Linking Health and Economic Prosperity: A Study of U.S. Metro Areas

Technical Supplement

This supplement provides detailed results of the statistical analysis for a study conducted by Wilder Research and the Federal Reserve Bank of Minneapolis in response to a call by the Robert Wood Johnson Foundation and AcademyHealth for research to build the evidence base for private sector investment in population health It includes a description of the longitudinal data panel and analytical approaches used to conduct this study. The final study report and other supporting documents appear at **www.wilder.org/study/linking-health-econ-19**

The data panel

We identified 74 data indicators related to population health, economic activity, social determinants of health, and policy. Using the 2015 definition of MSAs in the United States, we incorporated these into a data panel for 382 metro areas, where available. Most indicators were available from the early 2000s to 2015.[1] Our study focuses on 19 of these indicators.

Data sources for the panel

Two data sources comprise the majority of the panel data used for this study:

- Census Bureau – Decennial Census, Current Population Survey, American Community Survey
- Centers for Disease Control and Prevention – Behavioral Risk Factor Surveillance System

These sources provide data at regular intervals ranging from every year to every ten years.

Additional data sources in the panel include:

- Americans for Nonsmokers' Rights
- Business Dynamics Statistics
- Bureau of Economic Analysis
- National Establishment Time-Series (NETS) Database

[1] Not all indicators were available for each year. While some indicators were available as far back as the late 1970s, our primary data sources become available in the early 2000s. Our two largest data sources are BRFSS data which was available from 2002 to 2015, and Census/ACS data, which was available for the year 2000, and then from 2005 to present.

Bi-variate Analysis

We ran Pearson correlation tests to understand the connections between the health and economic indicators used in this study. These tests used all available data from our panel, so the total N used in each calculation varies according to data availability. In the following tables, we provide the correlations between our economic variables, between our health variables, and between our economic and health variables.

1. Bivariate correlations among economic activity indicators

		GMP per capita (real)	Median household income (real)	Labor force participation	Male labor force participation	Female labor force participation	Parent labor force participation	Male parent labor force participation	Female parent labor force participation	Net job creation rate	Net establishment creation rate
GMP per capita (real)	Pearson Correlation	1	.512**	.546**	.157**	.436**	.512**	.137**	.144**	0.036	0.031
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.140	0.196
	N	2895	2895	2895	2895	2895	2895	2895	2895	1704	1705
Median household income (real)	Pearson Correlation	.512**	1	.404**	-0.017	.372**	.321**	.052**	-.099**	-0.006	-.174**
	Sig. (2-tailed)	0.000		0.000	0.367	0.000	0.000	0.006	0.000	0.803	0.000
	N	2895	2895	2895	2895	2895	2895	2895	2895	1704	1705
Labor force participation	Pearson Correlation	.546**	.404**	1	.397**	.871**	.872**	.318**	.403**	-0.039	0.031
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.084	0.181
	N	2895	2895	3153	3153	3153	3153	3153	3153	1935	1881
Male labor force participation	Pearson Correlation	.157**	-0.017	.397**	1	.169**	.527**	.920**	.867**	.075**	.134**
	Sig. (2-tailed)	0.000	0.367	0.000		0.000	0.000	0.000	0.000	0.001	0.000
	N	2895	2895	3153	3153	3153	3153	3153	3153	1935	1881
Females labor force participation	Pearson Correlation	.436**	.372**	.871**	.169**	1	.521**	0.022	.315**	-.129**	-.111**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.221	0.000	0.000	0.000
	N	2895	2895	3153	3153	3153	3153	3153	3153	1935	1881
Parent labor force participation	Pearson Correlation	.512**	.321**	.872**	.527**	.521**	1	.529**	.401**	.058*	.172**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.010	0.000
	N	2895	2895	3153	3153	3153	3153	3153	3153	1935	1881

Note: *p < .05; ** p < .01; *** p < .001;

1. Bivariate correlations among economic activity indicators (continued)

		GMP per capita (real)	Median household income (real)	Labor force participation	Male labor force participation	Female labor force participation	Parent labor force participation	Male parent labor force participation	Female parent labor force participation	Net job creation rate	Net establishment creation rate
Male parent labor force participation	Pearson Correlation	.137**	.052**	.318**	.920**	0.022	.529**	1	.603**	.130**	.204**
	Sig. (2-tailed)	0.000	0.006	0.000	0.000	0.221	0.000		0.000	0.000	0.000
	N	2895	2895	3153	3153	3153	3153	3153	3153	1935	1881
Female parent labor force participation	Pearson Correlation	.144**	-.099**	.403**	.867**	.315**	.401**	.603**	1	-0.013	0.011
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.555	0.631
	N	2895	2895	3153	3153	3153	3153	3153	3153	1935	1881
Net job creation rate	Pearson Correlation	0.036	-0.006	-0.039	.075**	-.129**	.058*	.130**	-0.013	1	.406**
	Sig. (2-tailed)	0.140	0.803	0.084	0.001	0.000	0.010	0.000	0.555		0.000
	N	1704	1704	1935	1935	1935	1935	1935	1935	9851	8693
Net establishment creation rate	Pearson Correlation	0.031	-.174**	0.031	.134**	-.111**	.172**	.204**	0.011	.406**	1
	Sig. (2-tailed)	0.196	0.000	0.181	0.000	0.000	0.000	0.000	0.631	0.000	
	N	1705	1705	1881	1881	1881	1881	1881	1881	8693	10732

Note: *p < .05; ** p < .01; *** p < .001;

2. Bivariate correlations among population health indicators

		General health (good or better)	Heart disease	High blood pressure	High cholesterol	Obesity	Diabetes	Smoking	Exercise (frequent)	Mental health (poor)
General health (good or better)	Pearson Correlation	1	-.568**	-.634**	-.436**	-.525**	-.721**	-.273**	.704**	-.583**
	Sig. (2-tailed)		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	1930	865	911	911	1930	1930	1930	1930	1885
Heart disease	Pearson Correlation	-.568**	1	.575**	.485**	.355**	.512**	.480**	-.525**	.441**
	Sig. (2-tailed)	0.000		0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	865	865	865	865	865	865	865	865	865
High blood pressure	Pearson Correlation	-.634**	.575**	1	.606**	.693**	.811**	.383**	-.667**	.601**
	Sig. (2-tailed)	0.000	0.000		0.000	0.000	0.000	0.000	0.000	0.000
	N	911	865	911	911	911	911	911	911	911
High cholesterol	Pearson Correlation	-.436**	.485**	.606**	1	.456**	.535**	.251**	-.380**	.411**
	Sig. (2-tailed)	0.000	0.000	0.000		0.000	0.000	0.000	0.000	0.000
	N	911	865	911	911	911	911	911	911	911
Obesity	Pearson Correlation	-.525**	.355**	.693**	.456**	1	.699**	.218**	-.532**	.437**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000		0.000	0.000	0.000	0.000
	N	1930	865	911	911	1930	1930	1930	1930	1885
Diabetes	Pearson Correlation	-.721**	.512**	.811**	.535**	.699**	1	.194**	-.625**	.530**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000		0.000	0.000	0.000
	N	1930	865	911	911	1930	1930	1930	1930	1885
Smoking	Pearson Correlation	-.273**	.480**	.383**	.251**	.218**	.194**	1	-.358**	.357**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000
	N	1930	865	911	911	1930	1930	1930	1930	1885

Note: *p < .05; ** p < .01; *** p < .001;

2. Bivariate correlations among population health indicators (continued)

		General health (good or better)	Heart disease	High blood pressure	High cholesterol	Obesity	Diabetes	Smoking	Exercise (frequent)	Mental health (poor)
Exercise (frequent)	Pearson Correlation	.704**	-.525**	-.667**	-.380**	-.532**	-.625**	-.358**	1	-.407**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000
	N	1930	865	911	911	1930	1930	1930	1930	1885
Mental health (poor)	Pearson Correlation	-.583**	.441**	.601**	.411**	.437**	.530**	.357**	-.407**	1
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
	N	1885	865	911	911	1885	1885	1885	1885	1885

Note: *p < .05; ** p < .01; *** p < .001;

3. Bivariate correlations among economic activity indicators and population health indicators

		GMP per capita (real)	Median household income (real)	Labor force participation	Parent labor force participation	Female labor force participation	Male labor force participation	Male parent labor force participation	Female parent labor force participation	Net job creation rate	Net establishment creation rate
General health (good or better)	Pearson Correlation	.311**	.397**	.631**	.207**	.536**	.560**	.270**	0.049	.063*	.130**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.088	0.035	0.000
	N	1236	1236	1236	1236	1236	1236	1236	1236	1125	1213
Heart disease	Pearson Correlation	-.235**	-.383**	-.306**	-.181**	-.165**	-.363**	-.279**	0.019	-.110*	-.102*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.617	0.014	0.024
	N	665	665	665	665	665	665	665	665	499	491

Note: *p < .05; ** p < .01; *** p < .001;

3. Bivariate correlations among economic activity indicators and population health indicators (continued)

		GMP per capita (real)	Median household income (real)	Labor force participation	Parent labor force participation	Female labor force participation	Male labor force participation	Male parent labor force participation	Female parent labor force participation	Net job creation rate	Net establishment creation rate
High blood pressure	Pearson Correlation	-.161**	-0.074	-.399**	-.425**	-.129**	-.568**	-.574**	-0.071	-.125**	-.476**
	Sig. (2-tailed)	0.000	0.057	0.000	0.000	0.001	0.000	0.000	0.068	0.004	0.000
	N	665	665	665	665	665	665	665	665	539	537
High cholesterol	Pearson Correlation	-.205**	-.204**	-.238**	-.118**	-.120**	-.293**	-.219**	0.067	-.100*	-.276**
	Sig. (2-tailed)	0.000	0.000	0.000	0.002	0.002	0.000	0.000	0.086	0.021	0.000
	N	665	665	665	665	665	665	665	665	539	537
Obesity	Pearson Correlation	-.270**	-.238**	-.394**	-.133**	-.224**	-.466**	-.277**	.117**	-.060*	-.286**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.043	0.000
	N	1236	1236	1236	1236	1236	1236	1236	1236	1125	1213
Diabetes	Pearson Correlation	-.235**	-.166**	-.483**	-.300**	-.306**	-.538**	-.415**	-0.038	-.120**	-.331**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.178	0.000	0.000
	N	1236	1236	1236	1236	1236	1236	1236	1236	1125	1213
Smoking	Pearson Correlation	-.179**	-.467**	-.149**	-.175**	0.008	-.271**	-.334**	.109**	-.136**	-.074**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.789	0.000	0.000	0.000	0.000	0.010
	N	1236	1236	1236	1236	1236	1236	1236	1236	1125	1213
Exercise (frequent)	Pearson Correlation	.196**	.384**	.425**	.101**	.309**	.426**	.249**	-.143**	.117**	.161**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	N	1236	1236	1236	1236	1236	1236	1236	1236	1125	1213
Mental health (poor)	Pearson Correlation	-.284**	-.199**	-.414**	-.357**	-.257**	-.472**	-.407**	-.170**	-.102**	-.265**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000
	N	1236	1236	1236	1236	1236	1236	1236	1236	1115	1180

Note: *p < .05; ** p < .01; *** p < .001;

Multivariate analysis

Since correlation does not indicate causality, we conducted several additional analyses to produce evidence that suggests that better health in metro areas does, in fact, lead to better economic conditions.

Granger Test

The Granger Test provides a means for determining whether changes in one indicator seem to *precede* changes in another indicator over a period of time. The test does not conclusively determine whether X *causes* Y, but it can establish whether population health conditions are leading economic activity in MSAs, or whether these conditions mutually reinforce one another. We used Granger tests to examine relationships over time between:

- Each of the 9 population health indicators we included in our study – self-reported general health, heart disease, high blood pressure, high cholesterol, obesity, diabetes, self-reported mental health (poor), smoking, and exercise (frequent); and
- Each of 10 economic activity indicators we included in our study –gross metropolitan product per capita (in real dollars), median household income (in real dollars), labor force participation rates (for the total population, for males, for females, for all parents, for female parents, and for male parents), net establishment creation rate, and net job creation rate.

By applying the Granger method, we test whether past values of variable X are statistically significant in their ability to predict future values of variable Y. This test can help to determine the temporal order of changes in indicators, such as those in our study. (Some economists call this "Granger causality," which notes that changes in variable X precede and can statistically predict later changes in variable Y. However, we refrain from using that term, because the test does not conclusively determine that X causes Y. Conservatively described, it shows that changes in variable X precede and can statistically predict later changes in variable Y.)

To run these Granger tests, we regressed the most recent value of each economic activity variable X on four lags of variable X and four lags of each population health variable Y.[2] We then ran F tests on the lags of variable Y and looked for statistical significance at the .05 level, which indicates that changes in variable X are significantly associated with later changes in variable Y. We provide detailed results of the significance values for the Granger tests used in this study. The following tables, which depict the results, are broken out by the direction of the relationships that we found. Table 4 shows the series of results in which changes in population health are predictive of later changes in economic activity. Table 5 shows the series of results in

[2] BRFSS only includes questions about heart disease, high blood pressure, and high cholesterol every couple of years. Because of this, when using these variables in our Granger tests, we used the most recent year of data and the two most recent years of prior data. (Ex: high blood pressure, L.2 high blood pressure, and L.4 high blood pressure were used because L.1 and L.3 were unavailable.)

which changes in population health and economic activity are predictive of later changes in the other, or are mutually reinforcing. Table 6 shows the series of results in which changes in economic activity are predictive of later changes in population health. Finally, Table 7 shows the series of results in which neither changes in population health nor changes in economic activity are predictive of the other. Note that the Granger test does not indicate whether the relationship between two indicators is positive or negative; it simply establishes the temporal order of change.

4. Granger Test results; health indicators lead economic indicators

Leading variable	Following variable	F statistic
Exercise (in past month)	Labor force participation	0.0179
Labor force participation	Exercise (in past month)	0.3504
High blood pressure	Female labor force participation	0.0456
Female labor force participation	High blood pressure	0.1999
Exercise (in past month)	Female labor force participation	0.0142
Female labor force participation	Exercise (in past month)	0.1292
Exercise (in past month)	Male labor force participation	0.0454
Male labor force participation	Exercise (in past month)	0.2648
General health status (good or better)	Net job creation rate	0.0198
Net job creation rate	General health (good or better)	0.6120

5. Granger Test results; health indicators and economic indicators are mutually reinforcing

Leading variable	Following variable	F statistic
General health status (good or better)	Labor force participation	0.0426
Labor force participation	General health status (good or better)	0.0000
Heart disease	Labor force participation	0.0267
Labor force participation	Heart disease	0.0004
High cholesterol	Labor force participation	0.0399
Labor force participation	High cholesterol	0.0187
Smoking	Parent labor force participation	0.0042
Parent labor force participation	Smoking	0.0002
General health (good or better)	Male labor force participation	0.0012
Male labor force participation	General health (good or better)	0.0000
Heart disease	Male labor force participation	0.0002
Male labor force participation	Heart disease	0.0000
Smoking	Male labor force participation	0.0010
Male labor force participation	Smoking	0.0000
Diabetes	Male parent labor force participation	0.0046
Male parent labor force participation	Diabetes	0.0119
Smoking	Male parent labor force participation	0.0002
Male parent labor force participation	Smoking	0.0002

5. Granger Test results; health indicators and economic indicators are mutually reinforcing (continued)

Leading variable	Following variable	F statistic
Smoking	Female parent labor force participation	0.0386
Female parent labor force participation	Smoking	0.0015
High Blood Pressure	Per Capita Gross Metropolitan Product	0.0472
Per Capita Gross Metropolitan Product	High Blood Pressure	0.0006
Diabetes	Per Capita Gross Metropolitan Product	0.0313
Per Capita Gross Metropolitan Product	Diabetes	0.0523
General health (good or better)	Median household income	0.0001
Median household income	General health (good or better)	0.0000
High Blood Pressure	Median household income	0.0001
Median household income	High Blood Pressure	0.0000
Obesity	Median household income	0.0000
Median household income	Obesity	0.0244
Diabetes	Median household income	0.0001
Median household income	Diabetes	0.0000
Smoking	Median household income	0.0179
Median household income	Smoking	0.0000
Mental health (poor)	Parent labor force participation	0.0035
Parent labor force participation	Mental health (poor)	0.0005
Mental health (poor)	Female labor force participation	0.0035
Female labor force participation	Mental health (poor)	0.0005
Mental health (poor)	Male parent labor force participation	0.0362
Male parent labor force participation	Mental health (poor)	0.0000
Mental health (poor)	Net establishment creation rate	0.0001
Net establishment creation rate	Mental health (poor)	0.0000
Mental health (poor)	Net job creation rate	0.0002
Net job creation rate	Mental health (poor)	0.0000

6. Granger Test results; economic indicators lead health indicators

Leading variable	Following variable	F statistic
High blood pressure	Labor force participation	0.1152
Labor force participation	High blood pressure	0.0441
Diabetes	Labor force participation	0.6009
Labor force participation	Diabetes	0.0027
Smoking	Labor force participation	0.1399
Labor force participation	Smoking	0.0000
General health (good or better)	Parent labor force participation	0.1759
Parent labor force participation	General health (good or better)	0.0060
Heart disease	Parent labor force participation	0.8261
Parent labor force participation	Heart disease	0.0015
General health (good or better)	Female labor force participation	0.6598
Female labor force participation	General health (good or better)	0.0001
Heart disease	Female labor force participation	0.8387
Female labor force participation	Heart disease	0.0428
Smoking	Female labor force participation	0.2032
Female labor force participation	Smoking	0.0000
High blood pressure	Male labor force participation	0.7646
Male labor force participation	High blood pressure	0.0016
High cholesterol	Male labor force participation	0.1182
Male labor force participation	High cholesterol	0.0002
Diabetes	Male labor force participation	0.1405
Male labor force participation	Diabetes	0.0003
General health (good or better)	Male parent labor force participation	0.1075
Male parent labor force participation	General health (good or better)	0.0005
Heart disease	Male parent labor force participation	0.0670
Male parent labor force participation	Heart disease	0.0001
High blood pressure	Male parent labor force participation	0.5988
Male parent labor force participation	High blood pressure	0.0065
High cholesterol	Male parent labor force participation	0.1042
Male parent labor force participation	High cholesterol	0.0150

6. Granger Test results; economic indicators lead health indicators (continued)

Leading variable	Following variable	F statistic
General health (good or better)	Female parent labor force participation	0.3953
Female parent labor force participation	General health (good or better)	0.0489
Heart disease	Female parent labor force participation	0.4762
Female parent labor force participation	Heart disease	0.0254
Exercise (in past month)	Female parent labor force participation	0.2941
Female parent labor force participation	Exercise (in past month)	0.0097
General health (good or better)	Per Capita Gross Metropolitan Product	0.5904
Per Capita Gross Metropolitan Product	General health (good or better)	0.0000
Heart disease	Per Capita Gross Metropolitan Product	0.0690
Per Capita Gross Metropolitan Product	Heart disease	0.0005
High cholesterol	Per Capita Gross Metropolitan Product	0.1135
Per Capita Gross Metropolitan Product	High cholesterol	0.0013
Smoking	Per Capita Gross Metropolitan Product	0.2106
Per Capita Gross Metropolitan Product	Smoking	0.0000
Exercise (in past month)	Per Capita Gross Metropolitan Product	0.5362
Per Capita Gross Metropolitan Product	Exercise (in past month)	0.0070
Heart disease	Median household income	0.1591
Median household income	Heart disease	0.0000
High cholesterol	Median household income	0.3714
Median household income	High cholesterol	0.0000
Exercise (in past month)	Median household income	0.3008
Median household income	Exercise (in past month)	0.0058

6. Granger Test results; economic indicators lead health indicators (continued)

Leading variable	Following variable	F statistic
High blood pressure	Net establishment creation rate	0.4140
Net establishment creation rate	High blood pressure	0.0089
High cholesterol	Net establishment creation rate	0.6106
Net establishment creation rate	High cholesterol	0.0005
Diabetes	Net establishment creation rate	0.8876
Net establishment creation rate	Diabetes	0.0255
Smoking	Net establishment creation rate	0.6322
Net establishment creation rate	Smoking	0.0301
Mental health (poor)	Net establishment creation rate	0.9338
Net establishment creation rate	Mental health (poor)	0.0306
High blood pressure	Net job creation rate	0.4486
Net job creation rate	High blood pressure	0.0086
Mental health (poor)	Labor force participation	0.1128
Labor force participation	Mental health (poor)	0.0004
Mental health (poor)	Female parent labor force participation	0.0568
Female parent labor force participation	Mental health (poor)	0.0002
Mental health (poor)	Per Capita Gross Metropolitan Product	0.2788
Per Capita Gross Metropolitan Product	Mental health (poor)	0.0000
Mental health (poor)	Median household income	0.1516
Median household income	Mental health (poor)	0.0000

7. Granger Test results; neither health nor economic indicators lead the other

Leading variable	Following variable	F statistic
Obesity	Labor force participation rate	0.3495
Labor force participation rate	Obesity	0.8166
High blood pressure	Parent labor force participation	0.4951
Parent labor force participation	High blood pressure	0.7721
High cholesterol	Parent labor force participation	0.4144
Parent labor force participation	High cholesterol	0.5382
Obesity	Parent labor force participation	0.7628
Parent labor force participation	Obesity	0.7464
Diabetes	Parent labor force participation	0.0819
Parent labor force participation	Diabetes	0.2483
Exercise (in past month)	Parent labor force participation	0.3205
Parent labor force participation	Exercise (in past month)	0.1979
High cholesterol	Female labor force participation	0.1513
Female labor force participation	High cholesterol	0.1783
Obesity	Female labor force participation	0.4281
Female labor force participation	Obesity	0.9212
Diabetes	Female labor force participation	0.9369
Female labor force participation	Diabetes	0.2066
Obesity	Male labor force participation	0.2048
Male labor force participation	Obesity	0.4905
Exercise (in past month)	Male parent labor force participation	0.1550
Male parent labor force participation	Exercise (in past month)	0.0726
High blood pressure	Female parent labor force participation	0.1724
Female parent labor force participation	High blood pressure	0.0602
High cholesterol	Female parent labor force participation	0.9849
Female parent labor force participation	High cholesterol	0.2376
Obesity	Female parent labor force participation	0.8834
Female parent labor force participation	Obesity	0.0690
Diabetes	Female parent labor force participation	0.8290
Female parent labor force participation	Diabetes	0.7653

7. Granger Test results; neither health nor economic indicators lead the other (continued)

Leading variable	Following variable	F statistic
Obesity	Per Capita Gross Metropolitan Product	0.0632
Per Capita Gross Metropolitan Product	Obesity	0.7112
General health (good or better)	Net establishment creation rate	0.1228
Net establishment creation rate	General health (good or better)	0.1798
Heart disease	Net establishment creation rate	0.8807
Net establishment creation rate	Heart disease	0.6463
Obesity	Net establishment creation rate	0.5009
Net establishment creation rate	Obesity	0.0664
Exercise (in past month)	Net establishment creation rate	0.3827
Net establishment creation rate	Exercise (in past month)	0.6020
Heart disease	Net job creation rate	0.4950
Net job creation rate	Heart disease	0.2479
High cholesterol	Net job creation rate	0.7659
Net job creation rate	High cholesterol	0.3192
Obesity	Net job creation rate	0.9830
Net job creation rate	Obesity	0.1760
Diabetes	Net job creation rate	0.2557
Net job creation rate	Diabetes	0.4133
Smoking	Net job creation rate	0.0697
Net job creation rate	Smoking	0.8039
Exercise (in past month)	Net job creation rate	0.2846
Net job creation rate	Exercise (in past month)	0.8550
Mental health (poor)	Net job creation rate	0.2325
Net job creation rate	Mental health (poor)	0.0567
Mental health (poor)	Male labor force participation	0.5038
Male labor force participation	Mental health (poor)	0.1620

Fixed effects regression

We ran several fixed effects regression analyses in order to determine the significance of the relationships between population health indicators and economic activity indicators within metropolitan areas. In each regression, the population health indicators were the independent variables and the economic activity indicators were the dependent variables. We ran separate regressions for each of our 10 economic activity indicators.

In our regression analyses, we included both lagged and contemporaneous measures of our independent variables to capture the lagged effects of population health on economic activity. (A lagged effect occurs when a change in a population health indicator influences a change in an economic indicator in a later year.) To identify the optimal number of lags, we ran initial analyses with 2-year, 4-year, 6-year, 8-year and 10-year lags. Based on statistical testing, we dropped the longest insignificant lag. This process was repeated until reaching a significant lag or the contemporaneous measure. Tables 8 through 17 depict the results.

Our general regression model as applied can be written as:

$$\boldsymbol{EconomicVar_{it} = \alpha_i + \beta HealthVar1_{it} + \gamma ControlVar1_{it} \ldots + \varepsilon_{it}.}$$

In all of the regression analyses, we took into account the other socio-demographic characteristics of metro areas that might influence population health, economic activity, and the way that population health affects economic activity. We statistically controlled for the following characteristics: the proportion of adults age 25+ who have a college degree; the proportion of the population who are age 65+; the proportion of the population who are people of color; time trend variables (year, year squared); and year 2009 to account for the Great Recession. It was important to account for the influence of these socio-demographic characteristics in order to increase confidence in the validity of any statistically significant relationships we uncovered.

Metropolitan areas, not individual people, constitute the unit of our analysis. So, for example, where the regression table shows that the rate of heart disease rate in metro areas has a negative and statistically significant relationship with real median household income in metro areas, this does not mean that individuals with heart disease have lower incomes (although that very well might be true). What the data do show is that, in regions with higher levels of heart disease, households tend to have less income, even after controlling for other potential influencers of household income.

8. Per Capita Gross Metropolitan Product (PCGMP)

VARIABLES	(1) PCGMP	(2) PCGMP	(3) PCGMP	(4) PCGMP	(5) PCGMP	(6) PCGMP	(7) PCGMP	(8) PCGMP	(9) PCGMP
brfss_general_health	0.0440								
	(0.0965)								
L2.brfss_general_health	0.00363								
	(0.136)								
L4.brfss_general_health	0.228*								
	(0.135)								
brfss_heart_disease		-1.251							
		(0.779)							
L2.brfss_heart_disease		-0.222							
		(1.034)							
L4.brfss_heart_disease		0.249							
		(1.107)							
L6.brfss_heart_disease		-0.0196							
		(0.847)							
brfss_bphigh			-0.243						
			(0.363)						
L2.brfss_bphigh			-0.169						
			(0.340)						
L4.brfss_bphigh			-0.257						
			(0.239)						
L6.brfss_bphigh			-0.212						
			(0.202)						
brfss_cholesterol				-0.210					
				(0.163)					
brfss_obese					-0.0244				
					(0.0698)				
brfss_diabetes						0.0180			
						(0.165)			
L2.brfss_diabetes						-0.181			
						(0.156)			
L4.brfss_diabetes						-0.500***			
						(0.173)			
brfss_smoker							-0.0328		
							(0.219)		

VARIABLES	(1) PCGMP	(2) PCGMP	(3) PCGMP	(4) PCGMP	(5) PCGMP	(6) PCGMP	(7) PCGMP	(8) PCGMP	(9) PCGMP
L2.brfss_smoker							0.213*		
							(0.117)		
L4.brfss_smoker							-0.110		
							(0.271)		
L6.brfss_smoker							-0.173*		
							(0.102)		
brfss_exercise								-0.0587	
								(0.0623)	
brfss_mental_health									-0.0663
									(0.0987)
laborforce	0.803***	0.559	0.715**	0.406	0.524***	0.816***	0.831*	0.516***	0.521***
	(0.178)	(0.460)	(0.336)	(0.290)	(0.160)	(0.174)	(0.443)	(0.160)	(0.160)
college	0.805***	0.875**	1.116***	1.042***	0.735***	0.796***	0.684**	0.733***	0.736***
	(0.262)	(0.408)	(0.367)	(0.347)	(0.212)	(0.257)	(0.267)	(0.212)	(0.212)
elderlyrate	0.0524	-6.202	-6.194	3.251	2.592	-0.00446	-3.731*	2.673	2.561
	(2.153)	(9.128)	(3.852)	(2.078)	(1.941)	(2.125)	(2.231)	(1.946)	(1.956)
elderly2	-3.343	9.381	11.26	-14.38**	-11.72*	-3.610	6.845	-11.93*	-11.59*
	(6.351)	(25.44)	(12.40)	(5.743)	(6.344)	(6.280)	(6.430)	(6.352)	(6.409)
PropPOC	-0.392	-0.103	-0.145	-0.299	-0.306	-0.371	-0.235	-0.297	-0.306
	(0.473)	(0.746)	(0.627)	(0.469)	(0.423)	(0.469)	(0.669)	(0.421)	(0.423)
year	-8.743**	-3.660	-2.679	-4.703	-6.801***	-8.595**	-8.805	-6.793***	-6.776***
	(3.848)	(90.19)	(42.30)	(4.841)	(1.820)	(3.489)	(13.83)	(1.801)	(1.806)
year2	0.00217**	0.000914	0.000671	0.00117	0.00169***	0.00214**	0.00219	0.00169***	0.00169***
	(0.000958)	(0.0224)	(0.0105)	(0.00121)	(0.000453)	(0.000868)	(0.00344)	(0.000448)	(0.000450)
y2009	-0.0274***	-0.0120	-0.00400	-0.0283**	-0.0251***	-0.0281***	-0.0273***	-0.0248***	-0.0253***
	(0.00682)	(0.303)	(0.135)	(0.0127)	(0.00500)	(0.00625)	(0.00500)	(0.00496)	(0.00502)
Constant	8,797**	3,676	2,683	4,740	6,847***	8,647**	8,859	6,840***	6,822***
	(3,866)	(90,788)	(42,579)	(4,861)	(1,827)	(3,505)	(13,909)	(1,808)	(1,813)
Observations	875	286	323	665	1,236	875	651	1,236	1,236
R-squared	0.270	0.402	0.392	0.293	0.243	0.276	0.289	0.243	0.243
Number of geoid	127	100	103	164	169	127	111	169	169

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

9. Median Household Income (HHincome)

VARIABLES	(1) HHincome	(2) HHincome	(3) HHincome	(4) HHincome	(5) HHincome	(6) HHincome	(7) HHincome	(8) HHincome	(9) HHincome
brfss_general_health	0.306***								
	(0.0867)								
L2.brfss_general_health	-0.221***								
	(0.0768)								
brfss_heart_disease		-0.631**							
		(0.243)							
brfss_bphigh			-0.414						
brfss_cholesterol				-0.0992					
brfss_obese					0.0667				
					(0.0804)				
L2.brfss_obese					0.140**				
					(0.0706)				
brfss_diabetes						-0.0705			
						(0.124)			
L2.brfss_diabetes						-0.0113			
						(0.134)			
L4.brfss_diabetes						-0.174			
						(0.136)			
brfss_smoker							-0.262***		
							(0.0653)		
L2.brfss_smoker							0.0867		
							(0.0627)		
brfss_exercise								-0.0135	
								(0.0652)	
brfss_mental_health									-0.412***
									(0.0815)
laborforce	1.264***	0.502***	0.549***	0.523***	1.293***	1.453***	1.254***	1.358***	1.341***
	(0.165)	(0.177)	(0.141)	(0.177)	(0.168)	(0.136)	(0.168)	(0.150)	(0.144)
college	0.402***	0.540***	0.515	0.533	0.406**	0.584***	0.417***	0.409***	0.419***
	(0.152)	(0.0150)			(0.157)	(0.166)	(0.157)	(0.145)	(0.141)
elderlyrate	1.762	2.303**	2.176**	2.387**	2.382*	0.202	1.840	1.227	0.892
	(1.199)	(0.942)	(0.871)	(0.935)	(1.212)	(1.069)	(1.198)	(1.034)	(1.016)

VARIABLES	(1) HHincome	(2) HHincome	(3) HHincome	(4) HHincome	(5) HHincome	(6) HHincome	(7) HHincome	(8) HHincome	(9) HHincome
elderly2	-9.439***	-9.616***	-8.712***	-9.663***	-11.16***	-5.300*	-9.620***	-6.908**	-5.758**
	(3.336)	(2.893)	(2.817)	(2.823)	(3.330)	(2.836)	(3.258)	(2.832)	(2.832)
PropPOC	-1.262***	-0.824***	-0.771***	-0.809***	-1.272***	-1.230***	-1.314***	-1.259***	-1.275***
	(0.229)	(0.256)	(0.257)	(0.263)	(0.232)	(0.240)	(0.235)	(0.208)	(0.210)
year	3.853	3.557	4.593	3.836	3.143	-4.725*	3.858	3.969	4.251
						(2.495)			
year2	-0.000948	-0.000875	-0.00113	-0.000944	-0.000772	0.00118*	-0.000949	-0.000977	-0.00105
						(0.000621)			
y2009	-0.00955***	0.00732	0.00655	0.00881	-0.00595**	-0.00769*	-0.0100***	-0.00824***	-0.00953***
	(0.00303)				(0.00285)	(0.00420)	(0.00287)	(0.00284)	(0.00287)
Constant	-3,905	-3,603	-4,647	-3,883	-3,189	4,720*	-3,909	-4,021	-4,306
						(2,507)			
Observations	1,064	665	665	665	1,064	875	1,064	1,236	1,236
R-squared	0.862	0.889	0.891	0.888	0.859	0.864	0.861	0.851	0.854
Number of geoid	141	164	164	164	141	127	141	169	169

Robust standard errors in parentheses

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

10. Net Establishment Creation Rate (NetEstabs)

VARIABLES	(1) NetEstabs	(2) NetEstabs	(3) NetEstabs	(4) NetEstabs	(5) NetEstabs	(6) NetEstabs	(7) NetEstabs	(8) NetEstabs	(9) NetEstabs
brfss_general_health	0.196								
	(2.188)								
L2.brfss_general_health	3.412								
	(2.560)								
L4.brfss_general_health	5.615***								
	(1.937)								
brfss_heart_disease		-2.159							
		(7.853)							
brfss_bphigh			-2.415						
			(2.596)						
brfss_cholesterol				1.840					
				(1.877)					
brfss_obese					-1.179				
					(1.235)				
brfss_diabetes						0.428			
						(4.445)			
L2.brfss_diabetes						1.934			
						(4.136)			
L4.brfss_diabetes						-7.606*			
						(4.148)			
L6.brfss_diabetes						-8.711**			
						(3.739)			
brfss_smoker							-0.697		
							(1.703)		
L2.brfss_smoker							-3.306**		
							(1.619)		
brfss_exercise								3.510***	
								(1.264)	
brfss_mental_health									0.442
									(1.703)
L2.brfss_mental_health									-5.082**
									(2.229)
college	7.777***	4.843	4.803	5.046	4.952**	7.934**	3.698	5.477**	3.202
	(2.949)	(3.693)	(3.636)	(3.793)	(2.373)	(3.198)	(2.502)	(2.352)	(2.563)

VARIABLES	(1) NetEstabs	(2) NetEstabs	(3) NetEstabs	(4) NetEstabs	(5) NetEstabs	(6) NetEstabs	(7) NetEstabs	(8) NetEstabs	(9) NetEstabs
elderlyrate	22.32	5.775	4.892	8.201	-6.544	57.58	31.91*	-8.937	29.28*
	(21.46)	(19.96)	(20.24)	(19.26)	(14.54)	(39.78)	(17.03)	(14.60)	(17.58)
elderly2	-86.41	-12.57	-13.69	-22.26	23.17	-154.3	-124.9*	30.77	-113.6*
	(77.05)	(61.18)	(61.95)	(55.94)	(49.90)	(109.9)	(63.53)	(51.45)	(63.84)
PropPOC	-2.198	-1.983	-1.785	-1.699	2.205	-13.63**	-0.785	2.190	-1.372
	(4.536)	(4.589)	(4.672)	(4.462)	(2.859)	(5.378)	(3.226)	(2.779)	(3.240)
year	-272.8***	-132.8	-132.7	-135.9	-195.7***	-179.6	-217.1***	-194.3***	-212.6***
	(72.90)				(25.17)		(32.76)	(25.04)	(30.15)
year2	0.0678***	0.0330	0.0330	0.0338	0.0487***	0.0447	0.0540***	0.0483***	0.0529***
	(0.0181)				(0.00626)		(0.00815)	(0.00623)	(0.00751)
y2009	-1.142***	-1.314***	-1.294***	-1.350***	-1.240***	-1.714***	-1.223***	-1.245***	-1.166***
	(0.365)	(0.260)	(0.270)	(0.254)	(0.262)	(0.489)	(0.275)	(0.261)	(0.288)
Constant	274,218***	133,587	133,510	136,681	196,824***	180,452	218,277***	195,348***	213,778***
	(73,241)				(25,279)		(32,903)	(25,153)	(30,277)
Observations	529	374	374	374	791	350	673	791	673
R-squared	0.415	0.637	0.638	0.638	0.470	0.271	0.474	0.478	0.475
Number of geoid	119	147	147	147	163	103	128	163	128

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

11. Net Job Creation Rate (NetJobs)

VARIABLES	(1) NetJobs	(2) NetJobs	(3) NetJobs	(4) NetJobs	(5) NetJobs	(6) NetJobs	(7) NetJobs	(8) NetJobs	(9) NetJobs
brfss_general_health	-0.860								
	(1.972)								
brfss_heart_disease		6.180							
		(8.577)							
brfss_bphigh			-2.639						
			(2.595)						
brfss_cholesterol				-3.609					
				(2.934)					
brfss_obese					-1.690				
					(1.591)				
brfss_diabetes						-1.303			
						(3.313)			
brfss_smoker							1.157		
							(2.226)		
L2.brfss_smoker							-7.481***		
							(2.725)		
L4.brfss_smoker							1.479		
							(2.143)		
brfss_exercise								1.014	
								(1.259)	
brfss_mental_health									2.735
									(2.138)
L2.brfss_mental_health									-1.578
									(2.263)
college	-5.109	-7.722	-7.832	-7.630	-4.984	-4.987	-3.842	-4.881	-5.727
	(3.644)	(5.888)	(5.865)	(5.849)	(3.620)	(3.660)	(4.185)	(3.651)	(3.911)
elderlyrate	-0.124	-39.94**	-45.30***	-45.16***	-3.002	-1.256	2.543	-2.301	9.364
	(15.04)	(18.38)	(17.31)	(17.11)	(15.38)	(15.05)	(26.03)	(15.06)	(22.90)
elderly2	58.92	178.3***	189.0***	200.0***	68.42*	63.39	2.484	65.99*	-13.88
	(40.64)	(45.30)	(42.17)	(44.36)	(40.67)	(40.47)	(97.88)	(39.61)	(83.66)
PropPOC	-1.819	-9.952	-10.01	-10.33	-1.924	-1.703	-0.309	-1.793	1.126
	(4.169)	(7.456)	(7.310)	(7.428)	(4.101)	(4.124)	(5.278)	(4.162)	(4.922)
year	-60.33**	-72.63*	-74.69*	-68.43*	-59.59**	-60.42***	-165.7**	-60.09**	-75.91***
	(23.16)	(38.41)	(38.41)	(38.09)	(23.32)	(23.13)	(69.11)	(23.21)	(25.52)

VARIABLES	(1) NetJobs	(2) NetJobs	(3) NetJobs	(4) NetJobs	(5) NetJobs	(6) NetJobs	(7) NetJobs	(8) NetJobs	(9) NetJobs
year2	0.0150**	0.0181*	0.0186*	0.0171*	0.0148**	0.0150***	0.0412**	0.0150**	0.0189***
	(0.00577)	(0.00956)	(0.00956)	(0.00948)	(0.00580)	(0.00576)	(0.0172)	(0.00578)	(0.00635)
y2009	0.242**	-0.107	-0.107	-0.133	0.200***	0.197**	0.783***	0.221***	0.345***
	(0.0961)	(0.412)	(0.410)	(0.370)	(0.0570)	(0.0863)	(0.139)	(0.0782)	(0.124)
Constant	60,623**	72,859*	74,895*	68,635*	59,870**	60,707***	166,475**	60,377**	76,268***
	(23,265)	(38,582)	(38,582)	(38,263)	(23,427)	(23,233)	(69,430)	(23,307)	(25,628)
Observations	775	383	383	383	775	775	531	775	664
R-squared	0.038	0.097	0.097	0.102	0.039	0.038	0.100	0.038	0.036
Number of geoid	164	151	151	151	164	164	122	164	134

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

12. Labor Force Participation (LaborForce)

VARIABLES	(1) LaborForce	(2) LaborForce	(3) LaborForce	(4) LaborForce	(5) LaborForce	(6) LaborForce	(7) LaborForce	(8) LaborForce	(9) LaborForce
brfss_general_health	0.0480**								
	(0.0241)								
L2.brfss_general_health	0.0445								
	(0.0283)								
brfss_heart_disease		-0.0547							
		(0.102)							
L2.brfss_heart_disease		-0.0288							
		(0.100)							
L4.brfss_heart_disease		-0.143							
		(0.120)							
brfss_bphigh			-0.0134						
			(0.0749)						
L2.brfss_bphigh			-0.0389						
			(0.0716)						
L4.brfss_bphigh			0.00823						
			(0.0567)						
L6.brfss_bphigh			0.0478						
			(0.0516)						
brfss_cholesterol				-0.0154					
				(0.0567)					
brfss_obese					-0.0131				
					(0.0184)				
brfss_diabetes						0.0608			
						(0.0414)			
brfss_smoker							-0.0129		
							(0.0215)		
brfss_exercise								-0.0428**	
								(0.0181)	
L2.brfss_exercise								0.0501**	
								(0.0200)	
brfss_mental_health									-0.0276
									(0.0282)
college	0.208***	0.193**	0.160*	0.201*	0.205***	0.206***	0.206***	0.205***	0.205***
	(0.0528)	(0.0963)	(0.0959)	(0.120)	(0.0458)	(0.0455)	(0.0461)	(0.0516)	(0.0460)

VARIABLES	(1) LaborForce	(2) LaborForce	(3) LaborForce	(4) LaborForce	(5) LaborForce	(6) LaborForce	(7) LaborForce	(8) LaborForce	(9) LaborForce
elderlyrate	-0.492	-0.608	-0.100	-0.0345	-0.350	-0.323	-0.346	-0.473	-0.360
	(0.328)	(0.513)	(0.715)	(0.486)	(0.306)	(0.304)	(0.308)	(0.329)	(0.308)
elderly2	0.456	1.212	-0.961	-1.194	-0.0798	-0.174	-0.0851	0.384	-0.0304
	(0.945)	(1.701)	(2.252)	(1.180)	(0.900)	(0.891)	(0.897)	(0.947)	(0.897)
PropPOC	-0.137**	0.0522	0.0674	-0.0921	-0.164***	-0.163***	-0.163***	-0.138**	-0.163***
	(0.0612)	(0.111)	(0.103)	(0.0725)	(0.0597)	(0.0592)	(0.0594)	(0.0624)	(0.0596)
year	-0.254	-0.722	-0.0855	-0.846	-0.0455	-0.0796	-0.0521	-0.174	-0.0373
	(0.333)	(1.728)	(7.521)	(1.950)	(0.238)	(0.255)	(0.242)	(0.282)	(0.232)
year2	6.31e-05	0.000179	2.11e-05	0.000210	1.12e-05	1.96e-05	1.28e-05	4.30e-05	9.14e-06
	(8.30e-05)	(0.000430)	(0.00187)	(0.000485)	(5.91e-05)	(6.36e-05)	(6.02e-05)	(7.03e-05)	(5.79e-05)
y2009	0.00696***	0.0106***	0.0111	0.0108**	0.00677***	0.00692***	0.00660***	0.00698***	0.00668***
	(0.00115)	(0.00175)	(0.0239)	(0.00446)	(0.00110)	(0.00109)	(0.00115)	(0.00110)	(0.00110)
Constant	256.5	727.6	87.09	852.1	47.04	81.56	53.77	175.9	38.85
	(334.7)	(1,737)	(7,571)	(1,958)	(238.5)	(256.5)	(242.7)	(283.5)	(233.4)
Observations	1,064	400	323	665	1,236	1,236	1,236	1,064	1,236
R-squared	0.258	0.386	0.404	0.354	0.237	0.239	0.237	0.261	0.237
Number of geoid	141	120	103	164	169	169	169	141	169

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

13. Female Labor Force Participation (FemalesLaborForce)

VARIABLES	(1) Females LaborForce	(2) Females LaborForce	(3) Females LaborForce	(4) Females LaborForce	(5) Females LaborForce	(6) Females LaborForce	(7) Females LaborForce	(8) Females LaborForce	(9) Females LaborForce
brfss_general_health	0.0668**								
	(0.0274)								
brfss_heart_disease		-0.201**							
		(0.0882)							
brfss_bphigh			0.0365						
			(0.0462)						
brfss_cholesterol				-0.0239					
				(0.0359)					
brfss_obese					-0.00503				
					(0.0230)				
brfss_diabetes						0.0699			
						(0.0478)			
brfss_smoker							-0.0585**		
							(0.0285)		
L2.brfss_smoker							0.0341		
							(0.0245)		
brfss_exercise								-0.0262	
								(0.0196)	
brfss_mental_health									-0.0231
									(0.0348)
L2.brfss_mental_health									-0.0217
									(0.0321)
college	0.0880	0.0316	0.0321	0.0308	0.0849	0.0865	0.0841	0.0834	0.0787
	(0.0629)	(0.0976)	(0.105)	(0.0944)	(0.0624)	(0.0622)	(0.0698)	(0.0624)	(0.0715)
elderlyrate	-0.215	0.177	0.237	0.206	-0.174	-0.151	-0.388	-0.142	-0.353
	(0.308)	(0.371)	(0.396)	(0.367)	(0.309)	(0.309)	(0.365)	(0.312)	(0.365)
elderly2	-0.611	-2.121**	-2.318**	-2.162**	-0.754	-0.842	-0.279	-0.832	-0.380
	(0.774)	(0.918)	(0.952)	(0.933)	(0.767)	(0.766)	(1.015)	(0.776)	(1.027)
PropPOC	-0.132*	-0.0682	-0.0654	-0.0637	-0.140*	-0.140*	-0.140*	-0.136*	-0.141*
	(0.0718)	(0.0845)	(0.0895)	(0.0873)	(0.0728)	(0.0723)	(0.0794)	(0.0727)	(0.0806)
year	0.879	-0.162	-0.276	-0.105	0.901	0.870	0.825	0.909	0.665
		(0.830)	(1.138)	(0.742)					
year2	-0.000218	4.07e-05	6.89e-05	2.64e-05	-0.000224	-0.000216	-0.000205	-0.000226	-0.000165
		(0.000207)	(0.000283)	(0.000185)					

VARIABLES	(1) Females LaborForce	(2) Females LaborForce	(3) Females LaborForce	(4) Females LaborForce	(5) Females LaborForce	(6) Females LaborForce	(7) Females LaborForce	(8) Females LaborForce	(9) Females LaborForce
y2009	0.00874***	0.0137***	0.0144***	0.0143***	0.00930***	0.00948***	0.00881***	0.00940***	0.00974***
	(0.00116)	(0.00265)	(0.00320)	(0.00238)	(0.00114)	(0.00115)	(0.00120)	(0.00114)	(0.00125)
Constant	-884.3	162.3	276.8	104.5	-905.6	-874.7	-830.2	-914.3	-668.7
		(833.6)	(1,144)	(745.3)					
Observations	1,236	665	665	665	1,236	1,236	1,064	1,236	1,064
R-squared	0.094	0.190	0.184	0.183	0.089	0.091	0.103	0.091	0.096
Number of geoid	169	164	164	164	169	169	141	169	141

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

14. Male Labor Force Participation (MalesLaborForce)

VARIABLES	(1) MalesLabor Force	(2) MalesLabor Force	(3) MalesLabor Force	(4) MalesLabor Force	(5) MalesLabor Force	(6) MalesLabor Force	(7) MalesLabor Force	(8) MalesLabor Force	(9) MalesLabor Force
brfss_general_health	0.0520*								
	(0.0291)								
brfss_heart_disease		0.00835							
		(0.0796)							
brfss_bphigh			-0.00269						
			(0.0870)						
brfss_cholesterol				-0.00513					
				(0.0764)					
brfss_obese					-0.0206				
					(0.0225)				
brfss_diabetes						0.0489			
						(0.0538)			
brfss_smoker							-0.00351		
							(0.0252)		
brfss_exercise								-0.0519**	
								(0.0201)	
brfss_mental_health									-0.0291
									(0.0357)
college	0.325***	0.375**	0.375**	0.375**	0.323***	0.324***	0.323***	0.320***	0.323***
	(0.0546)	(0.160)	(0.157)	(0.159)	(0.0539)	(0.0535)	(0.0546)	(0.0540)	(0.0544)
elderlyrate	-0.478	-0.188	-0.191	-0.191	-0.460	-0.430	-0.445	-0.387	-0.465
	(0.389)	(0.678)	(0.646)	(0.662)	(0.389)	(0.387)	(0.391)	(0.393)	(0.388)
elderly2	0.547	-0.401	-0.390	-0.385	0.468	0.373	0.434	0.293	0.507
	(1.227)	(1.668)	(1.684)	(1.683)	(1.232)	(1.224)	(1.235)	(1.245)	(1.228)
PropPOC	-0.160**	-0.0963	-0.0963	-0.0967	-0.168**	-0.166**	-0.166**	-0.159**	-0.166**
	(0.0695)	(0.0956)	(0.0950)	(0.0958)	(0.0713)	(0.0707)	(0.0710)	(0.0712)	(0.0712)
year	-1.077*	-1.667	-1.659	-1.649	-1.046*	-1.082*	-1.062*	-1.038*	-1.043*
	(0.616)	(2.505)	(2.696)	(2.721)	(0.605)	(0.611)	(0.608)	(0.604)	(0.608)
year2	0.000267*	0.000414	0.000412	0.000409	0.000259*	0.000268*	0.000264*	0.000257*	0.000259*
	(0.000153)	(0.000624)	(0.000671)	(0.000677)	(0.000151)	(0.000152)	(0.000151)	(0.000150)	(0.000151)
y2009	0.00366**	0.00707	0.00704	0.00705	0.00410**	0.00422**	0.00405**	0.00429**	0.00401**
	(0.00178)	(0.00629)	(0.00657)	(0.00619)	(0.00175)	(0.00175)	(0.00185)	(0.00173)	(0.00176)

VARIABLES	(1) MalesLabor Force	(2) MalesLabor Force	(3) MalesLabor Force	(4) MalesLabor Force	(5) MalesLabor Force	(6) MalesLabor Force	(7) MalesLabor Force	(8) MalesLabor Force	(9) MalesLabor Force
Constant	1,086*	1,679	1,672	1,662	1,054*	1,091*	1,071*	1,046*	1,052*
	(618.4)	(2,516)	(2,708)	(2,733)	(607.9)	(613.5)	(610.9)	(606.5)	(611.2)
Observations	1,236	665	665	665	1,236	1,236	1,236	1,236	1,236
R-squared	0.398	0.534	0.534	0.534	0.397	0.397	0.396	0.400	0.397
Number of geoid	169	164	164	164	169	169	169	169	169

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

15. Parent Labor Force Participation (ParentsLaborForce)

VARIABLES	(1) Parents LaborForce	(2) Parents LaborForce	(3) Parents LaborForce	(4) Parents LaborForce	(5) Parents LaborForce	(6) Parents LaborForce	(7) Parents LaborForce	(8) Parents LaborForce	(9) Parents LaborForce
brfss_general_health	0.0216								
	(0.0245)								
L2.brfss_general_health	0.0475*								
	(0.0280)								
brfss_heart_disease		-0.0805							
		(0.0945)							
L2.brfss_heart_disease		-0.0339							
		(0.125)							
L4.brfss_heart_disease		0.271***							
		(0.100)							
brfss_bphigh			0.0236						
			(0.0801)						
brfss_cholesterol				0.0220					
				(0.0675)					
brfss_obese					-0.0508***				
					(0.0177)				
brfss_diabetes						-0.0251			
						(0.0667)			
L2.brfss_diabetes						-0.0223			
						(0.0408)			
L4.brfss_diabetes						0.0319			
						(0.0504)			
L6.brfss_diabetes						0.106**			
						(0.0497)			
brfss_smoker							-0.0163		
							(0.0217)		
brfss_exercise								-0.00822	
								(0.0157)	
brfss_mental_health									-0.0146
									(0.0275)
college	0.0624	0.110	0.133	0.133	0.0711	0.0646	0.0720	0.0706	0.0713
	(0.0663)	(0.126)	(0.153)	(0.155)	(0.0607)	(0.105)	(0.0603)	(0.0608)	(0.0607)

VARIABLES	(1) Parents LaborForce	(2) Parents LaborForce	(3) Parents LaborForce	(4) Parents LaborForce	(5) Parents LaborForce	(6) Parents LaborForce	(7) Parents LaborForce	(8) Parents LaborForce	(9) Parents LaborForce
elderlyrate	0.283	0.350	0.365	0.359	0.155	0.0700	0.189	0.208	0.188
	(0.328)	(0.505)	(0.493)	(0.510)	(0.270)	(0.501)	(0.278)	(0.283)	(0.275)
elderly2	-2.050*	-1.753	-2.040**	-2.025**	-1.806**	-0.550	-1.880**	-1.927**	-1.866**
	(1.052)	(1.555)	(0.816)	(0.789)	(0.749)	(1.507)	(0.753)	(0.768)	(0.748)
PropPOC	-0.0543	0.0280	0.0875	0.0902	-0.0608	-0.0152	-0.0552	-0.0537	-0.0551
	(0.0637)	(0.0860)	(0.0576)	(0.0592)	(0.0607)	(0.189)	(0.0606)	(0.0605)	(0.0608)
year	-0.628	0.171	-1.387	-1.399	-0.699	-1.706	-0.737	-0.739	-0.732
	(0.460)		(2.460)	(2.495)	(0.489)	(4.144)	(0.498)	(0.498)	(0.502)
year2	0.000156	-4.31e-05	0.000344	0.000347	0.000173	0.000423	0.000183	0.000183	0.000182
	(0.000115)		(0.000612)	(0.000621)	(0.000122)	(0.00103)	(0.000124)	(0.000124)	(0.000125)
y2009	0.00338**	0.00354**	0.00570	0.00558	0.00364**	-0.000464	0.00342**	0.00367**	0.00359**
	(0.00148)	(0.00139)	(0.00597)	(0.00563)	(0.00143)	(0.00205)	(0.00147)	(0.00145)	(0.00145)
Constant	633.5	-169.1	1,398	1,410	704.7	1,719	743.1	745.0	738.7
	(462.0)		(2,471)	(2,506)	(491.0)	(4,168)	(499.7)	(500.7)	(503.9)
Observations	1,064	400	665	665	1,236	651	1,236	1,236	1,236
R-squared	0.415	0.402	0.570	0.570	0.444	0.405	0.440	0.439	0.440
Number of geoid	141	120	164	164	169	111	169	169	169

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

16. Female Parent Labor Force Participation (FemaleParLF)

VARIABLES	(1) FemaleParLF	(2) FemaleParLF	(3) FemaleParLF	(4) FemaleParLF	(5) FemaleParLF	(6) FemaleParLF	(7) FemaleParLF	(8) FemaleParLF	(9) FemaleParLF
brfss_general_health	0.000249								
	(0.0148)								
brfss_heart_disease		-0.0532							
		(0.0427)							
L2.brfss_heart_disease		-0.0414							
		(0.0658)							
L4.brfss_heart_disease		0.114***							
		(0.0154)							
brfss_bphigh			0.0243						
			(0.0495)						
brfss_cholesterol				0.0104					
				(0.0415)					
brfss_obese					-0.00759				
					(0.0109)				
brfss_diabetes						0.0271			
						(0.0221)			
brfss_smoker							-0.0212		
							(0.0134)		
brfss_exercise								-0.0128	
								(0.0101)	
brfss_mental_health									0.00517
									(0.0167)
college	-0.0137	-0.0169	-0.00437	-0.00514	-0.0138	-0.0131	-0.0126	-0.0145	-0.0138
	(0.0369)	(0.0746)	(0.0973)	(0.0966)	(0.0368)	(0.0369)	(0.0364)	(0.0370)	(0.0368)
elderlyrate	0.143	0.0403	0.240	0.229	0.136	0.150	0.130	0.157	0.147
	(0.162)	(0.298)	(0.300)	(0.304)	(0.160)	(0.164)	(0.160)	(0.164)	(0.161)
elderly2	-1.107**	-0.147	-1.133**	-1.089**	-1.092**	-1.138**	-1.074**	-1.141**	-1.121**
	(0.483)	(1.023)	(0.443)	(0.429)	(0.484)	(0.490)	(0.474)	(0.490)	(0.477)
PropPOC	-0.0142	0.0680*	0.0803**	0.0826**	-0.0151	-0.0145	-0.0148	-0.0126	-0.0141
	(0.0398)	(0.0389)	(0.0313)	(0.0320)	(0.0397)	(0.0399)	(0.0395)	(0.0396)	(0.0397)
year	-0.117	0.406	-0.554	-0.526	-0.111	-0.128	-0.110	-0.111	-0.121
	(0.219)		(1.552)	(1.530)	(0.214)	(0.225)	(0.212)	(0.214)	(0.221)
year2	2.90e-05	-0.000101	0.000137	0.000130	2.74e-05	3.15e-05	2.71e-05	2.74e-05	2.99e-05
	(5.45e-05)		(0.000386)	(0.000381)	(5.34e-05)	(5.60e-05)	(5.27e-05)	(5.33e-05)	(5.50e-05)

VARIABLES	(1) FemaleParLF	(2) FemaleParLF	(3) FemaleParLF	(4) FemaleParLF	(5) FemaleParLF	(6) FemaleParLF	(7) FemaleParLF	(8) FemaleParLF	(9) FemaleParLF
y2009	0.00231***	0.00233***	0.00375	0.00363	0.00231***	0.00238***	0.00203**	0.00236***	0.00233***
	(0.000792)	(0.000350)	(0.00376)	(0.00345)	(0.000783)	(0.000800)	(0.000810)	(0.000784)	(0.000797)
Constant	118.8	-406.7	558.2	529.9	112.1	129.1	111.0	112.3	122.4
	(219.8)		(1,559)	(1,537)	(215.3)	(225.9)	(212.6)	(215.2)	(222.0)
Observations	1,236	400	665	665	1,236	1,236	1,236	1,236	1,236
R-squared	0.233	0.269	0.334	0.332	0.233	0.234	0.236	0.234	0.233
Number of geoid	169	120	164	164	169	169	169	169	169

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

17. Male Parent Labor Force Participation (MalePareLF)

VARIABLES	(1) MaleParLF	(2) MaleParLF	(3) MaleParLF	(4) MaleParLF	(5) MaleParLF	(6) MaleParLF	(7) MaleParLF	(8) MaleParLF	(9) MaleParLF
brfss_general_health	0.0223*								
	(0.0134)								
brfss_heart_disease		-0.0273							
		(0.0602)							
L2.brfss_heart_disease		0.00746							
		(0.0751)							
L4.brfss_heart_disease		0.157*							
		(0.0800)							
brfss_bphigh			-0.000745						
			(0.0591)						
brfss_cholesterol				0.0116					
				(0.0527)					
brfss_obese					-0.0432***				
					(0.0128)				
brfss_diabetes						-0.0253			
						(0.0510)			
L2.brfss_diabetes						-0.0345			
						(0.0305)			
L4.brfss_diabetes						0.00657			
						(0.0268)			
L6.brfss_diabetes						0.0633**			
						(0.0274)			
brfss_smoker							0.00486		
							(0.0131)		
brfss_exercise								0.00460	
								(0.00997)	
brfss_mental_health									-0.0198
									(0.0165)
college	0.0859**	0.127**	0.138	0.138	0.0848**	0.0825	0.0846**	0.0851**	0.0851**
	(0.0351)	(0.0627)	(0.110)	(0.113)	(0.0350)	(0.0683)	(0.0351)	(0.0351)	(0.0351)
elderlyrate	0.0413	0.310	0.125	0.130	0.0191	-0.0263	0.0593	0.0515	0.0413
	(0.165)	(0.251)	(0.363)	(0.382)	(0.158)	(0.300)	(0.164)	(0.167)	(0.161)
elderly2	-0.747*	-1.606**	-0.907*	-0.936*	-0.714*	-0.189	-0.806**	-0.786**	-0.745*
	(0.383)	(0.696)	(0.548)	(0.529)	(0.368)	(0.931)	(0.384)	(0.386)	(0.379)

VARIABLES	(1) MaleParLF	(2) MaleParLF	(3) MaleParLF	(4) MaleParLF	(5) MaleParLF	(6) MaleParLF	(7) MaleParLF	(8) MaleParLF	(9) MaleParLF
PropPOC	-0.0380	-0.0400	0.00716	0.00761	-0.0457	-0.0434	-0.0404	-0.0411	-0.0411
	(0.0301)	(0.0591)	(0.0391)	(0.0408)	(0.0302)	(0.153)	(0.0305)	(0.0304)	(0.0304)
year	-0.631	-0.235	-0.833	-0.873	-0.588	-1.228	-0.627	-0.628	-0.611
	(0.448)	(0.984)	(1.907)	(1.970)	(0.433)	(3.520)	(0.445)	(0.442)	(0.443)
year2	0.000157	5.80e-05	0.000207	0.000217	0.000146	0.000305	0.000156	0.000156	0.000152
	(0.000112)	(0.000245)	(0.000475)	(0.000490)	(0.000108)	(0.000875)	(0.000111)	(0.000110)	(0.000110)
y2009	0.00113	0.00122	0.00195	0.00195	0.00132	-0.00105	0.00139	0.00130	0.00126
	(0.00110)	(0.00110)	(0.00460)	(0.00442)	(0.00108)	(0.00152)	(0.00111)	(0.00109)	(0.00109)
Constant	636.0	237.7	839.8	879.8	592.6	1,237	632.1	632.6	616.3
	(450.1)	(989.1)	(1,915)	(1,978)	(435.0)	(3,540)	(447.2)	(444.0)	(445.5)
Observations	1,236	400	665	665	1,236	651	1,236	1,236	1,236
R-squared	0.475	0.406	0.604	0.604	0.483	0.411	0.474	0.474	0.475
Number of geoid	169	120	164	164	169	111	169	169	169

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

Cluster analysis

We performed a cluster analysis of the metro areas in the data panel and examined the trajectories of those areas over a nine-year period using two snapshots in time (2007 and 2015) to determine how the relative population health of an area might affect changes in relative economic activity in that area, and vice versa. This type of analysis enabled us to examine the relationship between regional population health and economic activity in a way that differs from regression analysis. Whereas the regression analysis focused on statistical associations between indicators of population health and indicators of economic activity, the k-means cluster analysis places metro areas into groups, taking into consideration both their relative population health and relative economic activity, and then examines how the metro areas in each group change over time.

Forming the clusters

We formed clusters of metro areas, using eight indicators of population health (self-reported general health "good" or better; rates of heart disease, high blood, high cholesterol, obesity, diabetes, smoking, and exercise) and three indicators of economic activity (GMP per capita, real median household income, and the employment to population ratio[3]). We used the k-means method for our cluster analysis; this procedure successfully produced two meaningful and interpretable clusters for both the economic activity and population health variables. F-tests confirmed that each of these clusters were statistically different from one another.

Based on the results of the cluster analysis, we placed metro areas into two groups with respect to population health: "better population health" and "worse population health." Similarly, based on the results of the cluster analysis, we placed metro areas into two groups related to economic activity: "higher economic activity" and "lower economic activity."

Our cluster analysis included only metro areas (n=76) that had complete data in both 2007 and 2015 for the eight population health indicators and the three economic activity indicators that served as the basis for the clustering.

[3] This differs from the labor force participation indicators used in the regression analyses. It is the ratio of employed people of working age to the total population of working age. Some of our advisors consider this a stronger measure of long-term change at two points in time.

18. Economic activity indicators, 2007 and 2015, by cluster

			Real per capita GMP	Real median household income	Employment to population ratio (age 16-64)[4]
2015	Lower economic activity	Median	67,606.19	51,352.19	0.6885
		Mean	67,863.93	51,719.26	0.6857
		N	41	41	41
		Std. Deviation	10,108.36	4,626.74	0.0276
		Minimum	43,323.98	42,958.08	0.6200
		Maximum	87,631.38	64,190.23	0.7300
	Higher economic activity	Median	89,155.39	62,215.15	0.7262
		Mean	89,296.10	64,142.83	0.7303
		N	35	35	35
		Std. Deviation	12,436.27	9,011.96	0.0258
		Minimum	61,993.63	51,648.45	0.6800
		Maximum	120,206.23	92,335.18	0.7800
2007	Lower economic activity	Median	68,939.21	38,875.49	0.6878
		Mean	67,894.36	39,578.13	0.6855
		N	27	27	27
		Std. Deviation	10,482.06	3,764.00	0.0238
		Minimum	47,151.39	29,027.03	0.6100
		Maximum	91,937.05	49,069.51	0.7200
	Higher economic activity	Median	82,835.06	46,477.81	0.7279
		Mean	83,552.54	47,972.73	0.7303
		N	49	49	49
		Std. Deviation	12,964.22	5,593.32	0.0249
		Minimum	59,454.97	41,294.41	0.6800
		Maximum	115,963.47	69,975.88	0.8000

[4] See footnote on previous page regarding this indicator.

19. Population health indicators, 2007 and 2015, by cluster

			Cholesterol	Diabetes	Exercise	General health	Heart disease	High blood pressure	Obesity	Smoking
2015	Worse population health	Median	0.36592	0.10547	0.72958	0.82826	0.0403	0.3325	0.30725	0.18032
		Mean	0.36907	0.11044	0.72608	0.82665	0.04042	0.3364	0.30647	0.18185
		N	46	46	46	46	46	46	46	46
		Std. Deviation	0.019717	0.014609	0.033166	0.027774	0.007719	0.033206	0.028278	0.032647
		Minimum	0.327	0.088	0.649	0.762	0.023	0.274	0.248	0.127
		Maximum	0.417	0.157	0.792	0.87	0.06	0.43	0.373	0.278
	Better population health	Median	0.34162	0.08227	0.79546	0.86673	0.03383	0.27885	0.24425	0.13989
		Mean	0.34324	0.08448	0.79185	0.86006	0.03203	0.27847	0.24913	0.1426
		N	30	30	30	30	30	30	30	30
		Std. Deviation	0.026849	0.015457	0.029829	0.028416	0.008005	0.029371	0.030354	0.033026
		Minimum	0.282	0.054	0.714	0.805	0.014	0.191	0.182	0.048
		Maximum	0.404	0.121	0.838	0.912	0.047	0.326	0.295	0.207
2007	Worse population health	Median	0.37379	0.08633	0.76558	0.84469	0.03999	0.27695	0.26009	0.20284
		Mean	0.3743	0.08764	0.76347	0.84413	0.0403	0.27838	0.26357	0.20337
		N	53	53	53	53	53	53	53	53
		Std. Deviation	0.023591	0.012958	0.028979	0.024374	0.008014	0.026493	0.024643	0.026502
		Minimum	0.318	0.066	0.696	0.764	0.022	0.229	0.216	0.142
		Maximum	0.423	0.146	0.82	0.893	0.062	0.341	0.346	0.288
	Better population health	Median	0.35047	0.06479	0.82313	0.88298	0.03216	0.24204	0.21042	0.16044
		Mean	0.34939	0.06295	0.82383	0.88534	0.03179	0.23246	0.21393	0.16237
		N	23	23	23	23	23	23	23	23
		Std. Deviation	0.022125	0.009822	0.020088	0.019779	0.007091	0.027866	0.030503	0.036477
		Minimum	0.3	0.046	0.79	0.849	0.018	0.162	0.135	0.065
		Maximum	0.384	0.082	0.868	0.928	0.047	0.268	0.261	0.213

20. MSA movement between clusters, 2007 to 2015

		MSA cluster location: 2015				
		Lower economic activity + worse population health	Lower economic activity + better population health	Higher economic activity + worse population health	Higher economic activity + better population health	**Total**
MSA cluster location: 2007	Lower economic activity + worse population health	21	2	1	0	24
	Lower economic activity + better population health	0	3	0	0	3
	Higher economic activity + worse population health	9	3	13	4	29
	Higher economic activity + better population health	1	2	1	16	20
Total		**31**	**10**	**15**	**20**	**76**

NETS Data Analysis

In the National Establishment Time Series Database there were 564 recorded headquarters moves in 2013 among firms with 100 or more employees. We removed 24 records that had missing data. We also removed an additional 118 records that were to areas not included in our cluster analysis. As a result, we were able to analyze 422 out of 564 records, which comprised (75%) of the total headquarters moves that occurred.

21. Counts of headquarters moves in 2013 by destination for each cluster analysis category

	Headquarters moves to new MSA	Headquarters moves to same MSA
Higher economic activity, Better population health category	71	131
Higher economic activity, Worse population health category	41	81
Lower economic activity, Worse population health category	49	31
Lower economic activity, Better population health category	15	3

Wilder Research

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DECEMBER 2019