ABSTRACT

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Researchers from a variety of fields have noted a sharp rise in mortality for widows soon after the death of their spouse, a relationship that has often been called the widowhood effect. Because of assortative mating, married couples tend to share many of the same lifestyle characteristics, so this result may reflect correlation rather than a causal relationship. In this dissertation, I attempt to decipher whether the widowhood effect reflects a causal relationship. The key innovation in the dissertation turns on the notion that some causes of death reveal more information about the surviving spouse than others. In the extreme, if a cause of death was randomly assigned, then these types of deaths could be used to identify the death of a spouse does in fact raise mortality of the surviving spouse. In practice, we cannot specify what causes of death are randomly assigned, but instead, we can identify those that are uncorrelated with observed characteristics. Specifically, I use data from the National Longitudinal Mortality Survey and the National Health Interview Survey Multiple Cause of Death supplement to create longitudinal datasets of married couples, aged 50 to 70. I initially use this sample to identify those causes of death that are predicted by socio-economic status (income, occupation and education) and those that are not. I refer to these

two types of deaths as informative and uninformative causes of death, respectively. If the heightened mortality of surviving spouses is subject to an omitted variables bias, in single-equation models, I should find a greater excess mortality for informative deaths than for uninformative ones. If omitted variable bias is not a serious concern, I should see little difference between the two types of widows. In Cox proportional hazard models, I find for men the death of a spouse from an uninformative cause has only a slightly smaller impact on mortality than a death from an informative cause. The findings suggest a 30 percent increase in male mortality as a direct result of becoming a widow. I do not find similar evidence for women; in fact, the results show no marriage protection effect.

THE CAUSALITY AND CHARACTERIZATION OF THE WIDOWHOOD EFFECT.

By

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Dedication

This dissertation is dedicated to the following people who have passed away in recent years: Juan Silva, Raquel Espinosa, Enrique Espinosa, and Jeff Cohen. Juan was a gentle and extremely generous man who was and will remain an important role model to me. Raquel was my aunt by genealogy but played the role of grandmother. She kept her home and heart open to so many, even if she had a hard and sometimes bitter way of expressing herself. Enrique was an uncle of mine, eldest brother to my father, who led life by his rules to achieve his own goals and pursuits, and he lived life to his fulfillment. These relatives all played critical roles in my development. Jeff was a close friend of mine from when I began my studies at the University of Maryland. When I met him, he was young, raw, passionate, intelligent, and at times a hard man with whom to get along. Jeff gave every drop of himself into his short life, and I will remember his successes and exploits with great fondness and, at times, lingering befuddlement.

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Any and all errors contained in this dissertation are solely attributable to me.

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Chapter 1: Introduction

To lose what we
never owned
might seem an
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has its' Affliction
as actually as
Claim.
-Emily Dickinson, 1870s

[Selection] evidently regulates…marriage in France. Cretins never marry; idiots do not marry; idle vagrants herd together, but rarely marry…..The beautiful, the good, and the healthy are mutually attractive; and their unions are promoted.
-William Farr, 1858

Consider a long lasting marriage that ends in death for one partner and widowhood for the other. Before any death, the surviving spouse shared a life expectancy similar to other married individuals of the same sex, and this mortality rate was significantly lower than that of the never married. Now in widowhood, what we witness is that the surviving spouse's risk of death changes to something resembling the profile of somebody who never married. Could it be that widowhood is prompting individuals to deteriorate more quickly? Could it be that one spouse's death is a signal of the other's impending death because of the similar lifestyles and behaviors of the spouses?

Emily Dickinson's poem suggests that the loss of a spouse may be seen as an illness on its own. The poem begins with the assumption that you can never lose what you have never owned in the first place, and it suggests that any claim of mourning seems to be an "eccentric bereavement". The assumption does not hold, though, in reality. In fact, people can form attachments to one another and develop some degree of a "presumption" of ownership over their loved ones. Thus, people are afflicted by the loss of loved ones just as claimed, and the change from married to widow by itself causes the bereft spouse to suffer a loss in their life expectancy.[1]

Close to the time Emily Dickinson wrote her poem, William Farr's words were published in Transactions of the National Association for the Promotion of Social Sciences, and they present an opposing view. The article on the marriage and mortality of the French stresses the role of selection and how the same characteristics on which couples match explain why widows have such poor mortality rates. A contemporary example would be the stylized fact that individuals who smoke are more likely to marry someone who smokes; therefore, we might expect both to have similar longevity because of this common behavior.

Most of us have experienced the passing of our grandparents or parents, often experiencing the loss of a set of parents in a short period of time. So familiar is the story that social scientists have been studying and remarking on the temporal correlation in spousal mortality for over a century and a half. A primary issue at stake is whether this correlation in mortality is the result of one spouse’s death causing the other spouse to die or is the product of the same mechanism that brings two similar individuals together.

In this dissertation, I call the heightened mortality that male and female widows seem to experience the widowhood effect. The widowhood effect can be the result of a loss of marriage protection—the causal story or the result of marriage selection—the selection story. This dissertation explores these possibilities and seeks to enrich the debate by providing an innovative strategy to isolate and determine the existence of causation in the widowhood effect. Widowhood is an important issue because so many experience this life event, and the correlation in spousal mortalities is a real phenomenon.

[1] I use "widow" interchangeably for the general state of being widowed (e.g., *Widows seem to suffer a heightened mortality after the loss of their spouse.*), and when necessary, I use it to describe a female whose husband dies in contrast to widowers (e.g. *Widowers, not widows, suffer a widowhood effect because of the loss of marriage protection.*)

The first step is to determine whether widowhood is really compromising people's health by determining if the widowhood effect varies by widow type. The essential problem with any study of widowhood and mortality is the suspicion of false positive results that indicate a causal relationship. Because of positive assortative mating and the convergence of spousal behaviors over time in such things as diet and health, the widowhood effect may be a signal of the couple's demise, not just one spouse's demise. This signal is not proof, though, that widowhood fundamentally changes people's lives and behaviors in a way that is detrimental to their livelihood. In fact, this idea of a signal would suggest that widowhood does not impact the mourning spouse's behavior whatsoever, and instead, the grieving spouse's consistency in behavior between the two marital states is why we as researchers witness the temporal correlation in spousal mortality. This is the false positive result we want to avoid.

To determine if widowhood is more than just a marker of impending death, I look at how the experiences of certain widows—those with spouses who died of a subset of diseases, may differ from the experiences of other widows—those with spouses who died of any disease not in the subset. This is a very common analytical technique used in epidemiological studies. I find that the incidence of a number of causes of death among 50-70 year old males and females to be largely unexplained by measures of socio-economic status which measure, in many ways, the behavior of individuals. I call these diseases uninformative causes of death. This cannot be said for the vast majority of causes for which the incidence tends to be explained by the way a person, and/or spouse, leads their life (i.e., informative causes of death).

Using a common econometric approach for identifying a treatment group in survey data that approximates what would result from a random assignment in a treatment/control study, I study how widowhood resulting from the death of spouse due to an uninformative cause compares to widowhood from an informative spousal death. If we are to believe the story that widowhood so significantly harms a surviving spouse that their own death hastens, we should find similar mortality outcomes across widow types. If we are to instead believe the alternate "signal" story, we should find that these different widow types have different hazards of death relative to people who are still married. Moreover, in this case, we should find that the widows by uninformative causes show little sign of any widowhood effect.

What I find is evidence to believe the widowhood effect is a real and dynamic phenomenon for men and not so much for women. For married men between the ages of 50 and 70, the widowhood effect translates into a 30% increase in their mortality. The average 5-year mortality rate for these married men is close to 10%; so a 30% increase would mean that widowers have a mortality rate of approximately 13%. As a rough estimate of the magnitude of this phenomenon, consider that there are currently about 50 million married men between the ages of 50 and 70 in the United States of America.2 If I conservatively estimate and assume 5% of these men will become widowers in the next 5 years (2.5 million), the result equates to 75,000 men dying from the loss of their wives. For married women of the same ages, the widowhood effect seems to be a product of behavioral similarities between them and their deceased husbands and not the product of the change in marital status. If an effect does exist, it appears to be less than 10 percent. While there are considerably more widows than widowers, women have such a low mortality rate that a 10 percent increase raises the mortality rate by less than a percentage point which means very few women are afflicted.

In Chapter 2, I explore the history of widowhood and mortality as a subject of research, replicate past results, introduce my innovative empirical strategy, and determine the

[2] Data was gathered using Census resources on the internet which are available at http://www.census.gov/popest. Generally speaking, there are approximately 50 million married men.

causality of the widowhood effect for men and women. In Chapter 3, I characterize the widowhood effect on several dimensions to determine if the effect varies by time since spousal loss, socioeconomic status, and expectations of spousal loss.

Chapter 2: Marriage Protection or Marriage Selection

Section 1: Introduction

Research from a variety of disciplines documents the social and economic outcomes of the married are better along many dimensions than singles. Married people, for example, have higher wages and lower levels of unemployment, accumulate more wealth, have higher rates of health insurance coverage, report higher levels of happiness, and are less likely to be involved in violent crimes, compared with singles. Researchers have also documented a potential health benefit of marriage -- married people have a longer life expectancy than the non-married. Scholars have titled this relationship 'marriage protection'. Some of the most convincing evidence consistent with the marriage protection hypothesis demonstrates a heightened mortality rate for widows and widowers in the years just after the death of their spouse.

There is, however, an alternative hypothesis called marriage selection that may explain the longer life spans of married individuals and why we witness a temporal correlation in spousal mortality. In a marriage market where potential husbands and wives find one another, there is a selection process that underlies the matching of two people. Much of the empirical work about marriage markets demonstrate positive assortative mating, which is the occurrence of mating between similar individuals at higher than random frequencies. Given the importance health habits have on life expectancy and mortality (McGinnis and Foege, 1993) and the similarity in health choices by spouses, we would expect to see life expectancy patterns among the married converge as well.

In this chapter, I estimate the impact of spousal death on the surviving spouse's mortality, what some researchers have come to call the “widowhood effect”. The heart of this chapter is determining whether the widowhood effect is caused by the death of a spouse—marriage protection, or is a byproduct of marriage selection by noting that some causes of death reveal more information about the surviving spouse than others. In the extreme, if a cause of death was randomly assigned, then these types of deaths could be used to identify the marriage protection effect among the surviving spouses.

In practice, I cannot specify what causes of death are random, but instead, I can identify those that are uncorrelated with observed characteristics. Using the National Longitudinal Mortality Survey (NLMS) to create longitudinal datasets of married couples, aged 50 to 70, I identify those causes of death that are predicted by socio-economic status (income, education and occupation) and those that are not. I label these two types of deaths as informative and uninformative causes of death, respectively.[3] If the widowhood effect is entirely a product of marriage selection, in single-equation models, I should find that the size of the widowhood effect resulting from uninformative causes of spousal death will be substantially smaller than the size of the effect for informative causes. In contrast, if marital protection explains all of the widowhood effect, then the impacts of informative and uninformative deaths should be similar.

Section 2: Marital Status and Mortality

The antecedents for the current study flow from two different but related strands of literature. The first group of papers document lower mortality rates among the married. Empirical investigations of the differences in mortality rates between married and unmarried individuals go back as far as Farr (1858) and Durkheim (1897). The negative association

[3] I additionally use the National Health Interview Survey (NHIS) data merged with the Multiple Cause of Death (MCOD) supplement. These results are reported in the appendix and are not the focus of this dissertation because of smaller sample size in the NHIS.

between marriage and mortality has been documented in the US by a number of authors including Gove (1973), Kobrin and Hendershot (1977), Smith and Waitzman (1994), Mergenhagen, Lee, Gove (1985), Rogers (1995), Kisker and Goldman (1987), Lillard and Waite (1995), and Johnson et al (2000). This relationship has been established for other countries including 16 developed countries (Hu and Goldman, 1990), England (Gardner and Oswald, 2002), Canada (Trovoto, 1991), Israel (Manor et al. 2000), and Bangladesh (Rahman, 1993).

There are a variety of reasons that mortality rates may be lower among the married. Marriage may increase the financial standing of the partners by increasing family income or providing insurance when bad health and/or financial shocks occur (Lillard and Waite, 1995). Marriage may also provide important psychological benefits such as reducing stress, improving one's disposition or integrating a person into a community. Finally, marriage may discourage risky behavior such as smoking (Duncan, Wilkerson and England, 2003) or criminal activity (Laub, Nagin and Sampson, 1998) or encourage healthy behavior such as visiting the doctor.

In a related line of work, researchers have also documented heightened mortality of the recently widowed, a relationship referred to by some as the "bereavement effect". This basic statistical relationship between widowhood and mortality has been documented by a number of authors including Cox and Ford (1964), Parkes, Benjamin and Fitzgerald (1999), Hesling and Szklo (1981), Hesling, Szklo and Hi (1981), Kaprio, Koskenvou and Rita (1987), Mendes de Leon et al. (1993), Mineau, Smith, and Bean (2002), Korenman, Goldman and Fu (1997), and Lillard and Waite (1995), just to name a few. Excess mortality among the recently widowed has been demonstrated to exist in a wide variety of age groups, socioeconomic levels, countries and cultures. The impact of a spouse's death is qualitatively large. After controlling for a variety of factors, Schaefer, Quesenberry and Wi, (1995) and

Kaprio, Koskenvou and Rita (1987), for example, found that mortality rates double for the surviving spouse in the first year after the death of their spouse. Estimates also suggest that the bereavement effect is strongest in the period right after the death of a spouse (Lichtenstein, Gatz, and Berg 1998; Manor and Eisebach, 2003).

All of the studies mentioned above demonstrate excess mortality for surviving males, but the results for surviving females are less definitive. Helsing and Szklo (1981) found no excess mortality for widows, and Mineaeu, Smith and Bean (2002) found smaller effects for widows compared with widowers, but the results for women vary considerably across birth cohorts. Lillard and Waite (1995) found some excess mortality for women, but the results were sensitive to model specification. Data on couples from Northern California (Schaefer, Quesenberry and Wi, 1995), Finland (Kaprio, Koskenvou and Rita, 1987), and Israel (Manor and Eisenbach, 2003) found similar bereavement effects on mortality for males and females.

There are several pathways through which widowhood can become an immediate health risk. Some suggest that excess mortality is generated by the emotional stress of the death of a loved one (Martikainen and Valkonen, 1996; Louma and Pearson, 2002) or the emotional and physical stress of caring for a dying loved one (Christakis and Iwashyna, 2003). Recent research by Wittstein et al. (2005) suggests that emotional stress can cause the over production of particular hormones that can cause a sudden life-threatening heart spasm in otherwise healthy people. Rosenbloom and Whittington (1993) found elderly widowed people suffer from poor nutrition right after the death of their spouse. Finally, Iwashyna and Christakis (2003) found evidence suggesting that widowhood compromises the quality of medical care sought by the surviving spouse.

The accumulated empirical evidence is convincing that mortality rates of the bereft are higher than their married counterparts. It is, however, not clear whether these events can be interpreted as causal relationships. The results are potentially explained by an alternative hypothesis called marriage selection, which has no causal interpretation. In a marriage market where potential husbands and wives find one another, there is a selection process that underlies the matching of two people (Becker, 1973 and 1974). Much of the empirical work about marriage markets demonstrate positive assortative mating, which is the occurrence of mating between similar individuals at higher than random frequencies. There are strong positive correlations between many characteristics of married couples including age, years of education, IQ, height, waist circumference, and even earlobe length (Vandenberg, 1972; Harrison, Gibson and Hiorns, 1976; Mascie-Taylor, Gibson, 1979; Johnson, 2002; Caspi and Herbener, 1994; Murray, 2000). Not surprisingly, there are also strong correlations in the investments that husbands and wives make concerning their health. Many married couples share a love of exercise, food, wine, cigarettes, or a sedentary lifestyle. Thus, given the similarity in health choices by spouses, I would expect to see life expectancy patterns among the married to converge as well.

The similarity in the characteristics of spouses is also matched by a similarity in life events. Married couples that last past middle-age live through the same inter-temporal events, shocks, income patterns, consumption patterns. Such a convergence of lives can explain why there is evidence that widowed spouses die soon after the loss of their spouse (Smith and Zick, 1994).

To demonstrate the strong correlation in health and health habits among older married couples, I use a sample of older married couples from the 1987-1990 National Health Interview Survey (NHIS). I introduce the dataset in more detail in more detail in Chapter 5, but I note here that the samples include information on white, married men aged 50-70 and a similar sample of women. First, I consider whether knowing information about a husband's health habits conveys any information about the wife's behavior. I look at four discrete outcomes: whether the person is obese (has body mass index > 30), whether they self-report fair or poor health, whether they had any bed rest days in the past 12 months, and whether they had a short term hospital stay in the past 12 months. I calculate the conditional probability that a wife answers yes to each of these questions (Xw=1) given that their husband answers yes or no (Xw =1 or 0).

The results from this exercise are reported in the top half of Table 2.1. Equality of the conditional probabilities means that the behaviors and outcomes for wives and husbands are independent. In the married women sample, for each of the four variables, the differences in the conditional probabilities are large, and I easily reject the null hypothesis that the conditional probabilities are equal. Wives with obese husbands are twice as likely to report they are obese. Wives with husbands in fair or poor health are 4.5 times as likely to report they are in poor health compared with when their husband are not in fair or poor health.

In the lower half of the table, I repeat the exercise for white married males, aged 50-70. In each of these cases, I can reject the null of equality in the conditional means, and the relative differences and absolute differences in probabilities are similar to the married women sample.

The NHIS survey that I use in this analysis does not ask respondents whether they smoked. Supplemental surveys to the NHIS do ask about smoking habits, but these surveys are typically only administered to one person in the household. Therefore, I cannot conduct this same analysis with this key health behavior. In the last row of each panel in Table 2.1, I generate estimates of probabilities for whether a married respondent currently smoked based on whether their spouse smokes from the September 1992, January 1993 and May 1993 Tobacco Use Supplements from the Current Population Survey. Both married women and married men are about three times as likely to report they smoke when their spouse smokes, compared with when their spouse does not smoke.

To date, there have been few attempts, other than efforts to control for more observed characteristics, to isolate whether the widowhood effect is a statistical correlation or a causal effect. Lichtenstein, Gatz and Berg (1998) use a large sample of twins from Sweden to control for unobserved genetic and environmental factors in surviving spouses. In this study, the authors found that recently-bereaved males and females had substantially higher mortality after the death of their spouse compared with their twin counterpart who still has a living spouse. Using a large sample from Finnish mortality records, Martikainen and Valkonen (1996) found that widows/widowers who die after the death of their spouse, as a group, had excess mortality in causes of death associated with behavior such as motor vehicle accidents, heart disease, suicide, and alcohol-related causes.

Section 3: Data and Descriptive Statistics

The data I use in my analysis come from two different sources: the National Longitudinal Mortality Study (NLMS). The data are the product of a merging of person-level U.S. Census data to death certificate information supplied by the National Center for Health Statistics. Mortality for most observations is censored by the endpoint of the follow-up period; so, I use Cox proportional hazard models to compare mortality risks between different marital states.

Data

The NLMS (Sorlie, Backlund and Keller, 1995; Rogot, Sorlie, Johnson and Schmitt, 1992) is a project that has linked data from a number of Current Population Surveys and the 1980 census to the National Death Index (NDI). I use a public-use version of the NLMS that contains data from five monthly CPS samples from 1979 through 1981.[4] The CPS data provide information on household income, labor force status, individual education and other demographic variables; however, they do not provide any information on health status. The endpoint to the mortality follow-up is fixed to nine years from entry into the CPS; so, I only observe mortality for those who die in my observation period. The NLMS measures days of follow-up from the original survey. Data from the NDI include information on the cause of death, which is recorded using the ICD-9 coding system. The NLMS contains CPS and NDI information for 637,162 individuals. The longitudinal component to an otherwise cross-sectional dataset, enables us to investigate how marital status impacts mortality for married men and women.

Analysis Sample

I focus my attention to married, white, non-Hispanic people between the ages of 50 and 70. Using household identification numbers and variables in the NLMS that identify a respondent's relationship to the head of household, I match the records of husbands and wives. Although spouses of 50-70 year olds are primarily within this age range, some are not, so there are different sized samples for "married men" and "married women".

Table 2.2 provides the means for several of the variables of interest, in the study, from the two data sources. Among the NLMS data, a smaller proportion of women die within nine years of being surveyed than do married men, 9 percent for women compared with 18 percent for men. Likewise, 8 percent of married men become widowers after their initial interview, and 22 percent of married women lose their spouse. As a different exercise, I calculate mortality rates over a shorter period of time after the initial interview. In Table 2.2, I report the proportion of married men and married women that died within five years of

[4] More information on the data may be found in Chapter 5.

entering the survey and the proportion that were widowed over the same period. These mortality rates for both men and women are much lower compared with the rates I compute when I do not restrict the follow-up period. Tables A and B of the appendix provide means and standard deviations for the income, education and age variables, as well as mortality, for the NLMS data.

Cox Proportional Hazard Models

In the data, an observation consists of a married couple that enters the NLMS between 1979 and 1981. The observation period begins with this entry point and extends nine years, or until death, which ever comes first. The data are therefore considered right-censored, because I do not observe events (i.e. widowhood and death) after the end of the mortality follow-up period. While there are several modeling techniques for the analysis of survival data, I follow previous work by employing a Cox proportional hazard model, which is a maximum partial likelihood estimation method (Cox, 1972; Allison, 1995). The Cox model begins with the assumption that hazard for individual i can be written as

$$(1) \qquad hi(t) = \lambda o(t)\exp(Xi\beta),$$

where, for simplicity, I assume Xi is a vector of time invariant characteristics. The model assumes that the hazard at time t for individual i is a function of the baseline hazard $\lambda o(t)$, plus a function of observed characteristics. The baseline hazard is left unspecified but it is assumed to be constant across people, meaning that the proportional hazard for person i relative to person j for fixed time t is only a function of observed characteristics $hi(t)/hj(t) = \exp(Xi\beta)/\exp(Xj\beta)$. To get around specifying the baseline hazard, the Cox model specifies a partial likelihood, which can be described as follows. If I order the data from the shortest to longest spell t1, t2, …tn, the conditional probability that person 1 dies at time period t1, given that anyone could have died at that time, is

(2) $\lambda o(t1)\exp(X1\beta) / \Sigma i\ \lambda o(t)\exp(Xi\beta) = \exp(X1\beta) / \Sigma i\ \exp(Xi\beta)$.

By definition, the baseline hazard drops out and term at the right in equation (2) represents the partial likelihood for person 1. The model is partial likelihood because the estimation does not exploit all the information in the data, namely, the baseline hazard $\lambda o(t)$. As a result, the estimates for β are consistent but not efficient. However, the benefit of the procedure is that the researcher does not have to specify the form for the baseline hazard $\lambda o(t)$. The Cox model outlined in (1) and (2) is easily adapted to include incomplete spells and time-varying covariates. In the study, primarily interested in a set of time-variant variables that indicate the respondent's spouse has died.

Raising Suspicion of Omitted Variable Bias and Evidence of Marriage Selection

In an effort to raise the suspicion that unobserved or omitted variables are potentially biasing single-equation estimates of the widowhood effect, I run a series of Cox proportional hazard models that begin with only the widowhood variable progressively add more covariates. If as I add more variables the estimated widowhood effect declines, this signals that widowhood is correlated with observed characteristics. Since we suspect to some degree that observed and unobserved characteristics are positively correlated, this would also indicate a concern that the widowhood effects are capturing unobserved factors as well. The illustration below summarizes the specifications, and Table 2.3 displays the results.

Illustration 2.1

	Time Dependent Variable (time-varying dummy variables)	Time-Independent Variables (Dummy Variables)
Specification 1	Spouse dies	None
Specification 2	Spouse dies	4 Education indicators
Specification 3	Spouse dies	4 Education indicators 6 Family Income indicators
Specification 4	Spouse dies	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women)
Specification 5	Spouse dies	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women) 20 Age indicators, age 51-70
The omitted group is composed of married individuals with family income greater than $50k, a college education, a professional job, and 50 years old.		

In these specifications, the time-invariant variables are income, education, and age at initial survey, which are all measured at the first interview. The only time-variant variable is one that takes a value of 1 the day an individual becomes a widow, and all subsequent days or months, and it equals zero otherwise. There are two panels to the table--in the top panel are the Cox regression results for married men and in the bottom panel are the results for married women. Since all of the covariates are dummy variables, I only report the hazard ratio. The two NLMS samples consist of 37,777 married men and 34,465 married women. Of course, I expect the widowhood effect estimate to begin to fall as more variables are introduced to explain the excess mortality of widows over people still married to their spouses.

The results in Table 2.3 show the widowhood effects for both men and women drop by approximately 50 percent as I move from the parsimonious to fully-specified model. For men, the hazard ratio begins at 1.787 and falls to 1.316, and the fall is from 1.617 to 1.196 for women. The findings are good evidence that widowhood is strongly correlated with observable and unobservable characteristics. This provides some validation to the theory of marriage selection for explaining the temporal correlation in spousal mortality. Continuing on with this mental experiment, assume the theory of marriage selection explained all of the excess mortality we see among widows. In other words, assuming I was capable of collecting all pertinent information for every married person and included these variables in my specification, I would find that the widowhood effect would be zero percent (i.e., a hazard ratio of 1.00) and that there is no good evidence of marriage protection. Because such an experiment is highly implausable, I use an empirical strategy to sidestep the issue of omitted variable bias and marriage selection.

The results in the last column Table 2.3 are comparable to other studies and provide the launching board for the next section. The full results of this specification are listed in Table 5.3. The point to take away from this column of results is that after a wife dies men have a 32 percent greater hazard of their life ending (hazard ratio = 1.32), and after a husband dies, women have a 20 percent greater hazard (h.r. = 1.20).

Section 4: Informative and Uninformative Causes of Death

In order to reduce the omitted variable bias possibly present in previous analyses, I exploit the exogeneity that some causes of spousal death exhibit in their affliction (e.g., leukemia, pancreatic cancer). In these special cases, the death of a spouse reveals less information regarding the health of the surviving spouse. Therefore, if there is an effect from a disease that conveys less information about the health of the surviving spouse, we are less concerned that the widowhood effect is driven by omitted variables that would be able to measure individual and couple behavior. In what follows, I provide evidence that certain causes of death (COD) are uncorrelated with socio-economic status (SES) indicators like income, education and occupation; therefore, the COD is not explained well by the theory of assortative mating.

I use income, education and occupation as my measures of socioeconomic status because the bulk of research that has examined the SES/mortality gradient for all-cause and cause-specific mortality has predominantly used these three variables as the primary covariates of interest (Berkman and Kawachi, 2000). The genesis for much of the work in social sciences is the research of Kitagawa and Hauser (1973) who matched survey data from the 1960 Census long form, conducted in April of 1960, to death records from the May - October 1960 period. The stylized facts from their work are that mortality rates decline with income and education but at a decreasing rate. This relationship is present for all age groups, but Kitagawa and Hauser find less variation in mortality across socioeconomic groups for the elderly. These basic results have been replicated for more recent datasets in numerous papers for all-cause mortality, and the basic stylized facts are present in a number of cause-specific death categories. In this chapter, I verify many of these socio-economic gradients in mortality, and in the next chapter, I determine whether the widowhood effect itself varies by income and education. For example, do higher income widows fair better after the loss of their spouse than lower income widows?

Causes of Death

From the NLMS data, I use detailed 3-digit ICD-9 cause of death information to construct a series of dummy variables to indicate whether a person died in the nine-year follow-up from a particular cause. For example, a dichotomous variable for the cause of death "ischemic heart disease" takes on the value of 1 for an individual who dies of ischemic heart disease. For both married men and women, I then run a series of logistic regressions that identify whether the death from a particular cause is predicted by the income and education of the respondent—my SES measures, controlling for a cubic term in age. For each regression, I conduct four -2 log likelihood tests: whether the income dummies are jointly zero, whether the education dummies are jointly zero, whether the occupation dummies are jointly zero, and whether income, education and occupation dummies are jointly zero. If I can reject any of the four null hypotheses, then I consider the cause to be an informative-COD group (ICOD). Likewise, if I cannot reject all four hypothesis tests, I consider the cause of death to be uninformative (UCOD).

Note that I am careful to not disaggregate death causes into too small of cells so that I have a high Type II error rate for the -2 log likelihood tests. For example, there are very few incidents of acute lymphoma; therefore, I aggregate to a more general COD, in this case a category that includes acute and chronic forms of lymphoma and leukemia. I find that 9 percent of deaths for men married to women aged 50-70 fall and 26 percent of deaths for women married to men aged 50-70 falls into causes that are uncorrelated with observed characteristics. A full list of the causes in the UCOD group for both men and women is listed in Table 2.4. The list includes the number of deaths attributed to each cause, as well as each cause's proportion of UCOD deaths, using NLMS data only.

Some other authors have demonstrated in the past that these causes of death are uncorrelated or, at best, weakly correlated with SES. Steenland, Henley and Thun (2002) use data from 2.2 million respondents to two American Cancer Society cohort studies and find less educated women have higher death rates for almost all cause-specific groups they consider except external causes (e.g. accidents) and breast cancer. They also show a weak relationship between education and stroke mortality with the only statistically significant relationship being the two lowest education groups. The same study finds for men a weak relationship between education and prostate cancer death risk, a cause in the UCOD group. They found this was true for household income and education, for men. In the group of UCOD, I do not include motor-vehicle accidents among men because of the strong correlation between SES indicators and these accidents, but I do include other types of accidents like poisonings and accidental falls. Eng, et al. (2002) find similar evidence; however, they do not make the distinction between motor vehicle and other types of accident. I should note that my results are not directly comparable to most studies because I restrict my attention to married white respondents in a particular age range, whereas most other datasets have no sample restrictions based on marital status and race.

Narrowing the range of ages is a common technique, and I use it here to focus on an at-risk group of people who have certain favorable attributes for this analysis. The only longitudinal variable measuring marital status is whether a spouse has died therefore indicating the change of the surviving spouse’s status from married to widowed. For example, I do not measure whether a couple, who was married at the initial survey point, divorces. This factor is indeed important, but because divorce rates are low for married people over the age of 50, divorce is not a serious concern of my sample (NCHS). Another issue for married individuals over the age of 70 is that their expectations of widowhood are different than younger people because they are closer to the end of life. I explore expectations in the following chapter, but I would like to mention here that wives and husbands over the age of 70 have 5-yr mortality rates that begin overlapping with respective life expectancy—approximately 75 years for men and 80 years for women.

Verification

I verify the validity of the UCOD group as a proxy for a randomly-assigned group of deaths using an analysis sample composed of women married to men aged 50-70 and men married to women aged 50-70 and extracted from the NLMS. For each sex, I run two specifications. In one specification, the dependent variable is the probability the individual dies of an UCOD within the sample time frame, and for the other specification, the dependent variable is the probability of dying of an ICOD under the same condition. The other explanatory variables consist of income, education and age groups. The full results of these regressions are listed in Table 5.5, and I find an inverse, monotonic relationship between mortality and the SES variables for income and education when I model the probability of dying from an ICOD. This is not the case for the group of UCOD. The marginal effects I find are very small, and in every case, I cannot reject the null hypothesis that the individual coefficient estimates are equal to zero.

The results of the joint hypothesis tests are listed in Table 2.5. For both men and women in the NLMS sample, I easily reject the null that the ICODs are not correlated with income, education and occupation. All p-values for this outcome are <0.0001. In contrast to the results for ICODs, the results for UCODs differ between men and women. For females, I am able to support my assertion that income, occupation and education are uninformative about the probability of dying from these causes because the p-value for the hypothesis test is

0.539. Also, the p-value associated with the hypothesis that all education variables are jointly zero is 0.668 and that all the occupation variables are jointly zero is 0.423; however, the p-values for the hypothesis that all the income coefficients are jointly zero is low, 0.033 for women. For men, I am able to reject the hypothesis test on the education parameters, p-value = 0.395, but I have weaker statistics for the other tests. While this suggests some correlation between SES and the probability of dying from a UCOD, the point estimates and marginal effects of the income variables are very small and close to negligible in comparison with the magnitudes of the point estimates and marginal effects under the ICOD specification.

Another point of interest is whether a husband's (wife's) death from a UCOD or ICOD is correlated with the surviving wife's (husband's) type of death. This is of genuine interest for the verification of the UCOD classification. For example, if the probability of dying from a UCOD is significantly greater if the spouse died of an UCOD rather than of an ICOD, then I would argue that my classification system is incorrectly producing diseases that do reveal information regarding the mortality of the surviving spouse. In Table 2.6 I investigate this issue by comparing the probability of a widow dying from an UCOD (ICOD) given the spouse died of an UCOD or an ICOD; so, I take the difference of these two probabilities and check whether the difference is significantly greater than zero. As the table shows, there is nothing to indicate that I have misclassified diseases as uninformative.

Refining UCOD

Among the causes of death listed as UCOD for men are suicides and murders, non-motor vehicle accidents, and pneumonia. As justification for their inclusion, I primarily cite a weak correlation between SES indicators and these diseases, and I do not rely heavily on the support of past epidemiological research. However, a basic review of this literature would suggest, for example, that a death from pancreatic cancer and one resulting from a murder are fundamentally different. In this case, as in others, these causes differ in the nature of their affliction: pancreatic cancer cases result for primarily unknown reasons while murders result from random and non-random acts of violence. I may expect there to be unobservable or unmeasured traits that could explain why some people die from murders, and these same traits might result in a biased estimator of the UCOD parameter because of assortative mating. In what follows, I subject the causes in the UCOD grouping to a second "screen" based on the preventability of a disease.

Phelan et al. (2005) develop a preventability scoring index for causes of death that ranges from 1.0 for a cause that is almost entirely unpreventable (e.g., gall bladder cancer) to 5.0 for a cause that is almost entirely preventable (e.g., accidental poisoning). Two of the authors, both of whom are physicians and epidemiologists, independently rate the causes of death "in terms of the degree to which death was amenable to prevention or delay during the 1980s in the United States" (p. 272). An ideal uninformative death is one that does not reveal information regarding the surviving spouse. My strategy for identifying the UCOD was entirely empirical and labeled several causes as uninformative that seem contrary to the definition of an UCOD. For example, smoking increases the likelihood of contracting pneumonia, and by assortative mating, such a trait may be shared by the surviving spouse.

Using the preventability scoring index, I develop a subset of UCOD that includes only those causes of death that cannot be explained by income, education or occupation status and, moreover, cannot be explained by individual tastes for preventative behavior. For my screening process, the refined list of causes has scores of 2.0 or lower. Table 2.7 lists the UCOD for men and women, the Phelan et al. preventability score, and examples of other preventable causes of death with similar scores that were not found to be UCOD. The top panel shows that murder/suicide, non-motor vehicle accidents, genitourinary cancer, and pneumonia have relatively high preventability scores, ranging from 3.5 to 5.0 compared with pancreatic cancer, leukemia, or cardiomyopathy, which receive a score of 2.0. So, my refined list of UCOD (R-UCOD) for husbands includes only pancreatic cancer, cardiomyopathy and leukemia deaths. Among the UCOD for women, shown in the bottom panel of Table 2.7, I keep only genitourinary cancers as R-UCOD.

For verification purposes, I use logistic regressions and hypothesis tests, in the same fashion as before, to gauge the relationship between the probability of dying from a R-UCOD and SES indicators. As one would expect of the subgroup of UCOD, I cannot reject the null hypothesis that education, occupation, and income have no correlation with the chance of dying from a R-UCOD. Table 2.8 shows the results of the various hypothesis tests for males married to women aged 50-70 and females married to men aged 50-70 when I use the NLMS.

Using this subset of unpreventable and uninformative diseases, I estimate Cox proportional hazard models again for both sexes with specifications that include two time-dependent variables—ICOD and R-UCOD, and I draw comparisons to the other results in the following section.

Section 5: Cox Proportional Hazard Results

In this section, I examine whether the mortality of a surviving spouse depends of the type of death experienced by their spouse. In the Cox model results outlined in Table 2.3, I included a single covariate that indicated the period after their spouse died. Here, I estimate models where I replace the time-variant widowhood variable with two time-variant variables that distinguish between types of widows. The illustration below lists the specifications of the Cox proportional hazard models that I estimate. UCOD (R-UCOD) has a value of 1 for the day, and each subsequent day, an individual becomes a widow by a UCOD (R-UCOD). ICOD has a value of one when the spouse dies of an ICOD.

Illustration 2.2

	Time Dependent Variables (time-varying dummy variables)	Time-Independent Variables (Dummy Variables)
Specification 1	Spouse dies of an UCOD & Spouse dies of an ICOD	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women) 20 Age indicators, age 51-70
Hypothesis test	UCOD widows have the same widowhood effect as ICOD widows.	
Specification 2	Spouse dies of an R-UCOD & Spouse dies of an ICOD	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women) 20 Age indicators, age 51-70
Hypothesis test	R-UCOD widows have the same widowhood effect as ICOD widows.	
The omitted group is composed of married individuals with family income greater than $50k, a college education, a professional job, and 50 years old.		

The Cox regression results for married men and women using the three different methods of accounting for widowhood (i.e. (1) a single widowhood variable, (2) UCOD and ICOD widowhood variables, (3) R-UCOD and ICOD widowhood variables) are presented in Table 2.9, and the complete results are in the tables of Chapter 5. In the top panel, I present estimates for men, and in the bottom panel, I report the models for women. I report the hazard ratio and its associated standard error for the various covariates that measure widow/widower status.

I find widowers have a 1.32 hazard ratio or 32% widowhood effect (32% greater risk of death than still-married men), and widowed women have a 20% widowhood effect. The second columns in each group of results list the Cox proportional hazard model results when I split the widowhood variable into UCOD and ICOD. I find that men have a 31% greater likelihood of dying if widowed by a UCOD, while ICOD widowers experience a 32% greater risk of death. I cannot reject the null hypothesis that the two widowhood effects are equivalent (p-value = 0.9237). The similarity in results suggests that marital selection is not a major force in producing the widowhood effect for men and that the loss of marital protection may indeed be the culprit of a widower's demise.

When I move to the R-UCOD/ICOD specification in column 3, the hazard ratio and its standard error jump to 1.71 and 0.342, respectively. I hesitate to draw strong conclusions from these estimates. However, the estimates do indicate that widowers by R-UCOD may have a substantially larger widowhood effect than other widowers, 70%compared to the 29% (p-value = 0.1824). This result may highlight that some men (e.g., those whose wives die of genitourinary cancer) may suffer much worse than others because of widowhood.

For women in the NLMS, however, I find a different story. After breaking up the time-dependent variable by cause of death, I find that widows of UCOD spouses have a widowhood effect that is not statistically different from zero (h.r. = 1.041). I cannot reject the null hypothesis that the two estimates are the same (p-value = 0.22). Comparing these results to the result in the first column, the UCOD estimate is one-fifth the magnitude of the estimate in the first column while the ICOD estimate is almost the same. This suggests that the widowhood effect sometimes found for women is not due to the loss of marital protection; instead, the comparison supports the idea that marital selection explains the phenomenon of widows dying soon after their husbands. In the final specification that includes the R-UCOD variable, I find a widowhood effect greater than 10% for women whose husbands die of causes determined to be unpreventable and uninformative; however, the point estimate is not statistically significant different from zero or from the ICOD estimate. Again, I heitate to draw many conclusions from this finding, except that this gives weak evidence that women may have a small marriage protection effect from losing their husbands.

Section 6: Conclusion

This chapter has provided evidence that the widowhood effect for men is in fact causal. On the other hand, women do not seem to suffer from a causal relationship between widowhood and mortality. For women, the results show that the temporal correlation between a widow's death and their husband's death is a product of behavioral similarities.

With respect to past research, I am able to corroborate and provide evidence that refutes past claims. Because I find no causation in the widowhood effect of women, findings showing otherwise are most likely not appropriately accounting for marital selection (Smith and Zick, Kaprio, et al, Lillard and Waite). The estimates I find for the widowhood effect for men is in the neighborhood of previously stated results that show an effect of 30 percent, approximately. For the most part, many studies state much larger estimates. As for women, studies have found almost no widowhood effect (Manor; Kaprio, et al), and with these researchers, I find evidence to concur. In the next chapter, I will show how the widowhood effect for men and women can differ between widows of varying socio-economic status.

Table 2.1
Estimate of Probability (Standard Error) [Observation]
Married Male and Female Samples

		Married Women		
Variable	Dataset	Pr(Xw=1|Xh=1)	Pr(Xw=1|Xh=0)	Difference
Obese?	NHIS	0.233 (0.008) [2,870]	0.124 (0.002) [17,426]	0.109 (0.007)
Fair or poor health at survey?	NHIS	0.450 (0.008) [3,998]	0.097 (0.002) [16,298]	0.353 (0.006)
Bed days in past 12 months?	NHIS	0.500 (0.006) [6,724]	0.275 (0.004) [13,572]	0.225 (0.007)
Short term hospital stay past 12 months?	NHIS	0.118 (0.006) [2,618]	0.091 (0.002) [17,678]	0.027 (0.006)
Current Smoker?	CPS Tobacco Use Supple-ments	0.401 (0.008) [3,509]	0.123 (0.003) [15,316]	0.277 (0.007)
		Married Men		
		Pr(Xh=1|Xw=1)	Pr(Xh=1|Xw=0)	Difference
Obese?	NHIS	0.258 (0.008) [3,077]	0.133 (0.003) [19,094]	0.125 (0.007)
Fair or poor health at survey?	NHIS	0.507 (0.009) [3,281]	0.117 (0.002) [18,890]	0.390 (0.007)
Bed days in past 12 months?	NHIS	0.482 (0.006) [8,093]	0.255 (0.004) [14,078]	0.227 (0.006)
Short term hospital stay past 12 months?	NHIS	0.143 (0.008) [1,975]	0.114 (0.002) [20,196]	0.029 (0.008)
Current Smoker?	CPS Tobacco Use Supple-ments	0.459 (0.008) [4,085]	0.147 (0.003) [17,433]	0.312 (0.007)

Table 2.2
Characteristics of the
Married Male and Female Samples,
NLMS

	Married Males	Married Females
	NLMS	
Variable	Mean	Mean
Dead within 9 years of survey	0.178	0.093
Died within 5 years of survey	0.091	0.044
Widow or widower	0.066	0.206
Widow or widower (5 years)	0.032	0.112
Individuals	37,777	34,465

Table 2.3
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Married Male and Female Samples,
NLMS

	Married males, aged 50-70 (n=37,777)				
Specifications	1	2	3	4	5
Widow	1.787 (0.0956)	1.702 (0.0912)	1.542 (0.0828)	1.439 (0.0773)	1.316 (0.0710)
Additional Covariates:					
Education		X	X	X	X
Income			X	X	X
Occupation				X	X
Age					X
	Married females, aged 50-70 (n=34,465)				
Specifications	1	2	3	4	5
Widow	1.617 (0.0780)	1.521 (0.0738)	1.361 (0.0667)	1.346 (0.0660)	1.196 (0.0590)
Additional Covariates:					
Education		X	X	X	X
Income			X	X	X
Occupation				X	X
Age					X

There are 6 income, 4 education, 10 or 11 occupation, and 21 age dummy variables.

Table 2.4
Uninformative Causes of Death (UCOD)
NLMS

	Men		
ICD-9 (first 3 digits)	Cause of Death	Number	Proportion of UCOD
157	pancreatic cancer	107	9%
170-239 (various) +	other cancers	278	23%
179-187	genital cancer	212	18%
200-208	lymphoma, leukemia	203	17%
425	cardiomyopathy	65	6%
480-487	Pneumonia	149	13%
800-807; 826-999	non-mv accidents, murder/suicide	174	14%
	Women		
ICD-9 (first 3 digits)	Cause of Death	Number	Proportion of UCOD
140-239 (various)++	other cancers	256	27%
174	breast cancer	216	23%
179-189	genitourinary cancer	149	16%
390-459 (various) +++	general circulatory disease	241	26%
800-999	Accidents	79	8%

+These diseases include: neoplasms of bone, connective tissue and skin (ICD-9 codes 170-175); neoplasms of unspecified sites (190-199); benign neoplasms and carcinoma in situ (210-239).

++ICD 9 codes included are: 140-152;154-156; 157-161;163-173;175-178; 190-199.

+++These diseases include all general circulatory diseases except the following: acute myocardial infarction (410), other forms of chronic ischemic heart disease (414), other forms of heart disease (420-429), intracerebral hemorrhage (431), other and unspecified intracranial hemorrhage (432), and occlusion of cerebral arteries (434).

Table 2.5
Maximum Likelihood Estimates of Logistic Regression,
Die from Informative or Uninformative Causes,
NLMS

	NLMS: Males married to women aged 50-70		NLMS: Females married to men aged 50-70	
Hypothesis Tests:	Informative	Uninform.	Informative	Uninform.
	P-values on -2 log likelihood test statistics			
Education coefs. are all zero	< 0.0001	0.395	0.004	0.668
Income coefs. are all zero	< 0.0001	0.140	0.0003	0.033
Occupation coefs. are all zero	<0.0001	0.025	< 0.0001	0.423
Educ, Inc, & Occ coefs. are all zero	<0.0001	0.019	< 0.0001	0.539
Mean of outcome	0.185	0.035	0.052	0.025
-2 log likelihood	30,071.31	9,960.58	14,228.16	8,565.93

The reference person is 50 years old or younger, completed college, has $40K or more in family income, and is a professional. There are dummies for ages 51-70.

Table 2.6: Do UCOD spousal deaths produce UCOD widow deaths?
Married Males and Females Aged 50-70
NLMS
Mean (Standard Error)

	Spouse died of UCOD	Spouse died of ICOD	|Difference|
		Males	
Pr[Die of UCOD by end of followup]	0.030 (0.006)	0.027 (0.004)	0.003 (0.007)
Pr[Die of ICOD by end of followup]]	0.115 (0.011)	0.129 (0.008)	0.014 (0.014)
Observations	825	1,658	
		Females	
Pr[Die of UCOD by end of followup]	0.018 (0.004)	0.022 (0.002)	0.004 (0.005)
Pr[Die of ICOD by end of followup]]	0.044 (0.006)	0.057 (0.003)	0.014 (0.008)
Observations	1,104	5,981	

Table 2.7
UCOD and Preventability
Preventability Scores based on adults older than 25+

Men

Cause of Death	Preventability Score	Other Examples
pancreatic cancer	2.0	brain cancer
other cancers	3.0 – 4.0	chronic renal failure, epilepsy
genital cancer	3.5 – 4.0	colon cancer, coagulation defects
lymphoma, leukemia	2.0	muscular dystrophy
Cardiomyopathy	2.0	brain cancer
Pneumonia	4.5	mouth cancer, influenza
non-mv accidents and murder/suicide	3.5 – 4.5	lung cancer, appendicitis

Women

Cause of Death	Preventability Score	Other Examples
other cancers	1.0 – 3.5	aortic aneurysm, arrhythmias
breast cancer	3.5	throat cancer, skin cancer
genitourinary cancer	2.0	anterior horn cell disease
Accidents	3.5 – 5.0	hernia, viral hepatitis

+Table created using the following source: Phelan, JC, BG Link, A Diez-Roux, I Kawachi, B Levin. 2004. “Fundamental Causes” of Social Inequalities in Mortality: A Test of the Theory. Journal of Health and Social Behavior. 45: 265-285.

Table 2.8
Maximum Likelihood Estimates of Logistic Regression,
Die from Informative or Uninformative/Unpreventable Causes,
NLMS

	NLMS: Males married to women aged 50-70		NLMS: Females married to men aged 50-70	
Hypothesis Tests:	Informative	Uninform.	Informative	Uninform.
	P-values on -2 log likelihood test statistics			
Education coefs. are all zero	< 0.0001	0.850	0.001	0.657
Income coefs. are all zero	< 0.0001	0.271	< 0.0001	0.578
Occupation coefs. are all zero	<0.0001	0.652	< 0.0001	0.330
Educ, Inc, & Occ coefs. are all zero	<0.0001	0.764	< 0.0001	0.539
Mean of outcome	0.212	0.008	0.073	0.004
-2 log likelihood	32,192.89	2,965.03	18,331.39	1,893.42

The reference person is 50 years old, completed college, has $40K or more in family income, and is a professional (NLMS only). There are dummy variables for ages 51-70.

Table 2.9
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Married Male and Female NLMS Samples
Hazard Ratios and (Standard Errors)

	Married males, aged 50-70 (n=37,777)		
	Model (1)	Model (2)	Model (3)
Widower	1.315 (0.071)		
Widower due to uninformative COD		1.306 (0.121)	
Widower due to informative COD		1.320 (0.085)	
Widower due to uninformative and unpreventable COD			1.704 (0.342)
Widower due to informative COD			1.294 (0.072)
-2 log likelihood	129,942.01	129,942.00	129,940.38

	Married females, aged 50-70 (n=34,465)		
	Model (1)	Model (2)	Model (3)
Widower	1.196 (0.059)		
Widower due to uninformative COD		1.041 (0.129)	
Widower due to informative COD		1.222 (0.063)	
Widower due to uninformative and unpreventable COD			1.137 (0.286)
Widower due to informative COD			1.198 (0.060)
-2 log likelihood	63,773.35	63,771.78	63,773.31

The reference person is 50 years old, completed college, has $40K or more in family income, and is a professional (NLMS only). There are dummies for ages 51-70.

Chapter 3: Characterizing the Widowhood Effect

Section 1: Introduction

Literature in the social sciences has shown that spousal mortality results in a heightened mortality for the bereft spouse called the “widowhood effect”. In the previous chapter, I presented evidence that widowhood causes surviving male spouses to die sooner than married men who do not experience the loss of their wives. Essentially, widowhood is the first and catalyzing link in a short chain of events that leads to the early death of a widower. This chapter explores how the impact of widowhood varies by time since the passing of a spouse, by income and education, and by the expectations of spousal loss.

Generally speaking, an aim of any public health policy is to address and manage the health of a nation, and under this broad definition, public health policy is concerned with the health of the older population. Considering the large proportion of married couples among people over the age of 50 in the United States (about 20 million in 1990) and that close to half of these people will become widows, prevalence of this potential health risk is not at issue. Instead, determining the causality of the widowhood effect is essential, because a health intervention can only be effective if there is a way to identify the incidence of the problem, the severity of the problem, and groups within the population who may face a greater risk.

If marital selection is responsible for the widowhood effect then an effective intervention would have to alter a larger set of complex behaviors of the widow. More often than not, this behavior is the product of the unique coupling and experiences within a marriage, and these behavioral similarities are responsible for the observed widow effect. As I have showed, while marital selection seems to produce the widowhood effect for women, marital protection explains why we see men experiencing the widowhood effect. In this case, because of the causality, there is an identifiable point in time when male behavior is changing and male health is compromised. Losing the spouse is the starting point of the downturn in health, but the evidence presented in the previous chapter does not identify whether the downturn is temporary or permanent.

The distinction between short- and long-term effects is critical for health policy. A long-term effect suggests that even widows who survive many years later have difficulty coping and recovering from the erstwhile loss. This would make interventions designed to alleviate this problem difficult because they would require constant attention over an extended period of time. On the other hand, if the heightened mortality after the death of a spouse is concentrated in a short period of time after the death of the spouse, then an intervention need only be timed with the change in marital status, and spouses who can survive several years into widowhood may show improved health in terms of mortality gains. The first part of this chapter tries to provide an answer to this critical dimension of widowhood by looking at how the impact to mortality from widowhood varies by time since the death of the spouse. For example, in Cox proportional hazard models, I estimate separate coefficients for the widowhood effect for widows of less than two years, and for those two or more years past the death of their spouse.

As mentioned before, another important issue from the perspective of a public health official is whether there are any groups that experience greater shocks to their health from the loss of a spouse than others. For example, in an influenza outbreak, health officials will focus their attention to more densely populated areas where contagion can explode. Using my sample of married males and females aged 50 to 70 I analyze how the widowhood effect varies across levels of family income and surviving spouse education. Knowing whether or not the widowhood effect for people with less income is substantially greater can help direct health policy, such as providing an intervention through public health insurance programs.

The final dimension to this analysis is to look at how the widowhood effect may vary by expectations of spousal loss. By first developing a metric to approximate the probability a spouse will die in the next five years, I compare the widowhood effect for men (women) whose wives (husbands) had a high probability of dying to the effect for men (women) whose wives (husbands) had a low probability of dying. Assuming the predictability of widowhood is strongly correlated with the probability a spouse dies, these specifications attempt to estimate whether knowing you are going to be a widow makes you better off than not knowing.

Section 2: Is the Widowhood Effect Immediate?

For the purposes of this dissertation, the relationship between the "widowhood effect" and "bereavement" is important. The widowhood effect is the immediate change in mortality experienced by someone whose spouse dies. Bereavement refers more to the mourning period once widowhood begins and measures whether this heightened mortality is greater earlier in the widow's life, as opposed to after many years of living as a widow. The results in Chapter 2, for example, show that widowed men have a 30% greater likelihood of dying than men whose wives are still alive. If the assumption on baseline hazards holds in the Cox proportional hazard model, the widower's greater risk of death is 30% more than a married person's risk of death on any and every day after becoming a widow.

In this section, I relax the assumption and allow the widowhood effect to vary by day since the spouse’s passing. There are several methods to measure such variation in a time-dependent variable in survival analysis, and I assume that the widowhood effect follows a non-linear, "heaviside" functional form which results in constant hazard ratios for different time intervals (Kleinbaum and Klein, 2005). This provides an opportunity to test for a bereavement effect and apply my method of isolating the causal relationship between widowhood and mortality. In the illustration below, I list the Cox proportional hazard model specifications I use to estimate the bereavement effect, and I list the hypothesis tests I use to identify any significant difference in the magnitudes of the parameter estimates. If bereavement is a real phenomenon, we should find that the widowhood effect falls in value as time passes.

Illustration 3.1

	Time Dependent Variable (time-varying dummy variables)	Time-Independent Variables (Dummy Variables)
Specification 1	Spouse died within the past year & Spouse died between 1 and 3 years & Spouse died over 3 years ago	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women) 20 Age indicators, age 51-70
Hypothesis Tests	1. Ho: Widows of less than 1 year have the same widowhood effect as Widows of 1 to 3 years 2. Ho: Widows of less than 1 year have the same widowhood effect as Widows of more than 3 years 3. Ho: Widows of 1 to 3 years have the same widowhood effect as Widows of more than 3 years 4. Ho: All three types of widows have the same widowhood effect	
Specification 2	Spouse died within the past 2 years & Spouse died between 2 and 4 years & Spouse died over 4 years ago	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women) 20 Age indicators, age 51-70

Hypothesis Tests	1. Widows of less than 2 years have the same widowhood effect as Widows of 2 to 4 years 2. Widows of less than 2 years have the same widowhood effect as Widows of more than 4 years 3. Widows of 2 to 4 years have the same widowhood effect as Widows of more than 4 years 4. All three types of widows have the same widowhood effect	
Specification 3	Spouse died within the past 2 years & Spouse died more than 2 years ago	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women) 20 Age indicators, age 51-70
Hypothesis Test	Widows of less than 2 years have the same widowhood effect as Widows of more than 2 years	

The omitted group is composed of married individuals with family income greater than $50k, a college education, a professional job, and 50 years old.

The top three panels of Table 3.1 display the maximum likelihood estimates of these Cox proportional hazard specifications for both males and females, and Tables 6.1, 6.2, and 6.3 have a complete listing of results for all variables and hypothesis tests. In the first block of results where the widowhood effect is assumed to be the same for all causes of death, I find that the bereavement results for males show no difference in the magnitude of the hazard ratios between widowers of less than one year and widowers of one to three years. Widowers of more than 3 years appear to have a lower hazard ratio suggesting that relatively recent widows face a slightly larger widowhood effect. I am unable to reject the hypothesis that the hazard ratio estimates for widowers of less than one year and between one and three years are the same (p-value close to 1.0).

The middle panels of Table 3.1 show that for married males the widowhood effect in the first two years is close to 30%. In these specifications, I find almost a 50% larger widowhood effect for widowers of 2 to 4 years compared to widowers of less than two years, and widowers of more than 4 years have a widowhood effect that is lower than that for widowers of less than 2 years. When there are two types of widowers (i.e. less than 2 years, more than 2 years), there is only a 4-percentage point difference between the two hazard ratios. The p-values for the hypothesis tests mean that we cannot reject the null hypothesis these two coefficients are the same. While these tests are not statistically significant, the parameter estimates indicate that widowers of less than four years face a greater risk than widowers of more than four years. Perplexing, though, is the greater hazard ratio for widowers of two to four years relative to the ratio for widow of less than two years. But again, the large standard errors on this estimate prevent me from making any definitive claims about the differences in the estimates over time.

For females, I find a different story. The top three panels show a pronounced bereavement effect in that women who survive a longer time as widows have better mortality rates than more recent widows. I consistently find that recent widows experience a greater widowhood effect than those whose husbands passed away longer ago. In the top panel, the effect of losing a spouse in the last year is 35% which is almost three times greater than the effect for widows of one to three years (h.r. = 1.121) and of more than three years (h.r. = 1.183). The bottom of Table 5.1 shows that there may be a statistically significant difference between the widowhood effects for widows of less than one year and of one to three years (p-value = 0.12). The results in the middle panels of Table 3.1 are similar to these. Widows of less than two years have a hazard ratio of 1.303 while the other widow types exhibit smaller hazard ratios: 1.027 for widows of 2 to 4 years and 1.222 for widows of more than four years; 1.127 for widows of more than two years). The related hypothesis tests also give strong evidence suggesting there is a statistically significant difference between being a recent widow and a widow of more experience.

For females, these first passes at measuring bereavement are interesting, but as I showed in the previous chapter, the Cox proportional hazard models for women which do not account for the heterogeneity in the type of spousal death are more likely than not reporting a widowhood effect that is the result of marriage selection. The widowhood effect in these models is not representative of a causal relationship between widowhood and mortality for women. For this reason the next set of Cox proportional hazard models are important.

I have argued that there is a strong causal relationship between widowhood and mortality for men and weak evidence of a similar relationship for widows. The argument hinges on an empirical assumption that certain spousal deaths have little correlation with individual or couple characteristics and behaviors. I call these diseases uninformative causes of death (UCOD). By allowing the widowhood effect to vary between widows of UCOD and informative causes of death (ICOD), I isolate the causal relationship resulting from the loss of marriage protection benefits. In the same fashion, I consider how the impact to the mortalities of recent widows and widowers from spouses who die of UCOD compares to the impact on widows and widowers who experienced the loss of their spouse to a UCOD many years ago. I also do this for the ICOD widows. The illustration below exhibits the Cox proportional hazard model specification and hypothesis tests I conduct using the NLMS sample of married males and females aged 50-70.

Illustration 3.2

	Time Dependent Variable (time-varying dummy variables)	Time-Independent Variables (Dummy Variables)
Specification	Spouse died of UCOD within the past two years Spouse died of UCOD over two years ago Spouse dies of ICOD within the past two years Spouse dies of ICOD over two years ago	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women) 20 Age indicators, age 51-70

Hypothesis Test	1. UCOD Widows and ICOD Widows have the same widowhood effect, among widows of less than 2 years 2. UCOD Widows and ICOD Widows have the same widowhood effect, among widows of more than 2 years 3. Widows of less than 2 years have the same widowhood effect as Widows of more than 2 years, among UCOD Widows 4. Widows of less than 2 years have the same widowhood effect as Widows of more than 2 years, among ICOD Widows

The omitted group is composed of married individuals with family income greater than $50k, a college education, a professional job, and 50 years old.

The results of the specification and tests, displayed in the bottom panel of Table 3.1 and Table 6.4, help to clear things up, but I must be careful with the comparisons and inferences I make. For this reason, I will follow the order of the hypothesis tests in the exposition of these results. Starting with the hypothesis that the widowhood effect in the first two years is the same across widower types, I find no reason to believe there is a significant difference between the two. This result suggests that the widowhood effect in the first two years is real (i.e. the marriage protection story holds). I find similar evidence for the next test where I cannot reject the null hypothesis that the widowhood effect for widowers of more than 2 years is the same across cause of death types. Both widowhood effects result from the loss of marriage protection; however, as the third and fourth hypothesis test results show, there is no strong evidence indicating the magnitude of the widowhood effect is greater in the earlier period of the widower's experience.

There is weak evidence, though, of a bereavement effect for men, because the size of the UCOD widowhood effect falls over time. In the first two years, the relevant hazard ratio is 1.391 in comparison to the hazard ratio for UCOD widowers of more than two years, 1.244. If my empirical strategy works well, the results for the UCOD widowers represent a close approximation to the causal impact of widowhood on the surviving spouse's mortality. In sum, these findings suggest that (1) widowers have excess mortality rates regardless of time since spousal loss, and (2) there may be a bereavement effect with the UCOD results showing a 15-percentage point disadvantage for recent UCOD widowers relative to other UCOD widowers.

The results for females again show how important controlling for the heterogeneity in spousal mortality is for this investigation. Following the hypothesis tests, I find widows of less than two years to have no marriage protection effect; that is, I find good evidence indicating that I am able to reject the hypothesis that the UCOD and ICOD estimates are equivalent (p-value = 0.21). In contrast, the finding for widows of more than 2 years suggests no difference between widow type (p-value = 0.56). Furthermore, the widows of men who died of an UCOD less than 2 years ago have a widowhood effect of 4.6% (h.r. = 1.046), and the widows of an UCOD more than two years ago have an increase in their mortality of 3.4% (h.r. = 1.034). So, my findings for women show the following: (1) as in the previous chapter, I find that the change in marital status does not seem to have a causal impact on the mortality of widows, and (2) if there is an effect, women have a bereavement effect of a statistically insignificant magnitude.

Section 3: SES Gradients to the Widowhood Effect

My measure of mortality risk compares the hazard of dying of a group that has experienced an event, widows, to a group that has not, those still married. While the hazard ratio in this case represents the instantaneous change in mortality, the hazard ratio estimates associated with the education, income, age and occupation variables represent baseline differences in hazards due to socio-economic status (SES) differences. For example, people with no high school education have somewhere between a 30 to 40 percent greater baseline hazard of dying where the baseline group is composed of the college educated (see tables in chapters 5 and 6 for examples). In this section, I expand the specifications to determine whether widowhood impacts groups differentially by income and education levels.

Some authors have argued that widows with less income find themselves in "double jeopardy" relative to married individuals with more income (Smith and Zick, 1994). Income has often been shown to be an important explanatory variable for the variation of mortality rates in a population with lower income individuals having higher mortality rates. However, becoming a widow with low income may be quite different, because less money buys less health care that is of lower quality (Cutler, 2004). As an example, consider that researchers have discovered that hospice care improves health outcomes for the person receiving treatment and for the spouses and family members of the treated (Christakis and Iwashyna, 2003). Thus, higher income widows have fewer financial constraints to hospice care and may therefore have a smaller widowhood effect than lower income widows. Another pair of authors provides evidence that lower educated widows have greater excess mortality than higher educated widows, as well as finding the same result for income differences (Martikainen and Valkonen, 1998). However, other authors have found the reverse situation where more highly educated widowers in Israel have greater excess mortality rates (Manor and Eisenbach, 2000). Besides these studies, there has been little research performed on the topic of widow mortality differences due to SES in the last 30 years.

Education

The following illustration lists the Cox proportional hazard model specifications and tests that I conduct in this section.

Illustration 3.3

Married Males		
	Time Dependent Variable (time-varying dummy variables)	Time-Independent Variables (Dummy Variables)
Specification 1	Wife dies and widower has more than a high school education Wife dies and widower is a high school graduate Wife dies and widower did not complete high school	6 Family Income indicators 4 Education indicators 10 Occupation indicators 20 Age indicators, age 51-70
Hypothesis tests	1. Widowers with more than a high school education have the same widowhood effect as widowers who are high school graduates 2. Widowers with more than a high school education have the same widowhood effect as widowers with are not high school graduates 3. Widowers who are high school graduates have the same widowhood effect as widowers who are not high school graduates 4. All widowers have the same widowhood effect	
Specification 2	Wife dies and widower is a high school graduate or has higher education Wife dies and widower did not complete high school	6 Family Income indicators 4 Education indicators 10 Occupation indicators 20 Age indicators, age 51-70
Hypothesis tests	Widowers with more education have the same widowhood effect as widowers with less education	
The omitted group is composed of married individuals with family income greater than $50k, a college education, a professional job, and 50 years old.		

Table 3.2 contains the results of these models. In the left column, the results from the first specification show that widowers who have partially or completely finished a post-secondary education have a 40% widowhood effect (h.r. = 1.405), whereas widowers who are high school graduates without post-secondary education exhibit a much smaller widowhood effect of 8% (h.r. = 1.081). In fact, this difference is statistically significant (p-value = 0.062) at a modest degree of certainty and suggests that the severity of the widowhood effect may vary across widowers by their educational attainment (see Table 6.5).

Widowers who have not completed high school have a hazard ratio equal to 1.24; however, the associated hypothesis tests are not suggestive of statistically significant differences between widowers who do not finish high school and widowers who have finished high school, have some post-secondary education, and in comparison to both (i.e., the final joint hypothesis test). Looking at the male results in the middle panel of Table 3.2, there is only a slight difference between the hazard ratios of widowers who have completed high school, have some post-secondary schooling, or have college degrees and widowers who have not completed high school (1.325 and 1.253, respectively), and the difference is not significant (p-value = 0.72). The complete results for the specification in the middle panel are also in Table 6.5.

Before moving on to the female results, I look at how these male results are affected when I implement my empirical strategy that controls for the heterogeneity of spousal death. The illustration below shows the specification of the Cox proportional hazard model I use for this analysis.

Illustration 3.4

Married Males		
	Time Dependent Variable (time-varying dummy variables)	Time-Independent Variables (Dummy Variables)
Specification 1	Wife dies of an UCOD and widower has a high school education or more Wife dies of an UCOD and widower did not complete high school Wife dies of an ICOD and widower has a high school education or more Wife dies of an ICOD and widower did not complete high school	6 Family Income indicators 4 Education indicators 10 Occupation indicators 20 Age indicators, age 51-70

Hypothesis tests	1. Widowers by UCOD have the same widowhood effect as widowers by ICOD, among widowers with a HS education or more 2. Widowers by UCOD have the same widowhood effect as widowers by ICOD, among widowers who have not completed HS 3. Widowers with HS education or more have the same widowhood effect as widowers who have not completed HS, among UCOD 4. Widowers with HS education or more have the same widowhood effect as widowers who have not completed HS, among ICOD
The omitted group is composed of married individuals with family income greater than $50k, a college education, a professional job, and 50 years old.	

The bottom panel of Table 3.2 shows the hazard ratios and standard errors from the models that control for the heterogeneity of spousal death (see Table 6.7 for complete results and hypothesis tests). Following the order of the hypothesis tests sketched above, I find little evidence to infer a significant difference between the effects for UCOD and ICOD widowers with secondary or post-secondary education (p-value = 0.54). However, for the widowers with some or no high school education, the difference between UCOD and ICOD widowers is large and statistically significant with moderate certainty (p-value = 0.18). This relationship points to the possibility that widowers with less education suffer a worse fate in their widowhood than their more educated counterparts. What is important to note here is how the hazard ratio for the UCOD estimate (1.64) is greater than that for the ICOD estimate (1.09). If the hypothesis underlying our empirical strategy is correct, the test result shows that models without controls for cause of spousal death will lead to underestimates of the burden of widowhood on the less educated—an already at-risk group. The inferences I draw for males are (1) higher educated widowers have a marriage protection effect—approximately 25 percent, that is similar in magnitude to the general effect noted in Chapter 2—approximately 30 percent, and (2) the widowhood effect is more severe for widowers with less education.

Unlike these widower results, my findings for females point to an opposite relationship between widowhood and education. The illustration below displays the specifications and hypothesis tests that are intended to provide a benchmark to the measurement of educational variation in the widowhood effect for females.

Illustration 3.5

Married Females		
	Time Dependent Variable (time-varying dummy variables)	Time-Independent Variables (Dummy Variables)
Specification 1	Husband dies and widow has more than a high school education Husband dies and widow completed high school Husband dies and widow did not complete high school	6 Family Income indicators 4 Education indicators 11 Occupation indicators 20 Age indicators, age 51-70
Hypothesis tests	1. Widows with more than a high school education have the same widowhood effect as widows who have completed high school 2. Widows who are more than high school graduates have the same widowhood effect as widows who have not completed high school 3. Widows who are high school graduates have the same widowhood effect as widows who did not complete high school 4. All widows have the same widowhood effect	
Specification 2	Husband dies and widow has completed more than high school Husband dies and widow has a high school or less education	6 Family Income indicators 4 Education indicators 11 Occupation indicators 20 Age indicators, age 51-70
Hypothesis test	Widows with more than a high school education have the same widowhood effect as widows who have a high school education or less	
The omitted group is composed of married individuals with family income greater than $50k, a college education, a professional job, and 50 years old.		

The right column of Table 3.2 displays the hazard ratios from these specifications, and Table 6.6 has the complete results. The results from the first demonstrate that there is little difference in the widowhood effect between widows with post-secondary education and those with a high school degree. However, the experience between either of these groups and widows who did not finish high school is substantial.

Illustration 3.6

Married Females		
	Time Dependent Variable (time-varying dummy variables)	Time-Independent Variables (Dummy Variables)
Specification 1	Husband dies of an UCOD and widow has more than a high school education Husband dies of an UCOD and widow has a high education or less Husband dies of an ICOD and widow has more than a high school education Husband dies of an ICOD and widow has a high school education or less	6 Family Income indicators 4 Education indicators 11 Occupation indicators 20 Age indicators, age 51-70
Hypothesis tests	1. Widows by UCOD have the same widowhood effect as widows by ICOD, for widows who have more than a HS education 2. Widows by UCOD have the same widowhood effect as widows by ICOD, for widows who have HS or less education 3. Widows by UCOD who have more than a high school education have the same widowhood effect as widows who have a high school or less 4. Widows by ICOD who have more than a high school education have the same widowhood effect as widows who have a high school or less	
The omitted group is composed of married individuals with family income greater than $50k, a college education, a professional job, and 50 years old.		

Comparing widows with and without post-secondary education, there is a great disparity in the magnitudes of the hazard ratios, 1.239 and 0.984 respectively. In fact, the hypothesis test provides strong evidence to think the relationship is more than just a result of chance (p-value = 0.060). I explore this point further by looking at the results of the Cox proportional hazard models listed in the illustration above. The bottom panel of Table 3.2, and right column, contains the results from this specification and results from the hypothesis tests (see Table 6.8 for the complete set of results).

To begin with, I cannot reject the null hypothesis that there is no statistical difference between being a UCOD widow with high education and an ICOD widow with similar education attainment (p-value = 0.61). I also reject the similar null hypothesis for widows with lower education, and for these widows, I find no significant statistical difference between the widows by UCOD and widows by ICOD (p-values = 0.48). The magnitude of the widowhood effect for more educated widows is significantly larger for UCOD and ICOD widows (1.20 and 1.30, respectively). I am able to reject the hypothesis that higher educated widows have the same widowhood effect as lower educated widows among UCOD widows (p-value = 0.11), and I am able to reject the same hypothesis for ICOD widows (p-value = 0.09). These test results point to a widowhood effect among women that is concentrated among the more highly educated.

Income

Now I turn my attention to how the widowhood effect varies by the level of family income that is reported in the NLMS. If the widowhood effect negatively varies with income levels, I would have some evidence that greater financial security does not buffer the impact of widowhood. Below is an illustration of the Cox proportional hazard models I use to study how the widowhood effect varies by income. While there is a long line of literature that identifies the relative mortality differences between income groups and that a decreasing income gradient to mortality exists, there is almost no quantitative research on an income gradient to the widowhood effect. As I noted above, the few studies that have looked into this subject have not come to a consensus.

Illustration 3.7

	Time Dependent Variable (time-varying dummy variables)	Time-Independent Variables (Dummy Variables)
Specification 1	Spouse dies and Family Income is greater than $50,000 Spouse dies and Family Income is between $25,000 and $50,000 Spouse dies and Family Income is less than $25,000	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women) 20 Age indicators, age 51-70
Hypothesis tests	1. High income widows have the same widowhood effect as mid-income widows 2. High income widows have the same widowhood effect as low income widows 3. High income widows have the same widowhood effect as low income widows 4. All widow types have the same widowhood effect.	
Specification 2	Spouse dies Family Income is greater than $20,000 Spouse dies and Family Income is less than $20,000	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women) 20 Age indicators, age 51-70
Hypothesis test	Higher income widows have the same widowhood effect as lower income widows	

The omitted group is composed of married individuals with family income greater than $50k, a college education, a professional job, and 50 years old.

The top two panels of Table 3.3 display the results for these income and widowhood specifications, and Tables 6.9 and 6.10 contain the full sets of results. Beginning with the results for women, both panels tell the same story that higher income widows are the ones who suffer the most from the loss of a husband. These results indicate that higher income females have a widowhood effect that ranges from two to five times as large as for females in other income groups, depending on the specification. From the first specification, the hypothesis test gives relatively strong evidence that there is a statistically significant difference between the widowhood effect for women in the highest income group and those in the middle income group (p-value = 0.03), those in the lowest income group (p-value = 0.04), and in comparison to both middle and low income groups (p-value = 0.09).

For males, the specifications tell a consistent story, too. Higher income males have larger widowhood effects than lower income males. In the first specification, the hazard ratios are 1.661, 1.476, and 1.283 for the high, middle, and low income widowers respectively. This demonstrates a positive relationship between widower mortality and income. The second specification shows a widowhood effect close to 50 percent for men with more than $20,000 family income and 26 percent for lower income men. The hypothesis tests for the male results are not indicative of significant differences between widowhood effects.

Next, I use the UCOD/ICOD specifications to provide a better idea of whether a the causal relationship between widowhood and mortality exists and if it depends on the level of family income. The illustration below summarizes these Cox proportional hazard models.

Illustration 3.8

	Time Dependent Variable (time-varying dummy variables)	Time-Independent Variables (Dummy Variables)
Specifiation 1	Spouse dies of UCOD and Family Income is greater than $20,000 Spouse dies of UCOD and Family Income is less than $20,000 Spouse dies of ICOD and Family Income is greater than $20,000 Spouse dies of ICOD and Family Income is less than $25,000	6 Family Income indicators 4 Education indicators 10 (11) Occupation indicators for men (women) 20 Age indicators, age 51-70

Hypothesis test	1. UCOD widows have the same widowhood effect as ICOD widows, among higher income widows 2. UCOD widows have the same widowhood effect as ICOD widows, among lower income widows 3. Higher income widows have the same widowhood effect as lower income widows, among UCOD widows 4. Higher income widows have the same widowhood effect as lower income widows, among ICOD widows

The omitted group is composed of married individuals with family income greater than $50k, a college education, a professional job, and 50 years old.

The results from these specifications for males and females are listed in the bottom panel of Table 3.3. First, I find no statistically significant differences between UCOD and ICOD widowers with higher income (p-value = 0.82), and similarly, I find no statistically significant between these types of widowers with lower income (p-value = 0.73). These findings are consistent with the hypothesis that the widowhood effect is the result of a loss of marriage protection. Also, I am unable to reject the null hypothesis that higher income widows have the same widowhood effect as lower income widows, among UCOD widows (p-value = 0.27) and ICOD widows (p-value = 0.39). Together, these results show that the widowhood effect is real for all income groups, and while the test statistics are not very convincing, the large gap between the UCOD hazard ratios (1.519 for higher income and 1.223 for lower income) suggests a gradient in the widowhood effect that surprisingly favors lower income individuals.

The results for females are startling in comparison. I am unable to reject the hypothesis that the widowhood effect is the same for UCOD and ICOD widows with higher income indicating causality in the widowhood effect for this group. On the other hand, I am able to reject the other null hypothesis (p-value = 0.10) giving strong evidence that there is no causal relationship between widowhood and mortality for lower income females. In fact, the UCOD result would indicate that lower income widows have better mortality outcomes than women who are still married (h.r. = 0.93). I am also able to reject the null hypothesis that the widowhood effect is the same for high and low income wives of husbands who die of a UCOD. Adding this to the previous result, I have strong evidence showing that higher income females are more susceptible to the deleterious effects of widowhood than their lower income counterparts.

Section 4: Expectations of Spousal Mortality and the Widowhood Effect

I am primarily interested in understanding the temporal correlation of spouses' mortalities. The main thesis of this dissertation is that widowhood directly impacts the mortality of the surviving spouse, negatively. I give evidence of a causal relationship using our experiment to control for the suspected endogenous heterogeneity of spousal mortalities. Following the conjecture that not all deaths affect surviving spouses the same, we may expect to find that "unforeseen" deaths have a greater absolute impact on widows' mortalities than more predictable deaths (e.g. ischemic heart disease, lung cancer). In essence, I ask if a spouse with a greater expectation of becoming a widow suffers more or less when the event is realized than a spouse with less of an expectation of becoming a widow.

Using the wealth of health indicators at the time of the NHIS survey, I calculate probabilities of death for every individual in our sample based on logistic regressions.5 I model the probability of dying as a function of SES indicators (income, age, and education) and health characteristics (short-stay hospital visits, body mass index, etc.).6 After estimation, I determine individual-specific predicted probabilities of dying. Next, I match

[5] The NHIS is explained in more detail in Chapter 5.
[6] Body mass index (BMI) = weight (lbs) / [height (inches)]2 x 703. This factor is then compared to national standards and can be used to determine weight status: underweight, normal weight, overweight, or obese.

individuals to their spouses; so that each individual has an expectation of their spouse's mortality that is equivalent to their spouse's predicted probability of dying in the next five years. In my Cox regression specifications, I compare the hazards of dying between married people, widows of spouses with a low probability of dying, a lower than average probability of dying, a higher than average probability of dying, and a high probability of dying. The illustration below summarizes this.

Illustration 3.9

	Time Dependent Variable (time-varying dummy variable)	Time-Independent Variables (Continuous and Dummy Variables)
Specification 1 (25/50/75 percentile splits)	Spouse dies and high expected 5yr mortality Spouse dies and above-average expected 5yr mortality Spouse dies and below-average expected 5yr mortality Spouse dies and low expected 5yr mortality	Education (3) Income (4) Hispanic (1) Race (2) Activity Limitation (1) Body Mass Index (3) Self-Reported Health (1) Years difference between married couple Short Hospital Stays in the past 12 months (1)
Specification 2 (10/50/90 pecentile splits)	Spouse dies and high expected 5yr mortality Spouse dies and above-average expected 5yr mortality Spouse dies and below-average expected 5yr mortality Spouse dies and low expected 5yr mortality	Education (3) Income (4) Hispanic (1) Race (2) Activity Limitation (1) Body Mass Index (3) Self-Reported Health (1) Years difference between married couple Short Hospital Stays in the past 12 months (1)

Figure 3.1(a) shows the distribution of predicted probabilities of dying in the next five years for men, and Figure 3(b) shows the distribution for women. The figures also mark the

threshold values for our four groups. I use two sets of percentile markers: 25/50/75-percentiles and 10/50/90-percentiles. The groupings are based on the distribution of the predicted values, so the lowest 25% (or 10%), the below-average 25% to 50% (or 10% to 50%), the above-average 50% to 75% (or 50% to 90%), and the highest 25% (or 10%). Table 3.4 displays the results of the Cox proportional hazard models for men and women, and I find that the expectation of spousal mortality, at least in the manner that I measure, may not provide a buffer against the widowhood effect for men (and women). For every specification, the hazard ratio associated with becoming a widow of a spouse with a high probability of dying is higher than any other of the widow estimates in the same specification. This directly contradicts how we would expect expectations to work; that is, I would expect those with more information to be better prepared for the advent of widowhood and less susceptible to death.

When I look at the mortality outcomes for the people with the lowest expectation of becoming a widow (i.e. supposedly, the people with the smallest buffer), I find the widowhood effects for "above-," and "below average" widows to be comparatively lower. While this last point supports the idea that less predictability increases the magnitude of the widowhood effect, it cannot be separated from the array of other widowhood variables. Instead, I surmise that in the tails of the distribution of predicted probabilities of spousal mortality are the people most affected by widowhood, and they consist of those who "should have seen it coming" and those who "never saw it coming". What is left to be determined is whether the provision of more information to the first group would reduce the widowhood effect, or are these people poor at assessing their spouse's survival?

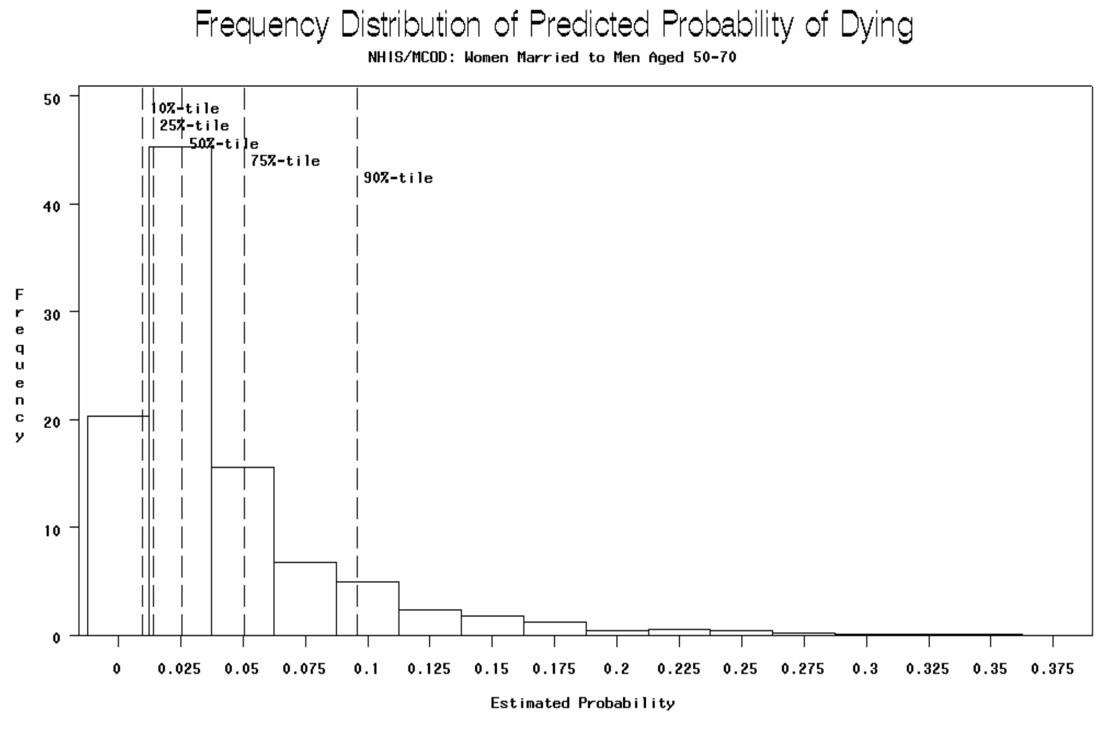
Section 5: Summary and Conclusion

This chapter provides more evidence that the widowhood effect is a real, causal phenomenon for men. The evidence demonstrates that men are subject to a bereavement effect that is slightly more than 15 percentage point excess mortality for recent widowers over other widowers. In testing for the possibility of socioeconomic status gradients to the widowhood effect, I found that widowers with higher educational attainment do experience a marriage protection effect, and it is less than that of widowers with lower education attainment. Also, higher and lower income males have widowhood effects due to the loss of marital protection, and there is weak evidence that there is an income gradient to the widowhood effect that is opposite of what one would expect—higher income widowers are worse off. Lastly, there is some evidence to suggest that expectations do play a role in buffering the widowhood effect, because widowers of women with average 5 year mortality rates have smaller widowhood effects than widowers of women with low rates. Surprisingly, males with greater expectation of becoming a widow also have the largest widowhood effect.

The story for women is similar in many ways. First, the bereavement results confirm that there does not seem to be a strong causal relationship between the death of a husband and the surviving wife's own demise. Next, I find a consistent story that higher SES widows have a greater widowhood effect than lower SES widows. First, more educated females do experience the causal relationship between widowhood and excess mortality, and their less educated counterparts do not have excess mortality rates. In fact, the results point to a possible mortality advantage for being less educated and widowed compared to people who are still married and other widows. As for the income gradient, higher income females appear to have larger widowhood effects than lower income females. In addition, the effect to higher income widows is real and large while the effect to lower income widows is small and negligible. Finally, expectations seem to play the same role for women as they do for men:

people with the greatest and lowest probability of becoming a widow have similar widowhood effects that are larger than the effect for people with an average probability of spousal loss.

Figure 3.1(a)



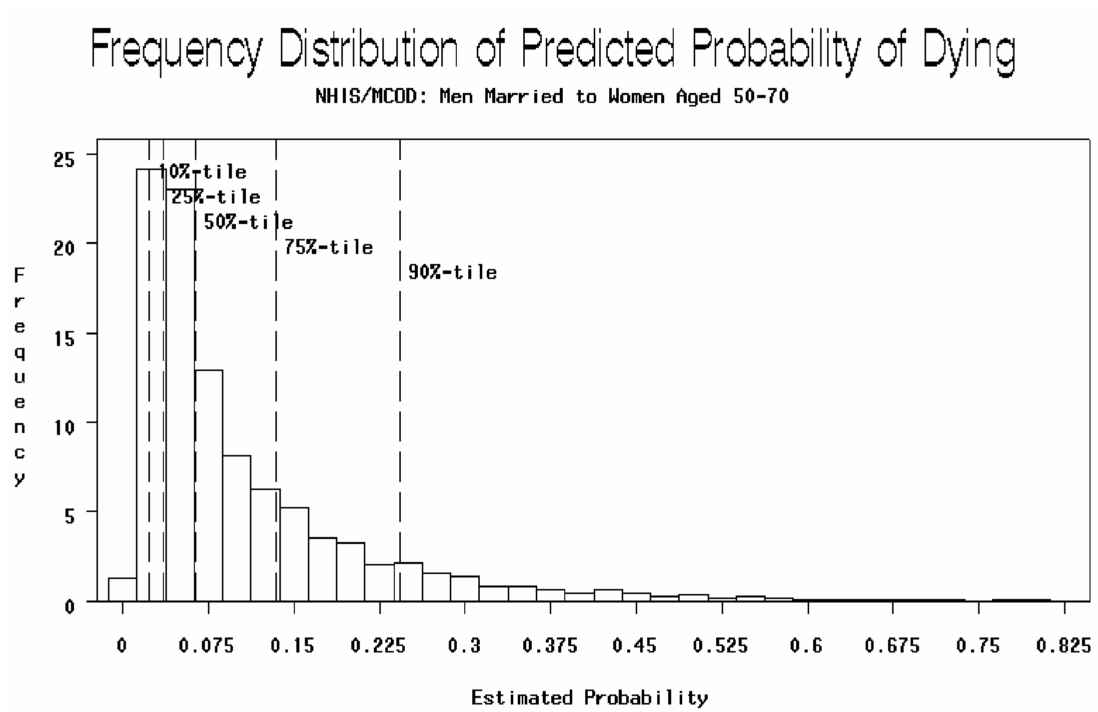


Figure3.1(b)

Table 3.1: Bereavement Results, Married Male and Female NLMS Samples
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Hazard Ratios and (Standard Errors)

	Married males, aged 50-70 (n=37,777)	Married females, aged 50-70 (n=34,465)
Widower for less than 1 year	1.348 (0.143)	1.346 (0.125)
Widower for 1 to 3 years	1.339 (0.001)	1.121 (0.089)
Widower for more than 3 years	1.276 (0.005)	1.183 (0.082)
-2 log likelihood	129,942.82	63,770.94
Widower for less than 2 years	1.290 (0.104)	1.303 (0.092)
Widower for 2 to 4 years	1.426 (0.132)	1.027 (0.091)
Widower for more than 4 years	1.238 (0.127)	1.222 (0.098)
-2 log likelihood	129,941.86	63,768.30
Widower for less than 2 years	1.290 (0.104)	1.303 (0.091)
Widower for more than 2 years	1.335 (0.093)	1.127 (0.069)
-2 log likelihood	129,942.94	63,770.66
Widower for less than 2 years and UCOD	1.391 (0.190)	1.046 (0.199)
Widower for more than 2 years and UCOD	1.244 (0.155)	1.034 (0.166)
Widower for less than 2 years and ICOD	1.243 (0.123)	1.349 (0.101)
Widower for more than 2 years and ICOD	1.379 (0.114)	1.141 (0.075)
-2 log likelihood	129,942.00	63,768.62

Table 3.2: Education and the Widowhood Effect
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Married Male and Female Samples, NLMS
Hazard Ratios and (Standard Errors)

	Married Males, 50-70 (n=37,777)			Married Females, 50-70 (n=34,465)	
Widower & more than HS education	1.405	(0.090)	Widow & more than HS education	1.210	(0.070)
Widower & a HS graduate	1.081	(0.136)	Widow & HS Graduate	1.267	(0.134)
Widower & not a HS graduate	1.242	(0.184)	Widow & not a HS Graduate	0.999	(0.143)
-2 log likelihood	129,939.25			63,771.16	
Widower & a HS graduate or more education	1.325	(0.076)	Widow & more than a HS education	1.239	(0.065)
Widower & not a HS graduate	1.253	(0.185)	Widow & a HS graduate or less education	0.984	(0.115)
-2 log likelihood	129,942.91			63,769.64	
Widower by UCOD & a HS graduate or more education	1.261	(0.126)	Widow by UCOD & more than a HS education	1.197	(0.174)
Widower by UCOD & not a HS graduate	1.637	(0.388)	Widow by UCOD & a HS graduate or less education	0.775	(0.179)
Widower by ICOD & a HS graduate or more education	1.356	(0.092)	Widow by ICOD & more than a HS education	1.299	(0.081)
Widower by ICOD & not a HS graduate	1.090	(0.204)	Widow by ICOD & a HS graduate or less education	1.100	(0.089)
-2 log likelihood	129,940.77			63,769.64	

Table 3.3: Family Income and the Widowhood Effect
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Married Male and Female Samples, NLMS
Hazard Ratios and (Standard Errors)

	Married males, aged 50-70 (n=37,777)	Married females, aged 50-70 (n=34,465)
Widow & more than $50k	1.661 (0.512)	2.028 (0.514)
Widow & between $25k and $50k	1.476 (0.211)	1.067 (0.165)
Widow & less than $25k	1.283 (0.008)	1.191 (0.063)
-2 log likelihood	129,941.70	63,768.96
Widow & $20K or more	1.477 (0.149)	1.335 (0.134)
Widow & less than $20K	1.263 (0.080)	1.159 (0.065)
-2 log likelihood	129,941.33	63,771.83
Widow of UCOD & $20K or more	1.519 (0.246)	1.452 (0.329)
Widow of UCOD & less than $20K	1.223 (0.138)	0.928 (0.137)
Widow of ICOD & $20K or more	1.452 (0.185)	1.312 (0.143)
Widow of ICOD & less than $20K	1.281 (0.095)	1.197 (0.070)
-2 log likelihood	130,050.21	63,876.98

Table 3.4: Expectations of Spousal Mortality and the Widowhood Effect
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Married Males and Females, NHIS Samples

Hazard Ratios and (Standard Errors)

	Married males, aged 50-70 (n=26,839)	Married females, aged 50-70 (n=21,502)
	25% and 75% splits	
Widow & high 5yr spousal mortality rate	1.257 (0.106)	1.212 (0.107)
Widow & above-average 5yr spousal mortality	1.115 (0.096)	1.028 (0.094)
Widow & below-average 5yr spousal mortality	1.203 (0.111)	1.054 (0.109)
Widow & low 5yr spousal mortality	1.180 (0.119)	1.119 (0.143)
-2 log likelihood	47,254.11	22,468.62
	10% and 90% splits	
Widow & high 5yr spousal mortality rate	1.340 (0.122)	1.186 (0.124)
Widow & above-average 5yr spousal mortality	1.148 (0.096)	1.110 (0.094)
Widow & below-average 5yr spousal mortality	1.188 (0.107)	1.090 (0.109)
Widow & low 5yr spousal mortality	1.267 (0.160)	1.112 (0.189)
-2 log likelihood	47,251.87	22,491.65

Chapter 4: Conclusion

There is no denying the strong correlation in spousal mortalities; so strong is the correlation that some have come to call it the widowhood effect. For years, scientists have speculated as to why this relationship exists, and two prevailing hypotheses have developed—marriage selection and marriage protection. The first is strictly a story of correlation founded on the theory of assortative mating at the time of marriage. The other is a story of causation where the event of widowhood itself sparks a change in the surviving spouse's mortality that is for the worse. This dissertation has sought to add to this line of inquiry by developing a method to directly determine whether causality is behind the widowhood effect for older men and women.

Cox proportional hazard models, and more generally survival analysis, have become a standard analytical tool used in recent studies on the relationship between widowhood and mortality. I show that marriage selection is indeed a vital aspect to the widowhood effect we observe, and I show how any estimate of the widowhood effect will be strongly correlated with unobservable and observable characteristics. Because of this, I allow the widowhood effect to vary between widows who differ by the cause of their spouse's death. If a widow's spouse died of a disease that is correlated with observed characteristics (e.g., income, education, occupation), the resulting widowhood effect is biased upwards. However, for widows whose spouses died of diseases that are not explained by observed characteristics, any estimate of the widowhood effect is less susceptible to the same bias.

I find that causation, the marriage protection hypothesis, is the story for men who experience a 30 percent widowhood effect, and I find that causation is not a dominant force in explaining widow mortality. These findings add to the body of research that has sought to explain the higher mortality rates of widows (Hu & Goldman, 1990; Sorlie, Backlund, &

Keller, 1995; Waldron, Hughes, & Brooks, 1996). This difference between sexes has been observed in the literature, and I am able to verify some of those results and give evidence that rebukes the marital protection story for women (Annandale & Hunt, 1990; Arber & Ginn, 1993; Martikainen & Valkonen, 1996).

I also find evidence suggesting that time since the passing of a spouse may impact the magnitude of the effect for men and not women. These results both verify and contradict previous research (Kaprio, Koskenvuo, & Rita, 1987; Martikainen & Valkonen, 1996). On the other hand, there is little research with which to compare my results of the impact of SES and expectations of spousal loss on the widowhood effect.

All of this evidence points to a public health hazard for more mature males who are married and experience the passing of their wives. I stress that widowhood is the start of a short chain of events that leads to death. I do not delve into the wealth of studies that have sought to explain what changes in behavior among widows and widowers that leads to their quick demise. Loss of breadth and depth in social networks that are only accessible through one spouse may explain why bereavement is more taxing on recent widowers who have not had enough time to rebuild their social networks, unlike widowers who have survived many years (Helsing, Szklo, & Comstock, 1981; Zick & Smith, 1991). The social network theory may also explain why we see widowers, and not widows, affected by widowhood; simply, wives were more often than not the husband's access point into their network. Therefore, a wife's death marks the husband's loss of access to their network which is followed by their slow demise. A bereft wife, however, retains the majority of their network after the passing of their husband; thus, widows do not have a social network effect. Another explanation is the "broken heart hypothesis" that purports the onset of depression to be the pathway to excess mortality rates among widows. Because losses in social networks are likely to be correlated with depression, these two pathways may be quite similar. For example, Scheerer and Brandt find that family and social support are critical to improving the health outcomes of bereft wives whose husbands die in farming incidents.

While this dissertation provides new findings and an innovative empirical strategy for the study of widowhood and mortality, there is work to be done. Future research must continue to develop strategies that minimize the risk of producing a false positive result verifying the marriage protection theory. Also, new studies using large time-use survey data may provide researchers an avenue to investigate how the day-to-day lives of men change when they lose their wives. Researchers have long suspected widowhood to be a health hazard, and this dissertation has provided corroborating and new evidence about the causality and characterization of the widowhood effect.

Chapter 5: Appendix to Chapter 2

Section 1: Data

This appendix covers the data used in chapter 2 and provides more comprehensive tables of descriptive statistics and regression results at the end of the chapter.

NLMS

The main informational website for the National Longitudinal Mortality Study (http://www.census.gov/nlms) lists the National Institute on Aging, National Cancer Institute, the National Heart, Lung and Blood Institute, the National Center for Health Statistics (NCHS), and the U.S. Census Bureau as sponsors to the data which have been collected for the purpose of studying demographic and socio-economic differences in mortality.

The data are formed from a merging of Census data and NCHS death records maintained in the National Death Index. Using a 1980 cohort from the Census long-form, the individuals are matched to data collected in the NDI, the Annual Social and Economics Supplements, and the Current Population Surveys of February 1978, April 1980, August 1980 and December 1980. The NLMS data I use has a fixed mortality follow-up period of nine years.

I have included a basic SAS program as Illustration 5.1. This program reads in the NLMS data and lists the variables, and their positions in the raw dataset, that I use in my analysis. Generally speaking, the NLMS data is publicly available by a request to the NLMS-Census Bureau's principal investigator.

NHIS

To begin with, the NHIS data that was used to show assortative mating can also be expanded into a longitudinal dataset. I used these data for many of the same maximum likelihood estimations of Cox proportional hazard models. The NHIS and Multiple Cause of Death (MCOD) supplement file are datasets maintained by the National Center for Health Statistics (NCHS). The NHIS is a cross-sectional household interview survey conducted continually throughout the year. For the interview years the data span, 1987-1990, between 36,000 and 47,000 households were surveyed providing annual samples of 92,000 to 125,000 individuals (NCHS, 2005). The household information includes type of living quarters, size of family, region, and other household identifiers. Personal information includes demographic variables (i.e. race, sex, age, etc.), marital status, veteran status, family income, employment information, and detailed health information such as self-reported health status, bed days, work-loss days, and restricted-activity days.

In similar fashion to the NLMS, the NHIS data can be merged to the Multiple Cause of Death (MCOD) supplement that matches individuals 18 years and older at the time of interview for NHIS to the NDI. Using the MCOD, able to observe deaths of respondents to the month and year through December 31, 1995. MCOD also provides cause of death information using ICD-9 codes.

I focus attention to married, white, non-Hispanic people between the ages of 50 and 70. Using household identification numbers and variables in the NHIS that identify a respondent's relationship to the head of household, I match the records of husbands and wives. Although spouses of 50-70 year olds are primarily within this age range, some are not, so there are different sized samples for "married men" and "married women". As Table 5.2 shows, the NHIS produces mortality statistics slightly lower than the NLMS.

In the data, an observation consists of a married couple that enters the NHIS at some point between January 1, 1987 and December 31, 1990. Our observation period begins with this entry point and extends until December 31, 1995, or until death, which ever comes first.

In Table 5.4, I report results from Cox proportional hazard models for married women and married men. In these specifications, the time-invariant variables are income, education, and age at initial survey, which are all measured at the first interview. The only time-variant variable is one that takes a value of 1 in the month an individual becomes a widow, and all subsequent days or months, and it equals zero otherwise. For each model, I report both the parameter estimate and the hazard ratio, which measures the ratio of the hazard when the particular covariate equals 1 divided by the hazard when the same covariate is zero. The two NHIS samples have 20,290 observations of married women and their spouses and 22,171 observations of married men and their spouses. I use these same samples for the logistic regressions that validate the use of the UCOD/ICOD strategy and the R-UCOD/ICOD strategy that were developed using NLMS data, and I use these samples to measure how the widowhood effects vary between these types of spousal death. The logistic regression results for the UCOD/ICOD strategy are reported in Table 5.6 and for the R-UCOD/ICOD strategy in Table 5.8. The Cox proportional hazard models using the UCOD/ICOD strategy are reported in 5.10, and the Cox results from the R-UCOD/ICOD strategy are reported in Table 5.12.

Section 2: Other Specifications

To thoroughly investigate, I ran several specifications with the same samples I have used throughout the entire dissertation and larger samples that do not have the same age constraints.

For the 50-70 year old, white, non-Hispanic samples, I have specifications where I include interaction terms for the income, education and age variables. For example, a reasonable hypothesis is that low education is singly responsible for a portion of the mortality differences between people. This can be said of low income as well. In addition, having a low education and a low income may combine to explain a portion of the mortality differences that is greater than the sum of the individual portions. I find no evidence to believe that the interactive effects of these variables have any additional power to explain the differences in mortality experiences. Also, the widowhood effects that I find for men and women are entirely robust to these specifications.

In addition to these specifications, I open the sample to include 35 to 80 year old married individuals who are white and non-Hispanic. I do not employ the same methodology that I do in other parts of this dissertation to distinguish between marital protection and marital selection. However, in the simple model where there is only one time-dependent variable measuring when someone becomes a widow, I find the widowhood effects to be much larger. I believe this to be caused by the under-50 individuals, and when I specify the sample to 50-80 year olds, I find widowhood effects close to those that I report in Table 2.3. Because these results are not the focus of this dissertation, I do not include full listings of the findings.

Table 5.1
Characteristics of the
Married Male and Female Samples,
NLMS

Variable	Married Males		Married Females	
	Mean	Standard Deviation	Mean	Standard Deviation
Dead by the end of follow-up	0.18	0.38	0.09	0.29
Died within 5 years of survey	0.09	0.29	0.04	0.20
Widow or widower	0.07	0.27	0.21	0.40
Widow or widower (5 years)	0.03	0.19	0.11	0.32
Age: 50-59	0.54	0.50	0.57	0.49
Age: 60-70	0.46	0.50	0.43	0.49
Income < $5K	0.04	0.20	0.05	0.22
$5K <= Income < $10K	0.13	0.34	0.17	0.37
$10K <= Income < $15K	0.17	0.37	0.19	0.39
$15K <= Income < $20K	0.14	0.35	0.14	0.34
$20K <= Income < $25K	0.15	0.36	0.14	0.35
$25K <= Income < $50K	0.28	0.45	0.25	0.43
$50K <= Income	0.08	0.27	0.07	0.25
No high school	0.21	0.40	0.16	0.36
Some high School	0.16	0.37	0.16	0.37
High school graduate	0.34	0.47	0.46	0.50
Some college	0.12	0.33	0.13	0.33
College graduate	0.17	0.37	0.09	0.29
Occupation: never work, missing value, etc.	0.26	0.44	0.60	0.49
Farming	0.05	0.09	0.01	0.12
Household	< 0.01	0.01	< 0.01	0.08
Service	0.05	0.21	0.06	0.24
Laborers	0.03	0.16	< 0.01	0.06

Operatives, not Transport	0.04	0.19	< 0.01	0.05
Operatives, Equipment Operative	0.06	0.24	0.04	0.20
Craftsmen	0.17	0.37	< 0.01	0.09
Clerical	0.05	0.21	0.13	0.34
Sales	0.05	0.21	0.04	0.18
Managers	0.15	0.36	0.04	0.19
Professionals	0.11	0.31	0.06	0.23
Individuals	37,777		34,465	

Standard errors are in parenthesis. Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 5.2
Characteristics of the
Married Male and Female Samples,
NHIS/MCOD 1987-1990

Variable	Married Males		Married Females	
	Mean	Standard Deviatio n	Mean	Standard Deviatio n
Dead before by 01/01/1996	0.12	0.33	0.07	0.26
Died within 5 years of survey	0.08	0.27	0.05	0.21
Widow or widower	0.06	0.24	0.16	0.37
Widow or widower (5 years)	0.04	0.19	0.10	0.31
Age: 50-59	0.50	0.50	0.52	0.50
Age: 60-70	0.50	0.50	0.48	0.50
Income < $10K	0.05	0.21	0.06	0.23
Income $10K - $20K	0.18	0.39	0.22	0.41
Income $20K - $30K	0.20	0.40	0.22	0.41
Income $30K - $40K	0.17	0.37	0.16	0.36
Income > $40K	0.40	0.49	0.35	0.48
No High School	0.13	0.33	0.09	0.28
< High school	0.13	0.34	0.14	0.34
High school graduate	0.51	0.50	0.65	0.48
College graduate	0.23	0.42	0.13	0.34
Individuals	22,171		20,290	

Standard errors are in parenthesis. Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 5.3
Maximum Likelihood Estimates
Cox Proportional Hazard Models
NLMS

Covariate	Married Men (n=37,777) Parameter Estimate	Married Men (n=37,777) Hazard Ratio	Married Women (n=34,465) Parameter Estimate	Married Women (n=34,465) Hazard Ratio
Widow/Widower	0.274 (0.054)	1.316 (0.071)	0.179 (0.049)	1.196 (0.059)
Income < $5K	0.666 (0.083)	1.947 (0.161)	0.354 (0.111)	1.425 (0.158)
$5K <= Income < $10K	0.526 (0.074)	1.692 (0.125)	0.327 (0.098)	1.387 (0.136)
$10K <= Income < $15K	0.416 (0.072)	1.515 (0.109)	0.202 (0.098)	1.223 (0.120)
$15K <= Income < $20K	0.325 (0.074)	1.384 (0.102)	0.080 (0.102)	1.083 (0.110)
$20K <= Income < $25K	0.287 (0.073)	1.333 (0.097)	0.080 (0.102)	1.083 (0.110)
$25K <= Income < $50K	0.197 (0.069)	1.218 (0.084)	0.040 (0.096)	1.040 (0.100)
No high school	0.270 (0.052)	1.310 (0.068)	0.327 (0.085)	1.387 (0.118)
Some high School	0.303 (0.053)	1.353 (0.072)	0.256 (0.086)	1.292 (0.111)
High school graduate	0.146 (0.048)	1.157 (0.056)	0.156 (0.078)	1.168 (0.091)
Some college	0.184 (0.054)	1.203 (0.065)	0.064 (0.090)	1.066 (0.096)
Occupation: never work, missing value, etc.	0.526 (0.061)	1.693 (0.103)	0.403 (0.112)	1.496 (0.168)
Farming	-0.251 (0.086)	0.778 (0.067)	-0.311 (0.236)	0.733 (0.173)

Household	na	na	0.064	1.066
			(0.267)	(0.285)
Service	0.221	1.247	0.025	1.026
	(0.080)	(0.100)	(0.139)	(0.143)
Laborers	0.058	1.060	-0.037	0.963
	(0.100)	(0.106)	(0.351)	(0.338)
Operatives, not Transport	0.109	1.116	-0.125	0.882
	(0.091)	(0.101)	(0.512)	(0.452)
Operatives, Equipment	0.004	1.004	-0.026	0.974
Operative	(0.081)	(0.081)	(0.152)	(0.148)
Craftsmen	0.022	1.022	-0.618	0.539
	(0.067)	(0.068)	(0.351)	(0.189)
Clerical	0.202	1.224	-0.004	0.996
	(0.083)	(0.101)	(0.126)	(0.125)
Sales	0.200	1.222	-0.098	0.906
	(0.082)	(0.100)	(0.166)	(0.150)
Managers	0.089	1.093	0.106	1.112
	(0.066)	(0.072)	(0.155)	(0.172)
-2 log likelihood	129,942		63,773	

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 5.4
Maximum Likelihood Estimates, Cox Proportional Hazard Models
NHIS

Covariate	Married Men (n=22,171)		Married Women (n=20,290)	
	Paramete r Estimate	Hazard Ratio	Paramte r Estimate	Hazard Ratio
Widow/Widower	0.200 (0.088)	1.222 (0.108)	0.192 (0.082)	1.212 (0.099)
Income < $10K	0.804 (0.080)	2.236 (0.180)	0.516 (0.111)	1.676 (0.186)
$10K <= Income < $20K	0.552 (0.060)	1.738 (0.105)	0.367 (0.081)	1.444 (0.118)
$20K <= Income < $30K	0.384 (0.059)	1.47 (0.088)	0.234 (0.082)	1.265 (0.103)
$30K <= Income < $40K	0.147 (0.067)	1.159 (0.078)	0.025 (0.096)	1.026 (0.098)
No high school	0.411 (0.073)	1.509 (0.110)	0.362 (0.124)	1.437 (0.179)
Some high school	0.386 (0.072)	1.471 (0.107)	0.264 (0.118)	1.303 (0.154)
High school graduate	0.202 (0.060)	1.225 (0.073)	0.165 (0.099)	1.180 (0.117)
-2 log likelihood	39,338.83		21,978.07	

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 5.5
Maximum Likelihood Estimates of Logistic Regression
Die from Informative or Uninformative Causes
Married, White Males and Females aged 50-70
NLMS

Marginal Effects and (Standard Errors)

	Males Observations		Females Observations	
	Die by the end of the follow-up from an:		Die by the end of the follow-up from an:	
Covariates	Informative death	Uninform. Death	Informative death	Uninform. death
Income < $5K	0.031 (0.006)	0.006 (0.003)	0.005 (0.002)	-0.002 (0.002)
$5K <= Income < $10K	0.025 (0.005)	0.002 (0.002)	0.004 (0.001)	0.002 (0.002)
$10K <= Income < $15K	0.017 (0.004)	0.002 (0.002)	0.003 (0.001)	0.002 (0.002)
$15K <= Income < $20K	0.011 (0.004)	0.002 (0.002)	0.001 (0.001)	-0.001 (0.001)
$20K <= Income < $25K	0.011 (0.004)	0.002 (0.002)	0.001 (0.001)	0.002 (0.002)
$25K <= Income < $50K	0.006 (0.003)	0.001 (0.002)	< 0.001 (0.001)	-0.001 (0.001)
No high school	0.016 (0.003)	-0.001 (0.001)	0.004 (0.001)	0.002 (0.002)
Some high School	0.015 (0.003)	-0.001 (0.001)	0.003 (0.001)	0.001 (0.001)
High school graduate	0.008 (0.002)	-0.001 (0.001)	0.001 (0.001)	< 0.001 (0.001)
Some college	0.007 (0.003)	0.001 (0.001)	< 0.001 (0.001)	0.001 (0.001)

Occupation: never work, missing value, etc.	0.025 (0.005)	0.003 (0.002)	0.008 (0.002)	0.001 (0.002)
Farming	-0.008 (0.003)	-0.001 (0.002)	-0.004 (0.002)	-0.004 (0.003)
Household	na	na	0.001 (0.003)	< 0.001 (0.005)
Service	0.008 (0.004)	0.004 (0.003)	0.002 (0.001)	< 0.001 (0.002)
Laborers	0.002 (0.004)	0.004 (0.003)	-0.002 (0.004)	< 0.001 (0.006)
Operatives, not Transport	0.004 (0.004)	0.001 (0.003)	-0.002 (0.004)	-0.001 (0.008)
Operatives, Equipment Operative	-0.002 (0.003)	-0.001 (0.002)	0.003 (0.002)	-0.002 (0.002)
Craftsmen	0.002 (0.003)	-0.001 (0.002)	-0.001 (0.003)	-0.006 (0.003)
Clerical	0.011 (0.004)	0.001 (0.002)	0.002 (0.002)	-0.001 (0.002)
Sales	0.009 (0.004)	-0.001 (0.002)	0.001 (0.002)	-0.001 (0.002)
Managers	0.005 (0.003)	-0.001 (0.002)	0.002 (0.002)	0.001 (0.003)
	P-values on -2 log likelihood test statistics			
Education coefs. are all zero	< 0.0001	0.395	0.004	0.668
Income coefs. are all zero	< 0.0001	0.140	0.0003	0.033
Occupation coefs. are all zero	<0.0001	0.025	< 0.0001	0.423

Education, income and Occupation coefs. are all zero	<0.0001	0.019	< 0.0001	0.539
Mean of outcome	0.185	0.035	0.052	0.025
-2 log likelihood	30,071.31	9,960.58	14,228.16	8,565.93

+NLMS-PU

Note: The reference person is someone married to a 50-70 yr. old white woman or man, who is 50 years old or younger, and has a college degree, $40K or more in family income, and is/was employed in a professional occupation. Other covariates include dummy variables for each age 51 through 70 and a dummy for 71 and over.

Table 5.6
Maximum Likelihood Estimates of Logistic Regression,
Die from Informative or Uninformative Causes,
Married, White Males and Females aged 50-70,
1987-1990 NHIS/MCOD

Marginal Effects and (Standard Errors)

	Male Observations		Female Observations	
	Die by the end of the follow-up from an:		Die by the end of the follow-up from an:	
Covariates	Informative death	Uninformative death	Informative death	Uninformative death
No High School	0.026 (0.007)	< 0.001 (<0.001)	0.006 (0.002)	< 0.001 (0.001)
Some high school	0.014 (0.004)	< 0.001 (<0.001)	0.005 (0.002)	< 0.001 (0.001)
High school graduate	0.008 (0.002)	< 0.001 (<0.001)	0.003 (0.001)	0.001 (0.001)
<$10K family income	0.003 (0.001)	0.002 (0.001)	0.012 (0.003)	0.003 (0.002)
$10K, <$20K family income	0.010 (0.003)	< 0.001 (<0.001)	0.006 (0.002)	0.002 (0.001)
$20K, <$30K family income	0.010 (0.003)	< 0.001 (<0.001)	0.004 (0.001)	0.002 (0.001)
$30K, <$40K family income	0.002 (0.001)	< 0.001 (<0.001)	0.001 (<0.001)	0.002 (0.001)
	P-values on -2 log likelihood test statistics			
Education coefs. are all zero	< 0.0001	0.018	0.0014	0.493
Income coefs. are all zero	< 0.0001	0.053	< 0.0001	0.314
Educ. and income coefs. are all zero	<0.0001	0.002	< 0.0001	0.411
Mean of outcome	0.130	0.029	0.039	0.021
-2 log likelihood	14,282.85	5,154.88	6,625.39	4,273.40

Table 5.7
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Uninformative and Informative Causes of Death
Married Male and Female Samples, NLMS

	Married Males (n=37,777)		Married Females (n=34,465)	
Covariates	Parameter Estimate	Hazard Ratio	Parameter	Hazard
Widower due to uninformative COD	0.267 (0.093)	1.306 (0.121)	0.041 (0.124)	1.041 (0.129)
Widower due to informative COD	0.278 (0.064)	1.320 (0.084)	0.200 (0.052)	1.222 (0.064)
Income < $5K	0.666 (0.083)	1.946 (0.162)	0.353 (0.112)	1.424 (0.159)
$5K <= Income < $10K	0.526 (0.074)	1.692 (0.125)	0.326 (0.099)	1.386 (0.137)
$10K <= Income < $15K	0.415 (0.072)	1.515 (0.109)	0.201 (0.098)	1.223 (0.120)
$15K <= Income < $20K	0.325 (0.074)	1.384 (0.102)	0.079 (0.102)	1.082 (0.110)
$20K <= Income < $25K	0.287 (0.073)	1.333 (0.097)	0.079 (0.102)	1.082 (0.110)
$25K <= Income < $50K	0.197 (0.069)	1.218 (0.084)	0.039 (0.096)	1.040 (0.100)
No high school	0.270 (0.051)	1.310 (0.067)	0.327 (0.085)	1.386 (0.118)
Some high School	0.302 (0.052)	1.353 (0.070)	0.255 (0.086)	1.291 (0.111)
High school graduate	0.146 (0.048)	1.157 (0.056)	0.155 (0.078)	1.168 (0.091)
Some college	0.184 (0.054)	1.203 (0.065)	0.064 (0.090)	1.066 (0.096)
Occupation: never work, missing value, etc.	0.526 (0.061)	1.693 (0.103)	0.403 (0.112)	1.496 (0.168)
Farming	-0.251 (0.086)	0.778 (0.067)	-0.310 (0.236)	0.733 (0.173)

Household	Na	na	0.065 (0.267)	1.068 (0.285)
Service	0.220 (0.079)	1.247 (0.099)	0.024 (0.139)	1.025 (0.142)
Laborers	0.058 (0.100)	1.060 (0.106)	-0.033 (0.351)	0.968 (0.340)
Operatives, not Transport	0.109 (0.091)	1.116 (0.102)	-0.127 (0.512)	0.881 (0.451)
Operatives, Equipment Operative	0.004 (0.081)	1.004 (0.081)	-0.027 (0.152)	0.973 (0.148)
Craftsmen	0.022 (0.067)	1.022 (0.068)	-0.616 (0.351)	0.540 (0.190)
Clerical	0.202 (0.083)	1.224 (0.102)	-0.003 (0.126)	0.997 (0.126)
Sales	0.200 (0.082)	1.221 (0.100)	-0.099 (0.166)	0.906 (0.150)
Managers	0.089 (0.066)	1.093 (0.072)	0.106 (0.155)	1.111 (0.172)
Hypothesis tests on widow variables				
H_o: UCOD = ICOD	p-value = 0.9237		p-value = 0.2180	
-2 log Likelihood	129,943.04		63,772	

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 5.8
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Married Male and Female Samples,
NHIS

	Married Males (n=22,164)		Married Females (n=20,290)	
	Parameter Estimate	Hazard Ratio	Parameter	Hazard
Widow due to uninformative COD	0.235 (0.147)	1.265 (0.187)	-0.700 (0.708)	0.496 (0.351)
Widow due to informative COD	0.195 (0.108)	1.216 (0.132)	0.137 (0.089)	1.147 (0.102)
Income < $10K	0.805 (0.080)	2.237 (0.180)	0.525 (0.111)	1.691 (0.187)
$10K <= Income < $20K	0.552 (0.060)	1.738 (0.105)	0.372 (0.081)	1.451 (0.118)
$20K <= Income < $30K	0.385 (0.059)	1.470 (0.088)	0.237 (0.082)	1.268 (0.104)
$30K <= Income < $40K	0.147 (0.067)	1.159 (0.078)	0.027 (0.096)	1.027 (0.098)
No high school	0.411 (0.073)	1.509 (0.110)	0.364 (0.124)	1.440 (0.179)
Some high school	0.385 (0.072)	1.471 (0.107)	0.267 (0.118)	1.307 (0.155)
High school graduate	0.202 (0.060)	1.225 (0.073)	0.167 (0.099)	1.183 (0.118)
-2 log Likelihood	39,338.40		21,979.74	

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 5.9
Maximum Likelihood Estimates of Logistic Regression
Die from Informative or Uninformative/Unpreventable Causes
Married, White Males and Females aged 50-70
NLMS 1979-1980+

Marginal Effects and (Standard Errors)

	Males Observations		Females Observations	
	Die by the end of the follow-up from an:		Die by the end of the follow-up from an:	
Covariates	Informative death	Uninform. & Unprevent. death	Informative death	Uninform. & Unprevent. death
Income < $5K	0.037 (0.006)	0.001 (0.001)	0.006 (0.003)	< 0.001 (0.001)
$5K <= Income < $10K	0.029 (0.005)	0.001 (0.001)	0.007 (0.002)	< 0.001 (0.001)
$10K <= Income < $15K	0.020 (0.004)	-0.001 (0.001)	0.005 (0.002)	0.001 (0.001)
$15K <= Income < $20K	0.013 (0.004)	0.001 (0.001)	0.002 (0.002)	< 0.001 (0.001)
$20K <= Income < $25K	0.014 (0.004)	-0.001 (0.001)	0.002 (0.002)	< 0.001 (0.001)
$25K <= Income < $50K	0.006 (0.003)	0.001 (0.001)	< 0.001 (0.002)	< 0.001 (0.001)
No high school	0.016 (0.004)	-0.001 (0.001)	0.007 (0.002)	< 0.001 (0.001)
Some high School	0.015 (0.004)	-0.001 (0.001)	0.005 (0.002)	< 0.001 (0.001)
High school graduate	0.008 (0.003)	-0.001 (0.001)	0.003 (0.002)	< 0.001 (0.001)
Some college	0.009 (0.003)	-0.001 (0.001)	0.002 (0.002)	< 0.001 (0.001)
Occupation: never work, missing value, etc.	0.030 (0.005)	0.001 (0.001)	0.011 (0.003)	- 0.001 (0.001)
Farming	-0.009 (0.003)	-0.001 (0.001)	- 0.008 (0.003)	- 0.001 (0.001)

Household	Na	na	- 0.001 (0.005)	0.002 (0.003)
Service	0.012 (0.005)	0.001 (0.001)	0.002 (0.003)	0.001 (0.001)
Laborers	0.004 (0.005)	0.001 (0.001)	- 0.004 (0.006)	0.001 (0.003)
Operatives, not Transport	0.005 (0.005)	-0.001 (0.001)	- 0.006 (0.007)	0.004 (0.006)
Operatives, Equipment Operative	-0.002 (0.004)	-0.001 (0.001)	0.001 (0.003)	< 0.001 (0.001)
Craftsmen	0.002 (0.003)	-0.001 (0.001)	- 0.006 (0.004)	- 0.001 (0.002)
Clerical	0.011 (0.005)	0.001 (0.001)	0.001 (0.002)	< 0.001 (0.001)
Sales	0.008 (0.004)	-0.001 (0.001)	0.001 (0.003)	- 0.001 (0.001)
Managers	0.005 (0.003)	-0.001 (0.001)	0.001 (0.003)	0.002 (0.002)
	P-values on -2 log likelihood test statistics			
Education coefs. are all zero	< 0.0001	0.850	0.001	0.657
Income coefs. are all zero	< 0.0001	0.271	< 0.0001	0.578
Occupation coefs. are all zero	<0.0001	0.652	< 0.0001	0.330
Education, income and Occupation coefs. are all zero	<0.0001	0.764	< 0.0001	0.539
Mean of outcome	0.212	0.008	0.073	0.004
-2 log likelihood	32,192.89	2,965.03	18,331.39	1,893.42

+NLMS-PU

Note: The reference person is someone married to a 50-70 yr. old white woman, who is 50 years old or younger, and has a college degree, $40K or more in family income, and is/was employed in a professional occupation. Other covariates include dummy variables for each age 51 through 70 and a dummy for 71 and over.

Table 5.10
Maximum Likelihood Estimates of Logistic Regression,
Die from Informative or Uninformative/Unpreventable Causes,
Married, White Males and Females aged 50-70,
1987-1990 NHIS/MCOD

Marginal Effects and (Standard Errors)

	Male Observations		Female Observations	
	Die by the end of the follow-up from an:		Die by the end of the follow-up from an:	
Covariates	Informative death	Uninformative /Unpreventable death	Informative death	Uninformative /Unpreventable death
No High School	0.011 (0.003)	< 0.001 (<0.001)	0.006 (0.002)	< 0.001 (<0.001)
Some high school	0.012 (0.003)	< 0.001 (<0.001)	0.004 (0.002)	< 0.001 (<0.001)
High school graduate	0.004 (0.002)	< 0.001 (<0.001)	0.002 (0.001)	< 0.001 (<0.001)
<$10K family income	0.028 (0.008)	< 0.001 (<0.001)	0.016 (0.004)	< 0.001 (<0.001)
$10K, <$20K family income	0.014 (0.004)	< 0.001 (<0.001)	0.008 (0.002)	< 0.001 (<0.001)
$20K, <$30K family income	0.009 (0.003)	< 0.001 (<0.001)	0.005 (0.002)	< 0.001 (<0.001)
$30K, <$40K family income	0.004 (0.002)	< 0.001 (<0.001)	0.003 (0.002)	< 0.001 (<0.001)
Education coefs. are all zero	< 0.0001	0.408	0.012	0.818
Income coefs. are all zero	< 0.0001	0.205	< 0.0001	0.567
Educ. and income coefs. are all zero	<0.0001	0.191	<0.0001	0.798
Mean of outcome	0.152	0.007	0.059	0.003
-2 log likelihood	15,764.09	1,575.15	8,791.16	1,008.87

Appendix Table 5.11
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Uninformative/Unpreventable and Informative Causes of Death
Married Male and Female Samples,
NLMS

	Married Males (n=37,777)		Married Females (n=34,465)	
Covariates	Parameter Estimate	Hazard Ratio	Parameter	Hazard
Widower by uninformative and unpreventable COD	0.534 (0.200)	1.706 (0.341)	0.128 (0.251)	1.137 (0.285)
Widower due to informative COD	0.258 (0.056)	1.294 (0.072)	0.181 (0.050)	1.198 (0.060)
Income < $5K	0.666 (0.083)	1.947 (0.162)	0.354 (0.112)	1.425 (0.160)
$5K <= Income < $10K	0.526 (0.074)	1.693 (0.125)	0.327 (0.099)	1.387 (0.137)
$10K <= Income < $15K	0.415 (0.072)	1.514 (0.109)	0.201 (0.098)	1.223 (0.120)
$15K <= Income < $20K	0.325 (0.074)	1.384 (0.102)	0.079 (0.102)	1.083 (0.110)
$20K <= Income < $25K	0.287 (0.073)	1.332 (0.097)	0.080 (0.102)	1.083 (0.110)
$25K <= Income < $50K	0.197 (0.069)	1.217 (0.084)	0.039 (0.096)	1.040 (0.100)
No high school	0.271 (0.052)	1.311 (0.068)	0.327 (0.085)	1.387 (0.118)
Some high School	0.303 (0.053)	1.354 (0.072)	0.256 (0.086)	1.292 (0.111)
High school graduate	0.146 (0.048)	1.158 (0.056)	0.155 (0.078)	1.168 (0.091)
Some college	0.185 (0.054)	1.203 (0.065)	0.064 (0.090)	1.066 (0.096)
Occupation: never work, missing value, etc.	0.526 (0.061)	1.693 (0.103)	0.403 (0.112)	1.496 (0.168)
Farming	-0.251 (0.086)	0.778 (0.067)	-0.311 (0.236)	0.733 (0.173)

Household	na	Na	0.064 (0.267)	1.066 (0.285)
Service	0.220 (0.080)	1.247 (0.100)	0.025 (0.139)	1.025 (0.142)
Laborers	0.058 (0.100)	1.060 (0.106)	-0.037 (0.351)	0.964 (0.338)
Operatives, not Transport	0.110 (0.091)	1.116 (0.102)	-0.126 (0.512)	0.882 (0.452)
Operatives, Equipment Operative	0.004 (0.081)	1.004 (0.081)	-0.026 (0.152)	0.974 (0.148)
Craftsmen	0.022 (0.067)	1.022 (0.068)	-0.618 (0.351)	0.539 (0.189)
Clerical	0.202 (0.083)	1.224 (0.102)	-0.004 (0.126)	0.996 (0.125)
Sales	0.200 (0.082)	1.222 (0.100)	-0.099 (0.166)	0.906 (0.150)
Managers	0.089 (0.065)	1.093 (0.071)	0.106 (0.155)	1.112 (0.172)
Hypothesis tests on widow variables				
H_o: UCOD = ICOD	p-value = 0.1824		p-value = 0.8363	
-2 log Likelihood	129,941.42		63,773	

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Appendix Table 5.12
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Uninformative/Unpreventable and Informative Causes of Death
Married Male and Female Samples,
NHIS

	Married Males (n=37,777)		Married Females (n=22,290)	
Covariates	Parameter Estimate	Hazard Ratio	Parameter	Hazard
Widow due to uninformative COD	0.073 (0.379)	1.076 (0.407)	-0.486 (0.409)	0.615 (0.252)
Widow due to informative COD	0.172 (0.093)	1.188 (0.110)	-0.203 (0.084)	0.816 (0.069)
Income < $10K	0.805 (0.080)	2.239 (0.180)	0.522 (0.110)	1.687 (0.186)
$10K <= Income < $20K	0.553 (0.060)	1.739 (0.105)	0.367 (0.081)	1.444 (0.118)
$20K <= Income < $30K	0.385 (0.059)	1.47 (0.088)	0.234 (0.082)	1.264 (0.103)
$30K <= Income < $40K	0.147 (0.067)	1.159 (0.078)	0.024 (0.096)	1.025 (0.098)
No high school	0.412 (0.073)	1.51 (0.110)	0.363 (0.124)	1.438 (0.179)
Some high school	0.386 (0.072)	1.472 (0.107)	0.265 (0.118)	1.305 (0.154)
High school graduate	0.203 (0.060)	1.225 (0.073)	0.165 (0.099)	1.180 (0.117)
-2 log Likelihood	39,335.18		21,976.76	

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Illustration 5.1: Basic SAS Data Program for NLMS Data
Example for Males

```
data a;
infile 'pubfilea.dat' lrecl=65;
input @7 ageh 2.
@9 raceh 1.
@10 sexh 1.
@11 maritalh 1.
@12 hispanh 1.
@13 hhinc 1.
@14 educh 1.
@15 pobh 2.
@21 hhid $6.
@29 relationh 1.
@36 occ70_12h 2.
@46 smsah 1.
@47 deathh 1.
@48 cause1h 3.
@53 followh 4.
@57 dowh 1.
@58 hrodh 1.
@60 intervh 1.
@61 podh 1.;
if 50<=ageh<=70;
if sexh=1;
if maritalh=1;
if raceh=1;
hispanich=(hispanh<8);
if hispanich=0;
if relationh=1 or relationh=3;
c=1;

proc sort data=a;
by hhid;
proc means data=a sum noprint;
var c;
by hhid;
output out=b sum=nobs;

data b;
set b;
keep nobs hhid;

data husbands;
merge a b;
by hhid;
if nobs=1;
drop nobs;
run;

data a;
infile 'pubfilea.dat' lrecl=65;
input @7 agew 2.
@9 racew 1.
@10 sexw 1.
@11 maritalw 1.
@12 hispanw 1.
@13 hhinc 1.
@14 educw 1.
@15 pobw 2.
@21 hhid $6.
@29 relationw 1.
@36 occ70_12w 2.
@46 smsaw 1.
@47 deathw 1.
@48 cause1w 3.
@53 followw 4.
@57 doww 1.
@58 hrodw 1.
@60 intervw 1.
@61 podw 1.;
c=1;
if sexw=2;
if maritalw=1;
if relationw=1 or relationw=3;
proc sort data=a;
by hhid;

proc sort data=a;
by hhid;
proc means data=a sum noprint;
var c;
by hhid;
output out=b sum=nobs;

data b;
set b;
keep nobs hhid;

data wives;
merge a b;
by hhid;
if nobs=1;
drop nobs c;
run;

data bmen;
merge husbands(in=in1) wives;
by hhid;
if in1;
if agew=. then delete;
if hhinc=. then delete;
if educw=. then delete;
run;
```

Illustration 5.2: Basic SAS Data Program for NHIS Data Example for Females and 1989 Survey Year

```
********************************
        1989
********************************
* read in data indicating died in 1989;
options obs=max;
data mcd89;
infile 'nhis_mcd_89.dat' lrecl=285;
input @1 personid $14.
@1 houseid $12.
@15 mod $2.
@17 yod $2.
@25 status $1.
@27 icd9 $4.
@31 cause_1 $5.
@36 cause_2 $3.;
run;

* sort the data by id;
* always store id as a character;
proc sort data=mcd89;
by personid;
run;

* read in eligibility flag data;
data inelig89;
infile 'nhis_inelig_89.dat' lrecl=14;
input @1 personid $14.;
inelig=1;
run;
**************************
* sort this data;
proc sort data=inelig89;
by personid;
run;

* read in data from 1989 nhis person;
data person89;
infile '\nhis_person_89.dat' lrecl=335
recfm=f;
input @3 houseid $12.
@3 personid $14.
@3 yos $2.
@5 qos $1.
@19 wos $2.
@22 housing $2.
@25 sex $1.
@27 age $2.
@34 mob $2.
@36 yob $4.
@52 ethn $1.
@43 race $1.
@46 hispan $2.
@48 marital $1.
@53 educr $1.
@58 income $2.
@61 poverty $1.
@62 relation_t $1.
@63 relation_ref $1.
@65 fam_sz1 $2.
@67 fam_sz2 $1.
@68 fam_desc $1.
@70 health $1.
@93 ht_no_shoes $2.
@95 wt_no_shoes $3.
@108 bed_days1 $3.
@111 bed_days2 $1.
@127 shstay12_num $2.
@129 shstay12_days $3.
@137 shstay6_num $2.
@182 region $1.
@183 msa_sz $1.
@219 annual_wt $9.;

proc sort data=person89;
by personid;
run;

* merge person data and eligibility
index;
* potentially invalid merges inelig=1;
data merge891;
merge person89 inelig89;
by personid;
if inelig=1 then delete;
drop inelig;

proc sort data=merge891;
by personid;
run;

* merge multiple cause of death file;
data merge892;
merge merge891 mcd89;
by personid;
dead=status=1;
if dead=0 then do;
        yod=.;
        mod=.;
        end;
if yob ne '9999';
run;
```

Chapter 6: Appendix to Chapter 3

Section 1: Introduction

This appendix chapter has the complete tables of results for all specifications discussed in Chapter 3.

Table 6.1
Bereavement I Results
Maximum Likelihood Estimates
Cox Proportional Hazard Models

Covariate	Married Men (n=37,777) Parameter Estimate	Married Men Hazard Ratio	Married Women (n=34,465) Parameter Estimate	Married Women Hazard Ratio
Widow for 1 year or less	0.29845 (0.10580)	1.348 (0.143)	0.29727 (0.09280)	1.346 (0.125)
Widow between 1 and 3 years	0.29158 (0.08680)	1.339 (0.116)	0.11413 (0.07979)	1.121 (0.089)
Widow for more than 3 years	0.24393 (0.08372)	1.276 (0.107)	0.16829 (0.06919)	1.183 (0.082)
Income < $5K	0.66623 (0.08292)	1.947 (0.161)	0.35466 (0.11164)	1.426 (0.159)
$5K <= Income < $10K	0.52624 (0.07400)	1.693 (0.125)	0.32753 (0.09854)	1.388 (0.137)
$10K <= Income < $15K	0.41529 (0.07242)	1.515 (0.110)	0.20165 (0.09752)	1.223 (0.119)
$15K <= Income < $20K	0.32533 (0.07376)	1.384 (0.102)	0.07942 (0.10179)	1.083 (0.110)
$20K <= Income < $25K	0.28722 (0.07337)	1.333 (0.098)	0.07958 (0.10220)	1.083 (0.111)
$25K <= Income < $50K	0.19719 (0.06898)	1.218 (0.084)	0.03740 (0.09640)	1.040 (0.100)
No high school	0.27023 (0.05157)	1.310 (0.068)	0.32736 (0.08487)	1.387 (0.118)
Some high School	0.30269 (0.05259)	1.353 (0.071)	0.25589 (0.08555)	1.292 (0.111)
High school graduate	0.14618 (0.04793)	1.157 (0.055)	0.15559 (0.07784)	1.168 (0.091)
Some college	0.18459 (0.05416)	1.203 (0.065)	0.06432 (0.08965)	1.066 (0.096)
Occupation: never work, missing value, etc.	0.08886 (0.06523)	1.093 (0.073)	0.10623 (0.15490)	1.112 (0.172)

Farming	0.20004 (0.08184)	1.221 (0.100)	-0.09855 (0.16563)	0.906 (0.150)
Household			-0.00390 (0.12645)	0.996 (0.126)
Service	0.20178 (0.08319)	1.224 (0.247)	-0.61689 (0.35096)	0.540 (0.189)
Laborers	0.02153 (0.06665)	1.022 (0.068)	-0.02595 (0.15239)	0.974 (0.148)
Operatives, not Transport	0.00368 (0.08094)	1.004 (0.081)	-0.12531 (0.51222)	0.882 (0.452)
Operatives, Equipment Operative	0.10923 (0.09143)	1.115 (0.102)	-0.03703 (0.35123)	0.964 (0.339)
Craftsmen	0.05769 (0.10019)	1.059 (0.106)	0.02540 (0.13867)	1.026 (0.142)
Clerical	0.22147 (0.07952)	1.248 (0.099)	0.06462 (0.26704)	1.067 (0.285)
Sales	-0.25171 (0.08624)	0.777 (0.067)	-0.31082 (0.23574)	0.733 (0.173)
Managers	0.52602 (0.06111)	1.692 (0.103)	0.40252 (0.11179)	1.496 (0.167)

Hypothesis tests on widow variables	p-values	
H_o: < 1yr = 1-3 yrs	0.9595	0.1214
H_o: < 1yr = 3+ yrs	0.6823	0.2456
H_o: 1-3 yrs = 3+ yrs	0.6875	0.5873
H_o: < 1yr = 1-3 yrs = 3+ yrs	0.8910	0.2919
-2 log likelihood	129,942.82	63,770.94

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 6.2
Bereavement II Results
Maximum Likelihood Estimates
Cox Proportional Hazard Models

	Married Men (n=37,777)		Married Women (n=34,465)	
Covariate	Parameter Estimate	Hazard Ratio	Parameter Estimate	Hazard Ratio
Widow for 2 years or less	0.25428 (0.08063)	1.290 (0.104)	0.26472 (0.07032)	1.303 (0.092)
Widow between 2 and 4 years	0.35521 (0.09270)	1.426 (0.132)	0.02639 (0.08864)	1.027 (0.091)
Widow for more than 4 years	0.21376 (0.10245)	1.238 (0.127)	0.20030 (0.07993)	1.222 (0.098)
Income < $5K	0.66607 (0.08292)	1.947 (0.161)	0.35437 (0.11165)	1.426 (0.159)
$5K <= Income < $10K	0.52613 (0.07400)	1.693 (0.125)	0.32746 (0.09854)	1.388 (0.137)
$10K <= Income < $15K	0.41522 (0.07242)	1.515 (0.110)	0.20170 (0.09752)	1.223 (0.119)
$15K <= Income < $20K	0.32530 (0.07376)	1.384 (0.102)	0.07934 (0.10179)	1.083 (0.110)
$20K <= Income < $25K	0.28717 (0.07337)	1.333 (0.098)	0.07955 (0.10220)	1.083 (0.111)
$25K <= Income < $50K	0.19721 (0.06898)	1.218 (0.084)	0.03943 (0.09640)	1.040 (0.100)
No high school	0.27033 (0.05157)	1.310 (0.068)	0.32751 (0.08487)	1.387 (0.118)
Some high School	0.30273 (0.05259)	1.353 (0.071)	0.25604 (0.08555)	1.292 (0.111)
High school graduate	0.14630 (0.04793)	1.157 (0.055)	0.15564 (0.07783)	1.168 (0.091)
Some college	0.18467 (0.05416)	1.203 (0.065)	0.06435 (0.08965)	1.066 (0.096)
Occupation: never work, missing value, etc.	0.08886 (0.06523)	1.093 (0.071)	0.10618 (0.15490)	1.112 (0.172)

Farming	0.19998 (0.08184)	1.221 (0.100)	-0.09838 (0.16563)	0.906 (0.150)
Household			-0.00385 (0.12645)	0.996 (0.870)
Service	0.20185 (0.08319)	1.224 (0.102)	-0.61690 (0.35096)	0.540 (0.189)
Laborers	0.02145 (0.06664)	1.022 (0.068)	-0.02580 (0.15239)	0.974 (0.148)
Operatives, not Transport	0.00368 (0.08094)	1.004 (0.081)	-0.12549 (0.51222)	0.882 (0.370)
Operatives, Equipment Operative	0.10939 (0.09143)	1.115 (0.102)	-0.03712 (0.35123)	0.964 (0.339)
Craftsmen	0.05763 (0.10019)	1.059 (0.106)	0.02554 (0.13866)	1.026 (0.142)
Clerical	0.22153 (0.07952)	0.248 (0.020)	0.06458 (0.26704)	1.067 (0.285)
Sales	-0.25187 (0.08624)	0.777 (0.067)	-0.31104 (0.23574)	0.733 (0.173)
Managers	0.52606 (0.06110)	1.692 (0.103)	0.40254 (0.11179)	1.496 (0.167)

Hypothesis tests on widow variables	p-values	
H_o: < 2yr = 2-4 yrs	0.4043	0.0279
H_o: < 2yr = 4+ yrs	0.7525	0.5239
H_o: 2-4 yrs = 4+ yrs	0.2986	0.1262
H_o: < 2yr = 2-4 yrs = 4+ yrs	0.5465	0.0853
-2 log likelihood	129,941.86	63,768.30

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 6.3
Bereavement III Results
Maximum Likelihood Estimates
Cox Proportional Hazard Models

	Married Men (n=37,777)		Married Women (n=34,465)	
Covariate	Parameter Estimate	Hazard Ratio	Parameter Estimate	Hazard Ratio
Widow for 2 years or less	0.2544 (0.0806)	1.290 (0.104)	0.2643 (0.0703)	1.303 (0.091)
Widow for more than 2 years	0.2892 (0.0698)	1.335 (0.093)	0.1195 (0.0619)	1.127 (0.069)
Income < $5K	0.6660 (0.0829)	1.946 (0.161)	0.3553 (0.1116)	1.427 (0.159)
$5K <= Income < $10K	0.5261 (0.074)	1.692 (0.125)	0.3279 (0.0985)	1.388 (0.136)
$10K <= Income < $15K	0.4151 (0.0724)	1.515 (0.109)	0.2016 (0.0975)	1.223 (0.119)
$15K <= Income < $20K	0.3251 (0.0737)	1.384 (0.102)	0.0794 (0.1017)	1.083 (0.110)
$20K <= Income < $25K	0.2870 (0.0733)	1.332 (0.097)	0.0797 (0.1022)	1.083 (0.110)
$25K <= Income < $50K	0.1971 (0.0689)	1.218 (0.084)	0.0394 (0.0964)	1.040 (0.100)
No high school	0.2701 (0.0515)	1.310 (0.067)	0.3272 (0.0848)	1.387 (0.117)
Some high School	0.3025 (0.0525)	1.353 (0.071)	0.2556 (0.0855)	1.291 (0.110)
High school graduate	0.1460 (0.0479)	1.157 (0.055)	0.1552 (0.0778)	1.168 (0.090)
Some college	0.1845 (0.0541)	1.203 (0.065)	0.0641 (0.0896)	1.066 (0.095)
Occupation: never work, missing value, etc.	0.5261 (0.0611)	1.692 (0.103)	0.4023 (0.1118)	1.495 (0.167)

Farming	-0.251 (0.0862)	0.778 (0.067)	-0.311 (0.2357)	0.732 (0.172)
Household			0.0649 (0.2670)	1.067 (0.284)
Service	0.2216 (0.0795)	1.248 (0.099)	0.0257 (0.1386)	1.026 (0.142)
Laborers	0.0579 (0.1001)	1.060 (0.106)	-0.036 (0.3512)	0.964 (0.338)
Operatives, not Transport	0.1093 (0.0914)	1.116 (0.102)	-0.124 (0.5122)	0.883 (0.452)
Operatives, Equipment Operative	0.0039 (0.0809)	1.004 (0.081)	-0.026 (0.1523)	0.974 (0.148)
Craftsmen	0.0217 (0.0666)	1.022 (0.068)	-0.615 (0.3509)	0.540 (0.189)
Clerical	0.2019 (0.0831)	1.224 (0.101)	-0.003 (0.1264)	0.996 (0.125)
Sales	0.2000 (0.0818)	1.221 (0.099)	-0.098 (0.1656)	0.906 (0.150)
Managers	0.0889 (0.0652)	1.093 (0.071)	0.1061 (0.1549)	1.112 (0.172)
Hypothesis tests on widow variables		p-values		
H_o: < 2yr = 2+ yrs	0.7389		0.0989	
-2 log likelihood	129,942.94		63,770.66	

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 6.4: Bereavement UCOD/ICOD Results,
Maximum Likelihood Estimates, Cox Proportional Hazard Models

	Married Men (n=37,777)		Married Women (n=34,465)	
Covariate	Parameter Estimate	Hazard Ratio	Parameter Estimate	Hazard Ratio
Widow for 2 years or less and spouse died of UCOD	0.32995 (0.13685)	1.391 (0.190)	0.04512 (0.19042)	1.046 (0.199)
Widow for more than 2 years and spouse died of UCOD	0.21867 (0.12436)	1.244 (0.155)	0.03305 (0.16038)	1.034 (0.166)
Widow for 2 years or less and spouse died of ICOD	0.21766 (0.09870)	1.243 (0.123)	0.29973 (0.07465)	1.349 (0.101)
Widow for more than 2 years and spouse died of ICOD	0.32139 (0.08273)	1.379 (0.114)	0.13222 (0.06544)	1.141 (0.075)
Income < $5K	0.66575 (0.08293)	1.946 (0.161)	0.35477 (0.11650)	1.426 (0.166)
$5K <= Income < $10K	0.52615 (0.07400)	1.692 (0.125)	0.32704 (0.09855)	1.387 (0.137)
$10K <= Income < $15K	0.41511 (0.07243)	1.515 (0.110)	0.20107 (0.09752)	1.223 (0.119)
$15K <= Income < $20K	0.32520 (0.07376)	1.384 (0.102)	0.07918 (0.10179)	1.082 (0.110)
$20K <= Income < $25K	0.28700 (0.07337)	1.332 (0.098)	0.07915 (0.10220)	1.082 (0.111)
$25K <= Income < $50K	0.19716 (0.06897)	1.218 (0.084)	0.03901 (0.09640)	1.040 (0.100)
No high school	0.27009 (0.05157)	1.310 (0.068)	0.32653 (0.08487)	1.386 (0.118)
Some high School	0.30243 (0.05259)	1.353 (0.071)	0.25450 (0.08555)	1.290 (0.110)
High school graduate	0.14602 (0.04793)	1.157 (0.056)	0.15450 (0.07784)	1.167 (0.091)
Some college	0.18452 (0.05416)	1.203 (0.065)	0.06374 (0.08965)	1.066 (0.096)

Occupation: never work, missing value, etc.	0.08907 (0.06523)	1.093 (0.071)	0.10556 (0.15490)	1.111 (0.172)
Farming	0.20000 (0.08183)	1.221 (0.100)	-0.09936 (0.16563)	0.905 (0.150)
Household			-0.00300 (0.12645)	0.997 (0.126)
Service	0.20223 (0.08319)	1.224 (0.102)	-0.61464 (0.35097)	0.541 (0.190)
Laborers	0.02196 (0.06664)	1.022 (0.068)	-0.02682 (0.15239)	0.974 (0.148)
Operatives, not Transport	0.00390 (0.08094)	1.004 (0.081)	-0.12544 (0.51222)	0.882 (0.452)
Operatives, Equipment Operative	0.10933 (0.09143)	1.116 (0.102)	-0.03263 (0.35125)	0.968 (0.340)
Craftsmen	0.05772 (0.10019)	1.059 (0.106)	0.02532 (0.13867)	1.026 (0.142)
Clerical	0.22169 (0.07951)	1.248 (0.100)	0.06616 (0.26705)	1.068 (0.285)
Sales	-0.25145 (0.08624)	0.778 (0.067)	-0.31125 (0.23574)	0.733 (0.173)
Managers	0.52623 (0.06110)	1.693 (0.103)	0.40260 (0.11180)	1.496 (0.167)

Hypothesis tests	p-values	
< 2 yrs, H_o: UCOD = ICOD	0.503	0.208
> 2 yrs, H_o: UCOD = ICOD	0.486	0.558
UCOD, H_o: < 2yrs = 2+ yrs	0.5446	0.9610
ICOD, H_o: < 2yrs = 2+ yrs	0.4138	0.0738
-2 log likelihood	129,942.00	63,768.62

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 6.5
Education and Widowhood Results, Married Men
Maximum Likelihood Estimates, Cox Proportional Hazard Models

	Married Men (n=37,777)			
	Specification 1		Specification 2	
Covariate	Parameter Estimate	Hazard Ratio	Parameter Estimate	Hazard Ratio
Widow and more than a HS education	0.34018 (0.06396)	1.405 (0.090)	n.a.	n.a.
Widow and a HS graduate (or HS+ for Spec. 2)	0.07797 (0.12574)	1.081 (0.136)	0.28161 (0.05720)	1.325 (0.076)
Widow and not a HS graduate	0.21710 (0.14805)	1.242 (0.184)	0.22517 (0.14800)	1.253 (0.185)
Income < $5K	0.66511 (0.08292)	1.945 (0.161)	0.66632 (0.08292)	1.947 (0.161)
$5K <= Income < $10K	0.52516 (0.07400)	1.691 (0.125)	0.52623 (0.07400)	1.693 (0.125)
$10K <= Income < $15K	0.41409 (0.07243)	1.513 (0.110)	0.41515 (0.07243)	1.515 (0.110)
$15K <= Income < $20K	0.32449 (0.07376)	1.383 (0.102)	0.32507 (0.07376)	1.384 (0.102)
$20K <= Income < $25K	0.28678 (0.07337)	1.332 (0.098)	0.28707 (0.07337)	1.333 (0.098)
$25K <= Income < $50K	0.19700 (0.06898)	1.218 (0.084)	0.19715 (0.06898)	1.218 (0.084)
No high school	0.28315 (0.05203)	1.327 (0.069)	0.27153 (0.05169)	1.312 (0.068)
Some high School	0.30233 (0.05259)	1.353 (0.071)	0.30253 (0.05259)	1.353 (0.071)
High school graduate	0.14607 (0.04793)	1.157 (0.055)	0.14609 (0.04793)	1.157 (0.055)
Some college	0.18383 (0.05416)	1.202 (0.065)	0.18449 (0.05416)	1.203 (0.065)
Occupation: never work, missing value, etc.	0.08897 (0.06523)	1.093 (0.071)	0.06523 (0.08893)	1.093 (0.097)

Farming	0.20002 (0.08183)	1.221 (0.100)	0.20008 (0.08184)	1.222 (0.100)
Household				
Service	0.20176 (0.08318)	1.224 (0.102)	0.20191 (0.08319)	1.224 (0.102)
Laborers	0.02153 (0.06664)	1.022 (0.068)	0.02155 (0.06665)	1.022 (0.068)
Operatives, not Transport	0.00223 (0.08094)	1.002 (0.081)	0.00367 (0.08094)	1.004 (0.081)
Operatives, Equipment Operative	0.10798 (0.09143)	1.114 (0.102)	0.10927 (0.09143)	1.115 (0.102)
Craftsmen	0.05603 (0.10020)	1.058 (0.106)	0.05756 (0.10020)	1.059 (0.106)
Clerical	0.22155 (0.07951)	1.248 (0.100)	0.22131 (0.07912)	1.248 (0.099)
Sales	-0.25251 (0.08623)	0.777 (0.067)	-0.25171 (0.08624)	0.777 (0.067)
Managers	0.52522 (0.06110)	1.691 (0.103)	0.52607 (0.06110)	1.692 (0.103)

Hypothesis tests on widow variables	p-values	
H_o: HS+ = HS	0.0620	n.a.
H_o: HS+ = no HS	0.4437	n.a.
H_o: HS = no HS	0.4659	0.7196
H_o: HS+ = HS = no HS	0.1620	n.a.
-2 log likelihood	129,939.25	129,942.91

Other covariates include a complete set of dummy variables age in years at the time of the initial survey.

Table 6.6
Education and Widowhood Results, Married Women
Maximum Likelihood Estimates, Cox Proportional Hazard Models

	Married Women (n=34,465)			
	Specification 1		Specification 2	
Covariate	Parameter Estimate	Hazard Ratio	Parameter Estimate	Hazard Ratio
Widow and more than a HS education	0.19042 (0.05755)	1.210 (0.06963)	0.21454 (0.0522)	1.239 (0.06467)
Widow and a HS graduate (or less for Spec. 2)	0.2367 (0.10603)	1.267 (0.13434)	-0.01599 (0.11642)	0.984 (0.11455)
Widow and not a HS graduate	-0.000928 (0.14317)	0.999 (0.14302)		
Income < $5K	0.35862 (0.11165)	1.431 (0.15977)	0.36458 (0.1117)	1.440 (0.16084)
$5K <= Income < $10K	0.32704 (0.09856)	1.387 (0.13670)	0.32872 (0.09852)	1.389 (0.13684)
$10K <= Income < $15K	0.20067 (0.09755)	1.222 (0.11920)	0.20018 (0.09751)	1.222 (0.11915)
$15K <= Income < $20K	0.07874 (0.10181)	1.082 (0.11015)	0.07774 (0.10179)	1.081 (0.11003)
$20K <= Income < $25K	0.07926 (0.10221)	1.082 (0.11059)	0.07841 (0.1022)	1.082 (0.11058)
$25K <= Income < $50K	0.03923 (0.09641)	1.04 (0.10026)	0.03867 (0.0964)	1.039 (0.10015)
No high school	0.33446 (0.08736)	1.397 (0.12204)	0.33793 (0.085)	1.402 (0.11917)
Some high School	0.25508 (0.08556)	1.291 (0.11045)	0.25866 (0.08555)	1.295 (0.11078)
High school graduate	0.15531 (0.07783)	1.168 (0.09090)	0.15659 (0.07783)	1.170 (0.09106)
Some college	0.06396 (0.08965)	1.066 (0.09556)	0.06426 (0.08965)	1.066 (0.09556)
Occupation: never work, missing value, etc.	0.40293 (0.11179)	1.496 (0.16723)	0.4023 (0.11178)	1.495 (0.16711)
Farming	-0.31204 (0.23574)	0.732 (0.17256)	-0.31008 (0.23574)	0.733 (0.17279)
Household	0.06399 (0.26704)	1.066 (0.28466)	0.06611 (0.26704)	1.068 (0.28519)
Service	0.02444 (0.13866)	1.025 (0.14212)	0.02715 (0.13866)	1.028 (0.14254)

Laborers	-0.04041 (0.35124)	0.960 (0.33719)	-0.03986 (0.35123)	0.961 (0.33753)
Operatives, not Transport	-0.12074 (0.51223)	0.886 (0.45383)	-0.12166 (0.51222)	0.885 (0.45331)
Operatives, Equipment Operative	-0.02633 (0.15239)	0.974 (0.14842)	-0.02564 (0.15238)	0.975 (0.14857)
Craftsmen	-0.61924 (0.35093)	0.538 (0.18880)	-0.62004 (0.35095)	0.538 (0.18881)
Clerical	-0.00381 (0.12645)	0.996 (0.12594)	-0.00324 (0.12644)	0.997 (0.12606)
Sales	-0.09849 (0.16563)	0.906 (0.15006)	-0.10113 (0.16563)	0.904 (0.14972)
Managers	0.10513 (0.1549)	1.111 (0.17209)	0.10475 (0.1549)	1.110 (0.17193)

Hypothesis tests on widow variables	p-values	
H_o: HS+ = HS grad	0.6975	
H_o: HS+ = not HS grad	0.2110	
H_o: HS grad = not HS grad	0.1551	
H_o: HS+ = HS grad = not HS grad	0.3462	
H_o: HS+ = HS grad or less (applies to Spec. 2)		0.0602
-2 log likelihood	63,771.16	63,769.64

Other covariates include a complete set of dummy variables age in years at the time of the initial survey.

Table 6.7: Education and Widowhood, UCOD/ICOD Results
Maximum Likelihood Estimates, Cox Proportional Hazard Models

	Married Men (n=37,777)	
Covariate	Parameter Estimate	Hazard Ratio
Widow by UCOD and a HS graduate or more education	0.23204 (0.10028)	1.261 (0.126)
Widow by UCOD and not a HS graduate	0.49286 (0.23721)	1.637 (0.388)
Widow by ICOD and a HS graduate	0.30447 (0.06799)	1.356 (0.092)
Widow by ICOD and not a HS graduate	0.08595 (0.18753)	1.090 (0.204)
Income < $5K	0.66564 (0.08293)	1.946 (0.161)
$5K <= Income < $10K	0.52592 (0.07400)	1.692 (0.125)
$10K <= Income < $15K	0.41506 (0.07242)	1.514 (0.110)
$15K <= Income < $20K	0.32497 (0.07376)	1.384 (0.102)
$20K <= Income < $25K	0.28698 (0.07337)	1.332 (0.098)
$25K <= Income < $50K	0.19716 (0.06897)	1.218 (0.084)
No high school	0.27142 (0.05169)	1.353 (0.070)
Some high School	0.30226 (0.05259)	1.157 (0.061)
High school graduate	0.14590 (0.04793)	1.202 (0.058)
Some college	0.18435 (0.05416)	1.946 (0.105)
Occupation: never work, missing value, etc.	0.08898 (0.06523)	1.093 (0.071)

Farming	0.20005 (0.08183)	1.221 (0.100)
Household		
Service	0.20231 (0.08319)	1.224 (0.102)
Laborers	0.02147 (0.06664)	1.022 (0.068)
Operatives, not Transport	0.00430 (0.08094)	1.004 (0.081)
Operatives, Equipment Operative	0.10979 (0.09143)	1.116 (0.102)
Craftsmen	0.05759 (0.10020)	1.059 (0.106)
Clerical	0.22120 (0.07952)	1.248 (0.099)
Sales	-0.25143 (0.08624)	1.778 (0.153)
Managers	0.52622 (0.06110)	1.693 (0.103)

Hypothesis tests on widow variables	p-value
H_o UCOD = ICOD among HS graduates	0.5432
H_o: UCOD = ICOD among non-HS graduates	0.1752
UCOD, H_o: HS = not HS graduate	0.3095
ICOD, H_o: HS = not HS graduate	0.2704
-2 log likelihood	129,940.77

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 6.8: Education and Widowhood, UCOD/ICOD Results
Maximum Likelihood Estimates, Cox Proportional Hazard Models

	Married Women (n=34,465)	
Covariate	Parameter Estimate	Hazard Ratio
Widow by UCOD and HS+	0.17982 (0.14497)	1.197 (0.174)
Widow by UCOD and HS graduate or less education	-0.25518 (0.23151)	0.775 (0.179)
Widow by ICOD and HS+	0.26150 (0.06226)	1.299 (0.081)
Widow by ICOD and HS graduate or less education	0.09571 (0.08112)	1.100 (0.089)
Income < $5K	0.36516 (0.11169)	1.441 (0.161)
$5K <= Income < $10K	0.32941 (0.09853)	1.390 (0.137)
$10K <= Income < $15K	0.20013 (0.09751)	1.222 (0.119)
$15K <= Income < $20K	0.07680 (0.10179)	1.080 (0.110)
$20K <= Income < $25K	0.07737 (0.10220)	1.080 (0.110)
$25K <= Income < $50K	0.03745 (0.09641)	1.038 (0.100)
No high school	0.34423 (0.08519)	1.411 (0.120)
Some high School	0.26153 (0.08558)	1.299 (0.111)
High school graduate	15842 (0.07783)	1.172 (0.091)
Some college	0.06464 (0.08965)	1.067 (0.096)
Occupation: never work, missing value, etc.	0.10212 (0.15490)	1.108 (0.172)

Farming	-0.10125 (0.16563)	0.904 (0.150)
Household	-0.00279 (0.12643)	0.997 (0.126)
Service	-0.61913 (0.35096)	0.538 (0.189)
Laborers	-0.02621 (0.15238)	0.974 (0.148)
Operatives, not Transport	-0.12340 (0.51222)	0.884 (0.453)
Operatives, Equipment Operative	-0.03879 (0.35126)	0.962 (0.338)
Craftsmen	0.02564 (0.13866)	1.026 (0.142)
Clerical	0.07055 (0.26705)	1.073 (0.287)
Sales	-0.30901 (0.23574)	0.734 (0.173)
Managers	0.40154 (0.11178)	1.494 (0.600)

Hypothesis tests on widow variables	p-value
H_o UCOD = ICOD among widows with HS+	0.6057
H_o: UCOD = ICOD among widows HS grad or less	0.4834
UCOD, H_o: HS+ = HS grad or less	0.1087
ICOD, H_o: HS+ = HS grad or less	0.0870
-2 log likelihood	63,766.17

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 6.9
Income and Widowhood I Results
Maximum Likelihood Estimates, Cox Proportional Hazard Models
Married Male and Female Samples, NLMS

Covariate	Married Men (n=37,777) Parameter Estimate	Married Men (n=37,777) Hazard Ratio	Married Women (n=34,465) Parameter Estimate	Married Women (n=34,465) Hazard Ratio
Widow and Income >= $50K	0.50756 (0.30831)	1.661 (0.512)	0.70693 (0.25350)	2.028 (0.514)
Widow and $25K <=Income < $50K	0.38908 (0.14329)	1.476 (0.211)	0.06449 (0.15486)	1.067 (0.165)
Widow and Income < $25K	0.24931 (0.05882)	1.283 (0.075)	0.17461 (0.05267)	1.191 (0.208)
Income < $5K	0.67664 (0.08399)	1.967 (0.165)	0.41137 (0.11701)	1.509 (0.177)
$5K <= Income < $10K	0.53688 (0.08399)	1.711 (0.144)	0.38427 (0.10455)	1.469 (0.154)
$10K <= Income < $15K	0.42569 (0.07365)	1.531 (0.113)	0.25817 (0.10342)	1.295 (0.134)
$15K <= Income < $20K	0.33517 (0.07492)	1.398 (0.105)	0.13582 (0.10733)	1.145 (0.123)
$20K <= Income < $25K	0.29692 (0.07454)	1.346 (0.100)	0.13571 (0.10765)	1.145 (0.123)
$25K <= Income < $50K	0.20151 (0.07040)	1.223 (0.086)	0.10517 (0.10281)	1.111 (0.114)
No high school	0.27083 (0.05882)	1.311 (0.077)	0.32720 (0.08485)	1.387 (0.118)
Some high School	0.30316 (0.05259)	1.354 (0.071)	0.25603 (0.08554)	1.292 (0.111)
High school graduate	0.14677 (0.04793)	1.158 (0.056)	0.15537 (0.07782)	1.168 (0.091)
Some college	0.18510 (0.05417)	1.203 (0.065)	0.06432 (0.08964)	1.066 (0.096)
Occupation: never work, missing value, etc.	0.08859 (0.06523)	1.093 (0.071)	0.10091 (0.15492)	1.106 (0.171)

Farming	0.19957 (0.08183)	1.221 (0.100)	-0.10157 (0.16563)	0.903 (0.150)
Household			-0.00655 (0.12643)	0.993 (0.126)
Service	0.20137 (0.08319)	1.223 (0.102)	-0.62006 (0.35095)	0.538 (0.189)
Laborers	0.02103 (0.06664)	1.021 (0.068)	-0.02971 (0.15239)	0.971 (0.148)
Operatives, not Transport	0.00346 (0.08093)	1.003 (0.081)	-0.12761 (0.51221)	0.880 (0.451)
Operatives, Equipment Operative	0.10890 (0.09143)	1.115 (0.121)	-0.03882 (0.35123)	0.962 (0.338)
Craftsmen	0.05709 (0.10019)	1.059 (0.106)	0.02197 (0.13866)	1.022 (0.142)
Clerical	0.22118 (0.07951)	1.248 (0.100)	0.06207 (0.26705)	1.064 (0.284)
Sales	-0.25213 (0.08623)	0.777 (0.067)	-0.31337 (0.23573)	0.731 (0.172)
Managers	0.52556 (0.06110)	1.691 (0.103)	0.39903 (0.1180)	1.490 (0.176)

Hypothesis tests on widow variables	p-values	
H_o: HI inc = MID inc	0.4102	0.0302
H_o: HI inc = LO inc	0.7273	0.0393
H_o: MID inc = LO inc	0.3652	0.4981
H_o: HI inc = MID inc = LO inc	0.4964	0.0862
-2 log likelihood	129,941.70	63,768.96

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 6.10
Income and Widowhood II Results
Maximum Likelihood Estimates
Cox Proportional Hazard Models
NLMS

Covariate	Married Men (n=37,777) Parameter Estimate	Married Men (n=37,777) Hazard Ratio	Married Women (n=34,465) Parameter Estimate	Married Women (n=34,465) Hazard Ratio
Widow and Income > $20K	0.38983 (0.10121)	1.477 (0.149)	0.28904 (0.10003)	1.335 (0.134)
Widow and Income < $20K	0.23348 (0.06301)	1.263 (0.080)	0.14794 (0.05566)	1.159 (0.065)
Income < $5K	0.67342 (0.08311)	1.961 (0.163)	0.327238 (0.11257)	1.451 (0.163)
$5K <= Income < $10K	0.53374 (0.07422)	1.705 (0.127)	0.34488 (0.09954)	1.412 (0.141)
$10K <= Income < $15K	0.42242 (0.07264)	1.526 (0.111)	0.21727 (0.09834)	1.243 (0.122)
$15K <= Income < $20K	0.33157 (0.07392)	1.393 (0.103)	0.09361 (0.10244)	1.098 (0.112)
$20K <= Income < $25K	0.28608 (0.07338)	1.331 (0.098)	0.07581 (0.10225)	1.079 (0.110)
$25K <= Income < $50K	0.19697 (0.06898)	1.218 (0.084)	0.03805 (0.09641)	1.039 (0.100)
No high school	0.27060 (0.05157)	1.311 (0.068)	0.32795 (0.08486)	1.388 (0.118)
Some high School	0.30300 (0.05259)	1.354 (0.071)	0.25630 (0.08555)	1.292 (0.111)
High school graduate	0.14652 (0.04793)	1.158 (0.056)	0.15566 (0.07783)	1.168 (0.091)
Some college	0.18494 (0.05416)	1.203 (0.065)	0.06480 (0.08965)	1.067 (0.096)
Occupation: never work, missing value, etc.	0.08863 (0.06523)	1.093 (0.071)	0.10531 (0.15490)	1.111 (0.172)

Farming	0.19961 (0.08183)	1.221 (0.100)	-0.09953 (0.16563)	0.905 (0.150)
Household			-0.00407 (0.12645)	0.996 (0.126)
Service	0.20132 (0.08319)	1.223 (0.102)	-0.61741 (0.35095)	0.539 (0.189)
Laborers	0.02081 (0.06664)	1.021 (0.068)	-0.02783 (0.15239)	0.973 (0.148)
Operatives, not Transport	0.00278 (0.08094)	1.003 (0.081)	-0.12250 (0.51222)	0.885 (0.453)
Operatives, Equipment Operative	0.10790 (0.09144)	1.114 (0.102)	-0.03920 (0.35124)	0.962 (0.338)
Craftsmen	0.05704 (0.10019)	1.059 (0.106)	0.02404 (0.13866)	1.024 (0.142)
Clerical	0.22056 (0.07952)	1.247 (0.099)	0.06177 (0.26704)	1.064 (0.284)
Sales	-0.25246 (0.08624)	0.777 (0.067)	-0.31228 (0.23574)	0.732 (0.173)
Managers	0.52519 (0.06110)	1.691 (0.103)	0.40175 (0.11179)	1.494 (0.167)
Hypothesis test on widow variables	p-values			
H_o: HI income = LO income	0.1872		0.2118	
-2 log likelihood	129,941.33		63,771.83	

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 6.11: Income and Widowhood Results, UCOD/ICOD
Maximum Likelihood Estimates, Cox Proportional Hazard Models

	Married Men (n=37,777)		Married Women (n=34,465)	
Covariate	Parameter Estimate	Hazard Ratio	Parameter Estimate	Hazard Ratio
Widow by UCOD and Income > $20K	0.41813 (0.16174)	1.519 (0.246)	0.37327 (0.22662)	1.452 (0.329)
Widow by UCOD and Income < $20K	0.20094 (0.11272)	1.223 (0.138)	-0.07428 (0.14714)	0.928 (0.137)
Widow by ICOD and Income > $20K	0.37291 (0.12723)	1.452 (0.185)	0.27190 (0.10884)	1.312 (0.143)
Widow by ICOD and Income < $20K	0.24742 (0.07406)	1.281 (0.095)	0.17949 (0.05819)	1.197 (0.070)
Income < $5K	0.67310 (0.08311)	1.960 (0.163)	0.37226 (0.11258)	1.451 (0.163)
$5K <= Income < $10K	0.53373 (0.07422)	1.705 (0.127)	0.34472 (0.09955)	1.412 (0.141)
$10K <= Income < $15K	0.42248 (0.07264)	1.526 (0.111)	0.21761 (0.09834)	1.243 (0.122)
$15K <= Income < $20K	0.33165 (0.07392)	1.393 (0.103)	0.09440 (0.10244)	1.099 (0.113)
$20K <= Income < $25K	0.28613 (0.07338)	1.331 (0.098)	0.07639 (0.10225)	1.079 (0.110)
$25K <= Income < $50K	0.19701 (0.06898)	1.218 (0.084)	0.03849 (0.09642)	1.039 (0.100)
No high school	0.27059 (0.05157)	1.311 (0.068)	0.32713 (0.08488)	1.390 (0.118)
Some high School	0.30293 (0.05259)	1.354 (0.071)	0.25727 (0.08557)	1.293 (0.111)
High school graduate	0.14647 (0.04793)	1.158 (0.056)	0.15669 (0.07785)	1.170 (0.091)
Some college	0.18501 (0.05416)	1.203 (0.065)	0.06558 (0.08966)	1.068 (0.096)

Occupation: never work, missing value, etc.	0.08861 (0.06523)	1.093 (0.071)	0.10471 (0.15490)	1.110 (0.172)
Farming	0.19963 (0.08184)	1.221 (0.100)	-0.10124 (0.16263)	0.904 (0.147)
Household			-0.00379 (0.12644)	0.996 (0.126)
Service	0.20160 (0.08319)	1.223 (0.102)	-0.61446 (0.35096)	0.541 (0.190)
Laborers	0.02100 (0.06664)	1.021 (0.068)	-0.02981 (0.15239)	0.971 (0.148)
Operatives, not Transport	0.00279 (0.08094)	1.003 (0.081)	-0.12474 (0.51222)	0.883 (0.452)
Operatives, Equipment Operative	0.10819 (0.09144)	1.114 (0.102)	-0.03492 (0.35125)	0.966 (0.339)
Craftsmen	0.05677 (0.10019)	1.058 (0.106)	0.02257 (0.13866)	1.023 (0.142)
Clerical	0.22050 (0.07952)	1.247 (0.099)	0.06027 (0.26705)	1.062 (0.284)
Sales	-0.25241 (0.08624)	0.777 (0.067)	-0.31210 (0.23574)	0.732 (0.173)
Managers	0.52529 (0.06110)	1.691 (0.103)	0.40151 (0.11178)	1.494 (0.176)

Hypothesis tests on widow variables	p-values	
H_o: UCOD = ICOD among HI inc widows	0.8239	0.6806
UCOD, H_o: UCOD = ICOD among LO inc widows	0.7255	0.0976
UCOD, H_o: HI inc = LO inc	0.2698	0.0968
ICOD, H_o: HI inc = LO inc	0.3922	0.4491
-2 log likelihood	129,941.16	63,768.73

Other covariates include a complete set of dummy variables for age in years at the time of the initial survey.

Table 6.12
Maximum Likelihood Estimates, Cox Proportional Hazard Models
High, Above Average, Below Average, and Low Probability of Widowhood

	Males (N = 26,839)			
	25%/50%/75% splits		10%/50%/90% splits	
	Parameter	Hazard Ratio	Parameter	Hazard Ratio
Widow/Hi Prob.	0.2287 (0.0848)	1.257 (0.106)	0.2927 (0.0915)	1.340 (0.122)
Widow/MidHi Prob.	0.1090 (0.0863)	1.115 (0.096)	0.1380 (0.0836)	1.148 (0.096)
Widow/MidLo Prob.	0.1852 (0.0929)	1.203 (0.111)	0.1726 (0.0904)	1.188 (0.107)
Widow/Lo Prob.	0.1654 (0.1010)	1.180 (0.119)	0.2364 (0.1270)	1.267 (0.160)
Act. Lim Stat.	0.4969 (0.0420)	1.644 (0.069)	0.4968 (0.042)	1.643 (0.069)
Self-reported Health Fair or Poor	0.6849 (0.0435)	1.984 (0.086)	0.6874 (0.0435)	1.989 (0.086)
Short Stay	0.4783 (0.0423)	1.613 (0.068)	0.4789 (0.0423)	1.614 (0.068)
Obese	0.0547 (0.0516)	1.056 (0.054)	0.0566 (0.0516)	1.058 (0.054)
Overweight	-0.238 (0.0390)	0.788 (0.030)	-0.239 (0.0390)	0.787 (0.030)
Underweight	0.4540 (0.0738)	1.575 (0.116)	0.4510 (0.0738)	1.570 (0.115)
Income Low 1	0.2329 (0.0742)	1.262 (0.093)	0.2248 (0.0750)	1.252 (0.093)
Income Low 2	0.2843 (0.0580)	1.329 (0.077)	0.2770 (0.0589)	1.319 (0.077)
Income Middle	0.2256 (0.0567)	1.253 (0.071)	0.2138 (0.0578)	1.238 (0.071)
Income High 2	0.0532 (0.0631)	1.055 (0.066)	0.0452 (0.0638)	1.046 (0.066)
No High School	0.1967 (0.0666)	1.217 (0.081)	0.2032 (0.0667)	1.225 (0.081)
High School	0.2818 (0.0670)	1.326 (0.088)	0.2817 (0.0670)	1.325 (0.088)
High School Grad	0.1621 (0.0561)	1.176 (0.066)	0.1617 (0.0561)	1.176 (0.066)

H_o: Hi prob = Above-average prob	0.007	0.003
H_o: Hi prob = below-average prob	0.445	0.063
H_o: Hi prob = low prob	0.364	0.612
H_o: Above-average prob = below-average prob	0.165	0.464
H_o: Above-average prob = low prob	0.403	0.328
H_o: Below-average prob = low prob	0.770	0.505
-2 log-likelihood	47,254.11	47,251.87

Table 6.13
Maximum Likelihood Estimates, Cox Proportional Hazard Models
High, Above Average, Below Average, and Low Probability of Widowhood

	Females (N = 21,502)			
	25%/50%/75% splits		10%/50%/90% splits	
	Parameter	Hazard Ratio	Parameter	Hazard Ratio
Widow/Hi Prob.	0.1922 (0.0890)	1.212 (0.107)	0.1703 (0.1048)	1.186 (0.124)
Widow/MidHi Prob.	0.0273 (0.0919)	1.028 (0.094)	0.1046 (0.0853)	1.110 (0.094)
Widow/MidLo Prob.	0.0522 (0.1034)	1.054 (0.109)	0.0859 (0.1006)	1.090 (0.109)
Widow/Lo Prob.	0.1127 (0.1283)	1.119 (0.143)	0.1059 (0.1704)	1.112 (0.189)
Act. Lim Stat	0.5450 (0.0612)	1.725 (0.105)	0.5439 (0.0612)	1.723 (0.105)
Self-reported Health Fair or Poor	0.7713 (0.0645)	2.163 (0.139)	0.7600 (0.0644)	2.138 (0.137)
Short Hospital Stay	0.7267 (0.0638)	2.068 (0.132)	0.7261 (0.0638)	2.067 (0.131)
Obese	0.1695 (0.0795)	1.185 (0.094)	0.1692 (0.0795)	1.184 (0.094)
Overweight	-0.176 (0.0634)	0.838 (0.053)	-0.176 (0.0634)	0.838 (0.053)
Underweight	0.4625 (0.0995)	1.588 (0.158)	0.4599 (0.0995)	1.584 (0.157)
Income Low 1	0.1285 (0.1138)	1.137 (0.129)	0.1119 (0.1131)	1.118 (0.126)
Income Low 2	0.1587 (0.0862)	1.172 (0.101)	0.1496 (0.0853)	1.161 (0.099)
Income Middle	0.1658 (0.0841)	1.180 (0.099)	0.1644 (0.0832)	1.179 (0.098)
Income High 2	0.0012 (0.0954)	1.001 (0.095)	0.0072 (0.0948)	1.007 (0.095)
No High School	0.0987 (0.1223)	1.104 (0.135)	0.0919 (0.1222)	1.096 (0.133)
High School	0.0954 (0.1173)	1.100 (0.129)	0.0918 (0.1173)	1.096 (0.128)

High School Grad	0.1184 (0.0988)	1.126 (0.111)	0.1193 (0.0988)	1.127 (0.111)
H_o: Hi prob = Above-average prob	0.026		0.437	
H_o: Hi prob = below-average prob	0.110		0.416	
H_o: Hi prob = low prob	0.498		0.711	
H_o: Above-average prob = below-average prob	0.760		0.799	
H_o: Above-average prob = low prob	0.434		0.993	
H_o: Below-average prob = low prob	0.567		0.892	
-2 log-likelihood	22,468.62		22,491.65	

Glossary

Assortative Mating: a theory of marriage that suggests spouses match to one another based on certain criteria.

Informative Cause of Death (ICOD): a cause of death with an incidence that is explained by one or several socio-economic status characteristics.

Marriage Protection: a theory suggesting that marriage provides benefits to the partners that, among other things, extends life past the point which could otherwise be attained by remaining single.

Marriage Selection: a theory suggesting that the same behaviors and characteristics that spouses use to choose one another also explains why they live longer than those who never get married.

Positive Assortative Mating: a theory of marriage that suggests men and women with equal endowments of certain criteria are more likely to marry than men and women of disparate endowments (e.g. often religion and other family backgrounds play a large role in the matching of two individuals).

Refined-UCOD: an uninformative cause of death that is also classified as unpreventable by Phelan et al (2004).

Uninformative Cause of Death (UCOD): a cause of death with an incidence that is not eplained by socio-economic status.

Widowhood Effect: the observed increase in mortality that married people experience after the loss of their spouse.

Bibliography

Allison PD. 1995. Survival Analysis Using the SAS®: A Practical Guide North Carolina: SAS Institute.

Annandale, E & Hunt K (editors)., 2000. Gender Inequalities in Health. Philadelphia: Open University Press.

Anson O. 1989. Marital status and women's health revisited: the importance of a proximate adult. Journal of Marriage and the Family 51: 185-194.

Arber S and Ginn J. 1993. Gender and inequalitites in health in later life. Social Science Medicine 36(1): 33-46.

Bassuk SS, Berkman LF, and Amick BC. 2002. Socioeconomic Status and Mortality among the Elderly: Findings from Four US Communities. Ameican Journal of Epidemiology 155: 520-533

Becker GS. 1973. A theory of marriage: part I. Journal of Political Economy 81(4): 813-846.

Becker GS. 1974. A theory of marriage: part II. Journal of Political Economy 82(2.2): S11-S26.

Berkman LF. 2000. Social support, social networks, social cohesion and health. Soc Work Health Care 31(2): 3-14.

Berkman LF. 2000. Which influences cognitive function: living alone or being alone? Lancet 355: 1291-1292.

Berkman LF. 1995. The role of social relations in health promotion. Psychosocial Medicine 57(3): 245-254.

Berkman LF, Glass T, Brissette I, and Seeman TE. 2000. From social integration to health: Durkheim in the new millennium. Social Science and Medicine 51(6): 843-857.

Berkman LF and Kawachi I. 2000. Social Epidemiology. New York: Oxford University Press.

Berkman LF and Syme SL. 1979. Social networks, host resistance, and mortality: a nine-year follow-up study of Alameda County residents. American Journal of Epidemiology 109(2): 186-204.

Blazer DG. 1982. Social support and mortality in an elderly community population. American Journal of Epidemiology 115(5): 684-694.

Caspi A and Herbener ES. 1993. Marital assortment and phenotypic convergence---longitudinal evidence. Social Biology, 40(1-2): 48-60.

Christakis NA. 2004. Social networks and collateral health effects have been ignored in medical care and clinical trials, but need to be studied. British Medical Journal 329: 184-185.

Christakis NA and Iwashyna TJ. 2003. The health impact of health care on families: a matched cohort study of hospice use by decedents and mortality outcomes in surviving, widowed spouses. Social Science and Medicine 57: 465-75.

Cohen, Sheldon, et al. 1997. Social ties and susceptibility to the common cold. Journal of the American Medical Association 277(24): 1940-44.

Cutler, David M. 2004. Your Money or Your Life: Strong Medicine for America's Health Care System. New York: Oxford Books.

Cox PR and Ford JR. 1964. The mortality of widows shortly after widowhood. Lancet. 46: 163-164.

Cox R. 1972. Value of objective examinations. Nature. 237(5357): 489-492.

Deaton AS and Paxson CH. 1998. Aging and Inequality in Income and Health. American Economic Review 88: 248-53.

Duncan GJ, Wilkerson B, and England P. 2003. Cleaning Up Their Act: The Impact of Marriage and Cohabitation on Licit and Illicit Drug Use. Northwestern Working Paper WP-03-02

Durkheim E. 1951 (1897). Suicide: A Study in Sociology, translated by Spaulding JA and Simpson G. New York: The Free Press of Glenco.

Farr W. 1858. The influence of marriage on the mortality of the French people. In: Transactions of the National Association for the Promotion of Social Sciences, edited by Hastings GW. London: Parker and Son, p. 504-513.

Gardner J and Oswald A. 2004. How is mortality affected by money, marriage, and stress? Journal of Health Economics 23(6): 1181-1207.

Ginther DK and Pollak RA. 2004. Family structure and children's educational outcomes: blended families, stylized facts, and descriptive regressions Demography 41(4): 671-696.

Goldman N. 1994. Social factors and health: the causation-selection issue revisited. Proceedings of the National Academy of Sciences USA 91(4), 1251-1255.

Goldman N. 1993. Marriage selection and mortality patterns: inferences and fallacies. Demography 30(2): 189-208.

Gove WR. 1973. Sex, marital status and mortality. American Journal of Sociology 79: 45-67.

Gove WR, Hughes MM, and Style CB. 1983. Does marriage have positive effects on the psychological well-being of the individual? Journal of Health and Social Behavior 24: 122-131.

Harrison GA, Gibson JB, and Hiorns RW. 1976. Assortative marriage for psychometric, personality and anthropometric variation in a group of Oxfordshire villages. Journal of Biosocial Science 8(2): 145-153.

Helsing K, Szklo M, and Comstock G. 1981. Factors associated with mortality after widowhood. American Journal of Public Health 71: 802-809.

Herbener CA. 1993. Marital assortment and phenotypic convergence---longitudinal evidence. Social Biology 40(1-2): 48-60.

House JS, Robbins C, and Metzner HL. 1982. The association of social relationships and activities with mortality: prospective evidence from the Tecumseh Community Health Study. American Journal of Epidemiology 116(1): 123-140.

Hu Y and Goldman N. 1990. Mortality differentials by marital status: an international comparison. Demography 27(2): 233-250.

Hurd M, McFadden D, and Merrill A. 1999. Predictors of Mortality Among the Elderly. NBER Working Papers 7440.

Iwashyna TJ and Christakis NA. 2003. Marriage, widowhood, and health-care use. Social Science and Medicine 57(11): 2137-2147.

Johnson RC, DeFries JC, Wilson JR, McClearn GE, Vandenberg SG, Ashton GC, Mi MP, and Rashad MN. 1976. Assortative Marriage for Specific Cognitive Abilities in Two Ethnic Groups. Human Biology 48: 343-352.

Kalbfleisch J and Prentice R. 1980. The Statistical Analysis of Failure Time Data New York: Wiley.

Kaprio J, Koskenvuo M, and Rita H. 1987. Mortality after bereavement: a prospective study of 95,647 widowed persons. American Journal of Public Health 77(3): 283-287.

Kisker EE and Goldman N. 1987. Perils of single life and benefits of marriage. Social Biology 34(3-4): 135-152.

Kitagawa EM and Hauser PM. 1973. Differential mortality in the United States: A study in socioeconomic epidemiology. Cambridge: Harvard University Press.

Kleinbaum DG and Klein M. 2005. Survival Analysis: A Self-Learning Text, Second Edition. NY: Springer Science and Business Media, NY.

Kobrin, Francis E, and Hendershot G. 1977. Do family ties reduce mortality? Evidence from the United States, 1966-68. Journal of Marriage and the Family 39: 737-745.

Korenman S, Goldman N, Fu H. 1997. Misclassification bias in estimates of bereavement effects. American Journal of Epidemiology 145: 11(1997), 995-1002.

Korenman S and Neumark D. 1991. Does marriage really make men more productive? Journal of Human Resources 26 (2): 282-307.

Kremer M. 1997. How much does sorting increase inequality? Quarterly Journal of Economics 112(1): 115-139.

Laub JH, Nagin DS, and Sampson RJ. 1998. Trajectories of change in criminal offending: good marriages and the desistance process. American Sociological Review 63(2): 225-238.

Lichtenstein P, Gatz M, and Berg S. 1998. A twin study of mortality after spousal bereavement. Psychological Medicine 28: 635-643.

Lillard LA and Panis CWA. 1996. Marital status and mortality: the role of health. Demography 33(3): 313-327.

Lillard L and Waite L. 1995. Til' death do us part: marital disruption and mortality. American Journal of Sociology 100(5): 1131-1156.

Luoma JB, Pearson JL. 2002. Suicide and marital status in the United States, 1991-1996: is widowhood a risk factor? American Journal of Public Health 92(9): 1518-1522.

Manor O and Eisenbach Z. 2003. Mortality after spousal loss: are there socio-demographic differences? Social Science and Medicine 56(2): 405-413.

Manor O, Eisenbach Z, Israeli A, and Friedlander Y. 2000. Mortality differentials among women: the Israel longitudinal mortality study. Social Science and Medicine 51(8): 1175-1188.

Martikainen P and Valkonen T. 1996. Mortality after the death of a spouse: rates and causes of death in a large Finnish cohort. American Journal of Public Health 86: 1087-1093.

Martikainen P and Valkonen T. 1998. Do education and income buffer the effects of death of spouse on mortality. Epidemiology 9(5): 530-534.

Mascie-Taylor CG and Gibson JB. 1979. A biological survey of a Cambridge suburb: assortative marriage for IQ and personality traits. Annals of Human Biology 6(1):1-16.

McGinnis JM and Foege WH. 1993. Actual causes of death in the United States. JAMA 270(18): 2207-2212.

Mendes de Leon CF, Kasl SV, and Jacobs S. 1993. Widowhood and mortality risk in a community sample of the elderly---a prospective-study. Journal of Clinical Epidemiology 46(6): 519-527.

Mergenhagen PM, Lee BA, and Gove WR. 1985. Till death do us part: recent changes in the relationship between marital status and mortality. Sociology and Social Research 70: 53-56.

Mineau GP, Smith KR, and Bean LL. 2002. Historical trends of survival among widows and widowers. Social Science and Medicine 54: 245-254.

Montoya RM and Horton RS. 2004. On the importance of cognitive evaluation as a determinant of interpersonal attraction. Journal of Personality and Social Psychology 86(5): 696-712.

Murray JE. 2000. Marital protection and marital selection: evidence from a historical-prospective sample of American men. Demography 37(4): 511-521.

National Center for Health Statistics. 1995. Monthly Vital Statistics Report. Vol. 43(9).

National Center for Health Statistics. 2005. http://www.cdc.gov/nchs/. US Department of Health and Human Services.

Painter G and Levine DI. 2000. Family structure and youths' outcomes---which correlations are causal? Journal of Human Resources 35(3): 524-549.

Phelan JC, Link BG, Diez-Roux A, Kawachi I, and Levin B. 2004. "Fundamental causes" of social inequalities in mortality: a test of the theory. Journal of Health and Social Behavior 45(3): 265-285.

Putnam RD. 2000. Bowling alone: the collapse and revival of American community. New York: Simon & Schuster.

Rahman O. 1993. Excess mortality for the unmarried in rural Bangladesh. International Journal Epidemiology 22(3): 445-456.

Riessman CK and Gerstel N. 1985. Marital dissolution and health: do males or females have greater risk? Social Science and Medicine 20: 627-635.

Rogers RG. 1995. Marriage, sex and mortality. Journal of Marriage and the Family. 57(2): 515-526.

Rogot E, Sorlie PD, Johnson NJ, and Schmitt C. 1992. A mortality study of 1.3 million persons by demographic, social, and economic factors: 1979-1985 Followup. Bethesda, MD: National Institutes of Health.

Ross CD, Mirowsky J, and Goldsteen K. 1990. The impact of the family on health: decade in review. Journal of Marriage and the Family 52: 1059-1078.

Rosenbloom CA and Whittington FJ. 1993. The effects of bereavement on eating behaviors and nutrient intakes in elderly widowed persons. Journal of Gerontology: Social Sciences 48(4): S223-S229.

Schaefer C, Quesenberry CP Jr, and Wi S. 1995. Mortality following conjugal bereavement and the effects of a shared environment. American Journal of Epidemiology 141(12): 1142-1152.

Scheerer A and Brandt V. 2001. Interviews with widows following fatal farming incidents. Journal of Agricultural Safety and Health 7(2): 75-87.

Schoeni RF. 1995.Marital status and earnings in developed countries. Journal of Population Economics 8(4): 351-359.

Seeman TE, Kaplan GA, Knudsen L, Cohen R, and Guralnik J. 1987. Social network ties and mortality among the elderly in the Alameda County Study.
American Journal of Epidemiology 126(4): 714-723.

Smith KR and Waitzman NJ. 1994. Double jeopardy: interaction effects of marital and poverty status on the risk of mortality. Demography 31: 487-507.

Smith KR and Zick CD. 1994. Linked lives, dependent demise? Survival analysis of husbands and wives. Demography 31: 81-89.

Sorlie PD, Backland E, and Keller JB. 1995. U.S. Mortality by economic, demographic and social characteristics: The National Longitudinal Mortality Study. American Journal of Public Health. 85:949-56.

Spuhler JN. 1968. Assortative mating with respect to physical characteristics. Eugenics Quarterly 15 (2): 128-140.

Stack S and Eshleman JR. 1998. Marital status and happiness: a 17-nation study. Journal of Marriage and the Family 60(2): 527-536.

Steenland K, Henley J, and Thun M. 2002. All-cause and cause-specific death rates by educational status for two million people in two American Cancer Society cohorts, 1959-1996. American Journal of Epidemiology 156: 11-21.

Tcheng-Laroche F and Prince R. 1983. Separated and divorced women compared with married controls: selected life satisfaction, stress, and health indices from a community survey. Social Science and Medicine 17: 95-105.

Trovato F. 1991. Sex, marital status, and suicide in Canada: 1951-1981. Sociological Perspectives 34(4): 427-445.

Vandenburg SG. 1972. Assortive mating, or who marries whom? Behavior Genetics 2(2-3): 127-157.

Waldron H, Hughes ME, and Brooks TL. 1996. Marriage protection and marriage selection--prospective evidence for reciprocal effects of marital status and health. Social Science and Medicine 43(1): 113-123.

Waite LJ and Gallagher M. 2000. The Case for Marriage: Why Married People Are Happier, Healthier, and Better Off Financially. New York: Broadway Books, 2000.

Wittstein IS, et al. 2005. Neorohumoral features of myocardial studding due to sudden emotional stress. New England Journal of Medicine 352(6):539-548.

Zuckerman DM, Kasl SV, and Ostfeld AM. 1984. Psychosocial predictors of mortality among the elderly poor. The role of religion, well-being, and social contacts. American Journal of Epidemiology 119(3): 410-423.