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Leibniz University Hannover and IZA

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IZA – Institute of Labor Economics

Schaumburg-Lippe-Straße 5–9
53113 Bonn, Germany

Phone: +49-228-3894-0
Email: publications@iza.org

www.iza.org

ABSTRACT

The Marriage Age U-Shape

In this paper, I address the U-shaped dynamics (a decrease followed by an increase) in the age at first marriage during the twentieth century. First, I show that the U-shaped dynamics have been steeper in Western that in other countries. Second, I find that these dynamics in Western Europe are strongly related to the post-WWII economic development. By contrast, in the nineteenth and the first half of the twentieth centuries age of marriage was much less correlated across Western countries. I propose a simple model where age of marriage is a function of search frictions and a structural change of the economy. Both factors put together generate U-shaped dynamics as a result of an industrial boom that mimics the post-WWII economic development, especially in Western countries.

JEL Classification: J12, N32, N34

Keywords: age of marriage, economic development, twentieth century demography

Corresponding author:
Pavel Jelnov
Wirtschaftswissenschaftliche Fakultät
Institut für Arbeitsökonomik
Leibniz Universität Hannover
Königsworther Platz 1
30167 Hannover
Germany

E-mail: jelnov@aoek.uni-hannover.de

1 Introduction

A decrease followed by an increase in the age of marriage was observed in the twentieth century in all advanced economies. Today, a high level of 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. Studies published around the middle of the century document the trend toward an earlier marriage. For example, Newcomb (1937) writes with respect to the United States that

"Today the prospect of marriage and children is popular again; 60 percent of the girls and 50 percent of the men would like to marry within a year or two of graduation... boys and girls tend to take it for granted that they will be married, as they did not a decade ago."

Almost thirty five years later, Dixon (1971) writes that

"The trend away from the 'European' pattern is most obvious in the wealthier nations of the West, especially in the English-speaking nations overseas and in England, France, Belgium and parts of Scandinavia. These are also countries with increasingly assertive and independent youth who are taking advantage of the opportunities to marry young that the wealthy and secure economies provide."

The decades that followed have shown that this downward trend in the age of marriage was temporary. The age at first marriage has climbed sharply since the 1960s in the United States and advanced parts of Europe and since the 1970s and 1980s also in Southern Europe and Ireland. This upward trend reached the former Communist Eastern European countries in the 1990s. Few economists have addressed these U-shaped dynamics so far. Moro et al. (2017) relate the marriage age U-shape in 16 developed countries to economic structure and Iyigun and Lafortune (2016) relate the American dynamics to the spousal education gap.

In this paper, I vastly expand the sample of countries where the dynamics are documented. I compile data on age at first marriage from 160 countries. First, I compare Western and non-Western countries and find that Western countries have experienced a much sharper U-shape (in both decreasing and increasing portions) than the non-Western ones. Moreover, in some non-Western regions, in particular in Eastern Europe, no decreasing portion is observed and the increase only starts in the 1990s. Moreover, in post-WWII Western countries, age of marriage follows the same dynamics for men as for women and shows a strong correlation

with the economic development path. Furthermore, I show that the post-WWII U-shape is unique in its correlation across Western countries. For example, age of marriage in the nineteenth century in the U.S., England, and France plot three dissimilar time series. To summarize, the uniqueness of the U-shape consists in its association with economic development and in a strong correlation between countries and between genders. By contrast, marriage age dynamics in the earlier period are not synchronized across countries and genders.

I propose a simple model of the U-shaped dynamics. The model is an expanded version of the Becker hypothesis of the return to marriage. It relies on search frictions to explain the increasing male marriageability following a male labor-biased industrial boom. The improved male marriageability leads to a decrease in age of marriage of both genders. In the long run, this effect is gradually overtaken by the opposite effect of increased married women's labor force participation as a result of a shift of the economy from brawn-based to gender-neutral industries. The idea is that women who plan to work after marriage participate in a marriage market that is separate from the marriage market for future housewives because their skills matter. The skilled marriage market is heterogeneous for both genders and, thus, the search in this market takes longer than in the marriage market for future housewives, who are assumed to be homogeneous. Thus, age of marriage of men and women raises as a result of the structural change of the economy. Essentially, the model posits that men experience an increase in productivity before women, and that the resulting rise in incomes leads to earlier marriage, but that eventually womens' productivity sufficiently rises to the extent that assortative mating (on potential output) increases, thereby raising the incentive to delay marriage and reversing the trend in marriage age.

This paper makes two contributions to the literature. First, I compile data on age at first marriage from 160 countries, which is a broad extension to the data from 16 countries, presented in Moro et al. (2017), and, second, I contribute to the literature on the relationship between age of marriage and economic development. The difference between the Western European marriage pattern and that of the rest of the world can be traced back to the Black Death (Hajnal (1965)). To explain this difference, the literature has increasingly focused on the link between the European Marriage Pattern (EMP) and female labor markets (De Moore and van Zanden (2010), Minguela (2011), Voigtländer and Voth (2013)). The EMP depicts a pattern of late

marriage (25 years and older in pre-industrial Europe), a small spousal age gap, and a high proportion of never-married women. The Malthusian demographic regime explains the persistence of the EMP as a fertility restriction mechanism that was used for hundreds of years prior to the Industrial Revolution. Gradually, the role of the fertility restriction in the EMP declined, leading to a growing independence between the age at first marriage and the age at first birth (Coles and Francesconi (2017)). This growing independence, which started during the Demographic Transition, allowed for lower age of marriage with reduced fertility.

Since birth restriction is no longer the main determinant of marriage age, other factors play a larger role. For example, early urbanization decreased 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 contributing to the independence between 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 improved birth control technology *allowed* late marriage. The Pill explains some 30% of the increase in the singlehood rates of young American women (Goldin and Katz (2002), Edlund and Machado (2009)). The reason that women preferred postponing marriage was increasing opportunities for female education and careers (Goldin (1990, 2006)).

Recently, Autor et al. (2017) analyze the impact of negative shocks to American low-income males as a result of increasing competition with Chinese imports. They testify to the positive effect of these shocks to the share of single-parent households among the low-educated because of the lesser marriageability of the low-educated men affected by the shocks. The issue of marriageability of low-income American men is raised already in Wilson (1987). Moro et al. (2017) report the twentieth-century marriage age time series in the 16 OECD countries. They show that the fraction of married individuals is positively correlated with the share of manufacturing in the GDP. Schaller (2016) analyzes the effect of male and female local labor demand shocks of recent decades on fertility. She finds that improvements in male labor market conditions are associated with increased fertility, while improvements in female labor market conditions have smaller negative effects. Blau et al. (2000) use 1970-1990 American Census data to find an opposite-sign relationship between male and female labor market conditions and the share of married young women. Finally, Iyigun and Lafortune (2016) study the American marriage age U-shape in a model where age of marriage is endogenously associated with

a spousal educational gap. To obtain this result, they assume that spouses cannot study simultaneously. In the empirical part of the paper, they show that the spousal educational gap is negatively related to exogenous variation in the marriage timing instrumented by minimum marriage age laws. My simple model differs from Iyigun and Lafortune (2016) in relying on a single force to explain both the decreasing and increasing age at first marriage. This simplicity could be achieved due to a realistic incorporation of search frictions in the marriage market model.

The remaining of the paper proceeds as follows. Section 2 discusses the marriage age dynamics in 160 countries and addresses the differences between Western and other countries. Section 3 shows the strict relationship between the U-shaped dynamics and the economic development across Western Europe during the post-WWII decades. Section 4 frames the U-shaped dynamics in a broad context of 200 years of nuptiality history in Western countries to show its uniqueness in terms of correlation between countries and genders. Section 5 puts things together with a simple model that may explain the U-shaped dynamics in a context of industrialization that affects men first and women later. Section 6 concludes.

2 The Marriage Age U-Shape

Table I reports the mean age at first marriage, averaged over countries within the same region, for the years 1950 to 2004. The row data appears in Appendix A and the details of its compilation appear in Appendix B. Averaging over groups of countries allows a summary of the data but also solves the problem of gaps in data at the country level. The average is unweighted, and, thus, is not dominated by large countries. The number of countries is reported in parentheses. Summarizing the table, the mean age of marriage decreased in Northern and Central Europe and in Western Offshoots[1] by half a year every decade between 1950 and 1970 and has increased by one year every decade since then. The decrease in Southern Europe, Ireland, and Latin America started in the late 1950s and early 1960s and lasted until the late 1970s and early 1980s. In Eastern Europe there was almost no decrease at all and the sharp increase is observed only since the 1990s. It is difficult to draw any conclusions on the trend in Asia and Africa in the first years of the sample because of the small number of countries. For the later years, the sample of Asian and African countries is larger and

[1] United States, Canada, Australia, and New Zealand.

the trend in age of marriage is upward but the slope is not as sharp as in Europe and the Americas.

Figure I summarizes the findings by classifying all countries into two groups: Western countries, which include Central and Northern Europe and Western Offshoots, and other countries. The figure leads to three insights. First, the mean age of marriage changes faster in the West than in other parts of the world. This is true for both the decreasing and increasing portions of the U-shape. Second, in the West, age of marriage of men and women is much more strongly correlated than in the rest of the regions. Third, age of marriage of Western women was always above age of marriage for non-Western women, except for the bottom point in the 1960s. For men, the picture is different. Men married older in non-Western countries than in Western ones until the 1970s but the opposite has been true ever since then.

The post-WWII U-shape can be summarized by the following statistics. Age of marriage of Western women decreased from 23.8 to 22.5 between 1950 and 1965 while that of men decreased from 25.9 to 24.7. Age of marriage increased between 1965 and 2000 to 28.3 for women and 30.1 for men. In non-Western countries age of marriage of women decreased between 1950 and 1965 from 23.3 to 22.6, and increased between 1970 and 2000 to 25.6. For non-Western men, the decrease lasted until 1970 and constituted a drop from 26.3 to 25.3. It was followed by a rise to 27.8 until 2000.

3 The Marriage Age U-Shape and Economic Development

The post-WWII marriage age U-shape in Western countries perfectly mirrors the converging path of economic growth. As an example, Figure II shows the post-WWII mean age at first marriage in three very different developed countries: Australia, Norway, and Spain. The different timing of the U-shape observed in the figure, with Norway to be the first one to experience it, and Spain to be the last one, exemplifies the relationship of the U-shape and the growth path. The insight is that the U-shape is a reflection of the development: age of marriage sharply decreases when the economy booms and the turnaround from decrease to increase is associated with the slowdown of economic growth. Countries vary in the timing of the development path. Correspondingly, they vary in the timing of the marriage age U-shape. For example, at the time that age of marriage in Spain started to decrease and the economy to boom, age of marriage in Norway had already

Table I: Mean age at first marriage, 1950-2004

Men

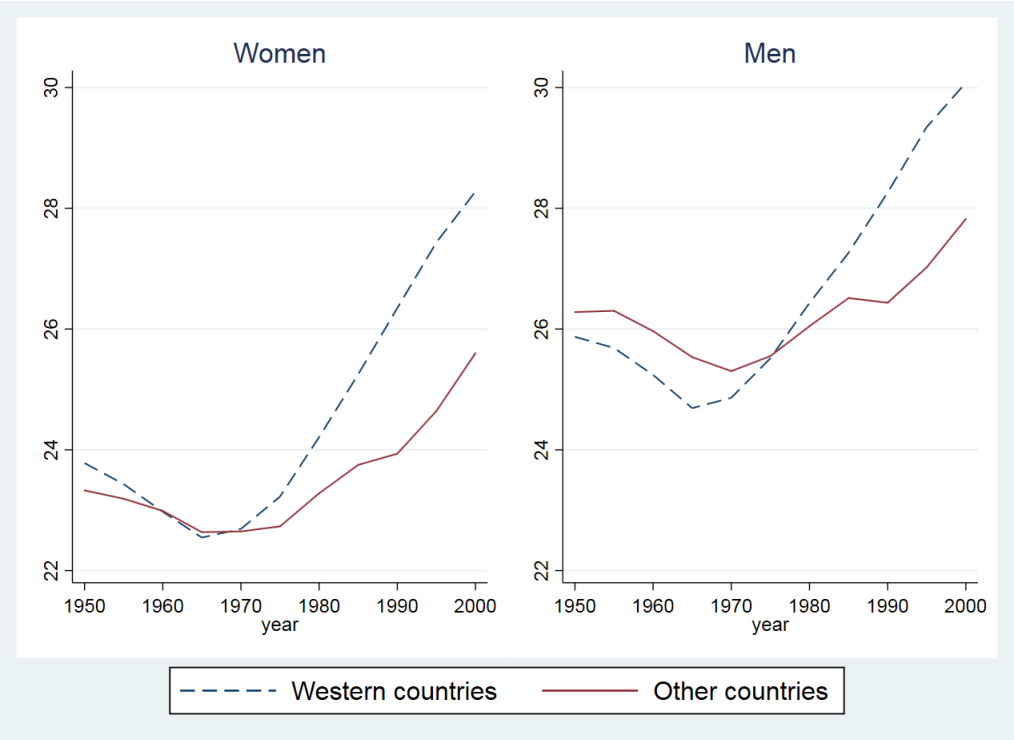
	1950-1954	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	2000-2004
Northern Europe	26.0	25.9	25.3	24.7	25.2	26.0	26.9	27.6	28.6	29.9	30.6
	(8)	(9)	(9)	(10)	(10)	(10)	(11)	(11)	(9)	(7)	(7)
Central Europe	26.0	25.8	25.6	25.1	24.9	25.3	26.0	27.0	28.1	29.1	29.9
	(7)	(7)	(8)	(8)	(7)	(7)	(7)	(7)	(8)	(8)	(7)
S. Europe & Ireland	26.5	26.7	26.3	25.9	25.5	25.4	25.7	26.4	27.2	28.0	28.9
	(4)	(7)	(9)	(10)	(10)	(9)	(9)	(9)	(9)	(9)	(9)
N. America & Pacific	25.1	24.8	24.3	23.8	23.9	24.7	25.7	26.8	27.7	28.6	29.1
	(3)	(3)	(3)	(4)	(4)	(4)	(4)	(4)	(4)	(3)	(3)
Eastern Europe	24.8	24.8	24.8	24.5	24.2	24.5	24.9	25.2	25.3	26.0	26.9
	(5)	(8)	(9)	(8)	(10)	(10)	(12)	(19)	(23)	(21)	(22)
Latin America	26.7	26.8	26.7	26.0	25.8	25.6	26.6	27.1	26.9	27.5	28.6
	(27)	(32)	(30)	(32)	(31)	(26)	(31)	(28)	(23)	(21)	(26)
Middle East	26.2	25.7	24.7	25.3	25.8	25.6	25.5	25.9	26.2	26.4	26.8
	(4)	(5)	(5)	(8)	(6)	(8)	(8)	(8)	(7)	(9)	(7)
Asia	26.4	26.9	26.5	26.4	25.8	26.2	26.7	26.1	26.5	26.7	27.1
	(1)	(5)	(5)	(7)	(7)	(8)	(8)	(13)	(12)	(13)	(13)
Sub-Saharan Africa	25.4	25.9	25.0	24.6	23.7	25.6	26.2	29.1	28.5	29.2	29.4
	(6)	(6)	(7)	(7)	(6)	(3)	(2)	(5)	(4)	(4)	(3)
Oceania	25.8	25.2	24.8	24.1	25.1	26.2	25.9	27.8	27.1	28.1	28.0
	(1)	(4)	(4)	(6)	(9)	(8)	(7)	(5)	(3)	(3)	(5)

Women

	1950-1954	55-59	60-64	65-69	70-74	75-79	80-84	85-89	90-94	95-99	2000-2004
Northern Europe	24.0	23.6	23.1	22.6	22.9	23.5	24.6	25.6	26.9	28.3	29.3
	(8)	(10)	(10)	(11)	(11)	(11)	(11)	(11)	(9)	(7)	(7)
Central Europe	24.3	23.9	23.4	23.0	22.9	23.2	24.0	25.0	26.0	27.1	28.0
	(7)	(8)	(9)	(9)	(9)	(9)	(9)	(9)	(8)	(9)	(8)
S. Europe & Ireland	24.5	24.5	24.0	23.7	23.5	23.3	23.7	24.3	25.2	26.2	27.1
	(4)	(7)	(9)	(10)	(10)	(9)	(9)	(9)	(9)	(9)	(9)
Western Offshoots	22.0	21.7	21.4	21.4	21.6	22.5	23.7	24.8	25.8	26.6	27.2
	(3)	(3)	(3)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Eastern Europe	21.3	22.1	22.1	22.2	22.2	22.4	22.5	22.5	22.7	23.5	24.5
	(5)	(14)	(14)	(17)	(20)	(23)	(24)	(25)	(25)	(22)	(21)
Latin America	23.7	23.7	23.6	23.1	23.0	22.9	24.1	24.7	24.8	25.6	26.7
	(27)	(32)	(30)	(32)	(30)	(26)	(31)	(26)	(23)	(21)	(26)
Middle East	21.7	21.1	21.2	21.8	21.3	21.0	21.0	22.1	22.4	23.0	23.4
	(4)	(5)	(5)	(8)	(6)	(8)	(8)	(8)	(8)	(9)	(7)
Asia	23.5	23.7	23.2	22.9	22.8	23.2	23.9	23.8	24	24.3	24.9
	(1)	(5)	(5)	(7)	(7)	(8)	(8)	(13)	(12)	(13)	(13)
Sub-Saharian Africa	23.8	23.1	22.1	21.7	21.1	22.9	23.5	24.9	25.8	26.7	26.9
	(6)	(6)	(7)	(7)	(6)	(3)	(2)	(5)	(4)	(4)	(3)
Oceania	23.5	23.2	22.4	21.2	23.2	23.6	23.9	25.4	25.2	25.8	25.9
	(1)	(4)	(4)	(6)	(9)	(8)	(7)	(5)	(3)	(3)	(5)

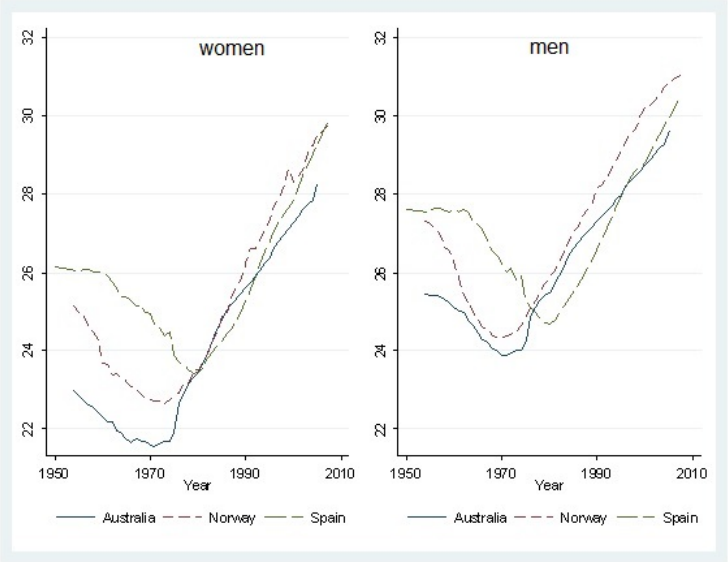
Note: The table reports unweighted average age of marriage.
The number of countries is reported in parentheses.

Figure I: The mean age at first marriage



Source of data: Appendix A, details of compilation appear in Appendix B. Western countries include Central and Northern Europe and Western Offshoots.

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

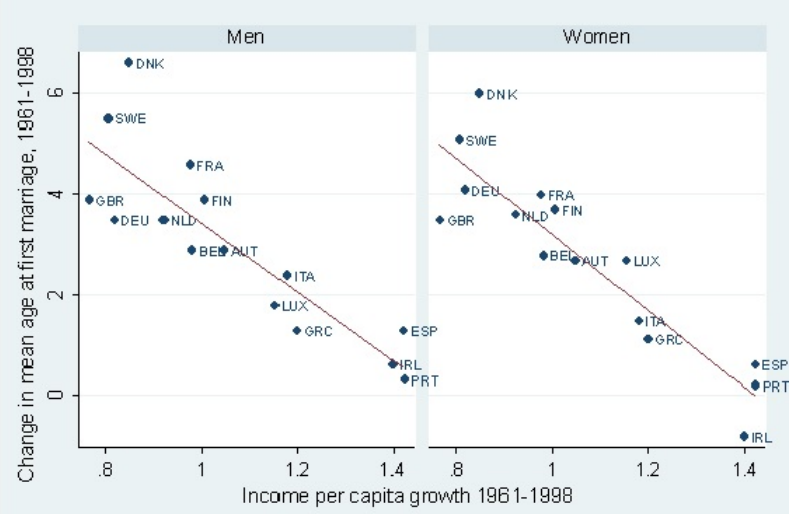


Note: Mean age at first marriage; see Appendix A for data and Appendix B for details.

started to increase. This makes the post-WWII decades a special event in economic and demographic history, where one observes a common growth pattern associated with common U-shaped marriage age dynamics.

Across the European Union, the correlation between changes in the mean age at first marriage and changes in the logged per capita GDP over the 1960-2000 period is -0.92 for men and -0.86 for women (see Figure III). Similarly, a negative correlation is also observed across the United States. In other words, the fast economic growth at the beginning of the income development path is associated with a declining age of marriage, but as growth slows down age of marriage starts to rise. While the former fast stage is related to the rising productivity in male labor-dominated sectors, the latter slow stage is related to the tertiarization of the economy, associated with rising female labor. In Northern and Central Europe the U-shape started either between the world wars or with the implementation of the Marshall Plan, and in Southern Europe and Ireland it started with the modernization of the economies in the 1960s. For example, in Spain, age of marriage started to decrease in 1962, at precisely the time the Stabilization Plan was implemented.

Figure III: The change in the real logged GDP per capita and the change in the age at first marriage



Source of data: Council of Europe for age of marriage, Maddison (1996) for GDP.

4 The U-Shape in a Historical Perspective

The uniqueness of the post-WWII marriage age U-shape consists in the strong correlation between Western countries, the correlation between genders, and the strong correlation between the U-shape and the economic development path. By contrast, before WWII the trends in the marriage age in different Western countries were not synchronized. Due to Wrigley et al. (1997) and other sources, we can follow the mean age of marriage in England since 1600. It is presented in Figure IV. Age of marriage decreased for men starting in the late seventeenth century and for women starting in 1700. It started to increase in the early nineteenth century and continued to increase slowly (with a short disturbance) until World War One. However, it decreased by about two years between WWI and 1970 and from then to the turn of the twenty-first century it steeply rose by about five years.

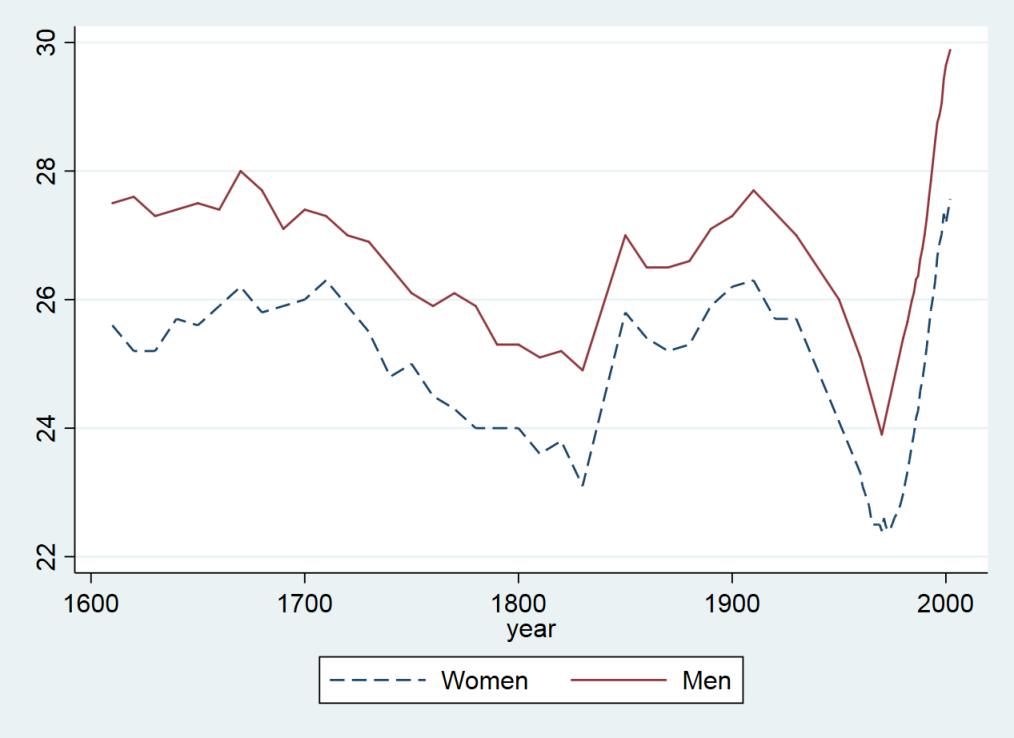
Wrigley et al. (1997) find that the source of the long-term decrease in age of marriage was driven by the manufacturing-biased parishes of England already in the eighteenth century. Furthermore, Grebenik et al. (1963) compare British data from the 1880s to data collected around 1960. They find that in the 1880s, male miners married at age 24, artisans and laborers at 25.5, farmers at 29, and professional men at 31. Age

of marriage of men and women in England decreased after WWI and continued to decrease after WWII. However, for couples where the groom was a high-skilled worker (either manual or non-manual) age of marriage decreased by one year more than for couples where the groom was a low-skilled worker.

Was the trend in other Western countries always similar to the one in England? No. Figure V presents time series for Western countries with data available since 1800 (for the UK it duplicates the post-1800 part of Figure IV). In Belgium, Denmark, and to a lesser degree France, age of marriage decreased during the nineteenth century. Belgium is the most extreme case of a steep fall in age of marriage from an extreme level of 30 in 1800. However, the same is not true for the U.S., where age of marriage increased during almost all of the nineteenth century. In Germany age of marriage of women decreased starting in the 1930s but that of men decreased only after WWII. In Italy, age of marriage decreased only in the 1960s and 1970s. In contrast to age of marriage in France, England, and Belgium, age of marriage in Sweden increased starting in the middle of the 18th century until the 1930s when it started to decrease. Similarly to Sweden, the age at first marriage started to decrease in Switzerland in the 1930s (Schoen and Baj (1984)).

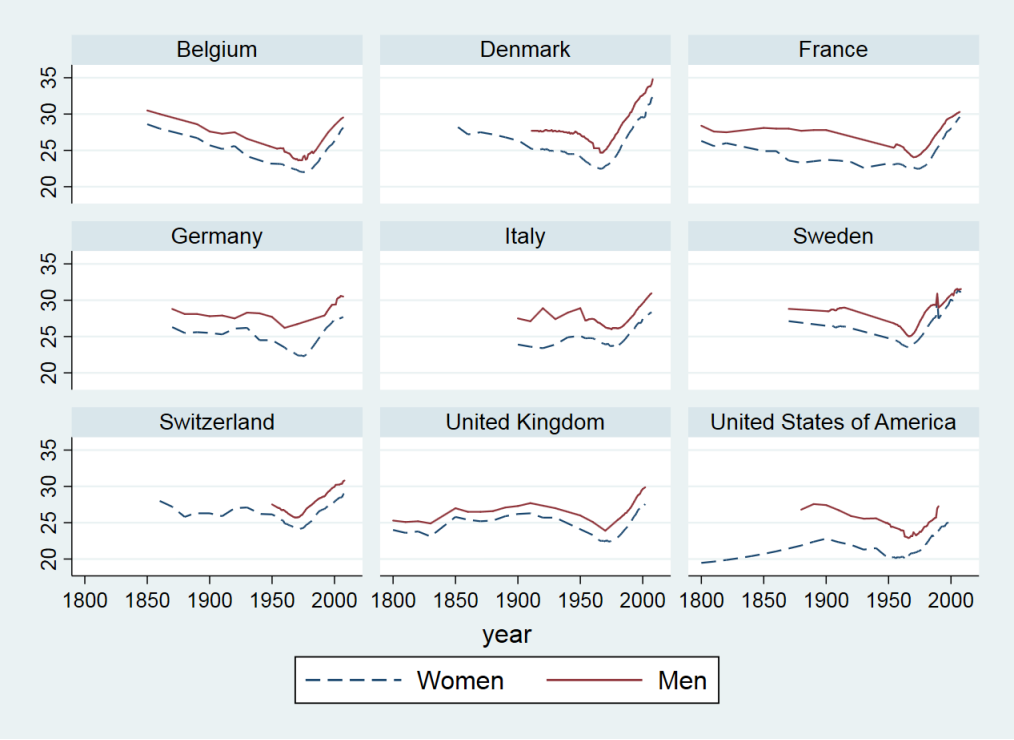
What can we learn from these examples? First, we observe that before WWII different Western countries followed different trends in age of marriage. In particular, as discussed in Haines (1996), the relatively low age of marriage in the U.S. during colonial times is associated with the fact that economic capacity in the American colonies was better than in Europe. Second, age of marriage in some countries followed a long decreasing trend. This was the case in England in the eighteenth century and in France, Belgium, and Denmark in the nineteenth century. Finally, the starting point of the twentieth century U-shape varies across countries. In the U.S. the decrease starts around the Second Industrial Revolution. In Sweden, Switzerland, and England it starts after World War One. In Germany, Italy, and (not shown in the figure) Spain, Portugal, and Ireland it starts as late as the 1960s.

Figure IV: Mean age at first marriage in England since 1600



Source of data: See Appendix B.

Figure V: Mean age at first marriage since 1800 in selected countries



Source of data: See Appendix B.

5 A Model for the Post-WWII U-Shape

An informal summary

Consider equal populations of men and women with observed heterogeneous ability endowment that participate in the marriage market for up to two periods. The generations are overlapping. There are two sectors of production: one is male-only as it requires physical strength and the second is gender-neutral. All men work in the market while some women work in the market and other women are housewives. Market workers (men and women) are heterogeneously productive in accordance with the ability endowment. By contrast, housewives are similarly productive, such that home product is homogeneous across households. Utility in singlehood is normalized to zero and saving is not possible, and so the question of whether single women work or not is irrelevant.

Married individuals obtain utility from consumption and, therefore, are concerned with the partner's productivity. The income of a couple is a public good and consists of wages and home product. There is no preference over the partner's age. Men search for women and propose marriage. The search for a woman is with respect to her contribution to the household income. Search within the pool of future housewives is random because the home product is homogeneous and does not depend on the woman's ability. Search within the pool of women who plan to work in the market after marriage is direct and not random because their wage depends on their ability. The latter direct search leads to assortative-by-ability matching.

The marriage market is driven by the key assumption that direct search is longer. This assumption is implied by fundamental results in search theory that link heterogeneity with duration of search. Thus, women who plan to work in the market after marriage (and their partners) postpone the marriage to the second period. Women who plan to be housewives are homogeneous in terms of production and behave differently. In the first period, they receive random offers from heterogeneous men and hold a reservation value i.e., the man's minimal ability level such that his marriage proposal is accepted. The analytical result, proven in Appendix C, is that the reservation value decreases when wages in the male-only sector rise because the value of entering the second period of search does not rise as fast as the utility from marrying the threshold-ability man. This decrease in the reservation value makes more low-ability men and women marry in the first period

as male productivity improves. Because fewer offers are rejected in the first period, the mean age of marriage decreases.

Thus, the marriage market consists of two parts. The first part is populated by low-ability homogeneous women and low-ability heterogeneous men. Some of them marry in the first period, whenever the male partner's ability is above the reservation value. Others marry in the second period because the first-period offer was rejected by the woman. Some low-ability men will not marry at all, if they are repeatedly matched with young women who reject them. The second part of the marriage market is populated by high-ability heterogeneous men and women who all marry in the second period. The dynamics follow from the assumption that increased male productivity spills over into increased female productivity. The reason for this spillover lies in the spillovers of technology or in the increased demand for goods produced in the gender-neutral sector as income rises. The rise of wages in the gender-neutral sector encourages more women to work in the market after marriage and hence to postpone their marriage (and that of their male partners) to the second period. Thus, the threshold ability level, which selects into the marriage markets, decreases over time. Because the high-ability marriage market becomes larger over time, at some point its growth dominates the decreasing reservation value in the low-ability marriage market. The resulting dynamics plot a marriage age U-shape over time if female labor force participation first grows slowly and later expands rapidly, which is the case, for example, when spillovers of productivity from the male to the gender-neutral sector are hyperbolic. In other words, in order for the decreasing portion of the marriage age U-shape to exist, there must be a period of time when the effect of an increase in the wages of low-skilled males exceeds the effect of increasing female labor force participation.

A formal model

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 of the technologies. Technology A requires male physical strength. Technology B is gender-neutral. For simplicity, I call technology B "female." The production function is linear with respect to human capital and the workers earn their marginal product. Therefore, 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. 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 (as estimated by Bridgman (2013)). Therefore, the home product is normalized to one unit.

The technologies A and B grow exogenously, but A affects B:

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

where some increasing function λ captures spillovers from the male sector to the female one. The function λ may be interpreted as direct technological spillovers or as increased demand for goods produced with technology B, triggered by income effect of the increased productivity of the A-technology workers. This increased demand is translated into a higher value of the B-workers production.

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. Because the utility of singles is normalized to zero and saving is not possible, it does not matter whether single women work or not.

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

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

where x_m and x_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

Let A-technology exogenously advance over time, such that $A_{t+1} > A_t$. All men work, but married women choose to work only if their productivity in the market is above their productivity as housewives,[2] 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 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 to B 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 with respect to ability, unless the man has to choose within a group of equally endowed 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.[3] The consumption of a 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.

[2] 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.

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

The following 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: Random matching takes one period, direct matching takes two periods.

Under Assumption 1, the equilibrium is as follows. The above-z_t men are positively assortative matched with the above-z_t women.[4] 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.

Interpretation of the model

The two forces that move 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. Note that these two forces do not have a simple mechanical relationship because the reservation value x_t^* depends on the utility function while z_t depends on the spillovers function λ from technology A_t to technology B_{t+1}. Decreasing reservation value means decreasing age of marriage for both genders because more young men are "marriageable" and more young women accept offers. Decreasing z_t means increasing age of marriage for both genders because a larger proportion of individuals enters the heterogeneous marriage market. Hyperbolic spillovers from A to B provide a good example of a gradual rise of the female sector that booms at some point, which leads in turn to a rise in the age of marriage.

In summary, technological development leads to a gradual rise in both male marriageability and married women's labor force participation. While increasing male marriageability leads to a shorter search for a

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

marriage partner and a decreasing age of marriage, increasing married women's labor force participation has the opposite impact because of market workers' heterogeneity. The proposed mechanism is consistent with the marriage age U-shape, with the rise of labor force participation among educated young married women,[5] and with the fact that marriage is positive assortative by education,[6] even though education does not appear explicitly in the model. The model implies an increasing high-skilled married women's labor force participation and, therefore, a decreasing weight of low-skilled single women in the female labor force. The model is thus consistent with empirical female labor force composition dynamics (Mulligan and Rubinstein (2008)) and increasing female college attendance (Goldin (2006)). An additional result of the model is that some low-skilled men never marry, which is consistent with Bruze et al. (2014) and Autor et al. (2017). Moreover, the model recalls the empirical finding of Zhang (1995) that a man's age of marriage and his wage are positively correlated if the wife is working but they are negatively correlated if the wife is not working. An additional important note is that age of marriage in the model is not necessarily correlated with the gender wage gap because the gender gap in the model depends not only on productivity but also on selection into the female labor force.

6 Conclusions

This paper addresses the twentieth century dynamics in the age of marriage across the globe with a special focus on U-shaped dynamics, more prominent in Western than in other countries, and taking place mostly after WWII. The post-WWII marriage age U-shape is special in its strongly correlated changes in the age of marriage across all Western countries, in its relationship to the economic development path that the West experienced, and in its strong correlation between the genders. The proposed explanation of the post-WWII marriage age U-shape relates to a shock to the male labor-biased sectors that triggers the dynamics and spills over into what become ex-post female labor-dominated sectors.

Compliance with Ethical Standards: The author declares that he has no conflict of interest.

[5] In 1950, around 80% of young married women in the U.S. did not participate in the labor force regardless of education. In 1980, educated young married women participated in much larger proportions than their uneducated counterparts (author's calculation from IPUMS, Ruggles et al. (2015)).

[6] In the U.S., about 60% marry within the same educational group (Schwartz and Mare (2005)).

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Appendix A - Mean Age at 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	20.4	20.3	20.4	20.8	21.1	21.8	22.9	24.0	24.8	25.5	25.9
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	22.6	22.5	22.6	23.0	23.3	23.9	24.9	25.9	26.7	27.3	27.7
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 at First Marriage Data Details

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

- United Nations Demographic Yearbook for 1948-2010 (UN (1948-2010))
- Council of Europe: mean female age at first marriage since 1960
- National Statistics Bureaus of France, Norway, Sweden, Iceland, Canada, Denmark
- NBER collection of Marriage and Divorce Data of the National Vital Statistics System of the National Center for Health Statistics (U.S.)
- U.S. Bureau of Census
- Schoen and Baj (1984) for Switzerland

The United Nations Demographic Yearbook (UN (1948-2010)) collects, compiles and disseminates official statistics on a wide range of topics. Data have been collected from national statistical authorities since 1948 through a set of questionnaires dispatched annually by the United Nations Statistics Division to over 230 national statistical offices. 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 of 40 as an approximation to first marriages. The mean age of marriage in the UN data, conditional on marriage before age of 40, strongly correlates with the age at first marriage from other sources, such as the Council of Europe and National Statistics Bureaus.

Since the ages in the UN Demographic Yearbook are totals grouped by five-year intervals, I consider the calculated means as less accurate than from other sources, where the data is by definition the mean age at first marriage. Thus, I give preference to the data from the Council of Europe and national statistics bureaus whenever it is available. For countries that have data in both the Council of Europe and the UN Demographic Yearbook, but for more years in the latter than in the former, I attempt to improve the quality of the UN data by extrapolating the better-quality Council of Europe data. To this end, I regress the Council of Europe

data on the UN data. Whenever R^2 is above 0.85, I extrapolate the Council of Europe data using the values predicted by the regression for the years appearing in the UN but not in the Council of Europe data.

For the U.S., I use this extrapolation methodology to adjust the median age at first marriage as reported by the Bureau of Census for the post-1850 period to the mean age at first marriage calculated from the Marriage and Divorce Data of the National Vital Statistics System of the National Center for Health Statistics for the 1968-1995 period.

Construction of long time series

The data used in Figures IV and V were constructed from the following sources: Haines (1996) who cites different sources, Wrigley et al. (1997), Hajnal (1953), European Fertility Project of the Office of Population Research at Princeton University, and row data used for tabulation in Appendix A (see details above). In cases of large disagreement, the later published source is considered as more credible. The time series are constructed in the following way.

1800-2005 time series:

United States. Females. 1800-1929: Haines (1996); 1930-2005: row data for Appendix A. Males. 1800-1939: Haines (1996); 1940-2005 - row data for Appendix A.

Sweden. Females and males. 1870, 1901-1915: Swedish Statistical Bureau; 1954-2005: row data for Appendix A.

Germany. Females. 1800-1950: Haines (1996); 1960-2005: row data for Appendix A. Males. 1870-1970: Haines (1996); 1992-2005: row data for Appendix A.

Italy. Females and males: 1900-1950 - Haines (1996), 1954-2005 - row data for Appendix A.

Belgium. Females and males. 1850-1930: Haines (1996); 1954-2005: row data for Appendix A.

Switzerland. Females. 1860-1940: European Fertility Project; 1950-2005: row data for Appendix A. Males. 1950-2005: row data for Appendix A.

Denmark. Females. 1852-1940: European Fertility Project; 1911-1949: Denmark Bureau of Statistics; 1950-2005: row data for Appendix A. Males. 1911-1949: Denmark Bureau of Statistics; 1950-2005: row data for Appendix A.

France. Females. 1800-1820: Henry and Houdaille (1979); 1870-1950: Haines (1996); 1954-2005: row data for Appendix A. Males. 1800-1900: Henry and Houdaille (1979); 1954-2005: row data for Appendix A.

1600-2005 time series:

England. Females and males. 1610-1830: Wrigley et al. (1997); 1850-1950: Haines (1996); 1960-2005: row data for Appendix A.

Appendix C - Proof of Proposition 1

Setup

Proof: 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-marriageable for young women and more of them remain single after the first period. Therefore, 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 endogenous variables are, therefore, x_t^* and M_t. The mass of first-period below-z_t individuals of either gender is $z_t N$. The probability of a man to be randomly matched with a first-period woman is, therefore, $\frac{z_t N}{M_t}$. The population of single below-z_t men consists of the $z_t N$ first period men and $\frac{z_t N}{M_t} F(x_t^*) N$ second-period men who in their first period are randomly matched with first-period women and rejected. Therefore,

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

or

$$F(x_t^*) = (m_t - 1) m_t$$

where $m_t = \frac{M_t}{z_t N}$. The value a woman has if she rejects an offer in her first period is the expected outcome of the second-period matching. With probability $(z_t - F(x_t^*)) \frac{N}{M_t}$ she will be matched with a first-period above-x_t^*man. With probability $1 - (z_t - F(x_t^*)) \frac{N}{M_t}$ she will be matched with a below-x_t^* man of either age. Thus,

$$V_t = (1 - p_t) E_x(u(A_t x + 1) | x < x_t^*) + p_t E_x(u(A_t x + 1) | x_t^* < x < \frac{1}{B_t})$$

where $p_t = (z_t - F(x_t^*)) \frac{N}{M_t}$ is the probability of a woman to be matched with a first-period above-x^* man. With probability $1 - p_t$ she is matched with a below-x_t^* man of either age. For (b) to be true, under

supermodularity of $u(1+A_t x)$, it is sufficient that $p_t < 0.5$. Note that p_t can be written as $\frac{1}{m_t} - m_t + 1$. The condition $\frac{1}{m_t} - m_t + 1 < 0.5$ is met when $F(x_t^*) = (m_t - 1)m_t$ is above $0.36 z_t$. ■