DRAFT: DO NOT CITE

A Changing Epidemiology of Suicide?

The Influence of Baby Boomers on Suicide Rates in the United States

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Acknowledgments: This research was supported in part by a grant from the American Foundation for the Prevention of Suicide.

Abstract

The increases in suicide among middle-aged boomers in the United States since 1999 suggest a changing epidemiology of suicide. Using data from 1935 to 2005, this paper applies recent developments in age-period-cohort analysis (the intrinsic estimation method) to determine the presence of cohort effects in shaping temporal patterns of suicide in the United States. Special attention is paid to the role of baby boomers, a birth cohort characterized by high rates of suicide in adolescence and now again in middle age. The analysis demonstrates that age, period and cohort effects are all important in determining suicide trends. However, net of age and period effects, the baby boomer cohort exhibits relatively *low* rates of suicide. Rather, boomers appear to have ushered in new patterns of suicide risk over the life course. Suicide rates begin to rise with boomers and subsequent cohorts exhibit increasingly higher rates of suicide once age and period effects are removed. Explanations for these patterns are considered, such as the substantial social change brought about since the 1960s that produced increasing risks and reduced protections for suicide for boomers and successive birth cohorts.

Introduction

Recent reports, both in the media and in academic circles, have documented a sharp rise in suicide rates among the U.S. middle-aged population beginning in 1999 (Hu, Wilcox, Wissow, & Baker, 2008; Phillips, Robin, Nugent, & Idler, 2010). For those aged 45-54, the suicide rate increased from 13.9 per 100,000 in 1999 to 19.6 per 100,000 in 2010, the most recent year for which data are available. Rates also rose substantially for those aged 55-64, but there has been no concomitant increase in rates for other age groups(Centers for Disease Control). This pattern has taken many by surprise as historically, the overall picture of suicide rates among the middle-aged has been one either of stability or decline. Prior to this recent increase, among males aged 45-64, rates had declined by more than half, from approximately 60 per 100,000 in 1930 to less than 30 per 100,000 by 1986. Rates for females aged 45-64 had shown more cyclical fluctuation, but they also decreased from about 13 per 100,000 in 1930 to about 8 per 100,000 by 1986 (McIntosh, 1991).

Among the explanations offered for this recent trend among the middle-aged as well as for the surging rates of adolescent suicide in the 1960s and 1970s is one that attributes the increases to cohort effects (Ahlburg & Shapiro, 1984; Phillips et al., 2010; Pollinger Haas & Hendin, 1983). Some have speculated that the baby boomer birth cohort, which occupied these age ranges during those time periods, may have a unique suicide risk that they carry with them through the life course. However, the challenge in explaining temporal patterns in suicide rates is to distinguish the effects of cohort membership from those of age or time period (Yang, 2007). Certainly, suicide rates vary with age due to biological or behavioral differences and accumulation of social experiences associated with age. Thus, shifts in the population's age composition or in the age pattern of suicide can produce changes in overall suicide rates. Furthermore, certain historical or social events that occur in a given time period, such as rising unemployment rates or new treatments for depression, can affect suicide rates across all age groups, altering the overall suicide rate by either increasing or decreasing deaths across all age ranges. Researchers have employed various techniques to disentangle these effects, and some find support for the

presence of cohort effects in explaining changes over time in suicide, e.g. (Ajdacic-Gross et al., 2006). Still, the research is generally limited in scope and dated – to my knowledge, no study has examined the time period that includes the recent increases in middle-aged suicide. Moreover, recent methodological advancements in age-period-cohort (APC) analysis have not been applied to the study of suicide (Yang et al., 2008).

The present paper is motivated by the recent increases in suicide among middle-aged boomers, which suggest a changing epidemiology of suicide. Using data from 1935 to 2005, I examine the relative role of age, period, and cohort effects in explaining temporal patterns of suicide in the United States. As shown in Figure 1, crude suicide rates have waxed and waned over this seventy year period, with declines and relative stability between 1933 and the early 1950s, increases through to the early 1980s, and then subsequent drops through to about 2000 before rates started to creep upward again. In particular, the analysis seeks to determine the extent to which cohort effects explain these patterns, with special attention to the role of the baby boomer cohort. Prior work speculates that baby boomers may have a unusual suicide risk and in fact, a recent study shows that the baby boomer cohort has lower self-reported levels of happiness, net of age and period effects, compared to other birth cohorts (Yang, 2008). However, this premise has not been rigorously assessed. This study aims to do just that now that boomers are beginning to enter the older age ranges, by compiling seventy years of data on U.S. suicide for twenty-six birth cohorts and applying new developments in APC analysis, namely the Intrinsic Estimator.

[FIGURE 1 ABOUT HERE]

Explaining Cohort Effects and the Influence of Baby Boomers on Suicide Rates

The etiology of suicide is undoubtedly complex, shaped by a confluence of social, economic, cultural and biological factors that operate at both the individual and societal levels (Maris, Berman, Silverman, & Bongar, 2000). Research coming out of the psychiatry and public health fields tends to emphasize the role of individual-level risk factors that are partly determined by biology, such as a history

of mental illness or substance abuse (Conner, Duberstein, Conwell, Seidlitz, & Caine, 2001). These studies indicate, for example, that two thirds or more of individuals completing suicide suffered from some severe depressive disorder at the time of death (Beautrais et al., 1996; Isacsson, Holmgren, Druid, & Bergman, 1997). Individual-level analyses also reveal that a loss or lack of connection to others is an important underlying risk factor for suicide and is one pathway through which (changes in) marital or employment status, physical or mental health problems, and substance abuse can affect the risk for suicide (Maris, 1997).

Since Durkheim's classic study on the subject, the important role of social structure in affecting suicide rates at the aggregate level has also been recognized. Low levels of social integration within a society lead to instability and lack of cohesion, producing excessive individualism and high rates of *egoistic suicide*. Lack of social regulation produces anomie, an absence of norms and an inability of society to meet the population's needs and expectations, and corresponds to high rates of *anomic suicide* (Durkheim, 1951). Just as Durkheim uncovered in 19th century Europe, recent cross-sectional studies that compare geographic areas such as countries or states tend to find that places that are less socially integrated, as measured by family structure and religious composition, and less regulated, often proxied by economic characteristics, have higher levels of suicide (Phillips, Forthcoming; Stack, 2000a; Stack, 2000b). Longitudinal studies investigating variation in suicide rates over time within a particular location reach similar conclusions (e.g. Luo, Florence, Quispe-Agnoli, Ouyang, & Crosby, 2011). Thus, both micro and macro features of life are important determinants of suicide, although relatively little work to date has attempted to consider their joint influence (but see e.g. Maimon & Kuhl, 2008; Denney, Rogers, Krueger, & Wadsworth, 2009).

Beyond the characteristics of an individual and a society (within a given time period), membership in a particular birth cohort, or "a social generation" to use Mannheim's terminology, influences individuals and takes into account not only the contemporaneous but also the historical socio-cultural context that people experience. Unlike much prior work on suicide that tends to be divided along

biological and social lines, the concept of a birth cohort implicitly *connects* biology and social structure by recognizing that the implications of a particular social or historical event can be distinct depending on the stage of life course or age at which that event occurs (Pilcher, 1994). Both sociologists and developmental psychologists assert that events occurring during the formative years of adolescence are most critical in shaping a birth cohort and locating them within a social structure. This shared experience of history at a young age can promote distinct behaviors, feelings, reactions and thoughts – in essence a comprehensive worldview that cohort members carry with them over the life course (Mannheim, 1923).

Baby boomers in the United States, a birth cohort with substantial influence across economic, cultural and political domains, have generated great interest from scholars, including in the study of suicide, e.g.(Ajdacic-Gross et al., 2006; Manton, Blazer, & Woodbury, 1987; Stockard & O'Brien, 2002). For instance, when attempting to explain the dramatic increase in adolescent suicide rates during the 1960s and 1970s, scholars noted a number of unique traits about the baby boom cohort that might account for the patterns and pointed to the possibility of continued high risk for the future. Some argued that membership in a large birth cohort might be detrimental to psychological well-being by reducing the degree of social integration and regulation experienced by the group. Those in exceptionally large cohorts face a number of possible disadvantages, such as over-crowded classrooms, less attention from parents due to larger family sizes, and increased competition in school and in the labor market, that may persist over the life course (Easterlin, 1980; Macunovich, 2002). Indeed, several studies based on U.S. data (Stockard & O'Brien, 2002) and cross-national data (Pampel & Williamson, 2001; Stockard & O'Brien, 2002) support this notion by demonstrating that cohort characteristics such as relative cohort size and prevalence of non-marital births are associated with higher rates of suicide, net of age and period effects.

Others adopted a psychological/cultural approach by suggesting that boomers were less likely than preceding cohorts to have faced adversity. They grew up during the post-war period of economic prosperity and rapidly improving health and life expectancy prospects. Boomers came of age during the 1960s and 1970s when dramatic cultural (e.g. the Civil Rights and Women's Movements) and political

(e.g. assassinations and the Vietnam War) change was underway, authority was questioned and the status quo successfully overturned. As a result of these formative experiences, the argument goes that boomers may possess poor coping skills to handle tough times (Sudak, Ford, & Rushforth, 1984; McIntosh, 1994). The notion of a boomer identity is certainly consistent with theoretical arguments put forward by Mannheim and Durkheim. Boomers came of age during a period of swift social and cultural change – the rapidity of change can enhance the formation of a generational identity (Mannheim, 1923) – and the turbulent period was marked by low social regulation in which expectations and norms could not be easily met or controlled (Durkheim, 1951). However, the idea of a generational identity and its linkage to rising suicide rates remains difficult to test directly due to data constraints.

Finally, researchers studying rising suicide rates during the 1960s through the early 1980s observed that boomers exhibited higher rates of depression relative to previous birth cohorts (Klerman & Weissman, 1989; Klerman, 1989), although some questioned the validity of these findings due to changing diagnostic criteria and recall/memory errors. In addition, growing rates of substance abuse among adolescent baby boomers may have affected suicide rates; substance abuse is a known risk factor for suicidal behavior as it reduces inhibitions and may raise impulsivity and is linked to depression and social isolation (O'Malley, Bachman, & Johnston, 1984). In sum, a number of unique attributes and experiences that describe boomers during their formative ages may have elevated their risk for suicide during adolescence and young adulthood: Membership in a cohort of large size, a distinct world perspective influenced by the tumultuous time period in which they came of age, and the possibility of higher rates of depression and substance abuse could all increase social isolation and lower social regulation among boomers, thereby affecting their risk of suicide.

Now in the middle to early-late stages of their life course, there are reasons to believe that these baby boomer patterns established earlier may be having new manifestations, but with similar consequences in the form of reduced social integration and regulation. Relative to previous cohorts in midlife, baby boomers are far more likely to live alone and carry less of the traditional protection of being

married into the high risk period of old age. Between 1990 and 2009, the "gray divorce rate" (for those over age 50) doubled while the overall divorce rate for the U.S. population remained steady. As a result, about one third of baby boomer men (ages 45-63) were unmarried in 2009, compared to just 20% of those in this age range in 1980, due both to higher divorce and never married rates (Brown & Li, 2012). In addition, baby boomer women have experienced sharply lower completed fertility rates (less than 2.0) than earlier 20th century birth cohorts, given the availability of oral contraceptives from the very beginning of their childbearing years (Hughes & O'Rand, 2004). Another traditional protection less available to baby boomers is religious involvement; the postwar cohorts have not shown the increase in religiosity that earlier cohorts have displayed as they aged (Hout & Fischer, 2009; Miller & Nakamura, 1996). These changing patterns contribute to rising social isolation in midlife. A 2010 AARP survey showed that 35% of adults over age 45 reported being chronically lonely, compared to just 20% in 2000 (Anderson, 2010).

Accompanying these reduced protections are increased risks, compared with earlier cohorts, from physical health and substance abuse. Data from the National Health Interview Survey show that the percent of those 45-64 reporting fair or poor health dropped from 21.9 in 1975 to 16.1 in 1989, reflecting an improvement in perceived health also seen in other older age ranges (National Center for Health Statistics, 1976 and 1990). However, when baby boomers started filling these middle-age ranges in 1990, the improvement stopped only for the middle-aged, suggesting either the onset of health problems or a more critical evaluation of a similar level of health status. In fact, the percentage of those aged 45-64 with multiple chronic diseases increased from 13% in 1996 to 22% in 2005, alongside a rise in out-of-pocket spending for health care services (Paez, Zhao, & Hwang, 2009). According to an AARP report on Baby Boomers at Midlife, about a third of boomers report that their health is worse off than they had anticipated at this stage in their lives, suggesting a lack of social regulation and mismatch between expectations and reality. In terms of substance abuse, the National Survey on Drug Use and Health finds

that baby boomer cohorts self-report lifetime use of illicit drugs at rates higher than both earlier and later cohorts (Gfroerer, 2004).

Alongside the above-mentioned factors that may contribute to the rising rates of suicide among middle-aged boomers, a variety of unstable economic conditions during the first decade of the twenty-first century that signal insufficient social regulation also undoubtedly played a role, particularly for the less educated boomers who exhibited the largest increases(Phillips et al., 2010). Bankruptcy rates increased between 1991 and 2007, in part because of changes in the law but still with personal financial consequences (Thorne, Warren, & Sullivan, 2009). The nature of work appears to have changed for men, with declines in long-term employment and increases in short-term employment (less than one year of tenure) for males as they enter their thirties and beyond (Farber, 2007). Last but certainly not least, the economic crisis of 2008 hit boomers particularly hard; they experienced longer periods of unemployment than younger workers and many have been forced to delay retirement to recoup their losses (AARP; Dugas, 2012). Together with eroding midlife protections, the economic shocks experienced by boomers may have affected suicide rates more severely than they would have for those in midlife at an earlier period or for those younger or older than middle age in the same period – a quintessential cohort effect.

Are Boomers Unique or the Harbinger of a New Epidemiology of Suicide?

How the new social and economic reality, confronted first by boomers in early adulthood and middle age, will affect future cohorts and societal levels of social integration and regulation is unclear. As younger cohorts move into middle age, they too will face many of the changes in exposure to risk and protective factors that characterize the baby boomer experience. Living arrangements in the United States have fundamentally changed with a dramatic rise in the percentage of the population living alone; 28% of all households were comprised of a single adult in 2010, compared to just 9% of households in 1950 (Klinenberg, 2012). Similarly, some polls suggest that religious involvement is in decline in the United States, with increasing numbers of American self-reporting as Atheists or without a religious identity

(Rosch, 2012). Rising obesity rates among young Americans will likely continue to compromise the health status of younger cohorts as they move into older age ranges. Thus, future cohorts can expect to age with fewer of the traditional social supports and more of some stressful circumstances than have past generations, which may elevate suicide risk over the life course.

However, as these new patterns become more normative, they may have less of an adverse effect on suicide risk. For instance, Klinenberg (2012) finds that many so-called singletons, individuals living alone, have active and rich social lives, suggesting that single marital status may no longer connote the same level of social isolation and suicide risk. People may adjust their expectations regarding health and employment into middle- and old-age as they witness the troubles experienced by older cohorts, recalibrating social regulation. The size and composition of cohorts can be an engine for social change, altering both the structures and functions of institutions, and the perception of them. If this is the case, the baby boomer experience regarding how these changes affect suicide risk may indeed be unique. Subsequent cohorts may confront similar scenarios, but those scenarios may not pose the same threat if society's expectations and opinions regarding them shift and/or if new forms of protections emerge in their place.

Approaches to Age-Period-Cohort Analysis

Birth cohorts can affect temporal variation in some social phenomena if they experience historical events at certain developmental ages (usually in their youth) that elevate their risk for that outcome over the life course. Using age-period-cohort models initially developed in the 1970s, studies of mortality show, for instance, that birth cohorts exposed to malnutrition in early life exhibit elevated mortality rates throughout their life, presumably because of a compromised immune system (Yang, 2008). This *cohort effect* in turn shapes trends in overall mortality rates. Cohort effects have been found important in other instances, offering a partial explanation for rising rates of obesity (Reither, Hauser, & Yang, 2009) and declining rates of prayer and religious service attendance in the United States (Schwadel, 2011). Similar

claims have been made in time-series analyses of suicide e.g. (Ajdacic-Gross et al., 2006; Manton et al., 1987; Stockard & O'Brien, 2002). Using Swiss suicide data that examines components of change over the 20th century, Ajdacic-Gross et al. (2006) observed that male suicide rates have shown a general pattern of decline over the course of the 20th century while female suicide rates have increased. These changes led to a reduction in the female to male ratio of suicide deaths from 1:6 to about 1:2.5, and the study concludes that birth cohort effects were important in producing this shift in Switzerland, with much bigger effects for men than for women.

The challenge with these time series analysis is to disentangle the distinct effects of age, period and cohort. A conventional linear regression model approach to APC analysis has a model identification problem, in that any two factors (e.g. age and birth cohort) enable us to predict exactly the third factor (here, time period) (Mason, Mason, & Winsborough, 1973; Binstock & George, 2011). In other words, one can determine the time period with knowledge of a person's age and year of birth, and thus it is not possible to obtain a unique solution to the model. A substantial body of literature coming out of the demography and sociology fields discusses this phenomenon and approaches to circumvent the problem, although each of these "solutions" has its own set of limitations (Mason et al., 1973; Smith, 2008).

Among the most common is an approach that constrains one or more coefficients in the conventional linear regression model to be equal (e.g. the coefficient for age group 15-19 equals that for age group 20-24), so as to obtain a solution. The limitation to this approach is that one must rely on potentially faulty assumptions when selecting the constraint, and results may vary wildly depending on the constraint adopted. Another method, commonly adopted by sociologists, is the "proxy variables approach", which substitutes either the age, period or cohort dummy variables with one or more alternate variables. Thus, if one believes that unemployment levels are the primary period effect of interest, the time period dummy variables would be replaced with unemployment rates for each period. The problem here is that the selected substitute variable(s) may not capture all relevant variation in that particular

component. Prior APC analyses of suicide have adopted these kinds of approaches and so are subject to the various limitations described.

Recent methodological developments by Yang and colleagues (Yang et al., 2008) enable us to bypass some of these limitations. Yang and colleagues developed the Intrinsic Estimator (IE) solution to APC analysis which has several desirable statistical properties compared to prior approaches. Among them is that the IE applies a constraint that produces a solution that may be considered representative, or the average, of all possible solutions (O'Brien, 2011; Smith, 2004). Yang applied this new approach to the study of adult chronic disease mortality from heart disease and certain forms of cancer, finding substantial reductions in mortality between the late 1960s and late 1990s that are largely accounted for by cohort effects (Yang Yang, 2008). To my knowledge, no one has applied this new approach to a study of suicide trends.

Study Objectives

This is an opportune moment to revisit the question of age, period and cohort in shaping U.S. suicide trends. Studies that investigate U.S. temporal patterns are somewhat dated and most examine only a limited range of years. While these analyses capture some of the decline in suicide rates that began in the 1980s, they do not consider the divergent trends by age group observed since 1999 and the marked increase in suicide rates among boomers while in middle age. Furthermore, prior work has not taken advantage of recent methodological developments in APC analysis and may not properly account for age, period and cohort effects simultaneously. The *Annual Review of Sociology* (Wray, Colen, & Pescosolido, 2011) calls explicitly for research that takes advantage of these newly-developed techniques and links micro and macro features of life to capture the ways in which individuals are embedded within social structures such as birth cohorts and time periods.

The present study will address these gaps by using the intrinsic estimation method to conduct an APC analysis of U.S. suicide rates with seventy years of data through to 2005. In particular, I seek to

determine the role of cohort effects in producing temporal change in suicide, with particular attention to the baby boom birth cohort, by describing the patterns of suicide risk by age, time period and birth cohort. An understanding of these patterns will provide insight into the possible reasons behind both the historical and recent trends over time in suicide rates. Are boomers a unique cohort in terms of their suicide risk and/or are they heralding in a new epidemiology of suicide brought about by substantial social change over the past forty years?

Data and Methods

Data on suicide deaths by five year age group and sex are obtained from the U.S. Vital Registration System for the period 1935 to 2005; those who did not reside in the U.S. at the time of death are excluded. The corresponding information on population counts by five year age group and sex come from the Census Bureau. Using these two pieces of information, age- and sex-specific suicide rates are computed for every five-year period between 1935 and 2005 for the population aged 15 and older. That is, for *a* age groups (15-19, 20-24 …, 70-74) and *p* time periods (1935-39, 1940-44, …, 2000-05) of equal length (five years), age-sex-specific suicide rates are computed. Over this time period, a total of 26 consecutive birth cohorts are represented, beginning with those born in 1860-64 and aged 70-74 in 1935 and ending with those born in 1985-89 and aged 15-19 in 2005.

The basic APC model is of a log linear regression form as follows (Mason et al., 1973):

$$\log (r_{apc}) = \log (s_{apc} / n_{apc}) = \alpha + \beta_a + \rho_p + \gamma_c ,$$

where r_{apc} represents the expected suicide rate in age-period-cohort group (a, p, c); s_{apc} denotes the expected number of suicide deaths; n_{apc} is the population at risk; α is the intercept or adjusted mean suicide rate; β_a is the effect for age groups a=1,…, a, ρ_p is the effect for time periods p=1, …, p; and γ_c is the effect for cohorts c=a, …, c. The model cannot be estimated with conventional regression techniques since any one component (age, period or cohort) is a linear function of the remaining two.

In this analysis, three approaches are used to estimate the APC model. I focus attention on the results obtained with the Intrinsic Estimator (IE) model proposed by Yang and colleagues (Yang, Fu, & Land, 2004; Y. Yang et al., 2008). Fu et al. (2011) argue that there are several advantages to the IE model. Although the IE model applies a constraint to obtain a solution[1], it does so by assuming no a priori knowledge of the phenomenon being studied and uses information that is completely independent of the event rate. This model attribute may be desirable since seemingly reasonable assumptions about constraints to place on age, period or cohort effects have been shown previously to lead to counter-intuitive estimates. Furthermore, the variances or error terms of the estimated coefficients obtained from the IE approach are smaller than those obtained from other constrained solutions. In this sense, the IE coefficients are an average of sorts of the constrained estimates and can serve as the representative solution (O'Brien, 2011).

However, O'Brien (2011) raises several concerns about the qualities of the IE approach – in particular, that the IE constraint may yield biased results – and recommends that researchers apply alternative constraints that can be justified on substantive or theoretical grounds. Thus, I estimate two additional constrained models to assess how robust findings are to different assumptions. First, a conventional APC model is estimated using Generalized Least Squares, and the coefficients for two adjacent time periods (1935 and 1940) are constrained to be equal (hereafter referred to as the CGLIM model). This particular constraint is chosen for the following substantive reasons: (1) the results reveal that period effects appear to be the least consequential of the three factors (age, cohort, period) in affecting suicide rates over time; (2) economic conditions – a period characteristic believed to be strongly associated with suicide rates (Luo et al. 2011) – were comparably poor in the two periods (unemployment rate was 17% in 1935 and 14.6% in 1940); and (c) suicide rates were similar in both periods (although

[1] The IE approach adopts the null vector constraint, which is determined entirely by the dimensions of the data and is a special form of a principal components estimator. For greater detail on the statistics behind the IE model, see (Yang, Schulhofer-Wohl, Fu, & Land, 2008) which offers an algebraic, geometric and verbal description of the Intrinsic Estimator and reports both empirical and simulation tests of its validity.

some caution against using the outcome to select a constraint). Second, I estimate a CGLIM with a Zero Linear Trend (ZLT) constraint following a recommendation by O'Brien (2011). The underlying assumption behind the ZLT model is that the long-run period effects on suicide have a zero linear trend – that is, there are periods of increase and decrease in suicide rates, with no particular trend over the long run. Similar results obtained across these three models should enhance confidence in the accuracy of the estimated age, period, and cohort effects. The above-described models are estimated in Stata 11 using the apc_cglim.ado and apc_ie.ado files (see http://www.unc.edu/~yangy819/research.html for more detail).

Following the sequence of analyses recommended by Yang (2004, 2008), I first present a descriptive analysis of age-specific suicide rates by sex for selected time periods and birth cohorts. This analysis provides a contextual account of suicide patterns over time. To obtain a quantitative evaluation of the sources of suicide change, I fit a sequence of one and two factor models to the data. A one-factor or gross-effect model is estimated for age effects (A), period effects (P) and cohort effects (C) only. Three two-factor models are estimated to determine the effect of age and period (AP), age and cohort effects (AC), and period and cohort effects only (PC). Finally, a full APC model, which controls for age, period and cohort simultaneously, is estimated. Two model selection criteria, Akaike's information criterion (AIC) and the Bayesian information criterion (BIC), are used to assess the fit of each model.

Results

Descriptive analysis.

Age-specific suicide rates, by time period. Figures 2a and 2b display the age pattern of deaths from suicide for selected years between 1940 and 2005 for males and females respectively. Among males, during the earlier portion of this period (1940-1970), there appears to be a steady and fairly linear increase in the risk of suicide with age. For example, in 1940, the risk of suicide among 15-19 year olds was about 5 per 100,000; the suicide rate for those aged 75-79 was over fifteen times that rate, at 80 per 100,000. In

the period since 1980, the age pattern has been such that rates increase dramatically in adolescence, achieve stability in the middle age ranges, and then rise steeply again in the older age ranges (65 +).

As a result of these patterns, we find that since 1970, suicide rates have been higher among adolescents and young adults relative to earlier time periods. In contrast, rates for the elderly have dropped substantially in more recent time periods. We also observe an increase in suicide rates among the middle-aged in 2000 and particularly in 2005, although these contemporary rates for the middle-aged don't approach the historical highs of the pre-1960 period. The age curves of suicide are not parallel across time periods, suggesting that cohort effects are present.

[FIGURES 2A AND 2B ABOUT HERE]

The age pattern of suicide is distinct for females. Historically, female suicide rates have risen sharply through young and middle adulthood and then stabilized or slightly declined during the older age ranges. More recently (post-1970), the overall shape of the curve has a more pronounced inverted U-shape, with rates for females peaking in the middle age ranges and then declining in the older age ranges (with the exception of 1990). While not completely uniform, female suicide rates within each age range exhibit a general pattern of decline over the 70-year period.

Age-specific suicide rates, by birth cohort. Figures 3a and 3b show the age-specific suicide rates for cohorts born in 1915-19 through to 1985-89, for males and females respectively. The age pattern for males is such that among the earliest cohorts (pre-1930), suicide rates tend to rise linearly with age. For the birth cohorts born after 1940, suicide rates increase sharply during adolescence and then plateau in the middle age ranges. As these birth cohorts have yet to reach the oldest age ranges, we do not know how their rates will change as they become elderly.

[FIGURES 3A AND 3B ABOUT HERE]

Given this pattern of age-specific suicide rates by birth cohort, the largest between-cohort differences are in the age ranges of 20-29, with World War II and Depression era birth cohorts (1930-44 birth cohorts) registering the lowest rates, mid- to late-wave Baby Boomers (1950-1964 birth cohorts) among the highest rates, and first-wave Baby Boomers (1945-49 birth cohort) in the middle along with the most recent birth cohorts (post 1970). In the middle age ranges (ages 40-50), suicide rates are remarkably similar across all birth cohorts. Note that the 1950-59 birth cohorts have among the highest rates in this age range as well as in adolescence.

In contrast, among women, there are larger between-cohort differences in age-specific suicide rates in the middle age ranges than in adolescence, where rates appear to be quite similar across birth cohorts. Suicide rates for those aged 20-24 are highest for the four baby boomer cohorts, a similar pattern to what we observed in males. All female birth cohorts born prior to 1949 experience their peak suicide rates in 1970-74, with steady declines since then. Thus, for these birth cohorts, their highest suicide rates were reached when members were in their 40s, 30s or late 20s. For the mid to late-wave Baby Boomers, who are already in their 40s and 50s, suicide rates are still climbing and thus they will reach their peak later in life. For both men and women, the age curves by cohort exhibit non-parallelism, indicating that period effects are present.

Analytic models.

Table 1 displays the results of six reduced log linear models. Among the three one-factor models, age variation best accounts for temporal patterns of suicide over the period, for both men and women. This result is similar to those of past analyses of temporal change in mortality and is not surprising given the strong association between age and suicide risk for both sexes. Variations across time periods are least effective in explaining suicide trends for both sexes. For men, the age-cohort model exhibits the superior fit among the two-factor models; for women, the age-period model best explains the temporal variation. However, both for men and women, the model accounting for all three components of change,

age, time period and cohort, best explains the changes in suicide rates over time, confirming the patterns found in the descriptive analysis.

[TABLE 1 ABOUT HERE]

Table A1 shows the results from the estimation of the full APC models using the IE method for males and females. Following Yang (2008), I created graphs of these model coefficients to show the net effects of age, time period, and cohort on overall suicide trends. The results largely confirm those of the descriptive analyses. Looking first at Figure 4a, we see the different age pattern of suicide for males and females. For both sex groups, suicide rates rise sharply in adolescence. Female rates continue to rise steadily through middle age before declining in the older age ranges. The risk of suicide for males appears to grow steadily over the life course. For both groups, the age effects are the largest of the three.

[FIGURES 4A, 4B AND 4C ABOUT HERE]

Figure 4b shows the variation in suicide rates by time period. Patterns are similar for both males and females, although the period effects appear somewhat more pronounced for females. Net of age and cohort effects, we observe the increase in suicide rates beginning in the late 1950s and continuing through until 1980, with sharp declines since then. Finally, Figure 4c displays the net cohort effect on suicide rates for males and females. For both sexes, rates are lowest for birth cohorts born between 1910 and 1940. Rates began to increase for the baby boomer cohorts and have continued to do so with subsequent birth cohorts. However, net of age and period effects, the Baby Boomer cohort does not appear anomalous.

To assess the robustness of the IE findings, I ran two additional models that apply different constraints, namely the traditional CGLIM model and the new ZLT constraint model. Since time period proves to be the least consequential determinant of suicide in the reduced log linear models, I chose to constrain the effect for time periods 1935 and 1940 to be equal in the CGLIM approach. The ZLT model applies a zero linear trend to the period coefficients. Both the CGLIM and the ZLT models yield similar

substantive results to those of the IE solution.[2] In particular, both models show a rise in suicide risk beginning with baby boomers and continuing with subsequent cohorts for males. For females, the ZLT model shows more of a leveling of the suicide rate for cohorts born after 1940 or so, although the CGLIM model suggests a steady uptick in risk for each subsequent cohort born after 1940 (similar to the IE results). Results are available upon request.

The APC analyses presented above shed light on the trends in overall suicide rates shown in Figure 1 and are consistent with arguments put forward by other researchers. The results show the importance of period effects that occurred during the 1960s through to the mid-1970s when suicide rates rose rapidly, but this analysis cannot identify the particular period effects that produced the rise. The results are also consistent with the notion that a changing age composition (a relatively young population as the large baby boomer cohort occupied the young adult and middle age ranges which have, until very recently, exhibited lower suicide rates than those in old age[3]) may have contributed to the declines in suicide during the last two decades of the 20th century, in combination with period effects that depressed rates, especially during the 1990s (e.g. (Gibbons, Hur, Bhaumik, & Mann, 2005; Luo et al., 2011). In contrast, the uptick in rates observed since 2000 may in part be attributable to the aging of the U.S. population alongside rising rates of suicide among recent birth cohorts that began with the baby boomer cohort.

Discussion

Age, period, and cohort effects play an important role in driving trends in U.S. suicide rates, and the patterns of variation across age, period and cohort are consistent with theoretical conjectures positing a link between social integration and regulation and suicide risk. Suicide risk is closely tied to age for both men and women. However, the age pattern is specific to sex and may reflect the differing levels of

[2] The age effects are virtually identical for males and females across the three models. The period effect estimated by the ZLT model for males and females is also very similar to that estimated by the IE approach; the period effect for males only in the CGLIM models shows more of a steady decline than that estimated by the IE models.
[3]This pattern of age-specific suicide rates is true for males, who comprise about 80% of all suicide incidents in the United States.

stress and social isolation experienced by men and women at various stages of the life course. Historically, suicide risk for women peaks in the middle age ranges when they are active parents, experiencing the empty nest, and undergoing physical (menopause) changes. In contrast, rates for men peak in old age, when their primary forms of social connection and support disappear through death of a spouse and retirement (Grzywacz, Almeida, & McDonald, 2002).

The pattern of period effects is similar by gender, although somewhat stronger for women than men, a finding that is consistent with those from Switzerland (Ajdacic-Gross et al., 2006). Among the period effects that likely influenced suicide rates over the study period are World War II (Thomas & Gunnell, 2010), fluctuations in rates of unemployment (Luo et al., 2011), alcohol consumption (Gruenewald, Ponicki, & Mitchell, 1995), religious composition and immigration (Phillips, Forthcoming), and the development of new antidepressants (Gibbons et al., 2005), all related in various ways to the underlying degree of social integration and regulation within a society. A recent study finds that the U.S. suicide rate closely tracked the business cycle between 1928 and 2007, particularly for those between the ages of 25 and 64 (Luo et al., 2011). Others identify the development and increased use of more effective antidepressants (SSRIs) as a factor that may explain the declines in suicide since 1985 (Gibbons et al., 2005; Ludwig, Marcotte, & Norberg, 2009; Milane, Suchard, Wong, & Licinio, 2006). However, these studies typically examine bivariate associations, and results should be interpreted with caution since they don't consider the confluence of factors that may produce change. The time-series analyses also don't distinguish between period and age or cohort effects.

Finally, I find evidence of cohort effects, with suicide risk for male cohorts beginning to rise sharply with the baby boomer generation and continuing for all subsequent birth cohorts. A similar increased risk in suicide for the post-war generations is observed for U.S. women although less pronounced than that for men and findings are more tentative since the ZLT model suggests that suicide risk plateaued for cohorts born after 1940 or so. Beginning in the 1960s, women's roles began to change in dramatic way, transformations that were first experienced during early and middle adulthood by baby

boomers and with significant repercussions for both men and women. To the extent that the broad social and cultural changes introduced during the 1960s have weakened forms of social integration and regulation and are behind rising suicide rates in recent cohorts, their adverse effects on suicide appear to have considerable reach beyond the baby boomer generation.

In some respects, it is not surprising to see larger cohort effects for men. The societal changes that occurred beginning in the late 1950s and early 1960s, including the rise in female labor force participation, the increasing prevalence of women in institutions of higher education, and changes in family formation patterns including increases in out-of-wedlock childbearing and divorce rates, have had profound implications for gender relations, leading the cover of a recent Atlantic Magazine issue to ask "The End of Men?" (Rosin, 2010). In a variety of ways, the status of men is threatened as institutions that historically have been good for them – education and marriage, for instance – are being transformed in fundamental ways. A college education is becoming increasingly more critical in this service economy, but women have been outpacing men for several decades in their acquisition of degrees and providing increasing competition for good jobs. Between 1981 and 2001, the number of women enrolled in post-secondary education institutions increased by 41%, compared to 20% for men, so that by 2007-2008, women comprise 56-58% of all undergraduates at community and four-year colleges (National Center for Education Statistics). As economic opportunities for women grow, marriage becomes more dispensable; an AARP report indicated that of divorces among those over aged 50, two-thirds are initiated by the female partner. Declining marriage rates mean that male partners are less likely to reap the benefits to marriage, such as those to health which appear greater for men than for women (House, Landis, & Umberson, 1988; Umberson, 1992). Furthermore, relative to the past, women are increasingly likely to be the primary breadwinner within a marriage but research indicates that this dynamic can have *detrimental* effects on men's health outcomes (Springer, 2009). Consistent with these conjectures, research shows that the post-1999 increase in suicide rates among middle-aged boomer men is far greater among those who are less educated and/or unmarried (Phillips et al., 2010). All these forces may combine

to affect psychological well-being and levels of stress, and to enhance feelings of social isolation, among birth cohorts of American men in the young and middle-age ranges in recent decades.

Many of these changes have been beneficial for women, but there are inevitable costs. Cohorts of women, beginning with the boomers, are often juggling work and motherhood (Bianchi, Robinson, & Milkie, 2006; Hochschild, 1989). For example, in 2000, 61% of women with children under the age of three worked outside the home, compared to just 34% in 1975 (Committee on Ways and Means, U.S. House of Representatives, 2000).These working mothers in dual-career marriages report that, compared to their husbands, they take on far more of the housework and child care responsibilities, coming home to what Arlie Hochschild coined a "second shift". Thus, working mothers walk a tight rope, juggling multiple tasks and feeling overwhelmed, exhausted and harried as a result (although women working outside the home report higher levels of self-esteem than those who do not). Even in families in which the father is involved in child care, the number of which has undoubtedly increased in recent decades, men do more of the "fun" child activities, such as taking their children on outings while women conduct more of the basic child maintenance, such as feeding, bathing, and taking a child to the doctor. These factors may play a role in explaining the rising rates of suicide among recent birth cohorts of women. Certainly, the rapid rate of increase in suicide in the middle age ranges since 1999 is unusual and hints at a complex interacting pattern of social change and aging.

Recent birth cohorts may differ fundamentally from preceding generations in other ways that are closely tied to suicide. Along with rising mobility and suburbanization, new forms of social media affect forms of social integration, changing the ways in which we communicate and connect in dramatic ways. On the one hand, these tools have greatly expanded our networks of friends and acquaintances and enhanced our levels of connectedness. Yet these new types of connections have emerged alongside growing rates of loneliness, as noted earlier. Studies indicate that loneliness declines with a greater relative frequency of face-to-face contact but *increases* with a greater proportion of online interactions (Cacioppo & Patrick, 2008), suggesting that to the extent that online interaction reduces personal

connections, it may contribute to higher levels of isolation. Turkle (2010) argues that the link is direct, with technology promoting superficial and tenuous connections and shallow degrees of intimacy.

Perhaps as a reflection of some of these societal-side changes in social integration and regulation, we have witnessed rising rates of diagnosed mental and psychiatric disorders over the past three decades. For example, in 1987, the rate of outpatient treatment for depression was 0.73 per 100 persons, but rose to 2.33 by 1997 (Olfson et al., 2002). However, changing diagnostic criteria and increased use of managed care make it difficult to ascertain whether these rising rates represent a true increase in the prevalence of psychiatric disorders. Since the 1980s, rates of suicide by firearms have been declining at the same time that rates of suicide by drug poisoning, particularly for women, have been increasing in the early 2000s, perhaps related to the sharp increase in the use of antidepressants and prescription drugs more generally (Zuvekas, 2005; Barber). If these kinds of shifts over time in methods used to commit suicide are related to birth cohorts, they also offer a potential explanation for the cohort effects observed.

This analysis provides a first important step – identifying, describing and distinguishing the patterns of suicide risk across age groups, periods and cohorts – and notes a number of important societal-level changes that have affected forms of social integration and regulation and are consistent with the observed patterns. Future research that can directly assess the extent to which the above-described factors explain rising rates of suicide among recent cohorts is now needed. The development of hierarchical APC models may be one fruitful way in which to test some of the conjectures put forward here. As with all work of this nature, there are limitations to the measurement of deaths by suicide. Between 1935 and 2005, the National Center for Health Statistics categorized deaths according to six different International Classification of Death (ICD) schemes,[4] and these revisions may have affected the recording of suicides over time. However, consistent with data from England and Wales (Thomas & Gunnell, 2010), there do not appear to be obvious discontinuities in the overall suicide rate or suicide rates by gender in the years

[4] The 5th, 6th, 7th, 8th, 9th and 10th revisions of the ICD were introduced in the years 1938, 1949, 1955, 1965, 1975, and 1990, respectively.

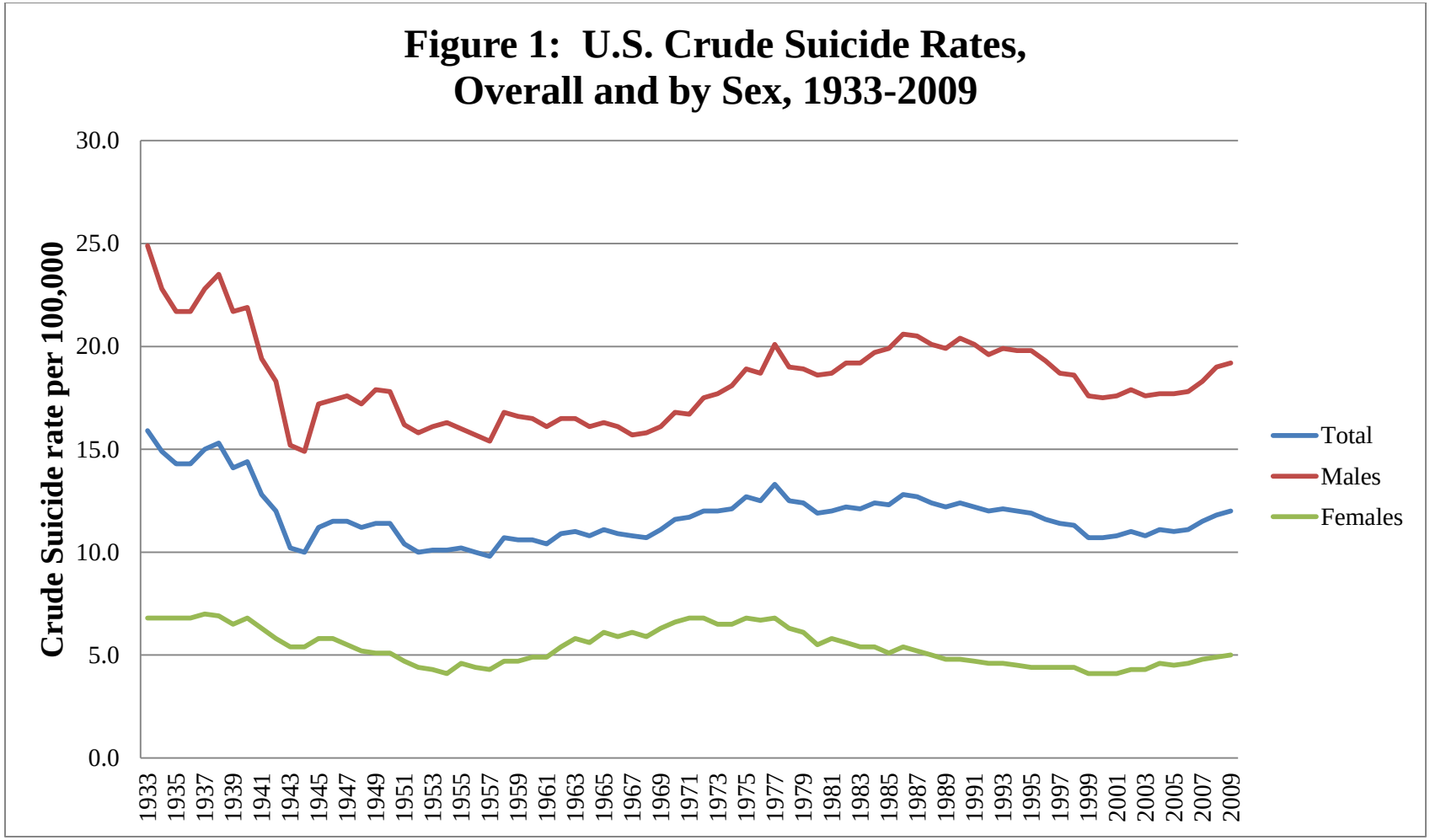
in which successive revisions of the ICD were introduced. In addition, the under-reporting of suicide deaths in official statistics may have declined over time as suicide becomes less stigmatized, although a study suggests that medical examiners are not greatly affected by pressure exerted by relatives to avoid the stigma of suicide (Timmermans, 2005). Distorting the statistics in the other direction is the declining rate of autopsies in the U.S. since the 1970s, which would tend to increase the rate of under-reporting. Shifts in method over time can also affect reporting – if drug poisoning accounts for a smaller proportion of suicides today than in the past,[5] suicides may be less likely to be under-reported in the more recent period since such incidents are more likely to be classified as "undetermined" or "accidental". Related to this point, there are important gender differences in the method of suicide used (females are more likely to commit suicide using drug poisoning relative to men) and hence female suicides may be underreported relative to men and affect the reported results.

This analysis offers some insight into effective strategies for suicide prevention (see Mann, Apter, & Bertolote, 2005; Wray et al., 2011). Age is closely tied to suicide risk but in different ways for men as opposed to women, suggesting that social isolation occurs at varying stages of the life course. Thus, programs that increase awareness of the detrimental effects of stress associated with work-family balance among middle-aged adults, particularly women, and isolation faced by the elderly, especially men, as they lose the social support of partners and employment, would be useful. The results also point clearly to the effect of social structure or context on suicide rates – beyond individual risk factors, the characteristics of time periods and birth cohorts exert an important influence on suicide rates. This point is largely ignored by suicide prevention efforts that tend to focus almost exclusively on conventional individual-level risk factors. To the extent that period and cohort effects are driven by deteriorating economic circumstances, poorer mental health and reduced accessibility to certain methods, programs that restrict access to means such as firearms, promote among primary-care physicians the importance of screening for major

[5] In 1960, poisoning accounted for 22% of all U.S. suicides and that percentage dropped to 16% by 1990. Since 1990, the percentage of all suicides by drug poisoning has started to increase slightly, to 17.6 % of all suicides in 2005 (NCHS).

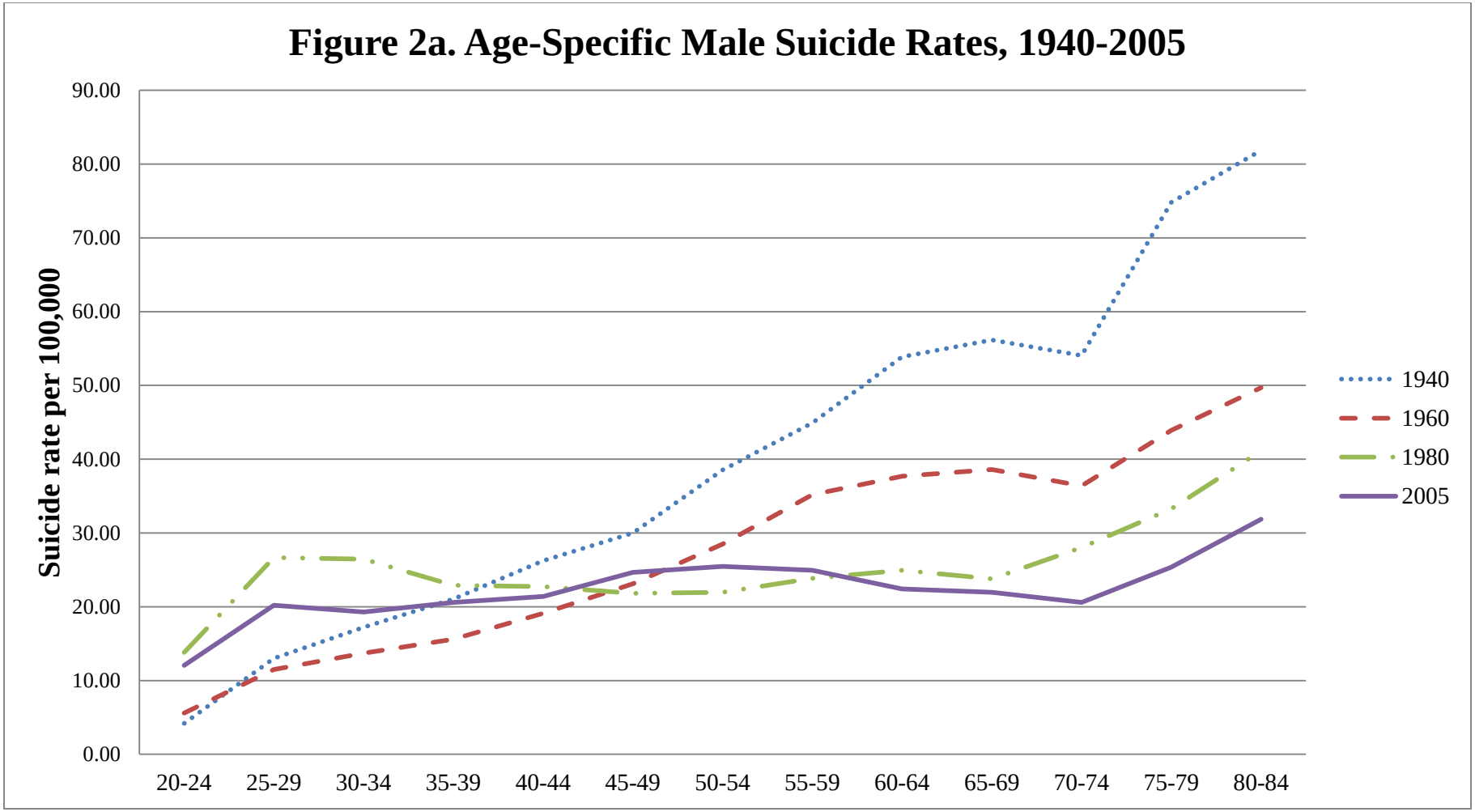
depression, and provide social support and counseling services during periods of economic recession may all be effective in reducing suicide rates.

In conclusion, the results presented here indicate that the baby boomer generation, rather than being an anomalous cohort with a high risk for suicide, may be the tip of the iceberg, ushering in a new period of dramatic economic and social change with important implications for suicide risk over the life course. Fortunately, overall rates of U.S. suicide since the 1980s have been in decline, due perhaps to a variety of period effects and to the age composition of the U.S. population. However, these patterns appear likely to reverse, as the large boomer cohort (particularly males) move into the older age ranges with traditionally higher suicide rates and with the development of increasing suicide rates among the middle-aged. As younger cohorts move through the life course and more data become available, we should closely monitor the extent to which these emerging new patterns hold.



Source: U.S. National Center for Health Statistics (http://mypage.iu.edu/~jmcintos/SuicideStats.html)

Figure 2a. Age-Specific Male Suicide Rates, 1940-2005



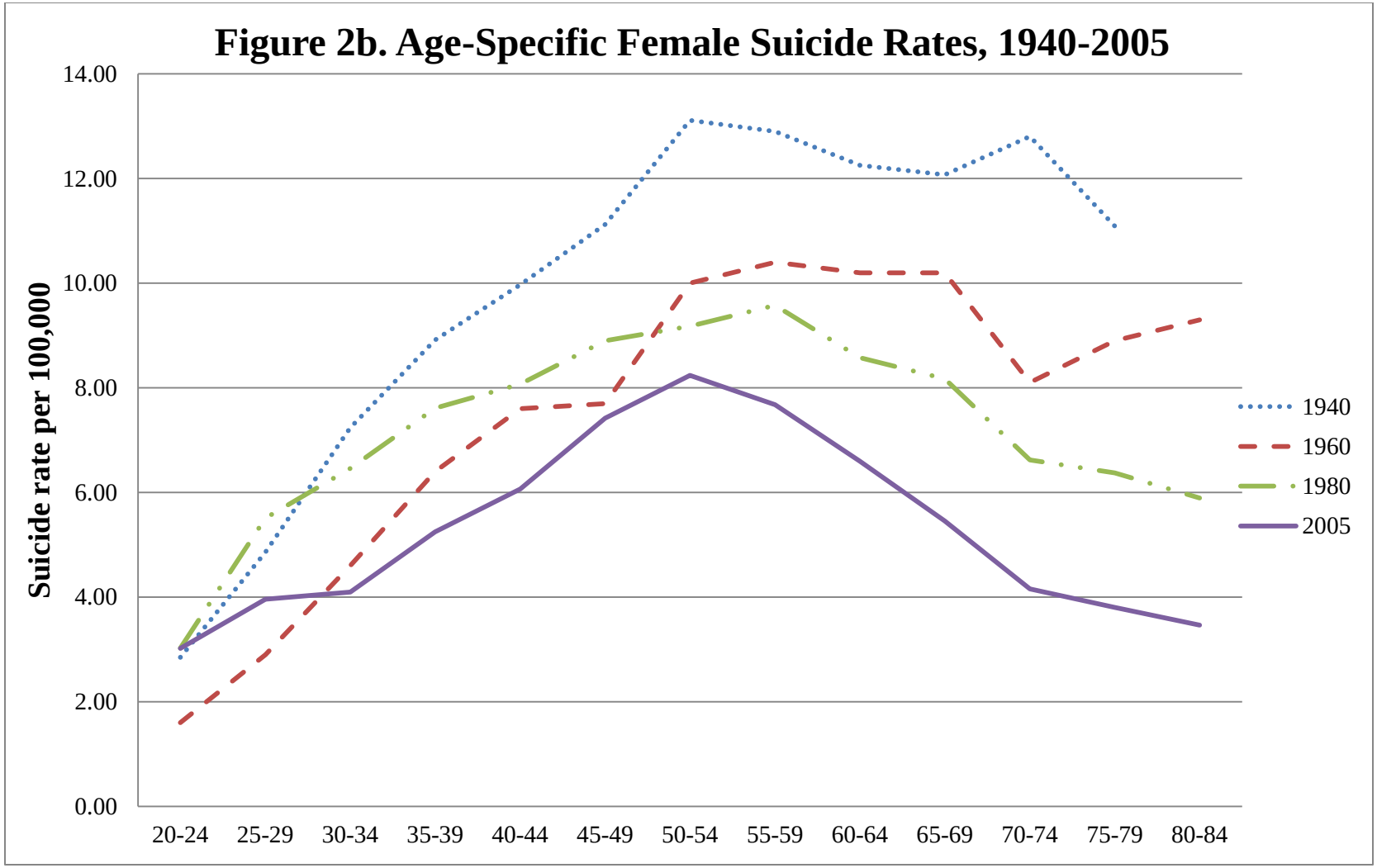


Figure 2b. Age-Specific Female Suicide Rates, 1940-2005
Suicide rate per 100,000
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
1940
1960
1980
2005

Figure 3a. Age-Specific Suicide Rates for Males

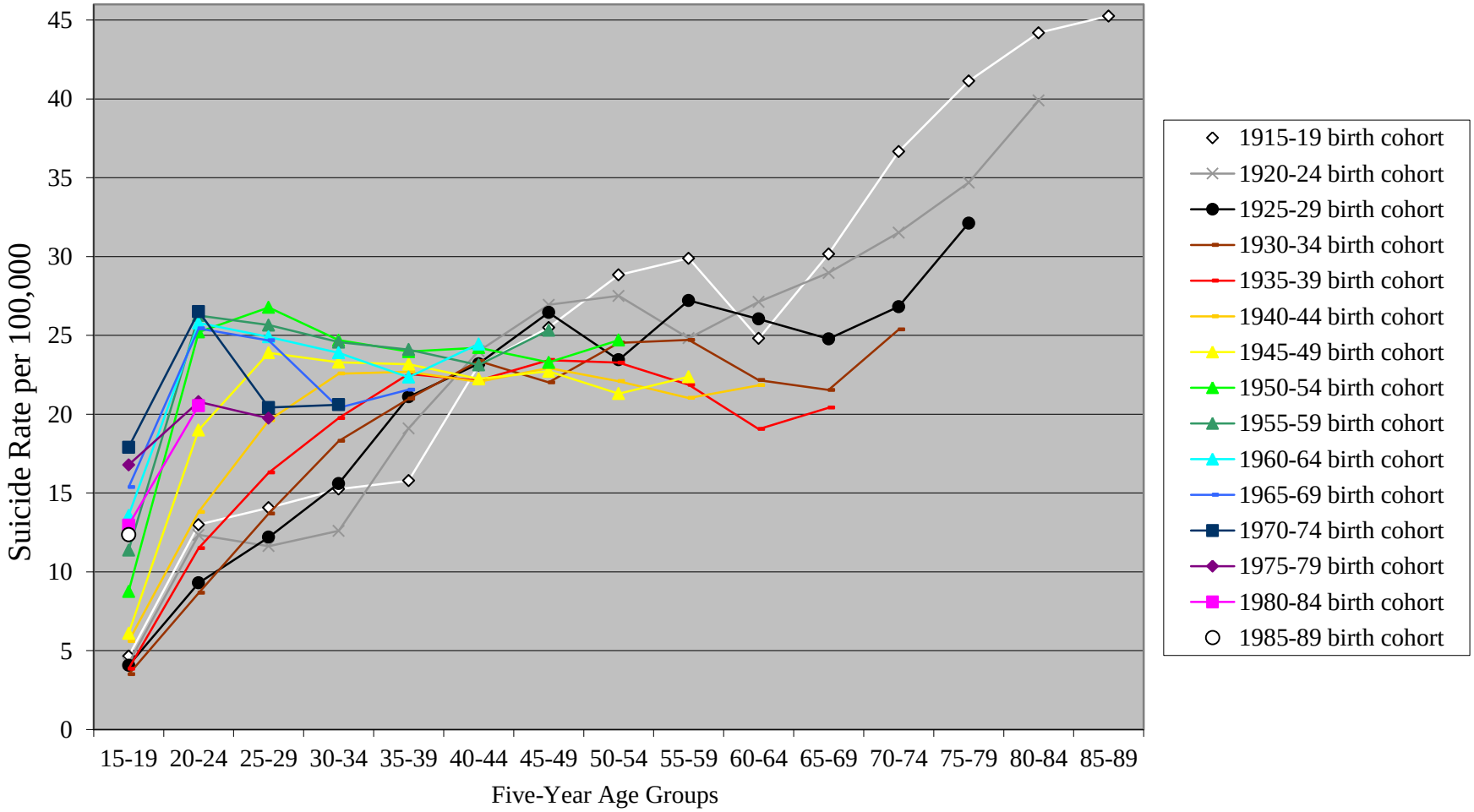


Figure 3a. Age-Specific Suicide Rates for Females

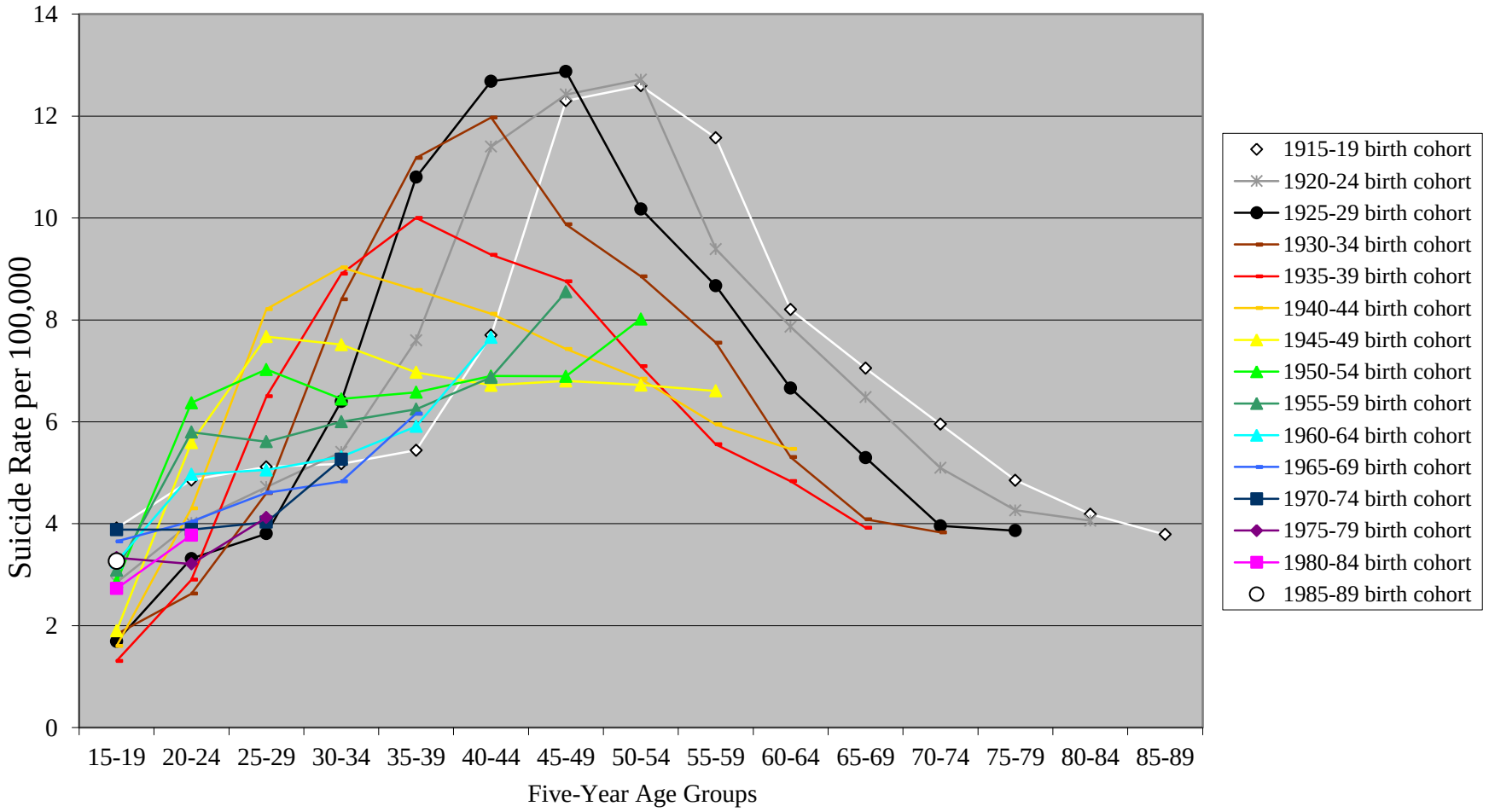


Table 1. Goodness-of-Fit Statistics for Age-Period-Cohort Log Linear Models of U.S. Suicide Rates, by Gender

	Age A	Period P	Cohort C	Age-Period AP	Age-Cohort AC	Period-Cohort PC	Age-Period-Cohort APC
Males							
Deviance	30822.44	62923.21	38818.96	25374.87	16414.27	21039.67	7080.35
AIC	32615.50	64722.26	40640.02	27195.93	18257.33	22888.73	8949.41
BIC	32653.82	64770.16	40723.04	27278.95	18375.47	23016.44	9109.06
DOF	168	165	154	154	143	140	130
Females							
Deviance	17036.89	26977.13	20209.46	3365.51	8378.80	15813.03	2224.23
AIC	18619.89	28566.13	21820.46	4976.51	10011.80	17452.03	3883.22
BIC	18658.21	28614.02	21903.47	5059.52	10129.94	17579.75	4042.87
DOF	168	165	154	154	143	140	130

Notes. AIC = Akaike's Information Criterion. BIC = Bayesian Information Criterion. DOF = Degrees of Freedom.
The smaller the AIC and BIC, the better the model fit.

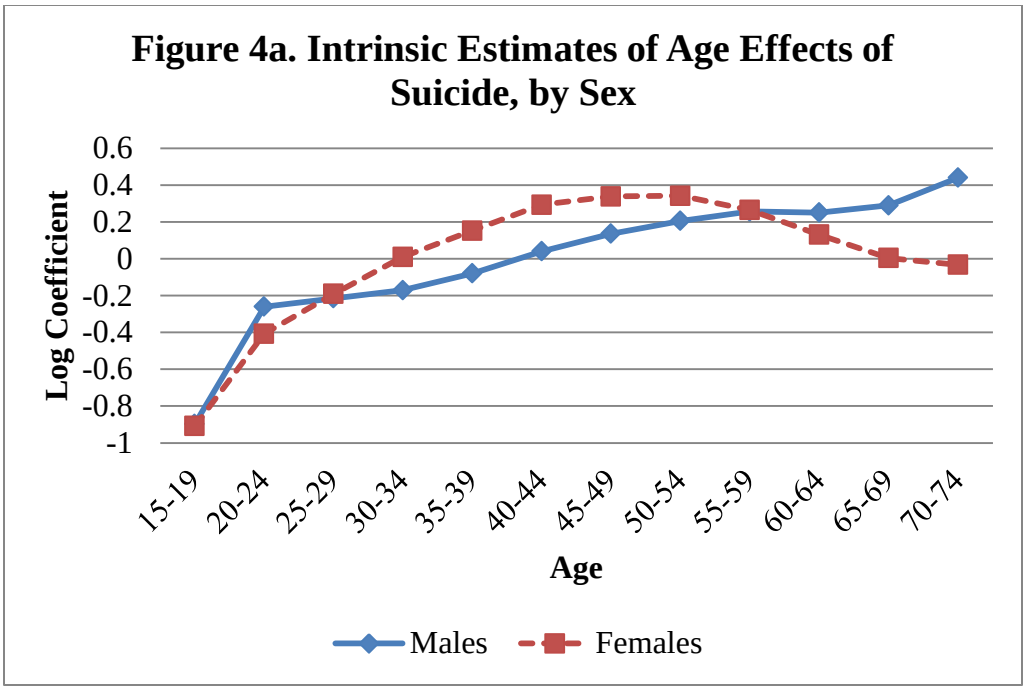


Figure 4a. Intrinsic Estimates of Age Effects of Suicide, by Sex
Log Coefficient
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
15-19
20-24
25-29
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
Age
Males
Females

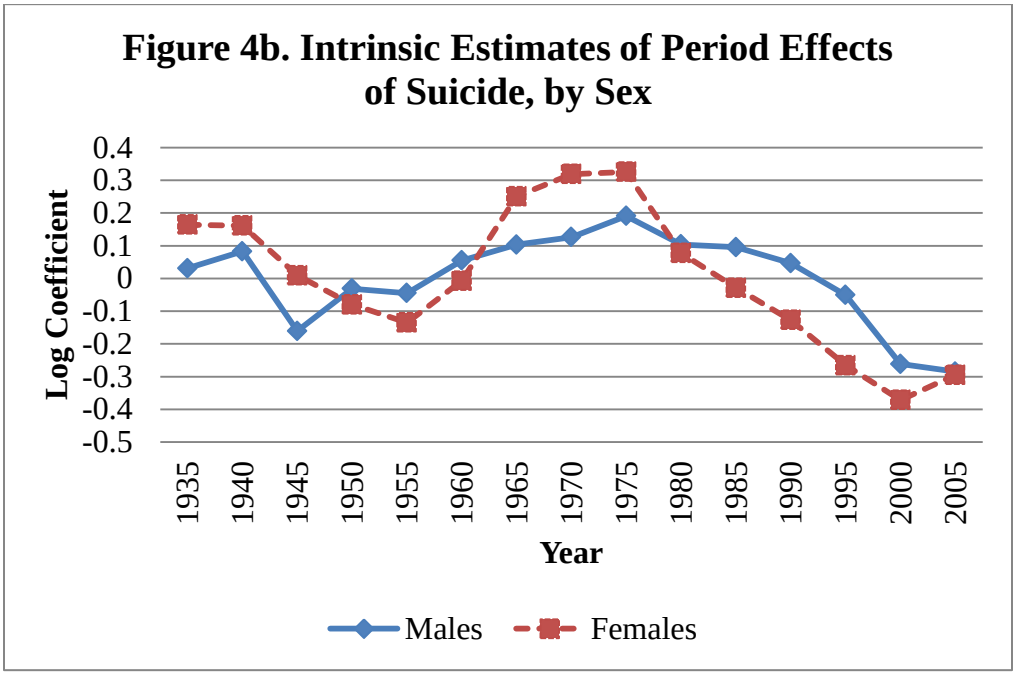


Figure 4b. Intrinsic Estimates of Period Effects of Suicide, by Sex
Log Coefficient
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
1935
1940
1945
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
Year
Males
Females

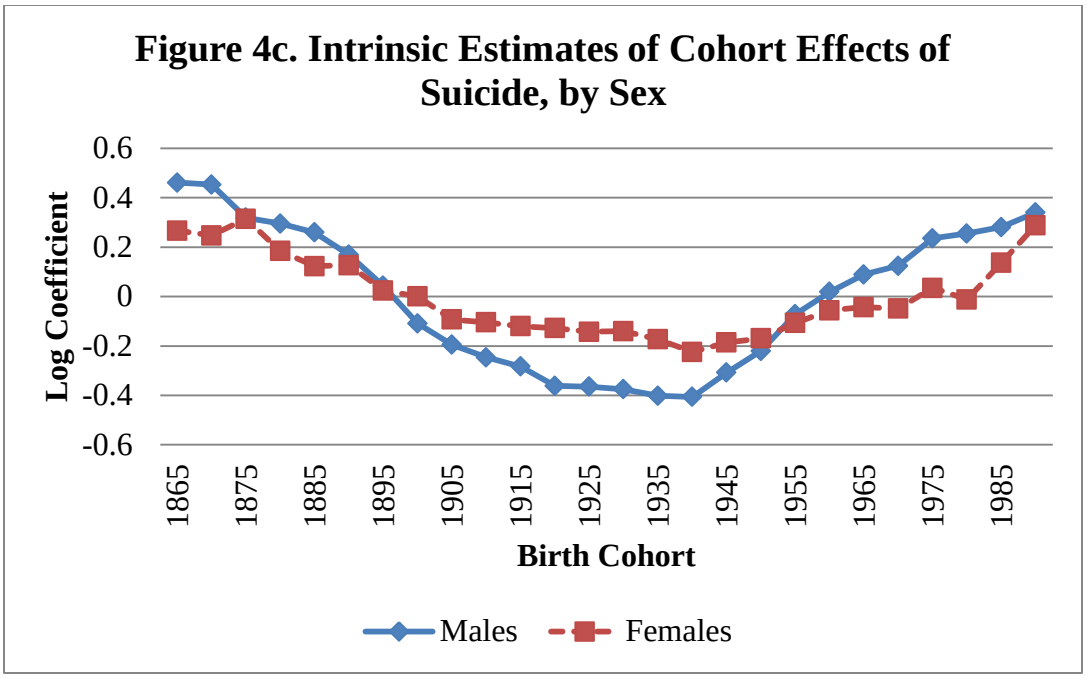


Figure 4c. Intrinsic Estimates of Cohort Effects of Suicide, by Sex
Log Coefficient
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
1865
1875
1885
1895
1905
1915
1925
1935
1945
1955
1965
1975
1985
Birth Cohort
Males
Females

Table A1. Intrinsic Estimates for U.S. Suicide Rates

	Males		Females	
	Coeff.	S.E.	Coeff.	S.E.
Intercept	-8.1808	0.018	-9.4920	0.022
Age				
15-19	**-0.8971**	0.037	**-0.9083**	0.043
20-24	**-0.2600**	0.028	**-0.4070**	0.034
25-29	**-0.2144**	0.026	**-0.1904**	0.030
30-34	**-0.1709**	0.025	0.0107	0.027
35-39	**-0.0789**	0.025	**0.1525**	0.025
40-44	0.0411	0.025	**0.2940**	0.024
45-49	**0.1367**	0.026	**0.3391**	0.025
50-54	**0.2056**	0.027	**0.3425**	0.026
55-59	**0.2570**	0.029	**0.2647**	0.029
60-64	**0.2512**	0.031	**0.1310**	0.033
65-69	**0.2897**	0.033	0.0039	0.037
70-74	**0.4401**	0.034	-0.0327	0.040
Period				
1935-1939	0.0312	0.060	**0.1647**	0.062
1940-1944	0.0826	0.060	**0.1616**	0.062
1945-1949	**-0.1609**	0.071	0.0095	0.065
1950-1954	-0.0314	0.064	-0.0797	0.067
1955-1959	-0.0451	0.065	**-0.1347**	0.067
1960-1964	0.0547	0.062	-0.0074	0.062
1965-1969	0.1033	0.060	**0.2512**	0.053
1970-1974	**0.1264**	0.030	**0.3191**	0.026
1975-1979	**0.1908**	0.028	**0.3258**	0.025
1980-1984	**0.1039**	0.027	**0.0774**	0.027
1985-1989	**0.0956**	0.026	-0.0288	0.028
1990-1994	0.0465	0.025	**-0.1271**	0.029
1995-1999	**-0.0507**	0.026	**-0.2652**	0.031
2000-2004	**-0.2618**	0.028	**-0.3714**	0.033
2005-2009	**-0.2852**	0.030	**-0.2949**	0.035
Cohort				
1865	**0.4608**	0.232	0.2669	0.328
1870	**0.4530**	0.154	0.2471	0.211
1875	**0.3193**	0.129	**0.3149**	0.154
1880	**0.2955**	0.107	0.1846	0.131
1885	**0.2597**	0.092	0.1232	0.112

1890	**0.1688**	0.084	0.1265	0.096
1895	0.0434	0.080	0.0243	0.088
1900	-0.1092	0.068	0.0002	0.072
1905	**-0.1954**	0.060	-0.0927	0.063
1910	**-0.2461**	0.053	-0.1043	0.056
1915	**-0.2829**	0.047	**-0.1200**	0.050
1920	**-0.3615**	0.044	**-0.1277**	0.045
1925	**-0.3650**	0.041	**-0.1429**	0.042
1930	**-0.3755**	0.039	**-0.1399**	0.039
1935	**-0.4015**	0.037	**-0.1731**	0.037
1940	**-0.4061**	0.036	**-0.2244**	0.036
1945	**-0.3078**	0.032	**-0.1859**	0.032
1950	**-0.2205**	0.028	**-0.1692**	0.029
1955	**-0.0720**	0.026	**-0.1073**	0.028
1960	0.0188	0.026	**-0.0558**	0.029
1965	**0.0890**	0.028	-0.0432	0.033
1970	**0.1241**	0.033	-0.0490	0.040
1975	**0.2353**	0.038	0.0351	0.048
1980	**0.2551**	0.046	**-0.0121**	0.060
1985	**0.2807**	0.058	0.1368	0.072
1990	**0.3401**	0.098	**0.2880**	0.114
Deviance	7080.35		2224.23	
DOF	130		130	

Notes. Bold = statistically significant at $p<0.05$.

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