Why Wait?
A Century of Education, Marriage Timing and Gender Roles*

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Abstract

This paper documents that, over the last century, U. S. marriage patterns and the gender educational gap followed a non-monotonic pattern. Cohorts born around the turn of the 20th century married late and they typically had slightly more educated wives than husbands, although the overall spousal education levels were very low. For cohorts born between the two World Wars, marriages occurred earlier and they involved husbands who were significantly more educated than their wives. Among the later born cohorts, marriages began to occur later and they involved more educated spouses with narrower gender gaps. In order to explain these patterns, we propose a multi-period framework in a frictionless matching model where educational and marriage decisions are endogenous. The two key features of our theory are that marriage requires a fixed entry cost and that married couples cannot study simultaneously. This simple model can replicate the aforementioned stylized facts. In accordance with our model, we also find evidence that exogenous delays in marriage age caused by minimum marriage age laws decreased the educational difference between women and men while increasing the educational attainment of both, in accordance with the predictions of our model.

PRELIMINARY, PLEASE DO NOT CITE

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1 Introduction

Age at first marriage has risen dramatically over the last 40 years in many advanced economies, particularly in the United States. However, hardly any attention has been paid to the fact that early marriages are actually a recent phenomenon and that individuals at the beginning of the 20th century were marrying at ages similar to the ones reported at the turn of the 21st century. Moreover, this non-monotonic evolution was accompanied by matching changes in educational differences between men and women. Broadly put, periods of early marriage are strongly correlated with women acquiring less education than their spouses. Hence, this paper first documents these facts to then propose a theoretical framework to explain them. It then tests whether exogenous delays in the age of first marriage can lead to a narrower gender gap between husbands and wives, as observed in the data.

We document through a number of different sources, a pattern that was previously ignored in the economics literature. Numerous papers have emphasized the recent upward trends in the age at first marriage and the reversal of the gender gap in education. Nevertheless, these trends actually came on the back of a similar but opposite evolution that had occurred around the turn of the 20th century. We are able to present these longer-term stylized facts using a number of different sources which, while they all potentially suffer from some bias, give us a similar picture. While the last part of this evolution has been the topic of numerous studies (i.e., theoretical models such as Mullin and Wang 2002, Olivettti 2006, Gustafsson 2001 and Conesa 2002), the earlier portion of this pattern has been practically ignored by the literature.[1] Our work thus hopes to provide a unified framework to explain the full pattern and various other stylized facts.

We develop frictionless matching model in which education, spousal matching, timing of marriage and divorce are all endogenous. According to our theoretical framework, individuals live for three periods. In the first period, they can match with a spouse or choose to remain single. During this period, individuals also decide whether to invest in education. By assumption, while all singles who find it feasible and optimal to invest in education can do so in the first period, only one spouse can get educated if they are married. In the second period of life, all individuals who chose to remain single earlier as well as those who could not afford to marry while young can do so. However, marriage in either period involves a fixed entry cost. At the end of second period, all married couples discover their match-specific quality shocks on the basis of which some couples would divorce and others remain married in the third and final period of life.

Our model predicts homogamy in skills although with some differences in educational matching.

[1] Parro (2012) does examine the long-term evolution of the gender educational gap in the United States. But he relates it to changes in the labor market only. By contrast, our paper is the first of its kind to link these two patterns together and provide a unified explanation. A contemporaneous work by Jelnov (2015) document the U-shape pattern for the age at first marriage but does not link it to the changes in educational attainment.

In the Census data from 1940 through 1980, we find that 30 percent of Americans married someone with exactly the same educational level as their own and 66 percent had a spouse whose highest level of educational attainment was within 2 years of their own. This type of homogamy evolved over time as predicted by our model which also matches the broad stylized facts regarding the educational distribution of men and women.

The key elements that enable our theory to match the empirical regularities are the existence of a fixed cost of marriage and the fact that two spouses cannot both study while married. Our first assumption is particularly salient in the United States where, since the post-colonial times, newlyweds were expected to move out of their parental homes to form their own household (see Shammas, 2002 for a description of U. S. marriage norms until the 20th century). This was also commonly the case in many European societies (Hajnal, 1965). Ruggles (2003) argues that children were often forced to wait until the father would die in order to inherit the property and thus be able to marry. In the Census data, less than 10 percent of newlyweds and 15 percent of young married individuals live with their parents or parents-in-law. This stands in stark contrast to other cultures where multi-family households are still more the norm than the exception and with youth marriages being prevalent despite limited economic resources. We argue that, as the United States became wealthier and returns to education, in particular for men, increased, fixed costs of marriage became less binding, thereby facilitating younger marriages by the middle of the 20th century. We also argue that this fixed marriage cost was much higher than the cost related to college attendance, for example. A large fraction of individuals attending college historically in the United States continued living with family members, based on the Census data, thus suggesting that "moving out" was related to marriage and not to educational decisions, at least historically.

The other driver of the pattern we document is the inability of spouses to both be studying simultaneously. We argue that when a couple is, in general, living alone, having two studying adults simply does not allow the household to survive. While this assumption is a bit drastic, it does seem to be validated by the data where very few young married adults have both members studying simultaneously. This assumption allows us to explain two different patterns in our time-series evidence. First, it implies that, as marriages occurred earlier in the middle of the 20th century, women had to halt their education earlier than before since it was impossible for them to be in school at the same time as their husbands. This can explain the reversal of the education gap which occurs simultaneously with changes in the age at first marriage. Second, it also implies that, as the returns to education for women increased in the second half of the twentieth century, age at first marriage had to rise again despite the lower costs of marriage. That is, since women would not be able to acquire education at the same time as their spouses were they to marry earlier.

Having established this framework, we then turn to exploring our data further in an attempt to provide more empirical justification of the mechanisms we propose. We find two additional facts that support our framework. One, the decrease in marriage age in the middle of our period occurs more strongly for men with high school and university education, as would be the case if these were the men that could reap the benefits of an early marriage. Furthermore, we also find that the increase in educational attainment was particularly marked for married men compared to their unmarried counterparts.

Two, because of land values, the fixed cost of marriage — the most important component of it being housing — may have been higher in urban areas than in rural areas. Land, after all, was relatively cheap in most rural areas of the United States in the early part of our period. Indeed, consistent with this observation, one sees that urban dwellers married later than their rural counterparts. Furthermore, it is particularly in urban areas that the fall in age at first marriage correlates strongly with an increase in the male-female educational gap, suggesting that earlier marriages through lower marriage fixed costs led men to attain higher levels of education than their spouses. While this is consistent with our model, we recognize that there exists many other differences between rural and urban areas that would affect not only the fixed cost of marriage but also the potential returns to education and earning patterns. Nevertheless, it is encouraging to see the pattern we expected to find.

Finally, we exploit laws that limited the age at which teenagers could legally marry in the United States to estimate a causal effect of delayed marriage on educational decisions. While these laws have been previously employed as sources of exogenous variation (see, for instance, Dahl, 2010; Rotz, 2011) for women, we extend the sample to laws that affected men and women and over a much longer time period. We find evidence that these laws affected the age at which teenagers were able to wed. This also appears to have caused a decrease in the absolute difference in spouses' education levels and an increase in the educational attainment of both spouses, as predicted by our model.

Previous papers have tried to explain how partners select each other based on their human capital. The seminal work of Becker (1973) emphasized that marriages are formed when the surplus generated by the union is larger than the sum of what each partner could earn in a different pairing or while remaining single. This simple result also explained that, if there are complementarities in household production such that the return to being high-skilled increases with the skill of one's spouse, one should observe positive assortative matching with men and women of similar skill levels being married. Similarly, if there are returns to specialization, the opposite pattern should be observed with high-skill men focusing on market work and while their lower-skilled partners engaging in home production. This type of result will be implicit in our approach such that, in early periods in life, returns to specialization may exist but it disappears as individuals (and their children) age. This would imply that the type of matches sought by individuals who marry young may be very different from those who marry later. Zhang (1995), indeed, argues that marriage

age is differently correlated with men's wage depending on whether or not their spouse is working, suggesting that marriage age and specialization may be related.

Most matching models take the education decisions of spouses as given and thus do not explore the interaction between educational decisions and spousal matching. Konrad and Lommerud (2000) propose a two-period model where education is decided non-cooperatively in the first period and then couples bargain in the second. They show that this may lead to spouses overinvesting in education. Chiappori, Iyigun and Weiss (2009) show that differences in the returns to education in the labor market and in specialization in the household may lead to males and females electing different levels of education and obtaining different shares of the household surplus. Iyigun and Walsh (2007) and Lafortune (2013) study the impact of skewed sex ratios on educational investment of men and women. While all these papers link marriage markets and human capital, in none of these is there the possibility that spouses can coordinate their investment decisions if they marry early enough.

Other explanations have been provided for delaying marriage. Bergstrom and Bagnoli (1993) argue that delaying marriage may allow high-quality men the time to reveal their type and as such, capture more attractive young women (as women's attribute, beauty, is easily observable in the market). Oppenheimer (1988) takes a similar approach to argue that the recent delay in marriage age of women is related to the fact that their "quality" now needs more time to be revealed as their labor market success becomes more and more relevant for their spouse. Diaz-Gimenez and Giolito (2013) focus on the age differences between spouses and not the changes in levels.

Empirically, the impact of marriage timing is difficult to estimate as it is a decision that agents undertake based on some unobservables. Thus, if one compares simply individuals who marry early and late, the difference in later outcomes may very well depend on the fact that some underlying characteristic induced both the timing of the marriage and other correlates. For example, studies have documented the recent rise in marriage ages and the simultaneous changes in labor supply, fertility and matching patterns (Goldstein and Kenney 2001, Qian 1998 and Oppenheimer et al. 1997). In the United States, early marriages have been correlated with many negative outcomes (Kalmuss and Namerow 1994, Martin 2004 and Kiernan 1986). For example, married teen mothers are 40 percent more likely to have a second birth within 24 months of their first birth compared to unmarried teen mothers. Women who marry before the age of 19 are 50 percent more likely to drop out of high school and four times less likely to obtain a college degree (Klepinger et al. 1999). In developing countries, youth marriages are considered particularly problematic for girls. Jensen and Thornton (2003) provide an overview of the various problems that are associated with younger marriages: lower schooling, less reproductive control, higher rates of pregnancy-related mortality and domestic violence.

It is unclear, however, whether any of these correlations also translate into causal channels as our model would imply. The only available causal estimate is provided by Field and Ambrus (2008). This paper uses variations in the age at menarche in Bangladesh as an instrument for age at first marriage of women. They find that a delay in the age of marriage for females decreases fertility, increases their schooling and literacy level as well as the quality of their marital life.

Finally, given how close our topic of study is to other fields in the social sciences, the literature from other disciplines must also be considered. Martin (2000, 2004) argues that the delay in average age at first marriage differs by women's educational status: high-skill women are postponing marriage while low-skill women are simply foregoing it. This is also the result of forecasts by Goldstein and Kenney (2001). Bitter (1986), using responses of married couples in an interview, argues that late marriages are more likely to involve heterogeneous spouses than earlier ones and that, once this is controlled for, late marriages are more stable. Qian (1998) studies the patterns of assortative mating by age and education and how these changed between 1970 and 1990 in the United States. Accordingly, later unions promote stronger educational homogamy, as would be generated by our framework. Oppenheimer et. al (1997) argue that marriage delay is more likely among men of race/schooling groups which experience higher career transition difficulties.

The rest of our paper is organized as follows: Section 2 documents the cross-sectional and the time-series patterns of educational difference and age at first marriage in the United States over the last century. Section 3 presents our theoretical framework. Section 4 explores some other empirical implications of our theory. Section 4.3 uses legal changes in marriage laws over this period to demonstrate that our previously documented correlations also appear to be causal. Our last section concludes.

2 Stylized Facts

In this section, we detail the relevant stylized facts and some of the basic correlations one can observe in the data.

2.1 Age at First Marriage

Demographers have previously studied the long-term trends in marriage in the United States. They have argued that a longer-term perspective provides a different conclusion than what can be gleaned by looking only at the second half of the 20th century. In particular, in an unpublished working paper of the Census Bureau, Elliott et. al (2012) document the changes in the fraction of individuals married in the 1890 to 2010 Censuses. They, in particular, show that it is the mid-20th century pattern of more frequent and earlier marriage that is more anomalous than the latter part of the century when fewer and later marriages were somewhat of a return to the turn of the 20th century trends. However, the economic literature has remained mostly quiet on this topic, focussing instead on the second half of the "U-shaped" curve for age at first marriage over this period.

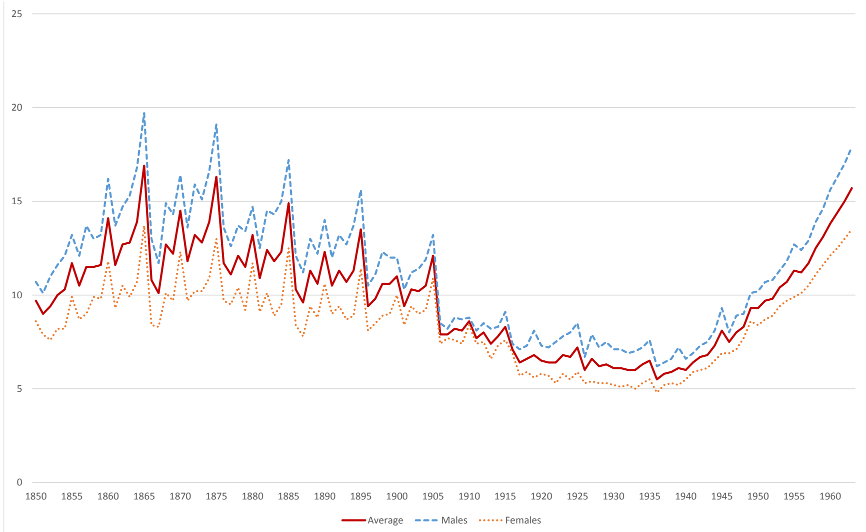
To demonstrate the existence of this long-term pattern, we shall focus on the prevalence of marriage and the age at first marriage by cohorts of births. This is on account of the fact that examining marriage years or census years can confuse the issue of when the marriage occurred and by whom. To study this, we use data from decennial censuses and the American Community Survey from 1850 to 2013 (Ruggles et. al, 2010). We classify individuals based on their year of birth by subtracting their age from the year of the census since the year of birth is not always specifically reported. We know the current marital status of individuals in the Censuses of 1880 to 2013. We first present, in Figure 1, the fraction of individuals aged 35 to 50 who have never been married by birth cohort.[2] We restrict our cohorts to those born between 1850 and 1963 given that those are the ones for which we observe individuals over their whole lifetimes. The figure provides a striking pattern. Individuals born before 1905 had a rate of non-marriage well above 10 percent. This falls for cohorts born between 1905 and 1950 to around 7 to 8 percent and it is only for cohorts born between 1955 and 1960, the last of the baby-boomers, that the proportion of unmarried individuals returns to the levels observed for the first sixty years of our sample. Throughout this period, the number of women who remained single is strictly smaller than that of men and both genders follow a very similar trend over time.[3]

If we want to particularly study the age at first marriage, we are slightly more limited in terms of data because the relevant survey question was only asked in the Censuses of 1930, 1940 (only for women), 1960, 1970 and 1980. Furthermore, we face a severe problem in terms of sample selection as none of the singles answered this question. To try to solve this problem but continue to include as many cohorts as possible, we use the following strategy: We take only individuals aged 20 to 50 in each census. We then take all the individuals born in one year and measure at what age the 50th percentile of the distribution married, assuming that all individuals who have not answered would marry after that median value (or not marry at all). Thus, the median age at first marriage we report is not, as usual, conditional on marriage but corresponds to the age at which 50 percent of the cohort had tied the knot. Despite the difference in measurement, Figure 2 suggests that the pattern we observed on the fraction of individuals who did not marry is a reflection of a similar pattern in the age at which individuals first married. For cohorts for which we have information, the tendencies are remarkably similar. From 1880 to 1929, cohorts married at a younger and younger

[2]We confine our attention to this age group initially in order to avoid problems associated with selective mortality. That is, if we look at age groups where mortality is higher, we will only observe individuals still alive and if there is correlation between the age at first marriage and mortality, this would bias our results.

[3]This graph is obtained combining data from decennial censuses and the annual ACS. The noisier pattern for the earlier cohorts is due to the fact that we have only decennial information for them, which implies that each cohort is observed at a different age, explaining the 10-year cyclical pattern displayed. The recent cohorts are observed annually in the ACS which makes the pattern smoother.

Figure 1: Fraction Unmarried (35 to 50 Year Olds by Birth Year)



age. While we are unable to study the trend for the most recent cohorts, there seems to be, like in the case of the fraction unmarried, a tendency towards an increase in the median age at which individuals marry. And again, the most recent cohorts are in no way very dissimilar from the patterns observed around the beginning of the 20th century. It is remarkable to think that, for cohorts born around the Great Depression, more than 50 percent of the cohort was already married by age 20 for women and 23 for men. The cohort born in 1880, on the other hand, had only seen between 20 and 25 percent of its individuals marry that early.

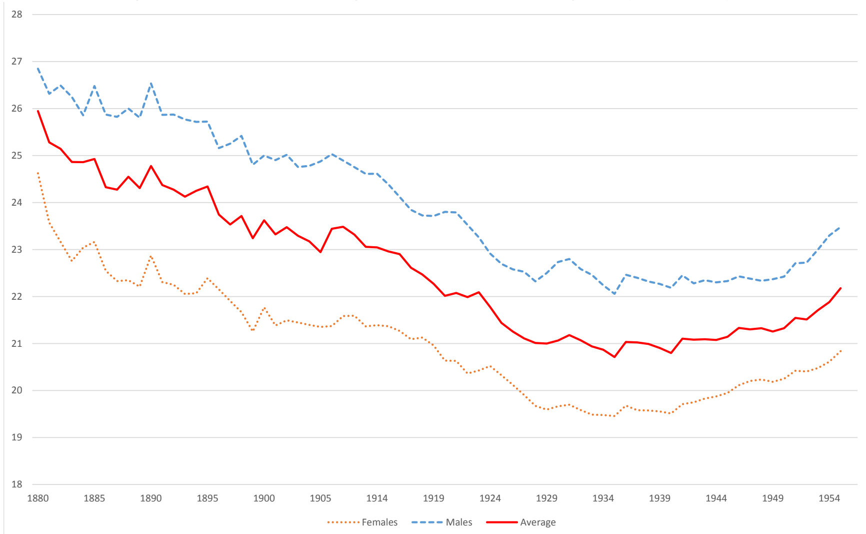
We have corroborated this pattern in a number of alternative sources. For example, the Vital Statistics, compiled by year of marriage, shows the median age at marriage falling for marriages that occurred in the 1950s and 1960s compared to those in the 1920s and 1930s. It then starts rising again for marriages in the 1970s and 1980s. This matches the pattern observed by cohorts very well.

2.2 The Education Gender Gap

While the age at first marriage was evolving as described above, cohorts were experiencing significant changes in their educational attainment. Over this whole period, educational attainment was increasing for both men and women but there were salient differences in how these increases came about vis-a-vis the opposite gender.

Figure 3 presents the fraction of a cohort that reports being "in school" in the decennial census. This is a problematic definition as not only it is unclear exactly what it involves but also because it has changed over time. However, these are the only data that allow us to study the educational

Figure 2: Median age at first marriage, by birth year



patterns for this cohort without potentially having problems with survival biases. The results indicate a clear inverse-U relationship over this period in the male-female ratio in school attendance, indicating that, as younger marriages were becoming the norm, men started attending school more than women, in particular for the 15 to 18 (high school) and the 19 to 21 (college) age groups. The pattern is particularly marked for college attendance. It is also interesting to note that, for cohorts born around the turn of the twentieth century, women were attending school more regularly than men, at least at the high school level despite the fact that women participated much less in the labor market back then than they do today.

To measure actual educational attainment, we are limited by the fact that education only enters the US Census in 1940. However, if we are willing to make the assumption that mortality rates do not significantly affect the differential pattern of education by gender, we obtain Figure 4. This graph presents the difference in average educational attainment of married males compared to that of married females for individuals aged 35 to 79. It displays two different measures of maximum grade attained "Higrade" and "Educ", as these are the two different alternative coding for highest grade attained available in *IPUMS*.[4] No matter which measure is employed, however, the inverted U-shape pattern is once again obvious. It suggests that, only for cohorts born between 1905 and 1955, was it the norm that men would be more educated than their spouses. For cohorts born before then, men were less educated than women. A similar pattern is obtained for unmarried

[4] "Higrade" is the coding designed for earlier waves of the Census. It provides a lot of detail about individuals who acquired low levels of education since this was where most of the population was concentrated at that point in time. It had, however, very crude measures for individuals completing more than a bachelor's degree. On the other hand, "Educ" is the classification used for more recent waves of the Census. It has very coarse measures for individuals who do not complete middle school but detailed information for advanced degrees. It is reassuring that despite the difference in the coding employed, our conclusion remains the same.

Figure 3: Male to female ratio in fraction enrolled in school by age, by decade of birth

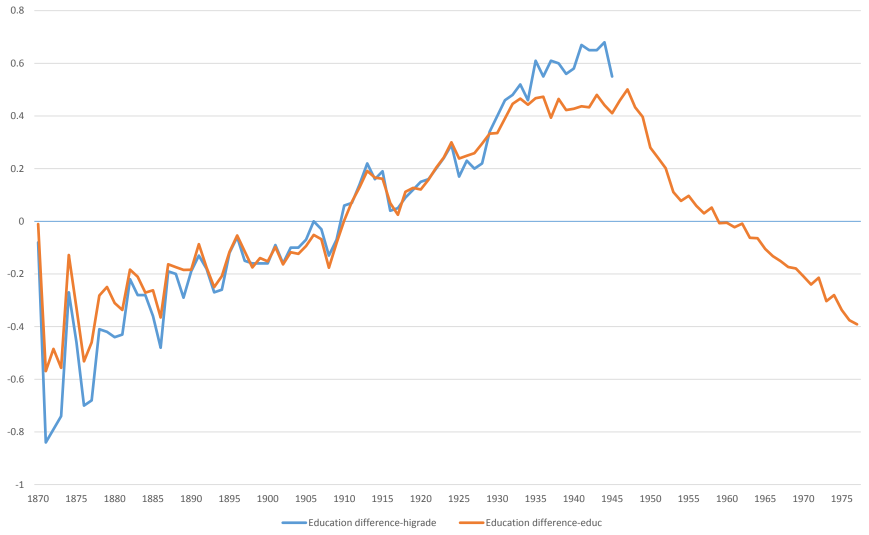
men and women which suggests that what is driving this pattern is not that who marries has changed dramatically over this period. Although it is true that high-skill women today have a higher probability of marrying than previously, something we will come back to later on.

While this pattern appears in the two measures we have presented above, one could be worried that they are biased by the fact that we only observe individuals' education later in life. Unfortunately, we do not have any other measures of education for the U. S. population before 1940. However, the state of Iowa conducted a Census in 1915 which included the number of years of education attained. For that particular state, our pattern appears to be confirmed. In 1915, there were more school-age women who attended high or preparatory school or college than men. For those above school age, there were much more women who attended high school or preparatory school and only a slightly larger number of men than of women who attended college. Using the table provided by the census, we conclude that men above schooling age on average had about 8.3 years of education while women had 8.6 years, consistent with the cohort results presented earlier. Observations from only one state may obviously not be representative of the United States. However, the fact that the results obtained in that one Census matches more or less the results presented above gives us more confidence that the pattern we presented here is not driven by some error in misreporting or biases due to differential survival probabilities, for example.

2.3 Correlations

Figures 1 through 4 suggest that, in the United States, there is a negative correlation over time between the age at which individuals marry and the spousal gaps in educational attainment. This is

Figure 4: Spousal educational difference, age 35-79, by birth year

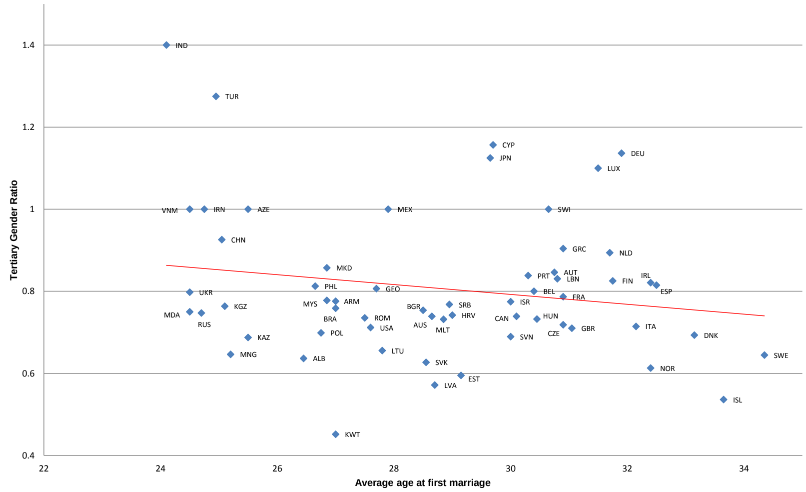


confirmed at the micro level as well. A simple regression of the difference in educational attainment by spouses on the age at first marriage suggests that marriages that are contracted earlier are less homogamous. Furthermore, the source of the difference is that men are more educated than their spouses when the marriage occurs earlier. We also document that this correlation exists in cross-national data. Figure 5 presents the correlation between the tertiary gender gap and the average age at first marriage in a number of countries. There is a clear negative correlation that can be observed between the two variables. These are obviously simple correlations. Nevertheless, they suggest that, while the level of education and the age at first marriage may be correlated with perhaps a causal link between them, there is also evidence that the educational gender gap and age at first marriage are related and this is what our model will next attempt to explore.

3 The Model

The economy is made up of individuals who live for three periods. There exists a continuum of men and a continuum of women. The measure of men is normalized to unity and, that of women to r, where $r \gtrless 1$.

Figure 5: Age at first marriage and Tertiary Gender Ratio



3.1 Endowments, Preferences & Matching

In each period, individuals derive utility from consumption. In addition, married individuals derive satisfaction from the quality of their match; i.e., individual utilities take the form

$$U^i = u^i + \theta, \qquad i = m, f \tag{1}$$

where u^i and θ denote respectively the monetary and non-monetary components of individual utility.

The Non-monetary Component Individuals can match and marry at the beginning of the first or the second period, although each person can choose to remain single. Marriage involves a fixed cost of F, $F > 0$.

At the beginning of the third and final period, marriage match qualities are revealed.[5] For any couple, match quality θ is drawn from a distribution Φ with mean zero; that is, each spouse derives the same utility from marriage match quality once it is revealed.[6] Once the match quality is revealed, couples can either stay together or divorce in the final period, depending on their marriage match quality. We assume that divorcees cannot or do not remarry.[7]

[5] Match qualities are revealed in the third period only (even for those who marry in the first period) for keeping the analysis tractable.

[6] Hence, marriage match quality, θ, is couple specific and does not vary by spouse. If our model were extended so that marriage match quality were individual specific, then our main conclusions would remain intact although such an extension could introduce other interesting aspects of marital matching, spousal allocations and divorce not covered below.

[7] We make these simplifying assumptions to keep our model tractable, although our main qualitative results would

The Monetary Component Individuals are born with an idiosyncratic (raw) efficiency units of labor endowment, y_1 for men and z_1 for women. The first-period raw endowments of men, y, are distributed over the support $[y_{\min}, y_{\max}]$, $0 < y_{\min} < y_{\max}$, according to some distribution G. Similarly, the first-period raw endowments of women, z, are distributed over the support $[z_{\min}, z_{\max}]$, $0 < z_{\min} < z_{\max}$ according to the distribution $\widetilde{G}$. If individuals choose not to get educated, we assume that their efficiency units of labor can still potentially grow in the second period due to experience or wisdom of age. Hence, the efficiency labor endowments of men and women in the second period respectively equal y_2 and z_2 such that $y_2 = xy$ and $z_2 = xz$, where $x \geqslant 1$.[8]

Individuals may choose to get educated in the first period at a cost of c, $c > 0$, per person. We let the education premium be gender specific and denote it by e_i, $i = m, f$, such that $e_i \geqslant 1$. For educated individuals, the efficiency units of labor endowment equal e_i *times* their unaugmented labor endowments in each period after they get educated, with the latter being determined as we discussed immediately above.[9] On that basis, the potential per-period incomes (defined as the labor income that would be generated if all available time was devoted to market work) are given directly by the efficiency units of labor endowments.[10]

Single individuals can get educated in the first period provided that it is feasible and optimal. However, we assume that education gets prohibitively costly for married couples if both spouses find it optimal to acquire education. Hence, among the married young couples, who get together in the first period, only one spouse can get educated.

Consider a man with a potentially augmented endowment of y who is matched with a woman with an endowment of z. In any given period, the 'marital production' technology is given by $h(y, z)$, with the monetary components of individual utilities, u^m and u^f, satisfy

$$u^m + u^f = h\,(y,\ z) \ \equiv \eta\,(y + z)^2 \qquad\qquad \eta \ \geqslant\ 1. \tag{2}$$

still hold if individuaks could remarry or different match qualities were revealed at the end of each period of marriage. For further details on remarriage and non-transferable utilities, for example, see Chiappori, Iyigun, Lafortune and Weiss (2014) Chiappori, Iyigun and Weiss, (2008, 2015).

[8] Note that, for expositional ease, we don't us the first-period subscript on endowments. Thus, $y_1 = y$ and $z_1 = z$. We further assume no additional growth due age or experience in the third and final period. Hence, $y_3 = y_2$ and $z_3 = z_2$.

Also note that, unless the discussion warrants reference to endowments in any given specific period, we shall generically refer to the (first period) labor-income generating endowments of men and women — which, over time could be augmented due to age and education as explained above — as y and z, respectively (and hence without the time subscripts).

[9] In particular, the efficiency units of labor endowments in the second and third periods equal $e_m x y_1$ for men and $e_f x z_1$ for women.

[10] By normalizing the wage rate to one for both genders, we are, in effect, folding the gender wage gap into the structural differences in the efficiency units of labor endowments of men and women. We do this mainly for expositional simplicity but also because it is inconsequential for our main theoretical and empirical results.

where η denotes the scale advantages and economics gains potentially associated with marriage.

If a man with an endowment of y remains single, his intra-temporal output is given by $f_m(y) \equiv y^2$ and if a woman with an endowment of z remains single, her intra-temporal output is given by $f_f(z) \equiv z^2$.[11]

Given the specification in (2), note that utility is transferable both between married spouses and divorced ex-spouses, a property that drastically simplifies our analysis.[12]

Based on equation (2), *the marital output function* $h(y,\, z)$ *is super-modular*, i.e. that $\partial^2 h \,/\, \partial y \partial z = h_{yz}(y,\, z) > 0$. The essential feature of the problem is the interaction in the traits that a couple brings to marriage. For instance, when income/endowment is the only important trait and the couple shares a public good, spousal endowments are complements in marital production.

It follows that

$$\begin{aligned} h_y(y,z) &= 2\eta(y+z) \geq h_y(y,0) = 2y, \\ h_z(y,z) &= 2\eta(y+z) \geq h_z(0,z) = 2z. \end{aligned} \tag{3}$$

Therefore,

$$\begin{aligned} h(y,0) &= \int_0^y h_y(t,0)\,dt \geq y^2, \\ h(0,z) &= \int_0^z h_z(0,t)\,dt \geq z^2, \end{aligned} \tag{4}$$

and

$$h(y,z) = h(0,z) + \int_0^y h_y(s,z)\,ds \geq y^2 + z^2. \tag{5}$$

We conclude that for any couple the marital surplus is positive and increasing in the endowments of both spouses.

3.2 Divorce

At the beginning of the third and final period, marriage match qualities are revealed for all couples who have married in the previous two periods, and couples divorce if their realizations are too low. Specifically, the total utility derived in the final period if the couple remains married is

[11] Alternatively, these payoffs could be linear in the endowments, as they are assumed to be in some other papers, such as Chiappori, Iyigun and Weiss (2015), although the qualitative nature of our conclusions below do not rest on either specification.

[12] See Chiappori, Iyigun and Weiss (2015) for a precise investigation of the transferability issue.

$\eta\,(y_3+z_3)^2+2\theta$ where the endowments y_3 and z_3 are the effective third-period endowments of a man and a woman (i.e., as described above, y and z are augmented via experience over time and potentially through education as well).

In our context, while the distribution of assets between divorced spouses depends on the legal system, the *total* surplus does not. Indeed, in both cases, it is equal to $y_3^2+z_3^2$. Our model thus satisfies the 'Becker-Coase theorem' property that divorce legislation influences the distribution of welfare after divorce but not its incidence.[13] In particular, divorce occurs 'efficiently' when the total surplus generated outside the relationship is larger than what can be achieved within it. Formally, divorce obtains if

$$\eta\,(y_3+z_3)^2+2\theta<y_3^2+z_3^2\ , \tag{6}$$

hence, if

$$\theta<\bar{\theta}\,(y_3,z_3)\equiv-\frac{1}{2}[(\eta-1)(y_3^2+z_3^2)+2y_3z_3]\ . \tag{7}$$

On this basis, the ex-ante probability of divorce for a couple with the endowments of y_3 and z_3 is

$$\alpha\,(y_3,z_3)\ \ \equiv\ \ [\Phi\bar{\theta}\,(y,z)]\ . \tag{8}$$

In summary, the couple $(y,\ z)$ generates the output $\eta\,(y+z)^2$ in the period(s) during which they are married. They stay married in the third period if the realization of the match quality is larger than the threshold $\bar{\theta}$ — an event of probability $1-\alpha\,(y_3,z_3)$. If $(y,\ z)$ stay together, they still produce $\eta\,(y_3+z_3)^2$ in the third period. In addition, they each get a positive utility from their marriage match quality, equal in expectation to $E\left\{\theta\mid\theta\geq\bar{\theta}(y_3,z_3)\right\}$.

Divorce occurs with probability $\alpha\,(y_3,z_3)$ in which case the total product of the separated couple as singles equals $y_3^2+z_3^2$. In our setting, divorce is a corrective mechanism that enables the dissolution of bad matches. In other words, the possibility of divorce unambiguously increases welfare. Following separation, we assume that the divorce legislation is neutral so that there aren't effectively any income transfers (i.e., alimony payments) between the ex-spouses. In particular, we let the efficiency labor endowments of men and women equal their endowments without any redistribution. Consequently, the husband retains his augmented third-period endowment y_3, thus generating $f_m\,(y_3)\equiv y_3^2$ upon divorce, and the wife keeps her augmented third-period endowment z_3, thereby producing $f_z\,(z)\equiv z_3^2$.[14]

[13] See Becker et al (1977). This property is obviously due to the transferable utility property assumed here. See Chiappori et al (2015) for a precise investigation.

[14] More generally, one could denote by β the share of endowments from which women can draw their incomes in divorce. Then, assuming that these transfers are fully determined by law and no further voluntary transfers are made, if a man with income y marries a woman with income z in the first period, her income following separation would be $z^D=\beta(y^2+z^2)$ and his income would be $y^D=(1-\beta)(y^2+z^2)$. Thus the net income of a 'divorced' person would generally be different from what his or her income would have been had he or she not paired up. When the divorce legislation is not redistributive as we assume here, all incomes are considered private so that β that is couple-specific,

3.3 Expected Lifetime Utilities

We now turn to the marriage-market outcomes and the description of maritally sustainable intra-household allocations.[15]

If an uneducated man and an uneducated woman get married when young (i.e., in the first period), the expected marital sum of utilities generated over the three periods by Mr. y and Mrs. z can be computed as follows:

$$\begin{aligned} S_1^U(y,\ z) &= \eta(1+x^2)\,(y+z)^2 + \alpha\,(xy,xz)\,x^2\left(y^2+z^2\right) \ -\ F \\ &\quad +[1-\alpha\,(xy,xz)]\left\{\eta x^2\,(y+z)^2 + 2E\left[\theta \mid \theta \geq \bar{\theta}(xy,\ xz)\right]\right\} \end{aligned} \tag{9}$$

In equation (9), the first term on the RHS represents the total output generated by the married couple $(y,\ z)$ in the first and second periods, with their second output being higher due to the experience factor, x. The second term on the RHS represents the third period output of the couple in case they choose to divorce, which occurs with $\alpha\,(xy,xz)$ likelihood and the final expression on the RHS of this equation is the marital output of the couple in the final period when their union endures, which has a $1-\alpha\,(xy,xz)$ likelihood.

Instead, if an uneducated man and an uneducated woman get married in the second period, then expected marital sum of utilities generated over the three periods by Mr. y and Mrs. z would be as follows:

$$\begin{aligned} S_2^U(y,\ z) &= [1+\alpha\,(xy,xz)\,x^2](y^2+z^2) + \eta x^2\,(y+z)^2 \ -\ F \\ &\quad +[1-\alpha\,(xy,xz)]\left\{\eta x^2\,(y+z)^2 + 2E\left[\theta \mid \theta \geq \bar{\theta}(xy,\ xz)\right]\right\} \end{aligned} \tag{10}$$

A couple could marry young and one of the spouses could get educated when married. Then,

namely $\beta \equiv \frac{z^2}{y^2+z^2}$.

Also, note that, given that we abstract from savings and the accumulation of human capital, the distinction between the post-divorce division of property and alimony payments is mostly semantic here. But one can interpret the variables y^D and z^D as the stream of incomes generated from the (underlying) assets of the couple which were redistributed according to the alimony laws that apply in legal separation.

[15] See Browning-Chiappori-Weiss (2003) and Iyigun-Walsh (2007) for two related perspectives.

$$\begin{aligned} S_1^H(y,\ z) &= \eta (y+z)^2 + \eta x^2 (e_m y + z)^2 + \alpha(e_m xy,\ xz)\, x^2 \left((e_m y)^2 + \ z^2\right) - \ F - c \\ & [1-\alpha(e_m xy, xz)] \left\{ \eta x^2 (e_m y + z)^2 + 2E\left[\theta \mid \theta \geq \bar{\theta}(e_m xy,\ xz)\right]\right\} \end{aligned} \tag{11}$$

would apply for couples who marry young and among whom only the husband is educated.

An analogous expression would apply for couples married young and among whom only the wife is educated:

$$\begin{aligned} S_1^W(y,\ z) &= \eta (y+z)^2 + \eta x^2 (y + e_f\ z)^2 + \alpha(xy,\ e_f\ x\ z)\, x^2 \left(y^2 + (e_f\ z)^2\right) \ - \ F - c \\ & +[1-\alpha(xy, e_f\ x\ z)] \left\{ \eta x^2 (y + e_f\ z)^2 + 2E\left[\theta \mid \theta \geq \bar{\theta}(xy,\ e_f\ x\ z)\right]\right\} \end{aligned} \tag{12}$$

By extension, one would get similar expected lifetime marital sum of utilities when considering the union of educated couples or mixed-education couples who marry late. In particular,

$$\begin{aligned} S_2^{HW}(y,\ z) &= y^2 + z^2 + \eta x^2 (e_m y + e_f\ z)^2 + \alpha(e_m xy, e_f\ xz)\, x^2 \left((e_m y)^2 + (e_f\ z)^2\right) \ - \ F - 2c \\ & +[1-\alpha(e_m xy, e_f\ xz)] \left\{ \eta x^2 (e_m y + e_f\ z)^2 + 2E\left[\theta \mid \theta \geq \bar{\theta}(e_m xy,\ e_f\ xz)\right]\right\} \end{aligned} \tag{13}$$

would apply for couples who marry late and among whom both spouses are educated;

$$\begin{aligned} S_2^H(y,\ z) &= y^2 + z^2 + \eta x^2 (e_m y + z)^2 + \alpha(e_m xy,\ xz)\, x^2 \left((e_m y)^2 + z^2\right) \ - \ F - c \\ & +[1-\alpha(e_m xy,\ xz)] \left\{ \eta x^2 (e_m y + z)^2 + 2E\left[\theta \mid \theta \geq \bar{\theta}(e_m xy,\ xz)\right]\right\} \end{aligned} \tag{14}$$

would apply for couples who marry late and among whom the husbands are educated;

$$S_2^W(y,\ z) \;=\; y^2+z^2+\eta x^2\left(y+e_f\ z\right)^2+\alpha\left(xy,e_f\ xz\right)x^2\left(y^2+\left(e_f\ z\right)^2\right)\ -\ F-c$$
$$+[1-\alpha\left(xy,e_f\ xz\right)]\left\{\eta x^2\left(y+e_f\ z\right)^2+2E\left[\theta\mid\theta\geq\bar{\theta}(xy,\ e_f\ xz)\right]\right\} \tag{15}$$

would apply for couples who marry late and among whom the wives are educated.

Note, first, that $S(y,z)>3\left(y^2+z^2\right)=(1+2x^2)(y^2+z^2)$ in all of the above cases. Hence, all individuals prefer to get married rather than stay single as long as they can cover the fixed cost of doings so. Under realistic parameter restrictions, it is straightforward to show that $\partial^2 S(y,z)\ /\ \partial y_1\ \partial z_1 \geqslant 0$ in all cases. Thus, individuals will sort positively in the marriage market in both periods.[16]

3.4 Marital and Educational Choices

Depending on the labor endowments, y and z relative to the parameterization of the cost of and the returns to marriage (F and η), the returns to experience (x), and the cost of and returns to education (c, e_i, $i=m,\ f$), there are five scenarios on which we shall focus involving each couple:

1. $\eta(y+z)^2 \geqslant F$: For a young couple whose endowments $(y,\ z)$ are high enough relative to F, marriage at a young age is feasible. For such couples, then, the choice is between delaying marriage so that both spouses can get educated and marrying young with one or none of the spouses getting educated. The expected lifetime payoffs to each of those cases are respectively given by (13), (11), (12) and (9).

   (a) If the returns to education are sufficiently low for both men and women, then it is straightforward to verify that (9) would strictly exceed other payoffs in which one or both of the spouses get educated.[17] The reason is that the cost of delaying marriage, which equals forgone marital gains, exceeds the benefit of it, which equals the education premia. In this case, the couple would marry young and choose not to get educated.

   (b) If, by contrast, the returns to education for men or women are sufficiently high, then it is straightforward to verify that (11) or (12) would strictly exceed the other lifetime payoffs in which both or none of the spouses get educated. In this case, the gains from education for one spouse is high enough for him or her to get educated, although they aren't sufficiently high for both spouses to delay marriage so that both get educated.

[16]See Chiappori, Iyigun and Weiss (2015) for a complete proof.
[17]For complete proofs, see Appendix A.

Under this scenario, the couple gets married young and one of the spouses gets educated while married.[18]

(c) Finally, if the returns to education are high enough for both men and women, then (13) would strictly exceed all other expected lifetime payoffs. Now, the cost of delaying marriage, which equals forgone marital gains, is lower than the benefit of it, which accrues with both men and women getting educated. Thus, in this case, the couple delays marriage and gets educated when young and marries later in life.

2. $\eta x^2(y+z)^2 \geqslant F > \eta(y+z)^2$: For a young couple whose endowments $(y,\, z)$ are high enough to cover the fixed cost of marriage, F, only when the couple is older, early marriage isn't feasible. For such couples, then, marriage occurs in the second period and, depending on the returns to education, both or one of the spouses may get educated when they are young and single. Thus, the relevant expected lifetime payoffs for comparison would be given by (10), (13), (14) and (15).

   (a) If the returns to education are sufficiently low for both men and women, then (10) strictly exceeds the three other relevant payoffs in which one or both of the spouses get educated. Here, the net benefit of education isn't high enough for anyone to get educated, although marriage is sufficiently expensive for the (uneducated) couple allowing them to only marry late.

   (b) If, by contrast, the returns to education for men or women are sufficiently high, then it is straightforward to verify that (14) or (15) would strictly exceed the other lifetime payoffs in which both or none of the spouses get educated. In this case, the gains from education for one spouse is high enough for him or her to get educated, although the couple cannot afford to marry young. Under this scenario, the couple gets married later and after one of the spouses gets educated while young.

   (c) If the returns to education are high enough for both men and women, then (13) would strictly exceed all other expected lifetime payoffs. And the couple, who cannot afford to marry young anyway, gets educated when young and marries later.

[18] We need to think about whether we want to impose the additional condition here that the marital production level with only the spouse who isn't getting educated producing an income by itself exceeds F. In other words, right now we check whether $\eta(y_1+z_1)^2 \geqslant F$ to decide if young marriage is feasible. But, if the husband is in school for example, should we consider his endowment to be irrelevant in the marital production so that $\eta(z_1)^2 \geqslant F$ needs to hold for the couple to be able to marry in the first period and send the husband to school? At least, we need a discussion of this.

3. $\eta x^2[\max(e_m y + z,\, y + e_f\ z)]^2 \geqslant F > \eta x^2(y+z)^2$: Here, the endowment bundle $(y,\, z)$ isn't even high enough for the couple to cover F and get married later in life if they both stay uneducated. Hence, either marriage isn't feasible for such a pairing so that Mr. y and Ms. z stay single. Or, one or both of them get educated when young and single, so that they can marry in the second period.

   The expected lifetime utilities relevant for comparison involve the uneducated singles payoff, $3\left(y^2+z^2\right) = (1+2x^2)(y^2+z^2)$, as well as (13), (14) and (15). The equilibrium outcome would once again depend on the education premia for men and women: All three cases (2.a), (2.b) and (2.c) above apply in this case as well. In addition, the education premia for both men and women could be low enough, however, that neither the marriage nor the education of this pairing would be feasible or optimal.

4. $\eta x^2\left(e_m y, e_f\ z\right)^2 \geqslant F > \eta x^2[\max(e_m y + z,\, y + e_f\ z)]^2$: Now the couples' endowment bundle $(y,\, z)$ is even lower, so that the couple faces one of two choices:

   Either the education premia aren't high enough to warrant *both* the man and the woman getting educated, as a result of which the pair stays single and never marries. Nevertheless, the returns to education could still be high enough for either gender so that Mr. y or Ms. z could choose to get educated. Thus, the lifetime payoff of such a pairing would equal

$$3\left(y+z\right) = \begin{cases} (1+2x)(y+z) & \text{if } 2xy(e_m-1) \leqslant c \ \text{ and } \ 2xz(e_f-1) \leqslant c \\ (1+2x)(e_m y+z) & \text{if } 2xy(e_m-1) > c \ \text{ and } \ 2xz(e_f-1) \leqslant c \\ (1+2x)(y+e_f\ z) & \text{if } 2xy(e_m-1) \leq c \ \text{ and } \ 2xz(e_f-1) > c \end{cases} ; \qquad (16)$$

   Alternatively, the education premia are sufficiently large so that the couple gets educated in the first period and marries in the second period, thereby generating the payoffs expressed in (13).

5. $F > \eta x^2\left(e_m y, e_f\ z\right)^2$: In our final scenario, marriage is too expensive for all couples, including those among whom both the man and the woman are educated. Hence, the pair stays single throughout and receives the lifetime payoff given by (16) above, with the additional case of both the man and the woman finding it optimal to get educated if the returns to schooling are high enough. That is, $3\left(y+z\right) = (1+2x)(e_m y + e_f\ z)$ if $2xy(e_m-1) > c$ and $2x\ z(e_f-1) > c$.

3.5 The Equilibria

3.5.1 Who Matches with Whom?

Given transferable utility and the complementarity of individual incomes in generating a surplus, a stable assignment must be characterized by *positive assortative matching.* (Becker 1981). That is, if a man with an endowment y is matched with a woman with an endowment z in the first or second periods, then the mass of men with endowments above y must exactly equal the mass of women with endowments above z. This implies the following spousal matching functions:

$$y = G^{-1}\left[1 - r\left(1 - \widetilde{G}(z)\right)\right] \equiv \phi(z) \qquad \text{and} \qquad z = \widetilde{G}^{-1}\left[1 - \frac{1}{r}\left(1 - G(y)\right)\right] \equiv \psi(y). \tag{17}$$

For heuristic purposes, we shall assume in the remainder of our analysis that there are more women than men on the marriage market in aggregate so that $r > 1$.[19] For $r > 1$, all men are married and women with endowments below $z_0 = G^{-1}(1 - 1/r)$ remain single. Women with endowments exceeding z_0 are then assigned to men according to $\psi(y)$ which indicates positive assortative matching.

Positive assortative matching has immediate implications for the analysis of separation. Because separation is less likely when a couple has higher total income and individuals sort into unions based on income, individuals with higher income are less likely to separate.[20]

3.5.2 Who Marries When

While there would be positive sorting in the marriage markets based on the spousal endowment levels and all matched couples would like to marry as soon as possible due to the marital surplus involved, not everyone may be able to afford to marry when young, as suggested by subsection 3.4 above. Hence, we next establish who marries when on the basis of the key parameter values. We also demonstrate that the positive spousal matching profile would remain intact even when some spousal pairings at the lower end of the endowment distribution cannot afford to marry young and those higher up would delay marriage so both spouses get educated.

For the remainder of our discussion and the derivation of the marriage-market equilibria, we

[19] In fact, over the long timeframe we are carrying out our analysis, the sex ratio varied, with there being more men than women in the cohorts leading up to those born in the 1930s, followed by a sex ratio tilted toward women thereafter. Further below, we shall address the potential effects of a variable sex ratio on who marrries whom, who marries when, spousal education patterns as well as intra- and inter-temporal intrahousehold allocations.

[20] Such a result is consistent with empirical findings on marriage and divorce patterns by schooling: individuals sort positively into marriage based on schooling and individuals with more schooling are less likely to divorce. See Browning, Chiappori, Weiss (2014, Ch. 1).

shall make the following two assumptions:

Assumption 1: $\eta\left(y_{\max},\ z_{\max}\right)^2 > F > \eta\left(y_{\min},\ z_{\min}\right)^2$

Assumption 2: $\eta x^2\left(y_{\min},\ z_{\min}\right)^2 > F$

Our first assumption ensures that there will always be some individuals who can afford to marry when the are young and some who cannot. Our second assumption guarantees that all couples can marry either when they are young or middle aged.

Positive sorting in the marriage markets unconditional on delay combined with Assumption 1, enables us to now define an explicit spousal endowment level below which couples would have to defer marriage until the second period when they are older and their incomes are higher. Defining as $(y^*,\ z^*)$ the pairing for which $\eta\left(y^*,\ z^*\right)^2 = F$, and relying on the fact that $z = \psi\left(y\right)$ based on positive assortative matching as in (17), we have

$$y^* + \psi\left(y^*\right) \equiv \Psi(y^*) = \sqrt{\frac{F}{\eta}} \qquad \Rightarrow \qquad y^* = \Psi\left(\sqrt{\frac{F}{\eta}}\right)^{-1}, \tag{18}$$

with the exposition in (18) assuming that the endowment distributions are such that the matching function $\psi(.)$ is amenable to an inversion as expressed above.

$\forall\ y < y^*$, couples would not be able to afford marriage when young and their union would inevitably be delayed until the second period when all such couples would be able to marry based on Assumption 2. $\forall\ y \geqslant y^*$, couples would afford to get married when young and without delay. However, whether or not they do so would depend on the returns to education for both men and women. There are three particular outcomes to consider:

I. With $e_m \rightarrow 1 \wedge e_f \rightarrow 1$, one can confirm that (9) strictly exceeds (11), (12) and (13) for all couples in the endowment hierarchy.[21] In this case, no individual chooses to get educated, couples for whom $y \geqslant y^*$ marry young and those for whom $y < y^*$ marry later. Hence, $\forall\ y \geqslant y^*$, (9) defines the sum of expected lifetime spousal utilities (with case (1.a) in subsection 3.4 above being relevant for all such couples), and, $\forall\ y < y^*$, (10) represents sum of lifetime expected utilities (with case (2.a) in 3.4 applying to all of these couples).

II. With $e_m > 1 \wedge e_f \rightarrow 1$, since both (11) and (14) are continuous and strictly increasing in e_m, it is straightforward to verify, as we have done in Appendix A, that $\exists\ \widetilde{e},\ \widetilde{e} > 1$, such that

[21] In fact, note that (11) equals (12) which strictly exceeds (13) under these parameter values.

(11) evaluated at $e_m = \widetilde{e}$ strictly exceeds (9) for some couples at the top of the endowment distribution and that (14) evaluated at $e_m = \widetilde{e}$ also strictly exceeds (10) for some couples in the neighborhood of y^* from below.[22] In this equilibrium, the threshold y^* continues to divide the population into two, with $\forall\ y \geqslant y^*$ marrying young and $\forall\ y < y^*$ marrying in the second period. However, if $e_m > \widetilde{e}$, then there would be couples at the top of the endowment distribution among whom men would get educated while they are young and married (with case (1.b) in 3.4 above applying to such couples). The equilibrium could also involve lower-endowment couples — those in the neighborhood of $y \to y^{*-}$ — such that the husbands are educated and the couple marries later (with either case (2.b) or case (3) in 3.4 being relevant among these couples).

III. With $e_m > 1 \wedge e_f > 1$, the strictly increasing nature and the continuity of (13) in both e_m and e_f ensures that $\exists\ \widetilde{(e_f,\ e_m)}$ defined over a continuum and a convex frontier such that, for some couples at the top of the endowment distribution, (13) strictly exceeds (11), (12), and (9), with the latter being strictly larger than (10) by construction. Thus, in an equilibrium such that $(e_m,\ e_f) >> \widetilde{(e_f,\ e_m)}$, couples at the top of the endowment distribution would involve educated men and women who marry late (representing couples in case (1.c) of subsection 3.4 above). If $e_m > \widetilde{e}$ as well, such couples could be followed potentially by couples who marry young and among whom the men are educated (drawing couples described by case (1.b) in 3.4 above) and maybe also couples in the neighborhood of $y \to y^{*-}$ who marry later in life involving educated husbands (such as those couples drawn from cases (2.b) or (3) in 3.4), followed finally by uneducated couples who marry late (described by case (2.a) in 3.4). With sufficiently large $(e_m,\ e_f)$, however, note that there would be no couples who marry young and among whom only the husbands are educated. In such an equilibrium, men and women would get educated and marriage would be delayed $\forall\ y \geqslant y^*$ (with case (1.c) applying to all such couples). And this could potentially hold for some couples who could not afford young marriage to begin with (i.e., those with $y < y^*$ and potentially encompassing couples described by cases (2.c), (3) and (4) in subsection 3.4 above).

For all the relevant proofs, see Appendix B.

[22] Within the relevant parameter ranges, for sufficiently high y and the corresponding $\psi(y)$ such that $y > \psi(y)$, (11) would strictly exceed (9) which would exceed (12) and (10). In turn, (10) would strictly exceed (15), with the latter being strictly larger than (13).

3.5.3 Stability Conditions & Within-period Utilities

Next, we address the stability of the matching equilibria and within couples allocations intra- and inter-temporally.

Stability Conditions The allocations that support a stable assignment must be such that the implied expected lifetime utilities of the partners satisfy

$$U_i(y) + U_j(z) \ \geq S(y,z) \ ; \qquad \forall \ y, \ z \ , \tag{19}$$

where $U_i(y)$ and $U_j(z)$ respectively represent the expected lifetime utilities of the male and female partners over the two periods.[23] For any stable union, equation (19) is satisfied as an equality, whereas for a pair that is not matched, (19) would be satisfied as an inequality. In particular, we have

$$U_i\left(y\right) \ = \ \max_z \left[S\left(y,z\right) - U_j\left(z\right)\right] \qquad \text{and} \qquad U_j(z) \ = \ \max_y \left[S\left(y,z\right) - U_i\left(y\right)\right] \ . \tag{20}$$

Using methods described in Browning et al. (2014) and as shown in Iyigun and Walsh (2007), it is possible to determine the life time shares $U_i\left(y\right)$ and $U_j(z)$ along the assortative matching profile, based on the distributions of male and female attributes in the population. It is important to stress that the stability conditions and the equilibrium shares can be derived without any assumption regarding the level of commitment attainable by the spouses. Competition in the marriage market determines the allocation of lifetime utilities between spouses. A woman would not agree to 'marry' a man who would provide less than the equilibrium utility because many perfect substitutes exist for each man. Likewise, a man would not 'marry' a woman who demands more than the going share because of the availability of very close substitutes for each woman.

However, for the determination of the *intertemporal distribution* of utility over the three periods, commitment issues are crucial. Two broad views emerge from the existing literature. Some contributors argue that only short-term commitment is attainable and that long-term decisions are generally open to renegotiation at a further stage. Other authors point out that a set of instruments, including prenuptial agreements, are available to sustain commitment. They, therefore, claim that divorce is the only limitation on commitment. For what lies ahead, we consider the second situation - i.e., couples can commit to their spousal allocations in their union ex ante. No renegotiation can therefore take place unless separation is credible. Moreover, if renegotiation does occur, it results in the minimal change needed for a union to continue, if that is indeed optimal. The no-commitment case can be solved in a similar way, and generates largely similar qualitative

[23] Some explanation here on how the $S(.)$ differ in interpretation, at least, in the first and second periods and based on whether the couple is together or not.

conclusions. Please see Browning et al. (2014) for a more detailed discussion on the topic.

Intra-temporal Spousal Utilities Let $u_{3i}(y)$ and $u_{3j}(z)$ denote the *economic* components of utility derived from the intra-marital allocations respectively of husband with endowment y and wife with endowment z in the third period should they continue with their partnership. Hence, the husband's (wife's) total third-period utility is $u_{2i}\left(y\right)+\theta$ (resp. $u_{2j}\left(z\right)+\theta$) if the union continues. Feasibility constraints require that $u_{2i}\left(y\right)+u_{2j}\left(z\right)=\eta\left(y+z\right)^{2}$.

As we noted in subsection 3.2 above, we assume that divorce does not entail any income transfers between the spouses, effectively implying that, upon separation, the streams of income generated from individual earnings accrue in their entirety to the individuals themselves. Specifically, that the husband retains his augmented second-period endowment y, thus generating $f_m\left(y\right)\equiv y^2$ upon divorce, and the wife keeps her augmented second-period endowment z, thereby producing $f_m\left(y\right)\equiv z^2$.

On that basis, individual rationality implies that these outside options cannot exceed the utility payoffs if the union continues. Therefore, it must be the case that

$$u_{3i}\left(y\right)+\theta\geq y^{2}\quad\text{and}\quad u_{3j}\left(z\right)+\theta\geq z^{2}, \tag{21}$$

which we shall hereafter refer as the *individual rationality constraints* (IR). Note that these conditions jointly imply that

$$u_{3i}\left(y\right)+\quad u_{3j}\left(z\right)+2\theta=\eta\left(t\right)+2\theta\geq y^{2}+z^{2}\ , \tag{22}$$

or equivalently that $\theta\geq\hat{\theta}\left(y,z\right)$, so that separation is not the efficient outcome.

For any realization of θ, either $\theta<\hat{\theta}\left(y,z\right)$ and separation takes place or $\theta\geq\hat{\theta}\left(y,z\right)$ and utilities are equal to $y^2+\theta-\hat{\theta}\left(y,z\right)$ and $z^2+\theta-\hat{\theta}\left(y,z\right)$ for the husband and the wife respectively, so that the time-consistency constraints are fulfilled for both spouses. Thus, any increase of a spouse's utility in separation is exactly reflected in that spouse's third-period utility even if the couple does not separate.

Inter-temporal Spousal Utilities The expected three-period utilities equal

$$U_i\left(y\right)=u_{1i}\left(y\right)+u_{2i}(y)+\bar{\theta}+\left(1-\alpha\left(t\right)\right)\left\{u_{3i}\left(y\right)+E\left[\theta\mid\theta\geq\hat{\theta}(t)\right]\right\}+\alpha\left(t\right)\left(1-\beta\right)t\ , \tag{23}$$

$$U_j\left(z\right)=u_{1j}\left(z\right)+u_{2j}(z)+\bar{\theta}+\left(1-\alpha\left(t\right)\right)\left\{u_{3j}\left(z\right)+E\left[\theta\mid\theta\geq\hat{\theta}(t)\right]\right\}+\alpha\left(t\right)\beta t\ , \tag{24}$$

These utilities must coincide with the equilibrium shares discussed above.

3.6 Some Comparative Statics

In order to set in context the empirical regularities we presented above and lay the foundations of the empirical work below, consider the following parameter values, specifically with reference to the quadruplet (F, η, r_m, r_f), which determines the cost and benefit of marriage and the returns to education for men and women, respectively:

The 1880s: Holding constant marital gains, if the cost of marriage is relatively but not prohibitively high and the returns to education are low, then the economy is more likely to be in the first equilibrium described in subsection 3.5.2 above, (I). This would be analogous to the late-19th century, as marriage costs were relatively high and the returns to schooling were uniformly low. Here, regime (2.a) in subsection 2.3.1 above is likely to apply to most couples. Recall, then, that a couple would be more likely to marry later in life and stay uneducated. This would be due to the fact that, for most couples with endowments (y_1, z_1), the condition $\eta x^2(y_1+z_1)^2 \geqslant F > \eta(y_1+z_1)^2$ would be satisfied. At the same time, due to the fact that the returns to education are low, the highest sum of expected lifetime utilities among the feasible choices of (10), (13), (15) and (14), would be attained by (10) for most couples.

The 1950s: Starting from the parameter quadruplet above, now consider a decrease in the cost of marriage, F, along with an increase in the return to education for men, r_m. This would be similar to the 1950s when improvements in white-appliance technologies lowered the cost of marriage (Greenwood, Seshadri and Yorukoglu, 2005) and the college education premia rose markedly, especially for men. Now the relevant equilibrium would be (II) above, with more couples likely to find themselves in regime (1.b). That is, for given endowment distributions among men and women, $G(y)$ and $\widetilde{G}(z)$, more couples would not only find it feasible to marry young, but also optimal for the husbands to get educated. This would be on account of the fact that the first-period endowments (y_1, z_1) could suffice to cover the cost of education when young (i.e., $\eta(y_1 + z_1)^2 \geqslant F$). But also the fact that, with higher returns to schooling for men, the highest sum of expected lifetime utilities among the optimal and feasible set of (13), (11), (12), (9) would likely be (11) for more couples.

The 1980s: Now consider further increases in the returns to education — this time for both genders — with a less-than proportional decline in the gains from marriage (as exemplified by a lower value of η). We think such changes exemplify the trends in the 1980s when returns to schooling rose sharply for both men and women. Such parameter changes would prompt more men and women to get educated prior to marriage, in effect making the equilibrium (III) the relevant one. However, the decline in marital gains would force a higher proportion of uneducated couples to delay marriage than before. Thus, cases (2.a) and (2.c) in subsection 3.4 would apply to more couples than before under such parameter restrictions. In fact, depending on how large the drop in η is vis-a-vis increases in r_m and r_f, cases 3 and 4 could apply to more couples as well.

In addition, our model predicts that the impact of increasing the cost of marrying early will be different depending on the setting we are studying. In a case where one or both of the returns to education are very low, such restriction will delay some marriages (the fraction of which will depend on F) but will keep unaltered the levels of educational attainment of the spouses and their differences. However, when returns to education are positive for both men and women, we can expect that this would be akin to $\forall\ y < y^*$. Then, for some couples who would have otherwise married early and had the husband acquire education, it could now be the case that marriage is delayed and both spouses get educated. Consequently, the spousal educational attainment gap would narrow as well.

4 Additional Empirical Tests

Having elaborated a model that matches the stylized facts we document, we now attempt to test further implications of this model. First, we examine whether the age at first marriage declines more strongly among the more educated men, as it would be these types of individuals who could now combine education and marriage. Then, we test whether in regions where the marriage fixed cost, F, was relatively higher, we observe a larger drop in the age at first marriage and a larger spousal gap in educational attainment. Finally, we also test whether, as predicted by our model, legal limits imposed on early marriage had an impact on the educational differences between men and women.

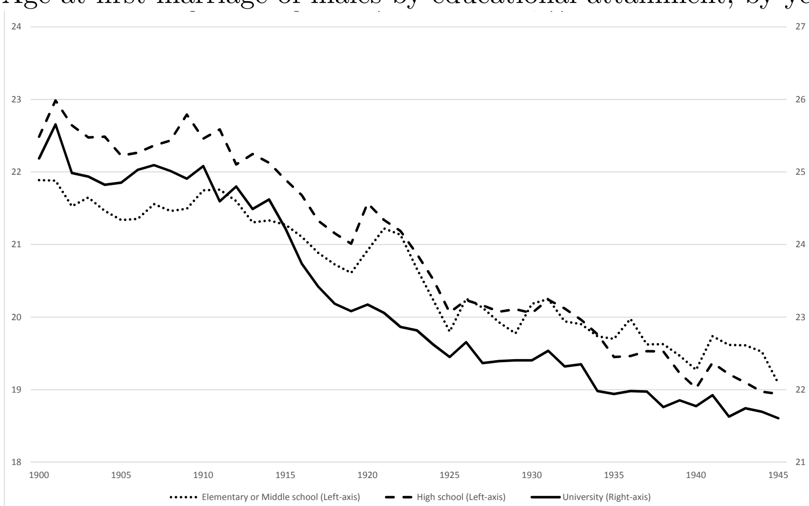
4.1 Age at First Marriage by Educational Attainment

According to our model, a fall in F would particularly lower the age at first marriage. In particular, when the fixed cost of marriage, F, is prohibitively high and the return to education for men is sufficiently rewarding, men would get educated but they would be forced to delay marriage. With a meaningful decline in F, however, men can marry young and get educated while they're married.

This, of course, is a crude generalization. Nevertheless, we can investigate whether, in the cohorts that began to marry younger, educated men responded in a similar way but more strongly. Said in another way, our model predicts that more men at the top of the distribution, who were the ones more likely to get educated, would start to marry young.

In Figure 6, we present the median age at first marriage of males by educational attainment.[24] It suggests that high-skilled men significantly lowered their marriage age. Men with at least some high school education, who used to marry about half a year later than those with only elementary or middle school at the beginning of the period were actually marrying earlier than lower educated men at the end of the period. For men with at least some college education, we do not observe a crossing but we still find that, over the sample period, they reduced their median age at first marriage by more than 3 years compared with at most 2 years for the other educational group. These findings are consistent with our model. Moreover, it is important to note that, due to data constraints, these medians were computed only for individuals who were married. We get very similar qualitative results when we instead consider the average age at first marriage instead.

Figure 6: Age at first marriage of males by educational attainment, by year of birth

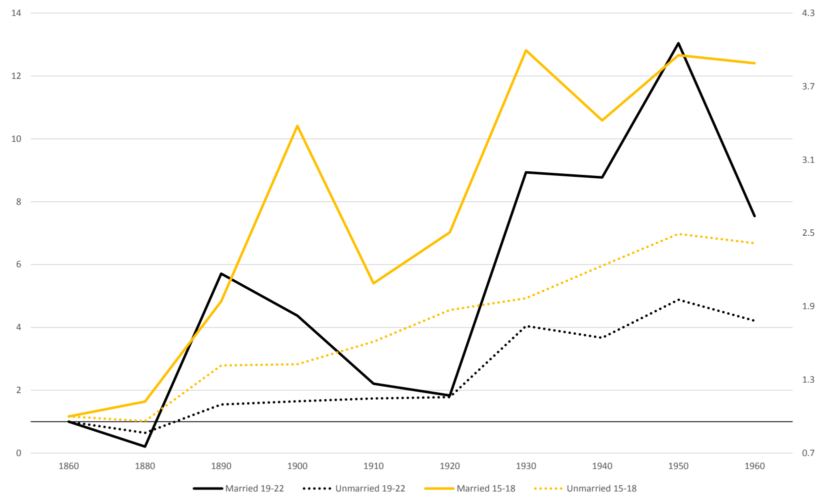


The measure discussed above could be biased because we only measure educational attainment and age at first marriage for a restricted set of cohorts. Figure 7 shows educational attendance by age group and marital status, information that is readily available for many more cohorts. Here, we again find that married teenagers and younger adult men most strongly altered their attendance decision at a time when we observe younger marriages and higher differences in educational attainment between men and women. The role of married college-age males is particularly relevant for the period in which the educational gap increases. This is not to say that married individuals attended

[24] Data limitations significantly narrow the window through which we can analyze this when we split our sample by educational attainment.

school more frequently than singles. However, married men did become much more involved in their education while married than they previously had been.

Figure 7: Growth in school attendance by age agroup and marital status, by birth year



4.2 Variations in the Fixed Cost of Marriage

Another testable implication of our model is that changes in the age at first marriage and patterns of spousal education ought to have been more pronounced in areas where the marriage setup costs were relatively high and the returns to schooling varied more. On this basis, regions with higher marriage fixed costs would have been likely to experience the transformation we identified in a more marked way because of the higher cost of setting up a household.

In fact, one can identify supporting empirical evidence when the sample is split into urban and rural areas and by regions of the United States. Land values were in general lower in rural areas and in parts of the United States that were still part of the frontier. If the largest cost of marriage was linked to the cost of setting up a household, land values would have been a very important component of that cost. Thus, we divide our sample into urban versus rural regions based on the premise that marriage fixed costs were higher in urban areas. We then check whether the pattern we identified is visible more strongly in urban locales — places where the initial cost of setting up a household may have been larger. Figure 8 shows that the fall in the age at first marriage for cohorts born in the first decades of the century is particularly marked for urban dwellers. Similarly, Figure 9 shows that only urban settings saw a significant change in the male-to-female educational gap.

We recognize that there may be other differences between urban and rural settings that could have driven these differences, potentially differences in the evolution of returns between men and

Figure 8: Median age at first marriage by rural/urban, by birth year

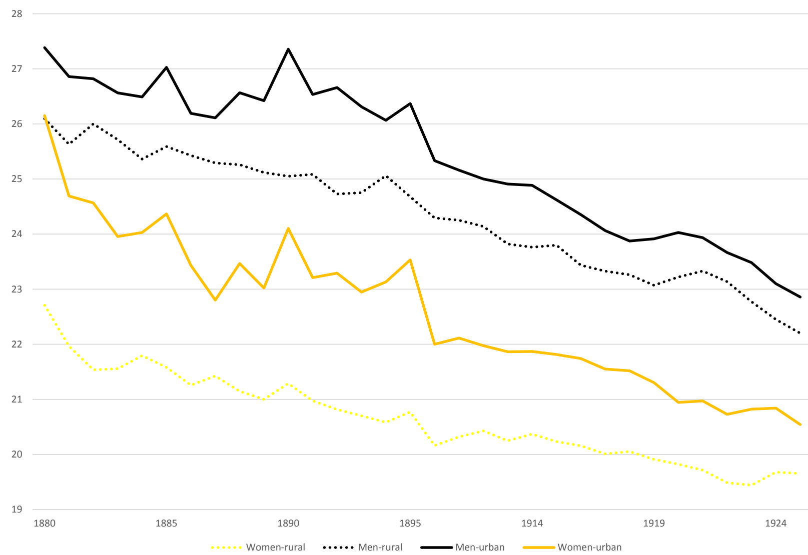
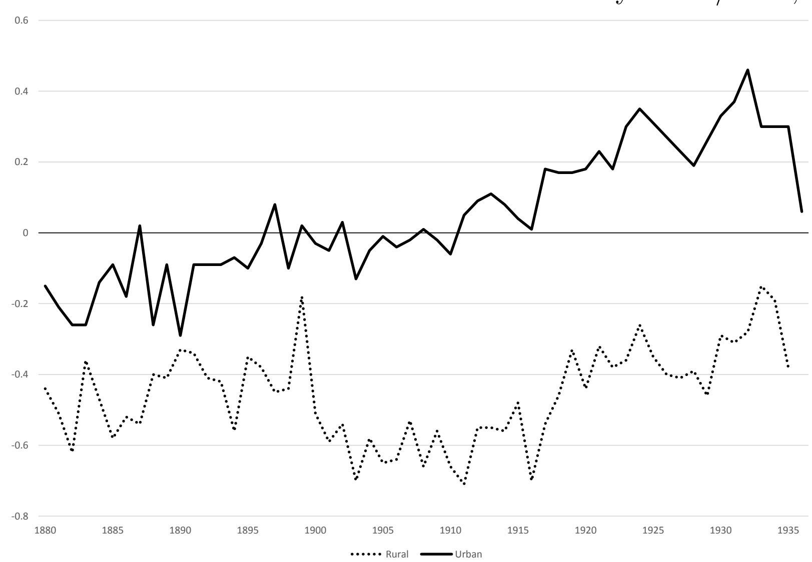


Figure 9: Educational difference between men and women by urban/rural, by birth year



women over the period but we see this as suggestive evidence that our model has some predictive value.

4.3 The Impact of Legal Changes

Our model also predicts that higher marriage fixed costs would force some couples to delay marriage, thereby discouraging couples who would have married young and put the husband through school while married. If we look at case III of our marriage market equilibria in subsection 3.5.2 above, then being forced to delay marriage would make some couples who had previously married young and educated only the husband to marry at a later age and have both spouses educated. Similarly, for some couples that were marrying young and not getting educated, there may now be an incentive to marry later and for both spouses to acquire more education. This would only be feasible in a world where F was not prohibitively costly (so that there are some young couples contemplating early marriage and others considering delay) or in a world where only men experience a positive return to education (since, in that case, being forced to delay marriage would not impact educational choices).

Thus, our model predicts that legislation to delay marriage would prompt both men and women to acquire more education, leading to a narrower gender education gap when the returns to schooling are relatively large for both genders. Note that this differs from Becker's seminal paper (1973) on household specialization since in this case, being forced to delay marriage would lead to higher assortative matching but with men decreasing their educational investment and women increasing theirs.

While it is true that couples who marry earlier are less assortatively matched than those who match later, this is a simple correlation that could be driven by many alternative factors. To check whether there is a potential causal channel, we explore a shock brought about during this period by state-level legislation that raised the legal minimum age at which individuals could marry. While there is ample evidence that one could likely marry at an age younger than the minimum legal one, it also appears that it would have involved additional costs for the individuals wanting to do so (such as traveling to a different state, forging age credentials, obtaining a false witness, etc.).

4.3.1 Legislative Details

To pursue this strategy, we need a complete record of the laws that pertain to marriage age laws over the 20th century and by state. There are no pertinent federal laws on this and states have the freedom to determine their own laws regarding marriage requirements. In general, however, states specify four sets of minimum-age guidelines that are gender-specific and they typically reflect qualifiers for marriage with and without parental consent. We thus need to code the effective minimum age for marriage in each state over the largest period possible.

To that end, we employ the *Westlaw Legal Database*. In this digital database, all years and versions of the previous versions of a given legislation were codified. When the registry did not allow us to codify in what year the law was enacted or revised, Westlaw also provides the history of associated legal cases, which can help one to identify the nature and the timing of changes in the laws. We complemented this information with data acquired through internet searches and contemporaneous publications detailing changes in the laws. In some cases when the relevant information was still not available, we contacted state legal offices.

Our database on minimum age at marriage and divorce laws is very extensive and, although it includes missing data, it is a fairly consistent panel dataset spanning the period between 1900 and 1980. This is a much more complete set of laws than what has been previously employed by Dahl (2010), Edlund and Machado (2011) and by Rotz (2011). Furthermore, the *Almanach of the United States,* which some previous studies employed, was found to reflect some inconsistencies.

Our database confirms that there were many legal changes in the effective legal minimum marriage age, with the latter rising and falling in some states over time.

4.3.2 Data and Empirical Strategy

We match the laws described above to individual data from *IPUMS* for the years between 1930 and 1980. As discussed in Blank et. al (2009), this dataset is preferable to the *Vital Statistics* data as it does not suffer from the same biases (i.e., individuals could, in the shadow of the law, provide misleading information on their marriage certificate applications, but not on their Census forms). We match an individual with the laws that were in place in her state of birth. However, not only the laws faced by that individual could impact the age at which they marry but also the laws affecting their spouse. The difficulty here is that who this person marries may directly be impacted by the age at which that individual marries. To solve this problem, we use the laws that would affect an average spouse as defined by someone who is from the same state (most couples marry within state) and who has two years age difference with the spouse (since this is the average age difference in our sample). An individual could potentially be bound by a number of different minimum age laws if the laws change during the teenage years. We here present the laws that an individual faced at age 16 since we think this likely corresponded more closely to what would have been anticipated by young adults when their marriage and educational decisions were being made. However, similar results were obtained with laws at different ages.

The outcomes we focus on in the empirical analysis below include the respondent's age at first marriage, her educational level as well as that of her spouse, respondent's occupational and educational score and those of her spouse, respondent's labor force status and that of her spouse. All of these aforementioned individual outcome variables are available in the 1930 through 2000 Censuses, although some are available only for a restricted number of years.

We next employ a difference-in-difference estimation strategy as given by the following regression equation:

$$y_{gst} = \beta_1 Withconsent_{gst} + \beta_2 Withoutconsent_{gst} + \beta_3 Withconsent_{g'st'} + \beta_4 Withoutconsent_{g'st'} + \mu_s + \eta_t + \varepsilon_{st} \tag{25}$$

where the outcome y_{gst} refers to that of person of gender g, born in state s and in year t. We regress this outcome against four potential types of laws, namely the minimum age at which she could marry with parental consent, without parental consent and the ones faces by her "average" spouse, which is a male of the same state but born two years before her. In all estimates, we shall control for state and year of birth fixed effects. Introducing the laws as controls in a regression in the presence of such fixed effects, as we shall do below, would manifest the premise that there would have been parallel outcome trends between the states in the absence of these laws. And further that the legislative changes would solely account for any deviations from trend. In all of our estimates, we cluster the standard errors at the level of the state of birth.

According to our theory, legal changes that pertain to age at first marriage should make it prohibitively costly for young adults to marry. Table 1 shows that there is a first-stage relationship between the legal environment and the age at which individuals married. In Panel A, where we combine all cohorts together, we find that men are particularly responsive to laws which allow marriage with parental consent while women are more responsive to laws that allow marriage without such consent. However, we find that for males, the significance is only visible for cohorts born after 1915, when the median age at first marriage begins to fall, as shown in Panel C. This is not surprising as laws were, on average, about 16 with parental consent and 20 without but mean age at first marriage for those born before 1915 was larger than 26 years old. Thus, there was little space for these laws to be particularly binding before 1915. Only 2 percent of men born before 1915 married before or on the age allowed by law with parental consent before 1915. This number more than doubled for the older cohorts. A similar, but less dramatic picture can be found for the minimum age without parental consent where less than 20 percent of men born before 1915 married before or on the age allowed by law but almost 30 percent of those born after 1915 did so. For women, the effect is limited before 1915 and concentrated for the minimum age without consent which is logical given that the age at first marriage was relatively high and only the laws pertaining to minimums around 18 years old may have been relevant. The estimates show that there is a strong relationship between the individual decisions to delay marriage and the age at which individuals could legally marry for cohorts born after 1915. Men seem to respond to both restrictions for these cohorts and do not appear to be influenced by the fact that their potential partners are also under differing regimes. The impact for women is more muted but stronger for

Table 1: Impact of the minimum age laws at age 16 on age at first marriage

	Men		Women	
	Own	Spousal	Own	Spousal
	(1)	(2)	(3)	(4)
	Panel A : Full sample			
Minimum Age with parental consent	0.033*	0.028*	0.021	0.004
	(0.019)	(0.017)	(0.015)	(0.023)
Minimum Age without parental consent	0.037	0.016	0.050*	0.088***
	(0.039)	(0.028)	(0.028)	(0.032)
N	2877259	2892196	3320348	3303860
	Panel B : Pre 1915			
Minimum Age with parental consent	0.034	0.003	0.002	-0.005
	(0.031)	(0.026)	(0.020)	(0.022)
Minimum Age without parental consent	0.000	-0.002	0.047**	0.064***
	(0.036)	(0.029)	(0.022)	(0.021)
N	1134845	1134577	1408936	1409477
	Panel C : Post 1915			
Minimum Age with parental consent	0.035*	0.024	0.032*	0.025
	(0.018)	(0.014)	(0.017)	(0.019)
Minimum Age without parental consent	0.021**	0.012	-0.003	0.004
	(0.008)	(0.016)	(0.019)	(0.013)
N	1742414	1757619	1911412	1894383

Each column and panel corresponds to a single regression which also includes fixed effects for state and for year of birth. Standard errors are clustered at the state level.

laws with parental consent which is to be anticipated in a period where the median age at first marriage was close to 18. Our first stage is much stronger when looking at the laws at age 14 which may due to the fact that a fraction of our female sample may have been married by age 16.[25] The magnitudes are relatively small as one would expect. An increase in one year in the minimum marriage law increases the average age at first marriage by 0.02-0.06, which is what would be expected if 5 percent of the population married below the new minimum and all delay by exactly one year their marriage while others do not change their behavior. While not reported here, we also find that a higher minimum age significantly reduces the probability of having married before age 20 for both periods, suggesting that it particularly affected the behavior in the age range where the laws actually were relevant.

Appendix C Figures 1 through 4 graphically illustrate that these laws also had an impact on the distribution of ages at first marriage with significant moves in the distribution occurring in

[25]The first-stage estimates are even stronger when the laws are included as dummies than as continuous variables as we have done in all the regressions reported in Table 1.

Table 2: Impact of minimum marriage age laws on being ever married by age 35

	Men		Women	
	Own	Spousal	Own	Spousal
	(1)	(2)	(3)	(4)
	Panel A : Pre 1915			
Minimum Age with parental consent	0.000	-0.000	-0.000	0.002
	(0.002)	(0.001)	(0.001)	(0.002)
Minimum Age without parental consent	-0.001	-0.001	-0.002**	-0.000
	(0.002)	(0.001)	(0.001)	(0.002)
N	1794795	1794111	2230149	2231089
	Panel B : Post 1915			
Minimum Age with parental consent	-0.002*	-0.002***	-0.002***	-0.002
	(0.001)	(0.001)	(0.001)	(0.002)
Minimum Age without parental consent	-0.000	-0.001	-0.003	-0.002*
	(0.001)	(0.001)	(0.002)	(0.001)
N	5159421	5206165	5812402	5760008

Each column and panel corresponds to a single regression which also includes fixed effects for state and for year of birth. Standard errors are clustered at the state level.

response to the legal restrictions in place. We see again that these are much less visible for men in cohorts born before 1915 and for women in minimum age with parental consent before 1915 and in age without parental consent, after 1915.

This increase in the age at first marriage could either simply bunch marriages just above the limit or have a long-lasting impact through the age distribution. We check whether there is any evidence that the laws modified the propensity that someone be married by age 35 in Table 2. We find some evidence there the laws significantly impacted the probability of ever being married but the magnitudes are very small suggesting that at most, a one year increase in the minimum age to marry decreases the probability of ever having married before age 35 by 0.2 percentage point. We see this as evidence that the legislation mostly altered the distribution of ages and not the probability to marry directly.

4.3.3 Results

Our results indicate that delayed marriage leads to changes that are consistent with our model. We estimate reduced-form regressions to measure the impact of the laws on educational and matching decisions. We choose to only present reduced form estimates because it is unclear to us that there could not be an indirect effect of the laws on an individual behavior that is not through their own age at first marriage but potentially through the age at which their spouse married them. Reduced

Table 3: Impact of minimum marriage age laws on highest grade achieved

	Highest Grade Achieved			
	Men		Women	
	Own	Spousal	Own	Spousal
	(1)	(2)	(3)	(4)
	Panel A : Pre 1915			
Minimum Age with consent	-0.055*	-0.005	-0.018	-0.052**
	(0.028)	(0.009)	(0.013)	(0.023)
Minimum Age without consent	-0.006	0.006	0.020	-0.008
	(0.023)	(0.023)	(0.016)	(0.029)
N	1001157	1000707	1278521	1279220
	Panel B : Post 1915			
Minimum Age with consent	0.072**	0.086**	0.069**	0.068**
	(0.033)	(0.034)	(0.030)	(0.026)
Minimum Age without consent	0.085***	0.036	0.035	0.092***
	(0.020)	(0.038)	(0.042)	(0.016)
N	1864211	1880845	2017585	1999048

Each column and panel corresponds to a single regression which also includes fixed effects for state and for year of birth. Standard errors are clustered at the state level.

form estimates allow us to remain agnostic on that point. Furthermore, given that our "first stages" were a bit weak, the reduced form will not suffer from the potential bias that could stem from weak instruments.

First, Table 3 presents the impact of these rules on the educational attainment of men (in the first two columns) and women (in the last two). We find limited impact before 1915 but, if anything, weak evidence that, when men married earlier, men and women tended to acquire a bit less education. On the other hand, our results for cohorts born after 1915 are much stronger and robust. They suggest that having laws that delay marriage by a year increases the highest grade achieved by .08. This is similar for men and women. While spousal laws had limited impact on own age at marriage, they appear to matter here, which suggests that having a spouse who is forced to delay marriage may also impact one's own educational decision, even if it does not necessarily impact one's own marriage timing.

Table 4 shows the impact of the laws on the absolute difference between the educational levels of each gender and their spouses. This table suggests a limited impact of the laws before 1915, although mostly negative. For cohorts born after 1915, we find much larger coefficients, uniformly negative and in general very significant. This suggests that, in a setting where there may have been incentives for couples to marry young and for only one of the spouses to educate themselves, there

Table 4: Impact of minimum age laws on absolute difference in educational attainment of spouses

	Men		Women	
	Own	Spousal	Own	Spousal
	(1)	(2)	(3)	(4)
	Panel A : Pre 1915			
Minimum Age with consent	-0.006	-0.015**	-0.011*	-0.015*
	(0.013)	(0.007)	(0.007)	(0.009)
Minimum Age without consent	0.010	-0.006	0.002	0.022***
	(0.012)	(0.010)	(0.005)	(0.007)
N	713303	712972	570589	570934
	Panel B : Post 1915			
Minimum Age with consent	-0.023**	-0.030**	-0.010	-0.011
	(0.011)	(0.012)	(0.012)	(0.011)
Minimum Age without consent	-0.053***	-0.019	-0.026*	-0.038***
	(0.009)	(0.024)	(0.015)	(0.006)
N	1528623	1541362	1487074	1474391

Each column and panel corresponds to a single regression which also includes fixed effects for state and for year of birth. Standard errors are clustered at the state level.

is evidence that being forced to delay marriage appears to have generated more educated couples but also couples that are "closer" to each other in terms of the number of years of schooling they have acquired.

While education is the type of human capital investment we focus on, one could also observe the same type of behavior for non-schooling investments that must be undertaken when young. We thus present, in Table 5, whether there is any indication that the laws also impacted the absolute difference in age between spouses. If we think that there is some learning-by-doing, age may be an indication that an individual has acquired more human capital before marriage. Thus, a smaller age difference may indicate that individuals have accumulated a similar amount of human capital compared to a larger age difference. The table shows no evidence of a link between the laws for individuals born before 1915 and the age difference of spouses. However, for the cohorts born after 1915, there seems to be a link, albeit weaker than for education, between restrictions on the age at which one or one's spouse can marry and the age of the spouse one elects.

Finally, we can ask whether this is not simply an indication that when a couple marries younger, women are disadvantaged compared to their spouse and this is reflected by a bigger educational difference. To investigate this, we look at two measures of post-marital welfare, namely the occupational score of each spouse and the labor force participation of each spouse. If leisure is a normal good and utility is transferable within marriage, we may expect that couples who marry young

Table 5: Impact of minimum age laws on age differences

	Men		Women	
	Own	Spousal	Own	Spousal
	(1)	(2)	(3)	(4)
	Panel A : Pre 1915			
Minimum Age with consent	0.017	0.002	-0.004	0.007
	(0.045)	(0.026)	(0.018)	(0.023)
Minimum Age without consent	-0.035	-0.043	-0.002	-0.010
	(0.053)	(0.048)	(0.020)	(0.020)
R2 adj	0.021	0.021	0.010	0.010
N	1375253	1374721	1151425	1151935
	Panel B : Post 1915			
Minimum Age with consent	-0.021	-0.032**	-0.017	-0.008
	(0.015)	(0.013)	(0.012)	(0.017)
Minimum Age without consent	-0.003	-0.025*	-0.034**	-0.015
	(0.013)	(0.014)	(0.016)	(0.014)
R2 adj	0.013	0.013	0.008	0.008
N	3846846	3880047	3738134	3705655

Each column and panel corresponds to a single regression which also includes fixed effects for state and for year of birth. Standard errors are clustered at the state level.

and with a larger educational gap may also exhibit larger differences in spousal labor supplies. We find no evidence of this suggesting potentially that the spousal division of household surplus is not driven by when marriage is contracted but by the distribution of males and females in the population, as is indicated by our framework.[26]

5 Conclusion

In this paper, we first document some novel aspects of the long-run educational and marital trends that unfolded in the United States during the 20th century. U. S. marriage patterns and the gender educational gap over the course of the last century followed a non-monotonic pattern, according to which cohorts born around the turn of the 20th century married late and they typically had slightly more educated wives than husbands. The overall spousal education levels of these cohorts were similarly low. For cohorts born between the two World Wars, marriages occurred earlier and they involved husbands who were significantly more educated than their wives. Among the later born cohorts, marriages began to occur later and they involved more educated spouses with narrower gender gaps.

In order to explain these patterns, we develop a multi-period marriage and educational attainment household model. It features frictionless matching with educational and marriage decisions being endogenous. The two key features of our theory are that marriage requires a fixed entry cost and that married couples cannot study simultaneously.

We illustrate that our model can replicate the aforementioned stylized facts. We also show that, in accordance with the predictions of our model, exogenous delays in marriage age caused by minimum marriage age laws decreased the educational difference between women and men, while not decreasing the levels of spousal educational investment. This would not be predicted by other models of marriage timing.

Divorce in our model is endogenous, although it is a Pareto optimum choice. Thus we have little to say about the recent increases in divorce experienced around the same period with the documented changes we presented above. Caucutt et. al (2002) propose a model where women may delay marriage due to the likelihood of divorce. In future work, we intend to incorporate endogenous divorce into the theoretical framework we already outlined.

Furthermore, we hope to utilize the variations we documented above to structurally estimate the value of marriage for different educational types at different points in time. This would further reinforce our conclusion that early marriage may have generated higher marital surplus for those couples among whom one spouse pursued education while married.

[26]Results not presented but available upon request.

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A Marital and Educational Equilibrium Choices

Proof of 1:

a. Let $e_i = 1$, $i = m, f$. Then, it follows that (11) and (12) both become

$$\begin{aligned} S_1^H(y,\ z) \ = \ & S_1^W(y,\ z) = \eta\,(y+z)^2 + \eta x^2\,(y+z)^2 + \alpha\,(xy,\ xz)\,x^2\left(y^2 + \ z^2\right) - \ F - c \\ & + [1-\alpha\,(xy, xz)]\left\{\eta x^2\,(y+z)^2 + 2E\left[\theta \mid \theta \geq \bar{\theta}(xy,\ xz)\right]\right\} \end{aligned} \tag{A.1}$$

With $e_i = 1$, $i = m$, f, one could rewrite the expected lifetime marital sum of utilities for the second-period union of educated couples and those with educated husbands or wives only respectively as follows:

$$\begin{aligned} S_2^{HW}(y,\ z) = \ & y^2 + z^2 + \eta x^2\,(y+\ z)^2 + \alpha\,(xy, xz)\,x^2\left(y^2+z^2\right) \ - \ F - 2c \\ & + [1-\alpha\,(xy, xz)]\left\{\eta x^2\,(y+z)^2 + 2E\left[\theta \mid \theta \geq \bar{\theta}(xy,\ xz)\right]\right\} \end{aligned} \tag{A.2}$$

$$\begin{aligned} S_2^H(y,\ z) \ = \ & S_2^W(y,\ z) = y^2 + z^2 + \eta x^2\,(y+z)^2 + \alpha\,(xy,\ xz)\,x^2\left(y^2+z^2\right) \ - \ F - c \\ & + [1-\alpha\,(xy,\ xz)]\left\{\eta x^2\,(y+z)^2 + 2E\left[\theta \mid \theta \geq \bar{\theta}(xy,\ xz)\right]\right\} \end{aligned} \tag{A.3}$$

In this case, (A.3) strictly exceeds (A.2). In turn, (A.1) strictly exceeds (A.3) but it is strictly lower than (9). If the endowments are large enough that $\eta(y+z)^2 \geqslant F$ holds as it does under this case, then the couple would either marry when they are young or remain single throughout their lifetimes. The latter would hold if and only if (9) is strictly larger than $(1+2x^2)(y^2+z^2)$. Under a sufficient but not necessary parameter range that satisfies $(\eta-1)(1+2x^2)\left(y_{\min}^2 + z_{\min}^2\right)$ $+\ 2\eta(1+x^2)y_{\min}z_{\min} > F$, all couples would marry young and remain uneducated.

b. Let $e_f = 1$. Then, (12) becomes

$$S_1^W(y,\ z) = \eta(y+z)^2 + \eta x^2(y+z)^2 + \alpha(xy,\ xz)\, x^2\left(y^2 +\ z^2\right) -\ F - c$$
$$[1-\alpha(xy, xz)]\left\{\eta x^2(y+z)^2 + 2E\left[\theta \mid \theta \geq \bar{\theta}(xy,\ xz)\right]\right\} \tag{A.4}$$

which is strictly smaller than (9) and (A.3) which represents the sum of spousal utilities among couples with educated wives who marry late. Provided that the parameter values satisfy the sufficient but not necessary condition $(\eta-1)(1+2x^2)\left(y_{\min}^2 + z_{\min}^2\right) + 2(1+x^2)y_{\min}z_{\min} > F$, (9) would once again strictly exceed (10). Noting that (11) is continuous and strictly increasing in e_m (i.e., $\partial S_1^H(.,.)/\partial e_m > 0$), one can conclude that $\exists\ \widetilde{e},\ \widetilde{e} > 1$, such that (11) evaluated at $e_m = \widetilde{e}$ strictly exceeds (9).

c. Equation (13) is strictly monotonic and increasing in both e_m and e_f, i.e., $\partial^2 S_2^{HW}(.,.)/\partial e_m \partial e_f > 0$. Thus, it follows that $\exists\ \widetilde{(e_f, e_m)}$ defined over a continuum and a convex frontier such that (13) strictly exceeds the values (9), (10), (11), (12), (14), (15) as well as $(1+2x^2)(y^2+z^2)$.

Proof of 2: Since initial endowments under these parameter restrictions are not high enough to afford marriage when young, only (10), (13), (14), (15) and lifetime singles utility need to be compared.

a. Letting $e_i = 1,\ i = m,\ f$, one can establish that (14) and (15) would both be given by (A.3) and (13) would be defined by (A.2). It immediately follows that (10) strictly exceeds (A.2) and (A.3). If, in addition, the parameter values satisfy the sufficient but not necessary condition $(\eta-1)x^2\left(y_{\min}+z_{\min}\right)^2 + 2\eta x^2 y_{\min}z_{\min} > F$, then one verifies that (10) would also exceed the sum of expected lifetime individual utilities of remaining single throughout all three periods.

b. With $e_f = 1$, (15) would be given by (A.3) which is strictly smaller than (10). With the parameter values satisfying the sufficient but not necessary condition $(\eta - 1)x^2 (y_{\min} + z_{\min})^2 + 2\eta x^2 y_{\min} z_{\min} > F$, (10) strictly exceeds the sum of utilities of always remaining single. With (14) being continuous and strictly increasing in e_m (i.e., $\partial S_2^H(.,.)/\partial e_m > 0$), one can conclude that $\exists\ \tilde{\tilde{e}},\ \tilde{\tilde{e}} > \tilde{e} > 1$, such that (14) evaluated at $e_m = \tilde{\tilde{e}}$ strictly exceeds (10).

c. Immediately follows from 1.c. above.

Proof of 3: This proof follows the one immediately above. The sole exception is that marriage among the uneducated is no longer an option even in older age. Hence, in this case, only (13), (14), (15) and singles lifetime utility levels need a comparison and ranking.

Proof of 4: In this case, the only relevant payoffs of comparison are (13) and (16). With either $e_m \to 1$ or $e_f \to 1$, marriage is not affordable even in old age. When either $e_m \to 1$ or $e_f \to 1$, men would consider the singles' net return from schooling and choose to get educated if and only if $2xy(e_m - 1) > c$. And women would acquire education if and only if $2xz(e_f - 1) > c$. Given that $\partial S_2^{HW}(.,.)/\partial e_m > 0$, $\partial S_2^{HW}(.,.)/\partial e_f > 0$ and $\partial^2 S_2^{HW}(.,.)/\partial e_m \partial e_f > 0$, one can establish that, $\forall\ (e_m, e_f) >> (\widetilde{e_f,\ e_m})$, (13) strictly exceeds (16).

Proof of 5: Now the only relevant payoffs are given by (16). The proof proceeds as in (4) although the returns to education are never high enough in this case for the couples to afford marriage even when they are older. Thus, individuals separately decide whether schooling is optimal and they acquire education if it is.

B Marriage-Market Equilibria

Proof of I. Without loss of generality, consider $e_m = e_f = 1$. Then, $S_1^U(y,\, z) > S_1^H(y,\, z) = S_1^W(y,\, z)$. By construction, we have $S_1^H(y,\, z) > S_2^H(y,\, z)$, $S_1^W(y,\, z) > S_2^W(y,\, z)$ and $S_1^U(y,\, z) > S_2^U(y,\, z)$. Thus, when $e_m = e_f = 1$, it follows that $S_2^U(y,\, z) > S_2^H(y,\, z) = S_2^W(y,\, z) > S_2^{HW}(y,\, z)$. Therefore,

i. $\forall\, y \geqslant y^* \wedge z = \psi(y)$, $S_1^U(y,\, z)$ is the feasible and optimal choice and

ii. $\forall\, y < y^* \wedge z = \psi(y)$, $S_1^U(y,\, z)$ isn't affordable, with $S_2^U(y,\, z)$ being the optimal choice.

Proof of II. Without loss of generality, now let $e_m > e_f = 1$. Thus, $S_1^H(y,\, z) > S_1^W(y,\, z) \wedge S_2^H(y,\, z) > S_2^W(y,\, z)$. Moreover, $S_1^H(y,\, z) > S_2^H(y,\, z)$ by construction. $S_1^H(y,\, z)$ and $S_2^H(y,\, z)$ are both strictly monotonic and increasing in e_m and $S_1^H(y,z) - S_2^H(y,z) = S_1^U(y,z) - S_2^U(y,z)$. Hence, $\forall\, e_m \equiv \widetilde{e} > 1$, $\exists\, y \equiv \widetilde{y} \wedge \widetilde{z} \equiv \psi(\widetilde{y})$ *s.t.* $S_1^H(y,\, z) = S_1^U(y,\, z)$ and where $S_2^H(y,\, z) = S_2^U(y,\, z)$. Thus, depending on parameter values, we have the following possible outcomes:

(a) For all $y > \widetilde{y} \wedge z = \psi(y)$, the optimal choice is S_1^H and if early marriage is not possible ($y < y^*$), then S_2^H will be elected.

(b) For all $y \leq \widetilde{y} \wedge z = \psi(y)$, the optimal choice is S_1^U and if early marriage is not possible ($y < y^*$), then S_2^U will be chosen.

Proof of III. Let $e_m = \widetilde{e} > 1$ as defined in the proof of (II) above. Now let $e_f = \widehat{e} > 1$ where $\widehat{e} \lesseqgtr \widetilde{e}$. Then, it follows that $\exists\, y \equiv \widehat{y} \wedge \widehat{z} \equiv \psi(\widehat{y})$ *s.t.* $S_2^{HW}(y,\, z) = S_1^H(y,\, z)$ and that $\exists\, y \equiv \widehat{\widehat{y}} \wedge \widehat{\widehat{z}} \equiv \psi(\widehat{\widehat{y}})$ *s.t.* $S_2^{HW}(y,\, z) = S_2^H(y,\, z)$. It also follows that $\exists\, y \equiv y' \wedge z' \equiv \psi(y')$ *s.t.* $S_2^{HW}(y,\, z) = S_1^U(y,\, z)$ and that $\exists\, y \equiv y'' \wedge z'' \equiv \psi(y'')$ *s.t.* $S_2^{HW}(y,\, z) = S_2^U(y,\, z)$.

Thus, depending on parameter values, we have the following possible outcomes:

1. If $\widetilde{y} > y' > y'' > \widehat{y} > \widehat{\widehat{y}}$ or $\widetilde{y} > y' > \widehat{y} > y'' > \widehat{\widehat{y}}$, then

   (a) For all $y > y' \wedge z = \psi(y)$, the optimal choice is S_2^{HW} and is feasible even when $y < y^*$.

   (b) For all $y \in [y'', y'] \wedge z = \psi(y)$, the optimal choice is S_1^U and if early marriage is not possible ($y < y^*$), S_2^{HW} will be chosen.

(c) For all $y < y'' \wedge z = \psi(y)$, the optimal choice is S_1^U and if $y < y^*$, S_2^U will be chosen.

2. If $\widehat{y} > y' > \widehat{\widehat{y}} > y'' > \widetilde{y}$, then

   (a) For all $y > \widehat{y} \wedge z = \psi(y)$, the optimal choice is S_2^{HW} and is feasible even when $y < y^*$.

   (b) For all $y \in [\widehat{\widehat{y}}, \widehat{y}] \wedge z = \psi(y)$, the optimal choice is S_1^H and if $y < y^*$, S_2^{HW} will be chosen.

   (c) For all $y \in [\widetilde{y}, \widehat{\widehat{y}}] \wedge z = \psi(y)$, the optimal choice is S_1^H and if $y < 4^*$, S_2^H will be chosen.

   (d) For all $y < \widetilde{y} \wedge z = \psi(y)$, the optimal choice is S_1^U and if $y < y^*$, S_2^U will be chosen.

3. If $\widehat{y} > y' > \widetilde{y} > y'' > \widehat{\widehat{y}}$, then

   (a) For all $y > \widehat{y} \wedge z = \psi(y)$, the optimal choice is S_2^{HW} and is feasible even when $y < y^*$.

   (b) For all $y \in [\widetilde{y}, \widehat{y}] \wedge z = \psi(y)$, the optimal choice is S_1^H and if $y < y^*$, S_2^{HW} will be chosen.

   (c) For all $y \in [y'', \widetilde{y}] \wedge z = \psi(y)$, the optimal choice is S_1^U and if $y < y^*$, S_2^{HW} will be chosen.

   (d) For all $y < y'' \wedge z = \psi(y)$, the optimal choice is S_1^U and if $y < y^*$, S_2^U will be chosen.

C Impact of legal changes on age distributions

Figure C.1: Distribution of ages at first marriage of females, impact of ages with consent

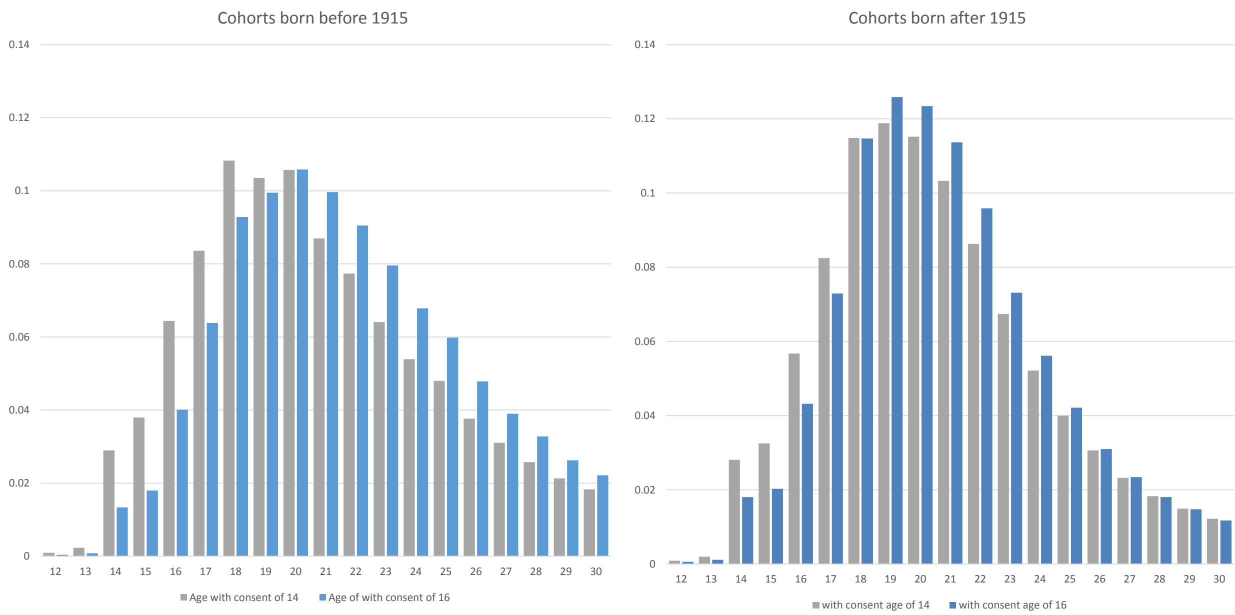

Figure C.2: Distribution of ages at first marriage of females, impact of ages without consent

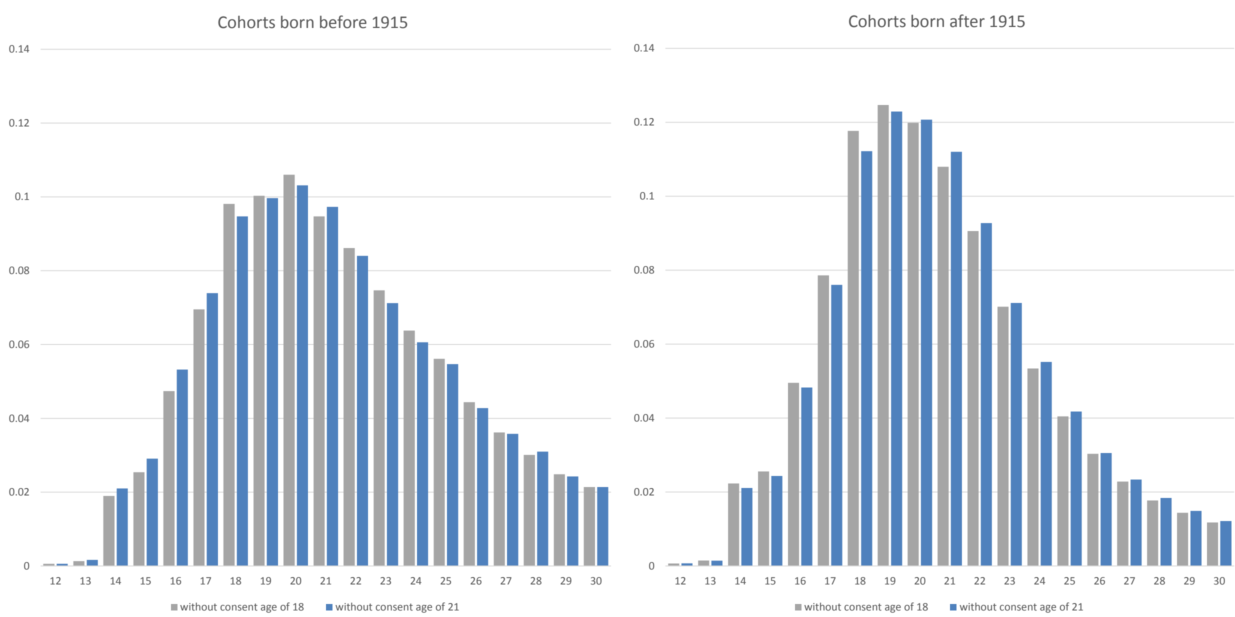

Figure C.3: Distribution of ages at first marriage of males, impact of ages with consent

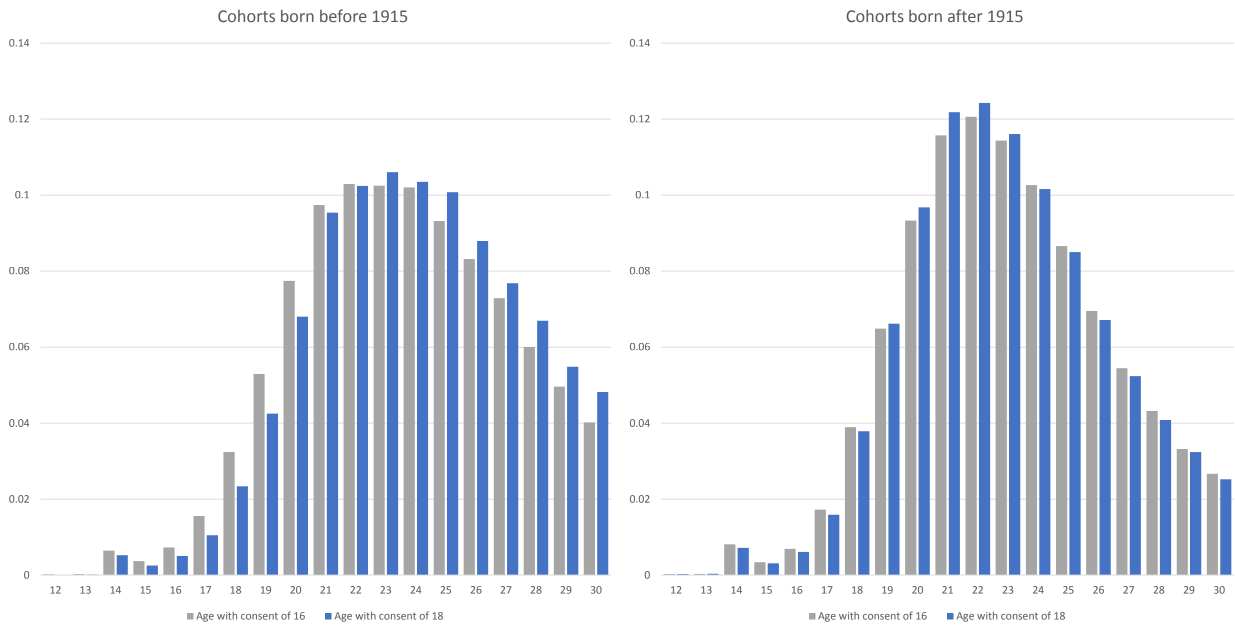

Figure C.4: Distribution of ages at first marriage of males, impact of ages without consent