Early Life Conditions, Marital Status, and Mortality

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Abstract

It is well-known that early life conditions as well as marital status affect health and mortality later in life. In this paper we analyze the interplay between these determinants of high-age mortality. First, we study the impact of economic conditions early in life on the individual rate of getting married. Secondly, we examine the protective effect of marriage and, in particular, to what extent this protective effect depends on conditions early in life. The results shed light on the use of marriage as a compensatory device in case of adverse early-life conditions. We use business cycle conditions in early years of life as an exogenous indicator of early-life conditions. The endogeneity of marriage calls for a simultaneous analysis that allows for selectivity on unobservables. We use individual data records from Dutch registers of birth, marriage and death certificates, covering an exceptionally long observation window from 1815-2000. These are merged with historical data on macro-economic and health indicators. The semi-parametric empirical analysis applies the timing-of-events approach in which bivariate duration models with unobserved heterogeneity and causal effects are estimated. It turns out that conditions around birth as well as around the school ages are important for marital status and mortality. The results are strikingly different across gender. Men on average enjoy a protective effect of marriage on mortality, and this effect increases with age. Women born in economic booms gain from marriage during childbearing ages, but women born in recessions suffer a substantial negative effect on life expectancy during these years.

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JEL codes: I12, J14, E32, N33, N13, C41.

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1 Introduction

Recently, a number of economic and epidemiological studies have drawn attention to the role of conditions early in life on health and mortality later in life. This work supports theories that poor socioeconomic status and the consequent poor nutrition and greater exposure to diseases in utero and during childhood are associated with increased vulnerability to a whole range of health problems later on in life (see for e.g. Case, Fertig and Paxson, 2003, Doblhammer, 2004, and Van den Berg, Lindeboom and Portrait, 2006).

A different body of literature has established the presence of a statistical association between marital status and mortality (Ebrahim et.al, 1995). In particular, the lower mortality of married individuals seems to have become a well-established fact (for e.g. see Hu and Goldman, 1990, Lillard and Panis, 1996). Married men seem to have lower susceptibility to health problems like cardiovascular diseases and consequently higher life expectancy (Phillips et.al, 2006). It is by now also well-accepted that part of the association between marital status and the mortality rate is causal (see Lillard and Panis, 1996). However, several studies also find support for what is called the '*selection effect*' hypothesis (e.g. Van Poppel, 1999).

In this paper we analyze the interplay between early-life conditions and marital status as determinants of high-age mortality. First, we study the impact of economic conditions early in life on the individual rate of getting married. Secondly, we examine the protective effect of marriage and, in particular, to what extent this protective effect depends on conditions early in life. The results shed light on the use of marriage as a compensatory device in case of adverse early-life conditions. First, individuals born in adverse conditions may have an incentive to marry earlier, so that they benefit sooner from a protective effect. Secondly, for individuals born in adverse conditions, the per-period protective effect of marriage may be larger. More in general, the results shed light on the extent to which the effect of early life conditions on mortality later in life is channeled through the marital status.

The empirical analysis uses exogenous determinants of individual economic conditions early in life. In particular, we use business cycle conditions in early years of life as an exogenous indicator of early-life conditions. The endogeneity of marriage calls for a simultaneous analysis that allows for selectivity on unobservables. We use individual data records from Dutch registers of birth, marriage and death certificates, covering an exceptionally long observation window from 1815-2000. These are merged with historical data on macro-economic and health indicators. The semi-parametric empirical analysis applies the timing-of-events approach in which bivariate duration models with unobserved heterogeneity and causal effects are estimated.

Before we outline the approach in the paper in more detail, we discuss some more literature on marital status and mortality. To aid future discussion, we start by describing the two possible mechanisms linking marital status with mortality. According to the 'selection hypothesis', there are a range of factors like age, health, social background, income, occupation, education and race that might affect marriage as well as mortality. Better health, for instance, of married persons is a consequence of the selection of 'healthy' persons into and 'unhealthy' individuals out of marriage. For instance, older works like Luback, 1872 and Turksma, 1898 emphasize the direct role of mental or physical handicap and religious restrictions in limiting person's social status to being single. Latter-day studies propose other indirect selection processes in which factors like job security (Frinking and Van Poppel, 1979 and Van Solinge and Van Poppel, 1995), high social background, high income, and education (Gardner and Oswald, 2004) increase one's marriage prospects and also favourably affect the individual's survival. Any such positive selection into marriage would then overstate the effect of marriage on mortality.

However a large amount of medical and demographic literature finds that marriage in itself could have the so called '*protection effect*' against mortality (see for eg.Johnson, Backlund, Sorlie and Loveless, 2000, Lund, Holstein and Osler, 2004, Gardner and Oswald, 2004 and Murrey, 2000). Marriage by means of lower psychological stress and more favorable societal attitudes could earn a married person higher social support (van Poppel, 2001). More directly, marriage could encourage healthier lifestyle (lower consumption of alcohol or smoking etc.), discourage risk taking behavior, provide support to the married person during ill health and finally may increase material well being owing to economies of scale and specialization within the household (Gardner and Oswald, 2004).

In the next subsection, we provide a more detailed overview of the existing literature on the subject from the fields of medicine, demography and economics.

1.1 Some literature on the determinants of marriage and the determinants of mortality

Socioeconomic factors like parental education, social class, occupation, education, income etc. and demographic factors like race are notably some of those that seem to greatly influence major events like marriage and even mortality. Exclusion of any factor that affects mortality as well as marriage from the estimation of the impact of marriage on mortality would lead to a spurious correlation between these two events. Therefore, any attempt to establish the correlation between marriage and mortality, and the underlying mechanisms should identify and include the factors that affect both occurrences. Different areas of research have emphasized on different realms of an individual's life in pursuit of these intervening factors.

Past studies of factors determining an individual's exit into marriage, have focussed on current conditions influencing a person's nuptiality decision. An individual's education level, contemporaneous labour market conditions and marriage market tightness are some of these. Boonstra, 1998 distinguishes between illiterates, first generation literates and second generation literates. Using a data set from Eindhoven, The Netherlands he shows that there is a steady decline in age of marriage as one moves from the first to the last of these three groups. The authors notes a strong correlation between literacy level and social class with illiteracy being lot more prevalent amongst the lower social classes. The results of this study then imply that lower social classes would on an average exhibit a higher marriage age than members of higher social classes. However, numerous studies on educational attainment of an individual find a strong positive effect of parental education and social background on a child's academic achievement. This therefore implies that any conclusive study on determinants of an individual's exit into marriage needs to not only consider current individual characteristics but also should control for the social background that the individual is born into.

Other studies have looked at labour and marriage market conditions as determinants of marriage rates. Blau, Kahn and Waldfogel, 2000 find that better female labour markets, worse female marriage markets and worse male labour markets imply lower marriage rates. Since, labour market conditions are strongly affected by on-going macro-economic conditions the latter can be used as a good proxy for the former. Moreover this would be particularly advantageous as, for any given individual these economy wide macro-conditions are clearly exogenous and would rule out any endogeneity issues. Marriage market tightness on the other hand should not be interpreted solely as a current situation. Marriage markets depend on cohort sizes of men and women within certain suitable age intervals. These are more likely to be determined by economic conditions affecting fertility decisions of parents prior to the birth of these individuals.

Coming to factors that could influence both matrimony and mortality literature points to *health* as the culminating factor that could influence an individuals entry into matrimony as well as mortality. The association between health and mortality is obvious. Unhealthy individuals are more susceptible to death and this might be particularly so in case of long-term illnesses. There is little ambiguity about the direction of causality between health and mortality and mortality in fact can be viewed as an extreme health outcome. However, the relationship between health and marriage, the operating mechanisms and the direction of causality, are less clear. As mentioned earlier, numerous studies have debated between the protection effect and the selection effect of marriage. If there indeed is a protection effect of marriage, then unhealthy people have an incentive to marry early. This would imply 'adverse selection' into marriage. But if in fact there is positive selection of healthy individuals into marriage, then this casts doubt over the hypothesis of the 'protective effect' of marriage.

Focussing on current health conditions, Fu and Goldman, 1994, in a study linking health with marriage find no direct explanatory power of current health conditions on exit into marriage. They however find that poor adult health conditions and unhealthy lifestyles like obesity, short stature, alcoholism, substance abuse etc., that result from poor socioeconomic background, adversely affect a person's probability of finding a marriage partner.

Murray, 2000 goes further to study the link between 'adult' health status, marriage and longevity. The author finds that while 'adult' health and marriage both are hypothesized to affect longevity, these two factors work independently of each other. Even after controlling for 'adult' health, marriage in itself appears to induce lower mortality and the author finds evidence for both a selection as well as protection effect of marriage. Murray convincingly argues the necessity and usefulness of longitudinal data covering long periods of peoples lives to empirically study the nuptiality-mortality relationship. Any conclusive work would require information from time of marriage till time of death for sufficient number of people, an interval that could span decades. Murray uses one such rare historical sample of male Amherst University, Massachusetts students born between 1832-1839 and for whom amongst other things information about height, weight, education, occupation, marriage and mortality is available. Although this data allows an improvement in some ways over past studies that used short risk periods (e.g. Lillard and Panis, 1996. Discussed briefly later) of mortality or measures of morbidity rather than mortality, the data and consequently the study suffers from certain problems. Firstly, given that the data is from the late 19th and early 20th century the sample of only male university students is not very representative of the average American person at that time. Moreover, the individuals in the sample are observed only from the age of 20 years and then 'adult' health is defined in terms of the height and weight measured at this age when these students entered university. However, several medical studies argue that height, weight and body mass of adults are determined by intrauterine and childhood conditions (see for e.g. Power, Li, Manor and Davey, 2003). Furthermore, poor childhood conditions like smoking or alcohol consumption during pregnancy by the mother, poor nutrition due to socioeconomic conditions etc. can have long term consequences like increased risk of metabolic and cardiovascular illness later in life, despite catch up growth during childhood years (Hack, Schluchter, Cartar, Rahman, Cuttler and Borawski, 2003).

In an earlier study Lillard and Panis, 1996, estimate the correlation between adult health status and marriage using a self-reported measure of health (measured on a scale of 1- being poor health to 5-being excellent health) and find evidence of 'adverse selection' into marriage i.e. unhealthier men are more likely to marry soon in an attempt to gain the 'protective effects' of marriage. After controlling for health status however, they find a much larger positive selection into marriage indicating a positive correlation between unobserved factors affecting both health and exit into marriage. This implies an endogeneity of the event of marriage owing to the correlation in individual unobserved heterogeneities of marriage and mortality requiring the joint modelling of health, marriage and mortality. Although they find evidence for higher mortality of never-married people compared to married people in their data set, they are unable to explain these differences on the basis of their general measure of health. The authors note, that the answers to these mortality differences could lie in the information about early life of the individuals. But since their data only provides information about the persons at 12 years of age and beyond they are unable to provide more insight. The study also, once again, just uses a sample of men and therefore only provides a partial glimpse into the matter.

Medical literature supports the role of early health conditions in life on health, marriage and mortality later in life. Phillips et.al, 2001, propose that its prenatal growth that provides this link between marital status and mortality. Using a Finnish data set on male births, the authors note that marriage rates are positively correlated to birth conditions like weight, height, head circumference, gestational age along with more conventionally acknowledged factors like mothers age at birth and parents social background. Additional controls for adult life, like height and weight at 15 years of age and social class, income and age of the individual herself, leaves their results unaffected. The authors hypothesize, without proof, that fetal conditions may affect an individual's personality, socialization, sexuality and emotional responses in later life, consequently affecting their marital status which eventually (in addition to other factors) affects mortality.

In a study commenting on Phillips et.al, Vågerö and Modin (2002) using a Swedish longitudinal panel covering individuals from birth to death, find no evidence in favour of prenatal conditions providing the link between the effect of marital status and mortality. Using birth weight for gestational age as a measure of fetal growth, the authors find no differences in mortality between ever married and never married women before and after adjusting for prenatal conditions once socioeconomic background (like marital status of mother, social class at birth etc.) and adult conditions (like occupation, education and income) have been controlled for. For men, while married men are less likely to suffer from heart diseases and stroke than unmarried men, the risk ratios remain unaffected when social factors at birth were adjusted for and adult conditions continue to have a substantial effect. The study provides no information on the empirical methods used, but the authors conclude by saying that they find no evidence for early health status in life being the factor explaining differences in mortality across different marital statuses.

These studies provide insight into what factors need to be accounted for when trying to disentangle the relationship between the seemingly endogenous event of marriage and the exogenous event of mortality. Despite the differences in approach, all fields of literature on the subject point to health as a crucial factor that might affect these two major events in a person's life. In turn the question arises, what are the determinants of adult health status? As mentioned above, the medical literature has looked into the contributions of intrauterine and childhood health conditions as one such determinant while economic and demographic literature has mentioned some socioeconomic factors like parents occupation and education. The literature acknowledges the necessity of lifetime longitudinal data covering an individual's life from birth to death, in order to provide any conclusive evidence on the nature of correlation between marriage and mortality. In absence of such data, past studies have had to focus on the intervening roles of factors like health in the relationship between marriage and death, while health itself appears to be determined by "initial conditions".

In our paper we use exogenous, cyclical macroeconomic conditions in early life and marital status as determinants of mortality, taking into account the potential endogeneity of the event of marriage itself. We base this approach on recent literature on mortality, which establishes the vital role of early conditions in life on mortality in later life (Van den Berg, Lindeboom and Portrait, 2006), and we combine this approach to the so-called Timing-of-Events approach for the analysis of the effect of a potentially endogenous event in time on the moment at which another event occurs (Abbring and Van den Berg, 2003). Given that mortality is an extreme, negative health outcome any factor influencing mortality would influence health throughout life. Therefore any study of the impact of conditions earliest in life, on later events like marriage and mortality would provide fundamental understanding of what really determines these events. This in turn would provide insight into what could potentially be the underlying workings of the correlation between the two. We consider both men and women, and we rely strictly on register data for all information on explanatory variables.

2 The Data

2.1 *Individual Records*

The Historical Sample of the Netherlands (HSN) is created by merging individual data from Dutch registers of birth, marriage and death certificates. It includes a random sample of 13,718 individuals born in one of the three provinces of Utrecht, Friesland or Zeeland[2] between 1812-1922. The end of the observation window is December 31, 1999. It records key events in an individual's life- birth, marriage and death- and also includes information on occupation of parents, gender and geographical location.

Individual lifetime durations are noted in days and if the individual is still alive at the end of 1999, the date of death is not observed. Therefore, for the purpose of this study we restrict ourselves to individuals born before 1902. Migration out of the regions of birth does not pose a problem as the data also provides dates of deaths of migrants. For some individuals born before 1902, dates of death are not available. The lifetime durations of these individuals are right censored at their last day of observation- i.e. at birth or at marriage. Right censoring is less and less frequent for later cohorts - date of death is not observed for as much as 21% of the 1812-1821 cohort but is missing for only 6% of the later cohorts. All observations that are right censored at time of birth (i.e. at age 0) are dropped as they don't contribute any further information. As the legal age of marriage at the time was 16 years and the people who died before this age cannot contribute to the likelihood of marriage, these people have been excluded as well. Missing values of explanatory variables lead to an additional loss of observations from the sample. The final sample used for the study includes 5593 individuals.

The original data registers do not contain any variable that provides information about the long-run economic status of the individual or his/her family. Families however, could use their long-run economic status to insure against shocks, for instance by means of accumulated assets, and this could be used to ensure proper nutrition and provision of healthy environment to infants even in times of adverse economic conditions and epidemics. Such insurance would then, affect the sensitivity of marriage prospects and mortality later in life to unexpected macro-economic down turns during childhood. We therefore want to derive and include in our study some indicator of such a long-run family economic position from the available variables. For this we adopt the idea of 'social class' of the individual or that of his/her family, developed in Van den Berg, Lindeboom and López (2006). The concept of social class is operationalised by creating a hierarchal index, using the father's occupation at the birth of the individual of interest. The social class index uses Van Tulder

[2]At the time, the Netherlands had 11 provinces. The three provinces included here were jointly rather representative of the Netherlands in terms of economic activity. Patterns of aggregate mortality rates in our data are similar to those observed in national rates.

(1962)'s mapping from occupation into a six-layer (1 being the lowest and 6 the highest) hierarchical scale. Table 1 provides the original general descriptions of the 6 levels with examples of occupations that were relatively common in the nineteenth century.

In selecting explanatory variables for individual marriage and mortality, we restrict attention to characteristics that are realized at birth as opposed to those acquired later in life, for the reason that the latter may be endogenous or confounded. Following existing literature marriage however, is included as an explanatory variable for mortality and we check for the endogeneity of this event. The place of residence at birth is included as a binary choice urbanization indicator which takes a value of 1 if the person is born in a city and 0 otherwise.

For the purpose of the analysis we distinguish between 3 types of people. The first group consists of people who never marry during their lifetime and therefore no marriage date is observed for them. The second group comprises of individuals for whom marriage as well as death dates are recorded and finally those in the third category who are not observed after their marriage and therefore whose death dates are missing. Table 2(a), 2(b), 2(c) and 2(d) provide sample statistics. Table 2(a) first briefly presents the sizes of the 3 groups and then compositions in terms of social class and gender. Table 2(b), 2(c) and 2(d) give further details for these 3 groups of people, once again by social class and gender for the duration of marriage and mortality where ever observed. The striking aspect of these figures is relatively late age of marriage for both men and women and particularly so for the higher social classes. This latter observation contradicts earlier studies (for e.g. Boonstra, 1998) that find relatively later marriages for lower social classes instead. However, in light of high costs of the formalities of marriage, stress on financial stability prior to starting a family and use of delayed marriages as a method of fertility control, which are some of the reasons proposed by demographic historians for the relatively late marriages in 19th and early 20th Century western Europe, later marriages for higher social classes seem more plausible

2.2 A brief overview of demographic and cultural changes in late 19th and early 20th Century Netherlands

The late 19th and the early 20th century witnessed a gradual demographic and cultural transition in most western European societies, including the Netherlands. Demographic historians note 3 stages in the evolution of family life, largely as a result of scientific progress and economic changes. The first stage pre-dates the industrial revolution and exhibits was is referred to as the 'agrarian-craftsmen' pattern of family formation. Right from the middle ages till the second quarter of the 19th Century a large proportion of the countries population lived in a rural society with the sib acting as an important legal body. Socioeconomic life revolved around the joint household where the eldest son alone inherited the family farm or business and was therefore in the financial position to marry. Younger children had to work for subsistence as labour on these household farms, owned by their older sibling, and were unable to support families themselves. This system discouraged early marriage and often marriage at all of a large proportion of family members in order to avoid growing families having to share the limited household farm income. Although the system was quite successful in maintaining undivided family farms generation after generation, it deprived a large section of the adult population of a normal family life (Petersen, 1960).

Scientific progress at the end of the 19th century led to artificial fertilizers and increased fertility of land allowed division of family farms into smaller viable units. Reclamation of arable land additionally helped support larger number of farming households. Increase in income and freedom allowed many of the previously deprived individuals to seek partners and start families. This change in farm ownerships was accompanied by an *embourgeoisement* of land owners that transformed them from traditional peasants to modern farmers. These modern farming households, moved away from the traditional system of having full time farm workers that lived on the farm and were supported by the farm owner. Instead there arose a large group of landless proletariat, who lived in nearby rural communities and were hired during the day as farm helps by the land owners. Independent living and increased social opportunities in rural communities helped break down institutional and moral inhibitions to procreation implicit in the old system. More and earlier marriages was a natural consequence.

Rising industrialization from 1870's onwards, provided further opportunities for impoverished rural masses looking to escape from dying rural occupations like peat cutting, fishing etc. High demand for low skilled workers in urban factories led to widespread immigration into growing cities. Emergence of a broad, middle class led to what is called a 'modern' family life. High costs and low standards of living for the working class in urban areas accompanied by a renewed sense of parental responsibility led to fewer and later marriages. The average age of marriage rose again.

This demographic and cultural change was more stark for the lower sections of society. Upper classes witnessed little change in their socioeconomic life over this period of time. Male members of higher society enjoyed their social freedom and often married to further consolidate their socioeconomic status by means of a bond of marriage between two affluent families. This often led to later and fewer marriages for upper class men. For women on the other hand social class differences were less obvious. All women at a certain age were expected to marry irrespective of their social class and historical records note a societal contempt for unmarried women beyond the age of 30 (van Poppel, 1992). Such societal pressures on women to marry were probably lower in the cities. Greater professional (and therefore economic) independence of women in urban areas allowed them to marry later. In the rural society, on the other hand, social status of women was linked to that of their parents. They usually worked only at home or as help in other households. They lacked economic independence and added to household prestige by marrying 'as well' as possible.

Changing demographic patterns, owing to the transformation of a poor agricultural society into a rich one with a large service sector, were also associated with declining mortality rates. To start with, urban areas had highest rates of infant and adult mortality mostly owing to poor urban health facilities and lack of segregation of sewage from drinking water. Cities were the hub of epidemic outbreaks with size of the settlement being positively correlated to mortality rates. Rising congestion in expanding cities resulted in a number of severe epidemics with high death tolls between 1830-1875. The cholera epidemics of 1848-49 and 1866-67 and the small pox epidemic of 1870-72 each wiped out about 0.7% of the population. Medical advances (from the beginning of the 19th century), decline in the virulence of certain diseases (e.g. transformation of scarlet fever from a frequently fatal illness to a relatively trivial complaint (Petersen, 1960)), improvements in the environments (1850 onwards) and active control of tuberculosis are some of the important factors that eventually helped curb high mortality rates.

2.3 Data on macro-economic conditions, business cycles, and historical events

Following the approach of Van den Berg, Lindeboom and Portrait (2006) we merge the individual data records with external information. Most importantly, we use historical time-series data on annual GNP over the observation window. Our choice for GNP instead of the more commonly used GDP is driven by the need for mutually consistent observations for as many years as possible. Since GNP is unavailable for the years 1812-1814, we discard these years, and so the study will focus on individuals who were born in and after 1815. Figure 1 plots the log annual real per capita GNP over the interval in which the sample members are born. Annual real per capita GNP over the interval in which the sample members are born. Annual real per capita GNP is measured in 1,000 Euros with 1995 as a base year. Clearly, in addition to the upward trend, there are many cyclical fluctuations. Jacobs and Smits (2001) provide a detailed analysis of GDP movements in the Netherlands in the 19th Century. Years with low and negative growth are observed more frequently than in the 20th century. The GDP fluctuations are strongly correlated to the business cycles in the United Kingdom and the United States.

Ideally one would like to compare cohorts born in booms to those born in recessions with otherwise identical circumstances throughout life. This is not feasible due to the steady secular improvements in life conditions over time. In practice one may compare a cohort born in a boom to the cohort born in the subsequent recession, because the latter benefit from secular developments, so that a decrease of expected lifetimes can be attributed to the cyclical effect. More in general, one may relate the mortality rate to the state of the business cycle early in life. To proceed one therefore needs to assign a value of a cyclical indicator to each year. Most results below are based on a trend/cycle decomposition of log annual real per capital GNP using the Hodrick-Prescott filter with smoothing parameter 500. The values of the cyclical terms are very robust with respect to the actual decomposition method and smoothing parameter, and so are the resulting intervals within which the terms are positive or negative. We are therefore in the fortunate position that booms and recessions are clearly identifiable in the data. Figure 1 displays the cycle and trend as functions of calendar time. Since the cyclical term (or indicator) will be our main explanatory variable, it is useful to know its distribution over time. Figure 2 provides a historgram where the cyclical term values are grouped in intervals of length 0.02. Below we occasionally round-off the value of the cyclical term to a binary outcome.

We also use external information on the incidence of epidemics and war because these cause pronounced spikes in the mortality rates. World War II (1940-45) has been the only war and occupation on Dutch soil since Napoleon. It included the famine of unprecedented severity of the winter on 1944/45, where mortality rates peaked because of malnutrition (Jewish genocide victims were excluded from the data). There are no reliable macro-economic statistics for the World War II period, so we represent it by a separate dummy variable.

The price to be paid for the fact that the observation window is of unprecedented size concerns the absence of a number of variables that are often used in the mortality literature but that are unobserved in the 19th century records. Notably, we do not observed the individual's cause of death, adult health status and aggregate amounts of health expenditures and numbers of medical innovations.

3 Data analysis

Certain factors need to be taken into account for our study. Firstly, given the small sample size of 5593 individuals, its impossible to compare outcomes from two consecutive years by gender and social class. Therefore, following Van den Berg, Lindeboom and Portrait (2006) we aggregate rows of successive years into "boom" and "recession" periods. This allows semi-parametric comparison of the average lifetimes in a cohort born in a single boom to those in the cohort born in the subsequent recession. However, it needs to be borne in mind that such a comparison allows individuals in the recession to benefit from secular improvements. Secondly, we also note that the booms and recessions should not include any epidemics and should also be long enough to have reasonable sample sizes. Third, the sharp and persistent increase in GNP and life expectancy after 1881 could make comparisons difficult and therefore we ignore the period after this year.

Other important factors that might influence our study of marriage and mortality concern the changes in the composition of the population in-flow by sex and social class particularly over time and as a function of the cyclical economic fluctuations in the macro-economy. In these cases fertility responses to changes in contemporaneous macroeconomic conditions might influence the available pool of potential marriage partners as well as the total number of individuals 'at risk' of marriage or mortality at any point in time. We check for the existence of any such phenomena in ninteenth century Netherlands using national time series of birth rates by gender[3]. However, using a simple regression of total births on the cyclical component of the GNP series, first in the year of birth and then separately in the year prior to birth, we find no significant correlations[4]. Thus, we find little evidence of such endogenous fertility. To give a closer look at the availability of potential marriage partners we consider sex-ratios over time and find that these remained pretty stable in the Netherlands at the time. Furthermore, regressing sex-ratios on cyclical component of GNP series we find no significant correlation at age 0 or at age 16[5]. The information on ages of grooms and brides is only available for the province of Utrecht. Using this subset of the data, we find that the age difference between the groom and the bride is approximately normally distributed with the mean close to 2 years and a standard deviation of 5.84 years. Although on an average the bride was younger than the groom, in light of this distribution the researcher is forced to make some assumptions about what comprises the potential pool of marriage partners. Considering the ratio of men to 2 year younger women, we find that this ratio also shows only little variation overtime. Finally, these findings continue to hold while studying the role of social class in determining marriage and mortality. Van den Berg, Lindeboom and Lopez, (2006) find no significant effects of cyclical components of the business cycle at birth on the over-all cohort size or the cohort size by social class.

A major disadvantage of comparing durations until marriage and death across cohorts

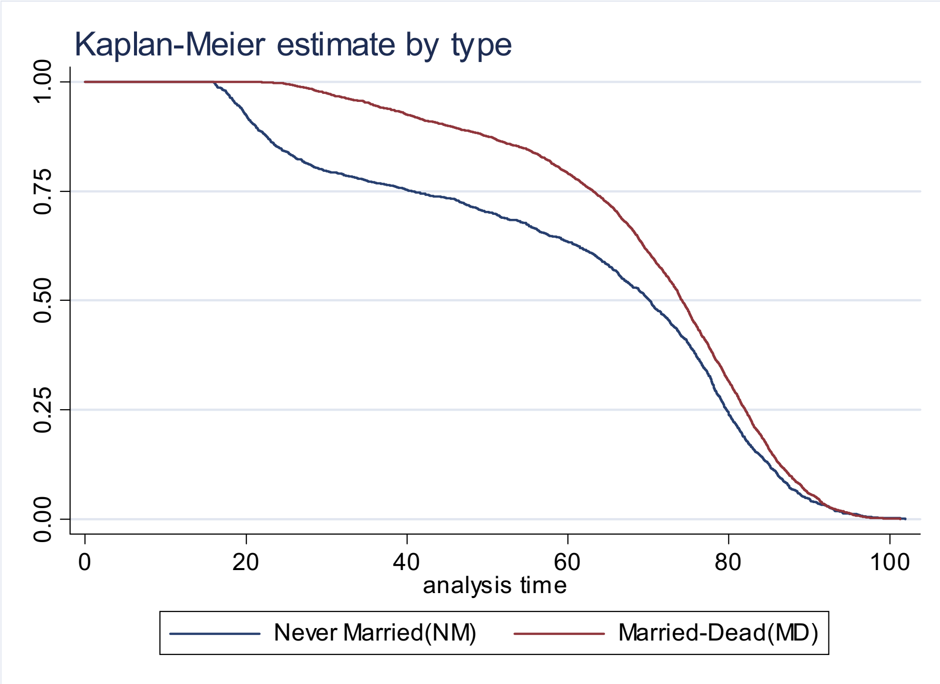
[3] Obtained for the whole of Netherlands from the Human Mortality Database (www.mortality.org).

[4] P-values of 0.37 and 0.84 respectively.

[5] p-value of 0.13 and 0.33 respectively.

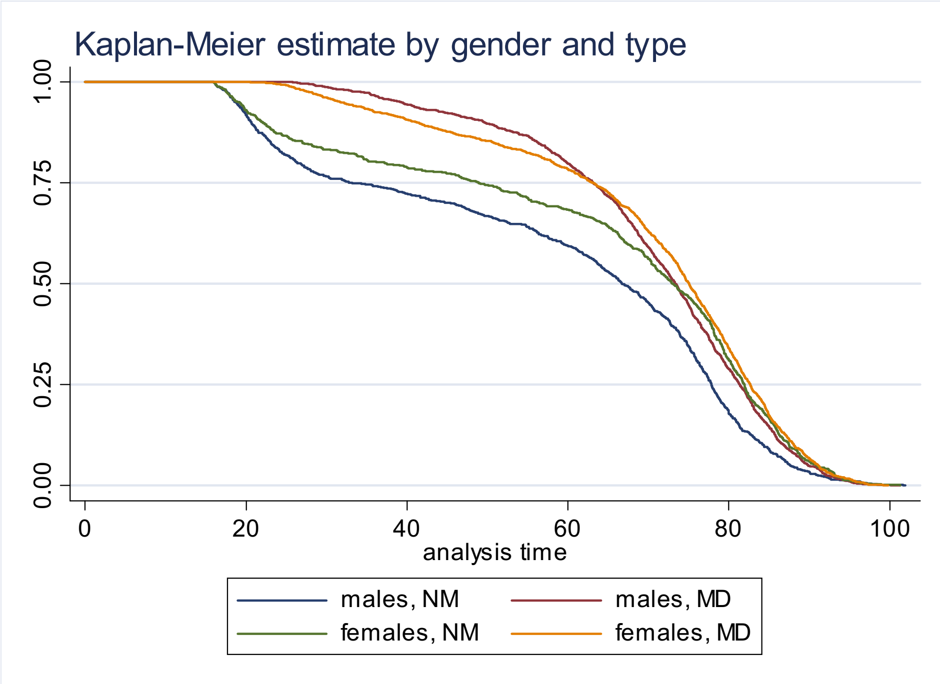
is that one ignores the cyclical patterns in the macro-economy that continue throughout the childhood years of an individual. A person who is born in bad times is likely to experience good times during some childhood years, and vice versa, just because good and bad times succeed each other with an average frequency of a few years. This leads to the possibility of what literature refers to as 'catch up growth'. This refers to the situation where favorable socioeconomic and environmental conditions in years after birth help mitigate the adverse effects of exposure to poor conditions in utero or at birth. But as mentioned earlier in section 1.1, several studies (for instance: Hack et.al., 2003) have shown that long-run affects of poor conditions early in life continue to persist later in life. To proceed, in the following sections, we estimate duration models where the individual marriage and mortality rates are allowed to depend on conditions at birth and on conditions during childhood. The estimation of these models exploits the variation in the timing of the stages of the business cycle across individuals, to disentangle the long-run effects of conditions at birth and during childhood. This results in parameter estimates of the effect of cyclical macroeconomic conditions at birth on the events of marriage and mortality later in life, given the conditions during childhood years following birth. Survival analysis also controls for individual characteristics. These advantages however come at a price - functional form model assumptions are required in order to proceed with the duration analysis.

In our study we attempt to shed light on the impact of early conditions in life as a determinant of health, on marriage and then disentangle the effect of both early conditions and marriage on mortality later in life. As preliminary analysis we would like to check for any support for the protective or selection effect hypothesis of marriage on mortality in our data. In Graph 1 we present the Kaplan Meier survival functions for married and never married individuals. This estimator provides the probability of survival in the current state beyond any given time for the sample.



Graph 1. Kaplan Meier survival functions of never married and married people.

From this graph we can see, that like previous studies, our sample also shows a visible difference in the survival probabilities of married and unmarried persons at any given age. Past research however, has found a protective effect of marriage only for men. Consequently and in part due to data limitations, recent studies (for e.g. Murray, 2000 and Lillard and Panis, 1996) have therefore used samples of men only to study effects of marriage on mortality and role of factors like health that might jointly effect both. So it becomes important to separate gender effects on mortality differences across marital status, as seen in Graph 1. Graphical analysis of our data set, does not provide complete support to earlier works that altogether rule out some effect of marriage on mortality for women as well. Graph 2 shows Kaplan Meier survival functions for married and never married, men and women separately. From this graph we can see that the probability of surviving at each age is not only higher for married men as opposed to unmarried men but the same also holds true amongst women. Although the difference appears to be larger for men, this preliminary analysis encourages a closer look at differences in mortality amongst women as well.



Graph 2. Kaplan Meier survival functions of never married and married men and women

4 Empirical Methodology

In our empirical analysis we estimate the impact of early macro-economic conditions in life, jointly on the hazards of marriage as well as death in an attempt to disentangle the impact of early conditions in life and marital status on the hazard of mortality. As discussed in section 1 above, marriage and mortality can be interdependent in two ways - via the selection effect and through the causal effect. Both marriage and mortality of an individual are likely to depend on the same or highly correlated set of personal characteristics (like health) of the person. Selection effect in the joint model of these two events can then arise due to the correlation between individual specific characteristics that might influence the hazard of marriage and those that effect mortality. In the presence of unobserved heterogeneities amongst individuals these correlations can lead to a spurious relation between the duration until marriage and the duration until death.

In our estimation we take care of this problem of potentially correlated unobserved heterogeneities by simultaneous modelling of the transition into mortality and marriage hazard using a bivariate duration model. Since we have single spell data for marriage and mortality is a one time occurrence for the we adopt the more flexible 'timing-of-events' approach developed in Abbring & Van den Berg (2003). The authors show that the causal effect can be identified even with single spell data without any parametric assumptions or exclusion restrictions. In this section we describe the implementation of this approach to our study of marriage and mortality.

4.1 Timing-of-Events Method: Bivariate Duration Analysis

In our model the variables of interest are the duration until marriage, denoted by a continuous and non-negative random variable T_m and the duration up to death, T_d. We assume that all individual differences in the joint distribution of these two processes is conditional on calender time τ, other socioeconomic and demographic factors x, current macro-economic conditions $z(\tau)$, trend components and cyclical indicators $z_{tr}(\tau - t + i)$ and $z_c(\tau - t + i)$ of macro-economic conditions in earlier years of life ($i \in \{0, ..., t-1\}$), various interaction terms and the unobserved characteristics 'v'. We assume x to include time constant covariates and v to be independent of x. Let t_m be the moment at which an individual gets married and the indicator function $I(t_m < t)$ is used to denote whether an individual is married or not.

Since in our data we do not observe transitions out of marriage over an individual's lifetime we assume that marriage has a permanent multiplicative effect on the transition rate. Moreover, in our basic model this effect is equal for all types of individuals and throughout life.

The hazard of mortality at any time t, conditional on τ, x, $z(\tau)$, $z_{tr}(\tau-t+i)$, $z_c(\tau-t+i)$ and t_m is denoted by $\theta_d(t, x, z(\tau), z_{tr}(\tau - t + i), z_c(\tau - t + i)) = \theta_d(t, x(t), v_{d,} t_m)$ where $i \in \{0, ..., t-1\}$ and is assumed to have the Mixed Proportional Hazard (MPH) specification

$$\theta_d(t, x(t), v_{d,} t_m) = \lambda_d(t) \exp(x'(t)\beta_d + \delta I(t_m < t) + v_d) \quad (1)$$

in which $\lambda_d(t)$ represents the time (in our case age) dependence of this function and is same for all individuals in the sample. The second argument of the hazard rate $x(t)$ includes linear parametric functions of socioeconomic factors, as well as time varying explanatory variables. The first group includes time constant socioeconomic characteristics at birth like social class, literacy of father, degree of urbanization of place of residence at birth (x) etc. The second subset of $x(t)$ incorporates macro-economic information on contemporaneous economic conditions ($z(\tau)$) and cyclical and trend components of the GNP series $z_{tr}(\tau-t+i)$ and $z_c(\tau-t+i)$ obtained using Hodrick-Prescott decomposition method. affecting exit into marriage or mortality. For $z(\tau)$ we take log annual real per capita GNP at t, as well as dummy variables for years with epidemics and World War II[6].

We note that since the focus is on studying the impact of marriage on mortality we only consider mortality after the age at which marriage becomes feasible i.e. the legal age of marriage of 16 years. But then we need to include information about the conditions prevailing in years of early childhood (1-5 years of age), leading right up to 16 years (i.e. ages between 6-12 and 13-15 years). The cyclical component $z_c(\tau-t+i)$ is used to calculate cyclical indicators that are used to include this information on economic conditions in the year of birth, childhood and adolescence. These are summarized using 4 dummies. A binary boom/ recession dummy is used to record a favorable/ adverse period of the business cycle in the year of birth. 3 additional indicators of average cyclical macro-economic conditions during the age intervals of 1-5, 6-12 and 13-15 years are also included by means of dummies for whether or not the averages of the cyclical element of the GNP series is positive or negative between these ages.

The trend component $z_{tr}(\tau - t + i)$ of the GNP series in the years of birth and childhood, obtained from the Hodrick-Prescott decomposition, captures the secular long-run effects. It is empirically difficult to distinguish the effects of these trend components from the effects of current log GNP $z(\tau)$, due to multicollinearity. Both these variables are almost always increasing over time, and at the individual level the latter can be captured relatively well by the sum of the former and an increasing function of age. We therefore mostly omit the trend component from the model specification. For similar reasons calendar time τ are also left out. However, we include in our analysis the cyclical and trend components of the contemporaneous GNP series in order to control for any correlation between cyclical conditions in early and later years of life. This would automatically take into account any possibility of compensatory gains that favorable economic conditions during adulthood might offer after having faced adverse cyclical conditions during childhood. Furthermore, contemporaneous cyclical conditions in the macro-economy are an indicator of current employment opportunities. Therefore inclusion of the cyclical component of the GNP would additionally control for the impact of on-going employment conditions on the 'marriageability' of the individual. The trend component of the series captures all secular effects from birth to the current age.

Therefore, the coefficients on the 3 indicators of early life conditions along with that on the dummy of marital status (included using the indicator $I(t_m < t)$) are the variables

[6] This takes care of the fact that GNP series is missing for the years of World War II.

of interest.

The conditional density function of $t_d|x(t), v_{d,}t_m$ can be written as:

$$f_d(t_d|x(t), v_{d,}t_m) = \theta_d(t_d|x(t), v_{d,}t_m) \exp(-\int_0^{t_d} \theta_d(z|x(t), v_{d,}t_m)dz \tag{2}$$

For an individual of age t years who is still unmarried, the marriage hazard at t conditional on observed and unobserved characteristics $x(t)$ and v_m is denoted by $\theta_m(t|x(t), v_m)$ and is also assumed to have the MPH specifications given by,

$$\theta_m(t|x(t), v_m) = \lambda_m(t) \exp(x'(t)\beta_m + v_m) \tag{3}$$

where once again $x'(t)$ is independent of v_m and the individual's background characteristics x are constant over time. The time dependence of the marriage hazard is $\lambda_m(t)$. If t_m is the moment of marriage, the conditional marriage duration density function of $t_m|x(t), v_m$ is

$$f_m(t_m|x(t), v_m) = \theta_m(t|x(t), v_m) \exp(-\int_0^{t_m} \theta_m(z|x(t), v_m)dz \tag{4}$$

Now consider the joint distribution of t_d and t_m. Conditional on $x(t)$, v_d and v_m, the only possible relation between the variables t_d and t_m is the relation by way of the direct/ causal effect of a marriage on the hazard of death. In case of independence of v_d and v_m, we would have a standard duration model for $t_d|x(t), t_m$ in which $I(t_m < t)$ can be treated as a time-varying regressor that is orthogonal to the unobserved heterogeneity term v_d. However, if v_d and v_m are not independent, inference on $t_d|x(t), t_m$ has to be based on $t_d, t_m|x(t)$. Let $G(v_d, v_m)$ be the joint distribution function of the unobserved characteristics v_d and v_m. Then using equations (2) and (4) above we find that the joint density function of t_d, t_m conditional on $x(t)$, equals

$$f_{d,m}(t_d, t_m|x(t)) = \int_{v_d} \int_{vm} f_d(t_d|x(t), v_{d,}t_m) f_m(t_m|x(t), v_m) dG(v_d, v_m) \tag{5}$$

This joint density function can be used to easily derive the individual contributions to the likelihood function (note the recursive nature of the expression in the integral above). The right censoring of individuals who drop out of our sample after marriage (i.e. death date not registered) is exogenous and is therefore solved in a straightforward manner within the hazard rate framework.

The identification of the model framework is proven and discussed at length in Abbring and Van den Berg (2003). For the identification of the model, first note that the data can be broken into two parts: (i) a competing risk part for the duration until an individual either gets married or dies, whichever comes first, and (ii) the residual duration from the moment of marriage until death. From Heckman and Honoré (1989), it follows that under general conditions the whole model except for the causal effect δ is identified from the data corresponding to the competing risk part. Subsequently, δ is identified from the data corresponding with part ii of the model.

To clarify further what drives the identification of δ, consider individuals who marry at time t. The natural control group consists of individuals who are of the same age at t but who have not yet married. A necessary condition for a meaningful comparison of these groups is that there is some randomization in who marries at t. The duration model framework allows for this. In addition, we have to deal with the selection issue that the unobserved heterogeneity distribution is different between the treatment and control groups at t. This is handled by exploiting the information in the data on what happened to individuals who got married or died before t.

Another way to look at this is to note that the timing of the consecutive events of {marriage} and {mortality} is informative on the presence of the causal effect of marriage. If marriages are often followed by a sharp decline in the hazard of mortality, then this indicates a protective marriage effect. The selection effect does not give rise to the same type of quick succession of events.

4.2 Parameterization

We use very flexible specifications for the duration dependence functions and the bivariate unobserved heterogeneity distribution. The time dependence of the hazard functions is expressed by a flexible polynomial, for instance, of degree 4. This polynomial could be specified simply as a sum of terms $\eta_\iota t^i$, $i = 0, 1, ..., 4$ where t is the age of the individual. However, since the terms of t^i are not orthogonal, estimation of the parameters η_i is afflicted by multicollinearity. We take care of this problem by using Chebyshev polynomials of the second kind. In this case, the polynomial is specified as a sum of terms $\eta_i U_i(t)$, $i = 0, 1, ..., 4$

where $U_0(t), U_1(t), U_2(t), U_3(t)$ and $U_4(t)$[7], are mutually orthogonal polynomials of indexed degree. Thus, the duration dependence of exit probabilities into marriage and mortality are respectively given by:

$$\lambda_m(t) = \exp\left[\sum_{i=0}^{4} \eta_i^m U_i(t)\right] \tag{1}$$

and

$$\lambda_d(t) = \exp\left[\sum_{i=0}^{4} \eta_i^d U_i(t)\right] \tag{2}$$

where t is any given age of the individual. Consequently, the duration dependences $\lambda_m(t)$ and $\lambda_d(t)$ are piecewise constant functions with shapes determined by the polynomial expressions in equations 6 and 7 above. These piecewise, baseline specifications lead to 10 parameters (η_i^m and η_i^d, with $i = 0, 1, ..., 4$).

We take the joint distribution of the unobserved heterogeneity terms v_d and v_m to be bivariate discrete, with two unrestricted mass-point locations for each term. Let v_d^1, v_d^2, v_m^1, and v_m^2 denote the points of support of v_d and v_m, respectively. The associated probabilities are denoted as follows:

$$\begin{array}{ll} \Pr(v_d = v_d^1, v_m = v_m^1) = q_1 & \Pr(v_d = v_d^2, v_m = v_m^1) = q_3 \\ \Pr(v_d = v_d^1, v_m = v_m^2) = q_2 & \Pr(v_d = v_d^2, v_m = v_m^2) = q_4 \end{array}$$

with $0 \leq q_i \leq 1$ for $i = 1, ..., 4$, and $q_4 = 1 - q_1 - q_2 - q_3$.

The covariance of v_d and v_m is given by, $cov(v_d, v_m) = (q_1 q_4 - q_2 q_3) \cdot (v_d^1 - v_d^2) \cdot (v_m^1 - v_m^2)$. We note that $cov(v_d, v_m) = 0$ would imply independence of v_d and v_m and $q_1 = q_4 = 0$ or $q_2 = q_3 = 0$ would mean perfect correlation.

[7] To start, the domain of the ages t where $t \in [0, 103]$ is linearly transformed to the domain of the orthogonal Chebyshev polynomials such that now $\widehat{t} \in [-1, 1]$. This is done in our case by using the simple rule $\widehat{t} = 2\frac{(t-t_0)}{(n_t-1)} - 1$ where n_t is the year of the individual's life that is being considered.
Then our orthogonal polynomials are
$U_0(\widehat{t}) = 1$
$U_1(\widehat{t}) = 2\widehat{t}$
$U_2(\widehat{t}) = 4\widehat{t}^2 - 1$
$U_3(\widehat{t}) = 8\widehat{t}^3 - 4\widehat{t}$
$U_4(\widehat{t}) = 16\widehat{t}^4 - 12\widehat{t}^2 + 1$

4.2 Estimation Results

In the following we present estimates of 3 different specifications of the effect of marriage on mortality, δ. A value of $\delta \neq 0$ would imply a causal effect of marriage on exit probability of death. But in each of these cases we also take into account any selection effects, by jointly estimating durations until marriage and death. Selection on unobservables is controlled for by including separate terms for the unobserved heterogeneities effecting marriage and those influencing mortality, and additionally any correlation between the two.

The first model, referred to as the basic model, follows past literature where the causal effect of marriage is measured using a time varying regressor that takes a value of 0 before the person is married and 1 after his marriage. Table 3 presents the estimation results for the basic model specification, for the impact of early conditions in life on exit into marriage and mortality and the effect of marriage itself on mortality. Results are presented for the entire sample and also men and women separately. For the estimates concerning exit probabilities into marriage, a positive value is associated with an earlier marriage. On the other hand for the exit rate into mortality, positive values of estimates signify a shorter lifetime.

Gender, as would be expected, is an important aspect that determines the exit probability of an individual into marriage as well as death. We find that women have a significantly higher marriage hazard and a lower death hazard than men. This encourages us to consider the durations until marriage for men and women separately.

Considering men and women individually, the crucial result we find in this basic model is a significant, negative, causal effect of being married on the mortality hazard for men but no such significant effect for women. The former result is in line with earlier works that find a longer life expectancy amongst married men i.e. a protective effect of marriage. Moreover, in the absence of information on transitions into widowhood, divorce or separation after marriage, this estimate is a only a lower bound of the protective, causal effect of marriage on mortality. Although the effect of marriage for women is insignificant we investigate it further later, in this and the next section to ensure that no salient aspects are being over looked.

Furthermore we find that early conditions in life play an important role in determining mortality later in life. Being born in a year of boom lowers the hazard of death throughout later life. On separate examination of samples of men and women we find that only for men there is a significant negative effect of being born during a boom on the mortality hazard. This reiterates the results of Van den Berg, Lindeboom and Portrait (2006) who test the model of mortality without including marital status as an explanatory variable. The striking result is that for men we also find a significant negative effect of average cyclical conditions during the age interval of 6-12 years of on the marriage as well as the death hazard . So children who enjoy favorable economic conditions during childhood and adolescence are less likely to marry or die at any given time t. Given that this age interval coincides with primary schooling age in the Netherlands, this result could be driven by better educational or occupational opportunities for young adults during economic booms. In case of nuptiality, better education in turn could lead to larger professional involvement and consequent delays in marriage. This seems plausible since prior to 1901 primary education was not compulsory and only free for the very poor[8]. Therefore parents were likely to send their children to schools only during favorable economic circumstances whereas in bad times they were expected to work and contribute to the family income. Better educational opportunities could also explain the significant negative impact of favorable early life conditions on mortality. Since at the time the primary cause of deaths were infectious diseases, better education which would imply increased awareness of hygiene and nutrition, would certainly help improve health and reduce mortality. The fact that we don't find a significant effect of average cyclical conditions during the age interval of 6-12 years on the marriage and death hazard for women further provides support for the possible role of education in determining the nuptiality and mortality hazards. Few women in the 19th century attended school at all (Lenders, 2005) and so their educational attainments were unaffected by the state of the cyclical macro-economic conditions.

Unlike the findings of Van den Berg, Lindeboom and Portrait (2006) we find that once marital status is taken into account social class affiliation no longer seems to affect mortality hazard for both men and women. However, class differences are very important for nuptiality. Male members of the three lower social classes exhibit a much larger marriage hazard relative to their upper class counterparts. This is in line with past observations of changing demographic patterns in most western societies post industrial revolution (refer section 2.2. above). Growing economic opportunities in the years following the industrial revolution led to more frequent and younger marriages amongst the lower classes. Within the higher classes on the other hand, there was continued stress on financial stability and certain amount of material wealth accumulation prior to starting a family often led to later marriages. Unlike men, possibilities of higher social class upward mobility in marriage also arise for women. Investigation into marriage market prospects is left to future work.

Coming to the impact of urbanization of the place of birth (and may be residence), we see urbanization effects the marriage hazard of women and the hazard of death of men.

[8] For details of history and changes in Dutch educational laws please refer to the website of the 'Nationaal Archief' at http://www.nationaalarchief.nl/kind_tot_burger/html/

The marriage hazard of women born in urban areas is significantly lower. This could be due to relatively higher incomes of women employed in predominantly industrial activities in urban areas. Poor working class parents would find their earning daughters financially less dispensable and therefore would be less keen on giving consent for marriage. Higher exit probabilities into death for urban men is consistent with the large historical evidence that records concentration of epidemics in crowded cities post industrial revolution (refer section 2.2 above).

There exist large regional differences in probabilities of marriage and death. Individuals born in Friesland have a much lower mortality rate. This observation supports a previously well established result and is explained by the high prevalence of breast-feeding in Friesland and the poor quality of water in the other two provinces. For the province of Zeeland, women exhibit a lot higher death as well as marriage hazard. This fact is in line with the relatively more religious mind set of the population in the area where strict parents would encourage earlier marriage and procreation by their children. Furthermore religious dictates promoting large families could lead to deterioration of health amongst women owing to repeated pregnancies and childbirth which at the time could often even lead to maternal mortality[9].

The model takes into account the severe cholera epidemic in Utrecht in 1849, the small pox epidemic in Utrecht in 1870 and in Friesland and Zeeland in 1871, and the influenza epidemic of 1918. The details can be seen from table 3(b) below. Looking more closely at the impact of epidemics, we find that experiencing the cholera epidemic during early years significantly raises the exit probability into death at later ages for men. This can be seen as evidence in support of medical literature that finds long term, adverse health impacts of disease infliction during childhood in absence of catch-up growth[10].

The trend in GNP has a significant negative effect on the exit probability into death for both men and women. This result is expected since the trend component captures long term increases in national income and consequently improvements in public health expenditures on, for instance, sanitation and medical care. For men we find a significant increase in marriage hazards during contemporaneous, cyclical upswings. This could indicate that better macro conditions, which imply more favorable labour markets, increase marriage prospects for men in a society where a certain level of economic strength was essential for marriage.

[9]Maternal mortality statistics are unavailable for the Netherlands however studies report figures of maternal mortality in pre-industrial western societies ranging upto 1600 deaths per 100,000 live births (De Brouwere et.al, 1998). Maternal mortality rates in the Netherlands can be expected to be similar to those of Sweden (250-300) and England and Wales (400-450) around 1870.

[10]For instance refer to Barker, 1992.

The estimates in table 3 indicate that significant unobserved heterogeneity exists in the sample, both for the events of marriage as well as mortality. Majority of the people ($\approx 81\%$) have a significantly higher hazard of death($v_d^1 = 0.15, v_d^2 = -1.11$). In case of the exit probabilities into marriage, despite significant unobserved heterogeneity the proportion of the people with high($v_m^2 = 0.67$) hazard of marriage is almost equal to($\approx 53\%$) those with a low one ($v_m^1 = -1.82$). amongst there is significant. In terms of joint probabilities, about 42% of the sample have a low exit probability of marriage and a high hazard of death, 39% has high hazards of both marriage and death, 11% has a low hazard of both marriage and death and about 8% has high exit probability of marriage and a low one for mortality. Most importantly we note from the estimation results that $q_1q_4 \approx q_2q_3$ for the samples of both men and women implying only a limited correlation between v_d and v_m in the present model. A simple likelihood ratio test to compare likelihood function values from a model that imposes independence between v_d and v_m with those from our unrestricted model in fact does not reject independence between the unobserved heterogeneities of marriage and death for both men and women[11]. Therefore in our case, once we take into account the earliest economic conditions in life, we only find evidence for a causal relationship between nuptiality and death.

Finally, considering age dependence of exit rates into marriage and mortality we find the expected inverted U-shape for the former and a monotonically increasing one for the latter (refer fig.3 for the basic model). We observe that the marriage hazard increases till the age of 32 for men and 29 for women after which it consistently declines though at a slower rate after the mid 40's. This sudden slow-down in the declining hazard of marriage could indicate second marriages. However, in the absence of information about multiple marriages and continued marital status of individuals we are unable to comment any further.

The second model specification estimates the impact of the number of years married on mortality. Instead of looking at the effect of a binary choice variable - married (1) or not (0) - we consider the cumulative effect of the duration of marriage on the hazard of death. We do so by using 4 degree Chebyshev polynomial for durations of marriage. Figure 4 plots this cumulative effect of being married, along with the 95% confidence intervals, on the exit probability of death for men and women respectively. 80 years is the maximum duration considered as its the smallest integer year larger than the longest duration of marriage in the sample, i.e. 79.2 years. We note that the basic model is nested in this cumulative marriage effect specification and a likelihood ratio test for model specification rejects the basic model

[11] LR test statistic of 0.12 (men) and 0.04 (women): with a $\chi^2(1)$ critical value of 3.84 at 5% level. These results are reiterated by a Pearson's Chi-square test of independence with a test statistic of 0.23 (men) and 0.01 (women): with once again a $\chi^2(1)$ critical value of 3.84 at 5% level.

in favour of the current model[12]. However,with this alternative definition results for all other coefficients besides the protective effect remain almost unchanged (results in table 4). For the causal effect we find that durations of marriage between 9-39 years have a significantly negative effect on the mortality hazard for men. So for men, the longer has the individual been married the higher is the protective effect. This result is in line with previous literature that has noted prolonged bereavement and often quick successive death after the demise of a long-term partner. However, given the obvious, close relationship between duration of marriage and age of an individual, it is important to try and distinguish between the cumulative effect of marriage and the varying impact of marital status at different ages before any firm conclusions can be drawn.

The third model specification studies the age dependence of the protective effect of marriage by once again employing 4 degree orthogonal polynomials (refer figure 5) shows a plot of this age dependent effect of marriage on mortality along with the 95% confidence intervals). We find results (refer table 5) that are similar to the findings of the cumulative duration, protective effect specification reiterating the correlation between these two models. Marriage has a significantly negative impact on the mortality hazard over the ages of 57-85 i.e. men benefit more and more from being married over the years as shown by the increasing protective effect of marriage on mortality hazard till around the mid 80's. This finding is intuitive in light of social observations like growing loneliness owing to shrinking social circles for single individuals after a certain age and consequent taking up of unhealthy habits like alcoholism and risk taking behavior etc. Marriage on the other hand could offer support from a wife during older ages and improve quality of life by means of better housekeeping and personal care. The HSN does not record the time of death of spouses of the individuals in the sample. Growing number of widowers at older ages could be partly responsible for the absence of a consistently increasing protective effect of marriage beyond the ages of 85 years. The fact that in both, the cumulative duration of marriage effect model and the age dependence of protective effect of marriage specification, we find a large positive effect of marriage for women on the exit probability of death in the first 14 years of marriage and during ages 16-41 years of age respectively is more surprising. Investigation into the driving force behind such a result would require data on causes of death (for instance during child birth). As for men, no conclusions can be drawn from the insignificant effect of marriage on mortality beyond 85 years of age in absence of further information about marital status transitions. Despite these shortcomings the results clearly show that marital status does not have a constant effect on mortality hazard through out life. Earlier studies that do not account for this time varying impact of marriage on mortality are only capturing a crude protective effect.

[12] LR test statistic of 9.88 (men) and 32.22 (women): with a $\chi^2(4)$ critical value of 9.49 at 5% level.

The duration of marriage (model 2) and the age dependence of marriage effect (model 3) models are not nested and therefore cannot be compared using a likelihood ratio test. But, the results of the two models closely follow each other indicating a strong correlation. In the next section we try to test which out of these two specifications performs better by estimating a model that includes both - the duration of marriage as well as the age dependence of the effect of marital status. The performance of this 'full' model is then separately compared with that of the two nested models- model 2 and model 3.

4.3 Duration of marriage vs. age dependence of marriage

Table 6 presents the results of the full model (model 4) which includes both, duration and the age dependence of marriage effects. We once again find that the coefficients on explanatory variables besides marital status remain unchanged from those in models 2 and 3. Favorable cyclical macro economic conditions in the year of birth (in the case of men) and contemporaneous economic conditions (for all individuals and measured partly in terms of the trend component of the current log per capita real GNP) continue to have a significant positive impact on longevity. As for marriage, social class continues to play a crucial role in determining the exit probability of marriage for men with lower class members exhibiting a significantly higher marriage hazard. Regional differences also persist with significantly higher marriage as well as death hazards for women born in Zeeland as compared to the 2 other provinces. Also, once again we find a lower marriage hazard for women born in urban areas.

Looking at the correlation between nuptiality and death we continue to find evidence for both a selection as well as causal effect. For the latter effect, we find that both the duration of marriage dependent and age of the married individual dependent causal effect of marital status are now individually insignificant at all durations of marriage and ages (refer figure 6). Comparing this model to model 2 and 3, we find that the likelihood ratio tests rejects model 2 but not model 3[13] in case of men. From this we conclude that the age of the individual is more important than the duration of marriage in explaining the protective effect of marriage for men. Given the correlation between age and duration, the highly significant effects of long marriage durations on mortality hazard (table4), are hardly surprising as in the specification of model 2 marriage durations act a proxy for age.

For women on the other hand the distinction is less clear as the likelihood ratio tests do

[13] LR statistic for model 2 vs.model 4, 11.75 and LR statistic for and model 3 vs.model 4, 8.11 for men with a $\chi^2(4)$, 5% critical value 9.49.

not reject either of the two specifications[14]. The likelihood function value of the model with age dependent causal effect of marriage is higher than that with the duration of marriage determined effect of nuptiality, but not significantly so. As previously mentioned, we lack information about the cause of death of individual women which disallows any conclusions about the reasons underlying the significantly higher mortality hazards amongst married women in early years of their marriages or up to the age of 41 years. However, very high maternal mortality rates at the time compels us to believe that death during child birth could be an important factor distinguishing women dying in their reproductive ages from those perishing at any other age. If this be the case, an age dependent effect of marriage on the hazard of death has a greater appeal than that determined by the duration of marriage, as the latter would have the unlikely implication of higher mortality amongst all women, in the early years of marriage, irrespective of their age at marriage. From this we conclude, that model 3 has the preferred specification (clearly for men and in light of supporting reasons for women) as it performs just as well as the full model but additionally avoids the complexities of model 4.

4.4 A Closer Look at the Impact of Early Conditions in Life on the Effect of marriage

In this section, we further investigate if the causal effect of marriage on mortality is in any way aggravated or mitigated by whether or not an individual is born during a boom. We do so by including in Model 3 interaction terms of the age-wise marital status effect and the dummy of being born in a boom or not. Table 7 presents the results of this extended model called Model 5[15]. The results are particularly striking for women. For men, we find no significant affect of being born in a boom as opposed to being born in a recession on the protective effect of marriage on mortality rate. However, for women born in years of macroeconomic upswings we find a large, significant protective effect of being married on death hazards during age interval 25-52 years (figure 7)[16]. These ages are almost the same

[14]LR statistic for model 2 vs.model 4, 7.46 and LR statistic for and model 3 vs.model 4, 5.26 for men with a $\chi^2(4)$, 5% critical value 9.49.

[15]For women we also estimate a model with interaction terms of the duration of marriage dependent protective effect of marriage and the dummy of being born in a boom or not. Results of this model, called model 6, are presented in table 8.

[16]A similar protective effect of being married is found for women born during macroeconomic booms in the model with interactions between dummy of being born in a boom or not with the duration of marriage between 2-28 years (model 6). Refer figure 8.

interval in which women on an average, had a strong adverse effect of being married on their mortality hazard. This implies that being born in a boom reduces the negative impact of marriage on life expectancy for women less than 52 years of age, an age interval that covers the child bearing ages. So women born in favorable economic times can cope a lot better with stresses of marriage and probably child birth, than women born in a year of recession. This suggests that (for women) the early conditions in life determine how well they are able to cope with physically stressful times through out life. For both men and women all other coefficients remain unchanged.

Model 3 is nested in model 5 and a simple likelihood ratio rejects model 3 in favour of model 5 for women[17] but not for men[18]. Therefore model 5 is the preferred model for women and model 3 for men[19]. Once again, a likelihood ratio test comparing likelihood function values from a model that imposes independence between v_d and v_m and an unrestricted model does not reject the null of independence between the two unobserved heterogeneity terms[20]. Thus for both men and women, the effect of marriage and mortality continues to be causal.

4.5 Discussion, Policy Implications and further work

Using the parameter estimates from Model 3 (Table 5) and the actual ages of marriage of the individuals in the sample we find that on an average marriage leads to a 4.37% increase in life expectancy for men. For women on the other hand estimates from model 5 show that marriage implies a 2.16% decrease in longevity. However, once we control for whether or not the married woman is born during a macro-economic upswing these figures look very different. For women born during a boom, marriage in fact has a positive impact on their life expectancy (0.61% increase in expected lifetime). Therefore, we find that the result of a positive impact of marriage on the mortality hazard for women aged less than 52 years is

[17] LR statistic for model 3 vs.model 5, 15.55 ($\chi^2(5)$, 5% critical value 11.07).

[18] LR statistic for model 3 vs.model 5, 7.22 ($\chi^2(5)$, 5% critical value 11.07

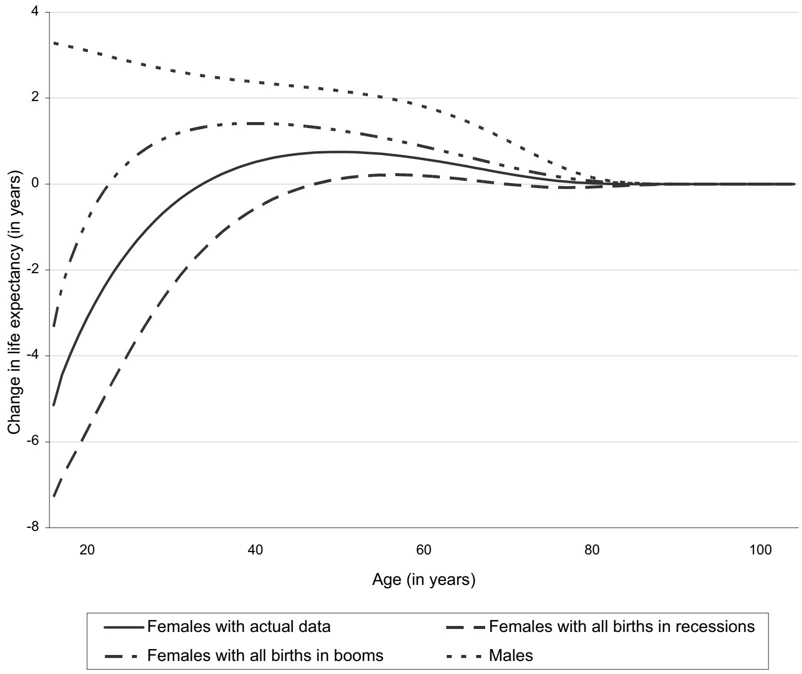
[19] Model 2 is nested in model 6 (the additional specification checked for women) and an LR test rejects model 2 in favour of model 6 for women.

Comparing performances of the two interaction models using the Vuong test statistic (Vuong 1989) for model selection for non-nested models we find that the simple test rejects the null hypothesis that either of the two models 5 or 6 are significantly different from the true model. However once again, the model with interactions between age of the married individual and dummy for being born in a boom (model 5) has a slightly better likelihood function value and more convincing implications.

[20] LR statistic for men is 0.54 (model 3) and for women is 0.72 (model 5) with a $\chi^2(1)$, 5% critical value 3.84. This result is once again confirmed using a Pearson's Chi-Square test of independence with test statistic for men being 0.27 (model 3) and for women 0.22 (model 5) and a $\chi^2(1)$, 5% critical value 3.84.

driven only by women born during economic downswings. For this group marriage reduces expected longevity by 5.40%.

These figures for changes in life expectancy however, average over the effect of marriage on individuals marrying at various ages. But given the non-constant protective effect of marriage over an individuals lifetime, it is more interesting for instance to consider by how much life expectancy increases or decreases if you marry at any given age. Moreover, since for women being born in a year of an economic boom greatly determines the impact of marriage on their mortality hazard we would also like to compare life expectancies at different ages for those born in a boom with the counter-factual scenario of them being born during a recession. Graph 3 below, shows the approximate increases or reductions in life expectancy (in years) for every possible age of being married (16 -103 years) for men. For (married) women, the graph plots changes in life expectancy at different ages and for whether or not they are born in a year of economic boom.



Graph 3. Expected changes in life expectancy at different ages as a causal effect of marriage.

It seems that getting married at very young ages (about less than <25 years) has a positive impact on mortality hazard for all women. This negative effect however, reduces over time with married women of 16 years of age being in the worst position. This of course would be understandable in light of adverse health consequences of pregnancies and child birth for teenage mothers. And, in the absence of advanced contraceptives one could expect that pregnancies followed soon after marriage. However, beyond the mid twenties the adverse effect of marriage on longevity during child bearing ages only holds for women born in recessions and not for those born in booms. This can be expected as women who might have already suffered a health set back early in life would be less able to cope with future health strains. For men on the other hand, the protective effect is generally higher the younger they marry. We cannot exactly identify the reasons for this result from the data we have. However, early on set of healthier lifestyle and safe habits could be plausible causes.

These results indicate that if early conditions in life are used as a proxy for adult health status, a fact that is supported by numerous studies in economics and medicine, we indeed find substantial effect of economic conditions during infancy (less than 1 year of age) on the probability of death. However, such impact of cyclical macro economic conditions during infancy or even childhood[21] is not found for exit probabilities into marriage. However, after checking the impact of average cyclical conditions during various different age intervals in early life, we find that favorable economic conditions during schooling years do have a crucial impact on the probability of marriage. Moreover, the fact that this result holds only for men, for whom education and profession was more relevant at the time, seems to indicate that unlike mortality the vital factor determining nuptiality decisions is more likely to be education rather than health. In addition, whether one marries or not and the timing of marriage depends on other current factors like social class, degree of urbanization of the place of birth (and probably residence), religious background and current economic conditions. This result supports some past studies that that rule out the role of early health conditions as the link between marital status and mortality (see for e.g. Vagero and Modin, 2001). However unlike some of the earlier works we find that health does interact with marriage when considering the hazard of mortality. Once married, healthier women are better able to enjoy the benefits from their married lives than women with worse adult health owing to unfavorable economic conditions at birth.

Several obvious similarities exist between 19th century Dutch society and current day developing world. Both scenarios involve largely rural economies with a relatively small upper class and little access to active family planning methods. Therefore results drawn

[21] Childhood being the age interval between 1-5 years of age which is also reported by the medical literature as being crucial stage in the long term development of an individual. Refer for e.g. Power, Li, Manor and Davey, 2003

from this study using 19th Century Dutch data could help policy makers in less developed economies in their struggle against high fertility and mortality rates. This is particularly so for poor countries where the status of the girl child is often considered only second to that of her male siblings. Therefore in times of adverse economic conditions she might suffer even more than the male children in the family and this would have life long adverse health consequences. Hence, additional focus should be on the female babies born during macro-economic down-turns. The contemporaneous mortality and that at all healthwise demanding points in future life, of these female children may be significantly reduced if their conditions are improved upon. This could be done by means of extra provisions of food, housing and health care. Moreover, policies should be put into place that support women during their child bearing ages. In the short run this could be done by discouraging marriages of very young women especially in rural areas or within lower social classes and religious communities by setting and enforcing suitable legal age of marriage. Additionally access to modern contraceptives could help curb quick successive pregnancies that lead to high infant and maternal mortality rates. Active family planning programs, could also allow couples to enjoy the benefits of partnership without suffering from its negative health consequences. Over a longer time horizon, urbanization and economic development of the country (reflected in high per capital real GNP) would help discourage early marriages and consequently its adverse consequences, especially for women.

In future work we would like to consider several extensions of the current model. We would like to acquire more information about other marital status like - divorced, separated, widowed etc. These could provide more precise results about the protective effect of marriage. Moreover multiple transitions for an individual would help identify causal effects of marriage under weaker assumptions (i.e.v could be dependent on x). On a slightly different front, it would be interesting to study marriage market tightness as a determinant of marital hazard by social classes, gender, degree of urbanization of place of residence and age. For this we would need to merge the HSN with marital life tables for the Netherlands for our observation window.

5 Conclusion

Using data covering the period of 1812-2000, our empirical analysis shows that business cycle conditions in the early years of life play a significant role in determining the individual's transition rate into marriage and mortality. On average, *cetirus paribus*, individuals who enjoy favorable macro-economic conditions during these years of schooling and may be profession building marry later than those who face economic downturns in years leading up to the legal age of marriage. We take this result as evidence of a causal negative effect of individual economic conditions in years of childhood and early teenage on the transition rate into marriage. This study therefore goes beyond past works that only focused on contemporaneous factors influencing an individual's exit into matrimony.

Moreover, from the joint model of marriage and mortality, conditional upon early conditions in life, we find evidence of a causal effect of marriage on mortality. We find significant gender differences in the impact of marital status on the exit probability into mortality. For men marriage is clearly 'protective' in the sense that there is a substantial negative impact of being married on the mortality hazard. Moreover, this protective effect is not constant over a man's lifetime but in fact increases with age. We find age dependence of the effect of marriage on mortality hazard for females as well, with women beyond the mid thirties, on an average enjoying a more favorable impact of marriage on death rates than younger married women. However, for women between the ages of about 25-60 there exist significant differences in the direction of this causal mechanism by whether or not they were born during an economic boom. Using cyclical conditions at birth as an exogenous indicator of individual economic circumstances, we note that women with good economic position in early life are better able to enjoy the benefits of marriage than women born in bad economic times. This is particularly so during the child-bearing ages when married women, born during economic recessions have a significant positive effect of their marital status on the mortality hazard. This suggests that there are long term impacts of early conditions in life on health throughout later life. These effects become particularly stark at times of extra physical stress where women with a superior health prior are able to cope a lot better. Therefore, unlike previous studies we find that there is a causal and possibly even a protective effect of marriage on mortality, for not only men but women as well.

The results from this study have several policy implications. Firstly, extra attention should be paid to children aged zero in bad economic times. This is particularly so for the girl child who has to bare the additional strains of child birth later on in life. This could be done by provisions of food, housing and health care. Secondly, women should be supported during their child bearing ages. This can be achieved by establishing and enforcing a suitable legal age of marriage to avoid marriages of very young women and its consequent adverse health effects. Additionally, family planning programs should be put into place so that young couples can better enjoy the benefits of marriage without physical and financial burdens of large families. In the long run urbanization and economic development could encourage a demographic change that inculcates the ideas of modern family formation - i.e. relatively later marriages and fewer children.

References:

Abbring, J.H. and Van den Berg, G.J. (2003), The non-parametric identification of treatment effects in duration models, *Econometrica*, Vol. 71, pp.1491-517.

Abbring, J.H., Van den Berg, G.J. and Van Ours, J.C. (2005), The effect of unemployment insurance sanction on the transition rate from unemployment to employment, *The Economic Journal*, Vol. 115, pp.602-630.

Barker, D.J.P., "The Fetal and Infant Origins of Adult Disease," British Medical Journal Books, 1st Edition 1992 .

Blau, F.D., Kahn, L.M. and Waldfogel, J. (2000), Understanding Young Women's Marriage Decisions: The Role of Labour and Marriage Market Conditions, *Industrial and Labour Relations Review,* Vol. 53, pp. 624-647.

Boonstra, O. (1998), The Impact of Education on the Demographic Life Course: The family reproduction process of literates and illiterates in the Netherlands at the end of the nineteenth century, *The History of the Family: An International Quarterly*, Vol. 3(3), pp.303-313.

Case, A., Fertig, A., and Paxson, C. (2003), From cradle to grave? The lasting impact of childhood health and circumstance, Working paper, NBER and Princeton University.

De Brouwere, V., Tonglet, R. and Van Lerberghe, W. (1998), Strategies for reducing maternal mortality in developing countries: what can we learn from the history of the industrialized West?, *Tropical Medicine & International Health*, Vol 3 (10), pp. 771–782.

Dehejia, R. and Lleras-Muney, A., (2004), Booms, busts and babies' health, *Quarterly Journal of Economics,* Vol. 119, pp.1091-1130.

Dolhammer, G. (2004), The late life legacy of very early life, Springer, Berlin.

Ebrahim, S., Wannamethee, G., McCallum, A., Walker, M. and Shaper, A.G. (1995), *American Journal of Epidemiology*, Vol. 142(8), pp. 834-842.

Gardner, J. and Oswald, A. (2004), How is mortality affected by Money, Marriage and Stress?", *Journal of Health Economics*, Vol. 23(6), pp. 1181-1207.

Hack, M., Schluchter, M., Cartar, L., Rahman, M., Cuttler, L., and E. Borawski. (2003), Growth of Very Low Birth Weight Infants to Age 20 Years., *Pediatrics, Vol.* 112 (1), pp. 30-38.

Hu, Y. and Goldman, N. (1990), Mortality differentials by marital status: An international comparison, *Demography*, Vol. 27, pp. 233-50.

Jacobs, J. and Smits, J.P. (2001), Business cycles in the Netherlands, 1815-1913. Working paper, Groningen University.

Johnson, N.J., Backlund, E., Sorlie, P.D. and Loveless C.A. (2000), Marital status and mortality: the national longitudinal mortality study, *Annals of Epidemiology*, Vol. 10(4), pp. 224-238.

Lenders, J. (2005), Van Kind tot burger. Basisonderwijs en burgerschap in de negentiende eeuw, *Leidschrift*, Themanummer Van Kind tot burger. Onderwijs en volksopvodeing in Nederland 1795-1920, Vol. 20(2), pp. 7-41.

Lillard, L.A. and Panis, C.W.A. (1996), Marital Status and Mortality: The Role of Health, *Demography*, Vol.33, No.3., pp. 313-327.

Lund, R., Holstein, B.E. and Osler, M.(2004), Marital history from age 15 to 40 years and subsequent 10-years mortality: a longitudinal study of Danish males born in 1953, *International Journal of Epidemiology*, Vol. 33(2), pp. 389-97.

Murray, J.E., (2000), Marital Protection and Marital Selection: Evidence from a Historical-Prospective Sample of American Men, *Demography*, Vol. 37, pp. 511-521.

Petersen, W. (1960), The Demographic Transition in the Netherlands, *American Sociological Review*, Vol. 25(3), pp. 334-347.

Power, C., Li, L., Manor, O. and Davey Smith, G. (2003), Combination of low birth weight and high adult body mass index: at what age is it established and what are its determinants?, Journal of Epidemiology and Community Health, Vol. 57, pp. 969-973

Phillips, D.I.W., Handelsman, D.J., Eriksson, J.G., Forsen, T., Osmond, C. and Barker, D.J.P (2001), Prenatal growth and subsequent marital status: Longitudinal study, *British Medical Journal*, Vol. 322, pp. 771.

Schrover, M. (1997), The demographic consequences of changing employment opportunities: Women in the Dutch Meierij in the nineteenth century, *The History of the Family: An International Quarterly,* Vol.2, pp. 451-480.

Schoen, R. (1983), Measuring the Tightness of a Marriage Squeeze, *Demography*, Vol. 20, pp. 61-78.

Vagero, D. and Modin, B. (2001), Prenatal growth, subsequent marital status, and mortality: longitudinal study, *British Medical Journal*, Vol 324, pp. 398.

Van den Berg, G.J., Lindeboom, M. and López, M. (2006), Inequality in individual mortality and economic conditions earlier in life.

Van den Berg, G.J., Lindeboom, M. and Portrait, F., (2006), Economic Conditions Early in Life and Individual Mortality, Vol. 96(1), pp. 290-302.

Van den Berg, G.J.,B. van der Klaauw and J.C. van Ours (2004), Punitive sanctions and the transition rate from welfare to work, *Journal of Labour Economics*, Vol. 22, pp. 211-241.

Van den Berg, G.J. (2001), Duration models: specification, identification and multiple durations, In (J.J. Heckman and E. Leamer, eds.), Handbook of Econometrics, Vol.V, pp. 3381-460, Amsterdam: North Holland.

Van Poppel, F. and Joung, I.(2001), Long-Term Trends in Marital Status - Mortality Differences in the Netherlands 1850-1970, *Journal of Biosocial Sciences*, Vol.33, pp. 279-303.

Van Poppel, F.,(1992), Trouwen in Nederland: Een Historische-Demografische Studie van de 19E en Vroeg-20e Eeuw, NIDI, Rapport nr. 31.

Vuong, Q.H., (1989), Likelihood Ratio Tests for Model Specification and Non-Nested Hypothesis, *Econometrica*, Vol. 57(2), pp.307-333.

Figure 1: log annual real per capita GNP

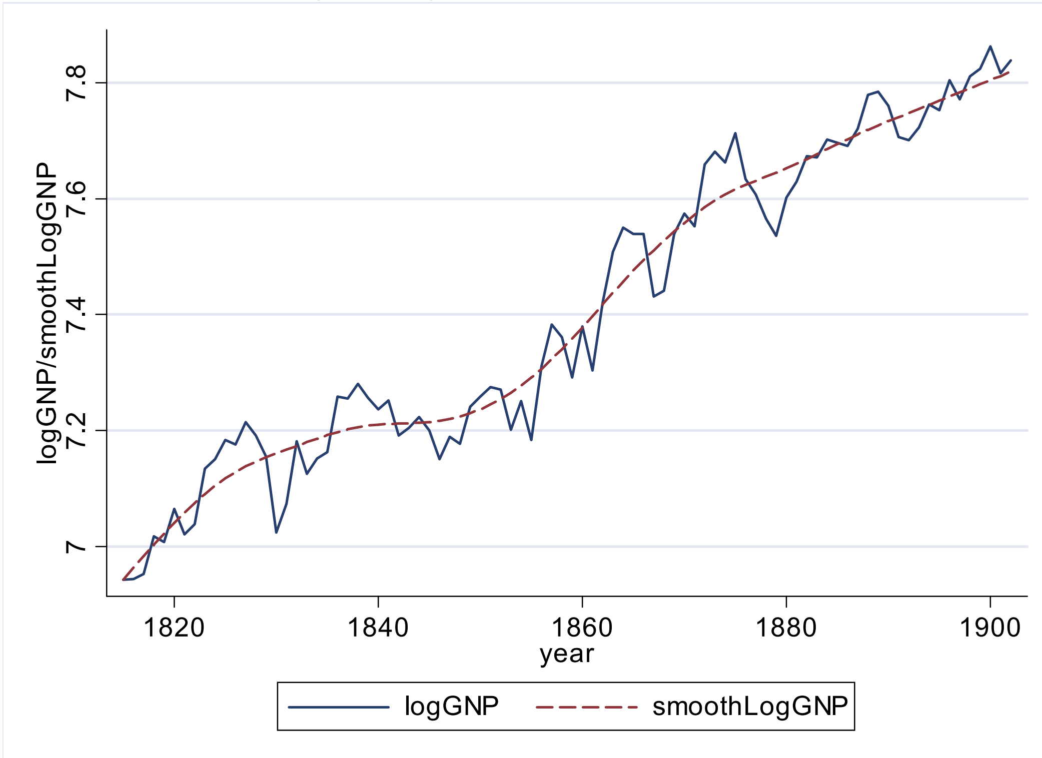


Figure 2: The distribution of the cyclical indicator of GNP

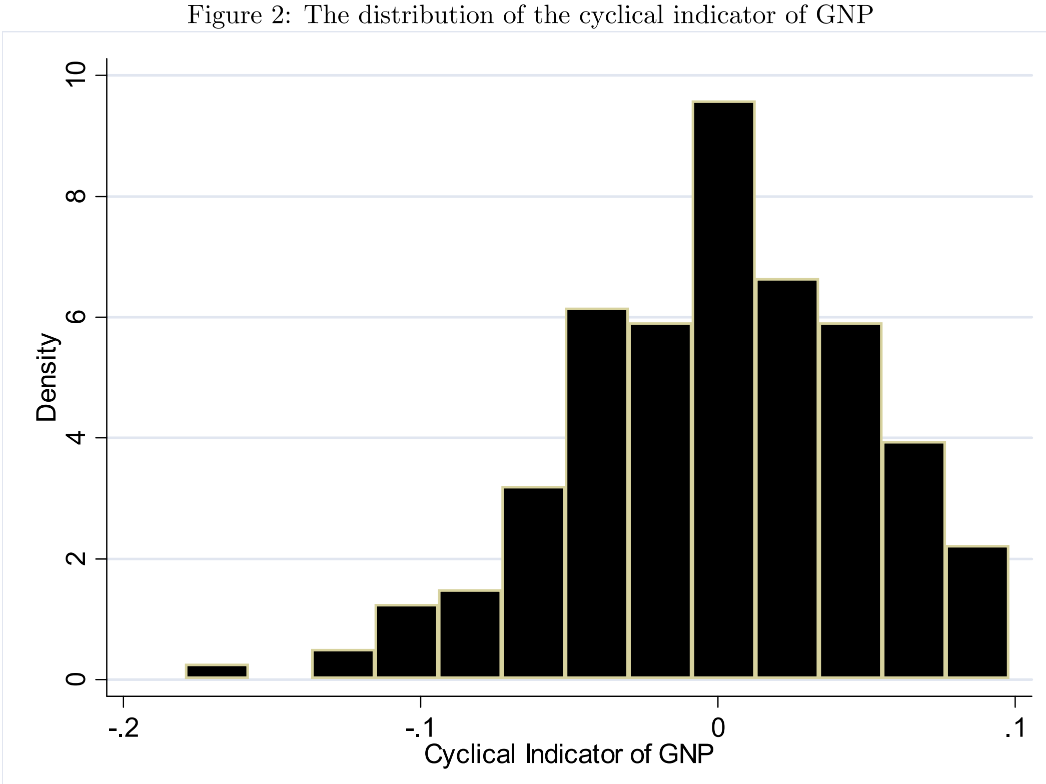


Figure 3: Age dependence of marriage and death (baselines) for basic model

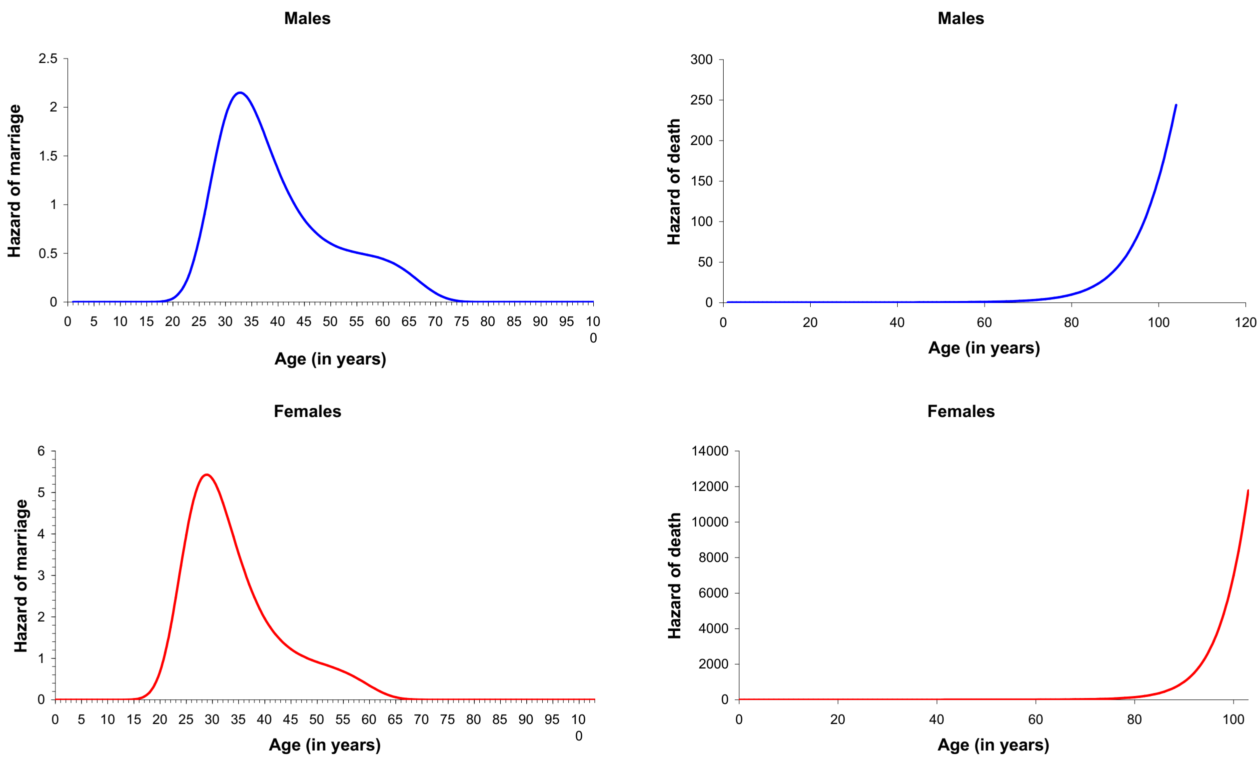
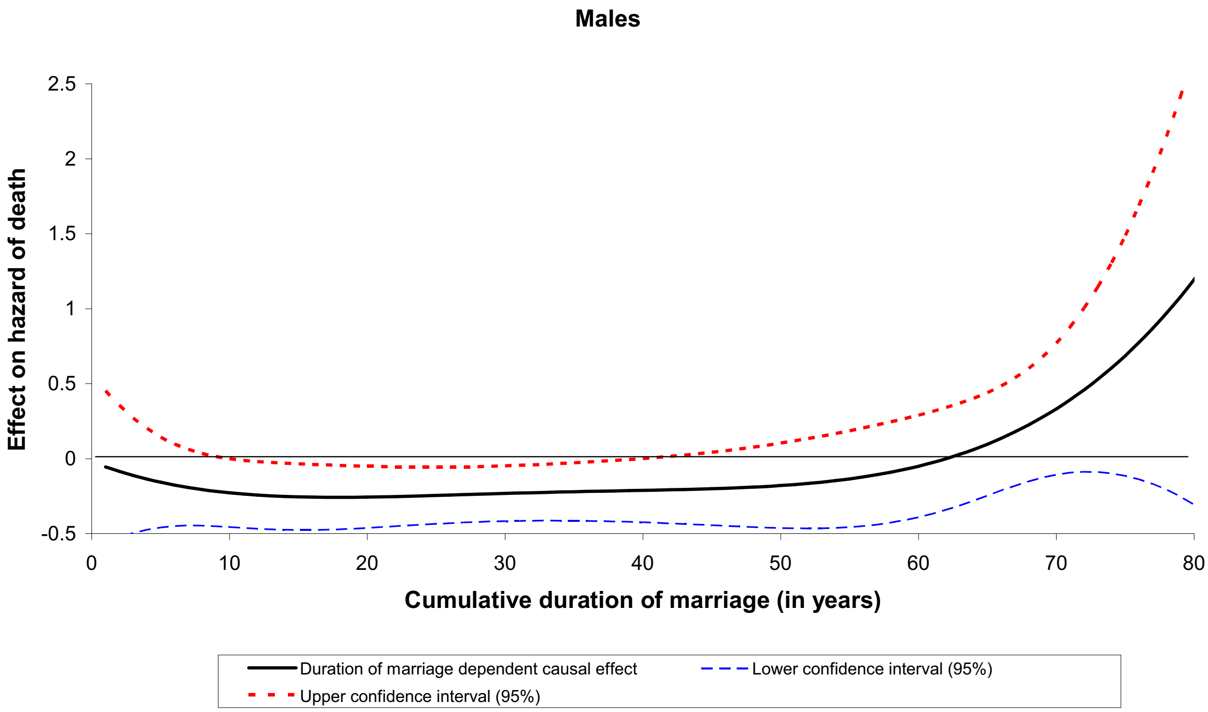


Figure 4: Cumulative duration of marriage dependent causal effect of marriage on hazard of death (Specification 2)



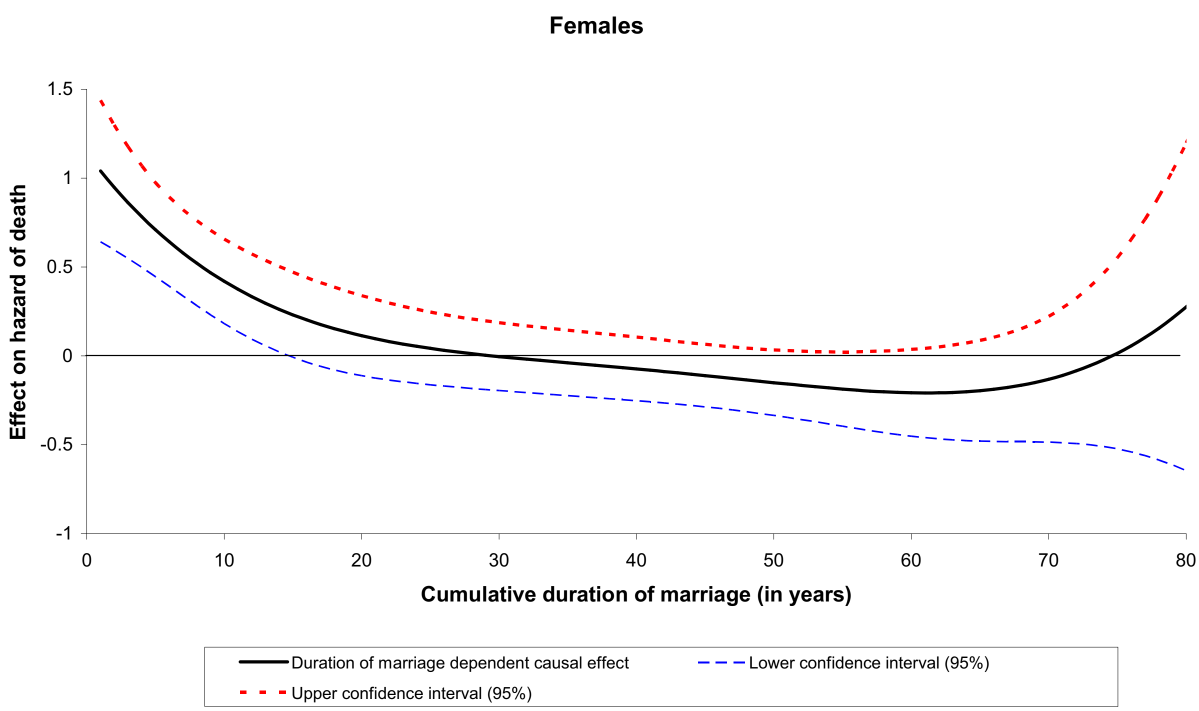
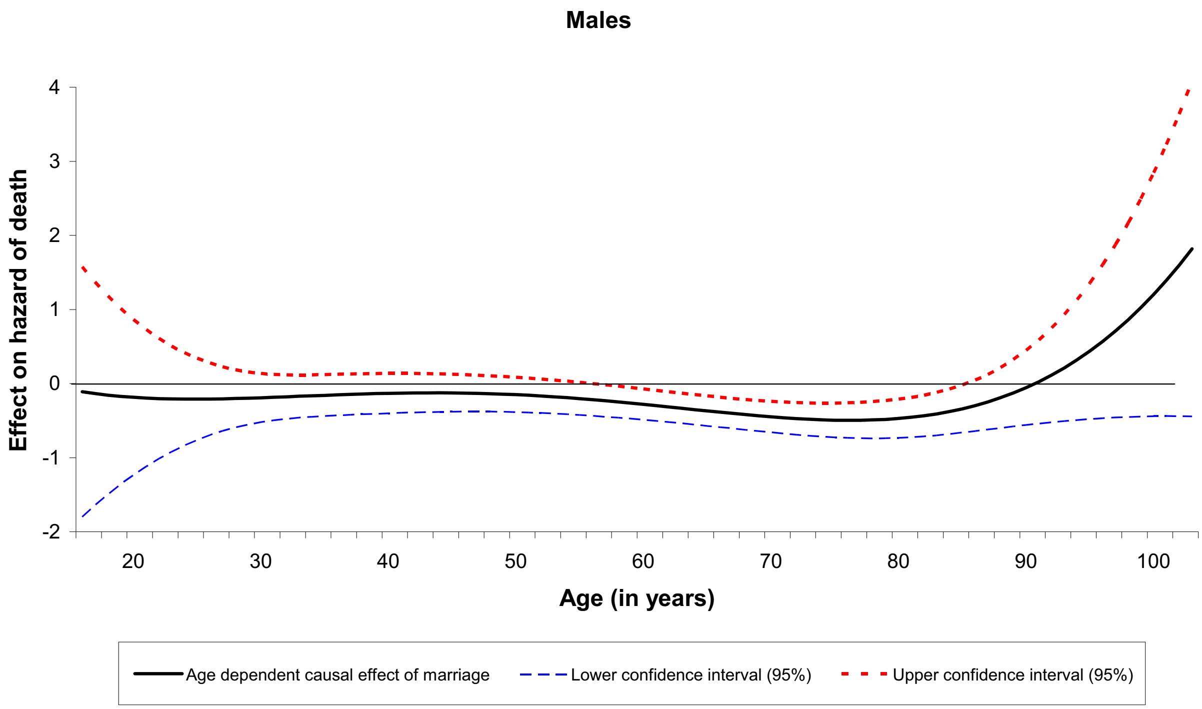


Figure 5: Age of the individual dependent causal effect of marriage on hazard of death (Specification 3)



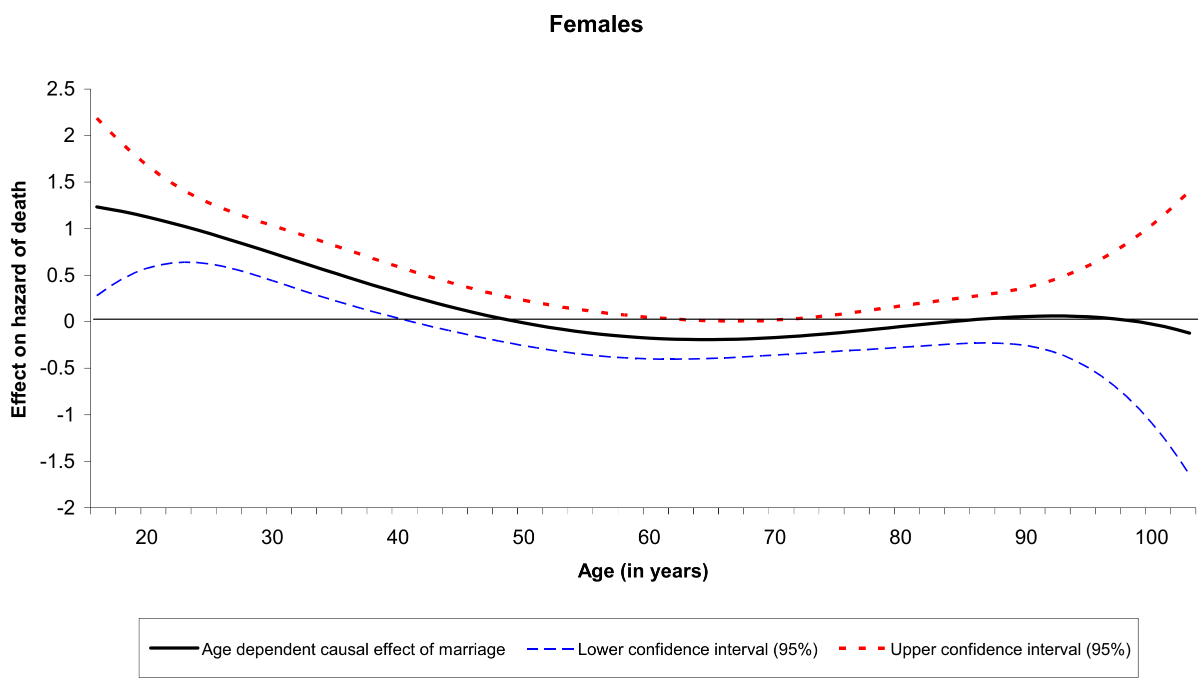
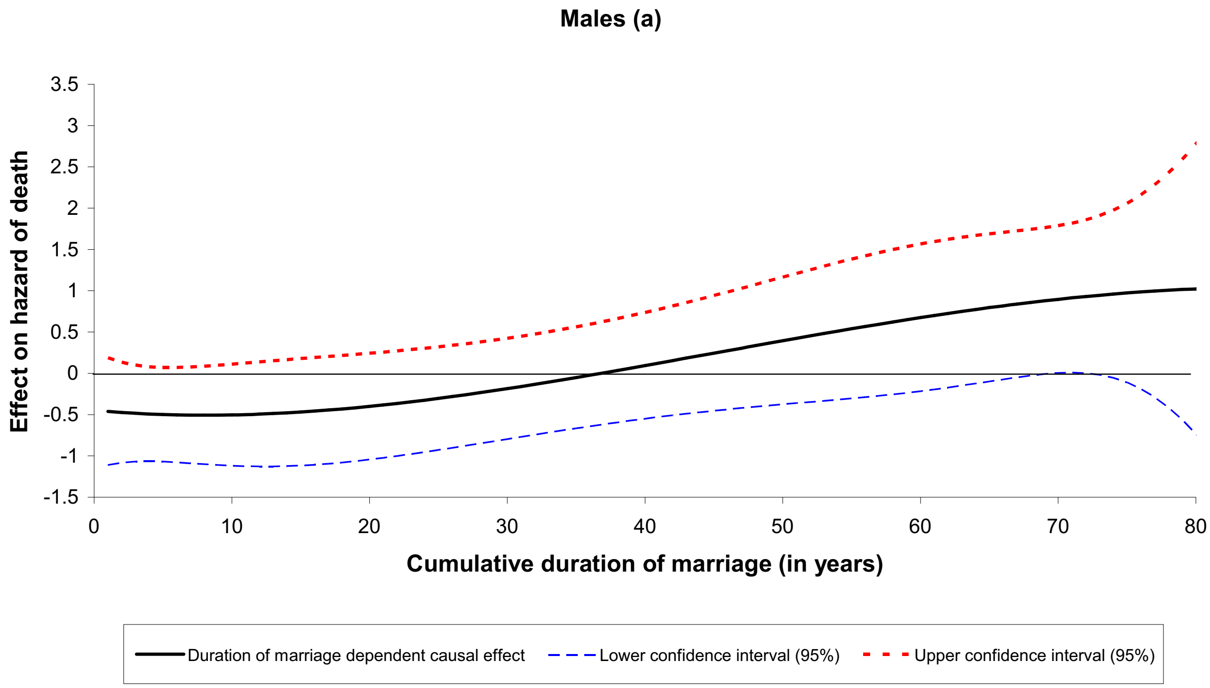


Figure 6: Cumulative duration of marriage dependent and age of the individual dependent causal effect of marriage on hazard of death (Specification 4, "full" model)



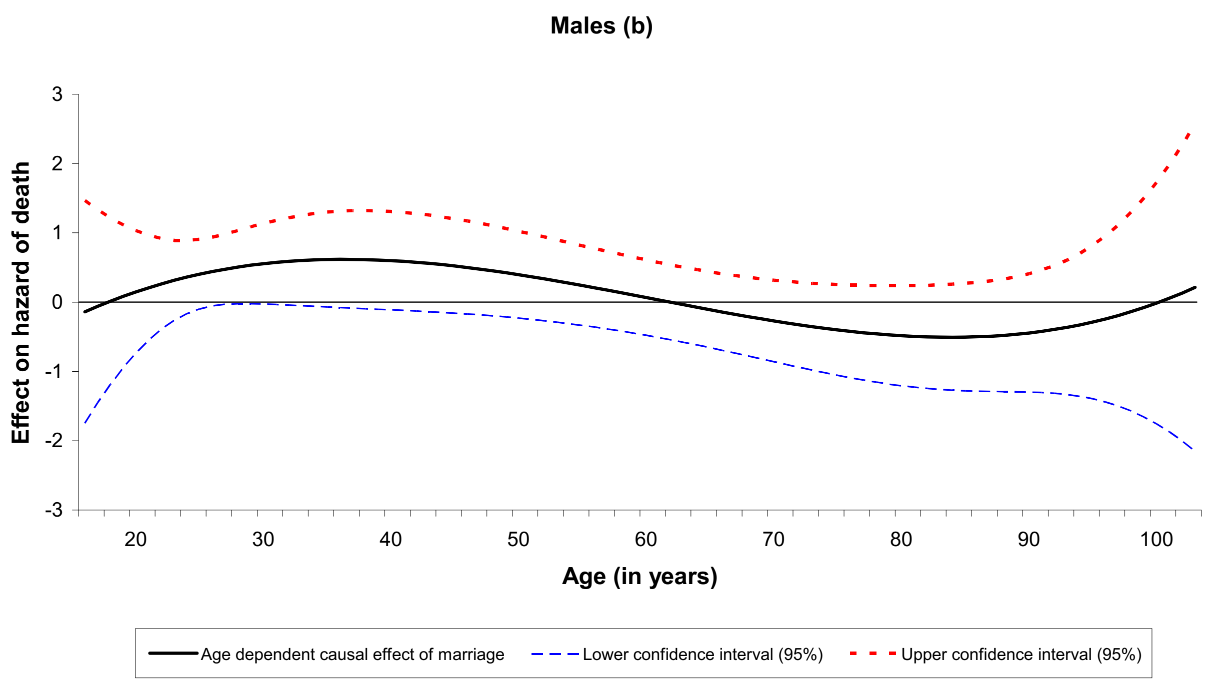
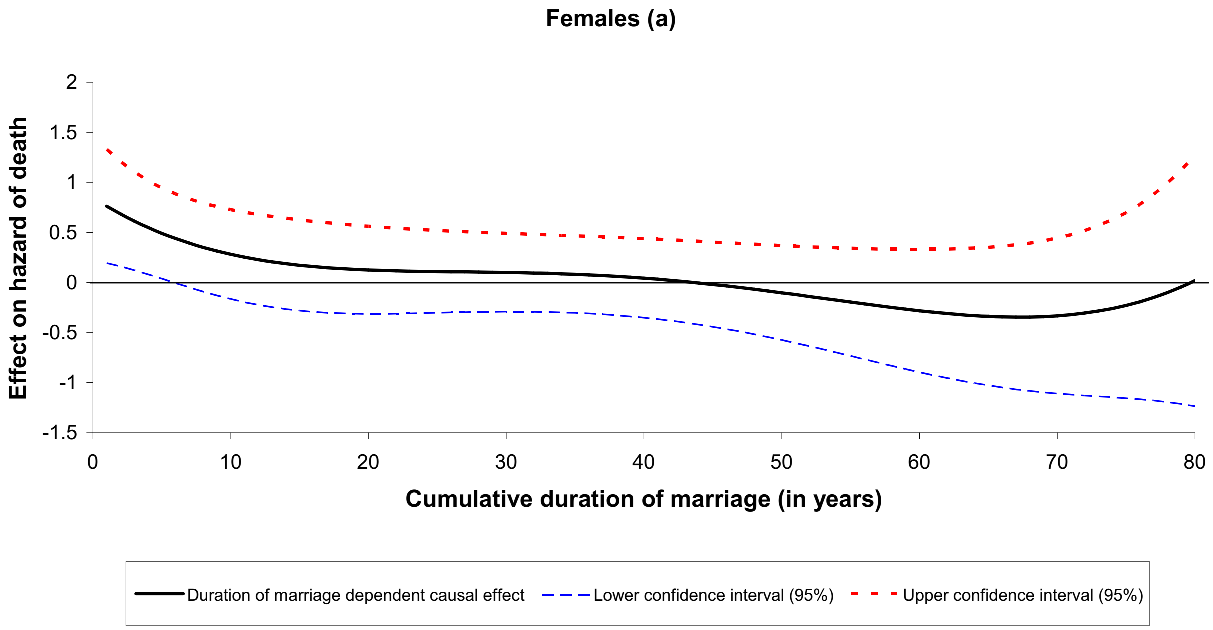


Figure 6 (Contd.): Cumulative duration of marriage dependent and age of the individual dependent causal effect of marriage on hazard of death (Specification 4, "full" model)



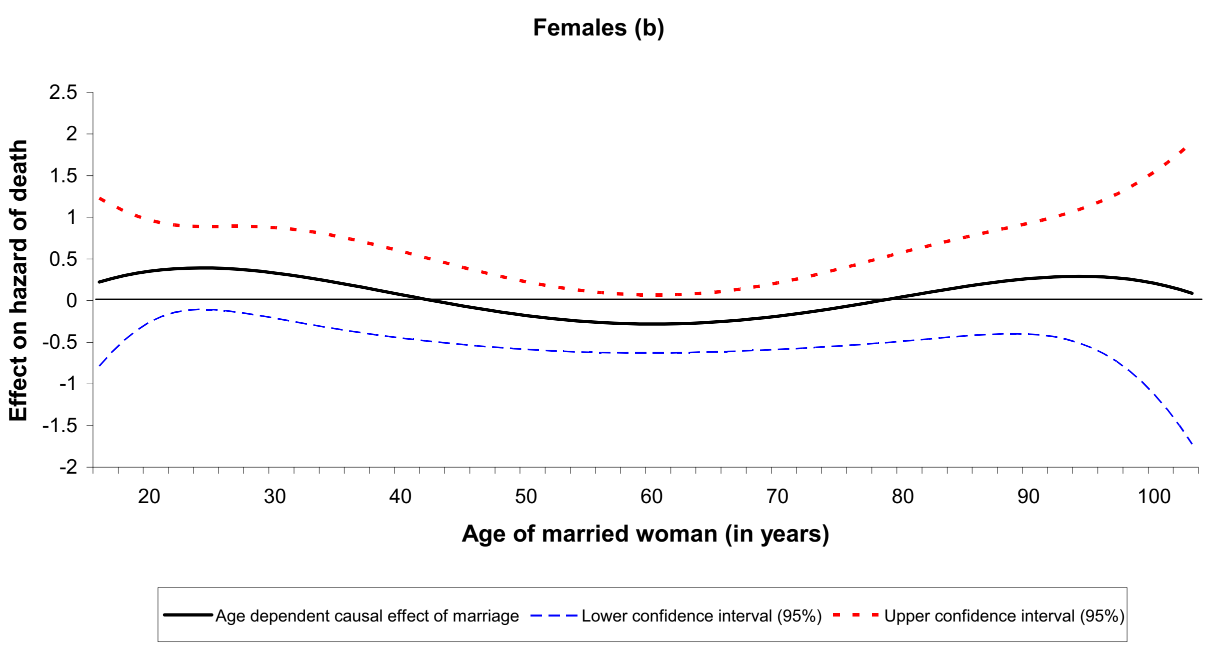
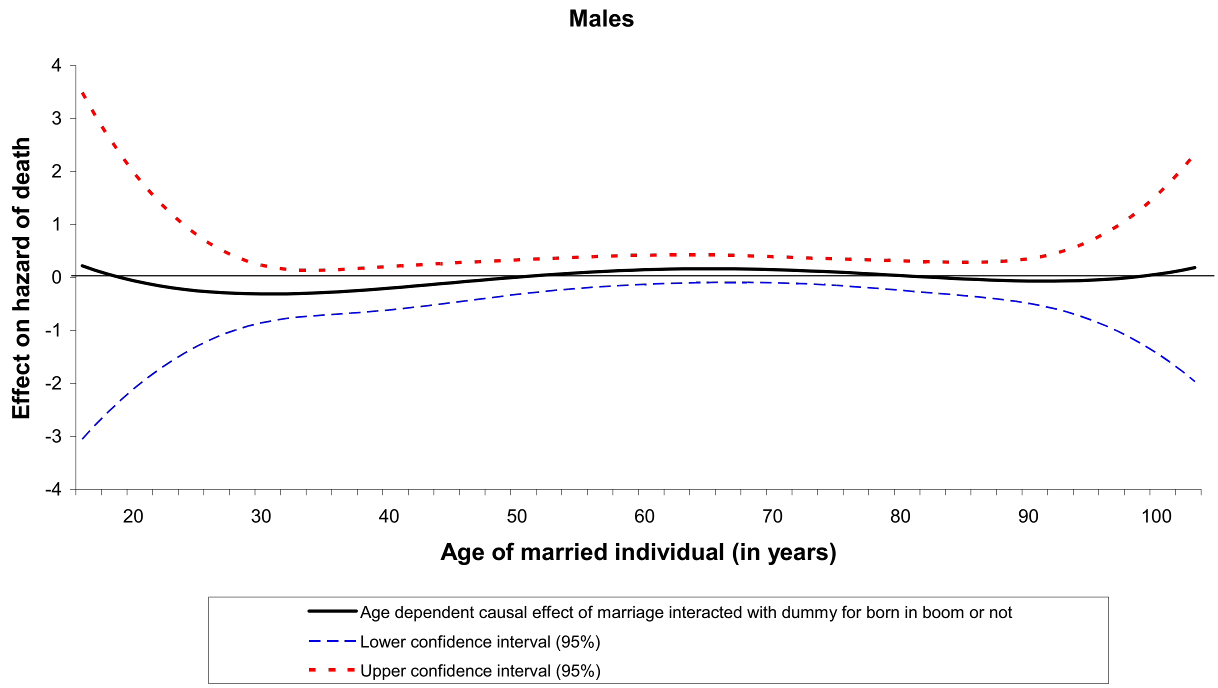


Figure 7: Age of the individual dependent, causal effect of marriage on the hazard of death interacted with born in a year of an economic boom or not (Specification 5)



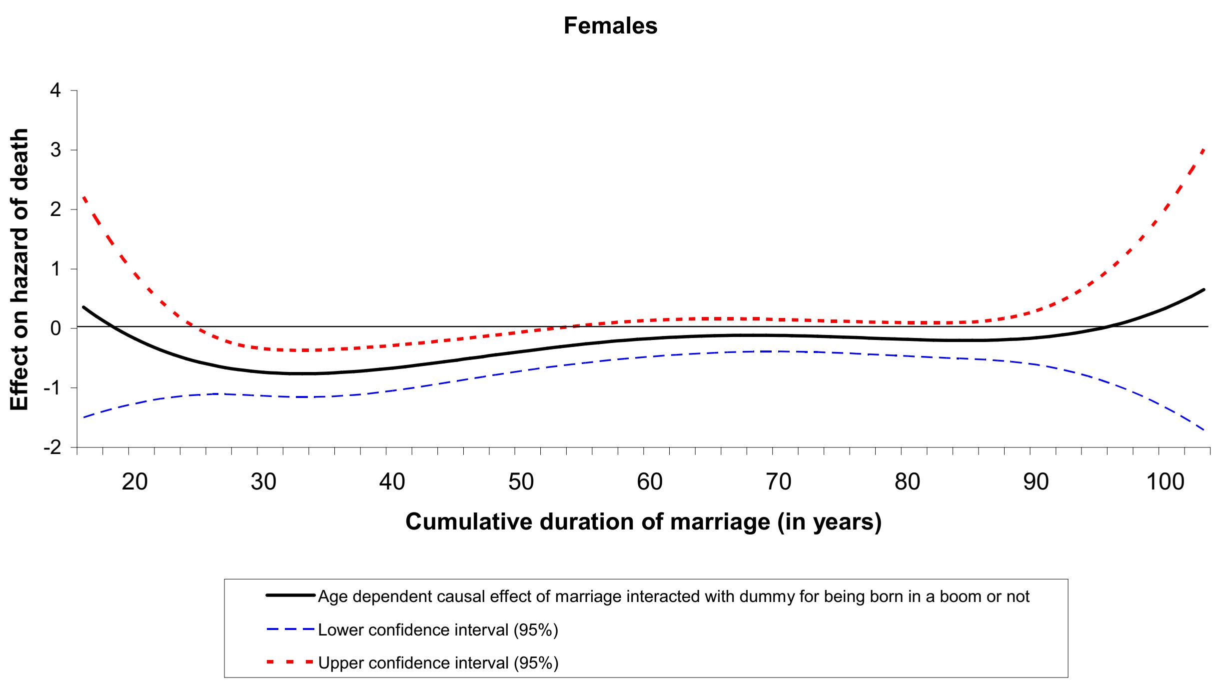


Figure 8: Cumulative duration of marriage dependent causal effect of marriage on the hazard of death interacted with born in a year of an economic boom or not (Specification 6)

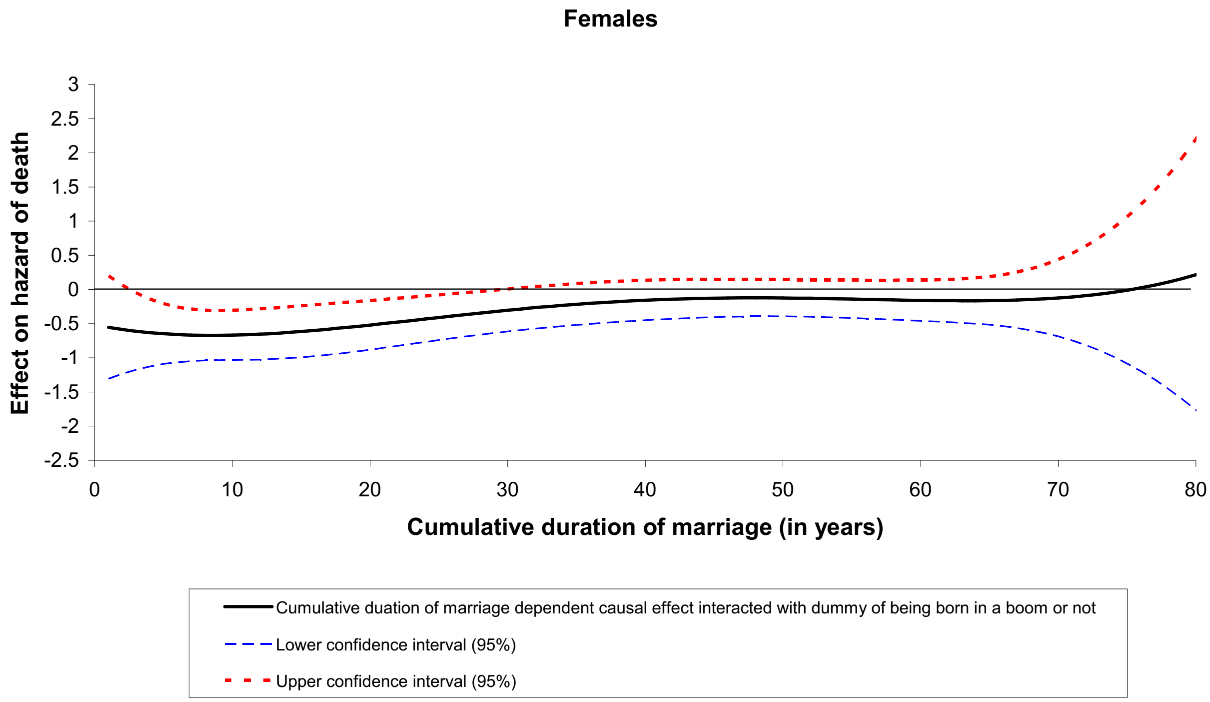


Table 1: Social Class Description

Social Class	General Description Examples
1	Unskilled labourers: diker, day labourer, dock worker
2	Semi-skilled labourers, low-level clerks: cow milker, beer brewer, farm labourer, gardner, florist, fisherman, wool sorter, tailor, painter
3	Small old and new middle class, skilled labourers, small farmers and gardners, clerks and low-level civil servants: potato farmer, barber, baker, shoemaker, smith, shop-keeper, mason, carpenter
4	Farmers and gardeners with average-sized farms,old and new middle class and medium-level civil servants: bailiff, corn dealer, merchant, innkeeper, miller
5	Higher staff, presidents of smaller firms, high-level civil - servants, farmers and gardners with large farms: factory manager, headmaster, infantry captain
6	Self-employed academics, teachers in secondary education, presidents of larger firms and top-level civil servants: auditor, lawyer, pharmacist, surgeon, professor

The general descriptions are based on Van Tulder (1962).

Table 2(a). Sizes and compositions of three different categories of people observed in the sample - those who never marry, those whose marriage and death date both are observed and those who are right censored at marriage. Percentage compositions by social class (categories 1-6 along the columns) and gender (rows).

		Social Class					
	Total	1	2	3	4	5	6
Number of Individuals	5593	2045	902	1343	1139	111	53
Men	2709	1015	440	617	561	46	30
Women	2884	1034	462	726	578	65	23
% Type 0: Never Married	21.38	32.78	15.80	26.17	19.98	2.84	2.42
% Men	53.85	33.07	15.68	24.38	22.05	2.17	2.64
% Women	46.15	32.43	15.94	28.26	17.57	3.62	2.17
% Type 1: Married-Dead	52.91	39.07	16.63	22.14	20.04	1.69	0.44
% Men	48.16	40.14	16.91	21.89	19.51	1.12	0.42
% Women	51.84	38.07	16.36	22.36	20.53	2.22	0.46
% Type 2: Married-Cens.	25.71	34.56	15.37	26.08	21.35	1.88	0.76
% Men	44.51	35.94	15.31	23.13	22.03	2.50	1.09
% Women	55.49	33.46	15.41	28.45	20.80	1.38	0.50

Table 2(b) Summary statistics of the sample of never married people whose death date only is observed (Type 0).

	Social Class						
	Total	1	2	3	4	5	6
Age of Death	57.10* [65.89] (25.22)	58.28* [67.24] (24.33)	54.82* [62.44] (26.61)	57.54* [67.73] (25.31)	56.62* [64.46] (25.29)	53.60* [65.08] (26.01)	59.57* [70.13] (26.14)
Men	53.87* [61.02] (24.91)	56.23* [64.26] (24.29)	50.62* [54.80] (25.66)	51.98* [56.24] (25.61)	55.25* [62.49] (23.89)	42.69* [25.48] (25.52)	58.84* [75.62] (26.63)
Women	60.88* [70.36] (25.09)	60.71* [69.48] (24.21)	59.64* [72.44] (27.00)	63.13* [71.50] (23.79)	58.62* [67.03] (27.20)	61.23* [70.70] (24.09)	60.61* [68.73] (26.57)

Table 2(c) Summary statistics of the sample of people whose marriage and death dates are both observed (Type1)

	Social Class						
	Total	1	2	3	4	5	6
Age of Marriage	28.32* [26.34] (7.48)	27.81* [26.06] (7.36)	28.84* [26.32] (8.22)	28.51* [26.58] (7.18)	28.48* [26.72] (7.18)	29.89* [28.10] (8.49)	30.72* [26.08] (9.88)
Men	29.59* [27.32] (7.90)	29.05* [26.84] (7.99)	29.46* [27.20] (8.07)	29.52* [27.09] (7.49)	30.59* [28.28] (7.66)	35.51* [31.54] (11.15)	27.06* [26.87] (4.05)
Women	27.14* [25.42] (6.86)	26.59* [25.13] (6.45)	28.24* [25.65] (8.34)	27.60* [25.95] (6.77)	26.62* [24.99] (6.17)	27.25* [26.41] (5.30)	33.85* [26.08] (12.52)
Age of Death	70.82* [74.76] (16.36)	70.82* [74.86] (16.37)	69.52* [73.45] (16.96)	71.87* [75.02] (15.82)	70.72* [74.99] (16.17)	72.06* [76.76] (18.28)	66.95* [71.72] (19.36)
Men	71.27* [74.34] (15.07)	71.41* [74.47] (15.23)	70.66* [73.63] (15.87)	71.11* [73.71] (14.76)	71.79* [75.17] [75.17]	70.19* [69.45] (15.92)	69.93* [72.09] (11.55)
Women	70.40* [75.10] (17.47)	70.24* [75.06] (17.41)	68.42* [73.14] (17.91)	72.56* [76.54] (16.71)	69.78* [74.56] (17.49)	72.94* [78.93] (19.46)	64.39* [66.28] (24.95)

Table 2(d). Summary statistics of the sample of censored people whose marriage date only is observed (Type 2).

	Social Class						
	Total	1	2	3	4	5	6
Age of Marriage	27.90* [26.21] (6.67)	27.32* [25.88] (6.18)	28.31* [25.81] (7.20)	28.31* [26.31] (7.34)	27.92* [26.80] (6.31)	28.72* [27.55] (5.06)	30.25* [28.36] (5.30)
Men	28.97* [26.99] (7.14)	28.24* [26.73] (6.01)	29.59* [27.01] (8.28)	28.68* [26.46] (8.09)	29.87* [28.28] (7.14)	30.07* [29.95] (5.87)	29.62* [28.36] (3.52)
Women	27.06* [25.51] (6.14)	26.52* [24.80] (6.21)	27.29* [25.45] (6.05)	27.29* [26.22] (6.81)	26.27* [25.27] (4.96)	26.76* [25.91] (2.80)	31.35* [29.20] (8.14)

Table 3 Parameter estimates for the baseline bivariate model for the individual marriage and mortality rates

Variable	Full Sample		Men		Women	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
Individual background characteristics affecting hazard of marriage:						
Female	1.16	2.45				
Social class father at birth	-0.08	-4.41	-0.11	-4.00	-0.04	-1.59
Father is literate	-0.11	-1.51	-0.03	-0.26	-0.13	-1.37
Born in urban area	-0.07	-1.27	0.10	1.14	-0.19	-2.52
Born in province Utrecht*	0.04	0.73	0.12	1.42	0.02	0.27
Born in province Zeeland*	0.17	3.20	0.10	1.26	0.24	3.38
Business cycle conditions early in life affecting hazard of marriage:						
Boom (instead of recession) at birth	-0.04	-0.68	-0.01	-0.15	-0.08	-1.00
Cycle indicator for age 1 up to 6	-0.01	-0.20	-0.12	-1.51	0.03	0.45
Cycle indicator for age 7 up to 12	-0.11	-1.96	-0.20	-2.45	-0.08	-1.03
Cycle indicator for age 13 up to 15	-0.05	-0.80	-0.09	-1.07	-0.02	-0.28
Exposure to epidemics early in life affecting hazard of marriage:						
1849 Cholera in Utrecht during age 1-6	-0.14	-0.10	-0.03	-0.01	0.09	0.06
1870/1 smallpox during age 1-6	-0.89	-1.98	0.13	0.21	-1.83	-2.79
1849 Cholera in Utrecht during age 7-12	-2.40	-1.61	-1.90	-0.93	-3.10	-1.31
1870/1 smallpox during age 7-12	0.05	0.10	-0.10	-0.14	0.03	0.04
1849 Cholera in Utrecht during age 13-15	-0.81	-1.20	-2.99	-1.72	-3.21	-1.89
1870/1 smallpox during age 13-15	0.44	1.02	0.41	0.62	1.28	2.05
Contemporaneous macro conditions affecting hazard of marriage:						
1849 Cholera in Utrecht	-0.42	-1.01	-0.28	-0.48	-0.56	-0.95
1870/1 smallpox	-0.02	-0.11	-0.14	-0.57	0.11	0.50
1918 influenza	0.13	0.91	0.16	0.72	0.14	0.69
World War II (GNP missing)	-3.09	-4.04	-2.34	-2.21	-4.43	-3.85
Current Trend (log annual real per capita GNP)	-0.22	-2.68	-0.17	-1.46	-0.32	-2.94
Current Cycle (log annual real per capita GNP)	0.68	1.99	1.04	2.03	0.42	0.91
Age effect on hazard of marriage:						
η_0^m	-9.38	-7.10	-9.59	-5.62	-15.91	-5.04
η_1^m	-8.85	-5.79	-8.04	-4.40	-19.29	-4.65
η_2^m	-13.33	-8.56	-14.18	-7.16	-22.83	-5.77
η_3^m	-3.81	-4.48	-3.62	-3.45	-8.97	-4.21
η_4^m	-4.69	-10.10	-5.28	-8.11	-7.11	-7.65
Unobserved heterogeneity terms for marriage:						
v_m^1	-1.74	-15.77	-1.82	-12.02	-1.40	-9.56
v_m^2	0.60	23.72	0.67	17.43	0.77	16.42
Unobserved heterogeneity terms for death:						
v_d^1	0.20	6.38	0.15	3.19	0.18	6.37
v_d^2	-1.20	-3.01	-1.11	-1.63	-1.46	-2.58
Joint probabilties of unobserved heterogeneities:						
q_1	0.38	14.39	0.42	9.27	0.48	12.64
q_2	0.38	13.81	0.39	10.19	0.31	9.09
q_3	0.12	5.63	0.11	2.88	0.13	5.44
q_4	0.12	5.48	0.08	2.53	0.08	4.09

Table 3 (contd.)						
Variable	Full Sample		Men		Women	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
Individual background characteristics affecting hazard of death:						
Female	-3.45	-2.99				
Social class father at birth	0.00	0.23	0.02	0.84	-0.02	-0.79
Father is literate	-0.03	-0.47	-0.09	-1.07	0.04	0.69
Born in urban area	0.07	1.41	0.19	2.79	-0.06	-0.77
Born in province Utrecht*	0.24	4.51	0.21	2.92	0.27	0.00
Born in province Zeeland*	0.11	2.32	0.07	0.99	0.15	0.03
Business cycle conditions early in life affecting hazard of death:						
Boom (instead of recession) at birth	-0.16	-3.16	-0.27	-3.95	-0.00	-0.06
Cycle indicator for age 1 up to 6	0.01	0.29	0.02	0.31	0.00	0.02
Cycle indicator for age 7 up to 12	-0.13	-2.64	-0.15	-2.18	-0.09	-1.19
Cycle indicator for age 13 up to 15	-0.06	-1.23	-0.05	-0.68	-0.09	-1.17
Exposure to epidemics early in life affecting hazard of death:						
1849 Cholera in Utrecht during age 1-6	0.65	0.62	-0.27	-0.20	0.91	0.65
1870/1 smallpox during age 1-6	-1.49	-3.13	-1.26	-1.99	-1.71	-2.59
1849 Cholera in Utrecht during age 7-12	2.02	1.96	3.33	2.61	0.21	0.13
1870/1 smallpox during age 7-12	-1.49	-2.79	-1.05	-1.51	-2.22	-2.86
1849 Cholera in Utrecht during age 13-15	-0.16	-3.88	-1.05	-0.90	-1.07	-1.33
1870/1 smallpox during age 13-15	0.46	9.57	0.61	0.33	-0.07	-0.12
Contemporaneous macro conditions affecting hazard of death:						
1849 cholera in Utrecht	1.13	2.51	1.58	3.13	0.25	0.25
1870/1 smallpox	0.58	2.46	0.36	0.99	0.76	2.46
1918 influenza	-0.08	-0.43	-0.02	-0.08	-0.13	-0.46
World War II (GNP missing)	-4.78	-11.41	-3.50	-5.78	-6.50	-10.50
Current Trend (log annual real per capita GNP)	-0.59	-12.03	-0.45	-6.31	-0.79	-10.81
Current Cycle (log annual real per capita GNP)	0.24	0.68	0.02	0.05	0.50	0.99
Effect of marital status on the hazard of death:						
Married	-0.05	-0.89	-0.29	-3.61	0.13	1.69
Age effect on hazard of death:						
η_0^d	1.21	3.07	0.23	0.40	2.61	4.46
η_1^d	1.98	28.66	1.80	17.81	2.21	23.44
η_2^d	0.79	10.65	0.80	7.07	0.83	7.30
η_3^d	0.14	2.59	-0.03	-0.54	0.33	4.41
η_4^d	-0.20	-3.99	-0.10	-1.28	-0.24	-3.28

Table 4 Parameter estimates of Model 2 with cumulative marriage effect on mortality rates

Variable	Full Sample		Men		Women	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
Individual background characteristics affecting hazard of marriage:						
Female	0.45	9.49				
Social class father at birth	-0.08	-4.35	-0.11	-4.00	-0.04	-1.50
Father is literate	-0.11	-1.52	-0.02	-0.16	-0.13	-1.39
Born in urban area	-0.07	-1.52	0.09	1.14	-0.20	-2.55
Born in province Utrecht*	0.04	0.75	0.12	1.41	0.02	0.26
Born in province Zeeland*	0.17	3.24	0.09	1.23	0.24	3.42
Business cycle conditions early in life affecting hazard of marriage:						
Boom (instead of recession) at birth	-0.04	-0.70	-0.01	-0.11	-0.07	-0.95
Cycle indicator for age 1 up to 6	-0.01	-0.19	-0.12	-1.54	0.03	0.48
Cycle indicator for age 7 up to 12	-0.11	-1.98	-0.20	-2.35	-0.07	-0.92
Cycle indicator for age 13 up to 15	0.20	2.38	0.13	0.85	0.16	1.39
Exposure to epidemics early in life affecting hazard of marriage:						
1849 Cholera in Utrecht during age 1-6	-0.12	-0.09	-0.11	-0.05	0.07	0.05
1870/1 smallpox during age 1-6	-0.89	-1.98	0.13	0.22	-1.80	-2.75
1849 Cholera in Utrecht during age 7-12	-2.37	-1.58	-1.86	-0.90	-2.82	-1.20
1870/1 smallpox during age 7-12	0.03	0.06	-0.08	-0.11	0.01	0.01
1849 Cholera in Utrecht during age 13-15	-3.42	-2.95	-2.95	-1.71	-3.10	-1.81
1870/1 smallpox during age 13-15	1.15	2.44	0.36	0.55	1.25	2.00
Contemporaneous macro conditions affecting hazard of marriage:						
1849 Cholera in Utrecht	-0.42	-1.01	-0.27	-0.47	-0.56	-0.95
1870/1 smallpox	-0.02	-0.11	-0.14	-0.59	0.11	0.49
1918 influenza	0.13	0.92	0.16	0.72	0.14	0.70
World War II (GNP missing)	-3.12	-4.07	-2.36	-2.21	-4.47	-3.89
Current Trend (log annual real per capita GNP)	-0.23	-2.72	-0.18	-1.46	-0.33	-2.99
Current Cycle (log annual real per capita GNP)	0.97	3.04	0.85	1.22	0.61	1.45
Age effect on hazard of marriage:						
η_0^m	-9.37	-7.08	-9.39	-5.48	-15.99	-5.07
η_1^m	-8.87	-5.80	-7.86	-4.30	-19.45	-4.69
η_2^m	-13.37	-8.58	-13.99	-7.06	-23.00	-5.82
η_3^m	-3.82	-4.50	-3.52	3.36	-9.06	-4.26
η_4^m	-4.72	-10.14	-5.21	-8.00	-7.17	-7.35
Unobserved heterogeneity terms for marriage:						
v_m^1	-1.73	-15.81	-1.83	-11.97	-1.40	-9.63
v_m^2	0.60	23.74	0.66	17.45	0.78	16.73
Unobserved heterogeneity terms for death:						
v_d^1	0.16	6.03	0.26	4.22	0.17	5.95
v_d^2	-1.24	-2.81	-1.11	-2.06	-1.43	-2.47
Joint probabilties of unobserved heterogeneities:						
q_1	0.39	14.47	0.38	8.82	0.47	11.81
q_2	0.41	14.88	0.31	6.58	0.34	9.83
q_3	0.11	5.27	0.14	3.70	0.14	5.31
q_4	0.09	4.03	0.16	3.76	0.05	2.70

Table 4 (contd.)						
Variable	Full Sample		Men		Women	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
Individual background characteristics affecting hazard of death:						
Female	-0.15	-3.88				
Social class father at birth	0.00	0.18	0.02	0.66	-0.02	-0.85
Father is literate	-0.02	-0.41	-0.08	-0.93	0.05	0.54
Born in urban area	0.07	1.35	0.21	2.85	-0.06	-0.79
Born in province Utrecht*	0.24	4.62	0.21	2.76	0.27	3.62
Born in province Zeeland*	0.12	2.54	0.04	0.58	0.16	2.39
Business cycle conditions early in life affecting hazard of death:						
Boom (instead of recession) at birth	-0.17	-3.28	-0.29	-3.98	-0.01	-0.12
Cycle indicator for age 1 up to 6	0.02	0.40	0.03	0.39	0.01	0.12
Cycle indicator for age 7 up to 12	-0.13	-2.67	-0.16	-2.25	-0.10	-1.38
Cycle indicator for age 13 up to 15	0.50	2.35	0.42	0.97	0.28	0.99
Exposure to epidemics early in life affecting hazard of death:						
1849 Cholera in Utrecht during age 1-6	0.62	0.60	0.18	1.63	0.97	0.67
1870/1 smallpox during age 1-6	-1.55	-3.36	-1.18	-1.65	-1.74	-2.64
1849 Cholera in Utrecht during age 7-12	1.82	1.84	4.07	2.89	0.03	0.02
1870/1 smallpox during age 7-12	-1.54	-2.99	-0.95	-1.26	-2.32	-3.00
1849 Cholera in Utrecht during age 13-15	-0.81	-1.18	-0.85	-0.64	-0.85	-0.99
1870/1 smallpox during age 13-15	0.42	1.00	0.80	1.19	0.06	0.10
Contemporaneous macro conditions affecting hazard of death:						
1849 cholera in Utrecht	1.14	2.53	1.54	3.04	0.31	0.30
1870/1 smallpox	0.57	2.44	0.35	0.97	0.74	2.40
1918 influenza	-0.08	-0.41	-0.03	-0.11	-0.13	-0.43
World War II (GNP missing)	-4.82	-11.56	-3.54	-5.57	-6.46	-10.69
Current Trend (log annual real per capita GNP)	-0.60	-12.17	-0.45	-6.07	-0.78	-10.99
Current Cycle (log annual real per capita GNP)	0.96	2.38	1.08	1.44	0.38	0.82
Effect of marital status on the hazard of death:						
η_0^{cpe}	0.52	2.33	0.55	1.16	0.28	0.91
η_1^{cpe}	0.26	0.74	0.02	0.04	0.57	1.12
η_2^{cpe}	-0.06	-1.10	-0.08	-1.04	-0.08	-1.09
η_3^{cpe}	0.68	2.00	1.03	2.00	0.43	0.92
η_4^{cpe}	-0.04	-0.77	-0.09	-1.04	-0.02	-0.25
Age effect on hazard of death:						
η_0^d	1.28	3.25	0.23	0.39	2.53	4.38
η_1^d	1.97	26.17	1.82	15.51	2.22	22.08
η_2^d	0.80	9.99	0.73	6.21	0.93	7.51
η_3^d	0.04	0.58	-0.06	-0.64	0.16	1.67
η_4^d	-0.17	-3.00	-0.19	-2.20	-0.15	-1.85

Table 5. Parameter estimates of Model 3 with age dependent marriage effect on mortality rates

Variable	Full Sample		Men		Women	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
Individual background characteristics affecting hazard of marriage:						
Female	0.45	9.47				
Social class father at birth	-0.08	-4.35	-0.11	-4.00	-0.04	-1.55
Father is literate	-0.11	-1.52	-0.03	-0.26	-0.13	-1.38
Born in urban area	-0.07	-1.30	0.09	1.14	-0.19	-2.53
Born in province Utrecht*	0.04	0.75	0.12	1.41	0.02	0.27
Born in province Zeeland*	0.17	3.24	0.10	1.27	0.24	3.39
Business cycle conditions early in life affecting hazard of marriage:						
Boom (instead of recession) at birth	-0.04	-0.70	-0.01	-0.16	-0.08	-0.98
Cycle indicator for age 1 up to 6	-0.01	-0.19	-0.12	-1.51	0.03	0.46
Cycle indicator for age 7 up to 12	-0.11	-1.98	-0.21	-2.45	-0.08	-0.99
Cycle indicator for age 13 up to 15	0.08	0.74	0.21	1.16	-0.12	-0.79
Exposure to epidemics early in life affecting hazard of marriage:						
1849 Cholera in Utrecht during age 1-6	-0.12	-0.09	-0.02	-0.01	0.09	0.05
1870/1 smallpox during age 1-6	-0.89	-1.98	0.13	0.21	-1.82	-2.77
1849 Cholera in Utrecht during age 7-12	-2.37	-1.58	-1.90	-0.92	-2.99	-1.27
1870/1 smallpox during age 7-12	0.03	0.06	-0.10	-0.14	0.02	0.03
1849 Cholera in Utrecht during age 13-15	-3.43	-2.95	-3.00	-1.72	-3.17	-1.86
1870/1 smallpox during age 13-15	1.15	2.44	0.41	0.62	1.27	2.02
Contemporaneous macro conditions affecting hazard of marriage:						
1849 cholera in Utrecht	-0.42	-1.01	-0.28	-0.48	-0.56	-0.95
1870/1 smallpox	-0.02	-0.11	-0.14	-0.57	0.11	0.50
1918 influenza	0.14	0.92	0.16	0.72	0.14	0.69
World War II (GNP missing)	-3.12	-4.07	-2.33	-2.19	-4.44	-3.85
Current Trend (log annual real per capita GNP)	-0.23	-2.71	-0.17	-1.44	-0.32	-2.95
Current Cycle (log annual real per capita GNP)	0.37	1.89	0.23	0.60	0.24	0.91
Age effect on hazard of marriage:						
η_0^m	-9.39	-7.10	-9.55	-5.58	-15.97	-5.07
η_1^m	-8.88	-5.82	-8.03	-4.39	-19.40	-4.69
η_2^m	-13.39	-8.60	-14.21	-7.17	-22.94	-5.82
η_3^m	-3.83	-4.51	-3.62	-3.46	-9.03	-4.25
η_4^m	-4.72	-10.16	-5.29	-8.15	-7.15	-7.33
Unobserved heterogeneity terms for marriage:						
v_m^1	-1.73	-15.79	-1.81	-12.01	-1.40	-9.57
v_m^2	0.60	23.74	0.67	17.42	0.77	16.52
Unobserved heterogeneity terms for death:						
v_d^1	0.17	6.12	0.16	3.71	0.17	6.04
v_d^2	-1.24	-2.85	-1.20	-1.78	-1.46	-2.46
Joint probabilties of unobserved heterogeneities:						
q_1	0.39	14.73	0.41	9.91	0.48	12.60
q_2	0.41	15.85	0.39	10.54	0.33	9.48
q_3	0.11	5.56	0.11	3.43	0.13	5.32
q_4	0.09	4.67	0.08	2.84	0.07	3.54

Table 5 (contd.)						
Variable	Full Sample		Men		Women	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
Individual background characteristics affecting hazard of death:						
Female	-0.16	-3.97				
Social class father at birth	0.00	0.17	0.02	0.68	-0.02	-0.87
Father is literate	-0.02	-0.36	-0.07	-0.85	0.05	0.54
Born in urban area	0.07	1.42	0.21	2.91	-0.05	-0.73
Born in province Utrecht*	0.25	4.73	0.23	3.08	0.27	3.65
Born in province Zeeland*	0.12	2.61	0.07	1.08	0.16	2.39
Business cycle conditions early in life affecting hazard of death:						
Boom (instead of recession) at birth	-0.18	-3.38	-0.29	-4.03	-0.01	-0.19
Cycle indicator for age 1 up to 6	0.02	0.45	0.03	0.46	0.01	0.13
Cycle indicator for age 7 up to 12	-0.14	-2.78	-0.17	-2.39	-0.09	-1.25
Cycle indicator for age 13 up to 15	0.01	0.04	0.12	0.48	0.07	0.38
Exposure to epidemics early in life affecting hazard of death:						
1849 Cholera in Utrecht during age 1-6	0.63	0.61	-0.28	-0.19	1.04	0.74
1870/1 smallpox during age 1-6	-1.61	-3.48	-1.36	-2.07	-1.79	-2.73
1849 Cholera in Utrecht during age 7-12	1.83	1.84	3.33	2.56	0.17	0.12
1870/1 smallpox during age 7-12	-1.55	-2.98	-1.07	-1.51	-2.35	-3.01
1849 Cholera in Utrecht during age 13-15	-0.85	-1.27	-1.20	-1.02	-0.96	-1.18
1870/1 smallpox during age 13-15	0.45	1.05	0.66	1.03	0.03	0.06
Contemporaneous macro conditions affecting hazard of death:						
1849 cholera in Utrecht	1.16	2.57	1.57	3.11	0.34	0.33
1870/1 smallpox	0.58	2.46	0.36	0.98	0.76	2.46
1918 influenza	-0.09	-0.45	-0.03	-0.12	-0.14	-0.47
World War II (GNP missing)	-4.88	-11.52	-3.55	-5.59	-6.63	-10.82
Current Trend (log annual real per capita GNP)	-0.60	-12.11	-0.45	-6.08	-0.80	-11.11
Current Cycle (log annual real per capita GNP)	-0.37	-2.27	-0.02	-0.05	-0.42	-2.13
Effect of marital status on the hazard of death:						
η_0^{ape}	0.17	1.46	-0.14	-0.60	0.29	2.00
η_1^{ape}	0.22	0.62	-0.05	-0.09	0.51	1.01
η_2^{ape}	-0.06	-1.23	-0.07	-0.93	-0.09	-1.14
η_3^{ape}	0.68	2.00	1.04	2.03	0.43	0.91
η_4^{ape}	-0.04	-0.78	-0.09	-1.07	-0.02	-0.27
Age effect on hazard of death:						
η_0^{d}	1.35	3.35	0.23	0.37	2.74	4.68
η_1^{d}	1.95	25.46	1.83	14.58	2.14	20.51
η_2^{d}	0.83	8.16	0.70	3.95	1.02	7.42
η_3^{d}	-0.05	-0.73	-0.13	-1.81	0.03	0.29
η_4^{d}	-0.15	-1.89	-0.24	-1.90	-0.02	-0.16

Table 6. Parameter estimates of Model 4 with cumulative marriage duration and age dependent marriage effect on mortality rates

Variable	Full Sample		Men		Women	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
Individual background characteristics affecting hazard of marriage:						
Female	0.46	9.54				
Social class father at birth	-0.08	-4.40	-0.11	-4.05	-0.04	-1.46
Father is literate	-0.11	-1.50	-0.01	-0.07	-0.13	-1.38
Born in urban area	-0.07	-1.28	0.10	1.24	-0.20	-2.55
Born in province Utrecht*	0.04	0.73	0.12	1.38	0.02	0.26
Born in province Zeeland*	0.17	3.20	0.09	0.08	0.24	3.43
Business cycle conditions early in life affecting hazard of marriage:						
Boom (instead of recession) at birth	-0.04	-0.68	-0.00	-0.04	-0.07	-0.93
Cycle indicator for age 1 up to 6	-0.01	-0.20	-0.12	-1.54	0.04	0.49
Cycle indicator for age 7 up to 12	-0.11	-1.96	0.18	-2.14	-0.07	-0.88
Cycle indicator for age 13 up to 15	0.69	2.69	0.38	0.70	0.24	0.66
Exposure to epidemics early in life affecting hazard of marriage:						
1849 Cholera in Utrecht during age 1-6	-0.14	-0.10	-0.75	-0.33	0.07	0.04
1870/1 smallpox during age 1-6	-0.89	-1.98	0.12	0.21	-1.79	-2.74
1849 Cholera in Utrecht during age 7-12	-2.40	-1.61	-1.80	-0.86	-2.71	-1.16
1870/1 smallpox during age 7-12	0.05	0.10	-0.04	-0.05	0.00	0.00
1849 Cholera in Utrecht during age 13-15	-3.45	-2.98	-2.94	-1.71	-3.07	-1.79
1870/1 smallpox during age 13-15	1.16	2.44	0.30	0.66	1.24	1.97
Contemporaneous macro conditions affecting hazard of marriage:						
1849 cholera in Utrecht	-0.42	-1.01	-0.26	-0.44	-0.56	-0.94
1870/1 smallpox	-0.02	-0.11	-0.15	-0.63	0.10	0.49
1918 influenza	0.13	0.91	0.16	0.72	0.14	0.71
World War II (GNP missing)	-3.09	-4.03	-2.42	-2.27	-4.49	-3.90
Current Trend (log annual real per capita GNP)	-0.22	-2.67	-0.18	-1.52	-0.33	-3.01
Current Cycle (log annual real per capita GNP)	0.09	0.57	0.36	1.17	0.22	0.98
Age effect on hazard of marriage:						
η_0^m	-9.38	-7.08	-9.08	-5.30	-16.08	-5.02
η_1^m	-8.85	-5.79	-7.57	-4.13	-19.58	-4.65
η_2^m	-13.34	-8.55	-13.57	-6.84	-23.14	-5.78
η_3^m	-3.81	-4.48	-3.36	-3.19	-9.13	-4.24
η_4^m	-4.70	-10.09	-5.03	-7.71	-7.21	-7.35
Unobserved heterogeneity terms for marriage:						
v_m^1	-1.74	-15.75	-1.86	-11.86	-1.40	-9.64
v_m^2	0.60	23.69	0.64	17.89	0.78	16.89
Unobserved heterogeneity terms for death:						
v_d^1	0.17	6.01	0.33	6.31	0.17	6.26
v_d^2	-1.24	-2.80	-1.26	-2.72	-1.47	-2.53
Joint probabilties of unobserved heterogeneities:						
q_1	0.39	14.39	0.40	11.58	0.46	11.36
q_2	0.40	13.39	0.25	5.65	0.34	9.86
q_3	0.10	4.75	0.12	4.20	0.15	5.33
q_4	0.11	4.27	0.23	5.73	0.05	2.39

Table 6 (contd.)						
Variable	Full Sample		Men		Women	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
Individual background characteristics affecting hazard of death:						
Female	-0.17	-4.21				
Social class father at birth	0.00	0.19	0.02	0.74	-0.02	-0.85
Father is literate	-0.02	-0.38	-0.08	-0.81	0.04	0.51
Born in urban area	0.07	1.33	0.20	2.71	-0.05	-0.74
Born in province Utrecht*	0.24	4.63	0.21	2.69	0.27	3.60
Born in province Zeeland*	0.12	2.43	0.03	0.40	0.16	2.39
Business cycle conditions early in life affecting hazard of death:						
Boom (instead of recession) at birth	-0.18	-3.35	-0.32	-4.21	-0.01	-0.13
Cycle indicator for age 1upto 6	0.02	0.44	0.03	0.44	0.01	0.21
Cycle indicator for age 7 up to 12	-0.13	-2.64	-0.16	-2.17	-0.10	-1.29
Cycle indicator for age 13 up to 15	-0.03	-0.26	-0.16	-2.17	-0.19	-1.12
Exposure to epidemics early in life affecting hazard of death:						
1849 Cholera in Utrecht during age 1-6	0.74	0.70	0.41	0.23	0.07	0.04
1870/1 smallpox during age 1-6	-1.58	-3.40	-1.17	-1.53	-1.79	-2.74
1849 Cholera in Utrecht during age 7-12	1.94	1.93	4.73	3.15	-2.71	-1.16
1870/1 smallpox during age 7-12	-1.55	-2.98	-0.82	-1.02	0.00	0.00
1849 Cholera in Utrecht during age 13-15	-0.76	-1.11	-0.49	-0.34	-1.00	-1.18
1870/1 smallpox during age 13-15	0.43	1.02	0.84	1.24	-0.03	-0.05
Contemporaneous macro conditions affecting hazard of death:						
1849 cholera in Utrecht	1.15	2.55	1.51	2.98	0.32	0.31
1870/1 smallpox	0.58	2.46	0.35	0.95	0.75	2.43
1918 influenza	-0.08	-0.43	-0.02	-0.06	-0.13	-0.45
World War II (GNP missing)	-4.88	-11.44	-3.63	-5.51	-6.60	-10.79
Current Trend (log annual real per capita GNP)	-0.60	-12.03	-0.46	-5.99	-0.80	-11.08
Current Cycle (log annual real per capita GNP)	0.12	0.53	-0.33	-0.69	0.02	0.08
Effect of marital status on the hazard of death:						
η_0^{cpe}	-0.05	-0.79	-0.08	-0.97	-0.02	-0.24
η_1^{cpe}	0.91	2.35	0.52	0.57	0.34	0.62
η_2^{cpe}	0.73	2.03	-0.10	-0.11	0.61	1.25
η_3^{cpe}	0.42	1.75	-0.12	-0.22	0.42	1.29
η_4^{cpe}	0.16	1.62	0.00	0.02	0.21	1.54
η_1^{ape}	-0.30	-1.37	-0.09	-0.21	0.02	0.07
η_2^{ape}	0.24	0.68	0.02	0.05	0.55	1.08
η_3^{ape}	-0.06	-1.17	-0.07	-0.87	-0.09	-1.16
η_4^{ape}	0.68	1.99	0.98	1.92	0.43	0.92
Age effect on hazard of death:						
η_0^{d}	1.34	3.30	0.25	0.41	2.74	4.69
η_1^{d}	1.93	24.21	1.85	15.16	2.18	20.77
η_2^{d}	0.84	8.22	0.80	4.82	0.99	7.18
η_3^{d}	-0.06	-0.80	-0.11	-1.11	0.05	0.43
η_4^{d}	-0.13	-1.71	-0.25	-2.07	-0.05	-0.46

Table 7. Parameter estimates of Model 5 with age dependent marriage effect on mortality rates and age dependent marriage effect interacted with whether the individual is born in a boom or not

Variable	Full Sample		Men		Women	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
Individual background characteristics affecting hazard of marriage:						
Female	0.45	9.46				
Social class father at birth	-0.08	-4.35	-0.11	-4.00	-0.04	-1.55
Father is literate	-0.11	-1.52	-0.03	-0.27	-0.13	-1.38
Born in urban area	-0.07	-1.30	0.09	1.15	-0.20	-2.53
Born in province Utrecht*	0.04	0.75	0.12	1.42	0.02	0.27
Born in province Zeeland*	0.17	3.24	0.10	1.27	0.24	3.40
Business cycle conditions early in life affecting hazard of marriage:						
Boom (instead of recession) at birth	-0.04	-0.70	-0.01	-0.16	-0.08	-0.98
Cycle indicator for age 1 up to 6	-0.01	-0.19	-0.12	-1.50	0.03	0.46
Cycle indicator for age 7 up to 12	-0.11	-1.97	-0.21	-2.46	-0.08	-0.98
Cycle indicator for age 13 up to 15	-0.04	-0.22	0.14	0.54	-0.28	-1.29
Exposure to epidemics early in life affecting hazard of marriage:						
1849 Cholera in Utrecht during age 1-6	-0.12	-0.09	-0.05	-0.02	0.08	0.05
1870/1 smallpox during age 1-6	-0.89	-1.98	0.12	0.21	-1.82	-2.77
1849 Cholera in Utrecht during age 7-12	-2.37	-1.58	-1.90	-0.93	-2.98	-1.26
1870/1 smallpox during age 7-12	0.03	0.06	-0.11	-0.15	0.02	0.02
1849 Cholera in Utrecht during age 13-15	-3.43	-2.95	-3.01	-1.73	-3.17	-1.85
1870/1 smallpox during age 13-15	1.15	2.44	0.42	0.63	1.27	2.02
Contemporaneous macro conditions affecting hazard of marriage:						
1849 cholera in Utrecht	-0.42	-1.01	-0.28	-0.48	-0.56	-0.95
1870/1 smallpox	-0.02	-0.11	-0.13	-0.56	0.11	0.50
1918 influenza	0.14	0.92	0.16	0.72	0.14	0.69
World War II (GNP missing)	-3.12	-4.07	-2.34	-2.19	-4.45	-3.84
Current Trend (log annual real per capita GNP)	-0.23	-2.71	-0.17	-1.44	-0.33	-2.94
Current Cycle (log annual real per capita GNP)	0.20	0.63	0.16	0.60	-0.06	-0.15
Age effect on hazard of marriage:						
η_0^m	-9.39	-7.10	-9.56	-5.58	-15.98	-5.07
η_1^m	-8.88	-5.81	-8.05	-4.40	-19.41	-4.69
η_2^m	-13.39	-8.59	-14.27	-7.17	-22.95	-5.81
η_3^m	-3.83	-4.51	-3.63	-3.46	-9.04	-4.25
η_4^m	-4.72	-10.15	-5.30	-8.15	-7.15	-7.32
Unobserved heterogeneity terms for marriage:						
v_m^1	-1.73	-15.78	-1.81	-11.99	-1.40	-9.56
v_m^2	0.60	23.73	0.67	17.41	0.77	16.53
Unobserved heterogeneity terms for death:						
v_d^1	0.16	5.68	0.14	3.511	0.17	5.618
v_d^2	-1.24	-2.66	-1.25	-1.65	-1.41	-2.36
Joint probabilties of unobserved heterogeneities:						
q_1	0.39	14.38	0.42	10.24	0.48	12.12
q_2	0.41	15.69	0.40	11.26	0.33	9.36
q_3	0.11	5.10	0.11	3.16	0.13	4.98
q_4	0.09	4.28	0.07	2.53	0.07	3.38

Table 7 (contd.)						
Variable	Full Sample		Men		Women	
	Estimate	t-stat.	Estimate	t-stat.	Estimate	t-stat.
Individual background characteristics affecting hazard of death:						
Female	-0.16	-3.96				
Social class father at birth	0.00	0.17	0.02	0.68	-0.02	-0.86
Father is literate	-0.02	-0.31	-0.07	-0.79	0.05	0.54
Born in urban area	0.07	1.42	0.21	2.89	-0.06	-0.81
Born in province Utrecht*	0.25	4.74	0.23	3.12	0.28	3.67
Born in province Zeeland*	0.13	2.67	0.08	1.10	0.17	2.49
Business cycle conditions early in life affecting hazard of death:						
Boom (instead of recession) at birth	-0.12	-1.63	-0.32	-3.08	0.17	1.40
Cycle indicator for age 1upto 6	0.02	0.44	0.03	0.47	0.01	0.19
Cycle indicator for age 7 up to 12	-0.14	-2.74	-0.17	-2.36	-0.09	-1.24
Cycle indicator for age 13 up to 15	0.18	0.93	0.14	0.54	0.28	1.14
Exposure to epidemics early in life affecting hazard of death:						
1849 Cholera in Utrecht during age 1-6	0.57	0.55	-0.38	-0.27	0.98	0.68
1870/1 smallpox during age 1-6	-1.61	-3.50	3.31	2.58	-1.70	-2.57
1849 Cholera in Utrecht during age 7-12	1.80	1.84	-1.38	-2.14	0.14	0.09
1870/1 smallpox during age 7-12	-1.55	-3.00	-1.06	-1.51	-2.37	-3.04
1849 Cholera in Utrecht during age 13-15	-0.88	-1.30	-1.20	-1.03	-0.96	-1.12
1870/1 smallpox during age 13-15	0.44	1.02	0.63	0.99	0.08	0.15
Contemporaneous macro conditions affecting hazard of death:						
1849 cholera in Utrecht	1.14	2.52	1.55	3.07	0.31	0.31
1870/1 smallpox	0.57	2.41	0.35	0.97	0.74	2.37
1918 influenza	-0.08	-0.40	-0.02	-0.08	-0.12	-0.42
World War II (GNP missing)	-4.86	-11.38	-3.55	-5.57	-6.62	-10.66
Current Trend (log annual real per capita GNP)	-0.60	-11.98	-0.45	-6.05	-0.80	-10.93
Current Cycle (log annual real per capita GNP)	-0.28	-1.13	0.00	0.00	-0.31	-1.03
Effect of marital status on the hazard of death:						
η_0^{ape}	0.16	0.84	-0.18	-0.50	0.33	1.38
η_1^{ape}	0.23	0.35	-0.05	-0.11	0.54	1.06
η_2^{ape}	-0.06	-1.17	-0.06	-0.88	-0.08	-1.03
η_3^{ape}	0.68	0.34	1.04	2.03	0.43	0.91
η_4^{ape}	-0.04	-0.77	-0.09	-1.07	-0.02	-0.26
Age interacted with boom at birth $\left(\eta_0^{a,int}\right)$	0.02	0.07	0.08	0.18	-0.09	-0.31
Age interacted with boom at birth $\left(\eta_1^{a,int}\right)$	-0.18	-0.60	-0.12	-0.19	-0.23	-0.64
Age interacted with boom at birth $\left(\eta_2^{a,int}\right)$	0.36	0.98	0.22	0.30	0.55	1.16
Age interacted with boom at birth $\left(\eta_3^{a,int}\right)$	-0.38	-1.60	-0.29	0.64	-0.46	-1.54
Age interacted with boom at birth $\left(\eta_4^{a,int}\right)$	0.23	1.43	0.18	0.68	0.30	1.33
Age effect on hazard of death:						
η_0^{d}	1.29	3.17	0.24	0.39	2.62	4.41
η_1^{d}	1.94	24.65	1.83	14.19	2.13	19.94
η_2^{d}	0.83	7.97	0.71	3.91	1.01	7.20
η_3^{d}	-0.05	-0.73	-0.12	-1.09	0.03	0.31
η_4^{d}	-0.14	-1.78	-0.23	-1.82	-0.02	-0.16

Table 8. Parameter estimates of Model 6 with cumulative duration of marriage dependent marriage effect on mortality rates and cumulative duration of marriage dependent marriage effect interacted with whether the individual is born in a boom or not

Variable	Women	
	Estimate	t-stat.
Individual background characteristics affecting hazard of marriage:		
Social class father at birth	-0.04	-1.48
Father is literate	-0.13	-1.39
Born in urban area	-0.20	-2.55
Born in province Utrecht*	0.02	0.27
Born in province Zeeland*	0.24	3.43
Business cycle conditions early in life affecting hazard of marriage:		
Boom (instead of recession) at birth	-0.07	-0.93
Cycle indicator for age 1 up to 6	0.04	0.49
Cycle indicator for age 7 up to 12	-0.07	-0.90
Cycle indicator for age 13 up to 15	0.06	0.34
Exposure to epidemics early in life affecting hazard of marriage:		
1849 Cholera in Utrecht during age 1-6	0.07	0.04
1870/1 smallpox during age 1-6	-1.79	-2.74
1849 Cholera in Utrecht during age 7-12	-2.76	-1.18
1870/1 smallpox during age 7-12	0.01	0.01
1849 Cholera in Utrecht during age 13-15	-3.08	-1.79
1870/1 smallpox during age 13-15	1.25	1.99
Contemporaneous macro conditions affecting hazard of marriage:		
1849 cholera in Utrecht	-0.56	-0.94
1870/1 smallpox	0.10	0.49
1918 influenza	0.14	0.70
World War II (GNP missing)	-4.48	-3.89
Current Trend (log annual real per capita GNP)	-0.33	-3.00
Current Cycle (log annual real per capita GNP)	0.36	0.46
Age effect on hazard of marriage:		
η_0^m	-15.09	-4.62
η_1^m	-19.47	-4.70
η_2^m	-23.03	-5.83
η_3^m	-9.07	-4.26
η_4^m	-7.18	-7.36
Unobserved heterogeneity terms for marriage:		
v_m^1	-1.40	-9.62
v_m^2	0.78	16.78
Unobserved heterogeneity terms for death:		
v_d^1	0.17	5.7
v_d^2	-1.38	-2.44
Joint probabilties of unobserved heterogeneities:		
q_1	0.46	11.04
q_2	0.34	9.80
q_3	0.15	5.15
q_4	0.05	2.54

Table 8 (contd.)		
Variable	Women	
	Estimate	t-stat.
Individual background characteristics affecting hazard of death:		
Social class father at birth	-0.02	-0.81
Father is literate	0.04	0.47
Born in urban area	-0.07	-0.93
Born in province Utrecht*	0.28	3.66
Born in province Zeeland*	0.17	2.47
Business cycle conditions early in life affecting hazard of death:		
Boom (instead of recession) at birth	0.18	1.53
Cycle indicator for age 1upto 6	0.01	0.18
Cycle indicator for age 7 up to 12	-0.10	-1.30
Cycle indicator for age 13 up to 15	0.09	0.17
Exposure to epidemics early in life affecting hazard of death:		
1849 Cholera in Utrecht during age 1-6	0.81	0.56
1870/1 smallpox during age 1-6	-1.64	-2.47
1849 Cholera in Utrecht during age 7-12	0.08	0.05
1870/1 smallpox during age 7-12	0.71	2.31
1849 Cholera in Utrecht during age 13-15	-0.92	-1.05
1870/1 smallpox during age 13-15	0.10	0.18
Contemporaneous macro conditions affecting hazard of death:		
1849 cholera in Utrecht	0.29	0.28
1870/1 smallpox	0.71	2.31
1918 influenza	-0.11	-0.39
World War II (GNP missing)	-6.51	-10.63
Current Trend (log annual real per capita GNP)	-0.79	-10.91
Current Cycle (log annual real per capita GNP)	-0.00	-0.01
Effect of marital status on the hazard of death:		
η_0^{dpe}	0.19	0.32
η_1^{dpe}	0.60	1.18
η_2^{dpe}	-0.08	-1.02
η_3^{dpe}	0.43	0.92
η_4^{dpe}	-0.02	-0.24
Marriage duration interacted with boom at birth $\left(\eta_0^{d,int}\right)$	0.07	0.11
Marriage duration interacted with boom at birth $\left(\eta_1^{d,int}\right)$	0.62	0.63
Marriage duration interacted with boom at birth $\left(\eta_2^{d,int}\right)$	0.38	0.43
Marriage duration interacted with boom at birth $\left(\eta_3^{d,int}\right)$	0.35	0.63
Marriage duration interacted with boom at birth $\left(\eta_4^{d,int}\right)$	0.18	0.78
Age effect on hazard of death:		
η_0^{d}	2.29	3.66
η_1^{d}	2.23	21.54
η_2^{d}	0.92	7.18
η_3^{d}	0.16	1.73
η_4^{d}	-0.17	-2.02