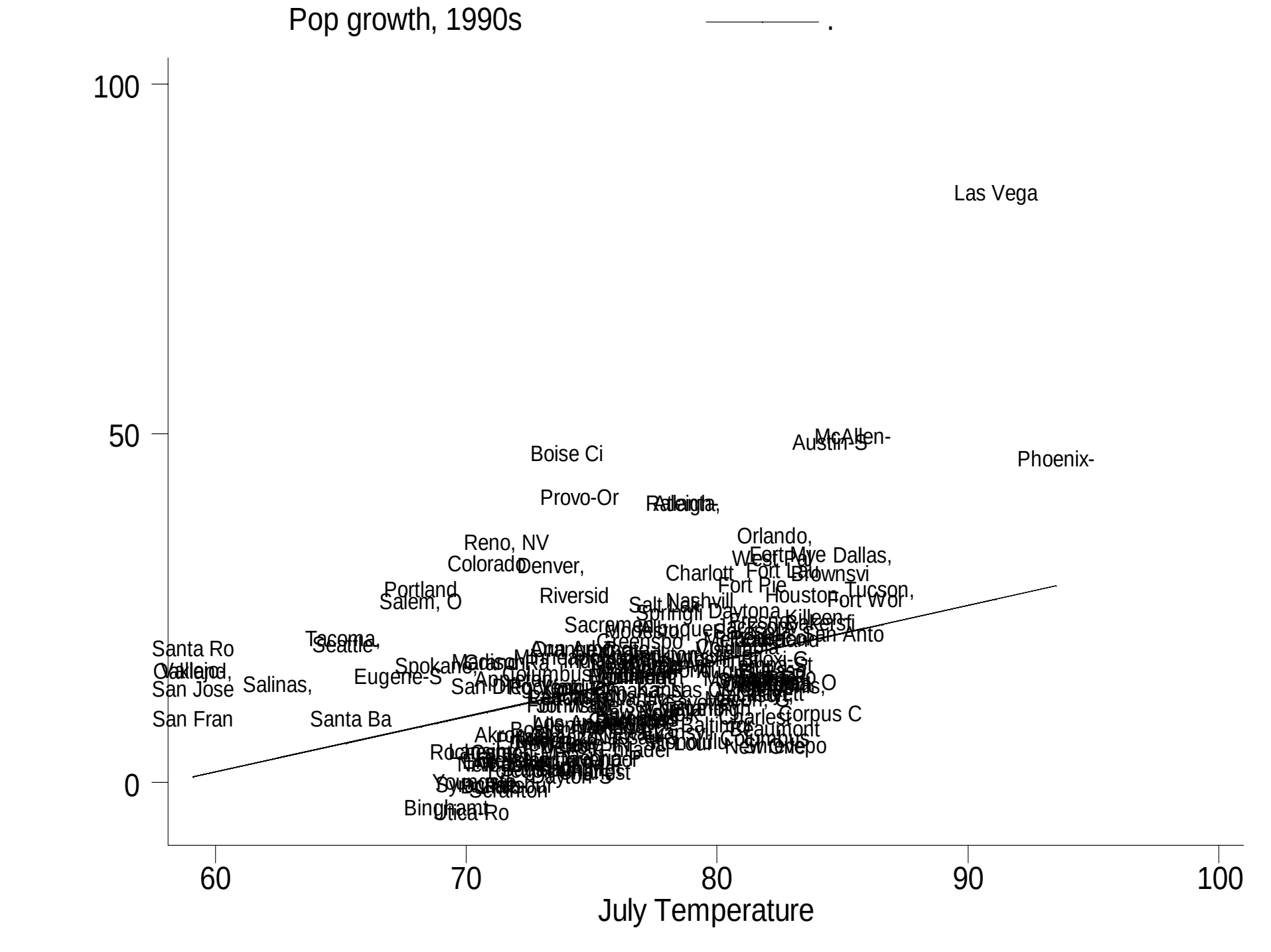
8


growth
Fitted values
.852277
-.129964
.6
2.3
avg. vehicles available per hhol


Pop growth, 1990s
100
50
0
60
70
80
90
100
July Temperature
Las Vega
Phoenix-
Austin-S
McAllen-
Boise Ci
Provo-Or
Orlando,
Reno, NV
Colorado
Denver,
Portland
Salem, O
Riversid
Tucson,
Tacoma,
Seattle-
Santa Ro
Eugene-S
Salinas,
San Jose
San Fran
Santa Ba
Corpus C
Beaumont
Binghamt
Utica-Ro

Lessons from Economic Theory

- If the environmental costs of CO2 emissions are taxed correctly, then private individuals will make the “right” decisions.
- If carbon isn’t taxed, then new construction in place A vs. place B (Boston vs. Houston) imposes a “social cost” equal to the emissions difference times the optimal carbon tax.

Transportation and Zoning

- Even if tax is right, other government policies could be making things worse.
- Subsidizing transportation in low density areas leads to extra carbon emissions.
  - In a sense, the government isn't internalizing the environmental costs of its actions.
- Restricting development in denser areas, likewise, creates extra carbon emissions

Emissions by Area

- This is an estimation procedure and it is far from perfect. We are doing all we can with the data we could get.
- The problems get more severe at lower levels of geography.
- We are generally forced to look at average emissions in an area, instead of the marginal emissions of a new home.

The Thought Experiment

- We move a household with a fixed income and size from one place to another.
- We estimate their emissions in difference places if they make decisions that are typical for their characteristics in those places.
- We CHOOSE NOT to hold housing characteristics constant. We ARE NOT interested in emissions assuming that suburbanites live in high rises.

Sources of CO2 Emissions

- Private Gasoline Consumption (Cars)
- Public Transportation Emissions
- Home Electricity
- Home Heating: Natural Gas and Fuel Oil

Gasoline Consumption

- We begin with the National Household Travel Survey, with zip code identifiers.
- Use those identifiers to estimate the impact of area density and proximity to downtown on gas, holding income and family size fixed.
- Use the equation to predict gas usage for an average household in every area, turning gas usage into emissions (19.564 plus 20 percent).

Public Transportation

- Start with information on energy use for every metropolitan public transportation company.
  - Must be public (we miss the Vegas monorail).
  - Scale gas up by emissions plus 20 percent
- Aggregate up to metropolitan area level.
- Divide by total metropolitan households.
- To form city/suburb splits, we allocate emissions based on ridership.

Home Heating (Fuel Oil plus Natural Gas)

- Use the Census IPUMS five percent sample, to estimate spending on these energy sources for an average person in each area.
- Convert spending into energy use with appropriate price data.
- Convert energy use into emissions.
- Calculate city-suburb difference with central city identifier (Lowell as well as Boston).

Home Electricity

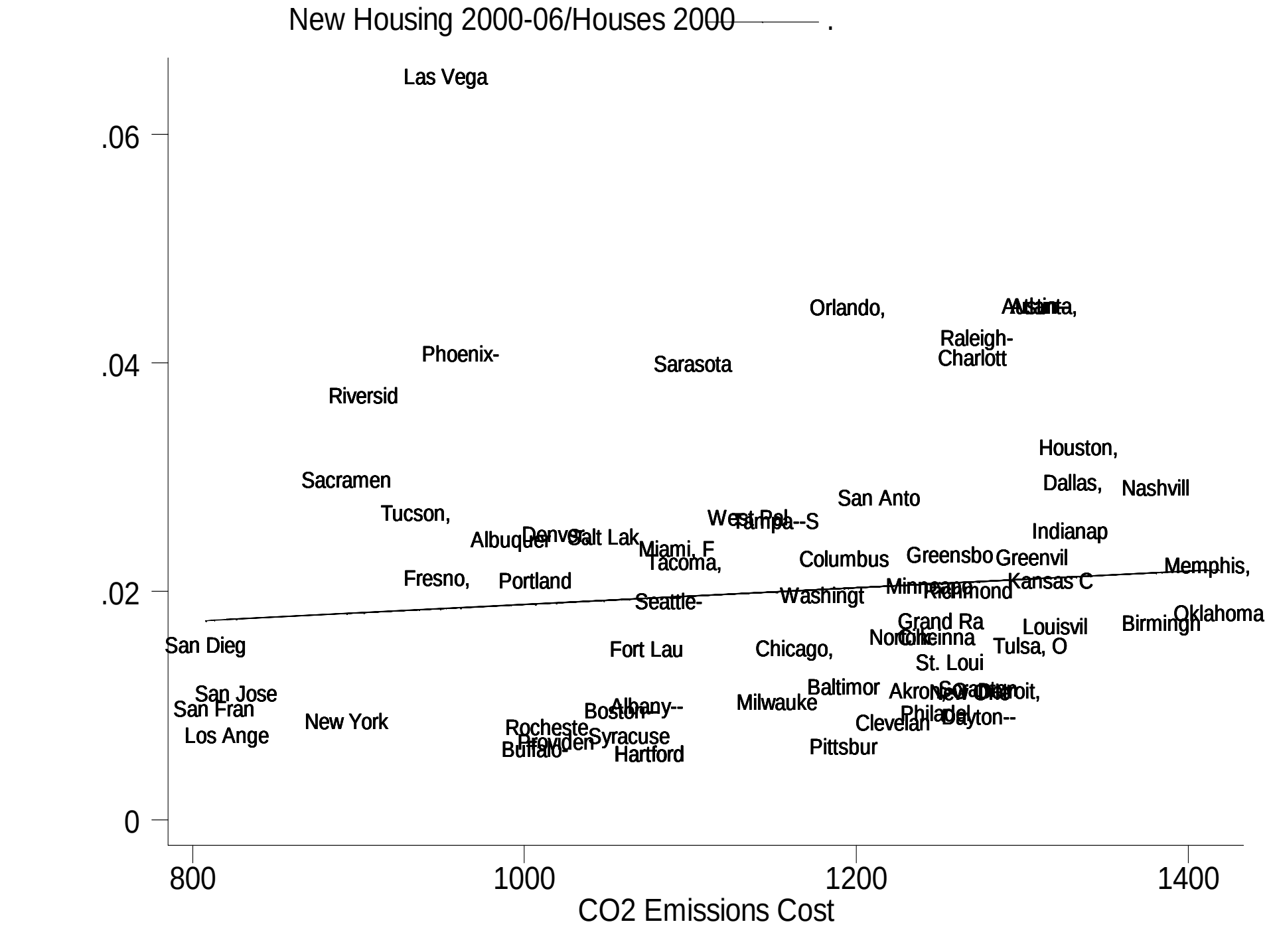
- We follow the basic procedure outlined above for home heating (use the IPUMS and convert spending into megawatt hours).
- We convert megawatt hours into CO2 with emissions data for the 8 NERC regions.
- The NERC regions are approximately closed systems. We are not giving credit to particularly clean users within regions, because if you are clean, someone else

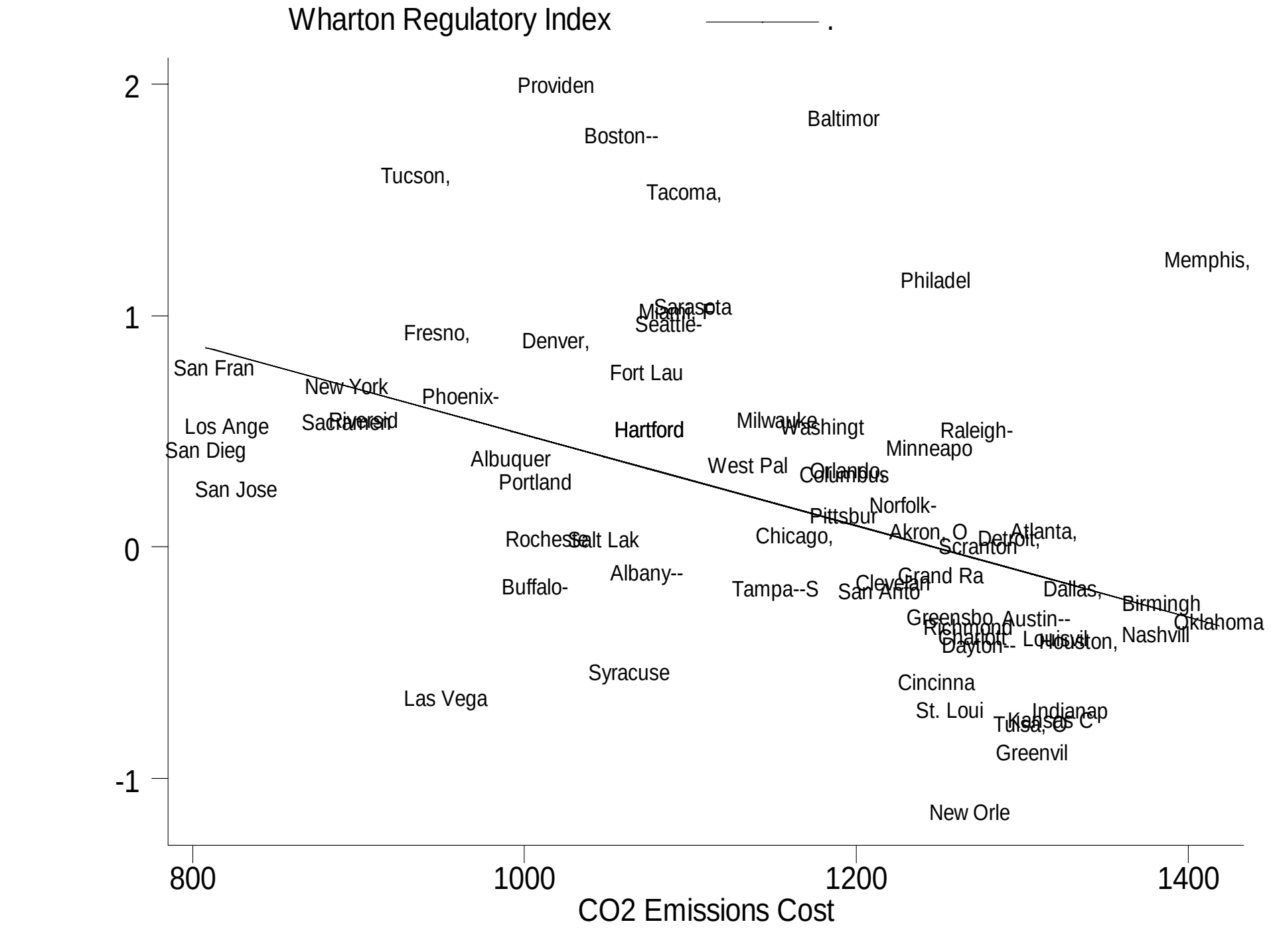
A Few Caveats

- We are not including anything about industry or workplace.
- We will use a 43 dollar per CO2 ton cost; this is highly debatable (about ½ Stern Report).
- Scale it up or down as you like.
- Average vs. marginal homes matter, especially in heating efficiency.

Table 1: Annual CO_2 Output Emissions

MSA Name	Gallons of Gas for Automobiles	Emissions from Public Transportation (Lbs of CO2)	Emissions from Home Heating (Lbs of CO2)	Electricity in Megawatt Hours	NERC Factor	Carbon Dioxide Emissions Cost ($ per year)	Rank out of 67 Areas
New York, NY	732	2328	11936	7.2	1400	893	6
Los Angeles-Long Beach, CA	964	350	6695	8.4	1007	820	3
Chicago, IL	1002	1882	12341	10.1	1614	1163	32
Boston, MA	967	870	15754	8.3	1185	1058	19
Philadelphia, PA	929	1499	14108	12.8	1614	1248	43
Detroit, MI	1124	338	17872	9.6	1614	1292	54
Washington, DC	1065	1778	5968	14.3	1543	1180	33
Houston, TX	1120	506	5255	19.3	1555	1334	63
San Francisco, CA	985	631	7074	6.9	1007	813	2
Atlanta, GA	1213	411	9425	15.5	1472	1313	58


New Housing 2000-06/Houses 2000
Las Vega
Orlando,
Atlanta,
Raleigh-
Charlott
Phoenix-
Sarasota
Riversid
Houston,
Dallas,
Nashvill
Sacramen
San Anto
Tucson,
Tampa--S
Indianap
Albuquer
Denver
Salt Lak
Miami, F
Tacoma,
Columbus
Greensbo
Greenvil
Memphis,
Fresno,
Portland
Kansas C
Minneapo
Richmond
Washingt
Seattle-
Oklahoma
Grand Ra
Louisvil
Birmingh
Tulsa, O
St. Loui
San Dieg
Fort Lau
Chicago,
Baltimor
San Jose
San Fran
Milwauke
Albany--
Boston
Detroit,
Philadel
Dayton--
New York
Los Ange
Rocheste
Syracuse
Cleveland
Buffalo
Hartford
Pittsbur
.06
.04
.02
0
800
1000
1200
1400
CO2 Emissions Cost


Wharton Regulatory Index
2
1
0
-1
Providen
Baltimor
Boston--
Tucson,
Tacoma,
Memphis,
Philadel
Sarasota
Miami-F
Seattle-
Fresno,
Denver,
San Fran
Fort Lau
New York
Phoenix-
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Sacramen
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Hartford
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Raleigh-
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Albuquer
West Pal
Orlando
Columbus
Portland
San Jose
Norfolk-
Pittsbur
Rochest
Salt Lak
Chicago,
Akron, O
Detroit,
Atlanta,
Scranton
Albany--
Grand Ra
Buffalo-
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CO2 Emissions Cost

City-Suburb Differentials

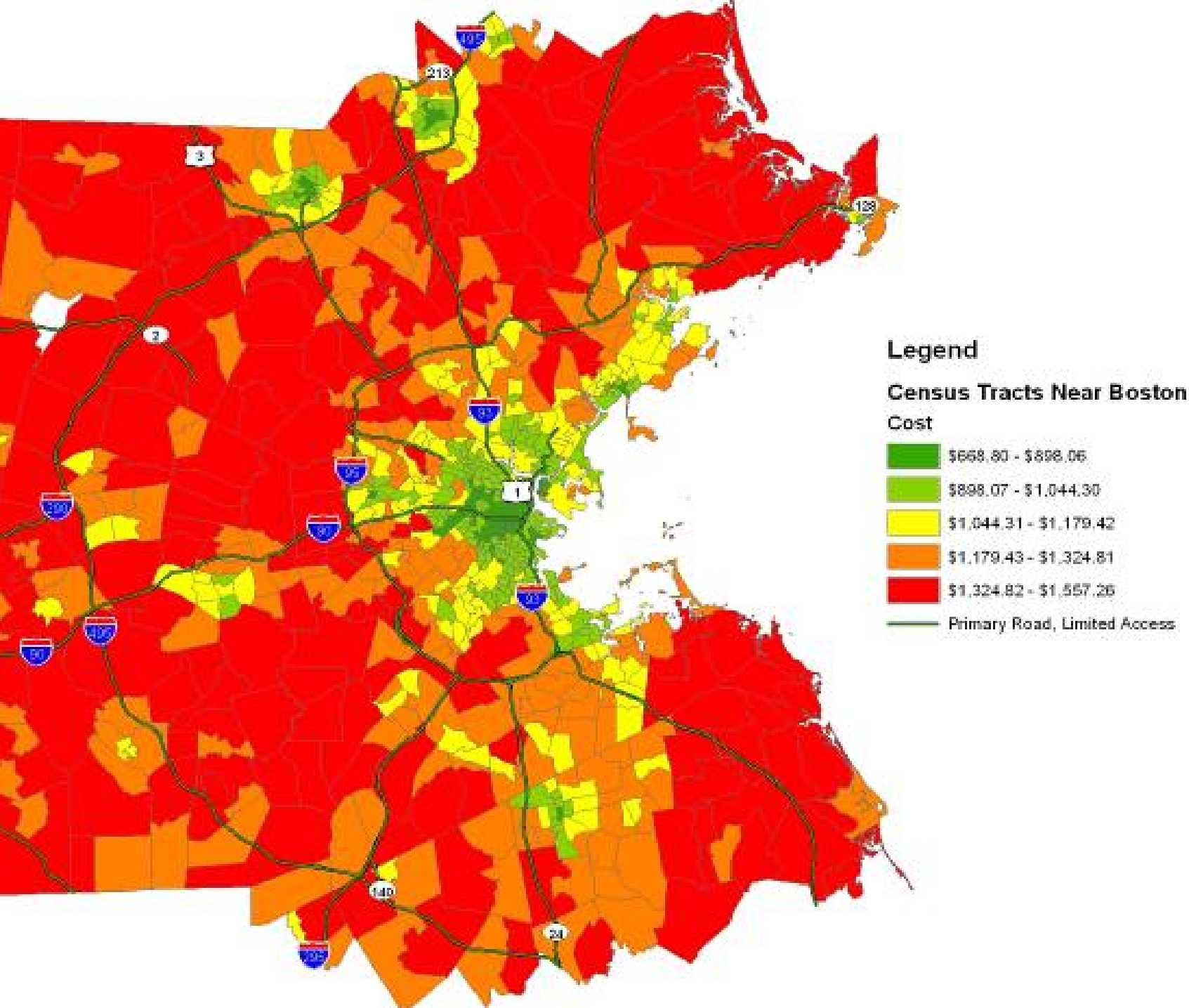
- For each metropolitan area, we can also calculate the difference between urban and suburban energy usage.
- Calculate gas usage by central city vs. suburb.
- Convert public transit by ridership using census figures.
- Calculate energy spending using the IPUMS for central city vs. suburb.

Table 2: City-Suburb Differences in CO_2 Emissions

MSA Name	Suburb-City Difference in Gas for Automobiles (Gallons)	Suburb-City Difference in Public Transit Emissions (Lbs of CO2)	Suburb-City Difference in Home Heating Emissions (Lbs of CO2)	Suburb-City Difference in Household Electricity (Megawatt Hours)	Suburb-City Difference in Cost of CO2 Emissions (Dollars)	Rank out of 41 MSAs
New York, NY	263	-2367	6497	2.7	302	1
Los Angeles-Long Beach, CA	28	-229	-382	-1.7	-36	40
Chicago, IL	233	-2624	-2449	0.9	38	27
Boston, MA	280	-1091	3413	0.9	214	3
Philadelphia, PA	291	-2286	256	2.4	185	4
Detroit, MI	186	-1214	-6702	-0.3	-88	41
Washington, DC	227	-2280	80	3.4	180	5
Houston, TX	118	-561	675	2.9	158	6
San Francisco, CA	169	-939	1726	1.8	142	10
Atlanta, GA	272	-1242	35	3.4	220	2

Tract Level Data

- Here we focus on Boston and we have three types of data at the tract level: (1) density, (2) commuting data, (3) share in multi-family dwellings.
- Use the NHTS coefficients from a Northeast based individual regression and tract characteristics
- Take the 2000 5 Percent IPUMS for Greater Boston and PUMA identifiers and distance to CBD (should use SFD)
- We calculate a predicted energy usage based on these tract characteristics
- We then multiply this by 30 dollars per ton to find total costs.


Legend
Census Tracts Near Boston
Cost
$668.80 - $898.06
$898.07 - $1,044.30
$1,044.31 - $1,179.42
$1,179.43 - $1,324.81
$1,324.82 - $1,557.26
Primary Road, Limited Access