Moody's
ANALYTICS

November 2016

Healthy People, Healthy Economies

PREPARED FOR BLUE CROSS BLUE SHIELD ASSOCIATION

Contacts

Daniel White
Senior Economist
+610.235.5249

Adam Ozimek
Economist
+610.235.5127

Contact Information

Client Services

Representatives are available: 7AM to 7PM EST (12PM-12AM GMT), Mon-Fri. Email help@economy.com or contact us at a location below:

U.S. & Canada				+1.866.275.3266 or +1.610.235.5299
EMEA	(London)	+44.20.7772.1646	(Prague)	+420.224.222.929
Asia/Pacific				+61.2.9270.8111

Worldwide Offices

West Chester 121 N. Walnut St., Suite 500, West Chester PA 19380	+1.610.235.5000
United Kingdom One Canada Square, Canary Wharf, London E14 5FA	+44.20.7772.5454
Australia Level 10, 1 O'Connell Street, Sydney, NSW, 2000 Australia	+61.2.9270.8111
Prague Washingtonova 17, 110 00 Prague 1, Czech Republic	+420.224.222.929

Events

Economic Outlook Conference

Our two-day flagship event, providing comprehensive insight on all the components that drive macro and regional economies.

Philadelphia PA	May 2017

Regional Economic Outlook Conference

A full day event, providing comprehensive insight on the components that drive regional economies.

West Chester PA	November 1, 2016

Visit www.economy.com/events for listings, details and registration.

Economic Briefings

Half- and full-day events designed to provide comprehensive insight on the macro and regional economies.

Regional Economic Briefings

Half-day events designed to provide detailed insight into an individual area's current and expected economic conditions.

Speaking Engagements

Economists at Moody's Analytics are available for your engagement. Our team of economists has extensive experience in making presentations on a variety of topics, including: macro outlook, consumer outlook, credit cycles, banking, housing/real estate, stress testing, sovereign credit, and regional economies. Contact us for more information.

Products & Services

This section provides information on a subset of solutions from Moody's Analytics. Visit moodysanalytics.com for a full listing of all solutions offered by the company.

Economic Forecast Databases

Global Macro Forecast Database*
Global Metropolitan Areas Forecast Database
U.S. Macro Forecast Database*
U.S. State Forecast Database*
U.S. Metropolitan Areas Forecast Database*
U.S. State & Metro Detailed Employment Forecast Database
U.S. County Forecast Database
U.S. County Detailed Employment Forecast Database
Case-Shiller® Home Price Indexes* (U.S.)
CreditForecast.com* (U.S.)
Forecasts of RCA CPPI™
Housing Stock Forecast Database (U.S.)
RealtyTrac Foreclosures (U.S.)

**With Alternative Scenarios*

Economic Historical Databases

Global National & Subnational Database
U.S. National & Regional Database
American Bankers Association Delinquency Database (U.S.)
Case-Shiller® Home Price Indexes (U.S.)
CoreLogic Home Price Indexes (U.S)
CreditForecast.com (U.S.)
LPS Home Price Indexes (U.S.)
National Association of Realtors:
- Pending Home Sales (U.S.)
- Monthly Supply of Homes (U.S.)

Data packages can be customized to clients' geographic areas of interest.

Economic Models & Workstations

U.S. Macro & State Model
U.S. Regional Workstation
World Workstation
Moody's CreditCycle™

Economic Research

Economy.com (Global)
Précis® Macro (U.S.)
Précis® Metro (U.S.)
Précis® State (U.S.)
Regional Financial Review®

Economic Advisory Services

Client Presentations
Consumer Credit Analytics
Credit Risk Management
Custom Scenarios
Economic Development Analysis
Market Analysis
Product Line Forecasting
Stress-Testing

Healthy People, Healthy Economies

Researchers and economists have long held a strong relationship between the health of a population and the health of an economy. This study aims to confirm the statistical relationship between those two concepts, as well as gain insight into any causal relationships that might exist. However, this study focuses solely on establishing a statistical foundation for that relationship, using a new groundbreaking health metric from Blue Cross Blue Shield. The Blue Cross Blue Shield (BCBS) Health Index provides a detailed and data-driven way to measure health across the U.S. The Health Index captures the relative health of nearly every county in the U.S. using rigorous statistical analysis and health insurance data from millions of members. This new measure has tremendous potential to help academics, policymakers and the industry better understand how health affects a variety of outcomes at the local level. In particular, it can help develop a better understanding of how a healthy population is related to a strong local economy.

Understanding the Health Index

The BCBS Health Index data analyzed by Moody's Analytics is derived from administrative health records from 27 million BCBS members in 2015.[1] The administrative records allow detailed and thorough measurement of current and past medical conditions for each member. These conditions are combined with disability information from the Institute of Health Metrics and Evaluation and cause of death information from the Centers for Disease Control to create disability and mortality scores.

Mortality and disability scores are combined to create an overall Health Index.

Numerically, the Health Index is equal to the ratio of expected remaining healthy years of life (after accounting for any mortality risk or disability) divided by the number of years that an individual would have under optimal health. The more healthy years of life that are lost because of medical conditions, the lower the Health Index.

For example, consider an individual whose current medical conditions and age imply 27 years of healthy life remaining but who would have 30 years under optimal health. The Health Index would be 0.9 (27/30), because 10% of the remaining years of healthy life are expected to be lost to mortality and disability. If instead that individual had 28.5 expected years of healthy life remaining, the Health Index would be 0.95 (28.5/30), suggesting a 5% loss due to health conditions.

Data coverage

The data analyzed by Moody's Analytics include average Health Indexes, mortality scores, and disability scores at the county level for the year 2015. The 27 million full-year members represent 8.5% of the population in the 3,083 U.S. counties for which health score and population data are available. Health indexes are available in all 50 states and the District of Columbia, with a wide range of coverage ratios. The wide range of coverage is controlled in this analysis by weighting geographies based on the number of persons covered. This helps eliminate potential distortions in the findings from counties with relatively low member counts.

The level of coverage in a county is related to the poverty rate in the county. An increase in county poverty of 1 percentage point decreases BCBS health coverage by 0.3 percentage point. However, when the percentage of the population without insurance is controlled for, poverty becomes statistically insignificant. This suggests that an overall lack of health insurance is why higher-poverty counties have less coverage in the BCBS data. Personal income, average pay, and median household income are not statistically related to coverage.

Wide disparities in outcomes

The average and median county Health Index is 0.925. County Health Indexes range from 0.86 to 0.97, however this wide range reflects a handful of outliers that arise from small sample sizes. A better measure of the range of outcomes is the difference between the 10th and 90th percentiles, which are 0.907 and 0.942, respectively (see Table 1). This means the residents of the county with the 90th percentile of Health Index can expect 3.5 percentage points more healthy years of life than those in the 10th percentile.

The difference in healthcare costs in healthy and less healthy counties provides a measure of the economic importance of this disparity. In a county in the 90th percentile of Health Index, average healthcare costs

1 The data are restricted to individuals who were members for the full year.

as provided by BCBS are 6% lower than for a county in the 10th percentile.

Among the 100 largest counties in the U.S., the average Health Index is 0.922, slightly lower than the overall average. Among these counties, the lowest Health Index is in Pinellas County FL, with a Health Index of 0.89 and the healthiest is Santa Clara County CA with a Health Index of 0.95.

Geographically, Health Indexes tend to cluster strongly and exhibit a clear spatial pattern. Health indexes are lower in the Southeast and up through the Atlantic and even the Northeast. The Midwest, Central and Mountain states are healthier (see Chart 1).

Table 1: Range of Outcomes for Health Scores

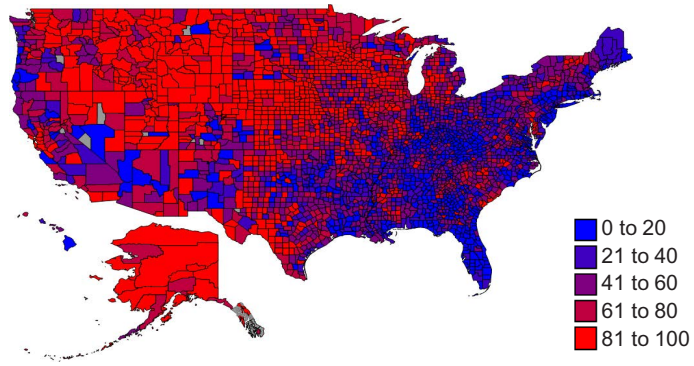
County percentiles, weighted by member count

Percentile	Health score	Mortality score	Disability score
10th	0.907	0.017	0.045
25th	0.916	0.021	0.050
50th	0.925	0.025	0.056
75th	0.934	0.029	0.063
90th	0.942	0.033	0.069

Sources: BCBS, Moody's Analytics

Chart 1: Lower Health Scores in South and East

Health score percentile



Sources: BCBS, Moody's Analytics

Healthy population and a strong economy

A wide literature suggests that the healthiness of a population should be related to the performance of the local economy. There are a variety of ways that health can contribute to the economy, and in turn many ways that the economy can contribute to health outcomes.

The most direct connection between health and the economy is that healthier populations mean healthier workers, and healthier workers, in turn, are likely to be more productive and employed. Poor health weighs on physical and mental strength that are essential to job performance in many occupations.

Less healthy workers are also more likely to have more frequent absences from work, which will further hurt productivity and pay. In addition, when poor health causes longer absences from the workforce, this can lead to the deterioration of job skills and trouble getting re-employed. For example, research has shown that workers who leave the labor force in order to apply for disability insurance later struggle to find work even if they do not end up qualifying for disability.[2]

Finally, mental and physical health can affect the accumulation of education and other skills. Just as poor health can cause significant absences from work, it can do the same for school. Research has shown that children who sustain major injuries have statistically significantly worse educational outcomes compared to unaffected siblings.[3] In addition to physical health, mental health contributes to success in school, which can increase educational and skill attainment. For example, children diagnosed with ADHD or conduct disorder have a literacy score that is half a standard deviation lower than unaffected siblings.[4]

While better health is likely to contribute to positive outcomes in the local economy, the effects likely go both ways. A strong economy means better jobs, which are more likely to provide health insurance. Higher pay also makes investment in education easier, which in turn improves health and income. For example, research has shown that compulsory schooling laws increased health and life expectancy.[5]

Healthier populations contribute to a stronger local economy, and a stronger local economy contributes to a healthier population. An important step in understanding this relationship is measuring the correlation between the two.

Empirical evidence

There are many plausible ways in which local economic conditions and healthy populations are related, but the BCBS data allow these relationships to be empirically quantified. Regression analysis was used to test for statistically significant relationships between the BCBS Health Index and various economic measures. These economic variables were tested, each in 2015 levels:

- Unemployment rate
- Income per capita
- GDP per capita
- Poverty rate
- Average annual pay

2 D. Autor, N. Maestas, K.J. Mullen, and A. Strand, "Does Delay Cause Decay? The Effect of Administrative Decision Time on the Labor Force Participation and Earnings of Disability Applicants," National Bureau of Economic Research working paper No. w20840, 2015.

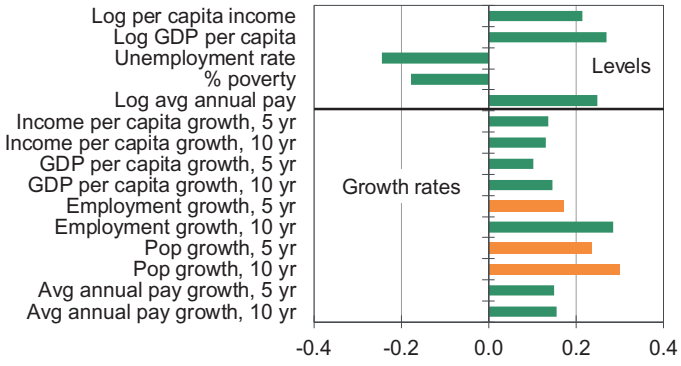
3 Currie, Janet, et al. "Child Health and Young Adult Outcomes," *Journal of Human Resources* 45.3 (2010): 517-548.

4 Ibid.

5 Philip Oreopoulos, "Do Dropouts Drop Out Too Soon? Wealth, Health and Happiness From Compulsory Schooling," *Journal of Public Economics* 91.11 (2007): 2213-2229.

Chart 2: Health Linked to Positive Outcomes

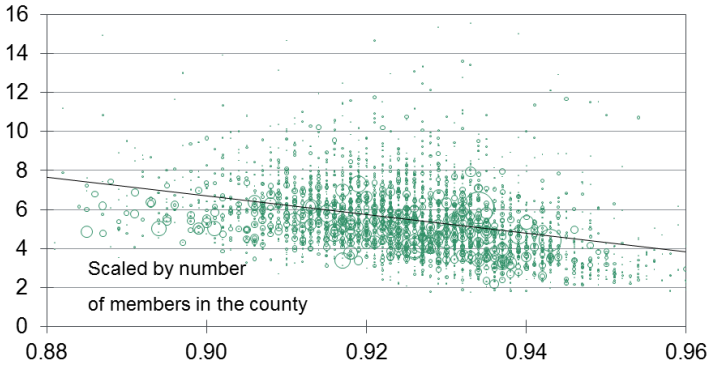
Pearson correlation (green=statistically significant, p<0.05%)



Sources: BCBS, Moody's Analytics

Chart 3: Unemployment Falls, Health Score Rises

X-axis: health score; Y-axis: unemployment rate



Sources: BLS, BCBS, Moody's Analytics

In addition to being associated with levels of outcomes, Health Indexes are associated with economic growth rates for a variety of reasons. This could occur if the healthiness of a population has changed over time and the effects take many years to fully affect the economy. Growth rates may also be associated with health if the relationship between health and the economy has become more important over time. Also, an association with growth rates may indicate that the recovery from the Great Recession has been stronger in healthier places.

These economic outcomes were also tested on five- and 10-year growth rates to 2015:

- Income per capita
- GDP per capita
- Employment
- Population
- Average annual pay

Regression analysis using only two variables measures whether they have a statistically significant relationship and also quantifies how strong the relationship is.[6] Each of the level variables has a statistically significant relationship with Health Index (see Appendix 1.1 for more statistical details). With the exception of population and five-year employment, the growth variables also have a statistically significant relationship with Health Index (see Chart 2).

Table 2: Effect of Two Standard Deviation Improvement in Health Score

Raw regression, no controls

Outcome	Health score = 0.925	Health score = 0.953	Difference
Level outcomes			
Per capita income	$45,326	$49,060	$3,734
GDP per capita	$44,836	$54,676	$9,839
Unemployment rate	5.2%	4.6%	-0.6%
Poverty	14.9%	13.7%	-1.2%
Avg annual pay	$44,188	$49,490	$5,302
Growth outcomes			
Income per capita growth, 5 yr	17.5%	19.3%	1.7%
Income per capita growth, 10 yr	33.5%	37.1%	3.6%
GDP per capita growth, 5 yr	5.7%	7.9%	2.2%
GDP per capita growth, 10 yr	4.3%	10.2%	5.9%
Employment growth, 5 yr	6.4%	9.0%	2.6%
Employment growth, 10 yr	6.0%	13.9%	7.9%
Pop growth, 5 yr	3.9%	6.5%	2.6%
Pop growth, 10 yr	9.8%	16.7%	6.9%
Avg annual pay growth, 5 yr	13.3%	15.1%	1.7%
Avg annual pay growth, 10 yr	29.6%	33.4%	3.7%

Sources: BCBS, Moody's Analytics

The scale shows how much each outcome changes when Health Index increases by one standard deviation. For example, when the Health Index increases by one standard deviation, the unemployment rate on average falls by a quarter of a standard deviation (see Chart 3).

A more intuitive comparison of the results can be made by showing what local economic outcomes would be associated with going from an average county to one of the healthiest counties.

Table 2 shows the improvement in economic outcomes that would be associ-

6 Equations were estimated using least squares regression techniques and relied on regression weights based on the number of full-year members in each county. The use of either county population weights or a geometric mean of county population and member weight did not notably alter the results. Standard errors were clustered at the state level.

ated with taking the average county and improving the Health Index by two standard deviations. The average county Health Index is 0.925. Increasing this by two standard deviations would take a county to 0.953, an increase of healthy years of 3 percentage points that would put it in the 99th percentile of healthiness.

For example, the average county unemployment rate is 5.2%, and an increase in the Health Index by two standard deviations would be associated with a 0.6-percentage point decline in unemployment and an increase in per capita GDP of more than $9,000. It would also be associated with significant improvement in growth rates, including pay growth over the last five years of 15.1% instead of 13.3%. The average worker would earn $5,302 more per year in a healthier county.

Table 3: Effect of Two Standard Deviation Improvement in Health Score
Model 4 controls

Outcome	Health score = 0.925	Health score = 0.953	Difference
Level outcomes			
Per capita income	$45,326	$47,797	$2,472
GDP per capita	$44,836	$48,678	$3,842
Unemployment rate	5.2%	4.9%	-0.2%
Poverty	14.9%	14.9%	Insignificant
Avg annual pay	$44,188	$47,515	$3,327
Growth outcomes			
Income per capita growth, 5 yr	17.5%	19.0%	1.5%
Income per capita growth, 10 yr	33.5%	35.9%	2.5%
GDP per capita growth, 5 yr	5.7%	7.0%	1.3%
GDP per capita growth, 10 yr	4.3%	4.3%	Insignificant
Employment growth, 5 yr	6.4%	9.5%	3.1%
Employment growth, 10 yr	6.0%	12.4%	6.4%
Pop growth, 5 yr	3.9%	6.4%	2.5%
Pop growth, 10 yr	9.8%	15.7%	6.0%
Avg annual pay growth, 5 yr	13.3%	14.5%	1.2%
Avg annual pay growth, 10 yr	29.6%	29.6%	Insignificant

Sources: BCBS, Moody's Analytics

Controlling for other factors

The association between health and outcomes for the local economy is valuable to measure in and of itself. But this does not prove that health causes those positive outcomes. Proving causality in this context is a difficult empirical task. However, if it can be shown that health and economic outcomes have a statistically significant relationship even after controlling for other factors, it makes it more likely that the effect being measured is causal.

A variety of demographic factors that may be contributing to both health and economic outcomes can be controlled for. Based in part on work by Chetty et al., we implemented a set of demographic controls, including characteristics such as age, race, population density and social capital, to help further refine the results.[7]

In addition to demographics, state fixed effects were utilized as a control. This approach estimates the models using differences from state averages for every dependent and independent variable. This means that the model uses only differences between counties within the same state and avoids any potentially important omitted variables that may vary by state. For example, Massachusetts has the 10th lowest Health Index despite having the fifth highest life expectancy at birth.[8] Some of the disparity is likely due to differences in health insurance coverage that arise from state policy, which can be controlled by implementing state fixed effects.

Several economic controls were also tested on the data across a variety of categories, but these risked masking important channels through which health affects the economy. For example, one economic control is the share of the adult population with less than a high school education. Educational attainment contributes to both health and economic outcomes, making it an intuitive choice for a control. However, there are two problems with this.

First, one of the ways that better health can affect income is by improving educational attainment, and controlling for education would remove this effect. Second, education is an important determinant of health, which means that controlling for education means removing much of the variation in health outcomes between counties. A full and detailed technical explanation of those additional controls and the results from those models can be found in Appendix 1.1. The demographics and state fixed effects model, Model 4 in Appendix 1.2, is preferred. However because this leans toward undercontrolling, it can be useful to consider the results from other variations of the model that control for economic factors also.

Most variables remain statistically significant even under the demographic controls and state fixed effects. The unemployment rate and average annual pay show strong relationships. These two variables measure outcomes for people who are in the labor force, which may be why they appear to have the most robust relationship to health as measured for the insured population.

The poverty rate, on the other hand, proves insignificant. This is largely due to the demographics of the sample group. Because many in poverty lack private health insurance, the BCBS data, estimated solely from those individuals with private health insurance, fall short as a proxy for this population.

Table 3 shows how these results translate into economic outcomes associated with a two standard deviation change in health

7 Raj Chetty, et al. "The Association Between Income and Life Expectancy in the United States, 2001-2014," *Journal of the American Medical Association* 315.16 (2016): 1750-1766.

8 http://kff.org/other/state-indicator/life-expectancy/

outcomes. Controlling for demographics and state fixed effects, a higher Health Index corresponds to an increase in average annual pay of $3,300 and a 0.2% decline in the unemployment rate.

The effect of health on growth rates is more robust. Eight out of 10 growth measures are statistically significant even in models that include state fixed effects and demographic controls. Five-year growth rates are generally more significant than 10-year growth rates. Importantly, six out of 10 growth measures also remain significant even after including economic controls.

Table 3 shows that a two standard deviation increase in the Health Index is associated with a 2.5-percentage point increase in five-year population growth, and a 1.5-percentage point increase in five-year income per capita growth.

The more robust results for growth rates than for levels are consistent with multiple theories. First, healthiness of a population may be gaining importance relative to economic outcomes. For example, a healthy population may help ease a local economy's adjustment to structural changes in the industrial, behavioral or socioeconomic landscape. This would mean that some areas are below average on economic outcomes but have above-average Health Indexes that are helping them catch up economically.

Additionally, healthy populations may be especially important for helping economies recover more quickly from economic shocks. The recovery from the Great Recession is not finished in some areas, and those that are farther along may be attracting healthier people to their workforces.

Disability, mortality and individual conditions

Regression models were also used to measure how strongly disability and mortality scores were associated with economic outcomes. The results are generally consistent with the analysis using Health Indexes (see Appendix 1.3 and Appendix 1.4). Disability and mortality have a statistically significant and economically meaningful association with the local economy. Including controls generally reduces the significance and the magnitude of the effect, but disability and mortality remain statistically significantly related to many economic outcomes. Growth rates again tend to have a more robust relationship than levels.

The BCBS data also provide county-level detail on the prevalence of specific groups of health conditions and a measure of the importance of these conditions in determining the Health Index. The effect of these individual conditions on the local economy was also tested using the regression models (see Appendix 1.5 and Appendix 1.6).[9] In general, individual conditions have a weaker relationship than the overall Health Indexes, disability scores, and mortality scores. Some conditions have the opposite effect as expected, with higher pay associated with worse health. For example, hyperactivity-related conditions are more prevalent in areas with higher average annual pay, regardless of whether or not demographics and statewide controls were included in the model. This is likely because higher-income households are more likely to seek treatment and diagnosis for some conditions, rather than the conditions causing higher income.

The mixed results for conditions validate the importance of BCBS efforts to create a single Health Index that summarizes across all conditions into a single measure.

Conclusion

Overall, the BCBS data clearly indicate that healthy populations are related to strong local economies. Where populations are healthier, we observe lower unemployment, higher income, and higher pay. Moving from a county of average health to the 99th percentile is associated with an increase in average annual pay of $5,302 and a 0.6-percentage point decline in the unemployment rate.

Even after controlling for demographics and statewide factors, the correlation is robust for most outcomes. The association between health and growth is even stronger. Healthier areas tend to have faster job growth, population growth, and income growth even compared with areas with similar demographics within the same state.

The results do not prove a causal relationship between healthy populations and strong local economies. However, the robustness of many measures to demographic controls and state fixed effects does give more reason to suspect a causal relationship may exist.

9 Reported models include the baseline, with no controls, and the preferred model, which incorporates demographic controls and state fixed effects but not economic controls.

Appendix

Appendix 1.1: Selection of Controls

The association between health and outcomes for the local economy is valuable to measure in and of itself. But this does not prove that health causes those positive outcomes. Proving causality in this context is a difficult empirical task. However, if it can be shown that health and other outcomes have a statistically significant relationship even after controlling for other factors, it makes it more likely that the effect being measured is causal. Three sets of controls were derived for use in this analysis; demographic, economic and state fixed effects.

A variety of demographic factors that may be contributing to health and economic outcomes can be controlled for. The following set of county-level demographic controls were included in the regression models: percentage of the population that is white, percentage of the population that is black, percentage of the population that is Hispanic, percentage of the population that is foreign born, population density, total population, percentage of the population under age 19, percentage of the population over age 65, and share of the population that is religious. Further, a social capital index is taken from Chetty et al that combines voter turnout, the percent of individuals who return census forms, and participation in community organizations.[1]

The economic controls utilized include household size, the share of children with single mothers, percentage of the population without health insurance, percentage of population in BCBS data, share of employment in manufacturing, share of adult population with less than a high school degree, share of adult population with a college degree or more, and median household income.

Finally, state fixed effects were utilized as an additional control. This approach estimates the models using differences from state averages for every dependent and independent variable. This means that the model uses only differences between counties within the same state and avoids any potentially important omitted variables that may vary by state.

It is useful to examine whether the relationship between healthcare and the local economy is robust to the inclusion of demographic, economic and state fixed-effect controls. However, the economic controls prove problematic because they also represent potential mechanisms through which health affects the economy and therefore their inclusion may bias the results toward observing no effect. For example, health may improve income by increasing educational attainment. If educational attainment is controlled for, then this effect of health on the economy will be missed.

In addition, some controls, such as median house prices, may be so strongly related to income that they act as proxies and remove the majority of the useful variation in income from county to county.

The tradeoff between controlling for relevant variables and potentially biasing the result toward observing no effect illustrates the econometric challenge of identifying the causal effect of health on the local economy.

Appendix 1.2 displays the results of the five regression models, including the baseline model with no controls. Model 4, which excludes economic controls but includes demographics and state fixed effects, is the preferred model because it likely represents the best trade-off between including relevant controls without including too many controls.

1 Raj Chetty, et al. "The Association Between Income and Life Expectancy in the United States, 2001-2014," *Journal of the American Medical Association* 315.16 (2016): 1750-1766.

Appendix 1.2: Health Score

	Model 1	Model 2	Model 3	Model 4	Model 5
Level outcomes					
Log per capita income	0.214**	0.070	-0.054	0.168*	-0.007
Log GDP per capita	0.269***	0.074	0.024	0.116**	0.018
Unemployment rate	-0.245***	-0.038	0.052	-0.115**	-0.036
% poverty	-0.177**	-0.055	0.030	-0.070	0.013
Log avg annual pay	0.248**	0.069	-0.020	0.150**	0.076
Growth outcomes					
Income per capita growth, 5 yr	0.136***	0.100*	0.080	0.126***	0.098*
Income per capita growth, 10 yr	0.131*	0.008	0.052	0.083*	0.085
GDP per capita growth, 5 yr	0.102**	0.035	0.027	0.053*	0.048
GDP per capita growth, 10 yr	0.145*	-0.023	-0.007	0.010	0.002
Employment growth, 5 yr	0.172	0.178*	0.124*	0.231***	0.199***
Employment growth, 10 yr	0.285*	0.182*	0.142**	0.260***	0.234***
Pop growth, 5 yr	0.236	0.158	0.079	0.263***	0.205***
Pop growth, 10 yr	0.299	0.252*	0.144*	0.303***	0.244***
Avg annual pay growth	0.150***	0.078*	0.079*	0.105***	0.088*
Avg annual pay growth	0.155***	0.002	0.013	0.041	0.024
Demographic controls		X	X	X	X
Economic controls			X		X
State fixed effect				X	X

P-values: * <0.05, ** <0.01, *** <0.001.

Notes: All dependent variable and health scores standardized to z-scores. Member count is used as the regression weights, and errors are clustered at the state level. Demographic controls include % white, % black, % Hispanic, % foreign born, log population density, log population density squared, log of population, % of population ages 1 to 19, % of population aged 65 and up, social capital index, % religious. Economic controls include household size, single mother % of families, % with health insurance, % of population BCBS members, % of employment in manufacturing, and log median household income.

Sources: BCBS, Moody's Analytics

Appendix 1.3: Mortality Score

	Model 1	Model 2	Model 3	Model 4	Model 5
Level outcomes					
Log per capita income	-0.266**	-0.132	0.078	-0.265**	0.014
Log GDP per capita	-0.271***	-0.082*	-0.009	-0.126**	0
Unemployment rate	0.277**	0.032	-0.082	0.154***	0.038
% poverty	0.266***	0.097*	-0.036	0.166**	-0.001
Log avg annual pay	-0.247**	-0.075	0.054	-0.137**	-0.025
Growth outcomes					
Income per capita growth, 5 yr	-0.107***	-0.072	-0.053	-0.097***	-0.061
Income per capita growth, 10 yr	-0.102	0.019	-0.012	-0.03	-0.017
GDP per capita growth, 5 yr	-0.075**	0.011	0.018	-0.02	-0.002
GDP per capita growth, 10 yr	-0.126*	0.047	0.044	0.013	0.044
Employment growth, 5 yr	-0.121	-0.137	-0.061	-0.205***	-0.145***
Employment growth, 10 yr	-0.237	-0.174	-0.098	-0.255***	-0.185***
Pop growth, 5 yr	-0.199	-0.157	-0.02	-0.275***	-0.154***
Pop growth, 10 yr	-0.275	-0.294*	-0.125	-0.343***	-0.214***
Avg annual pay growth	-0.132***	-0.058	-0.054	-0.086**	-0.054
Avg annual pay growth	-0.132***	0.017	0.027	-0.005	0.041
Demographic controls		X	X	X	X
Economic controls			X		X
State fixed effects				X	X

P-values: * <0.05, ** <0.01, *** <0.001. Green highlights indicate statistical significance.

Notes: All dependent variable and mortality score standardized to z-scores. Member count is used as the regression weights, and errors are clustered at the state level. Demographic controls include % white, % black, % Hispanic, % foreign born, log population density, log population density squared, log of population, % of population ages 1 to 19, % of population aged 65 and up, social capital index, % religious. Economic controls include household size, single mother % of families, % with health insurance, % of population BCBS members, % of employment in manufacturing, and log median household income.

Sources: BCBS, Moody's Analytics

Appendix 1.4: Disability Score

	Model 1	Model 2	Model 3	Model 4	Model 5
Level outcomes					
Log per capita income	-0.167*	-0.033	0.037	-0.112	0
Log GDP per capita	-0.251***	-0.067	-0.032	-0.104**	-0.025
Unemployment rate	0.215***	0.033	-0.036	0.087*	0.032
% poverty	0.115	0.025	-0.027	0.021	-0.018
Log avg annual pay	-0.231**	-0.066	-0.001	-0.148***	-0.093
Growth outcomes					
Income per capita growth, 5 yr	-0.150***	-0.111**	-0.091*	-0.130***	-0.106*
Income per capita growth, 10 yr	-0.147*	-0.024	-0.071	-0.099*	-0.105*
GDP per capita growth, 5 yr	-0.117**	-0.060*	-0.05	-0.068*	-0.067
GDP per capita growth, 10 yr	-0.152*	0.007	-0.012	-0.022	-0.022
Employment growth, 5 yr	-0.191	-0.183*	-0.146*	-0.225***	-0.209***
Employment growth, 10 yr	-0.299**	-0.173*	-0.159***	-0.244***	-0.243***
Pop growth, 5 yr	-0.241	-0.139	-0.103	-0.233***	-0.210***
Pop growth, 10 yr	-0.297	-0.209	-0.147*	-0.256***	-0.240***
Avg annual pay growth	-0.156***	-0.087**	-0.090**	-0.108***	-0.098**
Avg annual pay growth	-0.163***	-0.012	-0.032	-0.056	-0.05
Demographic controls		X	X	X	X
Economic controls			X		X
State fixed effects				X	X

P-values: * <0.05, ** <0.01, *** <0.001. Green highlights indicate statistical significance.

Notes: All dependent variable and disability score standardized to z-scores. Member count is used as the regression weights, and errors are clustered at the state level. Demographic controls include % white, % black, % Hispanic, % foreign born, log population density, log population density squared, log of population, % of population ages 1 to 19, % of population aged 65 and up, social capital index, % religious. Economic controls include household size, single mother % of families, % with health insurance, % of population BCBS members, % of employment in manufacturing, and log median household income.

Sources: BCBS, Moody's Analytics

Appendix 1.5: Specific Condition Regressions, Model 1

No controls

	Impact score		Prevalence	
Condition	coefficient	p-value	coefficient	p-value
BH - alcohol / substance abuse	-0.163	0.092	-0.352	0.000
BH - depression / anxiety / affective ds	0.322	0.000	-0.126	0.150
CV - hypertension	-0.629	0.000	-0.665	0.000
Endo - lipid ds	-0.373	0.000	-0.363	0.000
CV - coronary ds	-0.548	0.000	-0.484	0.000
Endo - DM	-0.512	0.000	-0.448	0.000
BH - psychotic ds	0.927	0.000	0.689	0.000
Resp - COPD	-0.784	0.000	-0.711	0.000
GI - regional enteritis / ulcerative colitis	0.491	0.000	0.491	0.000
Immune sys- rheumatoid arthr/related	-0.670	0.000	-0.629	0.000
BH - hyperactivity / related	0.397	0.000	0.391	0.000
Cancer - breast	0.283	0.102	0.159	0.096
Endo - hypothyroidism	-0.349	0.008	-0.344	0.008
CV - heart failure / cardiomyopathy	-0.370	0.001	-0.347	0.000
CV - valve dysfunction	-0.150	0.005	-0.102	0.033
GU - renal failure	-0.118	0.309	-0.195	0.003
Resp - asthma	0.332	0.000	0.257	0.001
Neuro - other cns ds	-0.077	0.412	-0.656	0.000
MS - spine / neck / back	-0.421	0.001	-0.462	0.000
NS - cerebrovascular ds / stroke	-0.271	0.014	-0.216	0.011
Immune sys - other autoimmune ds	-0.135	0.261	-0.090	0.333
Cancer - leukemia / lymphoma / myeloma	0.191	0.246	0.237	0.219
BH - dementia / related	0.018	0.913	0.212	0.206
Cancer - male gu	0.065	0.600	0.068	0.541
Endo - obesity	-0.151	0.097	-0.136	0.116

Notes: All dependent variable and health scores standardized to z-scores. Member count is used as the regression weights, and errors are clustered at the state level. Model includes demographic controls and state fixed effects.

Statistically significant, negative association

Statistically significant, positive association

Sources: BCBS, Moody's Analytics

Appendix 1.6: Specific Condition Regressions, Model 4

Demographic controls and state fixed effects

	Impact score		Prevalence	
Condition	coefficient	p-value	coefficient	p-value
BH - alcohol / substance abuse	0.019	0.595	0.013	0.821
BH - depression / anxiety / affective ds	-0.028	0.609	-0.062	0.220
CV - hypertension	-0.148	0.026	-0.218	0.000
Endo - lipid ds	-0.155	0.000	-0.158	0.000
CV - coronary ds	-0.059	0.324	-0.056	0.392
Endo - DM	-0.141	0.001	-0.152	0.004
BH - psychotic ds	0.045	0.308	0.050	0.200
Resp - COPD	-0.111	0.007	-0.102	0.013
GI - regional enteritis / ulcerative colitis	0.080	0.259	0.082	0.242
Immune sys- rheumatoid arthr/related	-0.107	0.153	-0.121	0.071
BH - hyperactivity / related	0.160	0.002	0.166	0.002
Cancer - breast	-0.022	0.690	-0.032	0.461
Endo - hypothyroidism	0.073	0.207	0.077	0.215
CV - heart failure / cardiomyopathy	-0.028	0.564	-0.020	0.738
CV - valve dysfunction	-0.104	0.000	-0.101	0.014
GU - renal failure	-0.090	0.020	-0.048	0.269
Resp - asthma	0.085	0.044	0.079	0.044
Neuro - other cns ds	-0.095	0.014	-0.124	0.001
MS - spine / neck / back	-0.123	0.035	-0.129	0.013
NS - cerebrovascular ds / stroke	-0.056	0.256	-0.050	0.545
Immune sys - other autoimmune ds	-0.156	0.000	-0.130	0.001
Cancer - leukemia / lymphoma / myeloma	-0.009	0.806	0.028	0.583
BH - dementia / related	-0.136	0.002	-0.051	0.291
Cancer - male gu	-0.030	0.307	-0.052	0.286
Endo - obesity	-0.053	0.018	-0.046	0.059

Notes: All dependent variable and health scores standardized to z-scores. Member count is used as the regression weights, and errors are clustered at the state level. Model includes demographic controls and state fixed-effects.

Statistically significant, negative association

Statistically significant, positive association

Sources: BCBS, Moody's Analytics

About Moody's Analytics

Moody's Analytics helps capital markets and credit risk management professionals worldwide respond to an evolving marketplace with confidence. With its team of economists, the company offers unique tools and best practices for measuring and managing risk through expertise and experience in credit analysis, economic research, and financial risk management. By offering leading-edge software and advisory services, as well as the proprietary credit research produced by Moody's Investors Service, Moody's Analytics integrates and customizes its offerings to address specific business challenges.

Concise and timely economic research by Moody's Analytics supports firms and policymakers in strategic planning, product and sales forecasting, credit risk and sensitivity management, and investment research. Our economic research publications provide in-depth analysis of the global economy, including the U.S. and all of its state and metropolitan areas, all European countries and their subnational areas, Asia, and the Americas. We track and forecast economic growth and cover specialized topics such as labor markets, housing, consumer spending and credit, output and income, mortgage activity, demographics, central bank behavior, and prices. We also provide real-time monitoring of macroeconomic indicators and analysis on timely topics such as monetary policy and sovereign risk. Our clients include multinational corporations, governments at all levels, central banks, financial regulators, retailers, mutual funds, financial institutions, utilities, residential and commercial real estate firms, insurance companies, and professional investors.

Moody's Analytics added the economic forecasting firm Economy.com to its portfolio in 2005. This unit is based in West Chester PA, a suburb of Philadelphia, with offices in London, Prague and Sydney. More information is available at www.economy.com.

Moody's Analytics is a subsidiary of Moody's Corporation (NYSE: MCO). Further information is available at www.moodysanalytics.com.

About Moody's Corporation

Moody's is an essential component of the global capital markets, providing credit ratings, research, tools and analysis that contribute to transparent and integrated financial markets. **Moody's Corporation** (NYSE: MCO) is the parent company of Moody's Investors Service, which provides credit ratings and research covering debt instruments and securities, and **Moody's Analytics**, which encompasses the growing array of Moody's nonratings businesses, including risk management software for financial institutions, quantitative credit analysis tools, economic research and data services, data and analytical tools for the structured finance market, and training and other professional services. The corporation, which reported revenue of $3.5 billion in 2015, employs approximately 10,400 people worldwide and maintains a presence in 36 countries.

This page intentionally left blank

CONTACT US
For further information contact us at a location below:

U.S./CANADA
+1.866.275.3266

EMEA
+44.20.7772.5454 London
+420.224.222.929 Prague

ASIA/PACIFIC
+852.3551.3077

OTHER LOCATIONS
+1.610.235.5299

Email us: help@economy.com
Or visit us: www.economy.com

MOODY'S
ANALYTICS