THE BUSINESS CYCLE AND MORTALITY: URBAN VERSUS RURAL COUNTIES

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ABSTRACT

Many studies have found that mortality declines during recessions, but do such results remain consistent in both urban and rural settings? To help uncover explanations for such a pro-cyclical nature of mortality, the present study revisits this topic but allows for associations between unemployment and mortality to differ between urban and rural areas. Using a total of 66,863 observations across 3066 counties of the U.S. from 1990 to 2013, we allow the coefficient on unemployment to differ between urban and rural counties. With an exception of deaths due to external accidents being pro-cyclical in rural settings, we find that the negative association between unemployment and mortality more generally holds for urban areas, particularly for females and the elderly. Moreover, we find death due to circulatory disease or influenza/pneumonia to be especially more prevalent in urban areas. Given that the negative associations between unemployment and mortality are generally stronger in cities, views attempting to explain pro-cyclical mortality should focus on characteristics in urban settings.

Keywords: United States; unemployment; mortality; health; urban; rural.

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I. INTRODUCTION

The association between the business cycle and mortality has been extensively studied. Such studies include Ruhm (2000, 2015) for the United States, Neumayer (2004) for Germany, Tapia Granados (2005) for Spain, Gonzalez and Quast (2010) for Mexico, Ariizumi and Schirle (2012) for Canada, Lin (2009) for Pacific Asian countries, and Gerdtham and Ruhm (2006) for OECD countries. Using unemployment as a proxy for the business cycle, these studies report a pro-cyclical pattern of mortality at the state or national level. Mortality falls when unemployment is high, a claim first reported over 90 years ago (Ogburn and Thomas, 1922). Such a finding, however, is not universal. Brenner (1973, 1975, and 1979) finds a countercyclical association. Moreover, many studies that use either family-level data (Strully, 2009) or individual-level data (Halliday, 2014; Sullivan and von Wachter, 2009; Gerdtham and Johannesson, 2005) find a countercyclical pattern with mortality rates rising during recessions.

How could mortality be pro-cyclical? For one, the opportunity cost of going to the doctor, of exercising, and taking time to eat healthy is, presumably, higher during expansions than during recessions. Alternatively, people might push themselves harder during expansions such as work overtime or work multiple jobs. Such activities could cause more stress or allow them to become more susceptible to disease. During expansions people become wealthier and that might encourage them to take on risky activities such as excessive drinking or driving more recklessly thereby increasing fatality rates (Ruhm, 1995). In all of these cases, people’s behavior changes across the business cycle and such changes hold ramifications for health and mortality. Rising pollution or changes in the quality of medical care could also play roles as factors external to an individual’s behavior.

When examining the U.S., the typical approach is to consider state-level variations in unemployment and mortality which is the approach first taken by Ruhm (2000) although Ruhm (2015) and Lindo (2015) use both state and county-level data. We, instead, employ county-level data as do Fontenla et al. (2011). County-level data holds both advantages and disadvantages over state-level data. The degree of within-county variation is likely to be smaller than within-state variation allowing for less heterogeneity within the unit of analysis. Moreover, a greater number of observations can increase the power of statistical tests. On the other hand, larger units of analysis are likely to better filter out random errors since one is averaging over larger units. Pierce and Denison (2006) identify reporting errors from Texas using county-level data. People are also more likely to migrate and commute across county lines as opposed to state lines. See Lindo (2015) for further discussion.

A second reason to conduct a county-level analysis is that it can allow us to better understand what could be driving previous results by uncovering differences across heterogeneous settings, in our case urban versus rural ones. Examining such differences across settings could help to offer explanations as to why mortality is countercyclical. For example, one reason is that the opportunity cost of going to a doctor or seeking medical treatment is relatively high during economic booms as people might find it costly to take time off from work. These opportunity costs could differ between urban and rural settings, especially if one from a rural area needs to travel long distances to receive medical care or see a specialist. If true, then the pro-cyclical association between mortality and unemployment should be stronger in rural areas. On the other hand, to the extent that stress contributes to mortality, that stress levels are higher in urban areas, and that stress is higher during expansions then the association between mortality and the business cycle should be stronger in urban areas. To the extent that pollution rises during economic booms thereby contributing to mortality, then associations should be stronger in urban areas where pollution levels are higher. In fact, Davis et al. (2010) find that emissions of particulate matter from trucking in New Jersey were higher during economic booms. Heutel and Ruhm (2013) find evidence at the state level that lower air pollution during recessions provides a partial explanation for why mortality is pro-cyclical (although Sameem and Sylwester [2016] find little evidence that pollution is what drives the pro-cyclicality of mortality).

Thinking of reasons why the overall mortality rate as well as mortality for specific types of death could differ between urban and rural areas is not difficult. As just suggested, more air pollution in cities could contribute to respiratory and related problems (Calderon-Garciduenas et al. 2015; Zhou et al. 2015; Heutel and Ruhm, 2013), especially in infants (Currie and Schmieder, 2009; Foster et al., 2009; Currie and Neidell, 2005; Chay and Greenstone, 2003). Similarly, the higher number of vehicles in metropolitan areas adds to traffic accidents and motor vehicle fatalities (French and Gumus, 2014). In this paper, we consider whether associations between mortality and the business cycle also differ between urban and rural areas. We find substantial differences in mortality rates between urban and rural settings, especially for women. We also find significant differences regarding deaths due to heart disease as these deaths are more pro-cyclical in urban areas. External causes of death such as accidents are found to be more pro-cyclical in rural counties.

This analysis could be especially enlightening when comparing findings from individual-level studies that often find that being unemployed raises mortality for individuals. See Winkleman and Winkleman (1998), Burgard et al. (2007), Sullivan and Wachter (2009), Strully (2009) and Tapia Granados at al. (2014). Job loss can be associated with depression, greater risks of disease, and deviant behaviors that diminish health and income thereby increasing mortality.

An explanation to reconcile these contrasting views is that relatively few people become unemployed during a recession as an increase in the unemployment rate from 5% to 9%, for example, still only directly impacts a minority of the labor force. So even if the newfound unemployed suffer greater mortality, overall mortality could still decrease if the slowing economy lowers pollution levels (which affects all residents) or lowers stress at work (for the majority who remain employed) as people find themselves less busy. Therefore, examining differences between rural and urban areas can help narrow explanations for the macroeconomic associations reported above.

The remainder of the paper is organized as follows: Section II describes the data and section III presents the methodology. Section IV provides results and Section V concludes.

II. DATA

Our sample spans the 24 years from 1990 to 2013 and includes three recessions:1990-91, 2001, and 2007-09. Data comes from the Bureau of Labor Statistics and the Compact Mortality Files (CMF) of the National Center of Health Statistics. Data on unemployment before 1990 is not compatible with subsequent data and the BLS cautions against using them together. The unemployment rate we use corresponds to U-3 (the official unemployment rate) and is calculated as the number of unemployed people as a percentage of the labor force. The CMF is a detailed databank that has information for the death of every U.S. resident including race, gender, and cause of death (although see Appendix for how the codes as to the cause of death have changed during our sample period). It also has data for population demographics. All mortality rates used here are crude rates that are calculated as the number of deaths per 100,000 people. Of note, however, is that data is suppressed when deaths number less than ten in order to preserve confidentiality. This unavailability is not a problem with overall mortality since almost all counties see at least ten deaths per year. This can be a problem, though, with specific causes of death since small counties might not have at least ten deaths within the year due to, for example, diseases of the digestive system. When data is suppressed in this way, these observations are then missing from the analysis. To determine to what extent data has been suppressed, one can compare the total number of observations and the total number of counties reported in the baseline regressions of Table 2 using overall mortality with their counterparts in later regressions that focus on specific types of mortality or the mortality of specific subgroups in the population. All data is publicly and freely available at the sources mentioned above.

We denote counties as "urban" or "rural" using a 50,000 person threshold (although we will later consider a 100,000 person threshold). This 50,000 person threshold is also what is used by the U.S. Office of Management and Budget to define what counties belong to a Metropolitan Statistical Area. Of the total 3,143 counties in the U.S., 1,121 (36%) were classified as metropolitan counties in 2013 and the rest as non-metropolitan ones although we will use the more simple terms "urban" and "rural".

Table 1 provides the means and standard deviations of the data. Of note is that mortality is higher in rural counties whether one considers overall mortality rates, rates for specific subpopulations, or rates for specific causes of death. A striking difference is the higher mortality rates for the under-5 and under-1 populations. The rate for both in rural counties is more than double its counterpart in urban counties. Standard deviations in mortality across subgroups are also higher in rural counties. Given differences in these distributions we find it plausible that other characteristics between urban and rural areas could also differ, including associations between mortality and the business cycle.

III. METHODOLOGY

To analyze the impact of cyclical fluctuations upon mortalities across urban and rural counties, we relate the natural log of mortality rate for the j^{th} type of mortality in county i at time t (H_{it}^{j}) to the natural log of the annual county unemployment rate (UR_{it}) and several county-year demographic control variables (X_{it}) along with time-invariant county fixed effects (α_i), county-invariant time fixed effects (θ_t) and an error term (ε_{it}). Use of natural logs allows one to interpret coefficient estimates as elasticities. The specification is:

$$H_{it}^{j} = \alpha_i + \theta_t + \beta * UR_{it} + \gamma * X_{it} + \varepsilon_{it} \tag{1}$$

The inclusion of fixed effects captures time-invariant unobserved characteristics of counties such as location and geography whereas time fixed effects control for variations across years that are consistent across counties such as changes in government policies at the national level. The control variables include demographic characteristics of the county such as the percentages of the county population who are white, African American, Hispanic, male, under five, and over sixty-five, respectively. We also include the natural log of the county population.

We estimate (1) using standard errors clustered at the county level. Admittedly, one could also allow for spatial autocorrelation across counties in the same metropolitan area. Nevertheless, we retain a more simple approach as it is not always clear how to best model this autocorrelation. For example, not all counties might have been a part of the same metropolitan area throughout our sample period. More generally, the extent to which counties are interconnected has also likely changed over time. Finally, even counties that are not officially part of the same metropolitan statistical area are also likely to be interconnected to some extent and so the presence of spatial correlation can still arise across the borders of counties not officially part of the same MSA.

We will estimate (1) separately for urban and rural counties and compare coefficients. However, we acknowledge an alternative specification where one includes an interactive term in (1) so that the new equation becomes:

$$H_{it} = \alpha_i + \theta_t + \beta * UR_{it} + \gamma * X_{it} + \delta * D * UR_{it} + \varepsilon_{it} \qquad (2)$$

where D is a dummy that equals one for urban counties and zero for rural ones. A second alternative is to replace the dummy *D* with the natural log of population so as to allow the coefficient on *UR* to vary continuously with population. The advantage of either of these alternatives is that the sample size is greater as all counties are simultaneously considered. However, a disadvantage is that the coefficients on X are restricted to be identical for urban and rural counties, which our results below will show to be unlikely. Therefore, we proceed by estimating the more general model of (1) for different subsamples although this approach is equivalent to interacting all right hand side variables by *D*.

A weakness of our approach concerns people's ability to commute across county lines from home to work. People are more likely to work and live in separate counties as opposed to separate states since crossing state lines always implies crossing county lines as well. Therefore, a mismatch between where people work and live is always a greater concern when using county level data.

IV. RESULTS

A. Baseline Results

Table 2 presents the estimates of equation (1) for all counties (column 1) and then for rural and urban counties separately (columns 2 and 3, respectively). We concur with previous findings that report a negative association between unemployment and mortality. Nevertheless, we also find distinctions as to the strength of these associations. The coefficient on the unemployment rate is 75% higher for urban counties, -0.014, than it is for rural ones, -0.008. Also of note is that the coefficients for the ethnicity variables greatly differ between urban and rural counties, suggesting that model (2) containing a single interactive term is overly restrictive since it constrains coefficients on all of the control variables to be identical between urban and rural counties. To formally test this, we ran a specification from column (1) where every right hand side variable was included by itself as well as interacted with an urban dummy. Of the eight right hand side interactive terms, four were statistically significant, suggesting that model (2) is too restrictive. Because of these differences for coefficient estimates across other variables, we focus on the results from estimating (1) separately for urban and rural counties.

Not surprisingly, older counties and counties with more young children have higher mortality rates. Population is associated with lower mortality. Counties with more males and Hispanics have lower mortality rates. Counties with more African-Americans have higher mortality rates. In addition to these controls, we included others such as the natural logs of personal income, Social Security benefits, Medicaid benefits, and Medicare benefits. Results (available upon request) were robust to their inclusion although we omit them here due to a large loss in sample size.

B. Demographic and Type of Mortality Subgroups

In addition to considering the overall mortality rate, we also consider the mortality rates of various subgroups and mortality rates due to specific causes of death. In Table 3, we continue to employ the same specification as that used in Table 2 but only present estimates for the coefficients on *UR*. Table 3 also provides the p-value in each specification from the test that the coefficient on the natural log of unemployment is the same in rural and urban counties. Unfortunately, the power of this test is quite low in that meaningful differences in coefficient estimates are not always statistically significant. As an example, consider mortality of whites. The coefficient on unemployment is 2.6 times as high than that for rural counties, suggesting large differences between the two, yet the null that the coefficients are equal cannot be rejected at conventional levels. We present these p-values so interested readers can draw their own conclusions about the strength of our findings.

We first consider different sample windows. Results remain robust to removing the 1990-1 recession as well as the Great Recession and its aftermath from 2008 to 2013 although coefficient estimates slightly diminish in the latter case.

We next consider gender. Male mortality shows little difference between urban and rural counties whereas the negative association between unemployment and female mortality is over three times as high for urban counties. What can explain these differences across gender? One possibility is that women more often than men visit the doctor and use medical services. Ashman et al. (2015) and Brett and Burt (2001) provide further discussion. Thus, fewer men visit a doctor during a recession even when the opportunity cost is low. Hence, their utilization of health care services is less dependent on the state of the business cycle. Ruhm (2000) reports that routine checkups and preventative care become less frequent during recessions. Nevertheless, people could put off treatment for “nagging” ailments, believing problems to be minor, when busier economic booms occur. Urban settings have more health care facilities and more specialists and so seeking medical treatment is more convenient than in rural areas. Therefore, the strongest associations for urban women could be due to women’s greater willingness to seek medical treatment (relative to men) and the greater opportunity within urban settings to find it (relative to rural ones). A third possibility relates to pollution. Chen et al. (2005) report that air pollution increases mortality in women but no strong evidence links air pollution to fatal coronary heart disease in men. Women are also more likely to die of cardiovascular heart disease than are men. Therefore, the decline in pollution that occurs during recessions could benefit women more than men and could be most relevant in urban areas, where pollution levels are generally higher.

The next two rows consider differences across ethnicity. Mortality for whites is pro-cyclical though significant in the urban sample only. Mortality for African-Americans is counter-cyclical in the full sample. The coefficient on *UR* remains high in the urban sample, albeit no longer significant. Fontenela et al. (2007) report a similar distinction between African-Americans and whites as to how mortality changes across the business cycle, namely that mortality for African-Americans is not tied to unemployment.

We then turn to age. As in Ruhm (2000), we consider three age ranges: 20-44 (young adults), 45-64 (middle aged), and 65+ (elderly). Mortality for young workers is most pro-cyclical in rural counties whereas for elderly it is most pro-cyclical in urban counties. These results only somewhat coincide with those of Stevens et al. (2015) who argue that the pro-cyclical mortality of the elderly primarily drives the negative association between unemployment and mortality commonly found in this literature. We differ in that we also find negative associations for younger workers in rural counties as well as middle-aged workers in both. Moreover, the association between elderly mortality and unemployment greatly weakens in rural counties. Although not reported, we did not find any differences across the business cycle of the mortality of under-5 children.

Stevens et al. (2015) point to staffing shortages and a lower quality of care within nursing homes during booms to explain their findings. As stated, we also find negative associations for young and middle-aged workers. Thus, the explanation of staffing shortages at nursing homes would not be applicable to these groups. But focusing just on the elderly, our results imply that such problems for nursing homes during strong economies might more commonly arise in larger counties. This at first would seem to counter findings from Bowblis et al. (2013) where nursing home quality is lower in rural areas. However, our focus is not the average quality of care between urban and rural nursing homes but the difference as to how this care changes across the business cycle. During booms nursing home workers could look for different job opportunities, causing greater transitions in nursing homes and so lower quality of care. If these other opportunities are likelier to arise in larger counties, then mortality for the elderly should more greatly respond to changing business cycle conditions in larger counties which is what we find.

A second possibility goes back to pollution. Pollution falls during recessions and the lower pollution levels in cities could lower mortality rates of the elderly, another group that is more susceptible to having heart problems due to air pollution. Simoni et al. (2015) explore this issue further. However, it is harder for falling pollution levels during recessions to explain a negative association for younger workers in rural counties.

Table 3 then turns to cause specific mortality. As per the ninth revision of International Classification of Diseases (ICD-9), the major causes of mortality are classified into seventeen broad categories. The list of these causes is available in the Appendix (although data is not available to consider all the causes of mortality listed in Table A1). We consider the following: neoplasms/cancer, circulatory/cardiovascular system diseases, respiratory system diseases, digestive system diseases, genitourinary system diseases, nervous system diseases, nutritional and metabolic diseases, aggregate external causes of death, chronic liver diseases, motor vehicle accidents, homicides, influenza and pneumonia, and suicides. These causes account for the majority of deaths in the U.S. They represent different aspects of physical and mental health and encompass natural and non-natural types of mortality. Some of these categories represent mortalities due to long term illnesses such as malignant neoplasms while others represent mortalities due to short term incidents such as motor vehicle accidents. Although the transitory cyclical fluctuations proxied by unemployment rates are more suitable for explaining variations in mortality that occur due to short-term rather than long-term illnesses, we consider both in order to provide better comparisons and because the business cycle could worsen ongoing health problems even if it does not trigger the onset of the disease.

Many of the coefficient estimates are insignificant although exceptions arise. Heart disease is strongly associated with the business cycle. Moreover, the strength of this association greatly increases for urban counties. The pro-cyclicality of heart related deaths could be caused by increased stress at work. The CDC acknowledges evidence linking work-related stress to heart disease. Heavy lifting in occupational settings can also result in an increased risk of a heart attack (CDC, 2016). The extent that people work harder during economic booms could cause a negative association between unemployment and mortality. Moreover, to the extent that urban settings cause more stress associations should be stronger for urban counties. Pollution has also been linked to heart disease and decreasing pollution during recessions could then lower mortality (World Health Organization, 2014).

Mortality due to influenza is also higher for urban counties, perhaps because any initial outbreak of the flu or pneumonia more easily spreads in urban settings. Results for cancer are acyclical. The lack of any positive or negative correlation with the business cycle could be due to a longer horizon. Consider heart problems as a contrast. Although heart problems could span years, they could be ignored until the onset of a heart attack comes suddenly. Likewise, coming down with a serious case of the flu could also happen suddenly. On the other hand, a cancer diagnosis often precedes death by months if not years. Similar reasoning might also explain why other causes of death appear to be acyclical. Weaker associations also arise for mortality due to respiratory causes. Presumably, these types of death should be tied to air pollution. However, a death due to lung disease is likely to be less sudden than one due to a heart attack, for example. This difference in timing could then weaken the correlation between unemployment and mortality due to respiratory causes.

The one type of death that is more strongly associated with the business cycle in rural counties is external causes of death. External causes of death cover vast categories of fatalities such as workplace accidents, poisoning, accidental falls, accidents caused by fire, submersion, suffocation, surgical and medical procedure mishaps, suicides, homicides, and so on. Since this category of external causes of death is an amalgam of many different causes, we focus on some of them specifically such as motor vehicle accidents, homicides, and suicides. External causes of death are found to be pro-cyclical but only for rural counties. One explanation is that many dangerous occupations occur in rural areas such as lumbering, mining, and farming and the number of occupational accidents decrease when fewer people work during recessions. The stronger, negative association in rural counties between unemployment and external accidents is robust to removing homicides, suicides, and vehicular accidents (the three we examine specifically) from the set of external accidents. These results are also available upon request.

Vehicle accidents are pro-cyclical in both types of counties but are more pro-cyclical in urban counties. Increased economic activity that leads to more traffic is more likely to lead to more accidents in urban areas where roads are already congested.

Not surprisingly, suicides are countercyclical but our results show that this holds true mainly for urban counties. Perhaps rural settings provide more supportive environments that help to deter their occurrence. Such support systems, however, are likely to be less formal since urban areas are more likely to have mental health treatment centers.

C. 100,000 threshold

The above analysis considers a 50,000 person threshold distinguishing rural from urban counties. One can also consider other thresholds, such as one at 100,000 people. (Results using higher thresholds are similar.) Table 4 presents four sets of results. The first two columns present results from previous tables to ease comparison. Column one presents coefficient estimates on *UR* for all counties and column two for rural counties (those with less than 50,000 people). Column three shows results for counties having between 50,000 and 100,000 people. Column four presents outcomes for counties with at least 100,000 people. Counties with less than 50,000 people comprise about 5/7th of the sample. Those in the middle group are a little less than 1/7th of the total and the largest a little more than 1/7th. Some interesting findings emerge, some supportive of previous conjectures whereas others raise doubts.

Mortality remains pro-cyclical for these largest counties. We also see that mortality for the elderly is strongly associated with the business cycle for counties above 100,000 people but not for smaller counties. Such a result supports both of the possible explanations previously raised. Pollution that more greatly impacts the elderly is most likely to be a factor in the largest counties. On the other hand, nursing homes in the largest counties could also be most susceptible to staff turnover that lowers quality given more opportunities in these largest counties. The coefficients for heart disease and influenza become largest for the 100,000+ counties. This result again coincides with explanations of stress, pollution, and congestion. Results are also stronger for suicides. The larger the county the more prevalent (in per capita terms) suicide becomes during tough times. Again, more people do not necessarily imply deeper support networks. Vehicular accidents are also more strongly associated with the business cycle in larger counties. Also of note is that external causes of death become countercyclical for these largest counties. A negative coefficient upon unemployment for these types of deaths in rural areas makes sense given that more dangerous jobs are often found in rural areas. It would then not be surprising to see little association between unemployment and these types of mortality in larger counties. But, instead, we find that these types of deaths actually fall during good times.

V. CONCLUSION

Using U.S. county-level data from 1990 to 2013, this study provides a nuanced story to the recent findings of the pro-cyclical behavior of mortality. We find that negative associations between unemployment and mortality are stronger in urban counties. In some cases including women and the elderly, the coefficients differ by more than a factor of 3. Therefore, our main conclusion is that the association between unemployment and mortality found by others appears to more strongly hold in urban areas.

What can explain the differences between urban and rural counties as to how mortality changes across the business cycle? Stronger economies could increase stress levels that are also more strongly felt in urban areas. It is also possible that weaker economies allow those who still have jobs more time to seek routine checkups and medical treatment and this is what explains our findings. However, the micro data is less supportive of this explanation, since such checkups and routine medical care fall during recessions. Further considering the characteristics of these counties in order to better explain results is a focus of future work.

A key exception to the stronger association between unemployment and mortality in urban areas involves external accidents. External accidents are more pro-cyclical in rural settings. Such accidents could increase during economic booms as more occupational accidents occur and prove more fatal in rural areas since distance from treatment centers could be decisive for survivability.

The often-reported finding that mortality falls in recessions seems counterintuitive given the hardships that we often see with the unemployed and so finding explanations to reconcile such results is necessary. By considering how associations between unemployment and mortality differ between urban and rural counties, we hope to have narrowed the set of possibilities although we acknowledge that our findings also raise important questions. More work needs to be done to further pare down these possible explanations. We encourage such future examinations, especially considering the nuances that our findings suggest.

Nevertheless, we acknowledge limitations of the data that should be kept in mind when making such conclusions. For one, our sample begins in 1990 and so earlier recessions are not considered. Perhaps associations between unemployment and mortality in urban or in rural (or in both) areas have changed over longer periods of time thereby limiting the extent that results generalize. Second, fewer controls can be included at the county level rather than the state level due to less availability of data and so omitted variable bias remains a stronger possibility with county-level data. Finally, although we find reverse causation from mortality to unemployment as unlikely, we cannot rule it out which would also bias our coefficient estimates.

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APPENDIX

This appendix lists the type of death under the International Classification of Diseases (ICD) from the World Health Organization. The ICD-9 coding system we use is listed in Table A1. ICD-9 is the official coding system used from 1979 to 1998 whereas ICD-10 codes have been used since (and are listed in Table A2). In order to provide a reasonable comparison among these codes, National Center for Health Statistics employed comparability ratios based on the relative number of cause-specific deaths in 1996 for reconciling ICD-9 and ICD-10 classifications (Anderson et al., 2001). Though the comparison is not perfect, an effort has been made to reconcile these codes for cause-specific mortality rates to provide a comparable estimation. Our results are robust to using classifications based upon ICD-10.

Table 1: Summary Statistics

	All Counties		Rural Counties		Urban Counties	
Variables	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Overall Mortality Rate						
Mortality	1023.2	269.6	1090.7	263.2	863.8	211.3
Male Mortality	1053.0	295.5	1126.9	290.6	881.6	228.0
Female Mortality	1001.3	282.7	1068.2	285.1	847.2	206.7
Whites Mortality	1057.5	284.5	1123.5	282.7	902.2	221.5
Blacks Mortality	889.9	406.7	1071.0	452.1	723.4	267.6
Mortality Rate by Age Group						
Infants	859.2	367.3	1969.8	628.6	826.8	300.5
Under 5	205.5	91.0	428.2	135.4	193.3	69.7
Young Age (20-44)	177.3	76.4	206.3	83.7	146.2	52.1
Middle Age (45-64)	744.5	224.6	781.6	239.2	671.3	170.4
Old Age (65+)	5070.9	801.1	5138.9	863.0	4911.3	603.2
Over 85	15606.5	2734.7	15779.8	3085.2	15222.4	1655.8
Mortality Rate by Cause						
Malignant Neoplasms	236.1	67.3	250.7	68.8	204.7	51.6
Metabolic Diseases	42.7	20.6	54.3	22.9	34.2	13.5
Nervous Diseases	47.0	27.6	62.1	31.0	36.6	18.7
Circulatory Diseases	394.7	141.1	428.8	143.1	317.4	100.2
Respiratory Diseases	106.3	42.0	118.2	44.4	85.7	27.3
Digestive Diseases	36.8	14.5	45.9	16.2	31.1	9.6
Genitourinary Diseases	26.0	13.5	40.1	15.2	21.1	8.5
External Causes of Death	74.8	29.2	85.1	30.9	60.1	18.8
Liver and Cirrhosis	15.3	8.6	33.8	16.4	14.0	5.8
Influenza and Pneumonia	33.7	21.7	51.0	26.1	24.7	11.3
Vehicle Accidents	24.7	15.4	41.6	16.9	18.3	8.4
Suicides	14.5	6.5	29.8	8.5	13.6	4.9
Homicides	9.7	7.7	31.6	8.5	9.3	7.0
Independent Variables						
Unemployment Rate	6.3	2.9	6.3	3.0	6.1	2.7
Population	90891	295770	18666	12757	263928	504227
Percent Male	49.8	2.0	49.8	2.2	49.1	1.3
Percent White	88.1	15.6	89.0	16.4	86.0	13.3
Percent African-American	10.2	15.1	10.0	16.3	10.6	12.3
Percent Hispanic	6.6	12.4	6.0	12.5	7.9	12.2
Percent Under 5	6.5	1.2	6.3	1.2	6.7	1.1
Percent 65 and Over	15.3	4.2	16.3	4.1	13.0	3.7

Note: Rural (Urban) counties are those with less than (more than) 50,000 people.

Table 2: Baseline Regressions

	All Counties	Rural Counties	Urban Counties
	(1)	**(2)**	**(3)**
UR (natural log)	-0.0078***	-0.0081**	-0.0140***
	(0.003)	(0.004)	(0.004)
Population (natural log)	-0.1452***	-0.1866***	-0.1105***
	(0.012)	(0.017)	(0.017)
Male (%)	-0.0087***	-0.0066***	-0.0090***
	(0.001)	(0.001)	(0.003)
White (%)	0.0085***	0.0039**	0.0151***
	(0.001)	(0.002)	(0.021)
African-American (%)	0.0122***	0.0065***	0.0178***
	(0.002)	(0.002)	(0.0024)
Hispanic (%)	-0.0014***	-0.0016***	-0.0014*
	(0.0004)	(0.0005)	(0.073)
Under 5 (%)	0.0055***	0.0077***	0.0061*
	(0.003)	(0.002)	(0.003)
Over 65 (%)	0.0347***	0.0328***	0.0433***
	(0.001)	(0.001)	(0.003)
Constant	7.395***	8.111***	6.395***
	(0.215)	(0.238)	(0.384)
# Observations	66,863	44,910	21,953
# Counties	3,066	2,243	988
R^2-Overall	0.50	0.37	0.57

Notes: Dependent variable is natural logarithm of total mortality rate per 100,000 people. All regressions contain county and year fixed effects. Sample period is 1990-2013. Clustered standard errors at the county level are in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Rural (Urban) counties are those with less than (more than) 50,000 people.

Table 3: Coefficients Estimates for *UR* for Different Mortality Rates

Mortality Rate for:	**All Counties**	**Rural Counties**	**Urban Counties**	**P-Value**
Total Population	-0.0078***	-0.0081**	-0.0140***	0.272
	66863 3066	44910 2243	21953 988	
Sample: 1994-2013	-0.0093***	-0.0090**	-0.0151**	0.280
	56787 3066	38228 2208	18559 987	
Sample: 1990-2007	-0.0068**	-0.0081**	-0.0113***	0.542
	48764 2998	32613 2172	16151 961	
Males	-0.0092***	-0.0115***	-0.0119***	0.953
	66603 3050	44650 2227	21953 988	
Females	-0.0067**	-0.0048	-0.0169***	0.054
	66497 3046	44544 2223	21953 988	
Whites	-0.0047	-0.0051	-0.0134***	0.151
	66794 3062	44841 2239	21953 988	
African-Americans	0.0149**	0.0025	0.0161	0.332
	31260 1524	14973 793	16287 821	
20-44 Year-Olds	-0.0238***	-0.0224**	-0.0042	0.398
	45079 2445	23140 1622	21939 988	
45-64 Year-Olds	-0.0143***	-0.0121**	-0.0154**	0.682
	62589 2929	40636 2106	21953 988	
≥ 65 Year-Olds	-0.0045	-0.0023	-0.0124***	0.051
	66777 3060	44824 2237	21953 988	
Heart / Circulatory Diseases	-0.0206***	-0.0140***	-0.0434***	0.000
	65975 3021	44022 2198	21953 988	
Neoplasms / Cancer	0.0044	0.0033	0.0044	0.858
	64665 2990	42712 2167	21953 988	
Influenza and Pneumonia	-0.0463***	-0.0185	-0.0519***	0.164
	30448 2132	10170 1303	20278 972	
External Causes of Death	-0.0106	-0.0359***	0.0167	0.000
	52431 2745	30479 1922	21952 988	
Vehicle Accidents	-0.0629***	-0.0347***	-0.0673***	0.060
	26771 1989	7298 1155	19473 974	
Homicides	0.0513*	0.1828	0.0527*	0.226
	6909 554	140 63	6769 498	
Liver and Cirrhosis	0.00002	-0.0518	-0.0069	0.264
	15776 1276	1049 377	14727 945	
Respiratory System Diseases	0.0065	0.0115	-0.0056	0.156
	57627 2854	35681 2031	21946 987	

Nervous System Diseases	0.0107	0.0243	-0.0023	0.237
	35373 2448	14537 1597	20836 987	
Suicides	0.0522***	0.0113	0.0506***	0.271
	17122 1285	1028 406	16094 955	
Digestive System Diseases	0.0019	-0.0043	-0.0016	0.851
	35063 2225	13416 1399	21647 987	
Nutritional and Metabolic	-0.0121	-0.0104	-0.0116	0.950
Diseases	37331 2348	15797 1518	21534 986	
Genitourinary System Diseases	-0.0190	-0.0119	-0.02183	0.668
	26203 1909	6705 1052	19498 982	

Notes: Dependent variable is natural logarithm of mortality rate per 100,000 people. All specifications include county and time fixed effects as well as controls for the natural log of population, the percentage of county populations who are male, white, African-American, Hispanic and in two age categories (<5 and ≥65 years old). Significance levels determined using standard errors clustered at the county level. *** p<0.01, ** p<0.05, * p<0.1. Rural (Urban) counties are those with less than (more than) 50,000 people. The number of observations and the number of counties are given underneath each coefficient estimate. Entries in the last column denote the p-value from the null hypothesis that the coefficients on the natural log of the unemployment rate for rural and urban counties are equal.

Table 4: Coefficients on *UR* for Different Population Thresholds

	Coefficients on UR			
Mortality Rate for:	**All Counties**	**< 50K Pop**	**50K-100K Pop**	**> 100K Pop**
Total Population	-0.0078***	-0.0081**	-0.0160**	-0.0128**
	66863 3066	44910 2243	7778 503	10781 589
Sample: 1994-2013	-0.0093***	-0.0090**	-0.0090**	-0.0128**
	56787 3066	38228 2208	7778 503	10781 589
Sample: 1990-2007	-0.0068**	-0.0081**	-0.0086	-0.0100**
	48764 2998	32613 2172	6955 509	9196 564
Males	-0.0092***	-0.0115***	-0.0125**	-0.0089
	66603 3050	44650 2227	9300 536	12653 589
Females	-0.0067**	-0.0048	-0.0144*	-0.0144**
	66497 3046	44544 2223	9300 536	12653 589
Whites	-0.0047	-0.0051	-0.0135*	-0.0092
	66794 3062	44841 2239	9300 536	12653 589
African-Americans	0.0149**	0.0025	0.0303	0.0059
	31260 1524	14973 793	5369 373	10918 550
20-44 Year-Olds	-0.0238***	-0.0224**	-0.0435***	0.0218
	45079 2445	23140 1622	9286 536	12653 589
45-64 Year-Olds	-0.0143***	-0.0121**	-0.0141	-0.0067
	62589 2929	40636 2106	9300 536	12653 589
≥ 65 Year-Olds	-0.0045	-0.0023	-0.0054	-0.0161***
	66777 3060	44824 2237	9300 536	12653 589
Heart / Circulatory	-0.0206***	-0.0140***	-0.0227**	-0.0543***
Diseases	65975 3021	44022 2198	9300 536	12653 589
Neoplasms / Cancer	0.0044	0.0033	0.0017	0.0124***
	64665 2990	42712 2167	9300 536	12653 589
Influenza and Pneumonia	-0.0463***	-0.0185	0.0215	-0.0836***
	30448 2132	10170 1303	7782 520	12496 589
External Causes of Death	-0.0106	-0.0359***	-0.0245*	0.0489***
	52431 2745	30479 1922	9299 536	12653 589
Vehicle Accidents	-0.0629***	-0.0347***	-0.0416**	-0.0683***
	26771 1989	7298 1155	7095 522	12378 586
Homicides	0.0513*	0.1828	-0.0472	0.0536*
	6909 554	140 63	488 121	6281 401
Liver and Cirrhosis	0.00002	-0.0518	-0.0582**	-0.0072
	15776 1276	1049 377	3343 454	11384 587
Respiratory System	0.0065	0.0115	0.0120	-0.0092

Diseases	57627 2854	35681 2031	9293 535	12653 589
Nervous System Diseases	0.0107	0.0243	0.0050	-0.0042
	35373 2448	14537 1597	8243 532	12593 589
Suicides	0.0522***	0.0113	-0.0073	0.0651***
	17122 1285	1028 406	4064 500	12030 589
Digestive System Diseases	0.0019	-0.0043	0.0185	-0.0159
	35063 2225	13416 1399	9004 534	12643 589
Nutritional and Metabolic	-0.0121	-0.0104	-0.0010	0.0035
Diseases	37331 2348	15797 1518	8895 533	12639 589
Genitourinary System	-0.0190	-0.0119	-0.0093	-0.0289
Diseases	26203 1909	6705 1052	7070 527	12428 589

Notes: Dependent variable is natural logarithm of mortality rate per 100,000 people. All specifications include county and time fixed effects as well as controls for the natural log of population, the percentage of county populations who are male, white, African-American, Hispanic and in two age categories (< 5 and ≥ 65 years old). Significance levels determined using standard errors clustered at the county level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. The number of observations and the number of counties are given underneath each coefficient estimate.

Table A1: List of ICD-9 Diagnosis Codes

ICD-9 Code	Description
001-139	Infectious and Parasitic Diseases
140-239	Neoplasms
240-279	Endocrine, Nutritional and Metabolic Diseases, and Immunity Disorders
280-289	Diseases of the Blood and Blood-Forming Organs
290-319	Mental Disorders
320-389	Diseases of the Nervous System and Sense Organs
390-459	Diseases of the Circulatory System
460-519	Diseases of the Respiratory System
520-579	Diseases of the Digestive System
580-629	Diseases of the Genitourinary System
630-679	Complications of Pregnancy, Childbirth, and the Puerperium
680-709	Diseases of the Skin and Subcutaneous Tissue
710-739	Diseases of the Musculoskeletal System and Connective Tissue
740-759	Congenital Anomalies
760-779	Certain Conditions Originating In the Perinatal Period
780-799	Symptoms, Signs, and Ill-Defined Conditions
E800-E999	External Causes of Injury and Poisoning

Note: For a more detailed list, go to: http://www.icd9data.com/2015/Volume1/

Table A2: List of ICD-10 Diagnosis Codes

ICD-10 Code	Description
A00-B99	Certain Infectious and Parasitic Diseases
C00-D49	Neoplasms
D50-D89	Diseases of the Blood and Blood-Forming Organs and Certain Disorders Involving the Immune Mechanism
E00-E89	Endocrine, Nutritional and Metabolic Diseases
F01-F99	Mental, Behavioral and Neurodevelopmental Disorders
G00-G99	Diseases of the Nervous System
H00-H59	Diseases of the Eye and Adnexa
H60-H95	Diseases of the Ear and Mastoid Process
I00-I99	Diseases of the Circulatory System
J00-J99	Diseases of the Respiratory System
K00-K95	Diseases of the Digestive System
L00-L99	Diseases of the Skin and Subcutaneous Tissue
M00-M99	Diseases of the Musculoskeletal System and Connective Tissue
N00-N99	Diseases of the Genitourinary System
O00-O99	Pregnancy, Childbirth and the Puerperium
P00-P96	Certain Conditions Originating in the Perinatal Period
Q00-Q99	Congenital Malformations, Deformations and Chromosomal Abnormalities
R00-R99	Symptoms, Signs and Abnormal Clinical and Laboratory Findings, Not Elsewhere Classified
U00-U99	Codes for Special Purposes
V01-Y89	External Causes of Morbidity and Mortality

Note: For a more detailed list, go to: http://www.icd10data.com/ICD10CM/Codes.