The Marriage Age U-shape

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Abstract

Data from 160 countries show that during the twentieth century, western countries followed a U-shaped pattern in the age of first marriage of both genders, while other countries did not. I explain the uniqueness of this pattern in terms of the low labor force participation of married women at the start of the productivity boom. The rise of the "male" industries decreased the age of first marriage as long as the "female" industries remained small. The increase in the age of first marriage is driven by productivity spillovers into the female industries. The data of the U.S. gross state product by industry provides supporting evidence that the rise of the female sectors explains up to 30% of the U-shape's increasing portion for both genders. Additionally, evidence from the 1970s oil boom in Montana demonstrates how, in accordance with the model, the age of marriage followed a U-shape in the oil counties while it rose monotonically in the rest of the state.

1 Introduction

Today, in the West, economic development is associated with late marriage, but for most of the twentieth century the opposite was true: economic growth was associated with early marriage. As late as the early 1970s, prominent demographers were still predicting that in western countries the age of marriage would continue to decrease (Dixon (1971)). While in the twentieth century, a U-shaped pattern in the age of first marriage is prevalent in all western countries, prior to the twentieth century, the patterns were different across countries. For example, for most of the nineteenth century, the age of first marriage increased in the U.S. but decreased in England and France. In the U.S., the U-shape started with the Second Industrial Revolution, in northern and central Europe it started between the world wars, and in Southern Europe and Ireland it started after World War II. The U-shaped pattern is observed also in Western Offshoots, and the most developed of the Latin American countries. In some countries that can not be clearly characterized as western or non-western, such as Israel, only men experienced the U-shaped pattern. Generally, the pattern is sharper among wealthier nations. To show its prevalence in the West, and its absence in other regions, I construct the mean age of first marriage time series for 160 countries and territories[1]. Some examples are shown in Figure 1 (median age of first marriage in the U.S.) and Figure 2 (mean age of first marriage in Australia, Spain, and Norway). In contrast, Figure 3 shows a different pattern in Japan and Bulgaria, where no U-shape is observed.

Surprisingly, the U-shape phenomenon was not directly addressed in the literature. This phenomenon is of interest because of its uniqueness in the West, the large changes in the age of marriage during the decreasing and increasing portions, and the narrowing spousal age gap through the century. In the U.S., the median age of first marriage of men decreased from 26.1 to 22.8 between 1890 and 1965, while that of women decreased only from 22 to 20.6. Between 1965 and 2000, the median age of first marriage of men increased from 22.8 to 26.8 and that of women increased from 20.6 to 25.1. As a result, the spousal age gap narrowed monotonically over the century. A similar pattern is observed in most European countries.

The present paper explains the uniqueness of the U-shaped pattern in the West in terms of the twentieth-century dynamics of two forces pushing the age of marriage in opposite directions: each dollar produced in sectors where women cannot or choose not to work pushes the age of marriage down, whereas each dollar produced in sectors open for women, and preferred by them to not participating in the labor force, pushes it up. The economic growth dynamics determined that these two coexisting forces triggered a U-shaped pattern over the century. Across European countries, the U-shape perfectly mirrors the economic growth: the correlation between changes in the mean age of first marriage and

[1]The data for all countries are reported in Appendix A, and further details are provided in Appendix B.

changes in income per capita is -0.92 for men and -0.86 for women (see Figure 5). This negative correlation is also observed across the United States. In other words, the fast economic growth at the beginning of the income convergence process is associated with a declining age of marriage, and as growth slows down the age of marriage starts to rise. In southern Europe and Ireland, where the economy boomed in the 1960s and 1970s, the decreasing portion of the U-shape lasted for only twenty years. But it lasted for 40 - 50 years in northern and central Europe and for 75 years in the U.S., where the economic growth was more gradual.

In the West, female labor force participation was low after World War II but has risen sharply since then. Figure 4 shows female labor force participation over time in the countries used as examples of the marriage age pattern. In the countries with a U-shaped pattern, female labor force participation has risen sharply since 1950. In contrast, in the countries where no U-shape is observed, female labor force participation has remained constantly high. Another example is China, where female labor force participation dramatically increased after the founding of the People's Republic, much before the 1990s industrialization (Li (2000)). Indeed, Xu et al. (2003) report that the recent Chinese growth surge had a positive impact on the age of first marriage of men and women. Moreover, Mu and Xie (2011) present evidence of a widening mean spousal age gap in China since 1990.

I develop a simple dynamic model where two forces, growing monotonically over time, push the age of marriage in opposite directions such that the resulting pattern is a U-shape. The economy has two sectors of production. One sector requires male physical strength, while the second does not. Initially, most women are more productive as housewives than in the market and withdraw from the labor force after marriage. The model assumes that technological change starts in the male sector and spills over into the female sector. As male productivity booms, young low-skilled men become acceptable for marriage, and the probability of a successful match increases such that the mean age of marriage declines for both genders. However, technological spillovers from the male sector into the female one encourage a growing number of married women to work in the market, where their skills are better compensated than their housework. This growing proportion of women develops a high-skilled marriage market where the skills of both genders are heterogeneous, individuals search longer for a mate, and use college as a marriage market, postponing marriage to the end of studies.

After presenting the model, I empirically support it using both macro and micro data. First, I use the gross state product data, classifying the sectors of production as either "male" or "female." I group sectors into fundamentally male and potentially female, retrospectively, according to the 1990 employment shares.[2] The explained variables are the age of marriage and the probability of singlehood at each age between 19 and 25. The explanatory variables are the output per capita in the male and female sectors. The results show that the female sector's rise explains 20%-30% of the increase in the proportion of singles among young women and 15% of the increase in the proportion of singles among young men, for cohorts born between 1945 and 1965. Male singlehood at ages 23-25 is found to be the most affected, while female singlehood is similarly affected between ages 19 and 25. In the robustness check, I alternatively define the explanatory variables as the weighted labor productivity in the male and female sectors, rather than output per capita. In Appendix D, I extend the estimation to compare different OECD countries. Finally, the model is supported by evidence from case-study micro data. I use the sharp increase in oil prices in the 1970s as a natural experiment that affected the marriage market in Montana. Mining is one of the sectors that are clearly "male", and the oil prices boom provided a shock on male income which affected the marriage market similarly to the mechanism described in the model. Until the oil boom, all parts of Montana had a similar marriage pattern. But as oil prices climbed, the age of first marriage in the oil-producing eastern part of the state followed a U-shaped pattern, whereas in the non-oil-producing western part, it rose monotonically.

The difference between the western European marriage pattern and that of the rest of the world has been recorded since the Black Death (Hajnal (1965)). The present paper extends the research by explaining why the twentieth-century U-shape is a pattern unique to the West. The literature is increasingly focused on the link between the European Marriage Pattern (EMP) and female labor markets (De Moore and van Zanden (2006), Voigtländer and Voth (2013), Minguela (2011)). The EMP depicts a pattern of both late marriage (25 years and later in pre-industrial Europe) and a high proportion of never-married women. The Malthusian demographic regime explains the persistence

[2]The question of which sectors are "male" and which are "female" is ex-post, because at early stages of the analyzed period all sectors were occupied mostly by men.

of the EMP as a fertility restriction mechanism that was used for hundreds of years preceding the Industrial Revolution. Gradually, the role of the fertility restriction in the EMP declined, leading to a growing independence between the age of first marriage and the age at first birth (Coles and Francesconi (2013)). This growing independence, which started during the Demographic Transition, allowed a lower age of marriage with reduced fertility. The mean female age at first birth in the U.S. *rose* from 23 to 24 between 1890 and 1945, while the age of marriage decreased. The age of first marriage and the age of first birth change in the same direction again after 1945. Between 1945 and 1965 both of them decreased during the post-war baby boom, and since 1965 they have both increased.

While birth restriction is no longer the main determinant of marriage age, other factors play a larger role. For example, early urbanization decreased the age of marriage as marriage markets became larger and the dependence of marriage on land ownership diminished (Dixon (1971, 1978); Oppenheimer (1988)). The strongest factor increasing the independence of marriage and fertility was improving birth control technology and especially the introduction of the Pill in the 1960s. While in the EMP, birth control was a reason for late marriage, in the late twentieth century late marriage was allowed by the improved birth control technology. The Pill explains some 30% of the increase in the singlehood rates of young American women in the relevant cohorts (Goldin and Katz (2002), Edlund and Machado (2009)). The reason that women preferred postponing marriage was the increasing importance of female education, careers, and economic independence (Goldin (1990, 2006)). Goldin thoroughly describes the development of female college attendance in the U.S. until it overtook male college attendance in the 1980s, as well as the rise of female professional careers and married women labor force participation. This evolution of female labor force participation was driven by the decreasing value of the home production on the one hand, and the diminishing advantage of male labor on the other, as mental skills became more important than physical strength (Acemoglu (1999); Galor and Weil (1996); Godin and Katz (2008); Goldin (1995); Greenwood and Guner (2011); Greenwood et al (2012); Mokyr (2000)).

An additional factor that started in the late 1970s is that the redistribution of income contributes to the increasing age of marriage. Particularly, the income inequality across skills and ages has increased, while the gender wage gap has narrowed. The increasing income inequality encourages individuals to search longer for a mate and the increasing uncertainty triggers them to prefer older partners whose ex-post income potential is observed (Keeley (1977, 1979); Gould and Passerman (2002); Loughran (2002); Coughlin and Drewianka (2011); Danziger and Neuman (1999); Bergstrom and Bagnoli (1993); Bergstrom and Schoeni (1996); Blau et al. (2000); Fortin and Lemieux (2000); Mu and Xie (2011); Bloom and Bennett (1990)).

This paper is concerned with the age of first marriage and not with the prevalence of marriage. While in some western countries, such as Sweden, the prevalence of marriage has decreased sharply over the past century,[3] in others it has not dropped. In the U.S., for example, the proportion of never married women by age 50 was 10% in 1900 and 7% in 2000,[4] while the median female age of first marriage increased from 22 to 25, respectively. Increasing cohabitation is another recent issue not covered in this paper. In most western countries, especially Catholic ones, cohabitation rates remained very low during the analyzed period. For instance, in the early 1980s only about 1% of couples cohabited in Italy, and about 5% of never-married individuals cohabited in the U.S. (Sigritta (1988); Casper et al. (1999)).

The paper is organized as follows. Section 2 presents the dynamic model. Section 3 analyzes the by-sector output data across the U.S. to show, in accordance with the model, the opposite impact of the male and female sectors on the age of first marriage of both genders. Section 4 demonstrates the case study of Montana, where the 1970s oil boom in the eastern part of the state triggered a marriage age U-shape. Section 5 concludes.

2 Model

Motivation

This section develops a simple dynamic model with overlapping generations of single individuals. The model predicts the marriage-age U-shape over time. To summarize, technological development leads

[3]Despite decreasing rates of marriage in Sweden, most Swedes currently in relationship report that they expect to marry within five years (Bernhard (2004)).

[4]Calculated from Integrated Public Use Microdata Series (IPUMS).

to a gradual rise of both male "marriageability" and married women labor force participation. While increasing male marriageability leads to a shorter search for mates and a decreasing age of marriage, the increased labor force participation of married women has the opposite impact. The basic idea is that while housewives produce a homogenous home product, the productivity of women who work in the market varies across women. According to the search and matching literature, the more heterogeneous the marriage market is, the longer the search for a mate is.

This basic model is consistent with the marriage age U-shape and the rise of married women labor force participation in the U.S., as well as with the following additional facts observed in the American data. The first fact is the rise of labor force participation among educated young married females: while in 1950, around 80% of young married women did not participate in the labor force regardless of education, in 1980, the educated young married women participated in much larger proportions than the uneducated ones. Second, marriage in the U.S. is positive assortative by education, with about 60% marrying within the same educational group (Schwartz and Mare (2005)).

In the data, the U-shaped patterns differ by length. The U.S. and northern Europe experienced a long U-shape while southern Europe and Ireland experienced a short one. The difference is that in the north, technology evolved gradually while the south adopted it intensively during the post-war industrialization boom. Both male productivity and female labor force participation evolved slowly in the north. In the south, the rapid industrialization, due to the Marshall Plan, triggered an income effect that led to a structural change toward services and high female labor force participation (for example, in Spain it rose from 15% to 55% between 1950 and 2000 (see Olivetti (2013))). In my model, the length of the U-shape depends on the technological spillovers rate.

Technology

Let us assume an economy with one market good that is produced using only human capital. There exist two technologies, A and B. Each worker works with one technology. Technology A requires male physical strength. Technology B suits both males and females, but as long as it is less productive, men prefer to work with A. For simplicity, I call technology B "female." The production function is linear with respect to human capital and the workers earn their marginal product. Thus, the wage per efficiency unit is A for the A-technology workers and B for the B-technology workers.

Each individual is endowed with an observed human capital of x efficiency units, distributed in the population with a cumulative distribution function $F(x)$. Individuals can produce a home product instead of participating in the labor force. It is not necessary to assume that only women are productive at home, and the results hold if both men and women have equal home production skills. However, for simplicity, I assume that only women are productive as housewives. Housework productivity does not depend on human capital. Its growth over time is slower than the growth of the market technology (this assumption is supported by the estimates of Bridgman (2013)). Thus, the home product is normalized to one unit and the market productivity is interpreted as relative to the housewives' productivity.

The technologies A and B grow exogenously with spillovers from A to B à la Acemoglu (1999):

$$B_{t+1} = \lambda(A_t)B_t$$

where the increasing function λ captures spillovers from the male sector to the female one.

Utility

The economy exists in the pre-cohabitation paradigm in which "It is not good that the man should be alone" (Genesis 2:18), and the utility of singles is normalized to zero. A married couple consumes its production as a public good. The couple's preferences over consumption c are given by a concave differentiable function $u(c)$. There is no time preference, and saving is not possible.

The consumption of a couple consists of the market products and the home products

$$c_t = A_t x_m + I_f B_t x_f + 1 - I_f$$

where a_m and a_f are the abilities of the spouses and I_f is the indicator of the wife's market labor force participation. If she does not participate, she produces one unit of home product.

Labor and marriage markets

All men work, but married women choose to work only if their productivity in the market is above their productivity as housewives,[5] that is, if $B_t x_f > 1$. Let $z_t = F(\frac{1}{B_t})$, the rank of the "worst" woman who participates in the labor market after marriage, where $F(x)$ is the ability cumulative distribution function which is constant over time. Let us call "above-z_t" and "below-z_t" individuals ranked above or below z_t in the ability distribution, respectively. $z_t = F(\frac{1}{B_t})$ implies that increasing B-technology means increasing the share of women working after marriage. In the beginning stages, the output in the male sector rises fast because the A-technology advances. The output in the female sector rises slowly. Later the female sector output rises fast, as both female productivity advances faster because of spillovers from A and more married women joining the labor market.

The economy is populated by overlapping generations of individuals. Every period, N individuals of each gender enter the marriage market. The individuals participate in the marriage market for up to two periods. Each period, every single man is matched with a single woman. The match is not random, unless the man has to chose withing a group of equally attractive women. The below-z_t women do not plan to work after marriage, and they are identical in the sense that they all offer their mates one unit of home production. The above-z_t women plan to work in the market after marriage, and because their market ability is heterogeneous, they all differ from each other.

A first-period below-z_t woman is indifferent between accepting the marriage offer of a man with reservation ability x_t^* and remaining single, according to the condition

$$u(A_t x_t^* + 1) = V_t \tag{1}$$

where V_t is her value if she rejects the offer: $V_t = \int_0^1 w_{t+1}(x) u(A_t x + 1) dF(x)$ where $w_{t+1}(x)$ is the probability of marrying a man with ability x.[6] The consumption of the couple where the male's ability is x is $A_t x + 1$ because the below-z_t woman offers one unit of home production.

[5]It will be clear from the following paragraphs that because the marriage search is direct and the ability is observed, a marginal woman does not gain additional expected utility by deviating from this rule.

[6]Although V_t relates to the next period, A is indexed by t because it is not assumed that individuals can predict future technology.

I make two assumptions. The first assumption provides that not all below-z_t men with ability above x_t^* marry in their first period. Otherwise, there is no internal solution to (1). The second assumption links the heterogeneity of the above-z_t individuals to their age of marriage. It states that direct search takes longer than random allocation.

Assumption 1: When both partners are young (in their first period), the match fails with probability p.

Assumption 2: Random matching occurs every period, assortative matching occurs every second period.

Under Assumptions 1 and 2, the equilibrium is as follows. The above-z_t men are positively assortative matched to the above-z_t women.[7] These individuals marry in their second period. The identical, in terms of post-marriage productivity, below-z_t women receive random offers from heterogeneous below-z_t men. In their first period, they accept the marriage offer whenever they are matched to a man with ability above the reservation value x_t^*. In their second period, they accept any offer. The following proposition explains the decreasing age of marriage as a result of rising male productivity.

Proposition 1: If $u(A_t x_t + 1)$ is supermodular in A_t and x_t, and x_t^* is sufficiently large, x_t^* decreases in A_t.

Proof: See Appendix C.

The two forces that move the age of marriage in opposite directions are the decreasing reservation value x_t^*, as male productivity A_t improves, and decreasing z_t as female productivity B_t improves. Decreasing reservation value means decreasing the age of marriage for both genders because more young men are "marriageable" and more young women accept offers. Decreasing z_t means increasing the age of marriage of both genders because a larger proportion of individuals enter the heterogeneous marriage market. The left panel of Figure 6 shows the two forces in a simulated solution: while the reservation value declines over time, the labor force participation of the married women rises. In the simulation, A-technology rises linearly, the spillovers function is hyperbolic, and the abilities

[7] A plausible interpretation of this direct search is that these high-skilled men and women meet in college.

distribution is lognormal. The hyperbolic spillovers are a good example of a long and slow rise of the female sector that leads to a boom, which leads in turn to a rise in the age of marriage. The resulting mean age of marriage pattern is a U-shape with a long decreasing portion (the right panel of Figure 6).

The dynamics of the model implies an increasing high-skilled-women participating in the labor force after marriage, thereby a decreasing proportion of low-skilled single women in the female labor force. Thus, the model is consistent with recent research on female labor force composition dynamics, such as Mulligan and Rubinstein (2008). Moreover, the interpretation of the above-z_t marriage market as a college marriage market is also consistent with the rising female college attendance during the twentieth century (Goldin (2006)). One more important note is that the age of marriage in my model does not necessarily correlate with the gender wage gap. The gender wage gap may increase or decrease monotonically while the age of marriage follows a U-shape.

3 Empirics

In the model, the state variables are the outputs in the male and female sectors, which depend on advancing technologies and the growing contribution of the married women to the labor force. This section quantifies their impact on the age of first marriage in the U.S., and testifies to the fact that their effects are opposite.

Data

To construct the explanatory variables of male and female sectors' output, I use two alternative data sets, which, to my knowledge, have not been used before by family economists. The first one is Renshaw et al. (1988) panel of the U.S. gross state product by indusry for the 1963-1986 period, and the second one is KLEMS sector productivity time series for the 1960-1986 period. Later years of KLEMS data are excluded because of increasing cohabitation rates that may bias the estimated effects, since cohabitation often replaces marriage. The explained variables are the age of first marriage and the singlehood dummies at each age between 19 and 25. The age of first marriage comes from the Vital Statistics marriage records for the 1968-1995 period, published by the National Center of Health Statistics.[8] The singlehood dummy is taken from the Current Population Survey (CPS).[9] The labor data is KLEMS, which decomposes the labor force time series by industry, sex, and age. These data were used for the decomposition of the sectors into male and female. The exact decomposition rule is described below. In addition, I estimate the impact of the male and female sectors on the mean age of first marriage in other OECD countries. To this end, I use two annual time series: Maddison (1996) and OECD International Sectoral Data Base. These analyses are relegated to Appendix D.

Estimation

The purpose of the estimation procedure is to show the two forces of the model across the U.S. It supports the model's predictions and shows that the two forces exist contemporaneously within a country. To show the sectors' effect on the age of marriage, I use two methods of measurement and two methods of estimation, ending with four regression analyses.

The sectors are decomposed into male and female, retrospectively. I denote by "male" industry an industry composed of more than 70% male workers among 25-34 year old workers in 1990, and by "female" industry an industry composed of less than 50% male workers.[10] The ages 25-34 were chosen to correspond young but probably already married individuals. This retrospective view explores the potential of the labor force of young married women, unobserved ex-ante. The endogeneity issue is the dependence of the female labor force (and hence of the output in the female sector) on the age of marriage and on other factors directly affecting the age of marriage. Retrospectively decomposing the sectors into male and female helps to manage this endogeneity issue, because it ignores the endogenous growth of female labor force and relates only the resulting share of women in the sector's labor force. For example, between 1950 and 1980, the share of female workers among furriers increased from 12%

[8]available on http://www.nber.org/data/marrdivo.html

[9]available on the Integrated Public Use Microseries (IPUMS) website

[10]The male sectors are agriculture, mining, construction, and durable goods manufacturing. The female sectors are retail trade, FIRE (finance, insurance, and real estate), services, Federal public services, and state and local public services. Non-durable goods manufacturing, transportation, public utilities, and wholesale trade are neither male nor female.

to 70%, the share of female bus drivers increased from 3% to 47%, and the share of female bartenders increased from 7% to 48%; whooping 2% to 65% increase occurred in the share of female crossing watchmen and bridge tenders[11]. The reason for defining the sectors binarily as male or female and not proportionally by the percentage of females is in keeping with the model's assumptions.

The first estimation uses KLEMS data. KLEMS time series of labor force and by-industry output are not divided by state. The variation across states comes from the different weights of each sector in the state's economy, calculated using Renshaw et al. (1988) panel of by industry gross state product. Calculating these weights yearly causes an endogeneity problem, because the rise of the female sectors may be driven by the same forces as the changes in the age of marriage. Thus, I calculate the share of each sector in the state's total output in the early years of the panel, 1963-1965, and keep these weights constant over time. It assumes the existence of each state's exogenous fundamentals, determining the initial weights of the different sectors. For each year, I calculate the weighted male- and female-sectors per-worker output, using KLEMS output and labor force time series. The variation of the weights across the states, and the rise of the sectors over time, provide the per-worker-ouput variation that I use to explain the age of first marriage. The method of estimation is OLS fixed effects regression where the explained variable is the age of first marriage, using the Vital Statistic marriage records. The model is

$$MA^{g}{}_{ist} = \alpha_0^g + \alpha_1^g M_{st}^1 + \alpha_2^g F_{st}^1 + \alpha_3^g W_{ist} + \alpha^g X_{st} + \gamma_s^g + \eta_t^g + \varepsilon_{ist}^g \tag{2}$$

where $MA^{g}{}_{ist}$ is the age of marriage of an individual i of gender g, living in State s, who married for the first time in year t. M and F are the weighted labor productivity (output per worker) in the male and female sectors, converted into thousands of 1980 constant dollars. The State and year fixed effects are γ_s and η_t, respectively. W is the dummy for whites since they have a higher marriage hazard than other races. X is a set of controls whose variation during the analyzed period explains some of the changes in the marriage age:

-The minimal legal age of marriage in State s in year t. Four variables are included: minimal age of

[11]The figures are calculated using the American Censuses of 1950 and 1980.

marriage for males and females, and with and without parental consent.

-A dummy for Early Legal Access (ELA) - the availability of oral contraception for single childless women below age 21.[12]

-A dummy for the possibility of no-fault divorce.[13]

-A dummy for legal abortion.[14]

Further, I estimate the same two regressions (one for men and one for women), using an alternative measure of the male and female sectors productivity, and an alternative data set. The data here is Renshaw et al. (1988) gross state product by industry panel for the 1963-1986 period. The model is similar to (2), but the explanatory variables M and F are defined as the total output in the male and female sector, divided by the size of population of the State s in year t:

$$MA^g{}_{ist} = \alpha_0^g + \alpha_1^g M_{st}^2 + \alpha_2^g F_{st}^2 + \alpha_3^g W_{ist} + \alpha^g X_{st} + \gamma_s^g + \eta_t^g + \varepsilon_{ist}^g \tag{3}$$

The intuition here is that the sizes of the male and female sectors per capita correspond to the importance of each of the two sectors for the state's economy.

In the last part of the analysis, I repeat the estimation separately for each age. The estimation method is linear probability regression where the dependent variables are the singlehood dummies at each age between 19 and 25[15]. I use the Current Population Survey data (CPS), which includes all individuals and not only married ones. For each individual, I calculate the explanatory variables in her (or his) State when she was 18 years old. This age corresponds to the beginning of the first period of her marriage market participation, that is, the age at which her strategy is determined. I separately estimate the effects for each age between 19 and 25, for men and for women. I estimate the regressions with the two definitions of M and F, similarly to (2) and (3). Thus, there are a total of 28 estimated regressions.

[12] Bailey et al. (2011).

[13] Ashbaugh et al. (2002).

[14] Levine et at (1999).

[15] The linear probability model gives consistent estimators, while probit regression estimators of a model with fixed effects are inconsistent.

The empirical models are

$$S^g(a)_{ist} = \alpha_0^g + \alpha_1^g M_{st}^1 + \alpha_2^g F_{st}^1 + \alpha_3^g W_{ist} + \alpha^g X_{st} + \gamma_s^g + \eta_t^g + \varepsilon_{ist}^g \tag{4}$$

$$S^g(a)_{ist} = \alpha_0^g + \alpha_1^g M_{st}^2 + \alpha_2^g F_{st}^2 + \alpha_3^g W_{ist} + \alpha^g X_{st} + \gamma_s^g + \eta_t^g + \varepsilon_{ist}^g \tag{5}$$

where $S^g(a)_{ist}$ receives 1 if an individual i of gender g, living in State s, has never been married on her a-th birthday, $19 \leq a \leq 25$. Index t is the year in which she was 18 years old. The variables M^1 and F^1 are the weighted labor productivity, and the variables M^2 and F^2 are the total output per capita in the male and female sectors, as defined above. The state and year fixed effects are γ_s and η_t, respectively. All of the regressors relate State s to year t. In this way reverse causality is ruled out: first, the definition of the male and female sectors is retrospective; second, the regressors are retrospective at the individual level, because they relate to the year she was 18. W is the dummy for whites and X the a set of the controls mentioned above.

Results

The results of the estimation of models (2) and (3) are given in Table 1, and the results of the estimation of models (4) and (5) are given in Tables 2 and 3, respectively. In all regressions, the standard errors are clustered by State. The results indicate that the weighted output per worker better explains, in terms of statistical significance, the age of first marriage (models (2) and (3)), while the output per capita better explains the probability of singlehood (models (4) and (5)). Recall that the sectors' output is measured in thousands of 1980 constant dollars. In accordance with the model, the effect of the male sectors on the age of first marriage and the probability of singlehood is negative, while the effect of the female sectors is positive. The results in Table 1 indicate that the increase in the female sector's weighted labor output is responsible for half a year's increase in the age of marriage of men and women between 1968 and 1986, the two extreme points in time covered by the data. This accounts for 19% of the increase in the male mean age of first marriage during this period, and 17% of the increase in the female mean age of first marriage. Regarding the probability of singlehood, the results in Table 3 indicate that for men, the respective negative and positive effects of the male and female sectors output rise, in absolute terms, with age and become statistically significant at age 20. For women, the effects are constant and significant for all ages. In absolute terms, the female sector's coefficient is between 1.5 and 2.5 times larger than the male sector's coefficients. For women, every 1000-dollar increase in the output per capita in the female sector increases the probability of singlehood in their early twenties by about 2.5 percentage points, and every 1000-dollar increase in the output per capita in the male sector decreases the probability of singlehood by about 1 percentage point. For men, the figures are 1.5 and 1 percentage points, respectively. These results imply that the increase in the size of the female sector between 1963 and 1983 is responsible for about a 7 to 8 percentage point increase in the probability of female singlehood and a 5 percentage point increase in the probability of male singlehood in their early twenties. This is about 15% of the increase in the singlehood probabilities for the 1945-1965 birth cohorts of men, and about 20%-30% of the increase for the same cohorts of women. For comparison, Goldin and Katz (2002) show that the introduction of the Pill is responsible for a 24%-37% of the increase in the proportion of single women at age 23 for the same birth cohorts. The results in Table 3 are depicted in Figure 7, which shows the estimated effects (with a 95% confidence interval) of the male and female sectors' per capita output on the singlehood probability, as a function of age.

4 Montana Case Study

This section presents micro-data evidence that, in accordance with the model, a positive income shock on a male industry triggers a U-shape. I focus on the 1970s oil boom in Montana, since the eastern part of the state has many oil fields and its economy was deeply influenced by oil prices, which doubled in 1974 and doubled again between 1978 and 1980. Oil producing is one of the most male-biased sectors of industry. The natural decomposition of Montana into the oil-producing east and non-oil-producing west allows a clear difference-in-difference exercise that demonstrates the model's predictions in data.

The main finding is shown in Figure 8. It presents the proportion of single men and women at ages

21-22, born in Montana, in the oil and non-oil producing parts of the state,[16] for each decade between 1960 and 2000.[17] In the non-oil area the proportion of young singles rises monotonically from 1960 on, whereas in the oil area it rose until the oil boom in the 1970s and then followed a U-shape. The way this finding corresponds to the model is the rise of the labor force participation of young married women in the oil area of Montana, during the decades following the oil boom. To show this rise, I regress the labor force participation of married women on the year and area dummies and interactions between them, controlling for the husbands income. The results are shown in Table 4. The estimated interaction effects testify to the fact that during the 1980-2000 period, the labor force participation of young married women (17-27 years old) increased much sharper in the oil area than in the non-oil area.[18] Moreover, this effect is not observed among older married women. This pattern of young married women's increased labor force participation after the male sector boom, follows the mechanism described in the model.

The rest of the section shows the causal inference of the oil boom as a trigger for the U-shape.

I identify the role of the oil income treatment on marriage timing through two methods. First, using a 2SLS regression where income is instrumented by the oil boom. The results show a 6 percentage point decrease in the probability of male singlehood on their twenty-second birthday for every additional 1000 income dollars. Second, I use a difference-in-difference design where two regions (oil and non-oil) and two periods (before and after the boom) are interacted. The results show a 27 percentage point increase in the male marriage probability within five years after treatment, relative to the non-treatment period, and a 16 percentage point increase in the female marriage probability. The difference between the two methods is that in the first one I look at men at each specific age, and ask how many of them are single as a function of their income. The second method asks how many of all single men marry shortly after they are treated by additional income. Then, I refine the estimated coefficient by a triple difference approach. I compare men working in the male sectors directly affected by the

[16]From this point on, for brevity's sake, I simply use"oil" and "non-oil" to name the two parts of the State.

[17]The 1980 Census is the last one that asked for both the marital status and the age of first marriage, and is used to construct retrospectively the singlehood probabilities in 1960 and 1970 in each part of the State, because Censuses before 1980 do not include intra-state division of Montana.

[18]The estimated regression is a linear probability model, with standard errors clustered by year of birth and group of counties. The results hold under alternative estimation procedures (logit and probit). The husband's income is converted into 1980 constant dollars.

oil boom (mining and construction) to the men working in an unaffected male sector (agriculture), and the results show that men working in agriculture do not contribute to the marriage age difference between the two parts of the state.

A small number of family economists use the 1970s energy boom as an instrument for income. Løken (2010) shows that the oil boom led to increased investment in children's education in the oil area of Norway. Black et al. (2013) show that it led to an increase in fertility in the Appalachia coal-mining areas. In an unpublished dissertation, Buckley (2003) found that the oil boom positively affected the female marriage hazard in Texas. In contrast, Maurer and Potlogea (2014) did not find any impact of the oil development on female labor force participation, fertility, and marriage hazard in the southern U.S. during the 19001940 period. My paper adds to the literature by analyzing both females and males in another U.S. region, and uncovering the U-shaped pattern triggered by the oil boom.

Background and data

Montana is an agricultural state with a lower than average U.S. per-capita income. Almost half of the population of Montana is rural, and this figure did not change during the oil boom. The main structural change in the economy of Montana until the 1970s was the development of oil and gas fields in the north-eastern part of the state, in a geological area named the Bakken Formation discovered in 1953. However, mining did not dramatically affect the state's economy until the 1974 oil crisis following the Yom Kippur War. As a result of the embargo by the oil-producing Arab countries, oil prices doubled in 1974 and then again between 1978 and 1980. The oil boom lasted for a decade until the oil sector collapsed in the 1980s.

The eastern county group[19] includes the area of oil exploration, which I define as the "oil area" and the rest of the state as the "comparison area" (see a map on Figure 9). Although most of the oil is concentrated only in the far east of Montana, the data do not allow for separation of this specific area from the eastern county group. The data set is the 1980 Census IPUMS. The descriptive statistics, presented in Table 5, show the differences between the oil and comparison areas. Unfortunately, it

[19] County group 4 in 1980 Census, PUMA 500 in 1990 Census, PUMA 300 in 2000 Census.

is not possible to directly compare between the two areas before the oil boom because there was no intra-state division of Montana in the census until 1980. However, I use two age groups, 17-35 and 36-50 years old, to compare the pre-boom and post-boom generations. The ages 17-35 were chosen as these are the ages of first marriage of over 90% of the ever-married men and women. In both parts of the state, whites constitute more than 90% of the population. The men to women ratio is close to one, and does not differ between the old and new generations. The two parts of the state have some demographic differences, some of which were present for both generations, and these fixed differences collapse in the difference-in-difference design. First, the comparison area has a half year more of schooling, on average. Second, the comparison area has more immigrants, contrary to the supposition that the oil boom attracted the immigration of young men. Moreover, the immigration patterns are the same among old and young men, and among women the share of immigrants decreased in the oil area relatively to the comparison area. To conclude, the descriptive statistics do not suggest an alternative story that could explain the above-mentioned difference in the age of marriage between the oil area and the rest of the state for the specific cohort of 17-35 years old.

Income gap

Figure 10 shows the 1980 total personal income of men by age, for those who had positive income. As the figure shows, men in their 20s and early 30s earned more in the oil area than in the comparison area. Older men earned more in the comparison area than in the oil area, because of higher earnings among middle age professional workers and a large number of middle-age workers in manufacturing, which is traditionally more developed in the west of Montana. This is important for the interpretation of the results, as young men are the population of potential marriage partners. If an income gap in favor of the oil area had existed among the "fathers", it might complicate the interpretation of the income effect on the marriage market. But in fact, the income shock affected only the young, thereby the interpretation of the effect is unambiguous.

To see what role the oil boom had on the income gap between the oil and comparison areas, Figure 11 decomposes this gap by industry sector. Each column is $s_{jo}I_{jo} - s_{jc}I_{jc}$ where s_{ji} is the share of sector j out of the 16-24 year old male labor force in area i (oil or comparison) and I is these men's mean income. The figure shows that mining is responsible for most of the gap between the areas.

2SLS

The first regression estimates the effect of every income dollar on the probability of singlehood at each age between 19 and 25. Because the dependent variable is the individual's singlehood dummy, and the explanatory variable is his own income, the regression is estimated for men only. Women are excluded because of the endogeneity of female income, as many women do not work after marriage.[20] To exclude migrants who lived in 1980 in either the oil or the comparison areas but did not experience the oil boom, I limit the sample to those individuals who lived in the same area (either oil or comparison) at the beginning of the oil boom as in 1980, the year the data were collected[21]. This allows for 1,646 observations in the oil area and 27,218 observations in the comparison area.

Any OLS estimator of income effect on singlehood may be biased because the 1980 income might be simultaneously influenced by the age of marriage and because of the omitted characteristics that correlate with both income and marriage age. Thus, I instrument the 1980 income with the oil boom's natural experiment. The instrument is a product of two dummies: being an individual in the oil area and belonging to the treated cohort. The treated cohort is comprised of men born between 1953 and 1958, who were 15-20 years old when the oil boom started. As shown above, the oil boom accounts for the income differences between the oil and comparison areas for this cohort, aged 22-27 in 1980, making it a valid instrument.[22] There are no retrospective data regarding income, except for 1980. I assume that the 1980 income represents the potential observed by the potential female marriage partners when the man was single. The estimated regressions are

$$S_{ij}^{A} = \beta_0^A + \beta_1^A I_{ij} + \beta_2^A W_{ij} + \gamma_j^A + \delta_{ij}^A + \varepsilon_{ij} \tag{6}$$

[20]The difference-in-difference analysis in the next subsection includes women since this analysis does not connect an individual's singlehood to her own income.

[21]For this purpose, I use two variables. The first is the group of counties of residence five years before the 1980 Census (MIGCOGRP). Unfortunately, this variable exists for only half of the respondents of the IPUMS. Thus, I additionallyusethe timing the respondents moved to their present residence (MOVEDIN). The sample is limited to those who were in the same area or moved to their present residence at least five years before the 1980 Census.

[22]The first-stage F-statistic in all regressions is between 23 and 40.

where the first stage is

$$I_{ij} = \alpha_0^A + \alpha_1^A C_{ij} O_j + \alpha_2^A W_{ij} + \gamma_j^A + \delta_{ij}^A + u_{ij}$$

where S_{ij}^A is the singlehood dummy of age A of a man i who lives in area j (oil or comparison), I_{ij} is his income in thousands in 1980, γ_j is the area fixed effect, and δ_{ij} is the fixed effect of the treated cohort. The instrument is a product of two dummies: the treated cohort C_{ij} and the oil area O_j. W is a dummy for whites. The regression is separately estimated for $19 \leq A \leq 25$. In each regression, only individuals who are at least of age A are included. The standard errors are clustered by birth year and county group (358 clusters). The results are reported in Table 6, and Figure 12 shows the estimated β_1^A as a function of A, where the shaded area is the 95% confidence interval. The results show that the income effect is insignificant at the age of 19, but becomes stronger and then stays constant and statistically significant starting at the age of 22, reaching a 5-6 percentage point decrease in singlehood probability for each additional thousand dollars of income. The first stage is very significant with F-statistics between 40 and 60.

Difference-in-difference

The second question is what happens to the male and female marriage hazard shortly after the male income treatment. For every single person at the beginning of the oil boom, I calculate the probability of her or his marrying within 5 years, and compare this probability to that of the parallel period before the oil boom.

The design is as follows. Let us take young individuals (15-20 y.o.) who were single when the oil boom started on January 1, 1974, and calculate their probability of marrying within the following five years, until the end of 1978. Then let us calculate the corresponding probability of young individuals who were single on January 1, 1969, of to marry within the same-length period, up to the end of 1973. To eliminate the bias caused by individuals who immigrated to Montana before 1975, the sample is restricted to individuals born in Montana. Among the comparison cohort, 91% of the men and 76% of the women were single on January 1, 1969, in the non-oil area, and, respectively, 89% and 88% in the oil area. Among the treated cohort, the figures for January 1, 1974, are 91% and 77% versus

85% and 69%. The figures show that nothing changed in the non-oil area, while in the oil area there are 10 percentage points fewer single young women at the beginning of the oil boom than five years earlier, and the estimated male income treatment effect on marriage would have been even stronger if the numbers had stayed the same. The estimated model is

$$Mp_{itj}^g = \beta_0^g + \beta_1^g O_j + \beta_2^g C_t + \beta_3^g C_t O_j + \beta_4^g W_{itj} + \varepsilon_{ijt}$$

where Mp_{itj}^g is the marriage-within-5-years dummy of a g-gender single i who was born in cohort t (treated or comparison) and who lives in area j (oil or non-oil). Again, O and C are the area and cohort dummies, respectively. W is a dummy for whites. The parameter of interest is β_3^g.

Figure 13 graphically shows the effect described above and Table 7 presents the regression results for both men and women. The figure plots the probability of being single on the twenty-second birthday (left panel) and the probability of marrying within five years (right panel), conditional on singlehood on January 1, 1969, for the comparison cohort, and on January 1, 1974, for the treated cohort. In both panels no significant difference between oil and non-oil areas is observed for the comparison cohort, and the comparison cohort is very similar to the treated cohort in non-oil area. However, the treated cohort in the oil area is very different. As the regression results on Column 1 of Table 7 show, the oil boom increased by 27 percentage points the probability of men marrying within five years. Column 2 shows that for women, the effect is 16 percentage points, which is significant and large, but smaller than for men. A plausible explanation of this difference is that in the oil area, as stated above, there were 17 percentage points fewer single women at the beginning of the oil boom relatively to the beginning of the comparison period.

Triple difference

Observe again the last three rows of Table 5. We can see that the young men in the oil area did not earn more in all industries compared to their peers in the rest of the state. In industries directly affected by the oil boom, mining and construction, they indeed earned more. However, this was not the case for the largest sector of Montana's economy, agriculture. Moreover, in the oil area the earnings in agriculture were 7% less than in the comparison area. Thus, the DD effect may be underestimated, as it includes the sectors unaffected by the treatment. Comparing the oil area to the rest of the state, figure 14 plots the singlehood probability on the twenty-second birthday for men working in agriculture, mining and construction. The figure shows three birth cohorts, where the rightmost is the treated cohort. Despite some fluctuation in the singlehood probability among untreated cohorts, the fluctuations are not significant relative to the large drop in the singlehood probability in the oil area for treated miners and constructors. The comparison to agriculture, where no difference between the oil area and rest of the state is observed, is the evidence of the treatment effect.

Formally, the estimated model is

$$S^A_{ijkt} = \beta^A_0 + \beta^A_1 O_j + \beta^A_2 C_t + \beta^A_3 F_k + \beta^A_4 C_t O_j + \beta^A_5 C_t F_k + \beta^A_6 O_j F_k + \mu^A O_j F_k C_t + \varepsilon_{ijkt} \qquad (7)$$

where $S(A)_{ij}$ is the singlehood dummy at age A of a man i who lives in area j, belongs to cohort t, and is occupied in sector k (treated or agriculture). C, O and F are, respectively, the cohort, oil area, and industry (treatment or comparison) dummies. The parameter of interest is the triple interaction effect μ. The regression is estimated separately for $19 \leq A \leq 25$. The results are reported in Table 8. Figure 15 shows the estimated μ as a function of age with a 95% confidence interval. Indeed, the treatment coefficients are larger than in the DD regression. The coefficients are statistically significant, going down to -0.5 around the age of 22. This drastic coefficient seems to be affected by endogenous selection into industries. It is plausible to assume that the selection of individuals into industries is not random, and more skilled men were selected for mining. This makes sense as earnings in mining are twice as high as earnings in agriculture, Montana's "default" industry. However, possible selection does not eliminate the effect of the oil boom, as shown by the triple interaction. If selection exists, it implies that the oil boom helped skilled men both to earn more, and marry younger.

5 Conclusions

This paper quantifies the changes in the age of marriage as a result of gender-biased economic growth. It shows that the mean age of first marriage followed a U-shape in the countries where industrialization preceded, by at least two decades, the formation of the modern female labor force. By ex-post observing the industries that remained "male" and the industries that became "female," and controlling for other factors such as the Pill, I find that the male and female sectors oppositely affect the age of marriage of both genders, and the rise of the female sectors explains a large part of the increase in the age of first marriage and in the singlehood probability of men and women in their early twenties. The dynamics starts with a shock in the male sector that triggers a change in the female sector. Montana's oil boom is an example of such an event resulting in a U-shape in the age of first marriage.

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Table 1: The effect of the male and female sectors on the age of first marriage

	Dependent variable: age of first marriage			
	weighted labor productivity		output per capita	
	(1)	(2)	(3)	(4)
	Males	Females	Males	Females
Male sectors	-0.014**	-0.021**	-0.017	-0.012
	(0.007)	(0.008)	(0.015)	(0.017)
Female sectors	0.119**	0.121**	0.068	0.113**
	(0.056)	(0.063)	(0.055)	(0.05)
Whites	-1.788***	-1.901***	-1.789***	-1.902***
	(0.117)	(0.154)	(0.117)	(0.154)
Year FE	YES	YES	YES	YES
State FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES
Constant	-147.87***	-188.76***	-208.845***	-231.264***
	(34.472)	(35.072)	(20.039)	(18.871)
Observations	6500955	6605439	6500955	6605439

Standard errors are given in parentheses.

Standard errors clustered by state.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 2: The male and female sectors' labor productivity effect on singlehood, weighted labor productivity

	Dependent variable: dummy for singlehood (men)							Dependent variable: dummy for singlehood (women)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	age=19	age=20	age=21	age=22	age=23	age=24	age=25	age=19	age=20	age=21	age=22	age=23	age=24	age=25
Male sectors	-0.002	-0.002	-0.003**	-0.004***	-0.005***	-0.005***	-0.005***	-0.004**	-0.005***	-0.006***	-0.006***	-0.006***	-0.005***	-0.005
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female sectors	0.003	-0.001	-0.002	-0.003	-0.000	0.001	0.001	0.005	0.002	0.002	0.001	-0.000	-0.001	-0.002
	(0.013)	(0.012)	(0.012)	(0.011)	(0.011)	(0.01)	(0.01)	(0.011)	(0.01)	(0.01)	(0.009)	(0.008)	(0.008)	(0.006)
White	-0.083***	-0.084***	-0.086***	-0.087***	-0.088***	-0.088***	-0.087***	-0.129***	-0.133***	-0.135***	-0.137***	-0.136***	-0.134***	-0.131
	(0.011)	(0.011)	(0.011)	(0.01)	(0.01)	(0.009)	(0.009)	(0.012)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.610	0.734**	0.79**	0.817**	0.243	0.666***	0.219	0.52	0.627**	0.644**	0.646**	0.657***	0.297	0.66
	(0.378)	(0.352)	(0.349)	(0.323)	(0.244)	(0.287)	(0.213)	(0.321)	(0.295)	(0.274)	(0.254)	(0.242)	(0.179)	(0.186)
Observations	512858	489323	466476	443073	419458	395137	370147	552007	526686	500978	474745	448786	422229	395456

The standard errors, clustered by state, are given in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: The male and female sectors' effect on singlehood, output per capita

	Dependent variable: dummy for singlehood (men)							Dependent variable: dummy for singlehood (women)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	age=19	age=20	age=21	age=22	age=23	age=24	age=25	age=19	age=20	age=21	age=22	age=23	age=24	age=25
Male sectors	-0.00475*	-0.00646**	-0.00802**	-0.00906**	-0.0107**	-0.0109**	-0.0108**	-0.0103**	-0.0115**	-0.0119**	-0.0112**	-0.0109**	-0.0101**	-0.00916**
	(0.00272)	(0.00317)	(0.00364)	(0.00401)	(0.00432)	(0.00472)	(0.00465)	(0.00419)	(0.00459)	(0.00480)	(0.00495)	(0.00497)	(0.00474)	(0.00449)
Female sectors	0.0125	0.0144*	0.0152*	0.0162*	0.0189**	0.0193**	0.0175**	0.0260***	0.0262***	0.0257***	0.0249**	0.0241**	0.0233***	0.0209***
	(0.00773)	(0.00821)	(0.00855)	(0.00865)	(0.00852)	(0.00834)	(0.00757)	(0.00856)	(0.00902)	(0.00895)	(0.00937)	(0.00924)	(0.00855)	(0.00776)
White	-0.0832***	-0.0840***	-0.0858***	-0.0867***	-0.0879***	-0.0874***	-0.0871***	-0.129***	-0.133***	-0.135***	-0.137***	-0.136***	-0.134***	-0.131***
	(0.0114)	(0.0108)	(0.0105)	(0.00986)	(0.00958)	(0.00930)	(0.00910)	(0.0116)	(0.0113)	(0.0112)	(0.0115)	(0.0117)	(0.0117)	(0.0115)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.613***	0.601***	0.606***	0.592***	0.122*	0.522***	0.129**	0.466***	0.468***	0.462***	0.451***	0.429***	0.146***	0.385***
	(0.121)	(0.109)	(0.0998)	(0.0894)	(0.0677)	(0.0730)	(0.0519)	(0.0978)	(0.0849)	(0.0769)	(0.0749)	(0.0690)	(0.0464)	(0.0523)
Observations	512858	489323	466476	443073	419458	395137	370147	552007	526686	500978	474745	448786	422229	395456

The standard errors, clustered by state, are given in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: The Montana married women labor force participation

	Dependent variable: dummy for labor force participation, married women			
	(1)	(2)	(3)	(4)
	17-27 years old	27-37 years old	37-47 years old	47-57 years old
Oil area	-0.0832***	-0.0762***	-0.0059	0.0099
	(0.0291)	(0.0072)	(0.0309)	(0.0447)
(Oil area)x1990	0.1082**	0.0870***	0.0224	-0.0464
	(0.0511)	(0.0332)	(0.0399)	(0.0533)
(Oil area)x2000	0.1071**	0.0621	0.0602*	0.0134
	(0.0507)	(0.0444)	(0.0350)	(0.0559)
(Oil area)x2010	0.2069***	0.1176***	0.0083	-0.0048
	(0.0743)	(0.0407)	(0.0366)	(0.0509)
1990	0.0743***	0.1502***	0.1491***	0.1592***
	(0.0223)	(0.0133)	(0.0179)	(0.0243)
2000	0.1424***	0.1838***	0.1739***	0.2203***
	(0.0262)	(0.0147)	(0.0168)	(0.0215)
2010	0.1206***	0.1571***	0.1778***	0.2670***
	(0.0239)	(0.0150)	(0.0170)	(0.0193)
ln(husband's income)	-0.0272***	-0.0203***	-0.0210***	-0.0117**
	(0.0104)	(0.0072)	(0.0056)	(0.0057)
Constant	0.6391***	0.6206***	0.6709***	0.5280***
	(0.0303)	(0.0212)	(0.0210)	(0.0226)
Observations	3934	8678	9324	8800

The regression procedure is OLS.

The standard errors, clustered by year of birth an group of counties, are given in parentheses.

The husband's income is in thousands of 1980 constant dollars.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Descriptive statistics, 1980 Census, Montana

	Males							Females						
	17-35 y.o.			36-50 y.o.				17-35 y.o.			36-50 y.o.			
	Comp. area	Oil area	Diff. (t-stat.)	Comp. area	Oil area	Diff. (t-stat.)	Diff. in diff. (t-stat.)	Comp. area	Oil area	Diff. (t-stat.)	Comp. area	Oil area	Diff. (t-stat.)	Diff. in diff. (t-stat.)
Whites	0.95	0.92	0.03	0.97	0.94	0.03	0.00	0.94	0.90	0.04	0.95	0.95	0.00	0.04
			(3.2)			(2.6)	(0.0)			(3.7)			(0.0)	(2.6)
Born in Montana	0.55	0.65	-0.1	0.49	0.61	-0.12		0.56	0.64	-0.08	0.49	0.51	-0.02	-0.06
			(-0.54)			(-4.8)				(-4.5)			(-0.8)	(-1.9)
Years of schooling	12.9	12.4	0.50	13.0	12.4	0.60	-0.10	12.7	12.4	0.30	12.5	12.3	0.20	0.10
	(2.4)	(2.7)	(5.3)	(3.2)	(3.1)	(3.8)	(-0.5)	(2.2)	(2.2)	(3.7)	(2.4)	(2.3)	(1.7)	(0.7)
Income in agriculture	8446	7601	845											
	(8903)	(8727)	(2.7)											
Income in mining	13650	16648	-2998											
	(8902)	(10085)	(8.5)											
Income in construction	11270	11673	-403											
	(8907)	(7708)	(-1.43)											
Observations	5,703	913		2,634	458			5,599	857		2,637	433		

Standard deviations are given in parentheses. Income is total personal income, including negative values. In diff. in diff. columns the t-statistic is given in parentheses.

For income, t-statistics are not given because the number of observations in each industry is not reported here.

Table 6: The 2SLS regressions of income effect on singlehood, Montana men

	Dependent variable: dummy for singlehood						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	age=19	age=20	age=21	age=22	age=23	age=24	age=25
Income	-0.014	-0.031***	-0.04***	-0.061***	-0.055**	-0.05***	-0.056**
	(0.009)	(0.006)	(0.014)	(0.021)	(0.023)	(0.019)	(0.029)
Oil area	-0.004	-0.023	-0.032	-0.067	-0.048	-0.051	-0.071
	(0.013)	(0.017)	(0.028)	(0.044)	(0.108)	(0.04)	(0.054)
Treated cohort	-0.065*	-0.169***	-0.24***	-0.368***	-0.321***	-0.272***	-0.26**
	(0.039)	(0.023)	(0.068)	(0.114)	(0.108)	(0.084)	(0.107)
White	0.142***	0.235***	0.277***	0.385***	0.33**	0.276**	0.285*
	(0.053)	(0.043)	(0.083)	(0.125)	(0.136)	(0.113)	(0.167)
Constant	1.009***	1.127***	1.16***	1.298***	1.157***	1.042***	1.056***
	(0.0845)	(0.064)	(0.143)	(0.229)	(0.241)	(0.201)	(0.302)
First stage F-stat.	46.3	50.64	54.69	60.41	55.24	47.30	40.21
N. of clusters	358	353	348	343	338	333	328
Observations	10817	10572	10308	10029	9760	9485	9225

The clustered standard errors are given in parentheses.

The treated cohort is 1953-1957 born, the instrument is (treated cohort)x(oil area).

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: The effect of the oil boom on the within 5-years marriage probability

	Dependent variable: dummy for marriage within five years	
	(1)	(2)
	Males	Females
(Treated cohort)x(Oil area)	0.265*	0.122*
	(0.136)	(0.072)
Treated cohort	-0.049	-0.08**
	(0.036)	(0.032)
Oil area	0.055	-0.031
	(0.129)	(0.064)
Whites	-0.046	0.148***
	(0.059)	(0.049)
Constant	0.559***	0.504***
	(0.066)	(0.051)
Observations	1336	1058

Standard errors are given in parentheses.

Standard errors are clustered by year of birth and group of counties.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Triple interaction regressions of male singlehood

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	age = 19	age = 20	age = 21	age = 22	age = 23	age = 24	age = 25
(Treated cohort)x(Oil area)x(Treated industries)	-0.0807	-0.0468	-0.296*	-0.564***	-0.259***	-0.0326	0.201*
	(0.0822)	(0.121)	(0.151)	(0.107)	(0.0934)	(0.116)	(0.108)
Treated cohort	-0.0361*	-0.0481	-0.0469	-0.0702	-0.122**	-0.0263	0.0706
	(0.0205)	(0.0355)	(0.0359)	(0.0513)	(0.0581)	(0.0761)	(0.0851)
Oil area	0.000860	0.0128	0.0123	0.0156	0.00417	-0.0154	-0.00749
	(0.0122)	(0.0179)	(0.0266)	(0.0369)	(0.0396)	(0.0437)	(0.0458)
Treated industries	-0.0371***	-0.0496***	-0.0743***	-0.103***	-0.131***	-0.114***	-0.116***
	(0.0104)	(0.0141)	(0.0183)	(0.0212)	(0.0233)	(0.0242)	(0.0226)
(Treated cohort)x(Oil area)	-0.00389	-0.0993	-0.0270	0.00202	-0.178	-0.220*	-0.388***
	(0.0653)	(0.0697)	(0.0722)	(0.0817)	(0.123)	(0.133)	(0.123)
(Treated cohort)x(Treated industries)	0.0515*	0.0745**	0.0455	0.0686	0.131**	0.0366	-0.0902
	(0.0268)	(0.0377)	(0.0440)	(0.0562)	(0.0625)	(0.0737)	(0.0872)
(Oil area)x(Treated industries)	0.0250	0.00926	0.0604	0.0990	0.0776	0.0597	0.0384
	(0.0236)	(0.0338)	(0.0419)	(0.0604)	(0.0620)	(0.0595)	(0.0587)
Whites	0.108***	0.106**	0.0698	0.0723	0.0791	0.00873	-0.0485
	(0.0395)	(0.0481)	(0.0544)	(0.0573)	(0.0565)	(0.0581)	(0.0593)
Constant	0.854***	0.798***	0.761***	0.673***	0.580***	0.553***	0.540***
	(0.0384)	(0.0492)	(0.0560)	(0.0572)	(0.0575)	(0.0589)	(0.0598)
N. of clusters	309	304	299	294	289	284	279
Observations	2927	2860	2801	2720	2649	2573	2492

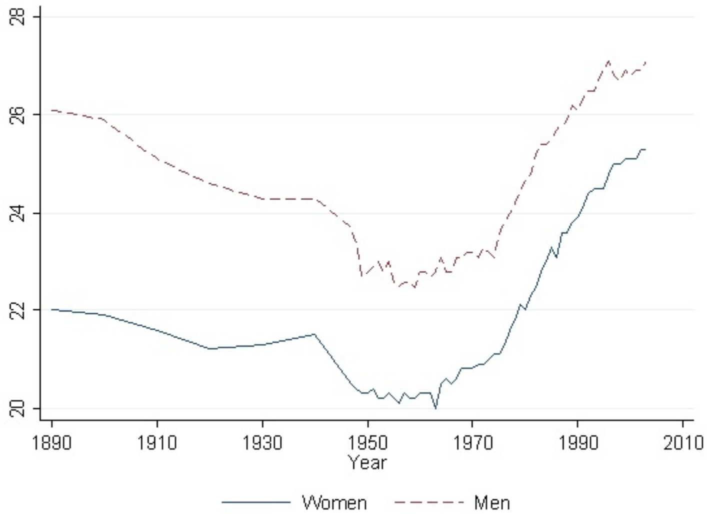
The clustered standard errors are given in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Time series estimation, dependent variable: mean age of first marriage

		Men	Women	N (men)	N (women)
OECD data					
Austria	male sectors	-0.062 (0.185)	0.011 (0.154)	28	28
	female sectors	0.077* (0.043)	0.055 (0.036)		
Belgium	male sectors	-0.310 (0.760)	0.236 (0.265)	18	27
	female sectors	0.388 (0.291)	0.052 (0.113)		
Canada	male sectors	-0.161 (0.303)	-0.356 (0.354)	35	35
	female sectors	0.126 (0.0849)	0.213* (0.096)		
Denmark	male sectors	-0.446* (0.254)	-0.365 (0.264)	29	30
	female sectors	0.332*** (0.072)	0.314*** (0.061)		
Finland	male sectors	-0.169 (0.515)	-0.195 (0.194)	33	37
	female sectors	0.143 (0.151)	0.123** (0.062)		
France	male sectors	-0.646 (1.554)	-0.459 (0.338)	37	38
	female sectors	0.155 (0.397)	0.165*** (0.092)		
Germany	male sectors	-0.438 (1.964)	-0.144 (7.346)	7	7
	female sectors	0.473 (1.964)	0.346 (2.052)		
Norway	male sectors	-0.897* (0.531)	-1.049*** (0.340)	36	38
	female sectors	0.086 (0.057)	0.111*** (0.037)		
United Kingdom	male sectors	-0.336 (1.137)	0.176 (0.218)	14	37
	female sectors	0.330 (0.345)	0.001 (0.041)		
United States	male sectors	-0.661*** (0.124)	-0.287* (0.162)	37	37
	female sectors	0.285*** (0.038)	0.228*** (0.037)		
Maddison (1996) data					
Denmark	male sectors	-0.205 (0.160)	-0.100 (0.189)	58	59
	female sectors	0.408** (0.189)	0.350** (0.176)		
France	male sectors	-0.651 (1.481)	-0.201 (0.176)	49	52
	female sectors	0.676 (0.914)	0.418** (0.200)		
Italy	male sectors	-0.080 (0.192)	-0.224 (0.147)	46	51
	female sectors	0.260 (0.251)	0.398*** (0.142)		
Netherlands	male sectors	-0.976* (0.502)	-0.135 (0.251)	44	45
	female sectors	1.007*** (0.288)	0.293** (0.135)		
Sweden	male sectors	-0.358 (0.688)	-0.458 (0.899)	49	52
	female sectors	0.792 (0.651)	1.081 ***(0.791)		
United States	male sectors	-0.181** (0.0923)	0.065 (0.088)	57	57
	female sectors	0.218** (0.085)	0.177** (0.073)		
Western Germany	male sectors	-0.342 (0.264)	-1.137*** (0.254)	34	33
	female sectors	0.452** (0.182)	0.914*** (0.186)		

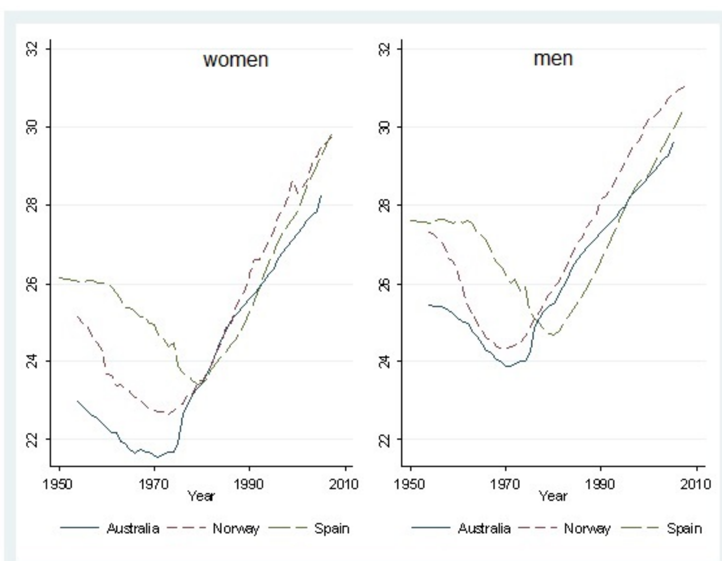
Standard errors are given in parentheses. The regressions include autoregression (1). * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: Median age of first marriage, United States 18902005



Source: Bureau of Census.

Figure 2: Examples of the U-shaped pattern; women (left) and men (right)

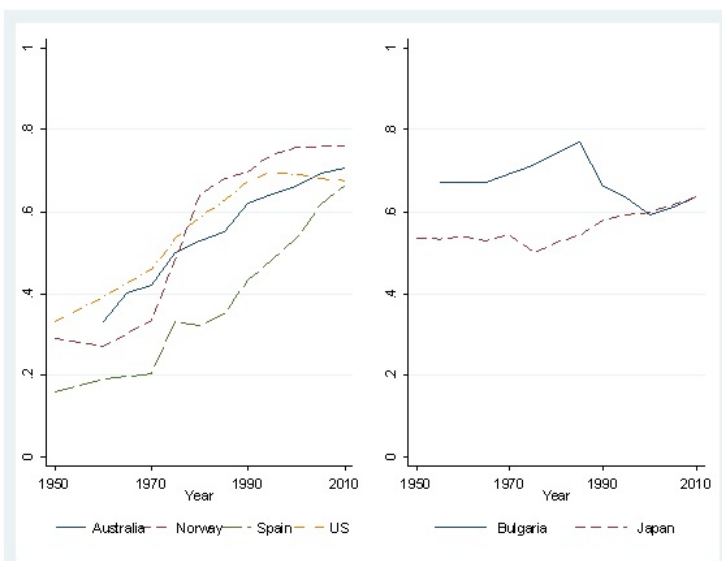


Note: mean age of first marriage; see Appendix A for data and Appendix B for details.

Figure 3: Examples of no-U-shape pattern; women (left) and men (right)

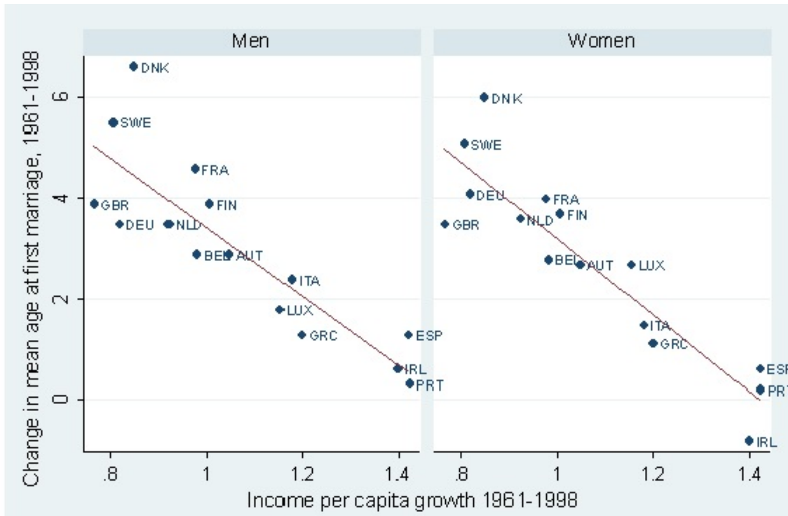
Note: mean age of first marriage; see Appendix A for data and Appendix B for details.

Figure 4: Female labor force participation



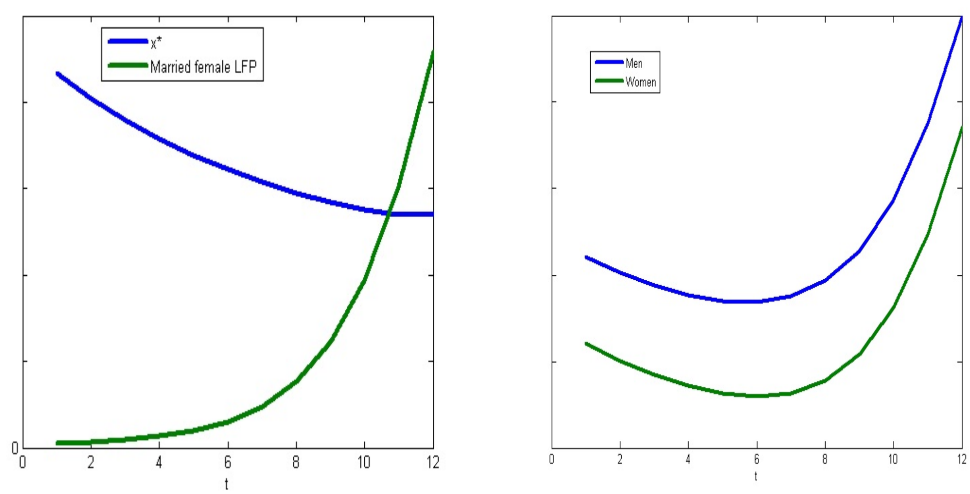
Source: Olivetti (2013).

Figure 5: Relationship between change in real income per capita and change in the age of first marriage (19611998), 15 EU countries



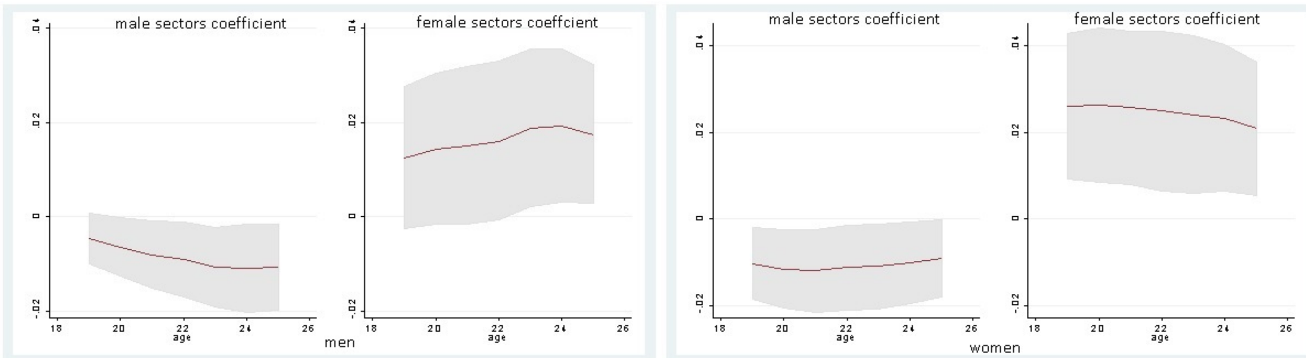
Sources: age of first marriage - Council of Europe, GDP (PPP) per capita - www.gapminder.org

Figure 6: The simulated forces of the model (left) and the mean age of marriage (right)



$\lambda(A_t) = (1 - 0.02A_t)^{-1}$, $u(c) = ln(c)$, $a \sim lognormal(0, 0.25)$, $\pi = 0.7$, $A_t = 0.75 + 0.25t$, $B_1 = 0.5$

Figure 7: The estimated male and female sectors' effect on the male (left) and female (right) singlehood probability (Equation 5)



All regressions include state and year fixed effects. Standard errors are given in parentheses, clustered by state. Controls: legal age of marriage with and without parental consent, Early Legal Access to contraception, no-fault divorce, and abortion laws. The shaded area is the 95% confidence interval.

Figure 8: Singlehood probability at age 20-21 of women (left panel) and men (right panel) in Montana

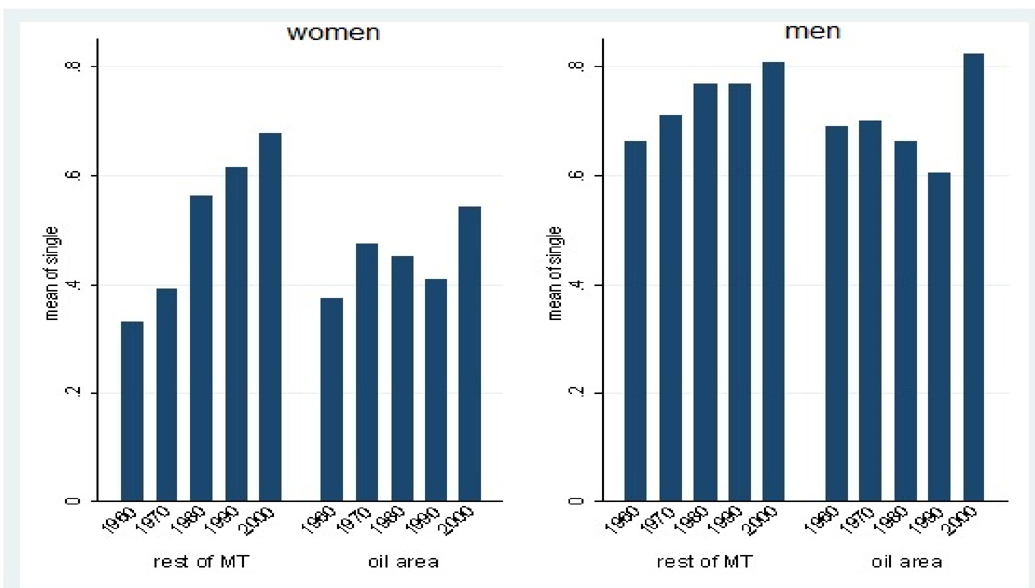


Figure 9: Montana division according to the 1980 Census county grouping

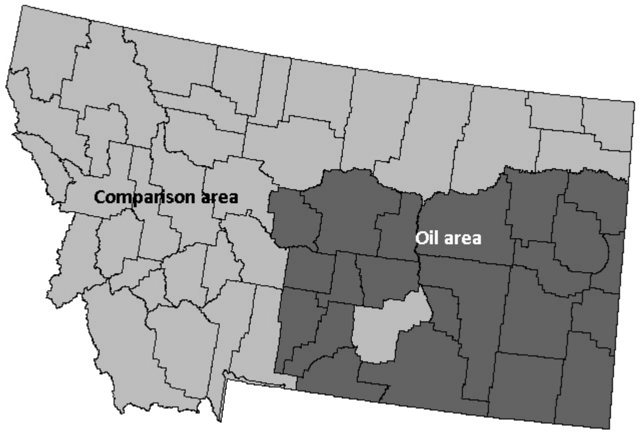


Figure 10: Male income in 1980

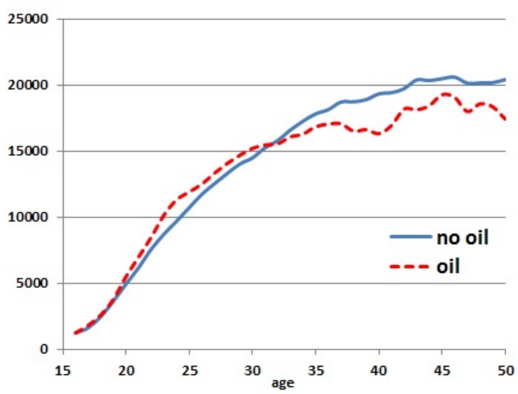


Figure 11: Decomposition of the income gap of 16-24 -year-old males

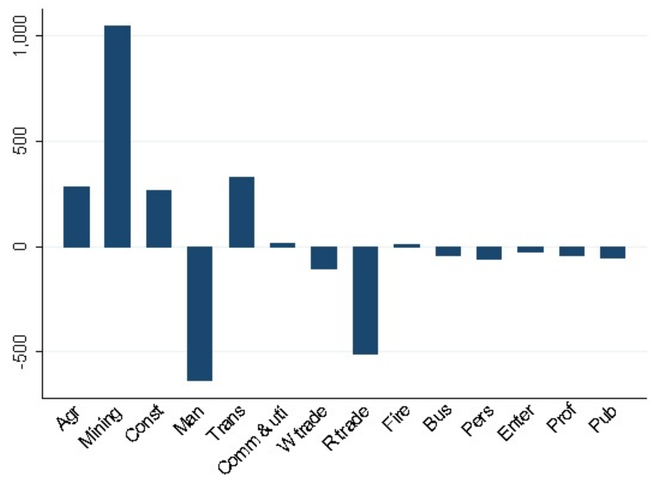
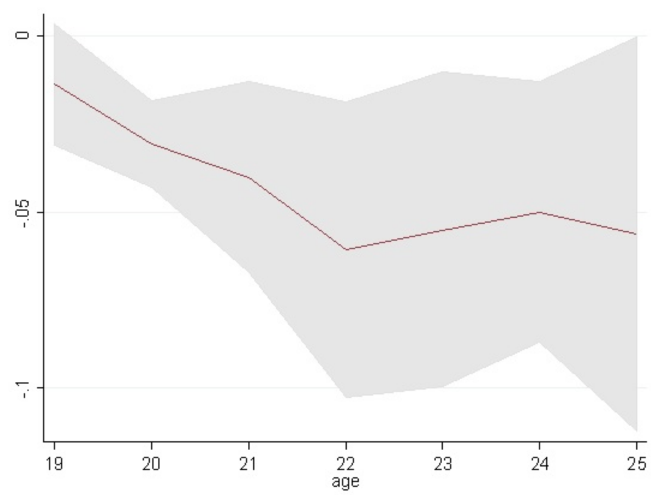


Figure 12: The income coefficient from the 2SLS estimation of Equation (6)



Note: The 2SLS coefficients of Equation (6) where singlehood is regressed on 1980 income in thousands of dollars. In the first stage, the income is regressed on the treatment cohort and oil area dummies and the product of the two. The standard errors are clustered by year of birth and group of counties. The shaded area is the 95% confidence interval.

Figure 13: Male singlehood probability on the 22nd birthday and marriage probability within the five-year period

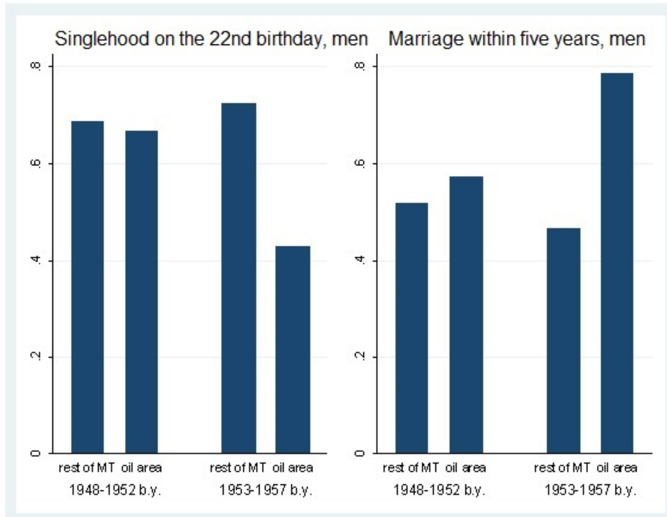


Figure 14: Singlehood probability on the 22nd birthday

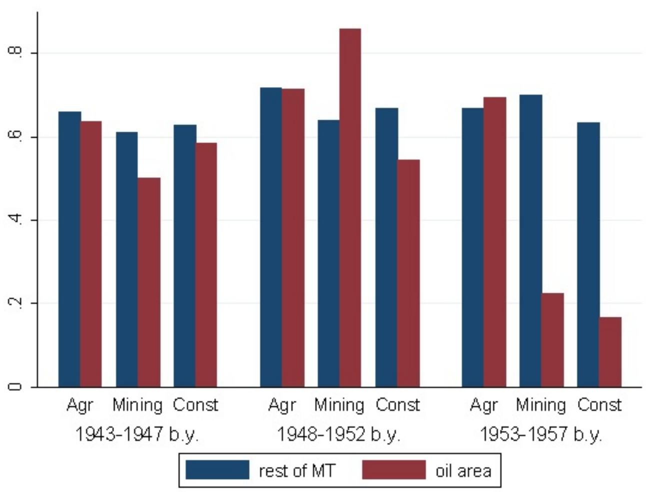
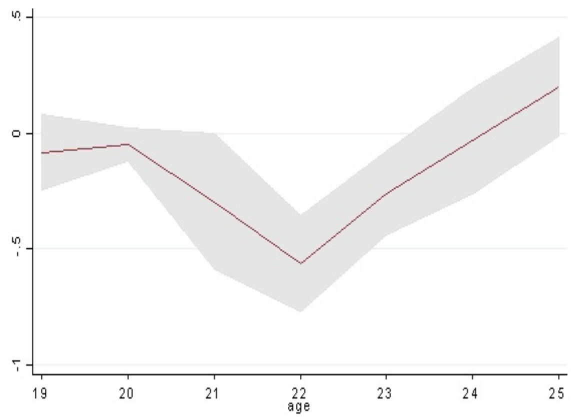


Figure 15: The estimated triple interaction effect on male singlehood probability (Equation (7))



Note: in all regressions, the standard errors are clustered by year of birth and group of counties. The shaded area shows the 95% confidence interval.

Appendix A Mean age of first marriage

Females

	1950-1954	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	2000-2004
Albania	20.5	20.8	21.2	21.4	21.6	22.1	22.5	22.6	22.8	23.4	23.1
Algeria	23.5	23.4	26.1	26.1		21.0	21.0				
American Samoa	23.5	23.5		23.0	23.0	23.0					
Angola	18.2	18.2	18.4	17.9	17.3						
Anguilla											27.2
Antigua and Barbuda	26.1	26.0	25.9	25.7	24.2	24.2	26.6		27.6	27.6	
Argentina		23.4	23.2	23.1	22.9	22.7	22.7				
Armenia								22.3	22.1	22.8	23.2
Aruba											28.7
Australia	22.9	22.6	22.0	21.7	21.7	22.9	24.1	25.2	26.0	26.9	27.7
Austria	24.9	24.4	23.6	23.1	22.8	22.9	23.6	24.5	25.5	26.6	27.4
Azerbaijan								23.8	23.3	23.3	24.4
Bahamas				23.8	23.8	23.9	25.0	26.1	27.7	31.3	27.4
Bahrain						20.1	20.4	22.5	23.0	23.0	23.3
Barbados	25.6	25.7	26.0	25.6	25.3	25.6	26.8	27.5	27.8		
Belarus					23.2	23.2	22.6	22.1	21.8	22.1	22.8
Belgium	23.1	23.1	22.7	22.4	22.1	22.1	22.6	23.6	24.8	25.8	26.8
Belize				21.3					23.4	24.8	
Bermuda	24.3	23.9	23.9	24.7	25.7		27.1	28.2	29.0	29.8	30.2
Bolivia	23.8	23.8		23.0		23.1					
Bosnia and Herzegovina						22.0	22.2	22.9	23.3		
Botswana								25.8			
Brazil						22.0	21.9	22.1	22.4	23.1	24.3
Brunei Darussalam				20.9	21.2	21.7	22.7	25.7	26.1	23.8	24.6
Bulgaria	21.2	21.2	21.3	21.4	21.4	21.4	21.4	21.5	21.9	23.2	24.9
Canada	22.8	22.3	21.8	21.8	22.0	22.9	24.1	25.5	26.6	27.1	27.6
Cayman Islands				22.3	22.3		25.6	26.7	26.8		
Central African Republic		28.7									
Chile	23.2	23.1	22.8	22.5	22.3	22.2	22.6	23.2	23.6	24.2	25.5
Christmas Island		23.7	21.4	20.7	22.6						
Cocos (Keeling) Islands				18.0	20.9						
Colombia	21.9	21.9	21.8	21.6	21.9	22.1	22.2	23.1			
Cook Islands		22.2	21.6		24.4	24.8	24.9	25.0			
Costa Rica	21.7	21.7	21.4	21.1	21.1	21.4	21.8	23.1	23.2	23.6	24.5
Croatia		22.4	22.4	21.7	21.5	21.9	22.3	22.8	23.6	24.9	25.9
Cuba		24.3	24.0	22.6	22.5	22.7	22.3	22.8	24.2	25.5	26.7
Cyprus			23.8	23.9	23.8	23.6	23.8	23.8	24.7	26.0	26.8
Czech Republic		22.0	21.8	21.6	21.7	21.6	21.6	21.6	22.0	23.5	25.4
Denmark	23.8	23.1	22.7	22.6	23.1	24.0	25.4	26.9	28.3	29.4	30.4
Dominica	27.3	27.0	25.6	26.3					27.3		
Dominican Republic	23.3	23.2	23.9	24.0	24.1	23.8	25.3				27.4
Ecuador		21.2	21.4	21.3	21.3	21.5	21.9	22.2	22.3	22.6	23.2
Egypt	21.5	21.1	20.7	20.6	20.5	20.7	20.9	21.7	22.6	25.8	
ElSalvador	22.3	22.2	22.1	22.0	22.2	22.6	23.4	23.6	24.0	24.6	25.1
Equatorial Guinea	27.4	23.6									
Estonia				23.5	23.3	22.8	22.9	22.7	22.9	24.1	25.5

	1950-1954	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	2000-2004
Faroe Islands		23.3	22.5	21.6	22.1	22.9	23.8	24.8	25.5		
Fiji				20.8	21.2	21.3	21.7	22.2			24.0
Finland	23.8	23.8	23.5	23.4	23.5	23.9	24.8	25.6	26.5	27.5	28.5
Former Czechoslovakia		22.0	21.4	21.3	21.7	22.1	22.2	22.2	21.9		
Former East Germany		22.6	22.4	22.0	21.8	21.8	22.2	23.0	24.3	25.3	
Former Panama Canal Zone				23.0	23.3	24.0					
Former West Germany	23.9	23.0	23.4	22.8	22.7	23.0	23.9	25.3	26.1	26.6	
Former Yugoslavia	22.1	22.3	22.5	21.8	21.5	21.9	22.3	22.7	22.9		
France	23.1	23.1	22.9	22.7	22.5	22.7	23.5	24.9	26.3	27.6	28.5
French Guiana	25.7	26.2	26.5	24.3			26.3				28.2
Georgia						26.1	25.2	24.2	23.5	24.3	24.8
Germany		23.5	23.2	22.7	22.4	22.6	23.5	24.7	25.9	26.8	27.3
Gibraltar				23.9	23.7						
Greece		24.5	24.5	23.8	23.7	23.4	23.5	24.2	25.2	26.3	27.5
Greenland	23.5	23.6	23.3	23.8	24.5	25.6	26.2	26.7	27.2		
Grenada	24.7	25.3	25.4	25.2						28.9	28.9
Guadeloupe	23.8	24.2	24.4	23.7	23.4		24.8	25.0	25.9		29.2
Guam		23.2	21.8	21.6	23.1	23.9	24.3	24.6	25.6		26.9
Guatemala	22.0	22.4	21.6	21.2	21.2	21.1	21.7	21.7	21.5	21.7	
Guyana	23.0	23.0	22.9								
Honduras	21.4	21.3	20.9	21.0	21.0	21.7	22.1				
Hong Kong				23.1	23.4	23.8	24.7	25.8	26.4	27.0	27.8
Hungary	21.8	21.8	21.9	21.6	21.3	21.2	21.4	21.7	22.3	23.7	26.0
Iceland	23.5	23.5	23.3	23.0	23.2	23.4	24.4	26.0	27.5	29.2	30.3
Iran, Islamic Republic of				20.8							
Iraq				25.8	26.0	24.0					
Ireland		26.9	26.3	25.3	24.7	24.7	25.2	26.0	27.3	28.4	29.1
Isle of Man	24.1	23.5	22.9	22.4	22.7	23.5	24.2	25.4	26.4	27.8	29.1
Israel	22.0	21.8	21.6	21.4	21.5	21.8	22.3	22.8	22.9	23.3	23.9
Italy	24.8	24.8	24.5	24.1	23.8	23.7	24.1	25.0	26.0	26.9	27.7
Jamaica	26.8	27.0	27.1								28.8
Japan	23.5	23.5	23.7	23.9	23.9	24.6	25.1	25.5	25.7	26.3	27.2
Jordan		19.7	19.7	19.8	19.8	20.0	20.4	21.0	21.3	21.9	
Kazakhstan								22.5	22.1	22.4	23.8
Kenya				24.3							
Korea, Republic of		23.0	22.7			23.3	23.3	24.1	25.0	26.0	27.2
Kuwait				20.3	20.4	20.9	21.5	21.9	21.5	22.6	23.3
Kyrgyzstan								21.8	21.9	21.9	22.7
Latvia					23.5	23.0	22.8	22.6	22.4	23.7	24.9
Liechtenstein			22.7	22.9	24.1	25.4	25.8	26.0		28.8	29.4
Lithuania				24.0	23.9	23.2	23.2	22.8	22.2	22.8	24.3
Luxembourg	24.2	23.9	23.5	23.1	22.7	22.9	23.6	24.7	26.0	27.0	27.8
Macao		27.2	25.0	24.2	23.4	24.3	25.6	26.3	27.3	27.5	27.3
Macedonia, TFYR of											
Madagascar				21.3	21.1						
Mali		22.1	22.2	22.2	22.1	22.2	22.5	22.6	22.7	23.1	24.1

	1950-1954	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	2000-2004
Malta								24.8			
Martinique	25.9	25.8	25.8	25.1	24.4		25.8	26.7			29.9
Mauritius								23.7	23.7	23.8	24.6
Mexico	20.7	20.8		21.3	21.3	21.1	21.4	21.6	21.9	22.4	23.0
Moldova							23.0	22.7	21.9	21.7	21.7
Mongolia										24.3	25.3
Montenegro						22.7	22.7	23.3	23.3	24.0	24.6
Montserrat				23.1	24.9		26.4	27.9			
Mozambique			19.8	19.9	20.4						
Myanmar		22.6	22.4	22.5	23.0	23.2	23.6	24.0	24.0	24.1	25.4
Namibia	27.1	22.5	22.4								
Nauru			24.7	23.1							
Netherlands	25.2	24.8	23.9	23.3	22.7	22.8	23.7	25.1	26.6	27.5	28.3
Netherlands Antilles	23.8	23.6	23.6	23.7	23.4						
New Caledonia						22.6	24.0	25.2	26.2	27.6	28.4
New Zealand					21.8	22.7	24.0	25.1	26.4	27.4	28.1
Norfolk Island					25.0	26.7	25.4	29.8			
Norway	25.1	24.5	23.4	23.0	22.7	23.2	24.1	25.5	26.8	28.0	28.9
Palestinian Authority										19.9	20.1
Panama	23.5	23.2	22.9	23.3	23.3	23.5	23.9	24.4	25.3	26.0	27.1
Paraguay		22.8	22.4	22.5	22.0	22.3	22.7	22.7	22.7		23.5
Peru	22.9	23.1	23.3	23.0	22.9	23.2					
Philippines		21.4	21.5	21.5	21.5	22.0	22.4	22.9	23.8	24.4	24.5
Poland	20.8	21.7	22.1	22.9	22.9	22.7	22.7	22.7	22.8	23.5	25.3
Portugal	25.1	24.9	24.7	24.4	24.0	23.4	23.3	23.7	24.3	25.0	26.1
Puerto Rico	22.2	21.8	21.4		22.2	22.5	23.1	23.6	24.2	24.5	25.3
Qatar							21.0	21.4	22.3	23.1	24.1
Reunion	23.0	22.8	22.8	22.6	22.2		23.0	23.9	24.5	26.8	27.3
Romania		21.9	21.9	21.4	21.8	22.1	21.8	22.1	22.2	23.0	24.0
Russian Federation		24.7	24.3	23.8	22.9	22.5	22.3	22.2	21.9	21.7	21.0
Saint Helena				20.2	21.3	21.4	24.3	23.9			
Saint Kitts and Nevis		26.2	25.6	24.7	24.6					29.3	
Saint Lucia						26.1	26.5	27.2		28.2	28.7
Saint Pierre and Miquelon				21.6							
Sn. Vincent and the Grenadines	24.4	24.5	25.2			25.1	25.1	26.2			
Samoa					23.8	24.7	24.8			25.9	26.0
San Marino			22.8	22.9	22.6	22.4	23.5	25.0	26.9	28.2	28.8
Scotland	23.5	22.8	22.3	22.0	22.0	22.4	23.3	24.0			
Serbia		22.0	22.1	22.4	22.0	22.3	22.7	23.1	23.8	24.5	27.3
Seychelles	24.6		24.7	23.2	22.9	22.4	23.9	26.3	27.6	28.4	28.6
Singapore		23.3	23.0	23.1	23.1	23.2	24.0	25.0	25.8	26.2	26.7
Slovakia		22.1	22.1	22.0	22.0	22.0	21.9	22.0	22.1	23.2	24.8
Slovenia				23.1	22.8	22.6	22.7	23.2	24.4	25.8	27.5
South Africa	22.7	22.5	22.6	22.6	22.6	23.1			27.4	27.7	

	1950-1954	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	2000-2004
Spain	26.1	26.0	25.7	25.1	24.5	23.6	23.8	24.7	26.1	27.4	28.7
Sri Lanka						22.8	23.2	23.6	24.0	24.1	24.9
Suriname										25.0	25.1
Swaziland			24.1								
Sweden	24.6	24.3	23.8	23.7	24.3	25.4	26.6	28.0	28.1	29.4	30.5
Switzerland	25.9	25.4	24.8	24.4	24.2	24.7	25.5	26.5	27.0	27.6	28.2
Tajikistan								21.6	20.2	20.9	20.9
Timor-Leste				23.9	23.3						
Tokelau					24.5	22.0	22.0				
Tonga									23.8	23.8	24.1
Trinidad and Tobago	22.3	22.3	22.4	22.5	22.6	22.8	23.0	23.8	24.1	25.0	26.2
Tunisia	23.7	22.5	20.5	21.1	20.9	20.9	21.5	22.7	23.8	24.4	25.6
Turkey	18.0	18.5	19.0	19.6	20.0	20.4	21.0	21.4	21.8	22.5	22.8
Turkmenistan								22.9			
Turks and Caicos Islands											30.4
Ukraine					22.1	21.9	22.1	22.3	21.9	22.4	23.2
United Kingdom		23.3	23.0	22.5	22.5	22.7	23.4	24.4	25.7	26.9	27.4
United States	20.3	20.2	20.3	20.7	21.1	21.7	22.8	23.9	24.9		
Uruguay						22.6	22.9	23.4	23.6	25.4	25.5
Uzbekistan								21.5	19.8	21.1	21.4
Venezuela	22.1	21.9	21.9	21.7	21.6	21.7	22.1	22.6	23.0	23.7	24.5
Virgin Islands, British					23.8		26.6	28.4			
Virgin Islands, U.S.	24.5	24.1	23.6		24.8		27.4	27.8	28.6		
Zimbabwe						23.2					

Males

	1950-1954	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	2000-2004
Albania	24.8	24.8	25.3				26.0	26.4	26.3		27.8
Algeria	25.9	25.6	21.0	21.0		25.9	25.9				
American Samoa	25.8	25.8		25.5	26.0	25.9					
Angola	18.4	18.5	18.7	18.3	17.7						
Anguilla											27.8
Antigua and Barbuda	29.5	28.9	28.8	28.2	28.2	28.2	29.0	29.2	29.3	29.3	
Argentina		26.5	26.3	26.0	25.7	25.2	25.2				
Armenia								25.4	25.4	26.3	26.5
Aruba											30.1
Australia	25.4	25.3	24.8	24.1	24.0	25.1	26.1	27.0	27.7	28.4	29.1
Austria	26.5	26.5	25.4	25.3	25.3	25.5	25.8	26.5	27.7	29.0	29.8
Azerbaijan								25.6		26.8	26.5
Bahamas				26.0	25.9	26.2	26.9	27.7	29.2	32.6	29.2
Bahrain						24.6	24.8	26.2	26.6	26.5	26.7
Barbados	28.5	28.5	28.3	27.8	27.4	28.0	28.8	29.5	29.5		
Belarus					24.2	24.0	24.0	24.6	24.5	25.0	25.5
Belgium	25.2	25.2	24.6	24.0	23.8	24.2	24.8	25.7	26.9	28.0	28.9
Belize				24.4					25.8	24.8	
Bermuda	25.9	25.7	26.1	26.0	26.1		28.7	29.5	30.2	30.7	31.2
Bolivia	25.5	25.6		25.1		24.3					
Bosnia and Herzegovina								25.7	25.8	27.3	27.2
Botswana								30.8			
Brazil						24.8	24.7	24.9	25.2	25.9	26.7
Brunei Darussalam				25.2	24.4	24.9	25.4	25.9	26.7	26.1	26.9
Bulgaria	24.1	24.4	24.6	24.3	24.2	24.3	24.6	24.7	24.9	26.1	27.5
Canada	25.2	24.9	24.5	24.1	24.1	24.9	26.0	27.1	28.1	28.6	29.0
Cayman Islands				25.2	25.2		27.1	28.0	28.0		
Central African Republic		30.8									
Chile	25.7	25.6	25.2	24.9	24.6	24.5	24.8	25.2	25.7	26.2	27.4
Christmas Island		24.9	24.4	25.7	24.8						
Cocos (Keeling) Islands				19.8	20.8						
Colombia	25.9	25.9	25.7	25.5	25.7	25.5	25.4	26.1			
Cook Islands		24.5	23.9		25.0	26.7	26.5	26.5			
Costa Rica	25.3	25.2	25.0	24.7	24.3	24.3	24.6	25.5	25.6	26.1	26.8
Croatia									26.6	27.1	27.7
Cuba		27.4	27.0	25.6	25.5	25.7	25.0	25.0	26.2	27.7	29.0
Cyprus			25.0	25.1	25.4	25.7	26.1	26.6	27.2	28.2	28.8
Czech Republic									24.7	26.4	28.3
Denmark	26.9	26.3	25.4	24.9	25.7	26.9	28.3	29.5	30.9	32.2	33.2
Dominica	28.3	29.5	28.4	28.7				29.6	29.6		
Dominican Republic	26.9	27.1	27.5	27.4	27.2	26.6	27.8				29.3
Ecuador		24.1	24.3	24.4	24.2	24.3	24.5	24.7	24.7	24.9	25.3
Egypt	26.9	26.8	26.5	26.1	25.5	25.6	25.8	26.8	27.5	27.5	
El Salvador	25.8	25.9	25.5	25.4	25.5	25.7	26.1	26.0	26.2	26.5	27.0
Equatorial Guinea	27.0	28.2									
Estonia								25.2	25.7	26.6	28.0

	1950-1954	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	2000-2004
Faroe Islands		26.3	25.4	24.4	25.1	25.8	26.6	27.0	27.4		
Fiji				24.0	24.3	24.2	24.5	25.1			26.9
Finland	25.6	25.2	24.8	24.2	24.6	25.6	26.7	27.4	28.2	28.8	29.4
Former Czechoslovakia		25.2	24.5	24.0	24.0	24.3	24.6	24.6	24.4		
Former East Germany			24.3	24.6	24.2		25.2	25.2			
Former Panama Canal Zone				24.6	24.8	25.3					
Former West Germany	24.9	24.2	25.6	25.3	25.2	25.5	26.2	26.9	27.9		
Former Yugoslavia	23.9	24.5	25.1	25.1	24.7	25.0	25.5	25.9	26.1		
France	25.4	26.1	26.0	24.4	24.2	24.8	25.8	27.1	28.2	29.1	29.9
French Guiana	28.4	29.2	29.1	27.4	26.7		28.7				30.6
Georgia								25.8		26.2	27.0
Germany									28.4	29.2	30.2
Gibraltar				25.5	25.1						
Greece		27.9	28.1	27.8	27.4	27.0	26.9	27.5	28.3	29.1	30.0
Greenland	25.0	25.6	25.9	26.4	27.4	28.4	29.0	28.9	29.2		
Grenada	28.1	28.5	28.8	28.2						30.6	30.7
Guadeloupe	27.8	28.0	28.1	27.3	26.8		28.0	28.1	28.6		31.4
Guam		25.5	25.0	24.2	25.2	25.8	26.1	26.6	27.0		28.1
Guatemala	25.3	25.6	24.8	24.2	24.1	23.7	24.2	24.2	24.0	25.0	
Guyana	25.0	26.1	26.2								
Honduras	25.3	25.6	25.0	25.1	24.7	25.0	25.2				
Hong Kong				28.2	27.4	27.0	27.4	28.2	29.0	29.4	29.9
Hungary	25.8	25.3	25.0	24.5	24.1	24.2	24.9	25.0	25.0	26.0	27.9
Iceland	25.0	25.7	25.1	24.1	24.2	24.7	25.8	27.3	28.6	30.1	30.4
Iran, Islamic Republic of				26.6							
Iraq				25.8	26.7	27.4					
Ireland		28.0	27.4	26.3	25.5	25.2	25.8	26.6	27.8	29.1	30.1
Isle of Man	26.2	25.7	25.3	24.6	24.9	25.6	26.3	27.1	28.0	29.3	30.0
Israel	25.7	25.4	25.4	24.9	24.4	24.7	25.3	25.8	26.0	26.2	26.7
Italy	27.2	27.4	27.2	26.6	26.1	26.1	26.3	27.1	28.0	29.0	30.1
Jamaica	29.6	29.6	29.4								30.1
Japan	26.4	26.5	26.7	26.8	26.5	27.2	27.7	28.0	27.9	27.9	28.5
Jordan		24.3	24.5	24.9	25.1	25.4	25.4	25.3	25.6	26.4	
Kazakhstan								24.8	24.5	25.0	26.2
Kenya				27.1							
Korea, Republic of		26.5	26.3			26.9	26.5	27.0	27.9	28.5	29.4
Kuwait				26.2	26.1	25.7	25.6	25.7	24.4	25.3	25.8
Kyrgyzstan								24.5	24.3	24.9	26.0
Latvia								24.9	24.9	26.1	27.2
Liechtenstein			25.5	25.7						30.0	
Lithuania								24.4	24.3	25.1	26.4
Luxembourg	26.1	25.9	25.7	25.3	24.9	25.3	26.4	27.2	28.6	28.9	30.2
Macao		30.7	28.6	27.7	27.6	27.6	28.8	28.9	29.9	29.7	29.2
Macedonia, TFYR of									25.3	25.7	26.4
Madagascar				25.2	24.4						
Mali								32.5			

	1950-1954	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	2000-2004
Malta		25.1	25.1	24.8	25.0	25.8	26.2	26.1	26.3	26.5	27.4
Martinique	28.5	28.5	28.4	27.8	27.3		28.1	29.1			31.5
Mauritius								27.7	27.9	28.0	28.2
Mexico	24.1	24.1		24.2	24.2	23.6	23.7	23.8	24.0	24.5	24.9
Moldova								24.4	24.2	24.0	24.2
Mongolia										25.5	26.4
Montenegro						26.6	26.6	27.3	27.3	28.1	28.3
Montserrat				25.5	26.9		28.5	30.6			
Mozambique			23.5	23.3	23.4						
Myanmar											
Namibia	26.5	26.0	25.7								
Nauru			25.8	25.5							
Netherlands	26.6	26.3	25.5	25.3	25.0	24.8	25.8	27.2	28.4	29.3	30.3
Netherlands Antilles	27.1	26.5	26.2	26.1	25.5						
New Caledonia						26.2	27.2	27.9	28.9	29.8	30.3
New Zealand					24.0	24.8	25.9	26.9	27.9	28.8	29.3
Norfolk Island					28.7	29.7	26.7	32.9			
Norway	27.3	26.8	25.4	24.5	24.5	25.4	26.4	27.5	28.5	29.7	30.5
Palestinian Authority										24.5	24.8
Panama	26.8	27.2	26.1	26.1	26.0	26.1	26.4	26.7	27.4	28.0	28.9
Paraguay		26.7	26.4	26.4	24.8	25.9	26.1	26.2	26.0		26.6
Peru	25.9	26.1	26.4	26.2	26.0	26.0					
Philippines		24.0	24.1	24.1	24.0	23.2	23.9	25.2	25.9	26.4	26.6
Poland	25.5	25.2	25.4	25.0	24.3	24.2	24.7	24.9	24.8	25.1	25.9
Portugal	25.6	25.6	25.6	25.3	24.7	24.1	24.3	25.0	25.6	26.1	27.4
Puerto Rico	25.2	24.7	24.0		24.2	24.5	24.9	25.1	25.5	25.9	26.6
Qatar							25.7	25.5	25.9	26.7	27.4
Reunion	26.3	26.1	26.0	25.6	25.3		25.7	26.4	27.0	29.0	29.4
Romania		24.9	25.2	25.0	24.4	24.7	25.1	24.9	24.8	25.7	26.9
Russian Federation		24.1	24.1	23.4	23.4	23.4	23.4	24.5	24.3	24.4	24.9
Saint Helena				24.9	25.6	25.7	27.3	27.5			
Saint Kitts and Nevis		29.1	28.0	27.5	27.6					30.5	
Saint Lucia						27.9	28.9	29.3		29.9	30.5
Saint Pierre and Miquelon				23.9							
Sn. Vincent and the Grenadines	27.7	28.2	28.3			28.3	28.3	29.1			
Samoa					26.3	27.3	27.0			28.6	28.7
San Marino			25.8	25.5	25.3	25.2	25.8	26.7	28.2	29.1	30.3
Scotland	25.6	24.9	24.4	23.7	24.0	24.1	24.9	25.6			
Serbia									26.6	27.0	27.7
Seychelles	28.4		27.3	27.2	26.6	25.8	26.8	28.4	29.5	30.0	30.8
Singapore		26.9	26.9	26.8	26.4	26.2	26.8	27.7	28.4	28.7	29.1
Slovakia									24.2	25.1	26.9
Slovenia									27.1	28.0	29.0
South Africa	25.8	25.5	25.5	25.5	24.9	25.3			29.4	29.7	

	1950-1954	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	2000-2004
Spain	27.6	27.6	27.5	26.7	25.9	24.9	24.9	26.2	27.3	28.4	29.4
Sri Lanka						26.6	26.8	27.2	27.3	27.3	25.9
Suriname										28.1	28.2
Swaziland			28.3								
Sweden	26.8	26.5	25.7	25.2	26.2	27.8	29.0	29.6	29.3	30.2	31.2
Switzerland	27.2	26.8	26.3	25.8	26.0	26.8	27.6	28.3	28.8	29.6	30.2
Tajikistan								23.9	23.1	24.0	24.0
Timor-Leste				26.1	24.2						
Tokelau					24.5	23.7	23.7				
Tonga									25.4	25.8	26.2
Trinidad and Tobago	26.1	25.9	25.7	25.7	25.7	25.9	25.9	26.5	26.6	27.6	28.5
Tunisia	26.8	26.4	26.2	26.8	26.7	25.8	26.3	27.3	28.6	28.8	30.5
Turkey	25.2	25.3	25.5	25.1	24.7	24.6	24.8	24.6	25.0	25.4	25.9
Turkmenistan								23.9			
Turks and Caicos Islands											31.3
Ukraine					24.2	24.0	24.0	24.5	24.3	24.7	25.5
United Kingdom							25.9	26.5	27.6	29.0	29.8
United States	24.6	24.0	23.5	23.1	23.3	23.8	24.8	25.8	26.7		
Uruguay						25.1	25.2	25.6	25.9	27.4	27.3
Uzbekistan								23.7	22.8	23.5	23.9
Venezuela	26.3	26.2	25.9	25.6	24.9	24.7	24.8	25.1	25.3	26.0	26.7
Virgin Islands, British					26.8		28.9	30.5			
Virgin Islands, U.S.	27.1	26.6	25.5		26.8		29.4	29.5	30.0		
Zimbabwe						25.8					

Appendix B Mean age of first marriage data details

I compiled the data in Appendix A using the following sources:

- United Nations Demographic Yearbook for 19482010
- Council of Europe: mean female age of first marriage since 1960
- National Statistics Bureaus of France, Norway, Sweden, Iceland, Canada, Denmark
- U.S. National Center for Health Statistics
- U.S. Bureau of Census
- Schoen and Baj (1984)

The UN Demographic Yearbook marriage data is the total number of marriages between brides and grooms, whose ages are grouped by five years (for example, 25-29 y.o. grooms with 20-24 y.o. brides). The marriages are not divided into first and subsequent marriages. Thus, I use only marriages until age 40 as an approximation to first marriages. The mean age of marriage in the UN data, conditional on marriage before age 40, strongly correlates with the age of first marriage from other sources, such as the Council of Europe and National Statistics Bureaus.

Since the ages in the UN Demographic Yearbook data are totals grouped by five-year intervals, I consider the calculated mean as less accurate than from other sources, where the data is by definition the mean age of first marriage. In countries that have data from both the Council of Europe and the UN Demographic Yearbook, but for more years in the latter than in the former, I regress the Council of Europe data on the UN data. For countries with R^2 above 0.85, I extrapolate the Council of Europe data using the values predicted by the regression.

I calculated the mean age of first marriage in the U.S. using the marriage records of the National Center for Health Statistics.

Appendix C Proof of Proposition 1

It is sufficient to show that (a) $\frac{\partial V_t}{\partial x^*} < \frac{\partial u(A_t x_t^*+1)}{\partial x^*}$ and (b) $\frac{\partial V_t}{\partial A_t} < \frac{\partial u(A_t x_t^*+1)}{\partial A_t}$.

(a) immediately follows from the fact that V_t is a weighted average of $u(A_t x + 1)$. Increased x_t^* leads to increased weights given to the values of x between the old and the new values of x_t^*, because men in this range of ability become non-marriagable for young women, and more of them remain single after the first period. Thus, V_t increases, but less than $u(A_t x_t^* + 1)$.

To prove (b), let us symbolize by M_t the total number of below-z_t marriage market participants of each gender. The probability of a random match with a young partner is, therefore, $\frac{N}{M_t}$. Note that

$$M_t = z_t N(1 + ((1 - \frac{F(x_t^*)}{z_t})p + \frac{F(x_t^*)}{z_t})\frac{N}{M_t}) \tag{8}$$

because the second-period population of the below-z_t single males consists of those who are above x_t^*but matched with young women in their first period, and their match failed with probability p, and of those who are below x_t^*who were matched with young women, and, therefore, rejected.

Under Assumption 1,

$$V_t = (1-(1-\frac{F(x_t^*)}{z_t})(1+\frac{pz_tN}{M_t})\frac{z_tN}{M_t})E_x(u(A_tx+1|x < x_t^*)+(1-\frac{F(x_t^*)}{z_t})(1+\frac{pz_tN}{M_t})\frac{z_tN}{M_t}E_x(u(A_tx+1|x_t^* < x < \frac{1}{B_t})$$

Under supermodularity of $u(1 + A_t x)$, it is sufficient to show that $1 - (1 - \frac{F(x_t^*)}{z_t})(1 + \frac{pz_tN}{M_t})\frac{z_tN}{M_t} > (1 - \frac{F(x_t^*)}{z_t})(1 + \frac{pz_tN}{M_t})\frac{z_tN}{M_t}$. Rearranging and substituting (8) lead to the condition

$$1 - \frac{F(x_t^*)}{z_t} = \frac{1 + m_t - m_t^2}{1 - p} < \frac{m_t^2}{2(p + m_t)}$$

where $m_t = \frac{M_t}{z_t N}$.

This condition is met when $F(x_t^*)$ is sufficiently large. Particularly, the minimal sufficient $F(x_t^*)$ is between $0.36z_t$ when p is close to zero and $0.5z_t$ when p approaches one. ■

Appendix D OECD Countries Analysis

Maddison (1996) and the OECD construct alternative by-industry productivity data sets for a sample of OECD countries. The two data sets are comparable but Maddison (1996) covers the 19472005 period and decomposes GDP into 10 sectors, while the OECD covers the shorter 19601997 period but, in more detail, decomposes GDP into 32 sectors. Thus, the two data sets are used separately for the estimation of the marginal effect of each additional per capita dollar, produced in the male or in the female sectors, on the age of marriage of men and women. I estimate a time series model and not a panel regression for two reasons. First, some countries appear in both data sets and can be used to testify to the robustness of the coefficients. Second, I would like to compare the estimated coefficients of different countries.

The decomposition of sectors into male and female is retrospective and U.S.es the employment shares in the U.S. in 1990:[23] sectors with more than 70% male workers are defined as male, and sectors with less than 50% male workers are defined as female.[24]

The empirical time series model is

$$A_t^g = \alpha_0^g + \alpha_1^g M_{st} + \alpha_2^g F_{st} + \varepsilon_{st}^g \tag{9}$$

where A_t^g is the mean age of first marriage in years[25] of gender g in year t. The variables M and F are the aggregated value added in the male and female sectors respectively, divided by the size of the population in year t. All values were converted into 1980 U.S. dollars purchasing power parity (PPP) to make the estimated coefficients comparable.[26] The standard errors are corrected for the first-order

[23] The 1990 Census was used for calculations.

[24] Maddison (1996) data decomposition: the male sectors are agriculture, mining, construction, durable goods manufacturing, transportation, and public utilities. The female sectors are retail trade, finance, and services. Wholesale trade, public services, and non-durable goods manufacturing are neither male nor female. OECD International Sectoral Data Base decomposition: the male sectors are agriculture, mining, metal products (all groups), transport equipment, mining (all groups), transport and storage, electricity, gas and water, construction, wood and wood products. The female sectors are financial institutions and insurance, textile and leather industries, restaurants and hotels, real estate and business services, wholesale and retail trade. All the other sectors are neither male nor female.

[25] Median for the U.S., because it is provided by Bureau of Census for all years. See Appendix B for details about the construction of the mean age of first marriage variable.

[26] First, OECD PPP converter was used to convert the values into U.S. constant dollars. Then the U.S. GDP deflator (provided by the Bureau of Economic Analysis) was used to convert the values into 1980 dollars.

autoregression and moving average.[27]

Table 9 shows the results of estimating Equation (9). Because OECD and Maddison (1996) are independent data sets, countries that appear in both data sets appear twice in the results table.

The results show that in almost all regressions, α_1^g is negative and α_2^g is positive. Moreover, they are negative and positive, respectively, in all cases where they are statistically significant. The differences between the countries are generally smaller in the male sector effect α_1^g than in the female sector effect α_2^g. While the male sector effect is about -0.4, the female sector effect varies between 0.05 and 0.5. Generally, the male marriage age is more affected by the sector sizes than the female one. In some countries, such as the Netherlands and Norway, the effect of the male sector on the male marriage age is as strong as -1, meaning that a one-thousand 1980 dollars increase in the male sector output per capita reduces the mean male age of marriage by one year. An interesting pattern is observable in most regressions: the two coefficients α_1^g and α_2^g , despite having opposite signs, are relatively similar in absolute terms within each country. Every dollar added to the female sectors is associated with a similar increase in the age of *marriage* as the decrease associated with every dollar added to the male sectors. Note that the data mostly cover the period when the age of marriage in the analyzed countries was increasing. At the same time, this is the period of the structural change toward services, which means a rise in the female sector. Thus, the fact that the effect of the male sector is still observed, is negative, and is statistically significant is surprising. This negative effect supports the model's prediction that the two forces exist contemporaneously.

[27] STATA command *arima* was used for estimation.