

Housing Price Equation Estimation PI+ v1.7

August 2014

Estimating Income and Population Elasticities

Housing price fluctuations are driven by changes in housing demand. The REMI housing price estimation starts with the following equation that predicts the responsiveness of regional housing prices to changes in housing demand due to real disposable income and population changes.

$$PH_t = \left\{ \left(\varepsilon_1 \left(\frac{\frac{RYD_t}{RYD_t^u}}{\frac{RYD_{t-1}}{RYD_{t-1}^u}} - 1 \right) + \varepsilon_2 \left(\frac{\frac{N_t}{N_t^u}}{\frac{N_{t-1}}{N_{t-1}^u}} - 1 \right) \right) + 1 \right\} \times PH_{t-1}$$

where

PH = relative housing price;

RYD = real disposable income;

N = population;

u represents the U.S.;

t is the time period;

ε_1 = income elasticity of housing price;

ε_2 = population elasticity of housing price.

In time period t , the change in relative housing price from the previous time period is determined by changes in relative real disposable personal income and changes in regional population as share of the national population. ε_1 and ε_2 are the elasticities to be estimated.

We use panel data of the 51 states from 1990 through 2013 to estimate the housing price equation. The real disposable personal income and population data is generated by the REMI PI+ model. The housing price index data is from the Federal Housing Finance Agency All-Transactions indexes data set. The regression variables are normalized to the U.S. national level and are in the form of first difference. The

data covers the stable time of the earlier 1990s, the bubble decade from the end of the 20th century to the unprecedented peak in 2006, and the recent recession. To separate out the business cycle effects on housing price changes, we include explanatory time dummy variables for 1994-1995, when residential investment slightly declined, and for the recession period from 2007 to 2009.¹

A pooled panel data regression is used to estimate the income and population elasticities. The estimated income elasticity $\varepsilon_1 = 0.4619$ (t-value = 5.08), imply that a one percent rise in relative income from last time period will increase the relative housing price by 0.4619 percent. The population elasticity $\varepsilon_2 = 0.6479$ (t-value = 7.51); the relative housing price will respond to a one percent upward change in population share with an increase of 0.6479 percent.

However, regional level housing prices do not respond identically to the same amount of housing demand change. Housing price is also affected by the supply side. Because of different levels of supply constraints in regional economies, there are great difference in housing price responsiveness across regions. To capture the regional heterogeneity in regional housing price responses, the REMI model estimates regional scaling factors with new state and MSA data and scale the income and population elasticities to the regional level.

Estimating Regional Scaling Factors

Assuming regional housing price changes depend on the housing demand change from the previous time period, we estimate the following equation for state and MSA housing prices, such that

$$\frac{HP_t}{HP_{t-1}} = b \times \frac{BP_t}{U_t} + 1$$

where

HP = housing price index;

BP = the number of building permits for single-family homes;

U = the number of housing units (1 unit detached);

b is the parameter to be estimated.

¹ The time dummy variables are selected by running the time-fixed effect model, and the years with significant time fixed effects are included in the regression.

Time series data from 2000 to 2012 are used to estimate the equation for each state and MSA. We utilize the number of new constructions during time period t , as measured by building permits, as the metric of relative housing demand change. The building permits data are from the Census Building Permits Survey. The housing units data are from the American Community Survey. The Freddie Mac house price index data are used as the dependent variable. For each state or MSA, a time series OLS regression is estimated. Time dummy variables are used to control for the cyclical effects of the recession period from 2007 to 2009.

Table 1 presents the results base on state data. The first column shows the estimated coefficients. The state specific elasticities of housing price are considerably at variance. The estimated coefficients varies from 1.275 (Georgia) to 14.235 (Rhode Island), with the mean value at 4.667 and standard deviation of 3.433. Z-score measures the distance between the state specific coefficient and the mean in units of standard deviation, and it is used to calculate the state scaling factors. The scaling factors are calculated using the following equation:

$$Scaling\ Factor = \frac{\frac{b - \bar{b}}{sd_b} + \bar{b}}{\bar{b}}$$

where

b = state specific housing price elasticity

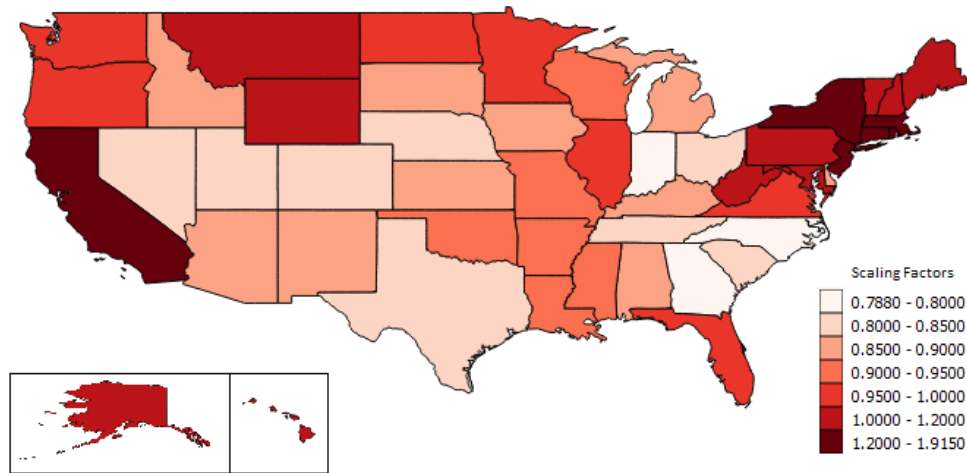
\bar{b} = the mean of b 's

sd_b = the standard deviation of b 's

The scaling factors are used to scaling the previously estimated income and population elasticities (ε_1 and ε_2) to the state level. For example, with a scaling factor of 1.228, the California housing prices are 22.8% more elastic than the national average. Multiplying ε_1 and ε_2 by 1.228 will make the elasticities specific for California. Thus, the income elasticity of California housing price is 0.567 (1.23×0.4619); and the population elasticity of California housing price is 0.796 (1.23×0.6479). In the case of Alamaba, a scaling factor of 0.887 indicates that the housing prices are 11.3% less elastic compared to the national average. The scaled income and population elasticities for Alabama are 0.4098 (0.887×0.4619) and 0.5748 (0.887×0.6479). Figure 1 shows the variance of state scaling factors in map.

Table 1: Housing Price Elasticities of States

	Coef.	Std. Err	t-value	z-score	Scaling Factor
Alaska	6.366	0.886	7.19	0.495	1.106
Alabama	2.860	0.880	3.25	-0.526	0.887
Arkansas	3.779	0.601	6.29	-0.259	0.945
Arizona	2.850	0.783	3.64	-0.529	0.887
California	8.320	0.859	9.68	1.064	1.228
Colorado	1.820	0.393	4.63	-0.829	0.822
Connecticut	8.515	1.321	6.44	1.121	1.240
District of Columbia	19.325	4.372	4.42	4.270	1.915
Delaware	3.039	0.590	5.15	-0.474	0.898
Florida	3.924	0.546	7.19	-0.217	0.954
Georgia	1.275	0.454	2.81	-0.988	0.788
Hawaii	6.351	0.871	7.29	0.490	1.105
Iowa	2.769	0.453	6.12	-0.553	0.881
Idaho	2.431	0.752	3.23	-0.652	0.860
Illinois	4.476	0.963	4.65	-0.056	0.988
Indiana	1.411	0.254	5.55	-0.949	0.797
Kansas	2.658	0.479	5.55	-0.585	0.875
Kentucky	2.623	0.385	6.82	-0.595	0.872
Louisiana	3.492	0.597	5.85	-0.342	0.927
Massachusetts	9.062	1.849	4.90	1.280	1.274
Maryland	5.812	1.124	5.17	0.334	1.071
Maine	5.611	0.844	6.65	0.275	1.059
Michigan	2.368	0.827	2.86	-0.670	0.856
Minnesota	3.898	0.756	5.16	-0.224	0.952
Missouri	3.821	0.840	4.55	-0.246	0.947
Mississippi	3.238	0.765	4.24	-0.416	0.911
Montana	7.861	1.347	5.84	0.930	1.199
North Carolina	1.317	0.392	3.36	-0.976	0.791
North Dakota	4.100	0.396	10.35	-0.165	0.965
Nebraska	2.085	0.279	7.46	-0.752	0.839
New Hampshire	5.447	0.906	6.01	0.227	1.049
New Jersey	8.929	1.436	6.22	1.241	1.266
New Mexico	3.023	0.736	4.11	-0.479	0.897
Nevada	2.147	0.562	3.82	-0.734	0.843
New York	12.180	1.619	7.52	2.188	1.469
Ohio	2.198	0.677	3.25	-0.719	0.846
Oklahoma	3.331	0.490	6.80	-0.389	0.917
Oregon	4.284	1.064	4.03	-0.112	0.976
Pennsylvania	5.763	0.896	6.44	0.319	1.068
Rhode Island	14.235	2.685	5.30	2.787	1.597
South Carolina	1.533	0.397	3.86	-0.913	0.804
South Dakota	2.427	0.268	9.07	-0.653	0.860
Tennessee	2.173	0.421	5.16	-0.727	0.844
Texas	1.724	0.310	5.56	-0.858	0.816
Utah	1.715	0.632	2.71	-0.860	0.816
Virginia	4.612	0.612	7.53	-0.016	0.997
Vermont	7.202	0.774	9.30	0.738	1.158
Washington	3.883	1.022	3.80	-0.228	0.951
Wisconsin	3.088	0.668	4.62	-0.460	0.901
West Virginia	5.943	0.820	7.25	0.372	1.080

Figure 1: State Scaling Factors

A similar procedure is taken to estimate the MSA demand elasticities of housing price and scaling factors. We use new metro level data from Census, the American Community Survey and the Freddie Mac house price index data set to expand our estimation to 350 MSAs.² The estimation results for the MSAs are shown in Table 2. The MSA results are used for the counties in MSAs in the REMI model. The non-MSA counties use the state values. Figure 2 shows the county-level scaling factors calculated using results from Table 2 in a map. We apply an identical regression equation to each MSA to ensure consistency across regions national wide.

² For the purpose of capturing the deviation from the national average and making the scaled MSA elasticities comparable to the state-level estimates, we use the state mean of 3.862 to calculate the MSA scaling factors.

Table 2: Housing Price Elasticities of MSAs

	Coef.	Std. Err	t-value	z-score	Scaling Factor
Abilene, TX Metro Area	7.659	2.851	2.69	0.8250	1.1768
Akron, OH Metro Area	0.494	1.816	0.27	-1.1508	0.7534
Albany, GA Metro Area	2.374	2.304	1.03	-0.6324	0.8645
Albany-Schenectady-Troy, NY Metro Area	7.431	3.088	2.41	0.7622	1.1633
Albuquerque, NM Metro Area	4.309	1.324	3.25	-0.0988	0.9788
Alexandria, LA Metro Area	3.149	0.851	3.70	-0.4187	0.9103
Allentown-Bethlehem-Easton, PA-NJ Metro Area	4.126	1.772	2.33	-0.1493	0.9680
Altoona, PA Metro Area	9.504	1.956	4.86	1.3339	1.2858
Amarillo, TX Metro Area	2.799	1.071	2.61	-0.5152	0.8896
Ames, IA Metro Area	1.156	0.326	3.55	-0.9683	0.7925
Anchorage, AK Metro Area	7.490	1.947	3.85	0.7783	1.1668
Anderson, IN Metro Area	1.591	0.810	1.96	-0.8484	0.8182
Anderson, SC Metro Area	1.512	0.778	1.94	-0.8700	0.8136
Ann Arbor, MI Metro Area	0.291	1.362	0.21	-1.2069	0.7414
Anniston-Oxford, AL Metro Area	5.445	4.700	1.16	0.2144	1.0459
Appleton, WI Metro Area	0.779	1.020	0.76	-1.0721	0.7703
Asheville, NC Metro Area	3.092	1.423	2.17	-0.4345	0.9069
Athens-Clarke County, GA Metro Area	0.693	0.921	0.75	-1.0959	0.7652
Atlanta-Sandy Springs-Marietta, GA Metro Area	0.894	0.995	0.90	-1.0404	0.7771
Atlantic City-Hammonton, NJ Metro Area	4.938	2.102	2.35	0.0747	1.0160
Auburn-Opelika, AL Metro Area	0.899	0.793	1.13	-1.0392	0.7773
Augusta-Richmond County, GA-SC Metro Area	1.363	1.430	0.95	-0.9111	0.8048
Austin-Round Rock-San Marcos, TX Metro Area	1.503	0.382	3.93	-0.8725	0.8131
Bakersfield-Delano, CA Metro Area	5.833	1.429	4.08	0.3215	1.0689
Baltimore-Towson, MD Metro Area	6.332	3.072	2.06	0.4591	1.0984
Bangor, ME Metro Area	3.419	1.389	2.46	-0.3443	0.9262
Barnstable Town, MA Metro Area	2.975	2.785	1.07	-0.4668	0.9000
Baton Rouge, LA Metro Area	2.428	0.950	2.56	-0.6174	0.8677
Battle Creek, MI Metro Area	2.658	1.571	1.69	-0.5542	0.8813
Bay City, MI Metro Area	-0.446	1.128	-0.40	-1.4101	0.6979
Beaumont-Port Arthur, TX Metro Area	1.328	2.526	0.53	-0.9208	0.8027
Bellingham, WA Metro Area	4.303	1.422	3.03	-0.1005	0.9785
Bend, OR Metro Area	3.352	0.858	3.91	-0.3628	0.9223
Billings, MT Metro Area	4.298	1.173	3.66	-0.1018	0.9782
Binghamton, NY Metro Area	16.889	6.040	2.80	3.3704	1.7221
Birmingham-Hoover, AL Metro Area	2.550	1.503	1.70	-0.5839	0.8749
Bismarck, ND Metro Area	2.683	0.315	8.51	-0.5471	0.8828
Blacksburg-Christiansburg-Radford, VA Metro Area	3.226	1.441	2.24	-0.3975	0.9148
Bloomington, IN Metro Area	2.430	0.180	13.53	-0.6168	0.8678
Bloomington-Normal, IL Metro Area	0.998	0.935	1.07	-1.0118	0.7832
Boise City-Nampa, ID Metro Area	3.051	1.442	2.12	-0.4456	0.9045
Boston-Cambridge-Quincy, MA-NH Metro Area	1.581	2.243	0.70	-0.8512	0.8176
Boulder, CO Metro Area	3.281	1.420	2.31	-0.3822	0.9181
Bowling Green, KY Metro Area	1.141	0.283	4.04	-0.9724	0.7917
Bremerton-Silverdale, WA Metro Area	6.250	3.050	2.05	0.4366	1.0935
Bridgeport-Stamford-Norwalk, CT Metro Area	5.349	3.615	1.48	0.1880	1.0403
Brownsville-Harlingen, TX Metro Area	0.976	0.324	3.02	-1.0178	0.7819
Brunswick, GA Metro Area	1.962	1.778	1.10	-0.7460	0.8402
Buffalo-Niagara Falls, NY Metro Area	6.018	1.482	4.06	0.3726	1.0798
Burlington, NC Metro Area	0.358	0.535	0.67	-1.1882	0.7454

Burlington-South Burlington, VT Metro Area	5.519	1.778	3.10	0.2349	1.0503
Canton-Massillon, OH Metro Area	0.651	2.095	0.31	-1.1076	0.7627
Cape Coral-Fort Myers, FL Metro Area	2.093	0.401	5.22	-0.7098	0.8479
Casper, WY Metro Area	4.569	1.314	3.48	-0.0271	0.9942
Cedar Rapids, IA Metro Area	0.891	0.735	1.21	-1.0412	0.7769
Champaign-Urbana, IL Metro Area	1.586	0.863	1.84	-0.8496	0.8180
Charleston, WV Metro Area	5.891	1.782	3.31	0.3374	1.0723
Charleston-North Charleston-Summerville, SC Metro Area	2.339	0.955	2.45	-0.6420	0.8624
Charlotte-Gastonia-Rock Hill, NC-SC Metro Area	1.146	0.752	1.52	-0.9712	0.7919
Charlottesville, VA Metro Area	3.616	1.524	2.37	-0.2899	0.9379
Chattanooga, TN-GA Metro Area	2.372	0.809	2.93	-0.6330	0.8644
Cheyenne, WY Metro Area	1.994	0.395	5.05	-0.7372	0.8420
Chicago-Joliet-Naperville, IL-IN-WI Metro Area	3.342	2.353	1.42	-0.3654	0.9217
Chico, CA Metro Area	4.154	2.258	1.84	-0.1416	0.9697
Cincinnati-Middletown, OH-KY-IN Metro Area	0.660	1.320	0.50	-1.1051	0.7632
Clarksville, TN-KY Metro Area	1.503	0.606	2.48	-0.8725	0.8130
Cleveland, TN Metro Area	2.192	0.765	2.86	-0.6827	0.8537
Cleveland-Elyria-Mentor, OH Metro Area	-0.335	2.082	-0.16	-1.3795	0.7044
Coeur d'Alene, ID Metro Area	4.235	1.367	3.10	-0.1192	0.9745
College Station-Bryan, TX Metro Area	1.583	0.461	3.44	-0.8505	0.8178
Colorado Springs, CO Metro Area	1.409	0.605	2.33	-0.8987	0.8075
Columbia, MO Metro Area	1.312	0.416	3.15	-0.9252	0.8018
Columbia, SC Metro Area	0.951	0.781	1.22	-1.0248	0.7804
Columbus, GA-AL Metro Area	1.904	1.824	1.04	-0.7620	0.8367
Columbus, IN Metro Area	2.151	0.795	2.71	-0.6939	0.8513
Columbus, OH Metro Area	0.711	1.072	0.66	-1.0911	0.7662
Corpus Christi, TX Metro Area	3.008	1.158	2.60	-0.4577	0.9019
Corvallis, OR Metro Area	6.967	1.928	3.61	0.6342	1.1359
Cumberland, MD-WV Metro Area	12.766	5.349	2.39	2.2334	1.4785
Dallas-Fort Worth-Arlington, TX Metro Area	0.987	0.469	2.10	-1.0149	0.7825
Dalton, GA Metro Area	1.843	1.681	1.10	-0.7787	0.8332
Danville, IL Metro Area	22.934	13.005	1.76	5.0373	2.0793
Davenport-Moline-Rock Island, IA-IL Metro Area	3.189	1.299	2.46	-0.4076	0.9127
Dayton, OH Metro Area	0.504	2.523	0.20	-1.1482	0.7540
Decatur, AL Metro Area	3.866	2.280	1.70	-0.2208	0.9527
Decatur, IL Metro Area	4.303	2.438	1.76	-0.1004	0.9785
Deltona-Daytona Beach-Ormond Beach, FL Metro Area	7.421	2.230	3.33	0.7595	1.1627
Denver-Aurora-Broomfield, CO Metro Area	1.128	0.830	1.36	-0.9761	0.7909
Des Moines-West Des Moines, IA Metro Area	0.581	0.499	1.16	-1.1268	0.7586
Detroit-Warren-Livonia, MI Metro Area	-0.068	3.521	-0.02	-1.3059	0.7202
Dothan, AL Metro Area	3.953	2.166	1.82	-0.1971	0.9578
Dover, DE Metro Area	2.076	1.177	1.76	-0.7145	0.8469
Dubuque, IA Metro Area	1.999	0.638	3.14	-0.7357	0.8424
Duluth, MN-WI Metro Area	3.274	2.092	1.57	-0.3843	0.9177
Durham-Chapel Hill, NC Metro Area	1.075	0.598	1.80	-0.9905	0.7878
Eau Claire, WI Metro Area	1.252	0.954	1.31	-0.9418	0.7982
El Centro, CA Metro Area	2.905	0.682	4.26	-0.4859	0.8959
Elizabethtown, KY Metro Area	1.401	0.482	2.91	-0.9007	0.8070
Elkhart-Goshen, IN Metro Area	1.659	1.043	1.59	-0.8296	0.8223
Elmira, NY Metro Area	14.738	1.878	7.85	2.7773	1.5951
El Paso, TX Metro Area	2.558	1.342	1.91	-0.5817	0.8754
Erie, PA Metro Area	4.413	0.573	7.70	-0.0700	0.9850
Eugene-Springfield, OR Metro Area	7.958	3.326	2.39	0.9076	1.1945
Evansville, IN-KY Metro Area	1.458	0.325	4.49	-0.8851	0.8104

Fairbanks, AK Metro Area	5.050	1.255	4.02	0.1056	1.0226
Fargo, ND-MN Metro Area	1.327	0.256	5.18	-0.9212	0.8026
Farmington, NM Metro Area	5.220	2.210	2.36	0.1524	1.0327
Fayetteville, NC Metro Area	1.286	0.813	1.58	-0.9324	0.8002
Fayetteville-Springdale-Rogers, AR-MO Metro Area	1.747	0.854	2.05	-0.8054	0.8274
Flagstaff, AZ Metro Area	7.677	2.875	2.67	0.8300	1.1778
Flint, MI Metro Area	-0.213	2.894	-0.07	-1.3459	0.7116
Florence, SC Metro Area	1.906	1.307	1.46	-0.7615	0.8369
Florence-Muscle Shoals, AL Metro Area	6.580	2.810	2.34	0.5276	1.1130
Fond du Lac, WI Metro Area	1.660	1.806	0.92	-0.8294	0.8223
Fort Collins-Loveland, CO Metro Area	0.815	0.378	2.15	-1.0622	0.7724
Fort Smith, AR-OK Metro Area	2.786	2.105	1.32	-0.5187	0.8889
Fort Wayne, IN Metro Area	0.839	0.382	2.19	-1.0558	0.7738
Fresno, CA Metro Area	5.401	2.196	2.46	0.2022	1.0433
Gadsden, AL Metro Area	5.156	2.171	2.38	0.1348	1.0289
Gainesville, FL Metro Area	5.446	2.627	2.07	0.2147	1.0460
Gainesville, GA Metro Area	1.219	1.211	1.01	-0.9509	0.7963
Glens Falls, NY Metro Area	6.661	2.364	2.82	0.5498	1.1178
Goldsboro, NC Metro Area	1.595	1.032	1.55	-0.8473	0.8185
Grand Forks, ND-MN Metro Area	6.037	0.754	8.01	0.3776	1.0809
Grand Junction, CO Metro Area	2.327	1.920	1.21	-0.6454	0.8617
Grand Rapids-Wyoming, MI Metro Area	0.132	1.338	0.10	-1.2508	0.7320
Great Falls, MT Metro Area	5.834	1.415	4.12	0.3217	1.0689
Greeley, CO Metro Area	0.154	0.390	0.39	-1.2447	0.7333
Green Bay, WI Metro Area	0.274	0.970	0.28	-1.2116	0.7404
Greensboro-High Point, NC Metro Area	0.924	0.806	1.15	-1.0323	0.7788
Greenville, NC Metro Area	0.908	0.485	1.87	-1.0366	0.7779
Greenville-Mauldin-Easley, SC Metro Area	1.103	0.638	1.73	-0.9830	0.7894
Gulfport-Biloxi, MS Metro Area	2.138	1.663	1.29	-0.6974	0.8506
Hagerstown-Martinsburg, MD-WV Metro Area	3.280	1.132	2.90	-0.3824	0.9181
Hanford-Corcoran, CA Metro Area	5.058	1.700	2.98	0.1078	1.0231
Harrisburg-Carlisle, PA Metro Area	2.800	1.604	1.75	-0.5149	0.8897
Harrisonburg, VA Metro Area	3.018	1.024	2.95	-0.4548	0.9026
Hartford-West Hartford-East Hartford, CT Metro Area	4.878	2.813	1.73	0.0582	1.0125
Hattiesburg, MS Metro Area	13.274	4.712	2.82	2.3735	1.5086
Hickory-Lenoir-Morganton, NC Metro Area	2.138	1.830	1.17	-0.6975	0.8506
Honolulu, HI Metro Area	11.072	2.367	4.68	1.7663	1.3784
Hot Springs, AR Metro Area	14.835	4.303	3.45	2.8040	1.6008
Houma-Bayou Cane-Thibodaux, LA Metro Area	3.684	1.162	3.17	-0.2712	0.9419
Houston-Sugar Land-Baytown, TX Metro Area	1.060	0.395	2.69	-0.9947	0.7869
Huntington-Ashland, WV-KY-OH Metro Area	12.487	2.653	4.71	2.1565	1.4620
Huntsville, AL Metro Area	1.212	0.859	1.41	-0.9528	0.7959
Idaho Falls, ID Metro Area	1.769	0.959	1.84	-0.7993	0.8287
Indianapolis-Carmel, IN Metro Area	0.579	0.358	1.61	-1.1275	0.7584
Iowa City, IA Metro Area	1.010	0.318	3.18	-1.0085	0.7839
Ithaca, NY Metro Area	5.174	1.699	3.04	0.1396	1.0299
Jackson, MI Metro Area	-0.100	2.802	-0.04	-1.3148	0.7183
Jackson, MS Metro Area	1.959	0.658	2.98	-0.7468	0.8400
Jackson, TN Metro Area	1.445	1.072	1.35	-0.8887	0.8096
Jacksonville, FL Metro Area	3.133	1.212	2.58	-0.4232	0.9093
Jacksonville, NC Metro Area	0.649	0.947	0.68	-1.1082	0.7626
Janesville, WI Metro Area	2.915	2.580	1.13	-0.4832	0.8965
Jefferson City, MO Metro Area	2.921	1.124	2.60	-0.4814	0.8968
Johnson City, TN Metro Area	3.005	0.913	3.29	-0.4583	0.9018

Johnstown, PA Metro Area	9.490	1.975	4.80	1.3300	1.2850
Jonesboro, AR Metro Area	1.411	0.286	4.94	-0.8978	0.8076
Joplin, MO Metro Area	4.214	1.120	3.76	-0.1250	0.9732
Kalamazoo-Portage, MI Metro Area	0.868	0.978	0.89	-1.0478	0.7755
Kankakee-Bradley, IL Metro Area	2.873	1.685	1.71	-0.4948	0.8940
Kansas City, MO-KS Metro Area	1.228	1.177	1.04	-0.9485	0.7968
Kennewick-Pasco-Richland, WA Metro Area	0.705	0.307	2.30	-1.0926	0.7659
Killeen-Temple-Fort Hood, TX Metro Area	0.986	0.407	2.42	-1.0152	0.7825
Kingsport-Bristol-Bristol, TN-VA Metro Area	4.925	1.541	3.20	0.0712	1.0153
Kingston, NY Metro Area	6.608	2.663	2.48	0.5353	1.1147
Knoxville, TN Metro Area	2.580	0.746	3.46	-0.5757	0.8766
Kokomo, IN Metro Area	-1.043	1.807	-0.58	-1.5746	0.6626
La Crosse, WI-MN Metro Area	1.920	1.124	1.71	-0.7575	0.8377
Lafayette, IN Metro Area	-0.044	0.483	-0.09	-1.2992	0.7216
Lafayette, LA Metro Area	2.281	0.748	3.05	-0.6579	0.8590
Lake Charles, LA Metro Area	2.832	2.066	1.37	-0.5060	0.8916
Lakeland-Winter Haven, FL Metro Area	3.205	1.087	2.95	-0.4031	0.9136
Lancaster, PA Metro Area	3.211	1.844	1.74	-0.4015	0.9140
Lansing-East Lansing, MI Metro Area	-0.699	2.448	-0.29	-1.4798	0.6829
Laredo, TX Metro Area	1.296	0.368	3.52	-0.9297	0.8008
Las Cruces, NM Metro Area	1.638	0.888	1.84	-0.8353	0.8210
Las Vegas-Paradise, NV Metro Area	1.993	0.845	2.36	-0.7375	0.8420
Lawrence, KS Metro Area	1.187	0.875	1.36	-0.9599	0.7943
Lawton, OK Metro Area	3.854	2.867	1.34	-0.2244	0.9519
Lebanon, PA Metro Area	2.969	1.197	2.48	-0.4682	0.8997
Lewiston-Auburn, ME Metro Area	3.764	1.499	2.51	-0.2492	0.9466
Lexington-Fayette, KY Metro Area	1.186	0.433	2.74	-0.9601	0.7943
Lima, OH Metro Area	2.510	2.230	1.13	-0.5950	0.8725
Lincoln, NE Metro Area	1.347	0.256	5.26	-0.9156	0.8038
Little Rock-North Little Rock-Conway, AR Metro Area	2.009	0.584	3.44	-0.7331	0.8429
Logan, UT-ID Metro Area	1.310	0.825	1.59	-0.9260	0.8016
Longview, TX Metro Area	7.156	3.323	2.15	0.6863	1.1470
Longview, WA Metro Area	6.679	2.634	2.54	0.5548	1.1189
Los Angeles-Long Beach-Santa Ana, CA Metro Area	18.355	5.090	3.61	3.7747	1.8088
Louisville/Jefferson County, KY-IN Metro Area	1.723	0.892	1.93	-0.8119	0.8260
Lubbock, TX Metro Area	1.513	0.531	2.85	-0.8700	0.8136
Lynchburg, VA Metro Area	3.455	1.140	3.03	-0.3343	0.9284
Macon, GA Metro Area	1.237	1.636	0.76	-0.9459	0.7973
Madera-Chowchilla, CA Metro Area	3.723	0.911	4.09	-0.2603	0.9442
Madison, WI Metro Area	1.834	1.221	1.50	-0.7814	0.8326
Manchester-Nashua, NH Metro Area	2.113	1.776	1.19	-0.7043	0.8491
Mansfield, OH Metro Area	0.282	2.399	0.12	-1.2092	0.7409
McAllen-Edinburg-Mission, TX Metro Area	0.974	0.398	2.45	-1.0184	0.7818
Medford, OR Metro Area	5.271	2.275	2.32	0.1666	1.0357
Memphis, TN-MS-AR Metro Area	1.242	0.754	1.65	-0.9446	0.7976
Merced, CA Metro Area	3.644	0.852	4.28	-0.2821	0.9396
Miami-Fort Lauderdale-Pompano Beach, FL Metro Area	10.245	2.429	4.22	1.5382	1.3296
Michigan City-La Porte, IN Metro Area	1.751	2.659	0.66	-0.8041	0.8277
Midland, TX Metro Area	6.817	2.235	3.05	0.5928	1.1270
Milwaukee-Waukesha-West Allis, WI Metro Area	3.259	3.787	0.86	-0.3882	0.9168
Minneapolis-St. Paul-Bloomington, MN-WI Metro Area	1.509	1.704	0.89	-0.8710	0.8134
Missoula, MT Metro Area	3.886	1.772	2.19	-0.2154	0.9538
Mobile, AL Metro Area	4.498	3.594	1.25	-0.0468	0.9900
Modesto, CA Metro Area	6.361	1.796	3.54	0.4669	1.1000

Monroe, LA Metro Area	2.190	0.515	4.25	-0.6832	0.8536
Monroe, MI Metro Area	-0.027	1.167	-0.02	-1.2946	0.7226
Montgomery, AL Metro Area	2.458	2.228	1.10	-0.6091	0.8695
Morgantown, WV Metro Area	19.157	9.330	2.05	3.9959	1.8561
Morristown, TN Metro Area	4.196	1.603	2.62	-0.1300	0.9721
Mount Vernon-Anacortes, WA Metro Area	4.806	2.104	2.28	0.0384	1.0082
Muncie, IN Metro Area	-0.823	1.838	-0.45	-1.5141	0.6756
Muskegon-Norton Shores, MI Metro Area	-0.012	2.213	-0.01	-1.2904	0.7235
Myrtle Beach-North Myrtle Beach-Conway, SC Metro Area	1.593	0.630	2.53	-0.8479	0.8183
Napa, CA Metro Area	7.286	3.259	2.24	0.7222	1.1547
Naples-Marco Island, FL Metro Area	4.797	1.094	4.38	0.0357	1.0076
Nashville-Davidson--Murfreesboro--Franklin, TN Metro Area	2.110	0.654	3.22	-0.7051	0.8489
New Haven-Milford, CT Metro Area	7.328	4.276	1.71	0.7338	1.1572
New Orleans-Metairie-Kenner, LA Metro Area	4.802	1.584	3.03	0.0371	1.0079
New York-Northern New Jersey-Long Island, NY-NJ-PA Metro Area	8.886	4.740	1.87	1.1633	1.2492
Niles-Benton Harbor, MI Metro Area	2.656	2.614	1.02	-0.5547	0.8811
Norwich-New London, CT Metro Area	4.676	3.508	1.33	0.0024	1.0005
Ocala, FL Metro Area	3.070	1.077	2.85	-0.4406	0.9056
Ocean City, NJ Metro Area	4.705	2.109	2.23	0.0103	1.0022
Odessa, TX Metro Area	5.550	4.037	1.37	0.2433	1.0521
Ogden-Clearfield, UT Metro Area	2.150	1.092	1.97	-0.6942	0.8513
Oklahoma City, OK Metro Area	2.176	0.513	4.24	-0.6871	0.8528
Olympia, WA Metro Area	2.905	1.468	1.98	-0.4860	0.8959
Omaha-Council Bluffs, NE-IA Metro Area	0.852	0.575	1.48	-1.0522	0.7746
Orlando-Kissimmee-Sanford, FL Metro Area	4.201	1.389	3.02	-0.1287	0.9724
Oshkosh-Neenah, WI Metro Area	0.688	1.469	0.47	-1.0975	0.7649
Owensboro, KY Metro Area	1.428	0.394	3.62	-0.8933	0.8086
Oxnard-Thousand Oaks-Ventura, CA Metro Area	8.253	2.435	3.39	0.9889	1.2119
Palm Bay-Melbourne-Titusville, FL Metro Area	5.002	1.664	3.01	0.0924	1.0198
Panama City-Lynn Haven-Panama City Beach, FL Metro Area	6.448	2.652	2.43	0.4911	1.1052
Parkersburg-Marietta-Vienna, WV-OH Metro Area	3.927	2.572	1.53	-0.2041	0.9563
Pascagoula, MS Metro Area	4.865	2.567	1.89	0.0544	1.0117
Pensacola-Ferry Pass-Brent, FL Metro Area	6.075	2.883	2.11	0.3883	1.0832
Peoria, IL Metro Area	2.611	1.880	1.39	-0.5672	0.8785
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD Metro Area	5.423	2.712	2.00	0.2083	1.0446
Phoenix-Mesa-Glendale, AZ Metro Area	5.892	1.615	3.65	0.3376	1.0723
Pine Bluff, AR Metro Area	10.003	4.950	2.02	1.4714	1.3153
Pittsburgh, PA Metro Area	4.390	0.341	12.89	-0.0765	0.9836
Pittsfield, MA Metro Area	7.583	3.310	2.29	0.8040	1.1723
Pocatello, ID Metro Area	3.322	1.251	2.66	-0.3709	0.9205
Portland-South Portland-Biddeford, ME Metro Area	2.053	1.128	1.82	-0.7210	0.8455
Portland-Vancouver-Hillsboro, OR-WA Metro Area	6.162	2.320	2.66	0.4123	1.0883
Port St. Lucie, FL Metro Area	2.747	0.646	4.25	-0.5296	0.8865
Prescott, AZ Metro Area	3.725	1.061	3.51	-0.2599	0.9443
Providence-New Bedford-Fall River, RI-MA Metro Area	3.505	3.846	0.91	-0.3204	0.9314
Provo-Orem, UT Metro Area	1.888	0.796	2.37	-0.7665	0.8358
Pueblo, CO Metro Area	1.236	0.686	1.80	-0.9461	0.7973
Punta Gorda, FL Metro Area	3.133	1.569	2.00	-0.4232	0.9093
Racine, WI Metro Area	2.900	3.196	0.91	-0.4873	0.8956
Raleigh-Cary, NC Metro Area	0.835	0.439	1.90	-1.0567	0.7736
Rapid City, SD Metro Area	1.718	0.410	4.19	-0.8132	0.8258
Reading, PA Metro Area	6.147	2.448	2.51	0.4080	1.0874
Redding, CA Metro Area	6.723	2.902	2.32	0.5668	1.1214
Reno-Sparks, NV Metro Area	3.207	1.606	2.00	-0.4027	0.9137

Richmond, VA Metro Area	4.117	1.860	2.21	-0.1519	0.9675
Riverside-San Bernardino-Ontario, CA Metro Area	3.734	0.713	5.23	-0.2573	0.9449
Roanoke, VA Metro Area	4.647	2.497	1.86	-0.0057	0.9988
Rochester, MN Metro Area	0.850	0.978	0.87	-1.0527	0.7745
Rochester, NY Metro Area	2.704	0.786	3.44	-0.5415	0.8840
Rockford, IL Metro Area	2.351	2.357	1.00	-0.6389	0.8631
Rocky Mount, NC Metro Area	0.992	1.444	0.69	-1.0136	0.7828
Rome, GA Metro Area	1.918	1.949	0.98	-0.7582	0.8376
Sacramento--Arden-Arcade--Roseville, CA Metro Area	4.554	2.314	1.97	-0.0311	0.9933
Saginaw-Saginaw Township North, MI Metro Area	-2.117	2.454	-0.86	-1.8709	0.5992
St. Cloud, MN Metro Area	1.382	0.916	1.51	-0.9058	0.8059
St. George, UT Metro Area	2.593	0.774	3.35	-0.5720	0.8775
St. Joseph, MO-KS Metro Area	5.344	3.752	1.42	0.1867	1.0400
St. Louis, MO-IL Metro Area	1.927	2.050	0.94	-0.7558	0.8381
Salem, OR Metro Area	5.149	2.636	1.95	0.1329	1.0285
Salinas, CA Metro Area	10.999	3.290	3.34	1.7461	1.3741
Salisbury, MD Metro Area	4.099	1.523	2.69	-0.1567	0.9664
Salt Lake City, UT Metro Area	4.426	1.744	2.54	-0.0666	0.9857
San Angelo, TX Metro Area	7.034	1.550	4.54	0.6526	1.1398
San Antonio-New Braunfels, TX Metro Area	2.609	0.487	5.36	-0.5675	0.8784
San Diego-Carlsbad-San Marcos, CA Metro Area	5.251	3.042	1.73	0.1608	1.0345
San Francisco-Oakland-Fremont, CA Metro Area	12.211	4.798	2.54	2.0803	1.4457
San Jose-Sunnyvale-Santa Clara, CA Metro Area	14.712	5.234	2.81	2.7701	1.5935
San Luis Obispo-Paso Robles, CA Metro Area	3.687	2.056	1.79	-0.2703	0.9421
Santa Barbara-Santa Maria-Goleta, CA Metro Area	8.141	7.077	1.15	0.9581	1.2053
Santa Cruz-Watsonville, CA Metro Area	10.355	4.641	2.23	1.5686	1.3361
Santa Fe, NM Metro Area	6.658	3.113	2.14	0.5489	1.1176
Santa Rosa-Petaluma, CA Metro Area	6.784	4.720	1.44	0.5837	1.1251
Savannah, GA Metro Area	1.766	1.241	1.42	-0.8000	0.8286
Scranton--Wilkes-Barre, PA Metro Area	7.446	3.026	2.46	0.7664	1.1642
Seattle-Tacoma-Bellevue, WA Metro Area	5.164	2.774	1.86	0.1369	1.0293
Sheboygan, WI Metro Area	3.891	3.078	1.26	-0.2140	0.9542
Sherman-Denison, TX Metro Area	3.979	1.428	2.79	-0.1898	0.9593
Shreveport-Bossier City, LA Metro Area	3.005	0.863	3.48	-0.4585	0.9018
Sioux City, IA-NE-SD Metro Area	3.179	0.945	3.36	-0.4103	0.9121
Sioux Falls, SD Metro Area	1.022	0.302	3.38	-1.0053	0.7846
South Bend-Mishawaka, IN-MI Metro Area	2.603	2.131	1.22	-0.5693	0.8780
Spartanburg, SC Metro Area	0.857	0.811	1.06	-1.0509	0.7748
Spokane, WA Metro Area	5.097	2.083	2.45	0.1186	1.0254
Springfield, IL Metro Area	2.739	0.850	3.22	-0.5318	0.8861
Springfield, MA Metro Area	6.033	3.296	1.83	0.3766	1.0807
Springfield, MO Metro Area	1.918	0.866	2.21	-0.7581	0.8376
Springfield, OH Metro Area	0.651	3.600	0.18	-1.1076	0.7627
State College, PA Metro Area	2.636	0.594	4.44	-0.5601	0.8800
Stockton, CA Metro Area	5.427	1.582	3.43	0.2096	1.0449
Sumter, SC Metro Area	1.396	1.208	1.16	-0.9021	0.8067
Syracuse, NY Metro Area	4.401	1.850	2.38	-0.0733	0.9843
Tallahassee, FL Metro Area	3.550	1.632	2.17	-0.3081	0.9340
Tampa-St. Petersburg-Clearwater, FL Metro Area	5.219	1.476	3.54	0.1521	1.0326
Terre Haute, IN Metro Area	3.725	1.316	2.83	-0.2597	0.9443
Texarkana, TX-Texarkana, AR Metro Area	6.709	0.752	8.93	0.5632	1.1207
Toledo, OH Metro Area	-0.387	1.767	-0.22	-1.3938	0.7014
Topeka, KS Metro Area	2.025	0.958	2.11	-0.7286	0.8439
Trenton-Ewing, NJ Metro Area	6.239	2.230	2.80	0.4334	1.0929

Tucson, AZ Metro Area	4.164	1.528	2.73	-0.1387	0.9703
Tulsa, OK Metro Area	1.514	0.777	1.95	-0.8696	0.8137
Tuscaloosa, AL Metro Area	2.513	0.828	3.04	-0.5941	0.8727
Tyler, TX Metro Area	4.262	1.222	3.49	-0.1116	0.9761
Utica-Rome, NY Metro Area	7.763	2.375	3.27	0.8537	1.1829
Valdosta, GA Metro Area	1.232	1.191	1.03	-0.9474	0.7970
Vallejo-Fairfield, CA Metro Area	7.584	3.240	2.34	0.8043	1.1723
Victoria, TX Metro Area	8.491	2.095	4.05	1.0545	1.2259
Vineland-Millville-Bridgeton, NJ Metro Area	6.449	2.970	2.17	0.4913	1.1053
Virginia Beach-Norfolk-Newport News, VA-NC Metro Area	6.591	3.356	1.96	0.5305	1.1137
Visalia-Porterville, CA Metro Area	5.752	2.525	2.28	0.2992	1.0641
Waco, TX Metro Area	2.262	0.385	5.88	-0.6633	0.8579
Warner Robins, GA Metro Area	0.708	0.532	1.33	-1.0917	0.7661
Washington-Arlington-Alexandria, DC-VA-MD-WV Metro Area	4.953	1.492	3.32	0.0789	1.0169
Waterloo-Cedar Falls, IA Metro Area	2.494	0.655	3.81	-0.5994	0.8716
Wausau, WI Metro Area	1.194	1.318	0.91	-0.9578	0.7948
Wenatchee-East Wenatchee, WA Metro Area	4.576	1.863	2.46	-0.0253	0.9946
Wheeling, WV-OH Metro Area	35.052	10.249	3.42	8.3790	2.7953
Wichita, KS Metro Area	1.419	1.054	1.35	-0.8957	0.8081
Wichita Falls, TX Metro Area	6.069	1.499	4.05	0.3866	1.0828
Williamsport, PA Metro Area	7.282	0.781	9.33	0.7212	1.1545
Wilmington, NC Metro Area	2.641	0.962	2.74	-0.5589	0.8803
Winchester, VA-WV Metro Area	3.268	1.007	3.24	-0.3859	0.9173
Winston-Salem, NC Metro Area	1.258	0.721	1.74	-0.9401	0.7986
Worcester, MA Metro Area	1.376	1.702	0.81	-0.9077	0.8055
Yakima, WA Metro Area	3.827	2.124	1.80	-0.2318	0.9503
York-Hanover, PA Metro Area	3.816	1.631	2.34	-0.2346	0.9497
Youngstown-Warren-Boardman, OH-PA Metro Area	1.488	2.902	0.51	-0.8768	0.8121
Yuba City, CA Metro Area	2.484	0.801	3.10	-0.6021	0.8710
Yuma, AZ Metro Area	3.952	1.330	2.97	-0.1974	0.9577

Figure 2: County-level Scaling Factors

