Symmetric Mortality and Asymmetric Suicide Cycles

Abstract

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In this investigation, tests were performed to determine whether mortality cycles are asymmetric. Results from an asymmetry test of U.S. time-series data from 1951 to 2005 provide no evidence that all-cause mortality or mortality caused by disease causes asymmetric cycles. However, the rate of fatalities from suicide exhibits the pattern of an asymmetric cycle. The evidence for asymmetric suicide cycles is statistically significant for men and working-age groups but not for women and non-working-age groups.

Keywords: Mortality and Suicide, Unemployment Oscillation, Asymmetric Cycle
JEL classification: I1, J6, E3

Introduction

One area of long-standing interest in both the social sciences and medicine is the response of mortality to oscillations in economic conditions. If mortality is positively associated with economic conditions, it is procyclical; if negatively correlated, it is countercyclical. Two main arguments are presented as to whether mortality is procyclical or countercyclical. The first argument is based mainly on various aspects of social and psychological hardship. There is a common perception that economic slumps must be bad for both physical and mental health because recessions increase the likelihood of experiencing poverty, lacking necessary resources, encountering psychological distress and facing stress associated with job loss. Brenner and Mooney (1983) provide more details about this. Thus, it is intuitively

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believed that total mortality should fall in times of economic expansion and rise during recessions.

An opposing argument based on the economic model of utility maximization provides an entirely counterintuitive viewpoint. This argument is that total mortality should fall during times of economic recession and rise during periods of economic expansion. Furthermore, it is argued that when the economy sinks into recession, the cost of leisure time is reduced, enabling people to spend more time on leisure activities including exercise. Work-related pressures diminish, and health risks such as work-related accidents and pollution are reduced. Thus, people are in a healthier condition in an economic downturn. Please see Ruhm (2000) for further explanation about this argument. In reality, these two opposing aspects should coexist in a complex society comprised of different types of people. The net effect on total mortality of short-run macroeconomic fluctuation depends upon which aspect dominates in a society or country.

Previous empirical studies have found inconsistent evidence concerning mortality cycles. For instance, a line of literature, including a series of papers written by Brenner (1971, 1973, 1975, 1979) and several recent studies (e.g., Gerdtham and Johannesson (2003, 2005); Svensson (2006) and Economou et al. (2008)), have provided statistical support for the argument that mortality is countercyclical. However, a number of studies have found counterintuitive evidence suggesting that mortality is procyclical. The evidence for procyclical mortality was first demonstrated in the 1920s by Ogburn and Thomas (1922) and addressed again five decades later by Eyer (1977). Furthermore, recent econometric studies using either time-series data (e.g., Tapia Granados (2005a, 2008); Hanewald (2008)) or panel data (e.g., Ruhm (2000); Tapia Granados (2005b); Neumayer (2004); Gerdtham and Ruhm (2006)) all confirm that the mortality rate is procyclical. Ruhm (2006) has an excellent survey on related studies. This procyclical evidence contradicts the conventional wisdom provided by Brenner in the 1970s and Menchik (1993). Reichmuth and Sarferaz (2008) contribute to the debate on the effects of economic conditions on mortality cycles by focusing on age-specific mortality. They find that young male adults exhibit a countercyclical pattern of mortality, whereas older adults exhibit a procyclical pattern. In fact, other earlier studies such as Ruhm (2000), Neumayer (2004), Tapia Granados (2005a, 2008), and Economou et al. (2008) have also conducted estimations of age-specific mortality in addition to total mortality.

As well as all-cause mortality, fatalities from specific causes are examined in some previous studies. These specific causes include events such as suicide, heart disease, pneumonia, all kinds of accidents, liver disease, senility, diabetes mellitus, and hypertensive diseases. Most causes of fatalities fluctuate procyclically, with suicide being an important exception. For instance, several studies (e.g., Ogburn and Thomas (1922); Eyer (1977); Tapia Granados (2005a, 2005b, 2008); Ruhm (2000), Gerdtham and Johannesson (2003); Economou et al. (2008); Lin (2006)) have provided significant evidence of countercyclical variations in deaths from suicide.

One implicit assumption that prevails in empirical work on mortality is that short-run macroeconomic oscillations have a symmetric impact. Is it possible, however, that mortality exhibits the pattern of an asymmetric cycle? Most causes of mortality, including diseases and unexpected accidents, are not directly chosen by individuals. Genes, epidemic viruses, various external conditions such as pollution, and childhood living conditions and poverty are the main causes. Of course, short-run macroeconomic fluctuations can certainly influence the mortality of various diseases. For instance, improved medical care and living conditions because of economic improvement may reduce the mortality of these diseases, while reduced medical care and poorer living conditions resulting from economic deterioration can symmetrically raise it. Individual responses to economic fluctuations can also symmetrically affect the mortality of these diseases. For instance, an individual response such as increasing leisure time or exercise can lower the mortality of certain diseases, whereas working more and exercising less can increase it. In summary, this study argues that both all-cause mortality and mortality caused by specific diseases exhibit only symmetric cyclic patterns.

Unlike other specific causes, suicide is a paradoxical decision. We argue that suicide exhibits the pattern of an asymmetric cycle, implying that the suicide rate rises stably in recession but falls dramatically in expansion. People are more likely to suffer from depression, anxiety, aversive self-awareness and frustration resulting from unemployment or income loss in recession. Moreover, unemployed people's human capital such as skill or psychological health (Becker (1964, 2002), William and Goldsmith (1996)) depreciates, and their expectancies of future wages are negative, so their expected remaining lifetime income, and therefore utility, is revised downwards in recession. However, the psychological (or utility) impact of unemployment is reduced if it becomes a social norm in recession (Clark (2003)). Therefore, only a certain proportion of them with very severe psychological pain and zero lifetime utility actually commit suicide. This implies that the suicide rate would rise in recession but on a stable path. However, in recovery, psychological pain related to both unemployment and income insecurity is significantly reduced, and expected remaining lifetime utilities significantly rise for most people who have been unemployed in recession. The propensity to commit suicide therefore becomes very low for these people. Moreover, because people with high suicidal risks are influenced by the spillover effects of optimistic people's positive attitudes and receive more social support in periods of expansion, they are likely to cancel or postpone their suicidal actions. Therefore, we expect that the suicide rate would fall dramatically in expansion.

By following similar asymmetric specifications to those in oil shock (e.g., Mork (1989); Hamilton (1996, 2003); Hooker (2002)) and crime studies (e.g., Mocan and Bali (2006)), the main goals of this paper are to examine whether all-cause mortality, mortality caused by certain diseases, or fatalities from suicide give rise to asymmetric cycles. Employing U.S. time-series data, we first use the ordinary least squares (OLS) method to estimate the linear and symmetric specifications proposed in earlier studies. Our findings are consistent with the patterns found in two recent papers using U.S. data, such as Ruhm (2000) and Tapia Granados (2005a). In the United States, all-cause mortality is procyclical, and death from suicide is countercyclical. Results from the current study obtained from asymmetric specification estimations provide no strong evidence that either all-cause mortality or mortality caused by certain diseases exhibits an asymmetric cycle pattern. However, we do find evidence that death from suicide exhibits an asymmetric cycle pattern.

In addition to total mortality, previous studies such as Tapia Granados (2005a) also study mortality by sex and age groups. These were therefore investigated in the current study, which finds that total mortality does not exhibit an asymmetric cycle pattern. However, the effect of economic conditions on suicide is believed to differ according to sex and age group. For instance, Qin et al. (2000) and Wunderlich et al. (2001) suggest that economic stressors play more important roles in suicide among men than among women. It is intuitive that economic stressors should play more important roles in suicide for working-age groups than for younger or older ones. Our results show that the asymmetric cyclic pattern is significantly applicable to male but not female suicides. Moreover, asymmetric suicide cycles are more significant for working-age groups than for younger or older ones.

Without controlling for confounding variables, no statistical result demonstrating a symmetric mortality cycle or an asymmetric suicide cycle is immune from omitted variable bias. Our study includes the following types of confounders for estimating mortality and suicide: a public health expenditure variable, a new immigrant population variable, a per capita consumption of alcohol and cigarettes variable. This study finds that these variables all have insignificant effects on total mortality. In addition to these confounders, we add a variable for the divorce rate as a confounder for the estimation of suicide. Our results suggest that the suicide rate is significantly and negatively associated with public health expenditure.

To test the stability of results, this investigation also follows previous studies such as that of Tapia Granados (2005a) and divides the full period into two subperiods. Tapia Granados (2005a) provides evidence that there were stronger oscillations of unemployment in the U.S. after 1971. Therefore, we divide the full period into the following subperiods: 1951–1970 and 1971–2005. Based on Chow test results, we find no evidence of structural changes in mortality and suicide. These Chow tests show that our results are stable across periods.

The remainder of this paper is organized as follows. The next section develops the hypothesis of the asymmetric suicide cycle. Section 3 introduces estimation strategies. Section 4 describes variables of interest. Section 5 details the sources of the data and the selected samples. Section 6 discusses the estimation results. The final section concludes.

Hypothesis Development of Asymmetric Suicide Cycle

Traditional Theories of Suicide

Sociologists played an early role in providing the theory of suicide. Durkheim (1897, 1951) viewed suicide as a sociological phenomenon. He claims that suicide is related to both social integration and social regulation. Durkheim's theory attracted considerable attention from sociologists, but several alternative theories should not be neglected. Henry and Short (1954) use the frustration–aggression theory to argue that frustration often results in aggression. They claim that frustration resulting from a change of social status drives people to commit suicide. Ginsberg (1966) believes that dissatisfaction is the source of suicide and that the dissatisfaction is related directly to a discrepancy between an actual reward and a person's level of aspiration.

The hopelessness theory proposed by Abramson et al. (1989, 2000) hypothesizes that both negative outcome expectancy and helplessness expectancy are proximal causes of the symptoms of hopelessness depression. Suicidality may be the core symptom of hopelessness depression. The self-discrepancy theory of Higgins (1987) proposes that individuals with discrepancies between their actual and ideal selves are more likely to develop depression, while those with discrepancies between their actual and ought selves are more likely to develop anxiety. Both depression and anxiety are associated with suicidality. Baumeister (1990) proposes the escape theory to explain self-destructive behaviors. The theory hypothesizes that self-destructive behaviors can be interpreted in terms of motivation to escape from aversive self-awareness. Attempts to escape from aversive thoughts and feelings may fail, so the individual needs a stronger means of terminating them. This contributes to an increased willingness to commit suicide.

Economists claim that some suicidal behaviors may not be explained completely by psychiatric illness or social factors but may involve rational economic decision making. Hamermesh and Soss's (1974) paper was the first to provide an economic model for suicide. They assume that an individual kills him/herself when his/her total remaining discounted lifetime utility reaches zero. Koo and Cox (2008) extend the model of Hamermesh and Soss (1974) and claim that individuals are likely to commit suicide when expected relative lifetime utility, the distance from the social mean (average) lifetime utility, falls below a certain threshold level. They define relative income as an increasing function of human capital that depreciates if an individual is unemployed. Furthermore, Suzuki (2008) incorporates the concept of income uncertainty into the model of Hamermesh and Soss (1974). Unlike Hamermesh and Soss (1974), his measure of expected lifetime income is conditional on a present wage and its stochastic process being continued. Generally speaking, these economic models all suggest that an individual's propensity to commit suicide is negatively associated with his/her expected remaining lifetime utility.

Asymmetric Suicide Cycle

Unemployment has been proved to be hazardous to mental health (e.g., Feather (1990); Murphy and Athanasou (1999); Frey and Stutzer (2002); Paul and Moser (2009)). It normally causes emotionally destructive consequences in the following forms: depression, anxiety, frustration, low self-esteem, aversive self-awareness and strained personal relations. Social psychologists believe that these emotionally destructive consequences of unemployment lead to an increase in suicide risk. Economists also believe that unemployment may generate motivations to commit suicide. The loss of income that results from unemployment lowers an individual's expected remaining lifetime income. Moreover, because of losing job training opportunities, the unemployed individual's human capital depreciates. This will negatively influence an individual's expected remaining lifetime utility. A significant drop in an individual's expected lifetime utility may generate suicide risks.

Unemployment rises during periods of recession and falls in expansion, so it is widely believed that suicide rates rise in recession but fall in expansion. People who suddenly lose their jobs in recession are likely to experience hopelessness, depression and anxiety because of negative expectancies of future employment and income outcomes. Moreover, they are likely to feel frustrated and to lose self-esteem because of a sudden drop from high to low hierarchical status. If aversive self-awareness and psychological pain is entirely unbearable, they commit suicide. Moreover, after a certain period of unemployment, these people's human capital depreciates and their expectancies of future wages are negative, so their expected remaining lifetime income and utility are revised downwards in recession. If their expected remaining lifetime utility reaches zero, they may be motivated to commit suicide. In reality, however, the psychological pain that most people experience in recession is hardly severe enough for them to kill themselves. Their expected remaining lifetime utilities may become very low in recession but remain above zero. Clark (2003) suggests that psychological (or utility) impact of an individual's own unemployment will be reduced by a higher level of unemployment among relevant others in recession. Therefore, we argue that only a certain proportion of people experiencing very severe psychological pain and zero remaining utility actually commit suicide in recession. This implies that the suicide rate definitely rises in recession but on a stable path.

On the other hand, when the economy is in expansion (recovery), most people who were unemployed during the period of recession are again employed. People with continued unemployment in recovery may have positive expectancies about their future outcomes, so they feel less depressed, anxious and frustrated. Moreover, their durations of unemployment in expansion are normally shorter, so depreciation of their human capital is less. Therefore, propensities to commit suicide become very low for these people. Furthermore, because people with high suicidal risks are surrounded by optimistic people, are exposed to positive information and receive more social support in expansion, they may cancel or postpone their extreme actions. Lastly, copycat suicides are most unlikely to occur in expansion. Therefore, we expect suicide rates to fall dramatically in expansion. According to these arguments, we hypothesize that suicide exhibits the pattern of an asymmetric cycle.

Estimation Strategy

Parameters of Interest

Let:

$$m_t = \alpha_0 + \alpha_1 M_t + \varepsilon_t \tag{1}$$

$$s_t = \beta_0 + \beta_1 M_t + v_t, \quad (2)$$

where m_t stands for the total mortality rate, s_t represents the death rate caused by suicide, M_t includes a vector of macroeconomic condition indicators, and ε_t and v_t are error terms with white noise processes that are assumed to be independent of M_t. The central parameters of interest are α_1 and β_1, which are viewed as the marginal responses of total mortality and fatality from suicide to changes in macroeconomic conditions.

Existing Identification Strategy

Tapia Granados (2005a) is the most recent paper using U.S. time-series data to examine how mortality and suicide respond to changes in economic conditions. He regresses the rate of change of mortality (suicide) on either the rate of change of unemployment or the GDP growth rate. Spurious regression caused by the nonstationary series is always a considerable econometric concern when using time-series data. A detrended series can be computed either with the Hodrick–Prescott (HP) filter or by transforming the series into first differences. He uses the statistical method of concomitant variation to ascertain the relationship between mortality variables and economic oscillation variables. To apply this method, Tapia Granados (2005a) transforms the variables into either rates of change or percentage deviations from the trend. The trend values of these variables are computed using the HP filter. The augmented Dickey–Fuller (ADF) test results indicate that all of the transformed series in Tapia Granados' (2005a) study are trend stationary. His linear regression specifications can be summarized as follows:

$$\tilde{m}_t = \alpha_0 + \alpha_1 \tilde{u}_t + \varepsilon'_t, \ \tilde{m}_t = (m_t - m_{t-1})/m_{t-1}, \ \tilde{u} = (u_t - u_{t-1})/u_{t-1} \quad (3)$$

$$\tilde{s}_t = \beta_0 + \beta_1 \tilde{u}_t + v'_t, \ \tilde{s}_t = (s_t - s_{t-1})/s_{t-1}, \quad (4)$$

where $\tilde{m}_t$ represents the change rate of total mortality, $\tilde{s}_t$ represents the change rate of mortality from suicide, $\tilde{u}_t$ represents the change rate of unemployment (or GDP growth rate), and ε'_t and v'_t are error terms with white noise processes that are assumed to be independent of $\tilde{u}_t$.

Note that in equations (3) and (4), the implied impact sizes of the change rate of unemployment on the change rate of total mortality (suicide) are symmetric on two paths of change: an increase and a decrease in unemployment. A symmetric setting suggests that the impact of increased unemployment on mortality (suicide) is equal to that of decreased unemployment on mortality (suicide).

Our Identification Strategy

Unlike previous studies using symmetric regression specifications, this work uses asymmetric regression specifications to examine the impacts of economic oscillations on total mortality and mortality from suicide. Unemployment change rate and GDP growth rate are two commonly used indicators of economic oscillations. Tapia Granados (2005a) used both indicators in his estimations. However, Tapia Granados (2005a) argues that from the point of view of population health, unemployment change rate is a better measure of economy than GDP growth. His argument is that unemployment is a better gauge of the population-level consequences of economic expansions and recessions. Therefore, we decided to adopt the unemployment change rate that is widely used in previous studies (e.g., Ruhm (2000); Neumayer (2004); Gerdtham and Johannesson (2003, 2005); Gerdtham and Ruhm (2006); Svensson (2006); Tapia Granados (2005a, 2005b, 2008); Economou et al. (2008); Hanewald (2008)) as our indicator of economic oscillation.

Rather than using relative percentage change rate, we adopt the absolute change rate in our study. In fact, we also conducted the estimation with the relative percentage change rate. A similar result and implication were found. Therefore, we only report the estimation results using the absolute change rate in this study. We measure the absolute change rate of these variables by computing deviation from the trend. This research constructs two paths for the business cycle based on changes in unemployment: recession (a positive deviation from the unemployment trend) and expansion (a negative deviation from the unemployment trend), identified as follows:

$$\hat{u}_t^+ = \begin{cases} \hat{u}_t \text{ if } \hat{u}_t \geq 0 \\ 0 \text{ if } \hat{u}_t < 0 \end{cases} \text{ and } \hat{u}_t^- = \begin{cases} |\hat{u}_t| \text{ if } \hat{u}_t < 0 \\ 0 \text{ if } \hat{u}_t \geq 0 \end{cases}, \ \hat{u}_t = (u_t - u_{trend,t}), \tag{5}$$

where the former represents the positive deviation from the unemployment trend and the latter represents the absolute magnitude of the negative deviation from the unemployment trend. To test the asymmetric hypothesis, we include these two paths and write the asymmetric regression specifications as follows:

$$\hat{m}_t = \alpha_0 + \alpha_1 \hat{u}_t^+ + \alpha_2 \hat{u}_t^- + \eta_t, \ \hat{m}_t = (m_t - m_{trend,t}) \tag{6}$$

$$\hat{s}_t = \beta_0 + \beta_1 \hat{u}_t^+ + \beta_2 \hat{u}_t^- + \xi_t, \ \hat{s}_t = (s_t - s_{trend,t}), \tag{7}$$

where $\hat{m}_t$ represents the deviation from the total mortality trend, $\hat{s}_t$ represents the deviation from the suicide trend, and η_t and ξ_t are error terms with white noise processes assumed to be independent of both $\hat{u}_t^+$ and $\hat{u}_t^-$. Asymmetry is obtained if $|\alpha_1| \neq |\alpha_2|$ or $|\beta_1| \neq |\beta_2|$. To avoid omitted variable bias, we control a vector for confounding variables X for mortality and one for confounding variables Y for suicides. When a vector of deviations from trends of these confounding variables is added, models (8) and (9) transform into the following:

$$\hat{m}_t = \alpha_0 + \alpha_1 \hat{u}_t^+ + \alpha_2 \hat{u}_t^- + \alpha_3 \hat{X}_t + \eta'_t, \ \hat{X}_t = (X_t - X_{trend,t}) \tag{8}$$

$$\hat{s}_t = \beta_0 + \beta_1 \hat{u}_t^+ + \beta_2 \hat{u}_t^- + \beta_3 \hat{Y}_t + \xi'_t, \ \hat{Y}_t = (Y_t - Y_{trend,t}), \tag{9}$$

where $\hat{X}_t$ stands for the deviation from X trend, $\hat{Y}_t$ represents the deviation from the Y trend, and η'_t and ξ'_t are error terms with white noise processes assumed to be independent of $\hat{u}_t^+$, $\hat{u}_t^-$, $\hat{X}_t$ and $\hat{Y}_t$. The error terms can be heteroskedastic and autocorrelate in the OLS estimation. Therefore, this study adopts consistent Newey–West (1987) standard errors.

Variables of Interest

Mortality numerical data can assume the form of crude mortality and age-adjusted mortality for measurement. Because employing crude mortality data involves potential age biases, this study uses age-adjusted data for all-cause mortality and cause-specific mortality.

The major explanatory variable for this study is the oscillation in unemployment, and its coefficients are our parameters of interest. In the asymmetric regressions, decreases and increases in unemployment are proxies for economic expansion (upturn) regimes and economic recession (downturn) regimes, respectively.

To avoid omitted biases, we control for a group of confounding variables for total mortality. The first confounding variable is public health expenditure. Kennelly et al. (2003) point out that public health expenditure increases the probability of some patients receiving services they could not otherwise afford. Therefore, a good public health environment enhances a citizen's health. To control for the effect of public health, the study uses the share of public health expenditure in total national health expenditure as a proxy for the government's public health investment.

The second confounding variable for mortality is the new immigrant population. Immigration affects the mortality rate through two opposite channels. On the one hand, immigration has the potential to raise the mortality rate by increasing crowding, introducing disease, and causing unfamiliarity with roads or medical infrastructure (Ruhm (2000)). On the other hand, immigration may reduce the mortality rate because immigrants are healthier as a positive selective outcome of the immigration screening process (e.g., Singh and Miller (2004); Antecol and Bedard (2006)). Therefore, the effect of immigration on mortality should depend on which of two opposite effects dominates.

Drinking alcohol and smoking cigarettes have both commonly been considered health risks, and several studies have included these behaviors as confounders in mortality regressions (e.g., Kennelly et al. (2003); Economou et al. (2008); Hanewald (2008)). In addition to being confounders, they can also serve as mediators in the relationship between unemployment and mortality (Ruhm (2006, 2008)). For instance, unemployment increases the inclination to smoke and to consume alcohol (Janlert (1997)). This would lead to a higher mortality risk.

These four variables can also be confounders in estimating numbers of suicides. Public health expenditure reduces the likelihood of suicide because it affects the level and quality of medical supervision during times when suicide is considered an option (Minoiu and Rodriguez Andres (2008)). Immigration has two opposite impacts on suicides. Singh and Miller (2004) report that immigrants have higher levels of social and familial support and social integration than U.S.-born citizens. However, Stack (1981) suggests that immigration decreases integration or the bonds between people and culture. Through decreasing the length of social relationship, immigration can be viewed as an important contributing factor to suicide potential. Therefore, the impact of immigration on suicide rates should depend on which effect dominates.

Because smoking leads to depression (e.g., Choi et al. (1997); Goodman and Capitman (2000); Martini et al. (2002)) and alcohol abuse induces aggressive and reckless behavior, these behaviors are considered to increase the risk of suicide (e.g., Miller et al. (2000); Norstrom (1995); Gruenewald et al. (1995); Mann et al. (2008)). Therefore, we include them as confounders in our suicide regression.

In addition to these four confounding variables, there are several possible confounders for suicide regression: per capita income, income inequality, religious affiliation, and divorce. Tapia Granados (2005a) indicates that per capita income and unemployment rate are strongly related. Moreover, income inequality is found to be closely related to unemployment (e.g., Cysne (2008); Macinko et al. (2004)). Including these as the confounders of unemployment would cause the problem of multicollinearity. This is why we decided not to include these two variables in the estimation. Yang (1992) controls for Catholicism with a variable in his suicide regression. However, his results contradict the proposition by sociologists that Catholic belief reduces the suicide rate. In fact, defining an appropriate religion variable for modern America is very difficult because there are currently a variety of religions. Therefore, we exclude the religion variable in our suicide regression.

Divorce is traditionally considered to be a factor that promotes suicidal behavior. For instance, Durkheim (1897, 1951) views divorce as a symptom of low social integration leading to a lack of social control, so it promotes suicidal behavior. Becker (1974) suggests that a divorced individual has lower utility than a married one because marriage has mercenary value. Following Becker's argument, Koo and Cox (2008) suggest that divorced individuals have less utility and are therefore more likely to commit suicide than married people. However, many scholars have totally opposing views. They believe the negative impact of divorce is reduced as divorce becomes a very common phenomenon (e.g., Stack (1990)) and that the end of an unhappy marriage may be a gain for an individual (e.g., Renne (1971); Norstrom (1995)). Therefore, the impact of the divorce rate on suicidal behavior depends on which effect is stronger.

Data Sources and Samples

Most of the data for the variables of interest in this study were obtained from the online Historical Statistics of the United States: Colonial Times to 1970, the U.S. 2009 Statistical Abstract, and historical statistics of the National Center for Health Statistics. Per capita alcohol consumption data were derived from the website of the National Institute on Alcohol Abuse and Alcoholism of the National Institute of Health, and per capita cigarette consumption was derived from the Tobacco Outlook of the U.S. Department of Agriculture website.

All variables used in our estimations were detrended using the HP filter method, and the smoothing parameter of the HP filter was set at 100. The setting of smoothing parameter is based on the suggestion of Backus and Kehoe (1992). The current study measured the absolute change rates of these variables by computing the deviation from the trend. The change rates of these variables proved to be trend stationary based on the ADF test. Our ADF test excludes the trends and the selection of lag structure is based on Akaike's information criterion (AIC).

Two important events occurred in the U.S. in the late 1930s and 1940s, namely the Great Depression and World War II. These two shocks caused mortality and suicide to fluctuate abnormally. To avoid the bias caused by these shocks, we excluded the period prior to 1950. Therefore, our sample covers the period from 1951 to 2005. Figure 1 shows that the age-adjusted all-cause mortality rate is negatively related to the unemployment rate, implying that mortality is procyclical. Figure 2 shows that the age-adjusted suicide rate is positively related to the unemployment rate, implying that suicide is countercyclical.

Empirical Results

Results of symmetric regression specifications shown in Table 1 provide the evidence that all-cause mortality is procyclical and fatality from suicide is countercyclical in the United States. These are consistent with findings of earlier studies such as Tapia Granados (2005a). Most confounders have statistically insignificant effects on mortality and fatality from suicide, with public health expenditure representing an exception. An increase in public health expenditure significantly reduces the risk of suicide.

Results of asymmetric regression specifications in the first column of Table 2 indicate a statistically significant fall in mortality during recession but a statistically insignificant rise in expansion. The P-value of the Wald statistic from asymmetric regression of all-cause mortality is greater than 0.05, implying that there are no significant differences in unemployment impact on all-cause mortality between economic upturns and downturns. To summarize, there is no evidence that all-cause mortality responds asymmetrically to business cycles. The following three columns in the same table provide evidence that rates of mortality caused by specific diseases such as cardiovascular diseases, liver cirrhosis and pneumonia are similar in expansion or recession. These empirical findings support our hypothesis that all-cause mortality and mortality from disease exhibit asymmetric cycles. Furthermore, the asymmetric regression results summarized in the last column of Table 2 suggest that the number of fatalities from suicide does not rise significantly during a downturn but falls significantly during an upturn. The very small P-value of the Wald statistic provides evidence that the number of fatalities from suicide responds asymmetrically to the business cycle. This empirical evidence supports our hypothesis that suicide exhibits an asymmetric cycle.

Results of asymmetric regression specifications, including the confounders in Table 3, provide empirical evidence of a symmetric mortality cycle and an asymmetric suicide cycle. Like symmetric regression results, few confounder effects are statistically significant in the asymmetric regression. Public health expenditure is shown to have a negative impact on suicide. The increase in a new immigrant population significantly reduces mortality caused by cardiovascular diseases. On the other hand, cigarette consumption significantly raises mortality caused by cardiovascular diseases.

Results from Table 4 also suggest that neither male mortality nor female mortality exhibits an asymmetric cycle. However, in the same table, results for suicide provide evidence that asymmetric suicide cycles are statistically significant for men but not for women. This statistical phenomenon may reflect the fact that economic stressors play more important roles in suicides for men than for women.

When asymmetry for various age groups is tested, results in Table 5 provide no evidence that total mortality exhibits an asymmetric cycle for any group. However, Table 6 indicates that suicide exhibits asymmetric cycles, particularly for working-age groups. For instance, excluding the confounding variables in the estimation provides evidence for statistically significant asymmetric suicide cycles for the following groups: 25–34, 35–44, 45–54, and 55–64. Including the confounding variables provides evidence for significant asymmetric suicide cycles only for the 35–64 groups. This evidence supports our argument that economic stressors play more important roles in suicide for working-age groups.

To test the stability of estimation results, the Chow test was used in this study to examine whether structural changes exist in our estimations across periods. Chow test results in Table 7 show no structural changes for total mortality, male or female mortality, or mortality of any age group except 15–24. Similarly, based on Chow test results in Table 8, we find no structural changes for total suicides, male or female suicides, or suicides in any age group. Using these structural change tests, the authors of this study are confident that its estimation results are stable. We also used four break points: 1973, 1974, 1979, and

1980 (oil crisis periods) to perform our structural change tests and still found no evidence of structural changes.

Conclusion

Many studies have examined whether mortality or death from suicide is procyclical or countercyclical. The results vary across time periods and countries. By examining U.S. time-series data from 1951 to 2005, our findings indicate that linear and symmetric regression results are consistent with those found in recent papers such as Ruhm (2000) and Tapia Granados (2005a). Mortality is procyclical and death from suicide is countercyclical in the United States.

Unlike earlier studies, this paper adopts the concept of asymmetric cycles in studying mortality and suicide. Our hypothesis is that all-cause mortality or that caused by certain diseases does not exhibit an asymmetric cycle, while suicide does. To our knowledge, this paper is the first to apply asymmetric specifications to study the impacts of short-run macroeconomic fluctuations on mortality or the number of deaths from suicide. The asymmetric regression results of this study support our hypotheses. We find evidence that all-cause mortality or that caused by certain diseases exhibits a symmetric cycle, while fatalities from suicide exhibit asymmetric cycles. This study also provides evidence that asymmetric suicide cycles are only statistically significant for men and working-age groups but not for women and non-working-age groups. Our statistical evidence of a symmetric mortality cycle and asymmetric suicide cycles provide policy makers with an alternative view to consider when implementing public policies.

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Figure 1 U.S. All-cause Mortality and Unemployment (absolute change rate)

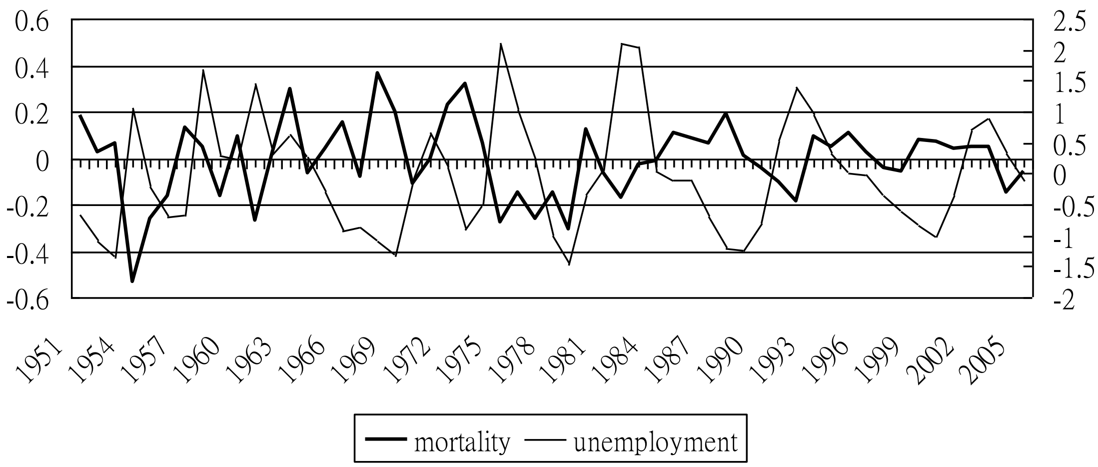

Figure 2 U.S. Suicide and Unemployment (absolute change rate)

Table 1 Results of Symmetric Regression Specifications on All-cause Mortality and Suicide

	All-cause Mortality		Suicide	
$\hat{u}_t$	–0.0680**	–0.0679**	0.1120**	0.0791
	(0.0237)	(0.0249)	(0.0471)	(0.0505)
Public Health		0.00151		–0.0455**
		(0.0117)		(0.0144)
Immigration		–0.0009		–0.0001
		(0.0005)		(0.0015)
Alcohol		0.1010		–2.3620
		(0.7690)		(1.8130)
Cigarettes		0.0004		0.0005
		(0.0003)		(0.0005)
Divorce				–0.3040
				(0.4000)
Constant	–0.0065	–0.0068	–0.0158	–0.0182
	(0.0253)	(0.0256)	(0.0481)	(0.0429)
Adj R_squared	0.1235	0.1065	0.1202	0.2238

Notes: 1. The values in the parentheses are the Newey–West standard error estimators.

2. ** represents significance at a 5% level.

Table 2 Results of Asymmetric Regression Specifications on All-cause vs. Cause-specific Mortality (Full Period)

	All-cause Mortality	Cardiovascular	Liver Cirrhosis	Pneumonia	Suicide
$\hat{u}_t^+$	–0.0854**	–0.0432	–0.0016**	–0.0107**	–0.0431
	(0.0316)	(0.0278)	(0.0007)	(0.0039)	(0.0634)
$\hat{u}_t^-$	0.0464	0.0084	0.0016	–0.0007	–0.3290**
	(0.0556)	(0.0276)	(0.0013)	(0.0075)	(0.0717)
Constant	0.0081	0.0093	0.00000348	0.0036	0.1200**
	(0.0323)	(0.0209)	(0.0011)	(0.0042)	(0.0588)
Adj R_squared	0.1150	0.0382	0.1471	0.0388	0.2423
Wald Statistics	0.2800	0.6100	0.0000	2.2400	11.1600**
	(0.5978)	(0.4373)	(0.9824)	(0.1407)	(0.0015)

Notes: 1. The values in the parentheses are the Newey–West standard error estimators.

2. ** represents significance at a 5% level.

3. The values in the parentheses for the Wald statistics are P-values.

Table 3 Results of Asymmetric Regression Specifications on All-cause vs. Cause-specific Mortality (with Confounders)

	All-cause Mortality	Cardiovascular	Liver Cirrhosis	Pneumonia	Suicide
$\hat{u}_t^+$	–0.0881**	–0.0459	–0.0016**	–0.0107**	–0.0367
	(0.0349)	(0.0304)	(0.0007)	(0.0037)	(0.0660)
$\hat{u}_t^-$	0.0407	0.0116	0.0009	0.0015	–0.2570**
	(0.0579)	(0.0360)	(0.0015)	(0.0072)	(0.0871)
Public Health	0.0025	–0.0047	0.0004	0.0005	–0.0380**
	(0.0114)	(0.0069)	(0.0003)	(0.0015)	(0.0153)
Immigration	–0.0009	–0.0012**	0.00001	0.00001	–0.0003
	(0.0005)	(0.0003)	(0.00001)	(0.00009)	(0.0014)
Alcohol	0.1660	0.0606	0.0125	–0.1100	–1.7540
	(0.8190)	(0.5340)	(0.0117)	(0.1050)	(1.7910)
Cigarettes	0.0004	0.0004**	–0.00000644	0.0000637	0.0006
	(0.0003)	(0.0002)	(0.00000545)	(0.0000375)	(0.0005)
Divorce					–0.2650
					(0.4180)
Constant	0.0109	0.0089	0.0003	0.0027	0.0902
	(0.0273)	(0.0156)	(0.0010)	(0.0031)	(0.0604)
Adj R_squared	0.0988	0.1191	0.1752	0.0593	0.2966
Wald Statistics	0.3700	0.4000	0.1000	1.0100	5.1200**
	(0.5478)	(0.5286)	(0.7583)	(0.3190)	(0.0283)

Notes: 1. The values in the parentheses are the Newey–West standard error estimators.

2. ** represents significance at a 5% level.

3. The values in the parentheses for the Wald statistics are P-values.

Table 4 Results of Asymmetric Regression Specifications on All-cause Mortality and Suicide by Sex

	All-cause Mortality				**Suicide**			
	Male		**Female**		**Male**		**Female**	
$\hat{u}_t^+$	–0.0998**	–0.1030**	–0.0717**	–0.0748**	–0.0546	–0.0389	–0.0566	–0.0541
	(0.0351)	(0.0389)	(0.0306)	(0.0335)	(0.105)	(0.1050)	(0.0463)	(0.0484)
$\hat{u}_t^-$	0.0260	0.0139	0.0316	0.0249	–0.5020**	–0.3830**	–0.1630**	–0.1380**
	(0.0722)	(0.0689)	(0.0470)	(0.0509)	(0.1090)	(0.1200)	(0.0494)	(0.0636)
Public Health		0.0089		0.0018		–0.0564**		–0.0241
		(0.0152)		(0.0095)		(0.0246)		(0.0139)
Immigration		–0.0005		–0.0012**		0.0009		–0.0008
		(0.0008)		(0.0005)		(0.0028)		(0.0006)
Alcohol		0.1900		0.2420		–3.3070		–0.1540
		(1.0440)		(0.7130)		(2.5400)		(1.1540)
Cigarettes		0.0005		0.0004		0.0008		0.0003
		(0.0004)		(0.0003)		(0.0007)		(0.0004)
Divorce						–0.5490		–0.1960
						(0.6560)		(0.2790)
Constant	0.0193	0.0242	0.0095	0.0129	0.1840**	0.1310	0.0709	0.0606
	(0.0408)	(0.0336)	(0.0276)	(0.0229)	(0.0892)	(0.0884)	(0.0470)	(0.0529)
Adj R_squared	0.0713	0.0512	0.0948	0.1038	0.2399	0.3033	0.0761	0.0463
Wald Statistics	0.6700	1.0100	0.4000	0.5100	9.7600**	5.1200**	3.9300	1.7300
	(0.4167)	(0.3203)	(0.5309)	(0.4791)	(0.0029)	(0.0284)	(0.0527)	(0.1952)

Notes: 1. The values in the parentheses are the Newey–West standard error estimators.

2. ** represents significance at a 5% level.

3. The values in the parentheses for the Wald statistics are P-values.

Table 5 Results of Asymmetric Regression Specifications on Age-specific Mortality

Age groups	Age_1524	Age_2534	Age_3544	Age_4554	Age_5564	Age_6574
Wald Statistics (a)	0.0000	0.9600	0.6300	0.5600	0.3100	0.3500
	(0.9470)	(0.3321)	(0.4310)	(0.4585)	(0.5807)	(0.5579)
Wald Statistics (b)	0.2000	0.3300	0.6500	2.0800	0.4900	0.8000
	(0.6582)	(0.5701)	(0.4224)	(0.1555)	(0.4872)	(0.3760)

Notes: 1. ** represents significance at a 5% level.

2. The values in the parentheses for the Wald statistics are P-values.

(a) Confounding variables are excluded from the estimation.

(b) Confounding variables are included in the estimation.

Table 6 Results of Asymmetric Regression Specifications on Age-specific Suicide

Age groups	Age_1524	Age_2534	Age_3544	Age_4554	Age_5564	Age_6574
Wald Statistics (a)	2.5500	5.5900**	8.6200**	9.4700**	10.8800**	1.5700
	(0.1163)	(0.0219)	(0.0049)	(0.0033)	(0.0018)	(0.2165)
Wald Statistics (b)	1.3500	2.3600	7.6400**	4.9000**	10.8100**	0.5800
	(0.2507)	(0.1315)	(0.0081)	(0.0317)	(0.0019)	(0.4488)

Notes: 1. ** represents significance at a 5% level.

2. The values in the parentheses for Wald statistics are P-values.

(a) Confounding variables are excluded from the estimation.

(b) Confounding variables are included in the estimation.

Table 7 Results of Structure Change Test of Total Mortality

	Total	Male	Female	Age_1524	Age_2534	Age_3544	Age_4554	Age_5564	Age_6574
Chow Test	0.9458	2.088	0.7177	2.9480**	1.1300	2.7855	2.6387	1.7943	0.8464
	(0.4258)	(0.1138)	(0.5462)	(0.0420)	(0.3461)	(0.0504)	(0.0600)	(0.1606)	(0.4752)

Notes: 1. ** represents significance at a 5% level.

2. The values in the parentheses for the Chow test statistics are P-values.

Table 8 Results of Structure Change Test of Suicide Rate

	Total	Male	Female	Age_1524	Age_2534	Age_3544	Age_4554	Age_5564	Age_6574
Chow Test	0.6570	1.5247	1.1962	0.8683	0.2699	0.0981	0.5090	0.7603	0.8987
	(0.5825)	(0.3002)	(0.3210)	(0.4369)	(0.8468)	(0.9607)	(0.6779)	(0.5218)	(0.4486)

Notes: 1. ** represents significance at a 5% level.

2. The values in the parentheses for the Chow test statistics are P-values.