A HEALTHY ECONOMY CAN BREAK YOUR HEART

By: Christopher J. Ruhm

Ruhm, C. " A Healthy Economy Can Break Your Heart" *Demography*, Vol. 44, No. 4, Nov. 2007, 829-848

Abstract:
Panel data methods are used to investigate how deaths from coronary heart disease (CHD) in the United States vary with macroeconomic conditions. A one-percentage-point reduction in unemployment is predicted to raise CHD mortality by 0.75%, corresponding to almost 3,900 additional fatalities. The increase in relative risk is similar across age groups, implying that senior citizens account for most of the extra deaths. Direct evidence is obtained of a role for decreases in medical interventions treating coronary problems. CHD mortality increases rapidly when the economy strengthens but returns to or near its baseline level within five years for most groups.

Article:
Does mortality from coronary heart disease (CHD) fall when macroeconomic conditions strengthen? The answer to this question may seem obvious. Heart disease is the leading source of death in the United States (Anderson and Smith 2005), and CHD, its most important component, is highly responsive to both environmental and individual risk factors. Because economic upturns are believed to reduce social and psychological hardship, health might be expected to improve and CHD mortality to decrease (Brenner and Mooney 1983; Catalano 1991). Moreover, widely cited investigations of aggregate time-series data covering the 1930s through the 1970s suggest reductions in CHD fatalities during periods of falling unemployment (Brenner 1971, 1979; Bunn 1979). However, these results are probably wrong. Evidence presented here suggests that mortality from heart disease rises when the economy expands and that this rise in heart-disease mortality is entirely due to increased CHD deaths.

How could the findings of the aforementioned time-series analyses be so at odds with the conclusions of this investigation? First, subsequent research has noted serious technical flaws in the methods used (Gravelle, Hutchinson, and Stern 198 1; Kasl 1979; Wagstaff 1985), and studies correcting the problems fail to replicate the findings (e.g., Forbes and McGregor 1984; Joyce and Mocan 1993; McAvinchey 1988). 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 coincided with wider availability of antibiotics that may have reduced mortality. Failure to fully control for these and other confounding factors leads to biased estimates and results that are sensitive to the choice of countries, time periods, and estimation methods (Ruhm 2005).

Instead of using national time-series data, this analysis uses longitudinal information from the United States on state mortality rates. Panel data permit the inclusion of controls for state fixed effects and general year effects, which fully account for time-varying determinants of death that are national in scope, as well as factors that differ across states but remain constant over time (Jones 2000). State-specific time trends are also incorporated in the models. These account for some (but possibly not all) confounding influences that fluctuate within states.

The estimates presented here indicate that declining unemployment raises overall and age-specific CHD fatality rates. Such results are consistent with recent research that used similar methods and provided evidence of increased mortality during economic expansions (Gerdtham and Ruhm 2006; Johansson 2004; Lin 2005; Neumayer 2004; Ruhm 2000; Tapia Granados 2005b). However, this investigation makes several new contributions. Most significantly, CHD is the focus rather than all fatalities or more broadly defined causes of cardiovascular-related deaths. This is important because CHD mortality has been widely studied, and the sources and timing of its determinants may differ markedly from those of other types of heart disease or other health outcomes. In particular, deaths from CHD respond rapidly to changes in environmental conditions, employment stressors, and health behaviors, including those that may vary with macroeconomic conditions (Grundy et al. 1999; Minino et al. 2002). Evidence of this is provided by systematic variations in CHD mortality by day of the week, season, air pollution levels, and exposure to traffic (Clancy et al. 2002; Kloner, Poole, and Perritt 1999; Peters et al. 2004; Willich et al. 1994), as well as increased fatality risk on birthdays and holidays (Phillips et al. 2004; Saposnik et al. 2006). The macroeconomic effects may vary by age, with direct labor market factors likely to be particularly important for persons in their prime working years, and with other environmental or individual risks predominating for older individuals. These issues are addressed through a detailed analysis of age-specific mortality, with distinctions made between CHD and other types of heart disease and, within CHD, for deaths attributable to acute myocardial infarction (AMI) versus other sources (such as angina pectoris or arteriosclerosis).[1]

Advanced medical interventions may substantially reduce deaths from CHD, particularly for seniors at special risk from even small, negative health shocks. This issue is addressed through a supplemental analysis of medical and surgical procedures used to treat coronary problems. The results indicate that these treatments become less common in good economic times and that this may explain a portion of the associated increase in CHD deaths. Such findings contrast with previous analyses, indicating procyclical fluctuations in other types of medical care, and also highlight the importance of detailed future research examining mechanisms for the observed health effects.

METHODS

Data and Outcomes

The primary dependent variable is the annual death rate from CHD (ICD-9 codes 410–414) in the 50 states and the District of Columbia over the 1979–1998 period (n = 1,020). Additional estimates are obtained for fatalities from AMI (ICD-9 code 4 10), 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 attributable to the specified cause divided by the state population. Data on these variables are from the Compressed Mortality Files (CMF), obtained from the Centers for Disease Control and Prevention (U.S. Department of Health and Human Services; Centers for Disease Control and Prevention 2000, 2003). The CMF provide information on all fatalities occurring in the given year (excluding deaths of foreign residents). Underlying cause of death is defined as the disease or injury initiating the sequence of events leading directly to death, or the circum-stances producing a fatal injury. Population data refer to U.S. Census Bureau estimates of residents in the state on July 1 of the specified year. Measurement error can occur if the cause of death is misclassified or if the population is incorrectly estimated. The first source of error is probably relatively minor; the second is discussed herein. Fatality rates are separately examined for men and women, and for six age groups (35–44, 45–54, 55–64, 65–74, 75–84, and ≥ 85 years old), with additional selected analyses of broader age ranges (55–74 and ≥ 75 years old).

The primary proxy for macroeconomic conditions is the annual state unemployment rate for the civilian, noninstitutionalized population aged 16 and older. Data are from the Local Area Unemployment Statistics (LAUS) database (Bureau of Labor Statistics 1979–1998). Most specifications control for the fraction of state residents who are female, black, have never attended college, and are college graduates. These data come from the Current Population Survey Merged Outgoing Rotation Group (CPS-ORG) extracts provided by the National Bureau of Economic Research (National Bureau of Economic Research 2006) .[2]

The analytic methods minimize the influence of confounding factors, such as changes in health behaviors and medical technologies. Several additional strategies are employed to directly test for remaining omitted variables bias. The role played by macroeconomic fluctuations in the composition of employment is examined by adding controls for the share of adults (25 and older) working in the cyclically sensitive construction and manufacturing industries.[3] A second set of specifications includes covariates for the prevalence of smoking and obesity (body mass index ≥ 30) because both represent modifiable lifestyle factors that are significant risk factors for CHD. These prevalence rates refer to adults (18 and older) and are taken from the Behavior Risk Factor Surveillance System (BRFSS; Centers for Disease Control and Prevention 1987–1998) for the years 1987–1998 (n = 555).[4]

State-level information on medical interventions used to treat CHD for 1994–2003 was obtained from The Dartmouth Atlas of Health Care (DAHC; Dartmouth Institute for Health Policy and Clinical Practice 1994–2003) (n = 510) and refers to hospital discharges involving 65- to 99-year-old, traditional (fee-for-service) Medicare beneficiaries. From these data, I estimate specifications for dependent variables representing annual hospital discharge rates attributable to AMI and those where the patient received coronary angiography, coronary artery bypass grafting (CABG), or percutaneous coronary interventions (PTCA). Angiography, usually done in conjunction with cardiac catheterization, is a diagnostic procedure for detecting coronary arterial narrowing or blockages, which can lead to a heart attack. CABG and PTCA (balloon angioplasty, with or without a stent) are alternative methods of treating such arterial blockage. Finally, because AMI discharges include both fatal and nonfatal heart attacks, it is useful to compare these results with findings for AMI mortality (among senior citizens) from the compressed mortality files.

Analytic Approach

Analyses of national time-series data are unlikely to adequately control for omitted determinants of CHD mortality. For instance, the sharp decline in heart attack deaths since the early 1980s partly resulted from increased use of aspirin therapy, thrombolysis, and other anticoagulants for acute in-hospital treatment; surgical interventions, such as cardiac catheterization and PTCA; and more rapid implementation of effective therapies (Heidenreich and McClellan 2001; McGovern et al. 2001; Rogers et al. 2000). Cardiovascular risk factors, such as hypertension, hypercholesterolemia, smoking, and fat consumption also were reduced throughout much of this period (Arnett et al. 2002; Cooper et al. 2000). These improvements occurred while the macroeconomy was generally strengthening—joblessness averaged 8.0% from 1979 to 1983 compared with 5.3% from 1994 to 1998—suggesting that economic conditions and CHD fatalities would be negatively correlated, even without a causal effect.

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

$$M_{jt} = \alpha_t + \mathbf{X}_{jt}\beta + U_{jt}\gamma + S_j + \varepsilon_{jt}, \qquad (1)$$

where M_{jt} is the natural logarithm of the mortality rate in state i at year t, U is the un-employment rate, **X** represents demographic characteristics, α is a year-specific effect, S is a state-specific intercept, and ε is the regression disturbance term.

The year dummy variables hold constant time-varying determinants that are national in scope, such as widely dispersed changes in medical practices. The state intercepts, often referred to as fixed effects, account for characteristics that differ across locations but remain constant over time (e.g., persistent heterogeneity in lifestyles, medical infrastructure, or population characteristics). The impact of the macroeconomy is therefore identified by within-state variations in unemployment, relative to the fluctuations occurring in other areas.[5] Note that unemployment rates are used here (as in most related research) to proxy underlying macroeconomic conditions rather than to indicate the health effects of individual job loss.[6]

Estimates of (1) will not account for confounding factors that vary over time within states except to the extent that they are captured by a parsimonious set of included demographic covariates. This problem can be substantially reduced by adding a vector of state-specific linear time trends ($S_j \times \mathbf{T}$) to the model .[7] Thus, the main estimation equation takes the form

$$M_{jt} = \alpha_t + \mathbf{X}_{jt}\beta + U_{jt}\gamma + S_j + S_j \times \mathbf{T} + \varepsilon_{jt}. \qquad (2)$$

The regressions are estimated by least squares, with observations weighted by the square root of the state population to account for heteroskedasticity. I also undertake extensive sensitivity testing. This includes examining the robustness of the results to excluding persons younger than 35 (who rarely die from CHD) or less populous states (where measurement error might be relatively large), calculating robust standard errors, and allowing for first-order autocorrelation with state-specific AR(1) coefficients. All statistical and econometric analysis is conducted by using the STATA software package (StataCorp 2005). [8]

The ket assumption of the estimation model is that the inclusion of state fixed effects, general time effects, state-specific trends, and the limited set of demographic characteristics account for all systematic determinants of mortality that are spuriously correlated with macroeconomic conditions. The potential for omitted variables bias is substantially reduced, but not completely eliminated, by using these procedures. The most plausible sources of remaining confounding are discontinuous changes in state characteristics not adequately captured by the state trends or demographics. For instance, rapid bursts of immigration could be problematic if the health status and personal characteristics of migrants differ substantially from those of the resident population. Because migrants are typically relatively healthy (Halliday 2006), such migration is likely to bias the results against finding increased mortality when the economy strengthens. However, the reverse bias could occur if migration introduces errors in the measurement of mortality rates. Specifically, because state populations (the denominator of fatality rates) are estimated for noncensus years, forecasting procedures that do not adequately account for migration flows will understate the population and thus overestimate death rates in states with high in-migration. If most migration is to states with robust economic conditions, this could induce a positive correlation between economic conditions and mortality.

The following discussion focuses on the effect of a one-percentage-point drop in the state unemployment rate. Changes in macroeconomic conditions of this magnitude (or larger) are common. For instance, the standard deviation of the unemployment rate in the main sample is 2.0 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 before falling 4.8 points by 1989. The effect of this reduction in unemployment is estimated as $e^{-\hat{\gamma}}-1$, for $\hat{\gamma}$ the regression coefficient on the state unemployment rate. The predicted variation in relative risk is also used to estimate the national change in CHD deaths, based on actual fatalities in 2000 (Minino et al. 2002).

Unemployment rates are highly correlated across years.[9] One consequence is that specifications controlling for only contemporaneous rates, such as Eqs. (1) and (2), capture macroeconomic influences that occur for considerably longer than one year. Two procedures are used to examine differences in the initial and medium-term effects of sustained economic expansions. The first involves estimating

$$M_{jt}=\alpha_t+\mathbf{X}_{jt}\boldsymbol{\beta}+\bar{U}_j\gamma+(U_{jt}-\bar{U}_j)\delta+S_j+S_j\times\mathbf{T}+\varepsilon_{jt}, \quad (3)$$

where $\bar{U}_j$ is the average unemployment rate during the five calendar years prior to the survey date, ($\bar{U}_j=1/5\sum_{k=1}^{5}U_{jt-k}$), and $(U_{jt}-\bar{U}_j)$ is the deviation of survey-year unemployment from this five-year average. Second, information on the full adjustment path is obtained from specifications holding constant unemployment rates in each year between $t-5$ and t:

$$M_{jt}=\alpha_t+\mathbf{X}_{jt}\boldsymbol{\beta}+\sum_{k=0}^{5}(U_{jt-k}\gamma_{t-k})+S_j+S_j\times\mathbf{T}+\varepsilon_{jt}, \quad (4)$$

with the cumulative impact of a one-point drop in joblessness lasting for n years ($0\le n\le 5$) estimated as

$$e^{\Gamma_n}-1 \text{ for } \Gamma_n=\sum_{k=0}^{n}-\hat{\gamma}_{t-k}.$$

$$e^{\Gamma_n}-1 \text{ for } \Gamma_n=\sum_{k=0}^{n}-\hat{\gamma}_{t-k}.$$

RESULTS

Descriptive Findings

Table 1 displays average values (weighted by population in the state and year) for selected variables. More than two-thirds of deaths from heart disease result from CHD and approximately half of the latter are due to heart attacks. Fatality risk from CHD rises sharply with age and is higher for men than for women.

Table 1. Summary Information on Selected Variables Used in the Analysis

Variable	Mean	*SD*
Age-Standardized Mortality Rates		
All heart disease	338.3	56.7
Coronary heart disease (CHD)	230.8	54.2
Acute myocardial infarction (AMI)	112.2	31.8
Heart disease other than CHD	107.5	24.4
Group-Specific CHD Mortality Rates		
Males (age-standardized)	306.8	73.7
Females (age-standardized)	176.5	42.6
Ages 25–34	2.8	1.1
Ages 35–44	20.4	7.1
Ages 45–54	89.6	30.4
Ages 55–64	269.6	76.5
Ages 65–74	682.6	176.0
Ages 75–84	1,689.0	404.9
Ages 85 or older	4,549.7	1,080.8
Hospital Discharges		
AMI	9.1	1.5
Coronary angiography	20.4	4.1
Coronary artery bypass grafting (CABG)	5.9	0.9
Percutaneous coronary interventions (PCTA)	8.6	2.4
State Characteristics		
State unemployment rate (%)	6.6	2.0
Black (%)	12.5	8.0
Female (%)	51.3	0.7
High school education or less (%)	59.7	8.6
College graduate (%)	20.8	4.4
Population (in millions)	1.06	0.83
Construction employment (%)	4.8	0.9
Manufacturing employment (%)	14.2	0.9
Obese (BMI ≥ 30) (%)	17.3	3.6
Current smoker (%)	23.5	2.9

Notes: Sample covers 1979–1998 unless otherwise noted. Sample statistics (other than state population) weight cells by state-year populations. ICD-9 codes are 390–398, 402, and 404–429 for heart disease; 410–414 for CHD; 410 for AMI; and 390–398, 402, 404, and 415–429 for non-CHD heart disease. Mortality rates are per 100,000 persons and, where noted, are age-standardized to the 2000-year standard population. Hospital discharges are per 1,000 traditional 65- to 99-year-old Medicare enrollees, with data obtained from the Dartmouth Atlas of Health Care (DAHC) for 1994–2003. Information on education and industry of employment are from the Current Population Survey and refer to adults aged 25 and older; those for smoking and obesity refer to adults aged 18 and older and are from the 1987–1998 Behavior Risk Factor Surveillance System.

Figure 1. Trends in Unemployment and Age-Standardized CHD Mortality

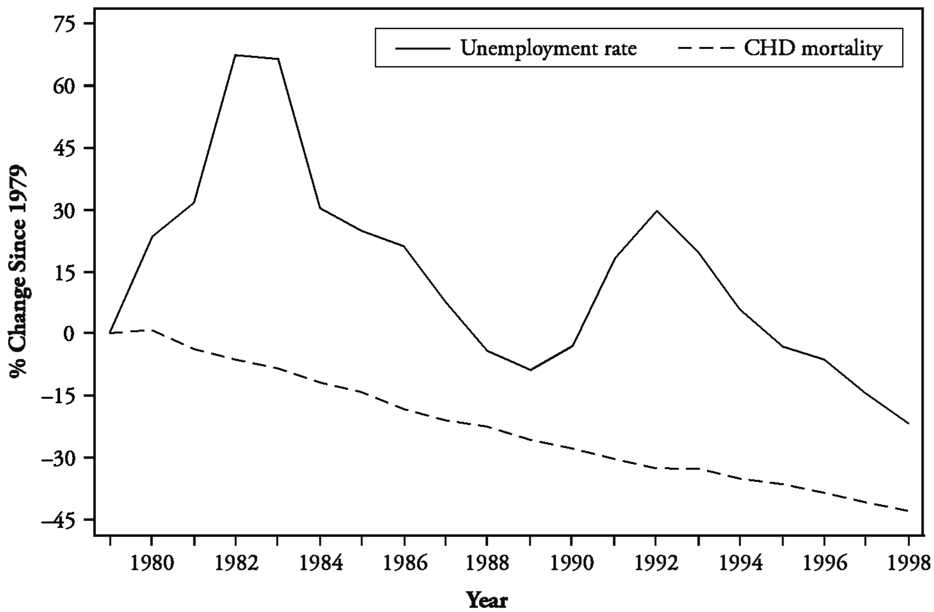

Figure 1 shows that unemployment increased during the recessions of the early 1980s and early 1990s but generally trended down, falling 22% between 1979 and 1998 (from 5.8% to 4.5%). Age-standardized CHD fatalities declined 43% (from 300.2 to 171.6 per 100,000) during the sample period.

A key advantage of examining mortality rates at the state level is that economic conditions evolve somewhat independently across locations. Consider California and Texas, the two most populous states. The top panel of Figure 2 demonstrates their different patterns of unemployment. California experienced sharper unemployment increases during the early 1980s and early 1990s, but joblessness rose substantially in Texas during the mid-1980s. The bottom panel shows corresponding age-adjusted CHD mortality rates, detrended and normalized to average 100 (in each state) during the two-decade period.[10] Notice that CHD 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 be spuriously correlated with macroeconomic conditions in either state but probably not in both simultaneously because their economies evolved so differently. The panel data econometric methods exploit this state-specific variation.

CHD Mortality Increases When Labor Markets Strengthen

Table 2 displays the unemployment rate coefficients from various specifications. The dependent variable is the (natural log of the) CHD fatality rate, and a negative sign corresponds to higher predicted mortality during economic expansions (when joblessness falls). The results in column a, where unemployment is the only covariate, indicate a positive correlation between joblessness and CHD deaths. This is expected because both variables trended downward during the sample period. The parameter estimate becomes small and insignificant when general time effects are incorporated (model b) and significantly negative with the inclusion of state fixed-effects (specification c). The coefficient increases in magnitude with the addition of state-specific trends (column d) and demographic characteristics (column e). A first attempt to account for the age structure of the population is provided in model f, where the dependent variable is the (log of the) CHD death rate age-standardized to the 2000-year standard population. Age-standardization attenuates the estimated effect, but it remains highly significant: a one-percentage-point drop in unemployment predicted to raise deaths by 0.75%; this corresponds to an elasticity of approximately –0.05.[11] The role of age is examined in greater detail later.

Figure 2. Unemployment and Age-Standardized CHD Mortality Rates in California and Texas

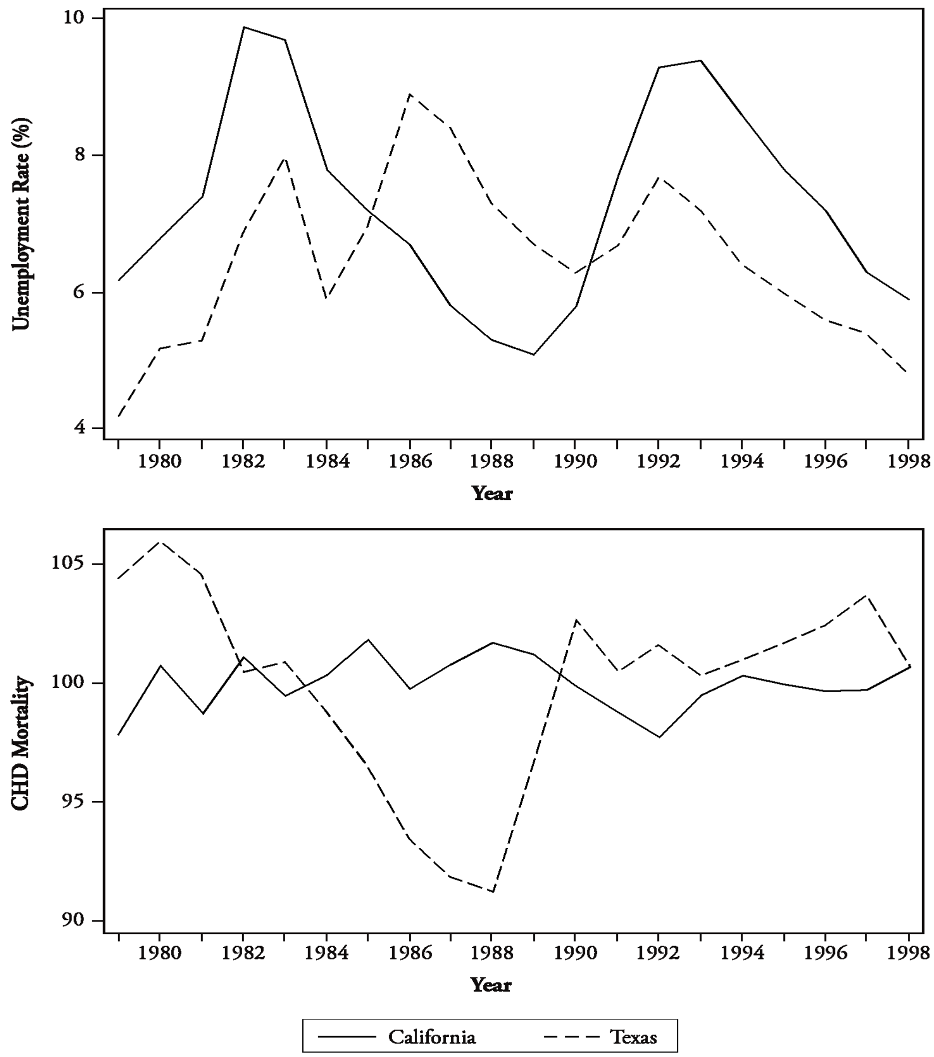

Table 2. Estimated Effect of a One-Percentage-Point Increase in Unemployment Rate on CHD Mortality

	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Unemployment Coefficient	0.0282	0.0034	−0.0045	−0.0077	−0.0091	−0.0075	−0.0094	−0.0074
	(0.0042)	(0.0053)	(0.0015)	(0.0012)	(0.0011)	(0.0010)	(0.0016)	(0.0010)
Year Effects	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effects	No	No	Yes	Yes	Yes	Yes	Yes	Yes
State Time Trends	No	No	No	Yes	Yes	Yes	Yes	Yes
Demographics	No	No	No	No	Yes	Yes	Yes	Yes
Age-standardized	No	No	No	No	No	Yes	Yes	Yes
20 Largest States Only	No	No	No	No	No	No	Yes	No
Ages 35 or Older Only	No	No	No	No	No	No	No	Yes

Notes: See the notes to Table 1. This table shows the predicted effect of a one-percentage-point rise in the state unemployment rate on the natural logarithm of CHD mortality. Standard errors are shown in parentheses. The sample includes the 50 states and the District of Columbia during the 1979–1998 period (n = 1,020). Vectors of year and state dummy variables, state-specific linear time trends, and demographic characteristics are incorporated as specified in the bottom panel. Demographic variables include the percentage of the state population who are black, female, without college education, and college graduates. Mortality rates are age-standardized to the 2000-year standard population in columns f through h. The sample in column g is restricted to the 20 largest states, based on population, and that in column h to individuals aged 35 and older.

The weighted least-squares estimates account for heteroskedasticity that is attributable to differences in state populations. As an alternative, I calculate robust standard errors. These are generally larger (0.0017 vs. 0.0010 for unemployment in model f), but statistical significance of the key findings is not affected. I also allow for autocorrelated errors, with state-specific AR(1) processes. The resulting unemployment coefficient was –0.0059 (with a standard error of 0.0016), again suggesting that mortality increases when the economy strengthens.

Column g restricts the sample to the 20 largest states (based on population); these states have the greatest number of deaths and least measurement error in the unemployment rate. 12 Excluding less populous states increases the magnitude of the unemployment coefficient by approximately 25% (compared with model f). Finally, specification h limits the analysis to persons 35 and older. This is done because CHD fatalities are extremely rare and may be idiosyncratic for younger individuals, possibly reducing the signal-to-noise ratio of the estimates.[13] The results, however, are virtually identical to those in column f.

Table 3. Estimated Effect of a One-Percentage-Point Drop in Unemployment on the CHD Mortality of Population Subgroups

Group	Unemployment Coefficient (a)	Number of Deaths (in 2000) (b)	Additional Deaths (c)
All	–0.0075 (0.0010)	515,204	3,876 [2,817–4,937]
Males	–0.0073 (0.0011)	260,574	1,910 [1,341–2,479]
Females	–0.0075 (0.0012)	254,630	1,913 [1,315–2,513]
Ages 35–44	–0.0072 (0.0039)	7,519	54 [–3–112]
Ages 45–54	–0.0070 (0.0023)	24,890	174 [59–290]
Ages 55–64	–0.0071 (0.0016)	47,737	339 [185–494]
Ages 65–74	–0.0078 (0.0013)	92,885	726 [491–962]
Ages 75–84	–0.0065 (0.0011)	163,692	1,074 [705–1,444]
Ages 85 or Older	–0.0086 (0.0014)	177,319	1,527 [1,021–2,033]

Notes: See the notes to Tables 1 and 2. This table shows the regression coefficient on unemployment and the predicted effect of a one-percentage-point drop in the state unemployment rate on the number of deaths, compared with 2000 year levels. Standard errors are in parentheses, and 95% confidence intervals are in brackets. The regression models also include controls for demographic characteristics, year and state effects, and state-specific time trends. Total, male, and female CHD mortality rates are age-standardized to the 2000-year standard population.

Increases in CHD Fatality Risk Are Widespread

Table 3 summarizes results for subgroups stratified by sex and age. Unless otherwise noted, all remaining specifications control for state and year effects, state-specific time trends, and demographic characteristics. Total and sex-specific fatality rates are also age-standardized. Column a shows the regression coefficient and standard error on the state unemployment rate. Estimated additional CHD deaths attributable to a one-percentage-point drop in un-employment, displayed in column c, are determined as the product of the expected change in relative risk multiplied by the base number of deaths in 2000 (presented in column b). A one-point fall in joblessness is predicted to result in almost 3,900 extra CHD deaths, equally split between men and women.

An important, and surprising, result is that the macroeconomic variation in relative risk is similar across sex and age groups: the unemployment rate coefficients vary from –0.0065 to –0.0086. Because mortality rates rise sharply with age, a vast majority of additional CHD deaths are therefore predicted to involve senior citizens: more than 85% among persons aged 65 or older and approximately 40% among those aged 85 or older.

Potential mechanisms for the macroeconomic fluctuations are examined through models adding plausible supplementary covariates. One set of regressions controls for shares of employment in manufacturing or construction industries (among adults 25 and older) because such jobs present health risks and increase disproportionately during economic upturns. A second specification accounts for the prevalence of obesity and smoking— unhealthy lifestyles linked to CHD deaths that some research (e.g., Ruhm 2004) has found to become more common when the economy strengthens. [14]

The results, summarized in Appendix Table A1, suggest that these are not key mechanisms. Positive predicted effects of construction and manufacturing employment shares on CHD mortality are obtained for 35- to 44-year-olds, but the coefficients are statistically insignificant, and their inclusion attenuates the parameter estimate on unemployment by just 17% (from –0.0072 to –0.0060). For the all-age fatality rate, the industry coefficient is smaller for manufacturing and negatively signed for construction, and only modestly affects the unemployment parameter estimates. Smoking and obesity prevalence are positively (but usually insignificantly) associated with CHD fatalities for 35- to 44-year-olds and at all ages. However, the inclusion of these controls again only slightly attenuates the unemployment coefficient: the point estimate changes from –0.0073 to –0.0071 for the full sample and from –0.0060 to –0.0056 for 35- to 44-year-olds.

CHD Deaths Explain the Macroeconomic Variation in Heart Disease Mortality

Two-thirds of deaths from heart disease are due to CHD. However, because CHD is likely to be particularly responsive to short-term changes in modifiable health behaviors and environmental conditions, it is anticipated to account for a still larger proportion of the total macroeconomic fluctuation in heart disease fatalities. Table 4 confirms this prediction. The dependent variables are mortality attributable to all types of heart disease (column a), CHD (specification b), and heart disease other than CHD (model c). The 0.75% rise in CHD deaths predicted to accompany a one-point reduction in unemployment is more than sufficient to explain the 0.25% increase estimated for mortality from all heart disease (see the first row of the table). Conversely, deaths from non-CHD sources (such as rheumatic heart disease or hypertensive disease) are predicted to decline by 0.5%.

Age differences in the macroeconomic effects on fatalities from heart disease are some-what larger than those for CHD fatalities. This mostly results from substantial disparities estimated for causes other than CHD, which are sometimes statistically significant but fail to exhibit any clear age pattern.

As an additional specification check, I estimate models (not shown) that decomposed CHD mortality into deaths from AMI and from other sources. The findings suggest that fatal heart attacks are particularly sensitive to the state of the economy. A one-point drop in unemployment is predicted to increase AMI fatalities by 0.99% (with a standard error of 0. 13%), compared with 0.53% for mortality from other types of CHD. The estimated AMI effect ranges from 0.66% for 45- to 54-year–olds to 1.34% for those 85 or older and exceeds the predicted impact for other CHD fatalities for each age group examined, although not always by statistically significant amounts.

CHD Fatalities Quickly Respond to Changing Macroeconomic Conditions

Research (Gerdtham and Ruhm 2006; Neumayer 2004; Ruhm 2000) indicates that the effects of sustained changes in macroeconomic conditions accumulate over time for many health outcomes. This is consistent with models (e.g., Grossman 1972) in which health capital is a stock that is gradually affected by flows of health investments. However, CHD deaths can exhibit a relatively rapid response because, as previously discussed, mortality risk varies with short-term factors, such as the day of the week, season, or 24-hour exposure to air pollution.

Table 4. Estimates of the Effects of Macroeconomic Conditions on Mortality From Various Types of Heart Disease

Group	All Heart Disease (a)	Coronary Heart Disease (b)	Non-CHD Heart Disease (c)
All	–0.0025 (0.0006)	–0.0075 (0.0010)	0.0049 (0.0018)
Ages 35–44	–0.0010 (0.0028)	–0.0072 (0.0039)	0.0043 (0.0050)
Ages 45–54	–0.0032 (0.0017)	–0.0070 (0.0023)	0.0012 (0.0038)
Ages 55–64	–0.0018 (0.0011)	–0.0071 (0.0016)	0.0076 (0.0027)
Ages 65–74	–0.0032 (0.0009)	–0.0078 (0.0013)	0.0055 (0.0023)
Ages 75–84	–0.0015 (0.0008)	–0.0065 (0.0011)	0.0067 (0.0021)
Ages 85 or Older	–0.0036 (0.0010)	–0.0086 (0.0014)	0.0018 (0.0020)

Notes: See the notes to Tables 1–3. This table shows the predicted effect of a one-percentage-point rise in unemployment on the natural logarithm of the specified source of mortality. Standard errors are shown in parentheses. The regression models also include controls for demographic characteristics, year and state effects, and state-specific time trends. Total mortality rates are age-standardized to the 2000-year standard population.

This issue is examined with models, corresponding to Eq. (3), that hold constant aver-age unemployment rates during the five preceding calendar years (to proxy medium-term effects) and deviations of the survey-year rate from this average (to indicate the contemporaneous impact). The findings, summarized in Table 5, suggest that CHD mortality declines quickly when the economy weakens but that the initial reduction dissipates fairly rapidly. For instance, a one-point increase in current unemployment (relative to the five-year aver-age) cuts the predicted full sample fatality rate by 0.92%, but there is no effect of a corresponding rise in joblessness during the preceding five years. The only groups providing evidence of a persisting effect are those aged 35–44 and 65–74, and the initial effects attenuate substantially even for them.

To provide a more complete indication of the adjustment path, Table 6 displays predicted effects of a lasting one-point increase in joblessness. These were obtained from estimates of Eq. (4) that incorporate a five-year lag in unemployment rates. Full sample results indicate that CHD death rates fall sharply in the year when the economy contracts and decrease further in the next year before returning to long-run levels by the end of five years. A one-percentage-point rise in unemployment is predicted to reduce CHD fatalities by 0.71, 0.82, 0.62, 0.41, 0.16, and –0.03% after 0, 1, 2, 3, 4, and 5 years, respectively.

The overall pattern conceals significant age disparities. The remainder of Table 6 demonstrates that CHD fatality risk falls more gradually for persons aged 35–44 than for older individuals, but that the decrease for them is ultimately larger and longer-lasting.[15] Thus, a sustained one-point rise in unemployment is predicted to leave the death rate of 35- to 44-year-olds essentially unchanged in the year it takes place, with a maximum drop of 1. 19% occurring after two years. By contrast, the estimated reductions are 0.3 5%, 0.90%, and 0.68% in Year 0 for persons aged 45–54, 55–74, and 75 or older, respectively; 0.79%, 0.86%, and 0.88% in the next year; and 0.13%, 0.66%, and 0.65% in Year 2. The change in death rates attenuates substantially after the second year for all age groups, with point estimates ranging between 0.03% and 0.41% in Year 4.

Table 5. Estimates of the Effects of the Average Unemployment Rate During the Previous Five Years and the Current Year on CHD Mortality

Group	Five-Year Average Unemployment Rate	Difference Between Current and Five-Year Unemployment Rate
All	–0.0003	–0.0092
	(0.0016)	(0.0011)
Ages 35–44	–0.0063	–0.0073
	(0.0060)	(0.0041)
Ages 45–54	0.0044	–0.0093
	(0.0035)	(0.0025)
Ages 55–64	–0.0001	–0.0090
	(0.0024)	(0.0017)
Ages 65–74	–0.0057	–0.0079
	(0.0019)	(0.0014)
Ages 75–84	–0.0012	–0.0078
	(0.0017)	(0.0012)
Ages 85 or Older	0.0013	–0.0110
	(0.0021)	(0.0015)

Notes: See the notes to Tables 1–3. This table shows predicted effect of a one-percentage-point rise in the state unemployment rate. Standard errors are shown in parentheses. The "five-year average unemployment rate" refers to the average during the five calendar years preceding the survey date; the current rate refers to unemployment during the calendar year analyzed. The regression models also include controls for demographic characteristics, year and state effects, and state-specific time trends. Total CHD mortality rates are age-standardized to the 2000-year standard population.

Table 6. Effect of a Sustained One-Percentage-Point Rise in Unemployment on CHD Mortality

	Years Since Rise in Unemployment					
Group	0	1	2	3	4	5
All	–0.0071	–0.0082	–0.0062	–0.0041	–0.0016	0.0003
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0017)	(0.0017)
Ages 35–44	0.0006	–0.0060	–0.0119	–0.0074	–0.0041	–0.0033
	(0.0060)	(0.0061)	(0.0061)	(0.0059)	(0.0063)	(0.0066)
Ages 45–54	–0.0035	–0.0079	–0.0013	–0.0021	–0.0003	0.0087
	(0.0036)	(0.0037)	(0.0036)	(0.0035)	(0.0037)	(0.0039)
Ages 55–74	–0.0090	–0.0086	–0.0066	–0.0052	–0.0031	–0.0037
	(0.0019)	(0.0020)	(0.0020)	(0.0019)	(0.0020)	(0.0021)
Ages 75 or Older	–0.0068	–0.0088	–0.0065	–0.0044	–0.0013	0.0009
	(0.0017)	(0.0018)	(0.0018)	(0.0017)	(0.0018)	(0.0019)

Notes: See the notes to Tables 1–3. This table displays the predicted change in the natural logarithm of CHD mortality from a one-percentage-point rise in unemployment that is sustained for the specified number of years. Standard errors are shown in parentheses. Estimates are from regression models that include controls for demographic characteristics, year and state effects, state-specific time trends, and unemployment rates in the survey year and the preceding five years. Total mortality rates are age-standardized to the 2000-year standard population.

Table 7. Estimated Effect of One-Percentage-Point Rise in Unemployment on Selected Hospital Discharges and AMI Mortality Among Senior Citizens

Type of Hospital Discharge/Mortality	No State Time Trends (a)	State Time Trends Included (b)
Hospital Discharges		
Acute myocardial infarction (AMI)	–0.0090 (0.0042)	0.0063 (0.0048)
Coronary angiography	0.0165 (0.0039)	0.0098 (0.0041)
Coronary artery bypass grafting (CABG)	0.0179 (0.0045)	0.0119 (0.0044)
Percutaneous coronary interventions (PCTA)	0.0227 (0.0069)	0.0159 (0.0062)
AMI Mortality	–0.0113 (0.0019)	–0.0102 (0.0013)

Notes: The table shows predicted effect of a one-percentage-point rise in the state unemployment rate on the natural logarithm of specific categories of hospital discharges and deaths attributable to AMI. Standard errors are shown in parentheses. The hospital discharge sample includes 65- to 99-year-old Medicare beneficiaries, using data obtained from the Dartmouth Atlas of Health Care (DAHC) for 1994–2003 (*n* = 510). AMI mortality is from the Compressed Mortality Files for 1979–1998 and refers to persons aged 65 and older. The regression models also include controls for educational attainment; year and state effects; and, in column b, state-specific time trends.

Medical Interventions Provide a Possible Mechanism for the Variation in CHD Deaths

Advanced medical treatments for CHD become less common in good economic times, providing a likely mechanism for the associated increase in fatalities. Evidence of this comes from a supplementary analysis of the DAHC, containing data on hospital discharges for 65- to 99-year-olds during 1994–2003. Two models are estimated. The first includes covariates for educational attainment and state and time effects; the next adds controls for state-specific trends. [16] Although the second specification would generally be preferred because it more comprehensively accounts for unobservables, the relatively short time period implies that the trends absorb a large portion of the variation in macroeconomic performance, making it difficult to identify independent effects of the latter.

The first row of Table 7 shows that a one-percentage-point drop in unemployment predicts a statistically significant 0.90% increase in hospitalizations for heart attacks in the model without trends. When trends are included, the coefficient reverses sign, resulting in a statistically insignificant 0.63% decrease in predicted AMI. The last row of the table shows corresponding changes in fatal heart attack risk among senior citizens (those aged 65 or older), based on the compressed mortality file sample covering 1979–1998. Here, a one-point fall in joblessness is associated with a 1.02%–1. 14% increase in AMI deaths.

Interpretation of two sets of findings depends on whether the model with or without trends provides the more accurate indication of the macroeconomic variation in AMI discharges. Without controlling for trends, a stronger economy predicts that fatal and nonfatal heart attacks increase by approximately equal amounts. When trends are included, AMI risk is anticipated to remain constant or decrease while fatal heart attacks are still estimated to rise. The DAHC data cover too short a period to rule out either possibility, but a reasonable hypothesis is that the true effect on AMI discharges lies between the two estimates. This would imply a stronger macroeconomic effect on fatal than on nonfatal heart attacks.

Some of the procyclical variation in AMI mortality seems likely to occur because senior citizens receive fewer medical treatments for coronary problems in boom times. As shown in the second through fourth rows of Table 7, a reduction in unemployment is associated with lower rates of coronary angiography, CABG, and PTCA. The effects are somewhat attenuated in model b, which includes state-specific trends, but remain highly significant. In this specification, a one-point drop in joblessness is predicted to decrease angiography, CABG, and PTCA by a statistically significant 0.98%, 1.20%, and 1.60%, respectively. Thus, decreases in medical care could help to explain why fatal heart attacks increase when economic conditions improve.

DISCUSSION

Deaths from heart disease rise when the economy strengthens because of increases in CHD mortality. A one-percentage-point drop in unemployment, which represents a modest improvement in macroeconomic conditions, is estimated to raise CHD fatalities by 0.75%, corresponding to almost 3,900 additional deaths annually and an elasticity of around –0.05. By contrast, mortality from other types of heart disease is predicted to decline. Increases in the relative risk of CHD death are similar across age groups and largely result from an increase in fatal heart attacks. The growth in mortality quickly follows the improvements in economic conditions but is generally fairly short-lasting, returning to or near its initial level within five years.

CHD fatalities might increase when the economy improves because long working hours make it more difficult for individuals to undertake time-intensive health-producing activities, such as exercise and eating a healthy diet (Chou, Grossman, and Saffer 2004; Ruhm 2004; Sokejima and Kagamimori 1998). Long working hours also lead to reductions in sleep (Biddle and Hamermesh 1990), which are linked to elevated stress; decreased alertness; and greater rates of injuries, obesity, and physiological or psychological symptoms (Sparks and Cooper 1997). Health-risk behaviors, such as heavy drinking and smoking, grow as well during such periods (Ruhm 2004; Ruhm and Black 2002), partly because of higher incomes (Chang et al. 2002). Job stress, which correlates with deaths from cardio-vascular disease (Kivimaki et al. 2002; Pickering et al. 2003), might similarly rise. And the health risks of employment in cyclically sensitive sectors, such as construction and manufacturing, may be exacerbated by hiring inexperienced workers and implementing production speedups (Brooker, Frank, and Tarasuk 1997; Catalano 1979).

However, there is reason to doubt that any of these mechanisms are of primary importance. The effects of each would probably be concentrated among prime-working-age individuals, whereas equally strong changes in relative mortality risk were obtained for persons aged 65 and older (who seldom hold jobs). Consistent with this, little of the macroeconomic fluctuation was accounted for by adding controls for the industrial composition of employment or the prevalence of obesity and smoking.

Instead, most of the variation in deaths involves senior citizens, reflecting their high absolute fatality rates and emphasizing the importance of pathways that extend beyond workers. Examples include air pollution and traffic congestion, which rise with economic activity and may have particularly strong effects on the mortality of vulnerable segments of the population (Braga, Zanobetti, and Schwartz 2001; Brunekreef and Holgate 2002; Clancy et al. 2002; Peters et al. 2004). Geographic migration, induced by economic expansions, could similarly increase social isolation and reduce community support, with particularly detrimental impacts for the old and young (Eyer 1977; Tapia Granados 2005b). Heightened intensity of employment may also make it harder for workers to care for their aged dependents (Vistnes and Hamilton 1995).

The results of a supplemental analysis examining patterns of medical care are particularly intriguing. They indicate that an improving economy reduces the likelihood that senior citizens receive coronary angiography, CABG, or PTCA. A portion of the increase in deaths from CHD may therefore reflect reductions in associated medical procedures. Evidence of larger variations in fatal than nonfatal heart attacks is consistent with this. Although Dehejia and Lleras-Muney (2004) showed that prenatal care is less often received by pregnant women during good economic times, the reductions in CHD treatments are at odds with evidence that most types of medical care become more common when the economy strengthens (Ruhm 2000, 2003). Further investigation of these patterns is warranted.

Fatalities from CHD respond faster to changes in macroeconomic conditions than most other disease-related causes of death but also return more rapidly to or near baseline levels.[17] This demonstrates that higher mortality during transitory upturns does not necessarily imply negative effects of lasting progress. One explanation is that temporary expansions require more intensive use of labor and health inputs, whereas permanent growth results from productivity or technological improvements that may ameliorate costs to health.[18]

Several caveats deserve mention. First, this ecological analysis measures how changes in the ambient economy affect individual CHD mortality. Thus, unemployment rates proxy macroeconomic conditions, but no attempt has been made to examine how the loss of a job affects fatality risk.[19] Second, the econometric techniques may not fully account for sudden or irregular changes occurring within states, such as temporary bursts of immigration. Third, including more complete controls for individual and environmental risks might help to identify mechanisms for the results. More generally, future analyses of microdata would permit in-depth study of how personal characteristics ameliorate or magnify the observed effects. Fourth, different findings might be obtained by using macroeconomic proxies other than unemployment rates or for countries with institutional environments that differ from those of the United States (Gerdtham and Johannesson 2005; Gerdtham and Ruhm 2006). That said, the strategies used here to control for omitted variables are far better than those in most related previous research.

These results obviously do not justify contractionary economic policies. Recessions have overwhelmingly negative consequences even if they do not raise deaths from CHD. On the other hand, the findings suggest that some previous advocates (e.g., Brenner 1984) have overly enthusiastically cited an assumed procyclical variation in health as an argument favoring macroeconomic stabilization policies. Interventions designed to reduce the negative health effects of expansions are, instead, likely to be microeconomic (rather than macroeconomic) in nature, as has been detailed elsewhere (Edwards 2005; Ruhm forthcoming). Finally, this analysis suggests that policy-makers and clinicians should take steps to ensure that patients with high risk of CHD receive beneficial medical treatments, particularly during economic upturns.

Appendix Table A1. Supplementary Estimates of the Effects of Macroeconomic Conditions on CHD Mortality

	All Ages		Ages 35–44	
Variable	(a)	(b)	(a)	(b)
Panel A.				
Unemployment rate	–0.0075 (0.0010)	–0.0081 (0.0011)	–0.0072 (0.0039)	–0.0060 (0.0040)
Construction employment		–0.0109 (0.0023)		0.0108 (0.0087)
Manufacturing employment		0.0009 (0.0015)		0.0048 (0.0057)
Panel B.				
Unemployment rate	–0.0073 (0.0017)	–0.0071 (0.0017)	–0.0060 (0.0081)	–0.0056 (0.0081)
Current smoker		0.0004 (0.0009)		0.0058 (0.0041)
Obese (BMI ≥ 30)		0.0031 (0.0009)		0.0019 (0.0044)

Notes: See the notes to Tables 1–3. This table shows the predicted effect on the natural logarithm of CHD mortality of a one-percentage-point increase in the fraction of the state adult population employed in construction or manufacturing jobs (Panel A) and of a one-percentage-point increase in the state adult population who are current smokers or are obese (Panel B). The regressions also control for demographic characteristics, year and state effects, and state-specific time trends. Standard errors are shown in parentheses. The sample in the bottom panel is limited to the years 1987–1998 and to states where BRFSS data are available on the specified health behaviors (n = 555). Total mortality rates are age-standardized to the 2000-year standard population.

Notes:

1. CHD is a narrowing of the small blood vessels that supply blood and oxygen to the heart, which usually occurs when fatty material and plaque builds up on the artery walls. When coronary arteries narrow, blood flow to the heart can slow down or stop, causing chest pain, shortness of breath, heart attack (AMI), and other symptoms. Heart disease other than CHD encompasses a wide variety of problems, including hypertensive, rheumatic, and pulmonary heart disease.

2. Education refers to persons 25 and older. Prior to 1992, this information indicated 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 were placed in the no college (college graduate) category.
3. Data on industry of employment are from the CPS-ORG.
4. The BRFSS began in 1984 but included only 15 states in that year. Data were available for 32 states and the District of Columbia by 1987, with all 50 states participating from 1996 onward.
5. Ruhm (2000) provided evidence that labor market conditions exhibit considerable independent variation across states over time, which is necessary for the fixed-effect methods employed in this analysis to be useful.
6. I do not include group-specific (e.g., age-specific or sex-specific) unemployment rates for the same reason. The state rates, however, may not fully account for more localized variations in factors like air pollution.
7. The trends are measured as years elapsed since 1978.
8. The model specified by Eqs. (1) and (2) is used because it has become standard in the related literature and has a number of advantages over possible competitors. For instance, it gives unbiased results when the (time-invariant) state-specific component is correlated with the other explanatory variables, whereas the random-effects estimator does not. Another alternative, the first-difference model, provides more efficient estimates if the error term follows a random walk but is less efficient without serial correlation. The latter assumption appears closer to being correct: $\hat{\rho} = 0.36$ in a model allowing for serial correlation. In future research, it would be interesting to estimate specifications that allow deteriorations and improvements in economic conditions to have asymmetric effects.
9. For example, the correlation coefficient between the survey-year unemployment rate and the average rate during the preceding five years is .63.
10. CHD deaths trended downward in California and Texas, as they did for the entire country. The fatality rates were age-standardized to the 2000-year standard population and were detrended by using the following procedure: (1) state-specific mortality rates were regressed on a state-specific linear time trend measuring years elapsed since 1979; and (2) the detrended rate was calculated by subtracting from the actual rate the product of the trend coefficient and number of years since 1979. Detrended fatality rates were then normalized to 100 by dividing by the state-specific average and then multiplying this amount by 100.
11. A one-point fall in unemployment is a 15.2% decrease at the sample average of 6.6%. Coefficients on the demographic variables generally conform to expectations. Most importantly, age-standardized death rates are predicted to fall dramatically as the population share of females increases.
12. These 20 states account for around three-quarters of national CHD deaths and have similar mortality patterns to the entire country.
13. The analysis of age-specific mortality that follows concentrates on persons 35 and older for the same reason.
14. A one-point drop in unemployment is associated with highly significant 1.3% and 0.7% increases in construction and manufacturing employment (at the sample average), controlling for state and year effects, demographics, and state time trends. Similarly, for states and years in which BRFSS data on obesity and smoking are available, a one-point reduction in joblessness predicts a 0.3% (0.7%) increase in obesity (smoking), at the sample mean.
15. Table 6 combines four age groups (55–64, 65–74, 75–84, and 85 or older) into two for clarity of display, but the results are similar when these age categories are separated.
16. Race/ethnicity is not included because reliable estimates are unavailable for years after the 2000 census.
17. For example, the adjustment path is more similar to that observed for traffic fatalities than for deaths from influenza/pneumonia or liver disease.
18. Reinforcing this distinction, some previous research found that temporary income growth worsens health, whereas permanently higher levels of wealth improve it (Dustmann and Windmeijer 2004; Graham, Chang, and Evans 1992).

19. There is little doubt that nonemployed individuals are relatively unhealthy; however, causation is dif~ cult to determine, and mixed evidence exists as to how employment status affects the risk of death from CHD (Gallo et al. 2004; Gerdtham and Johannesson 2003).

REFERENCES

Anderson, R.N. and B.L. Smith. 2005. "Deaths: Leading Causes for 2002." *National Vital Statistics Reports* 53(17). Hyattsville, MD: National Center for Health Statistics.

Arnett, D.K., P.G. McGovern, D.R. Jacobs, Jr., E. Shahar, S. Duval, H. Blackburn, and R.V. Luepker. 2002. "Fifteen-Year Trends in Cardiovascular Risk Factors (1980–1982 Through 1995–1997): The Minnesota Heart Survey." *American Journal of Epidemiology* 156:929–35.

Biddle, J.E. and D.S. Hamermesh. 1990. "Sleep and the Allocation of Time." *Journal of Political Economy* 95:922–43.

Braga, A.L., A. Zanobetti, J. Schwartz. 2001. "The Lag Structure Between Particulate Air Pollution and Respiratory and Cardiovascular Deaths in 10 US Cities." *Journal of Occupational and Environmental Medicine* 43:927–33.

Brenner, M.H. 1971. "Economic Changes and Heart Disease Mortality." *American Journal of Public Health* 61:606–11.

Brenner, M.H. 1979. "Mortality and the National Economy. A Review, and the Experience of England and Wales, 1936–76." *Lancet* 2:568–73.

———. 1984. *Estimating the Effects of Economic Change on National Health and Social Well-being.* Washington, DC: U.S. Government Printing Office.

Brenner, M.H. and A. Mooney. 1983. "Unemployment and Health in the Context of Economic Change." *Social Science Medicine* 17:1125–3 8.

Brooker, A.-S., J. Frank, and V. Tarasuk. 1997. "Back Pain Claims and the Business Cycle." *Social Science and Medicine* 45:429–39.

Brunekreef, B. and S.T. Holgate. 2002. "Air Pollution and Health." *Lancet* 360:1233–42.

Bunn, A.R. 1979. "Ischaemic Heart Disease Mortality and the Business Cycle in Australia." *American Journal of Public Health* 69:772–8 1.

Bureau of Labor Statistics. 1979–1998. Local Area Unemployment Statistics (LAUS) [Data on annual statewide unemployment]. Available online at http://www.bls.gov/lau

Catalano, R. 1979. "Health Costs of Economic Expansion: The Case of Manufacturing Injuries." *American Journal of Public Health* 69:789–94.

———. 1991. "The Health Effects of Economic Insecurity." *American Journal of Public Health* 81:1148–52.

Centers for Disease Control and Prevention. CDC. 1987–1998. Behavior Risk Factor Surveillance System Survey Data (BRFSS). Atlanta, GA: U.S. Department of Health and Human Services, CDC. Available online at http://www.cdc.gov/FRFSS

Chang, C.L., M.G. Marmot, T.M. Farley, and N.R. Poulter. 2002. "The Influence of Economic Development on the Association Between Education and the Risk of Acute Myocardial Infarction and Stroke." *Journal of Clinical Epidemiology* 55:741–47.

Chou, S.Y., M. Grossman, and H. Saffer. 2004. "An Economic Analysis of Adult Obesity: Results From the Behavioral Risk Factor Surveillance System." *Journal of Health Economics* 23:565–87. Clancy, L., P. Goodman, H. Sinclair, and D.W. Dockery. 2002. "Effect of Air-Pollution Control on Death Rates in Dublin, Ireland: An Intervention Study." *Lancet* 360:1210–14.

Cooper, R., J. Cutler, P. Desvigne-Nickens, S.P. Fortmann, L. Friedman, R. Havlik, G. Hogelin, J. Marler, P. McGovern, G. Morosco, L. Mosca, T. Pearson, J. Stamler, D. Stryer, and T. Thom. 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* 102:3137–47.

Dartmouth Institute for Health Policy and Clinical Practice. 1994–2003. Dartmouth Atlas of Health Care [data Þ le]. Available online at http://www.dartmouthatlas.org

Dehejia, R. and A. Lleras-Muney. 2004. "Booms, Busts, and Babies' Health." *Quarterly Journal of Economics* 119:1091–130.

Dustmann, C. and F. Windmeijer. 2004. "Wages and the Demand for Health—A Lifecycle Analysis." Unpublished document. Department of Economics, University College London.
Edwards, R.D. 2005. "Commentary: Work, Well-being, and a New Calling for Countercyclical Policy." *International Journal of Epidemiology* 34:1214–2 1.
Eyer, J. 1977. "Prosperity as a Cause of Death." *International Journal of Health Services* 7(1): 125–50.
Forbes, J.F. and A. McGregor. 1984. "Unemployment and Mortality in Post-War Scotland." *Journal of Health Economics* 3:239–57.
Gallo, W.T., E.H. Bradley, T.A. Falba, J.A. Dubin, L.D. Cramer, S.T. Bogardus, Jr., and S.V. Kasl. 2004. "Involuntary Job Loss as a Risk Factor for Subsequent Myocardial Infarction and Stroke: Findings From the Health and Retirement Survey." *American Journal of Industrial Medicine* 45:408–16.
Gerdtham, U.G. and M. Johannesson. 2003. "A Note on the Effect of Unemployment on Mortality." *Journal of Health Economics* 22:505–18.
———. 2005. "Business Cycles and Mortality: Results From Swedish Microdata." *Social Science and Medicine* 60:205–18.
Gerdtham, U.G. and C.J. Ruhm. 2006. "Deaths Rise in Good Economic Times: Evidence From the OECD." *Economics and Human Biology* 4:298–316.
Graham, J., B. Chang, and J. Evans. 1992. "Poorer is Riskier." *Risk Analysis* 12:333–37.
Gravelle, H.S., G. Hutchinson, and J. Stern. 1981. "Mortality and Unemployment: A Critique of Brenner's Time-Series Analysis." *Lancet* 2:675–79.
Grossman, M. 1972. "On the Concept of Health Capital and the Demand for Health." *Journal of Political Economy* 80:223–55.
Grundy, S.M., R. Pasternak, P. Greenland, S. Smith, Jr., and V. Fuster. 1999. "Assessment of Cardio-vascular 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* 100:1481–92.
Halliday, T.J. 2006. "Business Cycles, Migration and Health." Unpublished document. Department of Economics, University of Hawaii at Manoa.
Heidenreich, P. and M. McClellan. 2001. "Trends in Heart Attack Treatments and Outcomes." Pp. 363–409 in *Medical Care Output and Productivity,* edited by D.M. Cutler and E.R. Berndt. 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* 5:335–40.
Jones, A.M. 2000. "Health Econometrics." Pp. 265–344 in *Handbook of Health Economics,* edited by A.J. Culyer and J.P. Newhouse. Amsterdam: Elsevier Science North-Holland.
Joyce, T.J. and N. Mocan. 1993. "Unemployment and Infant Health: Time-Series Evidence From the State of Tennessee." *Journal of Human Resources* 28:185–203.
Kasl, S.V. 1979. "Mortality and the Business Cycle: Some Questions About Research Strategies When Utilizing Macro-Social and Ecological Data." *American Journal of Public Health* 69:784–88.
Kivimaki, M., P. Leino-Arjas, R. Luukkonen, H. Riihimaki, J. Vahtera, and J. Kirjonen. 2002. "Work Stress and Risk of Cardiovascular Mortality: Prospective Cohort Study of Industrial Employees. *British Medical Journal* 325:857–60.
Kloner, R.A., W.K. Poole, and R.L. Perritt. 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* 100:1630–34.
Lin, S.J. 2005. "The Effects of Economic Fluctuations on Health Outcome: Empirical Evidence From Asia-PaciÞ c Countries." Unpublished document. Department of Economics, Ming Chuan University.
McAvinchey, I.D. 1988. "A Comparison of Unemployment, Income and Mortality Interaction for Five European Countries." *Applied Economics* 20:453–71.
McGovern, P.G., D.R. Jacobs, Jr., E. Shahar, D.K. Arnett, A.R. Folsom, H. Blackburn, and R.V. Luepker. 2001. "Trends in Acute Coronary Heart Disease Mortality, Morbidity, and Medical Care From 1985 Through 1997: The Minnesota Heart Survey." *Circulation* 104:19–24.
Minino, A.M., E. Arias, K.D. Kochanek, S.L. Murphy, and B.L. Smith. 2002. "Deaths: Final Data for 2000." *National Vital Statistics Reports* 50(15). Hyattsville, MD: National Center for Health Statistics.

National Bureau of Economic Research. 2006. *Current Population Survey: Merged Outgoing Rotation Groups, 1979–2005*. Cambridge, MA: National Bureau of Economic Research.
Neumayer, E. 2004. "Recessions Lower (Some) Mortality Rates: Evidence From Germany." *Social Science Medicine* 58:103 7–47.
Peters, A., S. von Klot, M. Heier, I. Trentinaglia, A. Hörmann, H. Wichmann, and H. Löwell for the Cooperative Health Research in the Region of Augsburg Study Group. 2004. "Exposure to Traffic and the Onset of Myocardial Infarction." *New England Journal of Medicine* 351:1721–30.
Phillips, D.P., J.R. Jarvinen, I.S.R. Abramson, and R. Phillips. 2004. "Cardiac Mortality Is Higher Around Christmas and New Years Than at Any Other Time: The Holidays as a Risk Factor for Death." *Circulation* 110:3781–88.
Pickering, T., L. Clemow, K. Davidson, and W. Gerin. 2003. "Behavioral Cardiology—Has Its Time Finally Arrived?" *Mount Sinai Journal of Medicine* 70:101–12.
Rogers, W.J., J.G. Canto, C.T. Lambrew, A.J. Tiefenbrunn, B. Kinkaid, D.A. Shoultz, P.G. Frederick, and N. Every for the Investigators in the National Registry of Myocardial Infarction 1, 2 and 3. 2000. "Temporal Trends in the Treatment of Over 1.5 Million Patients With Myocardial Infarction in the U.S. From 1990 Through 1999: The National Registry of Myocardial Infarction 1, 2 and 3." *Journal of the American College of Cardiology* 36:2056–63.
Ruhm, C.J. 2000. "Are Recessions Good For Your Health?" *Quarterly Journal of Economics* 115:617–50.
———. 2003. "Good Times Make You Sick." *Journal of Health Economics* 22:637–58. ———. 2004. "Healthy Living in Hard Times." *Journal of Health Economics* 24:341–63.
———. 2005. "Mortality Increases During Economic Upturns." *International Journal of Epidemiology* 34:1206–11.
———. Forthcoming. "Macroeconomic Conditions, Health and Government Policy." In *Social and Economic Policy as Health Policy: Rethinking America's Approach to Health,* edited by R.F. Schoeni, J.S. House, G.A. Kaplan, and H. Pollack. New York: Russell Sage Foundation.
Ruhm, C.J. and W.E. Black. 2002. "Does Drinking Really Decrease in Bad Times?" *Journal of Health Economics* 21:659–78.
Saposnik, G., A. Baibergenova, J. Dang, and V. Hachinski. 2006. "Does a Birthday Predispose to Vascular Events." *Neurology* 67:300–304.
Sokejima, S. and S. Kagamimori. 1998. "Working Hours as a Risk Factor for Acute Myocardial Infarction in Japan: Case-Control Study." *British Medical Journal* 317:775–80.
Sparks, K. and C. Cooper. 1997. "The Effects of Work Hours on Health: A Meta-Analytic Review." *Journal of Occupational and Organizational Psychology* 70:391–408.
StataCorp. 2005. *Stata Statistical Software: Release 9*. College Station, TX: Stata Corporation. Tapia Granados, J. 2005a. "Increasing Mortality During Expansions of the U.S. Economy, 1900– 1996." *International Journal of Epidemiology* 34:1194–202.
———. 2005b. "Recessions and Mortality in Spain, 1980–1997." *European Journal of Population* 21:393–422.
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.
———. 2003. *Compressed Mortality File, 1989–98,* CD-ROM Series 20, No. 2E.
Vistnes, J.P. and V. Hamilton. 1995. "The Time and Monetary Costs of Outpatient Care for Children." *American Economic Review* 85:117–21.
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* 21:985–96.
Willich, S.N., H. Lowel, M. Lewis, A. Hormann, H.R. Arntz, and U. Keil. 1994. "Weekly Variation of Acute Myocardial Infarction. Increased Monday Risk in the Working Population." *Circulation* 90:87–93.