NBER WORKING PAPER SERIES

A HEALTHY ECONOMY CAN BREAK YOUR HEART

Christopher J. Ruhm

Working Paper 12102
http://www.nber.org/papers/w12102

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 2006

I thank Dana Goldman and Loren Baker for helpful suggestions. Financial support for this research was received from the National Institute on Alcohol Abuse and Alcoholism (AA12309) and the National Science Foundation (SES-9876511). The opinions, findings and conclusions expressed in this paper are those of the author and do not necessarily reflect the views of the funding agencies. The views expressed herein are those of the author(s) and do not necessarily reflect the views of the National Bureau of Economic Research.

A Healthy Economy Can Break Your Heart
Christopher J. Ruhm
NBER Working Paper No. 12102
March 2006
JEL No. E32, I12

ABSTRACT

Panel data econometric methods are used to investigate how the risk of death from acute myocardial infarction (AMI) varies with macroeconomic conditions after controlling for demographic factors, fixed state characteristics, general time effects and state-specific time trends. The sample includes residents of the 20 largest states over the 1979 to 1998 period. A one percentage point reduction in unemployment is predicted to raise AMI mortality by 1.3 percent, with a larger increase in relative risk for 20-44 year olds than older adults, particularly if the economic upturn is sustained. Nevertheless, the much higher absolute AMI fatality rate of senior citizens implies that they account for most of the additional deaths. This suggests the importance of factors like air pollution and traffic congestion that increase with economic activity, are linked to coronary heart disease and may have particularly strong effects on vulnerable segments of the population, such as the frail elderly. AMI mortality risk quickly rises when the economy strengthens and increases further if the favorable economic conditions persist. This is consistent with strong effects of other short-term factors on heart attack risk and with health being a durable capital stock that is affected by flows of lifestyle behaviors and environmental conditions whose effects accumulate over time.

Christopher J. Ruhm
Department of Economics
Bryan School, UNCG
P.O. Box 26165
Greensboro, NC 27402-6165
and NBER
chrisruhm@uncg.edu

A Healthy Economy Can Break Your Heart

Does the risk of death from heart attacks (acute myocardial infarction) fall when macroeconomic conditions strengthen? The answer to this question may seem obvious. Since economic upturns are often believed to reduce social and psychological hardship, health might be expected to improve and mortality to decrease. Moreover, widely cited investigations of aggregate time-series data from the 1930s through 1970s suggest gains in health and reductions in fatalities from coronary heart disease (CHD) during periods of reduced unemployment (Brenner, 1971, 1979; Bunn, 1979). However, these results are almost certainly wrong. Evidence presented below shows that mortality from heart disease rises when the economy expands and that this is almost entirely due to increases in AMI deaths.

How could the findings of the aforementioned analyses of time-series data be so at odds with the conclusions of this investigation? First, subsequent research (Gravelle, Hutchinson, & Stern, 1981; Kasl, 1979; Wagstaff, 1985) points out serious flaws in the methods used in these studies and research correcting the problems fails to replicate the findings (e.g. Forbes & McGregor, 1984; McAvinchey, 1988; Joyce & Mocan, 1993). Second, any lengthy time-series is likely to contain omitted determinants of health that are spuriously correlated with macroeconomic fluctuations. For instance, dramatic reductions in unemployment at the end of the great depression (of the 1930s) coincided with improvements in nutrition and wider availability of antibiotics. Failure to fully control for these and other confounding factors leads to biased estimates. One consequence is that the results are sensitive to the choice of countries, time periods and estimation methods (Ruhm, forthcoming).

Instead of using national time-series data, this analysis utilizes information on mortality rates for the 20 largest states pooled over the years 1979 to 1998. Longitudinal data permits the use of panel data techniques that are well-known in the econometrics literature, but less often employed in epidemiological or medical research. These methods fully control for time-varying determinants of death that are national in scope and factors that differ across states but remain fixed over time (Jones, 2000). Confounding influences that fluctuate within-states are also accounted for, although possibly less completely.

A one percentage point drop in the state unemployment rate is estimated to raise the overall AMI fatality rate by 1.3 percent, corresponding to approximately 2,500 extra heart attack deaths. The increase in relative risk is larger for 20-44 year olds than older individuals but the higher absolute AMI fatality risk of senior citizens implies that they account for most of the additional mortality.

These results are consistent with recent research using similar methods that provides evidence of increases in total mortality during economic expansions (Ruhm, 2000; Gerdtham & Ruhm, 2004; Johansson, 2004; Neumayer, 2004; Tapia Granados, 2004; Lin, 2005) but improves upon the previous work in at least three ways. First, the analysis focuses on acute myocardial infarction, rather than aggregating this with all types of mortality or more broadly defined causes of cardiovascular deaths. This is useful since AMI fatalities are well measured, their determinants have been widely studied and they are affected by changes in environmental conditions, employment stressors and health behaviors that vary with macroeconomic conditions (Grundy, Pasternak, Greenland, Smith, & Fuster, 1999; Minino, Arias, Kochanek, Murphy, & Smith, 2002). Second, separate estimates are provided for subsamples stratified by sex, race/ethnicity and age. Third, the investigation of potential mechanisms for the effects is more detailed than in past work, although still somewhat preliminary.

METHODS

Data and Outcomes

The primary dependent variable is the annual state AMI death rate (ICD-9 code 410) for the 20 largest states measured over the 1979 to 1998 period (n=400). Supplementary models use the following fatality rates as outcomes: coronary heart disease other than AMI (ICD-9 codes 411-414); all heart disease (ICD-9 codes 390-398, 402, 404-429); and heart disease other than CHD (ICD-9 codes 390-398, 402, 404, 415-429).

Mortality rates are constructed as the number of deaths from the specified cause divided by the state population, using data from the Compressed Mortality Files (CMF) obtained from the CDC (U.S. Department of Health and Human Services; Centers for Disease Control and Prevention, 2000, 2003). The CMF contain sufficient information to separately calculate AMI fatality rates for males, females, three age categories (20-44, 45-64, 65 years and over), whites and blacks. Changes in coding methods during the sample period preclude analysis of other race/ethnicity subgroups. The investigation is limited to the 20 largest states because of small samples sizes for subpopulations in some other states and since unemployment rates are frequently not supplied or are measured with considerable error for small states early in the sample period. The 20 states account for almost three-quarters of national AMI deaths and have similar mortality patterns to the entire country.

The primary proxy for macroeconomic conditions is the annual state unemployment rate for the civilian noninstitutionalized population aged 16 and over, with data obtained from the Local Area Unemployment Statistics Database (U.S. Department of Labor; Bureau of Labor Statistics, 2002). Most specifications control for the fraction of state residents who are female, black, under 25 years of age, 65 or older, who have never attended college and who are college graduates. These data are from the *Current Population Survey Merged Outgoing Rotation*

Groups, 1979-2001 (CPS-ORG) extract provided by the National Bureau of Economic Research (National Bureau of Economic Research, 2002). Education refers to persons 25 and older. Prior to 1992, the CPS-ORG supplied information on years of completed schooling, rather than explicitly identifying degree or graduation status. For these years, persons with 12 or fewer (16 or more) years of education are placed in the no college (college graduate) category.

The role played by changes in income, work hours or the composition of employment in explaining a portion of the observed macroeconomic variation in AMI mortality is estimated from specifications that include controls for average state per capita disposable income (in 1998 dollars), average weekly work hours of persons 25 and over, and the fraction of the population (25 and older) employed in the cyclically sensitive construction and manufacturing industries. Information on income is from the BEA Regional Accounts data (U.S. Department of Commerce; Bureau of Economic Analysis, 2002); that on work hours and industry of employment is from the CPS-ORG.

Analytic Approach

Analyses of national time-series data are unlikely to adequately control for omitted determinants of AMI mortality. For instance, the sharp decline in heart attack deaths since the early 1980s partly results from increased use of aspirin therapy, thrombolysis and other anti-coagulants for acute in-hospital treatment, and surgical interventions like cardiac catheterization, percutaneous transluminal coronary angioplastsy (PTCA) and PTCA with stent (Heidenreich &McClellan, 2001; McGovern, Jacobs, Shahar, Arnett Folsom, Blackburn et al., 2001). Throughout much of this period, there have also been reductions in cardiovascular risk factors like hypertension, hypercholesterolemia, smoking and consumption of dietary fat (Arnett, McGovern, Jacobs, Shahar, Duval, Blackburn et al., 2002; Cooper, Cutler, Desvigne-Nickens, For, Friedman, Havlik et al., 2000). These improvements took place during a period of strengthening macroeconomic conditions – joblessness averaged 8.0% from 1979-1983 versus 5.3% from 1994-1998 – implying a positive correlation between unemployment and AMI mortality, even absent a causal effect.

Longitudinal data permits the use of methods that better account for potential confounding factors. Following Ruhm (2000), the basic specification estimated below is:

$$M_{jt} = \alpha_t + X_{jt}\beta + U_{jt}\gamma + S_j + S_j*T + \varepsilon_{jt}, \quad (1)$$

where M_{jt} is a transformation of the mortality rate in state i at year t, U is the unemployment rate, X is a vector of demographic characteristics, α is a year-specific effect, S is a state-specific intercept, S_j*T is a state-specific linear time trend (years elapsed since 1978), and ε is a disturbance term. Since the dependent variables are mortality rates, restricted between zero and one, grouped data logit models (where M = $\ln[m/1-m]$ for m the specified mortality rate) are estimated using maximum chi-squared methods. All statistical and econometric analysis is conducted using the STATA software package (StataCorp, 2003).

The year dummy variables hold constant determinants of mortality that are national in scope and vary over time, such as widely dispersed changes in medical practices. The state intercepts, referred to as "fixed-effects" in the econometrics literature, account for characteristics that differ across locations but remain constant over time (like persistent differences in lifestyles, the medical infrastructure or population characteristics). The time trends control for factors that change slowly and continuously over time within states. The impact of the macroeconomy is therefore identified by within-state variations in unemployment rates, relative to the fluctuations occurring in other parts of the country.

The discussion focuses on the effects of a one percentage point drop in the state unemployment rate. This represents a small improvement in the macroeconomy. To provide perspective, the standard deviation of the state unemployment rate is 1.9 percentage points; the national rate increased 2.5 points between December 2000 and June 2003; and unemployment in California rose 3.7 points between 1979 and 1982 and then fell 4.8 points by 1989. Logit coefficients show the expected effect on the log-odds ratio of mortality. Since $M = \ln[m/1-m]$ and m is roughly 0.01 (see Table 1), $M \approx \ln(m)$ and the predicted effect of a one point reduction in unemployment is closely approximated by $e^{-\hat{\gamma}} - 1$, for $\hat{\gamma}$ the estimated logit coefficient. Standard errors are shown in parentheses and 95 percent confidence intervals are sometimes displayed in brackets. The logit estimates are also used to estimate national change in the number of AMI deaths, based on actual fatalities in 2000 (Minino, Arias, Kochanek et al., 2002).

Differences in the initial and medium-term effects of sustained economic expansions are examined through models that control for the average unemployment rate during the five calendar years prior to the survey date and the change in unemployment during the survey year, relative to this five-year average. Information on the full adjustment path is obtained from specifications that hold constant unemployment rates in each year between t-5 and t, with the cumulative impact of one point drop in joblessness that has lasted for n years (for n between 0 and 5) estimated as $e^{\Gamma_n} - 1$ for $\Gamma_n = \sum_{k=0}^{n} -\hat{\gamma}_{t-k}$, where $\hat{\gamma}_{t-k}$ is the logit coefficient on the kth-year lag of unemployment.

RESULTS

Descriptive Findings

Table 1 displays average values (weighted by population in the state and year) for the variables used in this analysis. One-third of deaths from heart disease are due to AMI, with other coronary heart disease being responsible for another 36 percent. AMI fatality risk rises sharply with age and is higher for men than women and whites than blacks.

Figure 1 shows that unemployment increased during the recessions of the early 1980s and early 1990s but generally trended down – falling 23% between 1979 and 1998 (from 5.4% to 4.5%). AMI fatalities declined 44% (from 134.1 to 75.2 per 100,000) over this period, mostly for reasons unrelated to macroeconomic conditions (e.g. changes in medical technologies and health behaviors). Including year dummy variables in the logit models accounts for all such confounding factors that are national in scope.

A key advantage of examining mortality rates at the state level is that economic conditions evolve somewhat independently across locations, with the result that each state represents a separate "experiment". Consider California and Texas, the two largest states. The top panel of Figure 2 demonstrates their quite different patterns of unemployment – California experienced sharper increases during the early 1980s and early 1990s, while joblessness rose substantially in Texas during the mid-1980s. The bottom panel shows corresponding AMI mortality rates, detrended and normalized to average 100 (in each state) over the two decade period – AMI deaths trended down in both states as for the entire country. Notice that heart attack fatalities fell relatively rapidly in Texas from the late 1970s through late 1980s, when unemployment was rising, and more slowly thereafter, when joblessness declined. The patterns are not as obvious in California, possibly reflecting the lack of a clear unemployment trend. Other determinants of mortality, such as changes in medical practices, could have been spuriously correlated with macroeconomic conditions in either state but probably not in both simultaneously, since their economies evolved so differently. The panel data econometric methods exploit these state-specific sources of variation.

AMI Mortality Increases When Labor Markets Strengthen

Table 2 displays the logit coefficients from various model specifications. A *negative* sign on unemployment corresponds to a higher predicted death rate during economic expansions (when joblessness falls). The results in column (a), where the only covariate is the state unemployment rate, indicate a positive correlation between joblessness and AMI fatalities. This is expected since both variables trended downwards during the sample period. Note, however, that the parameter estimate switches sign when general time effects are incorporated (model b) and becomes significantly negative with the inclusion of state fixed-effects (specification c). The coefficient remains negative and significant, but is somewhat attenuated, when adding state-specific time trends (column d) and demographic characteristics (column e). This last specification, or variants of it, is focused on below since it contains the most complete controls for potential confounding factors. In model (e), a one percentage point reduction in unemployment is predicted to increase AMI deaths by around 1.3 percent.

Coefficients on the demographic variables generally conform to our expectations. Most importantly, AMI fatalities are negatively (positively) related to the fraction of residents under 25 (over 64) years of age. To examine whether the included covariates adequately account for the age structure of the population, model (f) displays results for death rates that are age adjusted to the 2000-year standard population. As expected, doing so results in substantial attenuation of the coefficients on age and percent female (which, since women live longer than men, is positively correlated with population age). Importantly, the predicted effects of macroeconomic conditions are virtually identical with and without age-adjustment.

AMI Deaths Explain the Macroeconomic Variation in Heart Disease Mortality

AMI accounts for around one-third of deaths from heart disease. However, since heart attacks are likely to be particularly responsive to short-term changes in modifiable health behaviors and environmental factors, they are anticipated to explain a much larger proportion of the corresponding macroeconomic fluctuation in fatalities. This prediction is examined and confirmed in Table 3, where the dependent variables are mortality due to: all types of heart disease, AMI, coronary heart disease other than AMI, and non-ischemic heart disease.

The 1.3 percent rise in AMI deaths predicted to accompany a one point reduction in unemployment is more than sufficient to explain the 0.2 increase estimated for mortality from all types of heart disease (see the first two rows of the table), with similar results again obtained for crude and age-standardized fatality rates. The key role of heart attacks is further reinforced by the small and insignificant 0.1 to 0.3 percent increase predicted for deaths from CHD other than AMI (such as angina pectoris or arteriosclerosis) and the fairly large but imprecisely estimated 0.4 to 0.5 percent *reduction* for non-ischemic heart disease (like rheumatic heart or hypertensive disease).

Increases in Fatality Risk are Widespread

Table 4 summarizes results for the AMI mortality of subgroups stratified by sex, race and age. Here, and below, crude mortality rates are the dependent variables and the models control for state and year effects, state-specific time trends and demographic characteristics. The increase in AMI risk from a one percentage point drop in unemployment (column c) is determined as the average difference between predicted fatality rates at the actual unemployment rate and one point below it. Additional deaths (column d) are estimated by multiplying the average change in fatality risk by the base number of deaths (shown in column a). The p-value (column e) refers to the null hypothesis of no change in AMI mortality.

The estimated rise in relative AMI fatality risk from a one point decrease in joblessness is similar for males and females (1.34 versus 1.24 percent) and possibly smaller for blacks (1.04 percent) than whites (1.32 percent), although estimates for the former group are imprecise. The coefficients suggest considerably larger increases for 20-44 year olds (2.37 percent) than for those 45-64 (0.92 percent) or 65 and over (1.41 percent), although the 95 percent confidence intervals do overlap.

The stronger economy is predicted to result in 2,515 extra heart attack deaths, almost equally split between men and women. While the greatest increase in relative risk occurs among 25-44 year olds, the vast majority of the additional AMI fatalities (2,220) are predicted to involve senior citizens, reflecting their much higher absolute risk. This highlights the importance of mechanisms whose effects are not limited to workers.

Income, Work Hours and Industry of Employment

Work hours, income and employment in cyclically sensitive sectors such as construction and manufacturing rise during economic upturns. In this sample, a one point drop in unemployment is associated with highly significant increases of 0.3 hours per week, $260 per person per year, and .08 and .10 percentage points, respectively, controlling for state and year effects, demographics and state time trends. Since these factors represent plausible pathways through which macroeconomic conditions might affect AMI fatalities, Table 5 shows the results of logit models in which they are included as supplementary covariates.

Per capita income, work hours, manufacturing and construction employment shares are all positively related to AMI fatalities when controlled for individually (see columns b through d of Table 5), although only the first and last of these approach statistical significance. If the four covariates are included simultaneously (specification e), the coefficient on work hours falls essentially to zero but the others are only slightly attenuated. In model (a), a one standard deviation increase in income, construction and manufacturing employment shares is predicted to raise the AMI death rate by 2.1, 0.8 and 1.2 percent. The coefficient on unemployment is reduced approximately 20 percent, in absolute value, compared to the base model (column a), suggesting that changes in employment patterns and income explain a non-trivial portion of the overall macroeconomic fluctuation but that other sources, like health behaviors, are even more important.

Dynamics

Changes in lifestyles or environmental factors may rapidly affect the risk of death from heart attacks. Even so, the impact of many health inputs seems likely to accumulate over time (Grossman, 1972), as does the ability of individuals to make adjustments that partially mitigate the deleterious effects of negative health shocks. Moreover, since unemployment rates are fairly highly correlated across years (the R^2 between the survey year rate and the average over the preceding five calendar years is .523), the specifications above probably capture the effects of macroeconomic influences occurring over a period considerably longer than one year.

These issues are examined by estimating models that hold constant the average unemployment rate during the five preceding calendar years (to proxy medium-term effects) and deviation of the survey year rate from this five-year average (representing the contemporaneous impact). The findings, summarized in Table 6, suggest that AMI mortality quickly rises when the economy strengthens and then increases further if macroeconomic conditions remain robust over the next several years. A one point drop in current unemployment, relative to the five-year average, is predicted to raise the full sample AMI fatality rate by 0.8 percent. This compares to an increase of 2.2 percent for a corresponding reduction during the preceding five years. The initial and medium-term consequences are similar across race and sex groups but with particularly large macroeconomic fluctuations again observed for 20-44 year olds.

Information on the adjustment to a sustained improvement in the economy is obtained from models that separately control for unemployment rates in the survey year and each of the preceding five years. Appendix Table A.1 shows selected predicted effects of a sustained one point drop in unemployment, with the full adjustment path summarized in Figures 3 and 4. Since there is no evidence of important sex or race differences, these subgroups are not shown in the figures or emphasized in the discussion.

These estimates again indicate that AMI death rates rise in the year the economy expands and grow further if the lower rate of joblessness is maintained. This can be seen in Figure 3, where the solid line shows the point estimate of the change in mortality risk and the dotted lines the 95 percent confidence interval. A one percentage point reduction in unemployment is predicted to reduce fatality rates by 1.0, 1.1, 1.3, 1.7, 2.1 and 2.3 percent after 0, 1, 2, 3, 4 and 5 years. This overall pattern conceals sharp age disparities. Figure 4, which displays point estimates only, demonstrates that the increase in AMI fatality risk is similar for 24-44, 45-64 and ≥65 year olds in the year unemployment declines – rising 0.7, 0.8 and 1.1 percent. However, 1, 2, 3, 4 and 5 years later, the risk of death is estimated to have grown by 2.2, 2.6, 3.6, 3.2 and 4.2 percent for 20-44 year olds, which is two to three times as large as the 0.8, 0.8, 1.2, 2.0 and 1.9 percent (1.2, 1.4, 1.9, 2.1 and 2.4 percent) increase for those aged 45-64 (65 and older).

DISCUSSION

Heart attack fatalities rise when the economy strengthens. A one percentage point drop in unemployment, representing a modest improvement in macroeconomic conditions, is estimated to raise AMI mortality by 1.3 percent, corresponding to more than 2,500 additional deaths. By contrast, fatalities from other types of coronary heart disease are little affected and those due to non-ischemic heart disease either do not change or fall slightly. Increases in the relative risk of AMI mortality are similar for males and females. The predicted effects are larger for whites than blacks but the estimates are not precise enough to indicate whether this represents a true racial disparity or sampling error. Conversely, the growth in risk appears to be greater for 20-44 year olds than older persons, particularly if the economic upturn is sustained. The higher risk of AMI death may seem surprising since some researchers have hypothesized that health improves in good times due to reductions in stress and economic insecurity (e.g. Brenner & Mooney, 1983; Catalano, 1991). However, these findings are consistent with a growing body of recent research (e.g. Gerdtham & Ruhm, 2002; Neumayer, 2004; Ruhm, 2000, 2003; Tapia Granados, forthcoming) showing that health worsens and mortality increases when the economy strengthens.

This ecological analysis measures how changes in the ambient economy affect individual AMI mortality. Thus, unemployment rates are used as the proxy for macroeconomic conditions, rather than to test how becoming jobless affects fatality risk. There is little doubt that nonemployed individuals are in worse average health than workers, although the direction of causation is poorly understood and there is mixed evidence on how the risk of death from AMI is affected (Gallo, Bradley, Falba, Dubin, Cramer, Bogardus et al., 2004; Gerdtham & Johannesson, 2003). Even if unemployment has negative consequences, overall AMI fatalities could increase when the economy strengthens if these effects are more than offset by higher risk for other individuals (e.g. because pollution levels or job-related pressures rise).

Two limitations of this study deserve mention. First, the econometric techniques may not fully account for confounding factors associated with sudden or irregular changes occurring within states (such as temporary bursts of immigration). Second, different findings might be obtained using macroeconomic proxies other than unemployment rates or for countries with different institutional environments than the United States (Gerdtham & Ruhm, 2004; Gerdtham & Johannesson, 2005). That said, the strategies used here far better control for omitted variables than those employed in most related previous research.

There are several reasons why heart attack deaths might rise when the economy improves. First, longer working hours could make it more difficult for individuals to undertake time-intensive health-producing activities such as exercise and consumption of a healthy diet (Chou, Grossman, & Saffer, 2004; Ruhm, 2004; Sokejima & Kagamimori, 1998). The extra hours also lead to reductions in sleep (Biddle & Hamermesh, 1990), which is linked to elevated stress, decreased alertness, greater injury risk, higher rates of obesity and increases in physiological or psychological symptoms (Sparks & Cooper, 1997). Second, risky activities such as heavy drinking and smoking rise (Ruhm, 2004; Ruhm & Black, 2002), although for reasons that are not fully understood. Higher income may play a role in promoting these unhealthy behaviors and has been associated with increases in deaths from cardiovascular disease (Chang, Marmot, Farley, & Poulter, 2002). Third, health may be an input into the production of goods and services. For example, job stress is a risk factor for AMI (Kivimaki, Leino-Arjas, Luukkonen, Riihimaki, Vahtera, & Kirjonen, 2002; Pickering, Clemow, Davidson, & Gerin, 2003) and may rise during economic expansions. The health risks in cyclically sensitive sectors like construction and manufacturing may also be exacerbated by increased hiring of inexperienced workers and speedups in production (Catalano, 1979; Brooker, Frank & Tarasuk, 1997). In support of these last two points, this analysis finds that income and the share of construction employment are positively related to AMI mortality. However, work hours are not consistently linked to heart attack deaths.

The mechanisms just mentioned are likely to be concentrated among individuals of prime-working age. Consistent with this, this investigation presents evidence of particularly large increases in relative risk for 20-44 year olds. Nevertheless, the greatest number of new deaths is predicted to occur among senior citizens –who rarely hold jobs. This unsurprising, given their high *absolute* level of AMI fatality risk, but such "spillovers" highlight the importance of causal pathways that are not limited to workers. Examples include air pollution and traffic congestion, that increase with economic activity, are linked to higher rates of CHD and may have particularly strong effects on vulnerable segments of the population (Braga, Zanobetti, & Schwarz, 2001; Brunekreef & Holgate, 2002; Clancy, Goodman, Sinclair et al., 2002; Peters, von Klot, Heier et al., 2004). Increases in the intensity of employment may also make it more difficult for workers to care for their aged dependents (Vistnes & Hamilton, 1995) and the geographic migration induced by economic expansions could lead to increased social isolation or loss of community support, with particularly detrimental impacts for the old and young (Eyer, 1977; Tapia Granados, 2004).

A rapid response of AMI mortality to fluctuations in macroeconomic conditions is consistent with strong effects of other short-term factors such as greater heart attack risk on Mondays, during the winter months, within one day of a rise air pollution or one hour of exposure to traffic (Clancy, Goodman, Sinclair, & Dockery, 2002; Kloner, Poole, & Perritt, 1999; Peters, von Klot, Heier et al., 2004; Willich, Lowel, Lewis, Hormann, Arntz, & Keil, 1994). That said, it makes sense that the effects of sustained changes in the economy accumulate over time, since health is a durable capital stock that gradually depreciates but is affected by flows of individual lifestyle behaviors and environmental conditions (Grossman, 1972). Moreover, higher mortality during *transitory* upturns does not imply negative effects of lasting economic progress. Temporary expansions involve more intensive use of labor and health inputs with existing technologies, whereas permanent growth results from productivity or technological improvements that may ameliorate costs to health. Reinforcing this distinction, some previous research finds that temporary income growth worsens health whereas permanently higher levels of wealth improve it (Graham, Chang, & Evans, 1992; Dustmann & Windmeijer, 2004).

These results obviously do *not* justify contractionary economic policies but they do indicate that temporary improvements in the economy need not have uniformly beneficial effects and imply that some previous advocates (e.g. Brenner, 1984) have overly enthusiastically cited an assumed procyclical variation in health as an argument in favor of macroeconomic stabilization policies. On the other hand, clinicians may need to make efforts to identify patients at higher risk of AMI when the economy strengthens. For instance, this may be an issue for those whose employment hours, pace of work or job stress have increased, and for groups who are particularly vulnerable to increases in air pollution or other negative by-products of an improving economy. Lastly, this evidence demonstrates that many aspects of health are "produced" by activities of individuals and society in ways that remain poorly understood.

References

Arnett, D.K., McGovern, P.G., Jacobs, D.R., Jr., Shahar, E., Duval, S., Blackburn, H., & Luepker, R.V. (2002). Fifteen-year trends in cardiovascular risk factors (1980-1982 through 1995-1997): the Minnesota Heart Survey. *American Journal of Epidemiology*, 156(10), 929-935.

Biddle, J.E. & Hamermesh, D.S. (1990). Sleep and the allocation of time. *Journal of Political Economy*, 95(5), 922-43.

Braga, A.L., Zanobetti, A., & Schwartz, J. (2001). The lag structure between particulate air pollution and respiratory and cardiovascular deaths in 10 US cities. *Journal of Occupational and Environmental Medicine*, 43(11), 927-933.

Brenner, M.H. (1971). Economic changes and heart disease mortality. *Am J Public Health*, 61(3), 606-611.

Brenner, M.H. (1979). Mortality and the national economy. A review, and the experience of England and Wales, 1936--76. *Lancet*, 2(8142), 568-573.

Brenner, M.H., & Mooney, A. (1983). Unemployment and health in the context of economic change. *Social Science Medicine*, 17(16), 1125-1138.

Brenner, M.H. (1984). *Estimating the effects of economic change on national health and social well being* Washington D.C.: Joint Economic Committee, U.S. Congress, U.S. Government Printing Office

Brooker, A-S., Frank, J. & Tarasuk, V. (1997). Back pain claims and the business cycle. *Social Science and Medicine*, 45(3), 429-39.

Brunekreef, B., & Holgate, S.T. (2002). Air pollution and health. *Lancet*, 360(9341), 1233-1242.

Bunn, A.R. (1979). Ischaemic heart disease mortality and the business cycle in Australia. *Am J Public Health*, 69(8), 772-781.

Catalano, R. (1979). Health costs of economic expansion: the case of manufacturing injuries. *American Journal of Public Health*, 69(8), 789-94.

Catalano, R. (1991). The health effects of economic insecurity. *American Journal of Public Health*, 81(9), 1148-1152.

Chang, C.-L., Marmot, M.G., Farley, T.M., & Poulter, N.R. (2002). The influence of economic development on the association between education and the risk of acute myocardial infarction and stroke. *Journal of Clinical Epidemiology*, 55(8), 741-747.

Chou, S.-Y., Grossman, M., & Saffer, H. (2004). An economic analysis of adult obesity: results from the Behavioral Risk Factor Surveillance System. *Journal of Health Economics*, 23(3), 565-587.

Clancy, L., Goodman, P., Sinclair, H., & Dockery, D.W. (2002). Effect of air-pollution control on death rates in Dublin, Ireland: an intervention study. *Lancet*, 360(9341), 1210-1214.

Cooper, R., Cutler, J., Desvigne-Nickens, P., Fortmann, S.P., Friedman, L., Havlik, R., Hogelin, G., Marler, J., McGovern, P., Morosco, G., Mosca, L., Pearson, T., Stamler, J., Stryer, D., & Thom, T. (2000). Trends and disparities in coronary heart disease, stroke, and other cardiovascular diseases in the United States: findings of the national conference on cardiovascular disease prevention. *Circulation*, 102(25), 3137-3147.

Dustmann, C. & Windeijer, F. (2004). Wages and the Demand for Health – A Lifecycle Analysis. Mimeo, University College London, May.

Eyer, J. (1977). Prosperity as a cause of death. *International Journal of Health Services*, 7(1), 125-150.

Forbes, J.F., & McGregor, A. (1984). Unemployment and mortality in post-war Scotland. *Journal of Health Economics*, 3(3), 239-257.

Gallo, W.T., Bradley, E.H., Falba, T.A., Dubin, J.A., Cramer, L.D., Bogardus, S.T., Jr., & Kasl, S.V. (2004). Involuntary job loss as a risk factor for subsequent myocardial infarction and stroke: findings from the Health and Retirement Survey. *Am J Ind Med*, 45(5), 408-416.

Gerdtham, U.G., & Johannesson, M. (2003). A note on the effect of unemployment on mortality. *J Health Econ*, 22(3), 505-518.

Gerdtham, U.G., & Johannesson, M. (2005). Business cycles and mortality: results from Swedish microdata. *Social Science and Medicine*, 60(1), 205-18.

Gerdtham, U.G., & Ruhm, C.J. (2004). Deaths rise in good economic times: evidence from the OECD. Mimeo, Lund University, June.

Graham, J., Chang, B., & Evans, J. (1992). Poorer is riskier. *Risk Analysis*, 12(3), 333-7.

Gravelle, H.S., Hutchinson, G., & Stern, J. (1981). Mortality and unemployment: A critique of Brenner's time-series analysis. *Lancet*, 2(8248), 675-679.

Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy*, 80(2), 223-255.

Grundy, S.M., Pasternak, R., Greenland, P., Smith, S., Jr., & Fuster, V. (1999). Assessment of cardiovascular risk by use of multiple-risk-factor assessment equations: a statement for healthcare professionals from the American Heart Association and the American College of Cardiology. *Circulation*, 100(13), 1481-1492.

Heidenreich, P., & McClellan, M. (2001). Trends in Heart Attack Treatments and Outcomes. In D.M. Cutler, & E.R. Berndt (Eds.), *Medical Care Output and Productivity* (pp. 363-409). Chicago: University of Chicago Press.

Johansson, E. (2004). A Note on the Impact of Hours Worked on Mortality in OECD Countries. *European Journal of Health Economics*, 5(4), 335-40.

Jones, A.M. (2000). Health Econometrics. In A.J. Culyer, & J.P. Newhouse (Eds.), *Handbook of health economics* (pp. 265-344). Handbooks in Economics, vol. 17. Amsterdam; New York and Oxford: Elsevier Science North-Holland.

Joyce, T. J., & H. Mocan, N. (1993). Unemployment and Infant Health: Time-Series Evidence from the State of Tennessee. *Journal of Human Resources*, 28(1), 185-203.

Kasl, S.V. (1979). Mortality and the business cycle: some questions about research strategies when utilizing macro-social and ecological data. *Am J Public Health*, 69(8), 784-788.

Kivimaki, M., Leino-Arjas, P., Luukkonen, R., Riihimaki, H., Vahtera, J., & Kirjonen, J. (2002). Work stress and risk of cardiovascular mortality: prospective cohort study of industrial employees. *British Medical Journal*, 325(7369), 857.

Kloner, R.A., Poole, W.K., & Perritt, R.L. (1999). When throughout the year is coronary death most likely to occur? A 12-year population-based analysis of more than 220 000 cases. *Circulation*, 100(15), 1630-1634.

Lin, Shin-Jong. 2005. The effects of economic fluctuations on health outcome: empirical evidence from Asia-Pacific countries. Mimeo, Ming Chuan University.

McAvinchey, I.D. (1988). A comparison of unemployment, income and mortality interaction for five European countries. *Applied Economics*, 20(4), 453-471.

McGovern, P.G., Jacobs, D.R., Jr., Shahar, E., Arnett, D.K., Folsom, A.R., Blackburn, H., & Luepker, R.V. (2001). Trends in acute coronary heart disease mortality, morbidity, and medical care from 1985 through 1997: the Minnesota heart survey. *Circulation*, 104(1), 19-24.

Minino, A.M., Arias, E., Kochanek, K.D., Murphy, S.L., & Smith, B.L. (2002). Deaths: final data for 2000. *Natl Vital Stat Rep*, 50(15), 1-119.

National Bureau of Economic Research (2002). Current Population Survey Merged Outgoing Rotation Groups, 1979-2001: National Bureau of Economic Research.

Neumayer, E. (2004). Recessions lower (some) mortality rates: evidence from Germany. *Social Science Medicine*, 58(6), 1037-1047.

Peters, A., von Klot, S., Heier, M., & et al. (2004). Exposure to traffic and the onset of myocardial infarction. *N Engl J Med*, 351(17), 1721-1730.

Pickering, T., Clemow, L., Davidson, K., & Gerin, W. (2003). Behavioral cardiology has its time finally arrived? *Mount Sinai Journal of Medicine*, 70(2), 101-112.

Ruhm, C.J. (2000). Are recessions good for your health? *Quarterly Journal of Economics*, 115(2), 617-650.

Ruhm, C.J., & Black, W.E. (2002). Does drinking really decrease in bad times? *Journal of Health Economics*, 21(4), 659-678.

Ruhm, C.J. (2003). Good times make you sick. *Journal of Health Economics*, 22(4), 637-658.

Ruhm, C.J. (2004). Healthy living in hard times. *Journal of Health Economics*. 24(2), 341-363.

Ruhm, C.J. (Forthcoming). Mortality increases during economic upturns. *International Journal of Epidemiology*.

Sokejima, S., & Kagamimori, S. (1998). Working hours as a risk factor for acute myocardial infarction in Japan: case-control study. *British Medical Journal*, 317(7161), 775-780.

Sparks, K. & Cooper, C. (1997). The effects of work hours on health: a meta-analytic review. *Journal of Occupational and Organizational Psychology*, 70(4), 391-408.

StataCorp (2003). *Stata Statistical Software: Release 8* College Station, TX: Stata Corporation

Tapia Granados, J. (2004). Recessions and mortality in Spain: reconceptualizing and empirical relationship. Mimeo, University of Michigan.

Tapia Granados, J. (Forthcoming). Increasing mortality during expansions of the U.S. economy, 1900-1996. *International Journal of Epidemiology.*

U.S. Department of Commerce; Bureau of Economic Analysis. *Regional Accounts Data*. Available at: http://www.bea.doc.gov/bea/regional/spi. Accessed January 29, 2002.

U.S. Department of Health and Human Services; Centers for Disease Control and Prevention, National Center for Health Statistics. (2000). Compressed Mortality File, 1968-88 CD-ROM Series 20, No. 2A.

U.S. Department of Health and Human Services; Centers for Disease Control and Prevention, National Center for Health Statistics. (2003). *Compressed Mortality File, 1989-98*, CD-ROM Series 20, No. 2E.

U.S. Department of Labor; Bureau of Labor Statistics. (2002). *Local Area Unemployment Statistics Database*. Available at: http:/www.bls.gov/lau. Accessed January 28,2002.

Vistnes, J.P., & Hamilton, V. (1995). The time and monetary costs of outpatient care for children. *American Economic Review*, 85(2), 117-121.

Wagstaff, A. (1985). Time series analysis of the relationship between unemployment and mortality: a survey of econometric critiques and replications of Brenner's studies. *Social Science Medicine*, 21(9), 985-996.

Willich, S.N., Lowel, H., Lewis, M., Hormann, A., Arntz, H.-R., & Keil, U. (1994). Weekly variation of acute myocardial infarction. Increased Monday risk in the working population. *Circulation*, 90(1), 87-93.

Appendix

Table A.1:
Effect of a Sustained 1.0% Point Drop in Unemployment on AMI Mortality

Group	Year Unemployment Falls	Two Years Later	Five Years Later
Full Sample	-.0103 (.0030)	-.0126 (.0029)	-.0227 (.0029)
Males	-.0105 (.0031)	-.0122 (.0031)	-.0243 (.0030)
Females	-.0099 (.0034)	-.0130 (.0033)	-.0206 (.0032)
Whites	-.0104 (.0029)	-.0129 (.0028)	-.0224 (.0028)
Blacks	-.0088 (.0063)	-.0091 (.0062)	-.0204 (.0063)
20-44 Year Olds	-.0071 (.0090)	-.0254 (.0083)	-.0412 (.0088)
45-64 Year Olds	-.0075 (.0041)	-.0077 (.0040)	-.0192 (.0040)
≥65 Year Olds	-.0109 (.0030)	-.0142 (.0029)	-.0242 (.0029)

Note: See notes on Tables 1 and 2. Table displays the predicted change in the log odds-ratio of AMI mortality from a 1.0 percentage point rise in unemployment that is sustained for the specified number of years. The equations correspond to specification (e) of Table 2, with additional controls for unemployment rates during each of the previous five years.

Table 1:
Summary Information on Variables Used in Analysis

Variable	Mean	Standard Deviation
Mortality Rates		
All Heart Disease	305.1	58.5
Acute Myocardial Infarction (AMI)	101.9	28.4
Other Coronary Heart Disease (CHD)	110.2	34.1
Heart Disease Other than CHD	92.9	17.7
Group-Specific AMI Mortality Rates		
Males	116.0	36.7
Females	88.7	21.9
Whites	110.4	30.6
Blacks	60.8	16.5
20-44 Year Olds	4.9	1.8
45-64 Year Olds	102.9	42.1
≥65 Years Old	656.2	152.8
State Demographic Characteristics		
<25 Years Old	37.2%	2.8%
≥65 Years Old	12.3%	2.1%
Black	12.5%	5.7%
Female	51.3%	0.7%
High School Education or Less	59.4%	8.2%
College Graduate	31.2%	4.1%
Other Variables		
State Unemployment Rate	6.6%	1.9%
Per Capita Disposable Income ($1988)	$21,309	$4,476
Weekly Work Hours	23.5	1.8
Construction Employment	4.6%	0.8%
Manufacturing Employment	14.7%	4.2%
State Population (in 1000's)	9,316	5,978

Note: Sample covers 1979-1998 and included the 20 states with the largest populations (California, New York, Texas, Florida, Pennsylvania, Illinois, Ohio, Michigan, New Jersey, North Carolina, Georgia, Virginia, Massachusetts, Indiana, Missouri, Tennessee, Wisconsin, Washington, Maryland and Minnesota). Except for the state population, sample statistics weight the cells by state-year populations. ICD-9 codes are 390-98, 402 and 404-29 for heart disease; 410 for AMI; 411-414 for other CHD; and 390-98, 402, 404, 415-29 for non-CHD heart disease. Mortality rates are per 100,000 population. Data on work hours, education and industry of employment are from the Current Population Survey (CPS) and refer to persons 25 and older. Work hours refer to the week prior to the CPS interview.

Table 2:
Logit Estimates of the Effects of Macroeconomic Conditions on AMI Mortality

Regressor	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**
Unemployment Rate	.0384 (.0067)	-.0087 (.0079)	-.0172 (.0020)	-.0154 (.0020)	-.0130 (.0019)	-.0131 (.0019)
% <25 Years Old					-2.615 (1.104)	-1.812 (1.107)
% ≥65 Years Old					7.424 (1.579)	3.182 (1.527)
% Black					4.709 (1.068)	4.537 (1.099)
% Female					-1.119 (3.697)	-7.618 (3.554)
% No College					.4872 (.2639)	.4711 (.2629)
% College Graduate					.7657 (.3614)	.6070 (.3599)
Year Effects	No	Yes	Yes	Yes	Yes	Yes
State Fixed-Effects	No	No	Yes	Yes	Yes	Yes
State Time-Trends	No	No	No	Yes	Yes	Yes
Age-Standardized	No	No	No	No	No	Yes

Note: See note on table 1. Table shows predicted effect of a one percentage point rise in the state unemployment rate on the natural logarithm of the odds-ratio of AMI mortality, from grouped data logit models estimated using minimum chi-squared methods. Standard errors are shown in parentheses. Sample includes the 20 largest states, based on population, and covers the time period 1979-1998 (n=400). Vectors of year and state dummy variables, state-specific linear time trends and demographic characteristics are incorporated as specified in the bottom panel. Mortality rates are age-adjusted to the 2000-year standard population in column (f).

Table 3:
Logit Estimates of the Effects of Macroeconomic Conditions on Mortality from Various Types of Heart Disease

Type of Mortality	(a)	(b)
All Heart Disease	-.0019 (.0010)	-.0021 (.0010)
Acute Myocardial Infarction	-.0130 (.0019)	-.0131 (.0020)
Coronary Heart Disease Other than AMI	-.0013 (.0024)	-.0028 (.0023)
Heart Disease Other than CHD	.0043 (.0026)	.0049 (.0026)
Age-Standardized	No	Yes

Note: See notes on tables 1 and 2. Table shows the predicted effect of a one percentage point rise in the state unemployment rate on the natural logarithm of the odds-ratio of the specified source of mortality. All models included vectors of state and year dummy variables, state-specific linear time trends and the demographic covariates included in models (e) and (f) of Table 2. Mortality rates are age-adjusted in column (b).

Table 4:
Estimated Effect of a 1.0% Point Drop in Unemployment on the AMI Mortality of Population Subgroups

Group	# Deaths (in 2000)	Change in AMI Mortality Risk			
		Logit Coefficient	**Increase in Risk**	**Additional Deaths**	**P-Value**
	(a)	**(b)**	**(c)**	**(d)**	**(e)**
All	192,898	-.0130 (.0019)	1.30% [0.92% – 1.69%]	2,515 [1,772 – 3,262]	<.001
Males	100,306	-.0134 (.0021)	1.34% [0.93% – 1.76%]	1,347 [934 – 1,761]	<.001
Females	92,592	-.0123 (.0022)	1.24% [0.81% – 1.70%]	1,148 [752 – 1,545]	<.001
Whites	170,584	-.0132 (.0019)	1.32% [0.95% – 1.70%]	2,257 [1,623 – 2,893]	<.001
Blacks	19,112	-.0103 (.0042)	1.04% [0.21% – 1.87%]	198 [41 – 357]	.014
20-44 Years Old	3,542	-.0235 (.0058)	2.37% [1.22% – 3.54%]	84 [43 – 125]	<.001
45-64 Years Old	31,890	-.0092 (.0026)	0.92% [0.40% – 1.44%]	293 [128 – 460]	.001
≥65 Years Old	157,414	-.0141 (.0020)	1.41% [1.02% – 1.80%]	2,220 [1,611 – 2,833]	<.001

Note: See note on tables 1 and 2. Table shows predicted effects of a one percentage point drop in the state unemployment rate on the relative risk of AMI mortality and the number of deaths, compared to 2000 year levels, with 95 percent confidence intervals in brackets. The logit models correspond to specification (e) of Table 2. The P-value refers to the null hypothesis of no change in mortality risk.

Table 5:
Logit Estimates of the Effects of Macroeconomic Conditions and Supplementary Variables on AMI Mortality

Regressor	**(a)**	**(b)**	**(c)**	**(d)**	**(e)**
Unemployment Rate	-.0130 (.0019)	-.0116 (.0021)	-.0115 (.0024)	-.0119 (.0020)	-.0107 (.0025)
Per Capita Income		.0059 (.0034)			.0046 (.0035)
Weekly Work Hours			.0049 (.0049)		.0010 (.0051)
Construction Employment				.0114 (.0048)	.0102 (.0049)
Manufacturing Employment				.0032 (.0030)	.0027 (.0031)

Note: See notes on Tables 1 and 2. Table shows predicted effect of the following changes on the log odds-ratio of AMI mortality a: one percentage point rise in unemployment; $1000 increase in average state per capita income ($1988); 1.0 percentage point increase in the fraction of the state population who employed in construction or manufacturing jobs. The equations also include the covariates in model (e) of Table 2.

Table 6:
Logit Estimates of Effects of Average Unemployment Rate During Previous Five Years and the Current Year on AMI Mortality

Group	5-Year Unemployment Rate	Difference Between Current and 5-Year Unemployment Rate
All	-.0225 (.0025)	-.0083 (.0021)
Males	-.0243 (.0027)	-.0080 (.0022)
Females	-.0200 (.0029)	-.0086 (.0023)
Whites	-.0222 (.0025)	-.0087 (.0020)
Blacks	-.0208 (.0056)	-.0056 (.0045)
20-44 Years Old	-.0425 (.0078)	-.0146 (.0062)
45-64 Years Old	-.0193 (.0036)	-.0041 (.0028)
≥65 Years Old	-.0239 (.0025)	-.0093 (.0021)

Note: See notes on Tables 1 and 2. Table shows predicted effect of a one percentage point rise in the state unemployment rate. The "5-year unemployment rate" refers to the average over the five calendar years preceding the survey date; the current rate refers to unemployment during the calendar year analyzed. The equations also include the covariates in model (e) of Table 2.

Figure 1: Trends in Unemployment and AMI Mortality

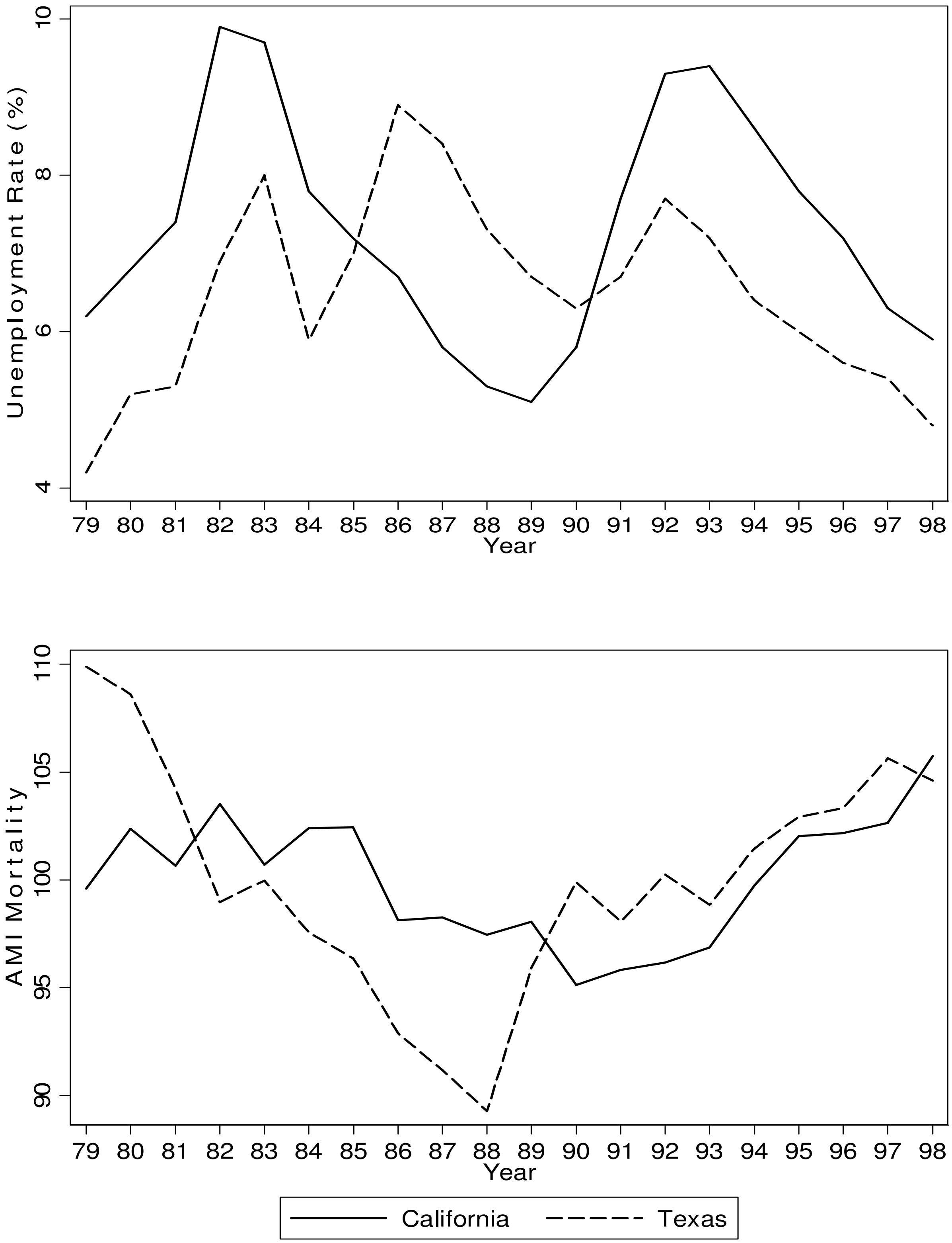

Figure 2: Unemployment and AMI Mortality Rates in California and Texas

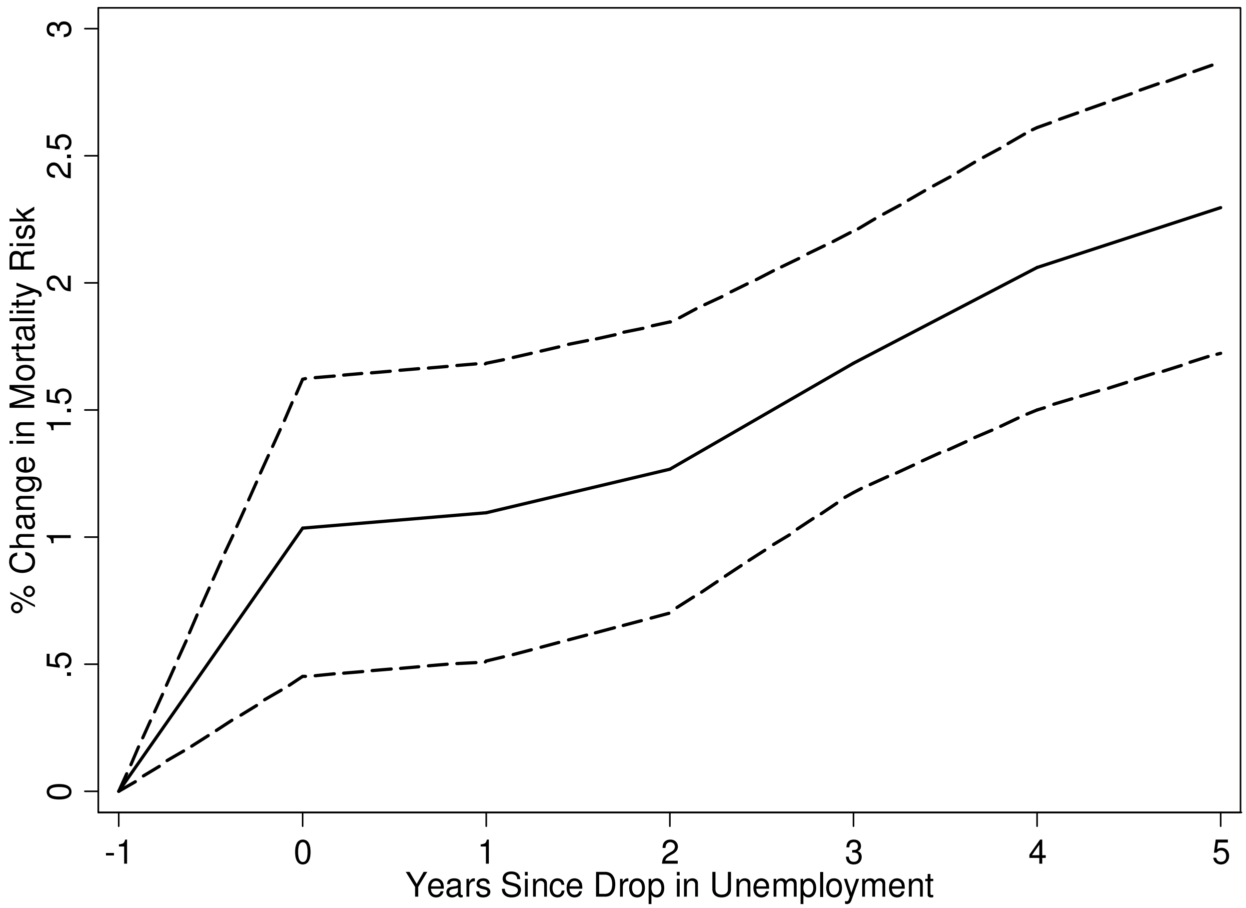

Figure 3: Effect of a Sustained 1.0 Percentage Point Drop in Unemployment on AMI Mortality

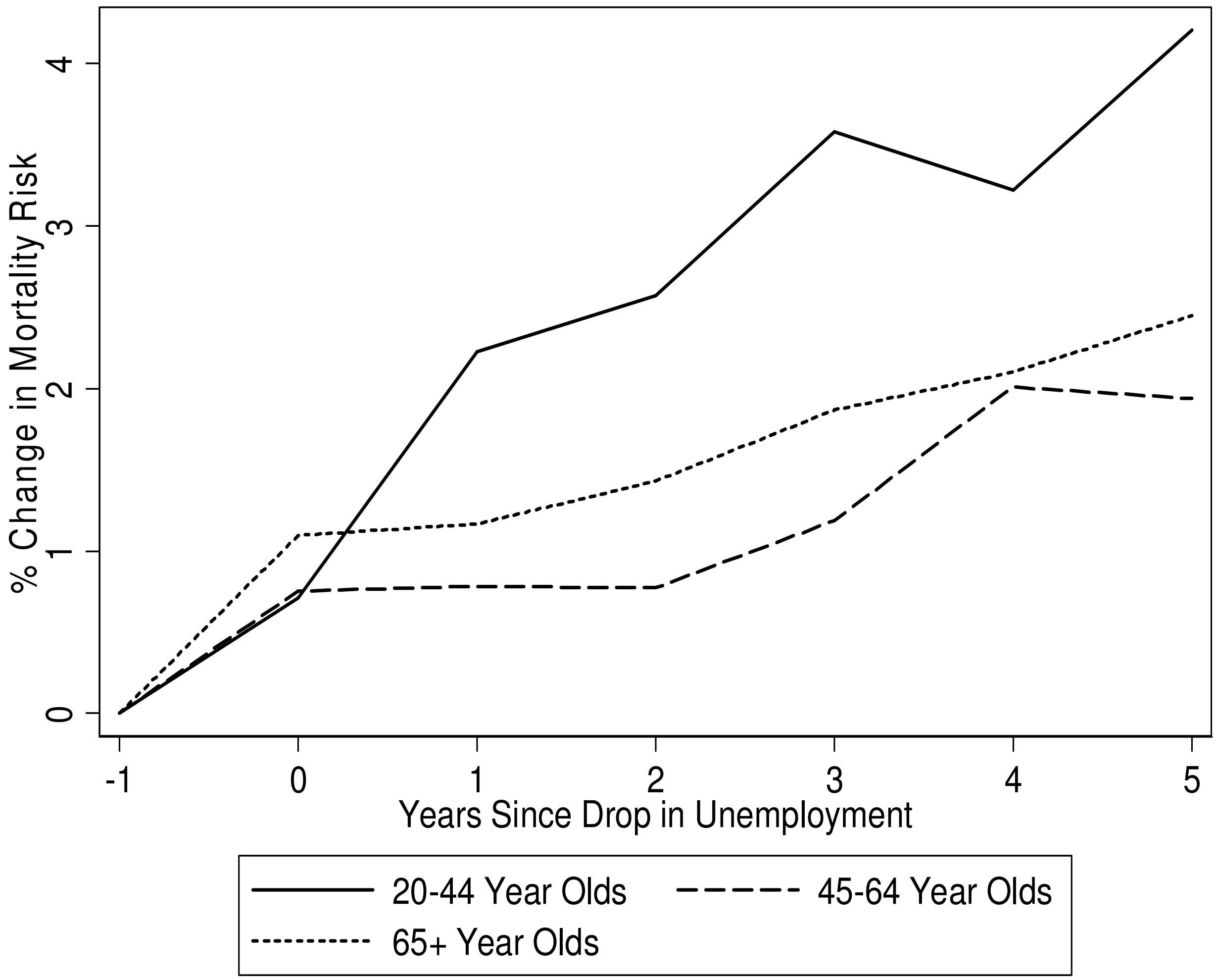

Figure 4: Effect of a Sustained 1.0 Percentage Point Drop in Unemployment Age-Specific AMI Mortality