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Keith A. Bender* and Ioannis Theodossiou**

Abstract:

Contrary to the epidemiological literature, some studies find that increases in unemployment decrease mortality. Using US state level data on unemployment, mortality and other covariates for 1974 to 2003, this paper revisits this issue by, first, allowing for transitory and permanent effects of unemployment and, second, by allowing for cross-panel correlations. The results show that most mortality measures increase with contemporaneous unemployment and indicate that increases in long-run unemployment increase mortality.

Keywords: Mortality, Unemployment, Cross-Sectional times-series models, Feasible GLS

JEL: J64, I10

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I. Introduction

On an intuitive level, one should expect a strong relationship between health and socio-economic status. As income increases, health should be expected to increase (or mortality to decrease) as better living standards enhance health. Likewise, as unemployment increases, health would be expected to deteriorate (and mortality increase) since the unemployed generally have lower living amenities and less access to health care, particularly in the US where health insurance is provided primarily through employment.

The above conjectures are supported by a substantial body of research which provides evidence on the detrimental effects of low socio-economic status (typically proxied by low income and unemployment) on individuals' health. Higher socioeconomic status, indicated usually by employment characteristics and financial position in the economic strata, is associated with better physical health (Blakely *et al*., 2002; Ecob and Davey-Smith, 1999; Grundy and Holt, 2000; Wagstaff *et al*., 2001), improved emotional and psychological health (Everson et al., 2002; Theodossiou, 1998), and reduced risk of mortality (Gardner and Oswald, 2004; Goldman *et al*., 1995; Van Rossum *et al*., 2000).

However, there is a debate over whether unemployment increases or decreases health. On the one hand, there is a large body of literature suggesting that unemployment leads to deteriorating health. Stern (1983), Creed (1998), and Ungváry *et al*. (1999) review the existing evidence of the various pathways through which unemployment affects individual health. They find that

unemployment is detrimental to the individual's standard of living and financial resources. Restricted financial resources can lead to poor nutrition and probable restriction to access to medical health care when needed. As Martikainen and Valkonen (1996 and 1998) indicate, this may cause increased physical morbidity and mortality. Martikainen and Valkonen (1996) show that individuals who experience unemployment are found to exhibit greater mortality rates compared to their employed counterparts, after controlling for demographic and socioeconomic indicators. Furthermore, Morris *et al*. (1994) show that not only unemployment experience, but also the duration of unemployment spells, increase the risk of mortality after controlling for potential confounders such as age, race, marriage, income, and occupational class. Finally, Brenner (1979) and Brenner and Mooney (1982) demonstrate the detrimental effects of recessions on mortality. In fact, Brenner (2005) reviews a wide epidemiological literature that provides consistent evidence of a positive relationship between unemployment and mortality.

On the other hand, despite the intuitive appeal of this evidence concerning the positive macro-relationship between unemployment and mortality and its consistency with micro evidence regarding the effect of unemployment experience on the individual's health status, a number of findings cast doubt on its validity. This view dates from the work of Thomas (1927) who finds procyclical fluctuation of mortality. Importantly Ruhm (2000, 2003) reexamines the issue of the unemployment-mortality relationship by applying a fixed-effects model in a state-level study for US. His results show that economic upturns, by decreasing the unemployment rate, have a negative effect on physical health; contrary to the notion that unemployment worsens health, physically and mentally. Other papers in this vein include Gerdtham and Ruhm (2003) and Neumayer (2004).

These studies imply that recessions and thus high unemployment rates are beneficial to population health. The above authors justify their empirical conclusions by arguing that during recessions health improves as individuals both improve their dietary habits and reduce lifestyle habits detrimental to health such as smoking and drinking (e.g. Ruhm, 2000, p. 637) and identify at least three reasons as to why increasing employment rates negatively affect individual health: (i) non-market leisure decreases, reducing the possibility of health enhancing activities such as exercise; (ii) in a growing economy, there should be an increase in hazardous working conditions, physical exertion and in working hours; (iii) the availability of higher income increases the propensity of individuals to take risks and to indulge in activities such as smoking drinking and excessive eating of high fat diets.

Yet, these claims are not supported by available medical evidence. On the contrary, it is unemployment that appears to be associated with stress, adoption of unhealthy lifestyles such as increased smoking. Stern (1983) argues that this link is probably established due to the increased psychological "burden" and the stress the unemployed individuals feel. Wood *et al*. (1999) argue that people of lower socioeconomic status are significantly more likely to adopt a sedentary lifestyle, to be overweight, and to smoke. Morris *et al*. (1992) finds that bodyweight increases during unemployment. Other studies such as Hammarström (1994) and Morris *et al*. (1994) show that smoking and drinking are more common and nutrition is worse among the unemployed compared to those who are working. Finally, high levels of unemployment rates are found to be accompanied with higher incidence of psychological and behavioral disorders by Morrell *et al*. (1994) and Theodossiou (1998), psychosomatic diseases, and suicide or

parasuicide by Moser *et al*. (1986), Junankar (1991), and Ungváry *et al*. (1999). Morrell *et al*. (1993), Yang and Lester (1995), Lester (2001), and Lewis and Sloggett (1998) investigate individuals' reactions to unemployment and find that economic recessions appear to trigger acts of violence, suicide and homicide.

Complicating the issue is the statistical way to estimate the relationships. In cases where nonindividual data are used, some studies (such as the Brenner citations above as well as others) examine 'between effects' focusing on differences in the health-unemployment relationship across countries or states. However, Ruhm's studies focus on 'within effects' by holding state fixed effects constant. Unfortunately, there are no econometric tests which identify the most appropriate approach.

Furthermore, there may be both short- and long-run effects at work that move in opposite directions. The effects described by Ruhm, for instance, might be salient in the short-run, while the medical evidence of the effects of unemployment on negative health behaviors might manifest when a longer run is considered. Ultimately, it is important to know if there are countervailing forces, since the implication of Ruhm's research (in the extreme, certainly) is that public policy might even encourage unemployment if its goal is to decrease mortality.

All in all, the above literature highlights a lack of consistency regarding both the sign of the unemployment-mortality relationship and the mechanisms that link these two phenomena. This paper uses Ruhm (2000)'s work as a point of departure to further explore the unemployment – mortality relationship in three ways. First, it updates the data through the year 2003. Second, it

explicitly incorporates time in the estimation framework by examining the short- and long-run effects of changes in unemployment on mortality. Finally, it estimates a model which controls for cross-panel correlations. The results show that the conclusions reached by Ruhm (2000) are not as straightforward as originally thought and that the short-run effects found by Ruhm while statistically significant are relatively small compared to the increased mortality arising from increased long-run unemployment.

II. Data

The dataset is constructed along the same lines as the one found in Ruhm (2000). Data on state level unemployment, demographic, and education are taken from the US Bureau of Labor Statistics website (www.bls.gov), while information on mortality rates are found in the Vital Statistics section of the National Center for Health Statistics website (http://www.cdc.gov/nchs/deaths.htm). The data employed in this study differ from Ruhm's in two primary aspects. First, Ruhm's data consists of data from 1972-1991, which includes two years of data (1972 and 1973) for which the BLS does not include information on all state unemployment rates. Hence, in this study the dataset starts from 1974. Second, the length of the dataset is expanded to 2003. Thus, an extra twelve years of data are added. Given the relative shortness of the length of the panel (particularly compared to the number of panels), the extra data should increase the precision of the estimates.[1] Descriptive statistics are given in an appendix table.

III. The Effect of Unemployment Rates on Mortality: Basic Results

The first step of the research is to make sure that the obtained results are similar and compatible to Ruhm, both with the somewhat smaller dataset (1974-1991) and with the longer run data (1974-2003).

In terms of the econometric approach a standard fixed effects regression model is estimated following the study by Ruhm. This model has the form

$$H_{jt} = \alpha_t + X_{jt}\beta + E_{jt}\gamma + S_j + \varepsilon_{jt} \quad (1)$$

where for state j and year t, H is (the log of) a mortality measure, X is a vector of demographic controls for the age, race and educational characteristics of each state, E is a measure of economic conditions (here, unemployment), S is a fixed effect control for time invariant state specific impacts on mortality, and ε is an error term. Table 1, Panel A reports the results of the fixed effects estimation of equation (1) for the years that are closest to Ruhm (2000, p. 628, Table II). The results show a consistently negative and statistically significant relationship between mortality and unemployment. Expanding the dataset to 1974 to 2003 does not change the pattern of the above results (Table 1, Panel B). The fixed effects regressions reveal a consistent negative relationship in the neighborhood of previous estimates. This shows both the robustness of Ruhm estimation and demonstrate that our data are similar to that used in previous work in this literature.[2]

A further test extends this replication to the eleven other adult mortality rates examined: the death rates by three age groups (20 to 44 year olds, 45 to 64 year olds, and 65 and older), and deaths caused by heart disease, cancer, flu/pneumonia, liver disease, vehicle accidents, other accidents, suicide, and homicide. Table 2, Panel A replicates Ruhm's (2000, p. 631) Table III

using the 1974-1991 time period. Overall, the results are qualitatively similar to Ruhm. The mortality-unemployment relationship is negative and statistically significant for 20 to 44 year olds, 65 and older individuals, heart disease, flu/pneumonia, liver disease, vehicle accidents, other accidents, and homicides. It is typically insignificant for deaths among 45 to 64 year olds and for cancer deaths, and positive and nearly significant for suicides. In addition, in line with our earlier findings, the results are similar for the entire sample of 1974 to 2003, as shown in Panel B of Table 2.

IV. The Dynamic Nature of the Unemployment-Mortality Relationship

Brenner (2005) discusses that a fiercely contested issue is the importance of lagged effects of unemployment on mortality. If the impact of unemployment is cumulative, then the effects of a change in unemployment on health may be felt for many years after the event of an increased rate of unemployment. Hence, the effect of the unemployment rate on mortality may take a long time to manifest itself, and one would not expect the only effect of unemployment on mortality to be of the contemporaneous nature modeled above.

Unfortunately, *a-priori* there is no theory to guide researchers as to the length or the shape of the lag structure that is appropriate to capture these effects, and therefore, there is no a consensus on how to model these dynamic effects. One way to circumvent this issue of lags is to make a distinction between the permanent and transitory components of unemployment on mortality. This concept is similar to the formulation for income and consumption by Friedman (1957) and employs the standard permanent-transitory decomposition using the Mundlak (1978) methodology. In doing so equation (1) can be specified slightly differently, since this

methodology cannot be combined with a fixed effects estimation.[3] Following Mundlak (1978) the state effect, S_j, is assumed to be a random effect disturbance term, that is likely to be correlated with some, if not all of the explanatory variables in X and/or the economic conditions, E. If that correlation takes place only through the long run components of the X and E variables, then these correlations can be captured via the average of these variables over time.

Since this study focuses on the effect of unemployment on mortality, we follow this procedure only for the unemployment variable. Hence, instead of estimating equation (1), the following specification is estimated:

$$H_{jt} = \alpha_t + X_{jt}\beta + E_j\gamma + \overline{E}_j\hat{\gamma} + \widetilde{S}_j + \varepsilon_{jt} \qquad (2)$$

where $\overline{E}$ is the mean level of unemployment for each state j and $\widetilde{S}_j = S_j - \overline{E}_j\hat{\gamma}$, such that $E(S_j E_j) = 0$.

The above procedure introduces some dynamics on the effects of unemployment on mortality. To fully identify the transitory and permanent effects of unemployment, the variable transformation suggested by Van Praag *et al*. (2002) is used which, in this context, redefines the term $E_j\gamma + \overline{E}_j\widetilde{\gamma}$ in equation (2) to $(E_{jt} - \overline{E}_j)\gamma + \overline{E}_j(\gamma + \widetilde{\gamma})$. This allows an explicit decomposition of the effect of unemployment into two distinct effects. Differences across states in the average unemployment rate measure *between* effects and the deviations from the average unemployment rate per state, $(E_{jt} - E_j)$, measure *within* effects. The coefficient, γ, reflects *shock, transitory, or short-run* effects and the coefficient $\gamma + \widetilde{\gamma}$ measures *level, permanent, or long-run* effects.[4] Note that since the 'between' effects are parameterized as differences in

unemployment rates, the relative importance of unemployment on mortality in both a short-run (as Ruhm does) and a long-run (as much of the medical literature does) effect can be assessed. If these effects point to different directions, then their relative importance can be evaluated

Table 3 reports the coefficients on these two variables for each of the mortality measures. The first two columns contain the results for the shorter panel. In general, the results show that there are different transitory short-run and more permanent long-run effects. For example, for the overall mortality results, there is a small negative transitory or shock short-run effect, revealing the familiar reduction in mortality from a transitory increase in the unemployment rate. However, the long term or permanent effect of an increase in the unemployment rate on mortality turns out to be positive. This pattern is found for several mortality measures: mortality for the 20 to 44 and 45 to 64 age groups, liver disease, other accidents, and homicide. In several other cases both the permanent and transitory effects turn out to be insignificant (mortality for the 65 and older, cancer, and suicide). In addition, the effect of unemployment on mortality is negative for only the short-run (heart disease) or for both short- and long-run (flu/pneumonia). These patterns do not register significant changes when the longer panel is used (reported in the last two columns of the table).

An important finding arising from the results reported in this table is that the long-run effects have larger marginal effects than a similar increase in short-run unemployment. For example using the results from the longer panel one finds that if transitory unemployment rates increase by one percentage point there is a 0.39 percent decrease in overall mortality. Importantly, a one percentage point increase in the long-run average unemployment rate causes the mortality rate to

increase by 1.82 percent. Hence, while a one percentage point increase in the average unemployment rate over 30 years is a relatively large change, it does limit the general conclusion that unemployment unequivocally causes mortality to decline. Clearly if recessions are 'good for health' then the effects are only short-lived, since any lasting impact of an unemployment rise diminishes the gains from lower mortality caused by a transitory unemployment rate increase.

V. The Effect of Unemployment on Mortality: Effects of Cross-Panel Correlations

A requirement in panel estimation for unbiased estimates is controlling for cross-panel correlations. That is, in terms of equation (1), to obtain unbiased and efficient coefficients $cov(\varepsilon_{jt},\varepsilon_{is})=0$ for $j\neq i$ and $t\neq s$. If this condition is violated then, even if heteroskedasticity is controlled for (that is, if one corrects for differences in the variance of the error terms), one might still obtain biased estimates of the coefficients. While the methodology in Ruhm (2000) does control for heteroskedasticity, it does not control for cross-panel correlations. Cross-panel correlations may be due to omitted factors. For instance, one should expect that national health policies would affect mortality similarly across panels (that is, states). If these policies are also correlated with the state unemployment rates, then the coefficient on the state unemployment rate would also be affected. To investigate if this is the case for the current study, correlations of the error terms were calculated. Table 4 contains the proportion of the correlations ($cov(\varepsilon_{jt},\varepsilon_{is})$) which are statistically significant at the 10 and 5 percent level for each of the mortality measures.[5] These correlations show that over 55 percent of the panels are significantly correlated at the ten percent level (and as high as 71.7 percent for overall mortality) and at least 49 percent are correlated at the five percent level (to a high of two-thirds for overall mortality). These are very large numbers of significant correlations indicating cross-panel correlation is a

significant issue. They, therefore, cast doubt on the unbiasedness of our earlier results and call for the need to be taken into account in the estimation procedure

Potentially, one could include variables to attempt to control for these correlations.[6] Unfortunately, this fix is not a trivial matter as there is no easy way to identify what variables are the correct ones. Alternatively, feasible generalized least squares (FGLS) can be used to control for cross-panel correlations without needing to model these effects directly. Unfortunately, the use of this procedure is not without its problems. On the one hand, Wooldridge (2002, p. 162) indicates that if there is cross-panel correlation, FGLS is more efficient than any other estimator that assumes no correlation (also echoed in Greene, 2000, p. 470ff). On the other hand, Beck and Katz (1995) indicate that there is reduced efficiency in the FGLS estimator if the number of time periods is small relative to the number of panels. The estimated standard errors tend to be very small in this case, leading to statistical significance when there may not be. Yet, this does not impact on the size or sign of the coefficient. Ultimately, the investigator is bound to choose between the risk of biased coefficient (by not controlling for cross-panel correlations) and inefficiency (by using FGLS). Since both Greene (2000) and Wooldridge (2002) indicate that the FGLS estimates are likely to be unbiased in the presence of cross-panel correlation (even if they are not efficient), an investigation of the data using FGLS is warranted as a further robustness check on the unemployment-mortality relationship.[7]

Table 5 contains the results from this exercise, using only the full sample of data from 1974-2003 to limit the effect of a small number of time periods relative to the number of panels. The first column reports the coefficients for a model where the state unemployment rate is included.

Importantly, the results here are considerably different from earlier reported results, since only three of the twelve mortality measures turn out to exhibit a negative unemployment –mortality relationship, once correlations in the errors are controlled for. In contrast to our earlier findings these results show that as unemployment increases by one percentage point, the overall mortality rate *increases* by 0.06 percent, a small impact, but a statistically significant one. The effect is much larger for the middle aged group (0.82 percent increase) which doubles for the young (1.7 percent increase). Mortality rates for cancer, liver disease, other accidents, suicide and homicide also *increase* with unemployment. It is only mortality from heart disease, flu/pneumonia, and vehicular deaths that decrease when unemployment rises.

The last two columns of Table 5 estimate FGLS models, but they also allow for the decomposition of the effect of unemployment into a transitory/short-run and permanent/long-run effect. Interestingly, as before, there appears to be a transitory negative effect of unemployment on the overall mortality measure arising from the impact of unemployment on the mortality of the younger population since this effect turns out to be insignificant for those over 45. The permanent effects of unemployment on mortality for all ages appear to be positive, significant and large. Thus, a one percentage point rise of the short-run unemployment rates decreases mortality by only 0.27 percent, while a similar increase in long-run unemployment rates increases mortality by 0.56 percent. Only three mortality measures appear to be negatively affected by unemployment even in the long-run, namely mortality from heart disease, flu/pneumonia, and vehicle accidents.[8] On the other hand, deaths from cancer increase with increases in either short- or long-run unemployment.

VI. Discussion and Conclusions

Intuition suggests that there should be a positive relationship between unemployment and mortality since the unemployed have fewer economic resources to contribute toward health care (particularly in the US). While there is a great deal of micro evidence, primarily from the health literature, to support this intuition, recent research using macro data find a seemingly robust negative relationship between unemployment and mortality. However, the findings of this study show that the unemployment – mortality relationship at a macro level is more complicated than this recent literature has indicated. Controlling for cross-panel correlations substantially changes the estimated contemporaneous relationship between unemployment and mortality, often finding a positive relationship. Decomposing the relationship into short- and long-run effects indicate large long-run effects of increased unemployment on increased mortality, with the effect often dwarfing similar short-run changes in unemployment.

To illustrate the magnitudes of these relative effects, we perform some simulations. Since the short- and long-run effects are in opposite directions for many of the mortality categories, the increase in short-run unemployment rates that would be needed to equal the increased mortality from a one percentage point increase in long-run unemployment rates can be estimated. (This is simply the negative of the ratio of the coefficients of the long- and short-run unemployment rates.) Table 6 reports the results from such a simulation, using the estimates from Tables 3 and 5. Based on the random effects estimates for overall mortality, if there was a one percentage point increase in the long-run unemployment rate (which would increase mortality by 1.82 percent according to Table 3), the short-run unemployment rate would have to increase by 4.7 percentage points to offset the increased mortality from the long-run unemployment change. On

the other hand, short-run unemployment rates would need to increase by 16.8 percentage points for the 20-44 year old group, although it is only 4.7 percentage points for the mortality of the 65 plus age group. In every case where the signs of the short-run and long-run effects are opposite, the short-run change in unemployment rates are a large multiple of the change in the long-run. Similar results, although smaller in magnitude, are found when the FGLS estimates are used.

An alternative way to show the relative effects of these short- and long-run effects is illustrated in Figure 1. Assume that up to time t there is no difference between short- and long-run unemployment rates and that they are equal to 5 percent. Then there is a shock at time 't' that changes either the short- or long-run unemployment rate or both. The lines continuing past 't' and denoted A, B, C, or D indicate four possible long-run unemployment rate levels (although there are obviously others possible).

As illustrated in the figure, assume that the shock at 't' increases the short-run unemployment rate to 6 percent. According to the random effects (FLGS) coefficient estimates in Table 3 (5), mortality would decrease by 0.39 (0.27) percent. However, this is only a partial effect on mortality. The total effect on mortality depends on what happens to long-run unemployment. If it continues at 5 percent (line A), then the total effect of a change in unemployment is just the short-run effect, resulting in the 0.39 (0.27) percent decrease in total mortality. However, if the long-run unemployment rate also increases to 6 percent (and the short-run unemployment rate stays at 6 percent) corresponding to line B, this would increase mortality by 1.82 (0.56) percent, making the total net change (the sum of the short- and long-run effects) an *increase* in mortality rates of 1.43 (0.29) percent. Alternatively, if the long-run unemployment rate increases to 5.5

percent at line C, then the total net effect would be an *increase* in mortality by 0.52 (0.01) percent, coming from a reduction in mortality from the short-run effect of 0.39 percent plus a 0.91 percent increase for the half of a percentage point increase in the long-run unemployment rate). Indeed, as represented by line D, any change in the long-run unemployment rate above 0.21 (0.48) percentage points would lead to an increase in overall mortality (given a one time, one percentage point increase in short-run unemployment rates).

Although these results come closer to our intuition, it is still not clear why the short-run effect of unemployment reducing mortality. One explanation might be the pathways that Ruhm (2000) suggests. Alternatively, as Brenner (1979) explains, at the start of economic expansions, an increase in work intensity occurs as firms react to the pressure of increasing aggregate demand. This effect is reinforced by the reluctance of employers to hire new personnel before they are confident that the increasing demand is long lasting. This pertains to increased incidence of accidents at work and high work stress that is reflected in an increased incidence of cardiovascular illnesses. In addition, since the detrimental effects of unemployment on health take relatively long time to manifest themselves, mortality occurring during the economic upturns has its roots on the worker's hardship during the preceding downturn and high unemployment. Hence, one would expect the short-run or transitory effects of unemployment on mortality to be negative. However, with the passage of time the permanent scars of unemployment on the health of the population become visible and overwhelming as the medical research has shown. Indeed, it appears that the long-run effects for many mortality measures are much stronger than the short-run gains for an increase in unemployment. All in all, in the long run unemployment does not appear to be good for your health.

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Table 1. Results of Replication of Ruhm (2000) Table II by Sample

	Base Specification					With State-Specific Time Trends					Death in Levels	
	(a)	(b)	(c)	(d)	(e)	(a)	(b)	(c)	(d)	(e)	(a)	(b)
					Panel A: Sample: 1974-1991							
State UR	-0.0045	-0.0050	-0.0065		-0.0073	-0.0050	-0.0060	-0.0056		-0.0063	-4.066	-4.588
	(-6.95)	(-7.37)	(-12.58)		(-10.31)	(-9.04)	(-10.68)	(-12.53)		(-9.93)	(-7.50)	(-8.22)
US UR				-0.0054	0.0016				-0.0045	0.0012		
				(-6.99)	(1.62)				(-7.35)	(1.49)		
Pers Inc		-0.0034					-0.0085					-4.242
		(-2.46)					(-6.40)					(-3.58)
Year Effects	Yes	Yes	No	No	No	Yes	Yes	No	No	No	Yes	Yes
					Panel B: Sample: 1974-2003							
State UR	-0.0041	-0.0048	-0.0070		-0.0073	-0.0053	-0.0062	-0.0061		-0.0069	-4.237	-4.830
	(-7.05)	(-8.04)	(-13.96)		(-10.95)	(-10.21)	(-11.04)	(-14.66)		(-12.42)	(-8.64)	(-9.52)
US UR				-0.0064	0.0070				-0.0048	0.0017		
				(-8.36)	(0.69)				(-7.72)	(2.16)		
Pers Inc		-0.0039					-0.0045					-3.171
		(-4.43)					(-4.06)					(-4.24)
Year Effects	Yes	Yes	No	No	No	Yes	Yes	No	No	No	Yes	Yes

All regressions include controls for demographic characteristics. Asymptotic t-statistics are in parentheses.

Table 2. Results of Replication of Ruhm (2000) Table III by Sample

	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
					Panel A: 1974-1991 Sample				
		20-44 year olds			45-64 year olds			65 and older	
State UR	-0.0095	-0.0058	-0.0190	-0.0017	-0.0015	-0.0035	-0.0018	-0.0019	-0.0052
	(-3.51)	(-2.08)	(-7.17)	(-0.97)	(-0.83)	(-2.09)	(-2.04)	(-1.97)	(-5.47)
US UR			-0.0072			0.0067			-0.0001
			(-1.96)			(2.90)			(-0.08)
Personal Inc		0.0299			0.0015			-2.7E-5	
		(5.18)			(0.40)			(-0.01)	
		Heart Disease			Cancer			Flu/pneumonia	
State UR	-0.0041	-0.0055	-0.0046	1.3E-6	-0.0022	0.0008	-0.0101	-0.0096	-0.0193
	(-3.29)	(-4.32)	(-3.78)	(0.00)	(-2.02)	(0.79)	(-3.53)	(-3.24)	(-5.07)
US UR			0.0060			-0.0031			-0.0125
			(3.52)			(-2.27)			(-2.35)
Personal Inc		-0.0110			-0.0172			0.0038	
		(-4.24)			(-7.72)			(0.62)	
		Liver Disease			Vehicle accidents			Other accidents	
State UR	-0.0065	-0.0080	-0.0124	-0.0250	-0.0186	-0.0210	-0.0144	-0.0137	-0.0219
	(-2.26)	(-2.69)	(-4.58)	(-8.03)	(-5.97)	(-6.65)	(-5.64)	(-5.18)	(-8.75)
US UR			0.0022			-0.0001			0.0112
			(0.57)			(-0.01)			(3.21)
Personal Inc		-0.0119			0.0508			0.0054	
		(-1.92)			(7.84)			(0.95)	
		Suicide			Homicide				
State UR	0.0037	0.0040	0.0035	-0.0084	-0.0026	-0.0177			
	(1.35)	(1.42)	(1.37)	(-1.76)	(-0.53)	(-3.80)			
US UR			-0.0066			-0.0010			
			(-1.87)			(-0.16)			
Personal Inc		0.0026			0.0461				
		(0.44)			(4.51)				

Table 2 continued

	(a)	(b)	(c)	(a)	(b)	(c)	(a)	(b)	(c)
					Panel B: 1974-2003 Sample				
		20-44 year olds			45-64 year olds			65 and older	
State UR	-0.0088	-0.0051	-0.0200	-0.0030	-0.0027	-0.0018	-0.0018	-0.0017	-0.0058
	(-4.01)	(-2.23)	(-8.67)	(-2.21)	(-1.90)	(-1.28)	(-2.69)	(-2.40)	(-7.87)
US UR			-0.0013			0.0064			-0.0025
			(-0.40)			(3.20)			(-2.28)
Personal Inc		0.0202			0.0017			0.0007	
		(6.04)			(0.80)			(0.68)	
		Heart Disease			Cancer			Flu/pneumonia	
State UR	-0.0034	-0.0058	-0.0041	0.0006	-0.0022	0.0017	-0.0112	-0.0103	-0.0187
	(-3.08)	(-5.22)	(-3.73)	(0.72)	(-2.59)	(2.08)	(-4.48)	(-3.94)	(-5.55)
US UR			0.0015			-0.0010			-0.0058
			(0.94)			(-0.83)			(-1.18)
Personal Inc		-0.0132			-0.0150			0.0051	
		(-7.97)			(-12.01)			(1.32)	
		Liver Disease			Vehicle accidents			Other accidents	
State UR	-0.0040	-0.0076	-0.0105	-0.0232	-0.0169	-0.0145	-0.0133	-0.0098	-0.0233
	(-1.40)	(-2.56)	(-3.80)	(-9.24)	(-6.65)	(-5.66)	(-5.16)	(-3.69)	(-8.29)
US UR			0.0033			-0.0055			0.0088
			(0.83)			(-1.47)			(2.14)
Personal Inc		-0.0190			0.0337			0.0186	
		(-4.37)			(8.97)			(4.74)	
		Suicide			Homicide				
State UR	0.0068	0.0051	0.0067	-0.0111	-0.0076	-0.0146			
	(3.04)	(2.21)	(3.16)	(-2.55)	(-1.70)	(-3.45)			
US UR			-0.0025			0.0123			
			(-0.81)			(1.99)			
Personal Inc		-0.0089			0.0182				
		(-2.59)			(2.75)				

Note: All regressions are fixed effects estimates including controls for demographic variables and year dummy variables. Numbers in parentheses are t-statistics. All mortality measures are logged.

Table 3. Short-run and Long-run Effects of Unemployment on Mortality

	1974-1991 Sample		1974-2003 Sample	
Dependent Variable	Short-run Effect	Long-run Effect	Short-run Effect	Long-run Effect
Overall Mortality	-0.0042***	0.0142*	-0.0039***	0.0182**
	(-5.87)	(1.78)	(-6.33)	(2.51)
Mortality 20-44 yr old	-0.0062**	0.0532***	-0.0047**	0.0779***
	(-2.28)	(4.12)	(-2.08)	(5.83)
Mortality 45-64 yr old	-0.0011	0.0256***	0.0004	0.0269***
	(-0.62)	(3.53)	(0.30)	(3.60)
Mortality 65 plus	-0.0010	0.0017	-0.0007	0.0033
	(-1.04)	(0.20)	(-1.03)	(0.42)
Heart Disease	-0.0043***	-0.0156	-0.0040***	-0.0032
	(-3.28)	(-1.14)	(-3.45)	(-0.26)
Cancer	-0.0001	0.01159	-0.0006	0.0106
	(-0.13)	(1.26)	(-0.72)	(1.34)
Flu/pneumonia	-0.0101***	-0.0543***	-0.0123***	-0.0753***
	(-3.48)	(-2.79)	(-4.72)	(-3.97)
Liver Disease	-0.0032	0.0841***	-0.0060**	0.0469**
	(-1.06)	(3.67)	(-2.03)	(2.40)
Vehicle accidents	-0.0217***	-0.0056	-0.0164***	0.0318
	(-6.68)	(-0.25)	(-6.15)	(1.57)
Other accidents	-0.0162***	0.0683***	-0.0114***	0.0670***
	(-6.14)	(2.81)	(-4.31)	(3.00)
Suicide	0.0015	0.0017	0.0030	0.0212
	(0.55)	(0.08)	(1.31)	(1.08)
Homicide	-0.0001	0.1711***	-0.0034	0.2275***
	(-0.02)	(4.34)	(-0.73)	(6.39)

Notes: All mortality measures are in log form. Numbers in parentheses are t-statistics. Regressions include demographic controls, year dummy variables, and per capita personal income. The 'Long-run Effect' is proxied by the average state unemployment rate, while the 'Short-run Effect' is proxied by the year specific difference in the actual unemployment rate and the average unemployment rate.

Table 4. Table of Percentages of significant correlations of error terms

Mortality measure	$p<0.10$	$p<0.05$
Overall Mortality	71.7%	66.7%
Mortality 20-44 yr old	58.2%	51.5%
Mortality 45-64 yr old	55.8%	49.1%
Mortality 65 plus	68.5%	61.7%
Cardio	65.3%	58.9%
Neoplasm	59.8%	52.8%
Flu	57.0%	49.3%
Liver	65.5%	57.8%
Vehicle	69.5%	63.9%
Other accidents	70.7%	63.7%
Suicide	60.5%	53.4%
Homicide	59.4%	52.9%

Table 5. Feasible GLS results.

Dependent Variable	Unemployment	Short-run Effect	Long-run Effect
Overall Mortality	0.0006***	-0.0027***	0.0056***
	(4.08)	(-10.84)	(20.80)
Mortality 20-44 yr old	0.0170***	-0.0079***	0.0518***
	(31.47)	(-16.47)	(65.98)
Mortality 45-64 yr old	0.0082***	-0.0002	0.0202***
	(27.67)	(-0.73)	(36.14)
Mortality 65 plus	0.0010***	-0.0007***	0.0035***
	(5.51)	(-3.57)	(10.92)
Heart disease	-0.0063***	-0.0008***	-0.0143***
	(-25.78)	(-2.66)	(-27.65)
Cancer	0.0040***	0.0033***	0.0052***
	(17.80)	(12.74)	(10.42)
Flu/pneumonia	-0.0230***	-0.0161***	-0.0314***
	(-36.06)	(-14.41)	(-34.16)
Liver disease	0.0274***	-0.0014	0.0695***
	(24.16)	(-1.09)	(36.22)
Vehicle accidents	-0.0258***	-0.0300***	-0.0209***
	(-33.61)	(-32.48)	(-15.44)
Other accidents	0.0103***	-0.0190***	0.0499***
	(11.98)	(-37.31)	(29.91)
Suicide	0.0013*	-0.0017	0.0053***
	(1.80)	(-1.56)	(5.14)
Homicide	0.0424***	-0.0036***	0.1050***
	(27.80)	(-2.67)	(23.29)

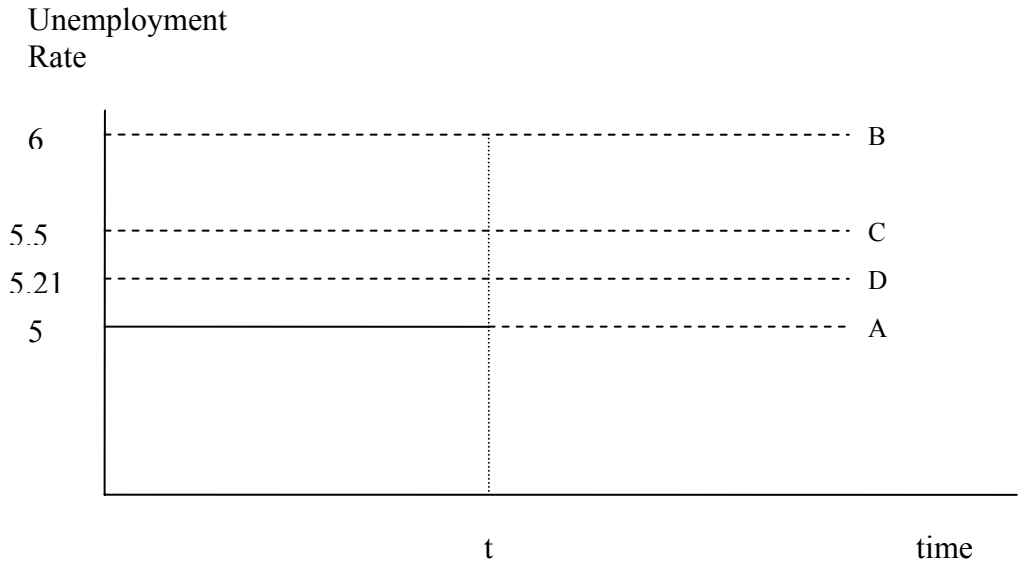
Notes: All regressions include demographic controls, year dummy variables and per capita personal income. All dependent variables are in log form. Numbers in parentheses are t-statistics.

Table 6. Percentage Point Increase Needed in Short-run Unemployment Rates to Counteract a One Percentage Point Increase in the Long-run Unemployment Rate

Mortality Measure	Random Effects Estimates	FGLS Estimates
Overall Mortality	4.7	2.1
Mortality 20-44 yr old	16.8	6.6
Mortality 45-64 yr old	NA	101.0
Mortality 65 plus	4.7	5.0
Heart disease	NA	NA
Cancer	17.7	NA
Flu/pneumonia	NA	NA
Liver disease	7.8	49.6
Vehicle accidents	1.9	NA
Other accidents	5.9	2.6
Suicide	NA	3.1
Homicide	66.9	29.1

Note: NA indicates that the short-run and long-run effects have the same sign. The 'Random Effects Estimates' are based on the short- and long-run estimates from Table 3. The 'FGLS Estimates' are based on the short- and long-run estimates from Table 5.

Figure 1



Appendix Table 1. Means of Data

Variable	1974-1992 Sample Mean	1974-1992 Sample Standard Deviation	1974-2003 Sample Mean	1974-2003 Sample Standard Deviation
Death rate per 100,000 population				
All causes	873.4	106.9	865.1	113.4
All causes, 20-44 year olds	161.9	29.4	158.2	30.1
All causes, 45-64 year olds	917.6	129.8	814.2	167.7
All causes, >=65 year olds	5173.2	368.2	5117.7	365.1
Malignant neoplasms (140-208)	188.5	29.5	192.6	30.2
Major cardiovascular diseases (390-448)	416.3	71.5	383.3	76.5
Influenza and pneumonia (480-487)	26.8	5.9	27.1	6.3
Chronic liver disease and cirrhosis (571)	12.3	3.9	11.0	3.5
Motor vehicle accidents (E810-825)	20.8	5.6	18.6	5.8
Other accidents (E800-807, E826-949)	21.6	4.9	20.7	4.6
Suicides (e950-959)	12.3	2.8	11.9	2.8
Homicides and legal intervention (E960-978)	9.4	4.1	8.6	4.0
Explanatory Variables				
State unemployment rate	6.7	2.2	6.2	2.0
Income per capita (thousands of 1987 dollars)	14.7	2.7	17.0	3.9
% of population under 5 years old	7.4	0.8	7.3	0.8
% of population aged 65 and over	11.6	2.0	12.1	2.1
High school dropouts (% of 25 and older pop)	31.8	7.8	26.9	8.5
High school degree (% of 25 and older pop)	51.1	5.3	53.1	5.4
College graduate (% of 25 and older pop)	17.2	3.8	19.9	5.1
% of population who are black	11.8	8.0	12.2	8.1
% of population who are Hispanic	7.2	8.1	9.2	9.7

Note: All variables are weighted by state populations. The unemployment rate refers to civilians aged sixteen and over. For the mortality rates, numbers in parentheses refer to the category listings from the Ninth Revision of the International Classification of Diseases.

Appendix Table 2. Coefficient on Unemployment for Random Effects Estimates

Dependent Variable	1974-1991 Sample	1974-2003 Sample
Overall Mortality	-0.0040***	-0.0037***
	(-5.65)	(-6.00)
Mortality 20-44 yr old	-0.0036	-0.0021
	(-1.34)	(-0.95)
Mortality 45-64 yr old	0.0005	0.0015
	(0.27)	(1.06)
Mortality 65 plus	-0.0009	-0.0007
	(-1.01)	(-0.97)
Heart disease	-0.0044***	-0.0039***
	(-3.37)	(-3.46)
Cancer	0.0001	-0.0005
	(0.06)	(-0.53)
Flu/pneumonia	-0.0112***	-0.0138***
	(-3.87)	(-5.29)
Liver disease	-0.0018	-0.0047
	(-0.60)	(-1.59)
Vehicle accidents	-0.0213***	-0.0155***
	(-6.64)	(-5.86)
Other accidents	-0.0151***	-0.0101***
	(-5.74)	(-3.86)
Suicide	0.0016	0.0033
	(0.56)	(1.44)
Homicide	0.0027	0.0011
	(0.55)	(0.24)

Note: Dependent variables are in log form. All regressions include demographic variables, , year dummies, and per capita personal income. Numbers in parentheses are t-statistics.

Footnotes

[1] One potential problem is the reclassification of the ICD mortality categories in 1999 from the ICD-9 classification to the ICD-10 classification. However, since the mortality categories used by Ruhm are broad, the conversion back to ICD-9 categories is straightforward to accomplish.

[2] The only major difference is the sign of the per capita personal income variable, which is negative in our estimations an often positive in Ruhm (2000). It is not clear where Ruhm's data on income comes from, although it is likely from the *Statistical Abstract of the United States*. The data on personal income used in the present study are obtained on from the US Bureau of Economic Analysis website (http://www.bea.gov/regional/spi/). While our results seem to make more intuitive sense in that increased income should decrease mortality, the key issue is that it does not seem to affect the key coefficient of interest – that is the coefficient on the unemployment rate.

[3] To make sure that the observed relationship in the previous section is not sensitive to the choice of fixed or random effects estimation, Appendix Table 2 reports the random effects coefficients on the unemployment rate. It is important to note that the coefficients which are statistically significant consistently indicate a negative relationship between the unemployment rate and mortality in line with the earlier findings. This is an important issue, since it shows that the relationship found in the 'within' estimators in Ruhm, are also found in the 'between' estimators implied by the random effects estimators.

[4] This methodology is similar but not identical to Gottschalk *et al.* (1994) in the context of earnings.

[5] The estimation is based on the 'Basic Specification' column (b) set of covariates from Table 1, Panel A, that is a fixed effects estimation with the demographic variables, year effects, and per capita personal income. The correlations come from the estimated 'sigma' matrix.

[6] Indeed, the inclusion of the US unemployment rate in Ruhm (2000) may go some way to do this. Unfortunately, since it is just a linear combination of the state unemployment rates, it is very highly correlated with the state unemployment rates and, furthermore, cannot be in regressions with year effects.

[7] We implement this in the statistical program Stata using the 'xtgls' command using the panels(correlated) option which controls for both the correlation as well as heteroskedasticity in the error terms.

[8] The overall negative impact of unemployment on mortality for some causes, namely from heart disease, flu/pneumonia, and vehicle accidents, can be attributed to the fact that during economic expansions and the increase in work intensity there may be a permanent increased incidence of vehicle accidents as more people travel to work and high work stress can be reflected in the higher rates of heart disease.