Appendix for "National Expenditures on Local Amenities"

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A Data

All of our data used in the hedonic wage and housing regressions is taken from the 5% sample of the public use microdata (PUMS) in the 2000 Census. We restrict our sample to non-farm households and person records above the age of 18 for which we construct a measure of hourly wages and monthly housing expenditure.

A.1 Hourly wages

Due to the fixed labour supply assumption in the standard Rosen-Roback model, we compute implied hourly wages for full-time workers from self-reported annual income, weeks worked and hours worked per week. Full-time workers are defined using the standard Bureau of Labor Statistics (BLS) definition as persons who work at least 35 hours or more per week. Using a more restrictive definition of workers who work at least 35 hours a week during at least 26 weeks of the year yields virtually identical results. The summary statistics for the imputed hourly wages across our three samples are reported in table A.1 below.

In order to assess the impact of regional variations in the burden of federal and state income taxes on quality-of-life estimates, we also derive a measure of hourly after-tax wages. For this purpose, we use estimates of average marginal tax rates for federal and state income taxes for 1999 from the NBER's TAXSIM database (Feenberg and Coutts, 1993). We also account for differences in the level of state excise tax rates which are obtained from from the Book of States (CSG, 2000) minus food tax exemptions (share weighted). The summary statistics of hourly after-tax wages across our three samples are also shown in table A.1.

A.2 Local cost-of-living and non-housing goods

Although the cost of living varies substantially across regions, wage are usually deflated using a single, nation-wide deflator, such as the CPI-U calculated by the BLS. The use a nation-wide deflator is particularly problematic given that more than 40% of the CPI-U is determined by housing costs. The local CPI-U released by the BLS and the ACCRA Cost-of-Living Indices (CoLI) are the two local price indices that are most widely used in empirical work. However, both measures have significant shortcomings: the local CPI-U is only produced for 23 of the largest metropolitan areas. Furthermore, there are slight differences in the

Table A.1: **Person record summary statistics**

	Mean	*Std. Dev.*	*Min.*	*Max.*
BBH COUNTIES				
Age	39.48	13.2	18	93
Weeks worked in 1999	45.11	12.7	1	52
Hours per week in 1999	39.93	11.97	5	99
Wage/salary income in 1999	34,591.73	40,794.10	10	347,000
Gross hourly wage	19.02	24.19	1.50	500
Hourly wage (after federal taxes)	14.15	17.98	1.09	385.70
Average marginal federal tax rate (%)	25.59	1.61	20.29	27.51
N. Obs		3,223,602		
CONTERMINOUS US				
Age	39.80	13.37	18	93
Weeks worked in 1999	44.89	12.89	1	52
Hours per week in 1999	39.83	12.02	5	99
Wage/salary income in 1999	32,046.98	38,249.52	20	385,000
Gross hourly wage	17.62	22.51	1.50	500
Hourly wage (after federal taxes)	13.17	16.84	1.09	395.95
Average marginal federal tax rate (%)	25.39	1.59	20.29	27.51
N. Obs		6,630,030		

composition of the underlying consumption baskets across cities and the index is normalized to 1 in a given year, thus precluding cross-sectional comparisons. The use of the ACCRA CoLI, on the other hand, might prove problematic due to problems related to its theoretical design, the data collection, and the sampling design, the consequences of which are discussed in more detail in Koo, Phillips, and Sigalla (2000).

The lack of reliable regional cost-of-living indices thus means that most empirical work on quality-of-life does not deflate nominal wages beyond the adjustment in the cost of housing services, as measured by local rents. However, recent work on urban compensating differentials suggests that non-housing goods might also play an important role in determining the local cost-of-living.

In order to account for the local variation in the price of non-housing goods, we follow the approach of Moretti (2013) who proposes an index that allows for both the cost of housing and the cost of non-housing consumption to vary across metropolitan areas. While the city-level CPI-U published by the BLS is limited in its geographical coverage, it can still be used to estimate what share of non-housing costs varies with the local cost of housing. The local CPI-U for city j in year t is a weighted average of housing costs (HC_j^t) and non-housing costs (NHC_j^t) such that

$$\text{BLS}_j^t = \alpha \text{HC}_j^t + (1-\alpha)\text{NHC}_j^t, \tag{1}$$

where α is the CPI weight used by the BLS for housing expenditure. Non-housing costs can now be expressed as consisting of an element that varies systematically with housing costs and an element that evolves independently form housing cost, i.e. $\text{NHC}_j^t = \pi \text{HC}_j^t + \upsilon_j^t$. Using first-differenced prices to avoid non-stationarity then gives the regression set-up $\Delta\text{BLS}_j^t = \beta \Delta\text{HC}_j^t + \varepsilon_j^t$, which in turn can be used to back-out an estimate of π by estimating $\hat{\beta}$, since $\hat{\pi} = \frac{\hat{\beta}-\alpha}{1-\alpha}$. We use panel data on the small sample of 23 MSAs for which a local BLS CPI is available from 1976-2000 to obtain the fixed-effects estimate for β which yields:

$$\Delta \text{BLS}_j = \underset{(0.07)}{1.792} + \underset{(0.01)}{0.619}\ \Delta \text{HC}_j + \varepsilon_j \qquad R^2 = 0.74. \tag{2}$$

With $\alpha = 0.427$ according to the BLS CPI-U weights in 2000, we can then impute the systematic component of non-housing costs for all MSAs based on their housing cost, i.e. $\hat{\pi}\text{HC}_j^{2000}$ with $\hat{\pi}$ =0.332. Lastly, we compute a local price index as the weighted sum of the cost of housing, the component of non-housing costs that varies with housing, and the component of non-housing costs that does not vary with housing. Our parameter estimates are close to Moretti's (2013) estimates of $\hat{\pi} = 0.35$ which corresponds to $\hat{\beta} = 0.63$ in 2000.[1]

A.3 Self-reported housing values

In the long form of the 2000 Census (question 51), housing values are self-reported in 24 intervals from "less than $10,000" to a top-coded category of "$1,000,000 or more". This implies that the data on housing values, our dependent variable for the housing hedonic regressions, is both interval censored and left- and right-censored. Using an ad-hoc OLS regression on the midpoints of the intervals of such grouped data could lead to inconsistent estimates, because it might not adequately reflect the true uncertainty concerning the nature of the exact values within each interval and because it might also inadequately deal with the left- and right-censoring issues in the tails. We address this issue by comparing the parameters from estimating the housing regression via OLS using the interval mid-points to those from using the more appropriate maximum-likelihood interval estimator.

As a result of our large sample sizes combined with a large number of intervals, we do not find a significant differences between the two sets of estimates. This suggests that the consequences of grouping are unlikely to be important for our application. Furthermore, the root mean-square errors for the two estimators are very similar which suggests that the loss of precision due to using interval midpoints is relatively small and confirms the large-sample findings of Stewart (1983).[2]

Finally, although owners tend to overstate the value of their homes compared to actual sales values, Kiel and Zabel (1999) provide evidence that the magnitude of the overvaluation is relatively small (5%), and—more importantly—that the valuation errors are not systematically related to characteristics of the homeowners, structural characteristics of the house, or the neighbourhood. This implies that empirical estimates based on self-reported house values will provide unbiased estimates of the hedonic prices of both house and amenity characteristics. The summary statistics for the housing sample are reported in table A.2.

A.4 Geography

Table A.3 reports summary statistics for three groups of counties. The first group consists of the same 253 urban counties that were studies by Blomquist, Berger, and Hoehn (1988, BBH hereafter). These counties cover less than 10% of land area in the lower 48 states, but account for almost half of its population. They are a subset of the second group comprising all metropolitan statistical areas (MSA). Using the MSA definitions from the 2000 Census, metropolitan counties contain 80.3% of the U.S. population and 29.7% of its land area. The final group of counties covers the contiguous U.S. This is our study area.

As a next step, we then aggregated the 3,108 counties in the contiguous U.S. into 950 locations, using "public use microdata area" (PUMAs) from the 2000 Census. This resulted in 950 locations, of which 379

[1] Albouy (2008) uses ACCRA data to run a regression similar to equation (2) and obtains a slightly smaller value of $\hat{\pi} = 0.26$.
[2] We adjust the top-coded housing values by multiplying them by 1.5.

Table A.2: **Housing summary statistics**

	Mean	*Std. Dev.*	*Min.*	*Max.*
BBH COUNTIES				
Number of rooms	5.41	2.03	1	9
Number of bedrooms	2.57	1.12	0	5
Acreage	0.86	2.02	0.1	15
Property value	106,632	153,198.1	5,000	1,000,000+
Gross rent	222.59	393.54	4	2,833
Effective property tax rate (%)	1.37	0.94	0	11.49
User cost of housing (%)	4.53	0.65	3.22	13.20
Price-rent ratio	22.08	3.17	31.06	7.58
Monthly housing expenditures ($)	665.47	479.67	50	4,290.42
Workers per household	1.75	1.39	0	4
N. Obs		2,395,116		
CONTERMINOUS US				
Number of rooms	6.15	1.68	1	9
Number of bedrooms	2.97	0.89	0	5
Acreage	1.52	3.08	0.1	15
Property value	92,536	132,544	5,000	1,000,000+
Gross Rent	175.19	340.25	0	2,917
Effective property tax rate (%)	1.28	0.95	0	12.49
User cost of housing (%)	4.48	0.68	3.22	13.20
Price-rent ratio	22.32	3.24	31.06	7.58
Monthly housing expenditures ($)	571.19	450.82	50	3,926.11
Workers per household	1.76	1.38	0	4
N. Obs		5,163,123		

are metropolitan counties. They cover 60% of the U.S. population. In rural areas where one PUMA covers multiple counties we aggregate amenities to the PUMA level using county population weights. The resulting 495 PUMAs contain 25% of the population. Because the affected counties are rural, residents are more likely to have to cross county lines within the PUMA to access public goods, infrastructure, and cultural amenities. Finally, PUMAs occasionally overlap county borders without encompassing both counties. In these cases, we merged the adjacent counties. There are 76 such PUMA-county unions, representing 15% of the population. Thus, each of the 950 locations is a county or the union of adjacent counties.

A.5 Spatial Variation in the User Cost of Housing

Figure A.1 shows how our estimate for the user cost of housing varies across the contiguous United States, by PUMA.

B Moving Cost

We calculated average moving costs between counties by combining information on both the average physical and financial costs of moving. The physical cost of the move includes cost of transporting household goods, vehicles and the people in the household. The financial costs included information on realtor fees, location-specific closing costs and search costs from trips to search for a new residence.

Table A.3: **Characteristics of geographical coverage**

		Geography		
		BBH urban counties	*Metropolitan counties*[*]	*All counties*[†]
No. of counties		253	1,085	3,108
No. of PUMAs		1,061	1,835	2,057
PUMAs per county		4.19	1.69	0.67
Population	*1980*	110,617,710	170,867,817	226,545,805
	2000	131,860,476	224,482,276	279,583,437
Pop. coverage[†]	*1980*	48.8%	75.4%	100.0%
	2000	47.2%	80.3%	
Pop. density (inh. per mi^2)	*1980*	419	402	77
	2000	500	259	94
Land area (mi^2)		263,840	865,437	2,959,064
Water area (mi^2)		25,273	61,081	160,820
Total area (mi^2)		289,113	926,518	3,119,885
Areal coverage		9.3%	29.7%	100.0%
N. obs from PUMS		4,833,916 (P) 2,587,457 (H)	8,875,172 (P) 4,795,515 (H)	10,198,936 (P) 5,484,870 (H)

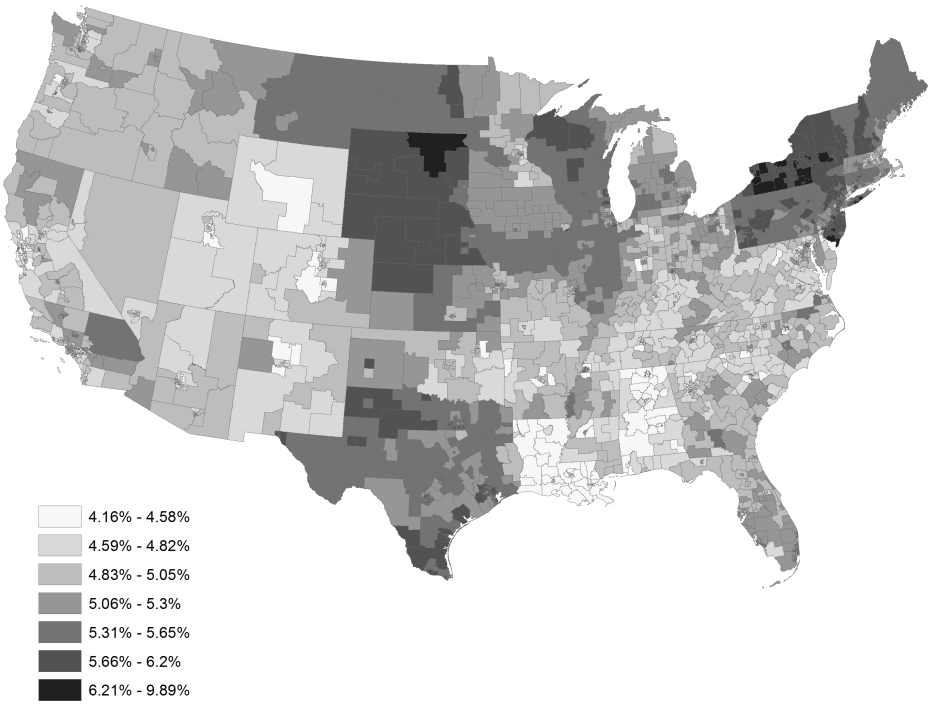
Notes: Public use microdata areas (PUMA) that receive the 5-percent data must have a minimum census population of 100,000. [*] 1980 or 2000 OMB definitions of metropolitan statistical areas (MSA) where applicable. [†] Contiguous U.S. only (Alaska and Hawaii are excluded from all metrics).

B.1 Physical Costs

The first step in calculating physical costs was to calculate the linear distance in miles between the population weighted centroids from each county in the United States to every other county. The next step was to use the PUMS data to calculate the average number of bedrooms and the fraction of renters in each of the counties. Based on the average number of bedrooms in a county, we used the "weight estimator guide" at www.movesource.com to calculate the weight (in pounds) that the average sized household would be transporting from their "origin" county to their "destination" county. The average number of bedrooms in the counties ranged from a minimum of 1.36 to a maximum of 3.46. Based on the weight estimator guide, counties with an average number of bedrooms between 1 and 2 were assigned a transportation weight that varied linearly between 3,500 (for a 1 bedroom) and 5,000 (for a 2 bedroom) pounds. For counties with an average number of bedrooms between 2 and 3, transportation weight ranged between 5,000 and 7,500 pounds and for counties with an average number of bedrooms between 3 and 4 the transportation weight ranged between 7,500 and 10,000 pounds. We assumed that renters in a county shipped on average 1500 pounds less than homeowner households such that our calculated cost to move between counties also depends on the fraction of renters in the origin county. The underlying parameters from the movesource.com moving calculator were used to calculate the cost of shipping based on the weight of the move and the distance between counties for each origin/destination county combination. Figure B.2 shows the cost of transporting various weights (between 2000 pounds and 15000 pounds) for distances between 5 miles and 3000 miles using the movesource.com calculator.

We also assumed that all households transport two vehicles to their new location. The cost of this transportation was based on the IRS's mileage rate for the year 2000 which was 32.5 cents a mile. Thus the vehicle transportation cost was calculated by multiplying 65 cents by the number of miles between the origin and destination counties. Finally, we assume that a household stays in a hotel every 500 miles along their move and incurs some additional daily expenses for food, etc. We apply the average room rate in 2000

Figure A.1: **Spatial variation in the user cost of housing, by PUMA**



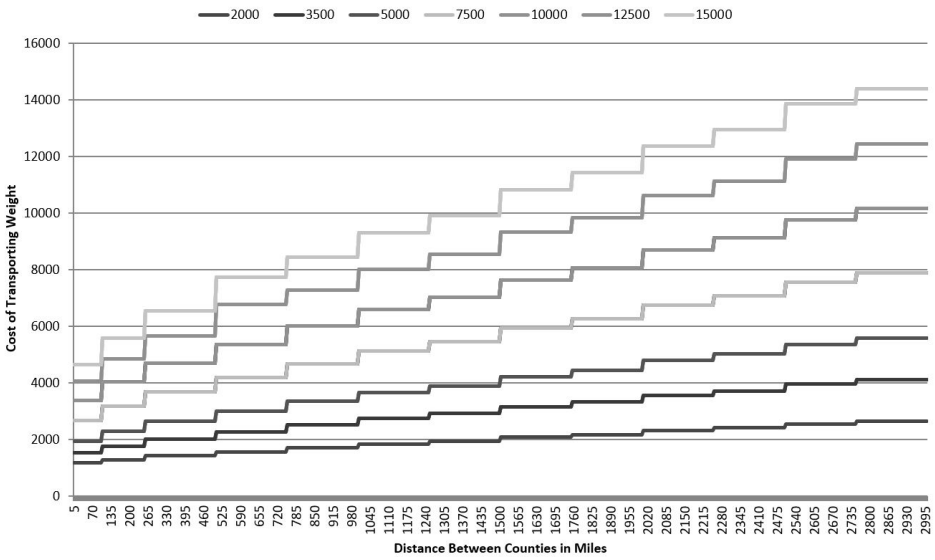
Notes: User cost of housing are the discount factor by which imputed rents are calculated from self-reported house values. They reflect several components that influence house ownership, namely the opportunity cost of foregone alternative investments, property taxes, tax subsidies, maintenance cost, expected capital gains and a risk premium. Each shade on the map represents a range of values. See main text for additional details.

(according to the American Hotel and Lodging Association) of $86 to each of these hotel stays and assume that a household's per diem is $100 per 500 miles. Thus, total physical costs of moving are the summation of the cost of transporting household goods, transporting vehicles, hotel stays and per diem costs as a household moves from an origin county to a destination county.

B.2 Financial cost

Financial costs also vary by renter and homeowner. We assume that homeowners (not renters) must pay closing costs to sell their house in their origin county. Our calculations are based on Bankrate.com's 2005 survey which provides average closing costs by state. We also assume that homeowners (not renters) pay a real estate agent 3% to facilitate selling their house and a real estate agent 3% to buy a house. Thus, we calculate these costs as 3% of the average housing value in the origin county and 3% of the average housing value in the destination county. We assume that both homeowners and renters pay to search for a new residence. These "finding costs" for moves within 60 miles, between 60 and 180, between 180 and 500, between 500 and 1000, and greater than 1,000 miles are assumed to be 0, 250, 500, 1,000 and 2,000 dollars. These finding costs reflect our best guess for the search costs when travel is local, requires at least a day, requires an overnight stay, or likely requires plane tickets in order to look for a new residence in the destination county.

Figure B.2: **Physical Cost Matrix**



Total financial costs are calculated by summing up the financial costs of searching for a new residence (for renters and homeowners) and the costs of buying and selling a home (for homeowners only). The weight assigned to the homeowner and the renter calculations is again based on the fraction of renters in a county. The total moving cost used in the final robustness check of the paper is calculated by summing the physical and financial costs we have described above.

C Amenity Database and Stata Code

The compressed data archive for this paper contains several files. The Stata file `bkp_amenities.dta` contains our county level database on amenities. The file `bkp_expenditures.dta` contains expenditure measures for specific counties, PUMAs, or PUMA-county unions. See the `readme.txt` file for details.

D Additional Results

D.1 Second stage regressions

Table D.4 reports coefficients and standard errors on amenities from the first stage model (equations 7a and 7b in the main text). Since the dependent variables in the first stage of our model are measured in natural logs we apply the Halvorsen-Palmquist adjustment to the dependent variables prior to second stage estimation to convert the "percentage" coefficients into dollar values. Thus, the coefficients in this table define the dollar value differentials in monthly rents and hourly wages associated with one-unit changes in each amenity. The sample size is 950 and the R^2 is 0.59 for the wage regression and 0.83 for the housing regression. We caution against direct economic interpretations of the coefficients as the amenities are correlated with each other and probably with unobserved amenities. Further, the standard errors do not have the usual statistical

interpretation as sampling error because these regressions are based on the entire population of locations in the contiguous United States. See Table 1 and the main text for variable definitions and sources.

Table D.4: **Results from the Amenity Regressions**

	Wage regression		Housing regression	
	Coefficient	*Std. error*	*Coefficient*	*Std. error*
	(1)	(2)	(3)	(4)
GEOGRAPHY AND CLIMATE				
Mean precipitation (inches p.a., 1971–2000)	-0.00481	-0.0024	-0.04027	-0.3930
Mean relative annual humidity (%, 1961–1990)	-0.00068	0.0053	2.623758	-0.8882
Mean annual heating degree days	-0.00000391	0.0	-0.05182	-0.0063
Mean annual cooling degree days	0.000168	-0.0001	-0.15483	-0.0129
Mean wind speed (m.p.h., 1961–1990)	0.07194	-0.0222	17.7336	-3.6985
Sunshine (% of possible)	-0.00839	-0.0058	2.980531	-0.9758
Heavy fog (no. of days with visibility $\leq$ 0.25 mi.)	-0.007	-0.0031	-3.05563	-0.5126
Percent water area	-0.00734	-0.0023	0.150983	-0.3872
Coast (=1 if on coast)	0.22782	-0.0824	65.38208	-13.7446
Non-adjacent coastal watershed (=1 if in watershed)	0.191503	-0.054	28.32203	-9.013
Mountain peaks above 1500 meters	0.0000694	-0.0008	-0.12432	-0.132
Rivers (miles per sq. mile)	0.33689	-0.2266	-60.0454	-37.8055
Federal land (percentage of total land area)	0.002121	-0.0015	0.367521	-0.2535
Wilderness areas (percentage of total land area)	-0.00642	-0.007	0.695603	-1.1701
National Parks (percentage of total land area)	-0.0044	-0.007	2.636924	-1.1703
Distance (km) to nearest National Park	0.001226	-0.0004	0.007341	-0.0696
Distance (km) to nearest State Park	0.004899	-0.0013	-0.25622	-0.2171
Scenic drives (total mileage)	-0.00685	-0.0265	-0.9234	-4.4174
Average number of tornadoes per annum (1950–2000)	-0.02984	-0.0675	-13.5571	-11.2667
Property damage from hazard events ($000s, per mi^2)	-0.00000019	0	0.0000308	0
Seismic hazard (index)	-0.00019	-0.0001	0.021329	-0.0184
Number of earthquakes (1950–2000)	0.00235	-0.0023	-0.21725	-0.38
Land cover diversity (index, range 0–255)	-0.00054	-0.0005	-0.07774	-0.0853
ENVIRONMENTAL EXTERNALITIES				
NPDES effluent dischargers (PCS permits, 1989–1999)	0.001081	-0.001	-0.37608	-0.1616
Landfill waste (metric tons, 2000)	0.00000104	0	0.000209	-0.0002
Superfund sites	0.021377	-0.0096	5.477996	-1.5947
Treatment, storage, and disposal facilities	0.00189	-0.0008	-0.08241	-0.1399
Large quantity generators of hazardous waste	-0.00059	-0.0002	0.051985	-0.0302
Nuclear power plants	0.054971	-0.0908	-6.6399	-15.1425
$PM_{2.5}$ (μg per m^3)	0.021281	-0.0076	-4.97903	-1.2635
PM_{10} (μg per m^3)	0.01028	-0.005	0.086907	-0.8305
Ozone (μg per m^3)	0.003089	-0.0021	0.266856	-0.348
Sulphur dioxide (μg per m^3)	0.017324	-0.0197	-6.97857	-3.2914
Carbon monoxide (μg per m^3)	0.000992	-0.0007	0.232968	-0.1216
Nitrogen dioxide (μg per m^3)	-0.02277	-0.0064	2.007788	-1.0677
National Fire Plan treatment (percentage of total area)	-0.07021	-0.0422	0.336637	-7.0321
Cancer Risk	0.005898	-0.0218	0.123181	-3.6292

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	Wage regression		Housing regression	
	Coefficient	*Std. error*	*Coefficient*	*Std. error*
	(1)	(2)	(3)	(4)
Neurological risk	-0.07458	-0.1947	-38.085	-32.4728
Respiratory risk	0.026031	-0.012	8.529988	-1.9965
LOCAL PUBLIC GOODS				
Local direct general expenditures ($ per capita)	0.12074	-0.0252	16.69893	-4.2092
Local exp. for hospitals and health ($ per capita)	0.00000115	-0.0001	-0.00309	-0.013
Local exp. on parks, rec. and nat. resources ($ pc)	-0.000035	-0.0001	-0.00425	-0.024
Museums and historical sites (per 1,000 people)	0.015623	-0.006	-0.74254	-1.0021
Municipal parks (percentage of total land area)	0.034804	-0.019	22.00409	-3.1715
Campgrounds and camps	-0.01629	-0.0049	0.671194	-0.8219
Zoos, botanical gardens and nature parks	-0.01608	-0.0187	3.11851	-3.118
Crime rate (per 100,000 persons)	0.0000194	0	-0.001	-0.0013
Teacher-pupil ratio	-4.21125	-1.0199	-369.679	-170.1414
Local expenditure per student ($, 1996-97 fiscal year)	-0.00023	-0.0002	0.027945	-0.0402
Private school to public school enrollment (%)	1.303005	-0.2828	475.888	-47.181
Child mortality (per 1000 births, 1990–2000)	0.029934	-0.0142	-13.9888	-2.3618
INFRASTRUCTURE				
Federal expenditure ($ pc, non-wage, non-defense)	-0.00000289	0	-0.00022	-0.0006
Number of airports	-0.02458	-0.019	-8.98683	-3.1654
Number of ports	0.076638	-0.0439	-32.9929	-7.3223
Interstate highways (total mileage per mi^2)	-0.5889	-0.4133	-59.0551	-68.9466
Urban arterials (total mileage per mi^2)	0.302337	-0.1283	-49.1626	-21.4098
Number of Amtrak stations	-0.04051	-0.0234	-7.89242	-3.8956
Number of urban rail stops	-0.0047	-0.002	0.093274	-0.3336
Railways (total mileage per mi^2)	-0.23618	-0.0573	-37.1567	-9.5507
CULTURAL AND URBAN AMENITIES				
Number of restaurants and bars (per 1,000 people)	-0.45898	-0.0837	23.73215	-13.9607
Theatres and musicals (per 1,000 people)	-0.88378	-1.4072	764.2094	-234.7595
Artists (per 1,000 people)	0.149605	-0.1131	51.07887	-18.8708
Movie theatres (per 1,000 people)	-4.73235	-1.6602	461.7623	-276.9558
Bowling alleys (per 1,000 people)	-1.58687	-1.3756	-789.71	-229.482
Amusement, recreation establishments (per 1,000 people)	-0.091	-0.0665	-19.5634	-11.0915
Research I universities (Carnegie classification)	0.007666	-0.0031	1.930234	-0.5184
Golf courses and country clubs	-0.03382	-0.0059	-0.16907	-0.9851
Military areas (percentage of total land area)	-0.29959	-0.0573	52.87875	-9.5544
Housing stress (=1 if $>$ 30% of hholds distressed)	-0.02292	-0.0803	-18.7777	-13.4008
Persistent poverty (=1 if $>$ 20% of pop. in poverty)	0.035727	-0.0607	9.500817	-10.1252
Retirement destination (=1 if growth retirees $>$ 15%)	0.004937	-0.0013	0.575421	-0.2135
Distance (km) to the nearest urban center	-0.00246	-0.0006	-0.5988	-0.105
Incr. distance to a metropolitan area of any size	-0.00106	-0.0003	-0.16107	-0.05
Incr. distance to a metro area $>$ 250,000	-0.00129	-0.0003	-0.06242	-0.0529
Incr. distance to a metro area $>$ 500,000	-0.00061	-0.0002	-0.15754	-0.0291
Incr. distance to a metro area $>$ 1.5 million	-0.00481	-0.0024	-0.04027	-0.393

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