Accounting for Age in Marital Search Decisions

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Abstract

Spouse quality varies significantly with the age at which an individual marries, peaking in the mid-twenties, then declining through the early-forties. Interestingly, this decline is much sharper for women than men, meaning women increasingly marry less educated men as they age. Moreover, quality has worsened for educated women over several decades, while it has improved for men. Using a non-stationary sequential search model, we identify and quantify the search frictions that generate these age-dependent marriage outcomes. We find that declining suitor quality and increasing single-life utility are equally important in explaining lifecycle variation in spouse quality for college graduates. The trends for less educated individuals, in contrast, are driven mostly by changes in single-life utility. Regardless of educational status, individual choice (as opposed to pure luck) is pivotal in explaining marriage market outcomes earlier in life.

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1 Introduction

The search for a spouse is undoubtedly influenced by many factors, including one's own qualities, the availability and quality of suitors, expectations about future opportunities, as well as the expected benefits obtained from marriage. Yet these factors may not stay constant over one's lifecycle; as a consequence, the quality of one's spouse could depend heavily on one's age at marriage. For example, worsening prospects will encourage singles to reduce their standards over time, whereas an increasingly vibrant social scene where singles meet frequently will lead them to be more selective. But which factors are changing significantly, and how consequential are they to marriage outcomes?

In this paper, we present a quantitative exercise to measure the size and importance of key frictions in the marriage market along an individual's lifecycle. To this end, we first document important facts from American Community Survey (ACS) data on how spouse quality, the hazard rate of marriage, and the quality distribution of suitors change with the age at marriage. In order to characterize dynamic behavior for the same group of people, we extract these facts for three different cohorts of men and women: those born in the 1950s, 1960s, and 1970s. The data reveal striking patterns regarding the average spouse quality (measured by educational attainment) as a function of an individual's age at marriage.

First, spouse quality is hump shaped with respect to age at marriage. For example, among college-educated women in the 1970 cohort, husband quality peaks at age 25, with 73% of college women marrying a college man. This falls steadily to 60% by age 40. Spouse quality is higher for men than women at each age, peaking with 78% of 25 year-old college men marrying college women. The subsequent decline is more gradual, reaching only 70% by age 40. Individuals without a college education are 50 percentage points less likely to marry a college graduate, but they follow the same trends with respect to age and gender.

Second, among women (regardless of education), spouse quality is the highest for those in the 1950 cohort, regardless of age at first marriage. This is in contrast to the experience of men; for them, wife quality is highest in the 1970 cohort. These facts are illustrated in Figure 2 on page 13.

Third, for any cohort and at any age, there are more college-educated single women than men — 6 to 10% more in the 1970 cohort, for instance (illustrated in Figure 3 on page 14). This gap has widened across our three cohorts, making educated men a relatively scarce resource in the marriage market.

These stark differences between men and women, as well as across cohorts, require a deeper investigation of the underlying dynamics that generate these marital outcomes. In order to identify and quantify the importance of the marriage market frictions, we turn our attention to a canonical non-stationary equilibrium search model (as in Wolpin, 1987; van den Berg, 1990) of marriage. The equilibrium conditions of this model, when matched to our marriage market facts from the data, discipline the behavior and magnitude of search parameters. As in Chari, Kehoe, and McGrattan (2006), we feed these measured frictions (or "wedges") back into our model to understand the contribution of each friction in explaining the observed marriage outcomes.

The model depicts dynamic choices in discrete time periods of one year. In each period, an unmarried individual encounters a suitor with some exogenous probability. A suitor's total quality is measured as the sum of educational attainment and intangible qualities. Both are drawn from an exogenous distribution; the individual observes both components while the econometrician only observes the former. If the individual accepts the suitor and vice versa, each enjoys utility equal to their partner's quality forever thereafter.[1] If either party declines, the individual resumes searching (without recall of past suitors), receiving an interim utility for each period of single life.

Our results uncover the dynamics driving the marital search process, highlighting the roles played by three main factors that can change as individuals age: the rate at which marriageable prospects are met (*arrival rate*), the cost associated with staying single and searching for a mate one more period (*single-life benefits*), and the distribution of quality among suitors (*average suitor quality*). The model also provides the optimal threshold rule at each age, so that an individual accepts any suitor whose quality exceeds the individual's reservation quality.

We find that the arrival rate is hump-shaped. For instance, among college women in the 1970 cohort, this rate triples from roughly an 18% chance of meeting a serious prospect for marriage at age 21, to a 53% chance at age 30, then falls nearly as

[1]In Section 5.2, we extend our analysis to add the possibility of divorce. However, this barely changes our findings, mostly because the divorce rate is fairly constant over the lifecycle, and therefore doesn't significantly alter the dynamic decisions of individuals.

much by age 40. This motivates singles to first raise, then lower, their selectivity (*i.e.* reservation quality) in choosing a spouse. Arrival rates for college men follow the same pattern but are slightly lower relative to women. The arrival rate peaks later and more dramatically for more recent cohorts, indicating a more active single life at relatively older ages.

We also find that the utility that individuals enjoy while single (relative to being married) increases with age for both genders and all cohorts. This trend suggests that marriage is more valuable at younger ages, perhaps because it facilitates child-raising or enables greater within-family specialization over market and non-market production. Interestingly, these single-life benefits are lower for more recent cohorts.

Increasing single-life utility would typically motivate an individual to raise her reservation quality over time; however, we find that this effect is dominated by the declining arrival rate and worsening quality of suitors. Therefore, our optimal reservation qualities are also hump-shaped, peaking around age 30. The decline is most pronounced for college women in every cohort; that is, college women adjust their selectivity in who they are willing to marry more than men do over the lifecycle.

We quantify the marginal contribution of each friction by comparing how choices and outcomes would have differed if a given friction had been held constant throughout the lifespan. For college graduates, we find that the declining quality of the pool of suitors is of roughly equal importance as the increasing utility from single life, each generating a 6 percentage point change in spouse quality. Among non-college individuals, single life benefits are three times more important than declining suitor quality.

The change in reservation quality over the lifecycle is significant, because it suggests that individual choice plays an important role in observed outcomes (rather than merely being a product of external circumstances), and can potentially magnify or moderate the exogenous frictions. Therefore, we distinguish how much of the observed decline in spouse quality is due to changes in an individual's reservation quality (*choice*) versus how much is due to exogenous factors in the marriage market (*luck*).[2] We find that choice is particularly important in improving outcomes in the early twenties, in spite of declining average suitor quality. However, the impact of choice is steady beyond age 30, which allows spouse quality to decline proportionately

[2]Krusell, *et al.* (2010) makes a similar distinction between choice and luck in the labor market and accounts for the importance of each factor in determining the unemployment rate.

with suitor quality.

Our analysis across these cohorts is significant because it spans a tectonic shift in education. As documented in Goldin, Katz, and Kuziemko (2006), the college graduation rate was higher for men before the 1960 cohort. Women reached parity in the 1960 cohort and surpassed men thereafter. This relative scarcity of college educated men may be responsible for the decline in an educated woman's likelihood to marry a college graduate. To test this, we ask how outcomes for the 1970 cohort of women would have changed if there were fewer educated single women in the market, as in the 1950 cohort. We find that the (remaining) college women would have been a little more selective, because the college men they encounter are quite a bit less selective. Hence, college women would be better off if there were fewer single educated women, marrying a college man 2 to 3% more often.

Our work offers an important foundation for policy-relevant empirical investigations. Many government programs distort the benefits of marriage, but perhaps not evenly over the lifecycle. Child tax credits have greatest value to those married earlier in life, as they are likely to have more children. The presence of such programs could contribute to one of our findings that marriage has the greatest benefits relative to being single early in life. On the other hand, eliminating the marriage tax (where married couples pay a higher marginal rate than if they had been taxed as singles) would have a broader impact across all ages. These and similar policies could potentially sway the timing of marriage and thus affect the quality of spouse. Indeed, we show that the widening gap in education between genders, while helping women in the labor market, has increased competition for educated men and put men at a relative advantage in the marriage market.

1.1 Related Literature

An extensive literature, both empirical and theoretical, investigates patterns in mate choice. However, most of these papers focus on time-independent patterns, without paying specific attention to the decision of individuals over the lifecycle, which separates our work from previous studies.

In his seminal work, Becker (1973) presents a theory of marriage based on utility-maximizing individuals and a marriage market that is in equilibrium. He shows that the gain to a man and woman from marrying (relative to remaining single) depends positively on their incomes, human capital, and relative difference in wage rates. His theory implies that men differing in physical capital, education, height, race, or many other traits will tend to marry women with similar traits.[3]

More recent theoretical literature has investigated marriage patterns in two-sided matching models. Burdett and Coles (1997), Shimer and Smith (2000), Chade (2001), and Smith (2006) each examine heterogeneous agents who face a stationary search problem. Upon meeting, both members of a pair must accept the other to marry; otherwise, they continue searching. A key assumption is whether match utility is transferrable; we follow Burdett and Coles (1997), Chade (2001), and Smith (2006) by assuming it is not. Non-transferrable utility eliminates any negotiation over the division of surplus, and prevents a mediocre individual from compensating a desirable partner through side payments.

Burdett and Coles (1997) show by examples that multiple equilibria can exist. By assuming utility is additively separable and strictly increasing in the partner's type, Chade (2001) shows a unique equilibrium occurs with perfect assortative mating. Smith (2006) gets a similar result by assuming the proportionate gains from having a better partner rise in one's type. Our main distinction is in modeling an individual's decisions as a dynamic search process, where search frictions change deterministically with age and a reservation quality threshold is formed at each age. In this framework, assortative mating is more subtle; even though the quality of a person does not change, the type of mate he will accept may change in response to an evolving search environment.

In this regard, Fernandez and Wong (2011) bears greatest resemblance to our attention to the lifecycle dimension of choices. They build a partial equilibrium dynamic lifecycle model to quantitatively evaluate why the labor force participation of women age 30 to 40 doubled between cohorts born in the 1930s and the 1950s. They find that both the higher probability of divorce and the rise in wages are able to explain about 60% of the rise in women's labor force participation. Guvenen and Rendall (2013) also investigate lifetime choices in a search environment, focusing on the role of education as insurance against bad marriage outcomes, as in Kotlikoff and Spivak (1981). They show that embedding the education decision of women in the model can lead to a large rise in divorce rates and a decline in marriage rates, similar

[3]Becker (1974) extends this analysis to include many circumstances such as caring between mates, genetic selection related to assortative mating, and separation, divorce, and remarriage.

to those observed in the US data.

Several other papers consider how dynamic lifetime decisions affect marriage outcomes, but these have primarily focused on the timing of marriage or the age gap between partners. Bergstrom and Bagnoli (1993) and Coles and Francesconi (2011) each investigate the effects of asymmetric career opportunities in generating marriages where one spouse is older than the other. Siow (1998) and Diaz-Gimenez and Giolito (2013) study how differential fecundity between men and women generates a competition for younger women by young and old men. The latter finds that the age gap is primarily explained by differences in reproductive potential and that earnings differences matter only little.

In our analysis, the offer arrival rate, the distribution of suitors, and the benefits of single life are all age-dependent. These frictions are calibrated so that the output of our dynamic search theoretical model replicates the observed trends in the data. In contrast to the preceding four papers, we take the average age difference in marriage as given; rather, our aim is to carefully account for the factors that determine the observed quality of spouse for each age at marriage. As in Diaz-Gimenez and Giolito, our agents differ in age, education, and sex. In addition, we allow for a random quality component of utility from marriage, above and beyond the observed characteristics of the spouse.

A broader quantitative literature focuses on factors which determine the timing of marriage (Keeley, 1979; Spivey, 2011), including how this is interrelated with wages and fertility decisions. Among those, Boulier and Rosenzweig (1984) emphasize the need to control for unobserved heterogeneity in the personal traits of agents, which is an important feature of our model. In a partial equilibrium search model for women, Loughran (2002) shows that increasing inequality in male wages can lead females to get married at later ages. Caucutt, *et al.* (2002) show how patterns of fertility timing in U.S. data can be explained by the incentives for fertility delay implied by marriage and labor markets. Rotz (2011) also works with a model of the marriage market similar to ours (but without the lifecycle dimension) to understand how increases in age at marriage after the 1980s affect divorce rates.

Figure 1: **Age at Marriage, 1970 Cohort**. The left panel indicates the fraction of college women who marry at each age; light bars indicate ages that are excluded from our analysis. The right panel does the same for non-college women. In both groups, a husband is on average 2 years older than his wife.

2 Empirical Facts

In this section, we document facts on three dimensions of marriage decisions that systematically change with age at marriage: the educational attainment of the spouse, the educational attainment of potential suitors (or *singles*), and the hazard rate of marriage. These facts are derived from the IPUMS-USA 2011 three-year census sample, which is a 3% sampling of US households. This provides enough observations to separately analyze three cohorts: those born five years before or after 1950, and similarly for 1960 and 1970.[4]

Our analysis relies heavily on three aspects of the survey. First, respondents indicate the year in which they were last married, which we can then use to compute their age at marriage. Because only the last marriage is recorded, we restrict our attention to those who are in their first marriage (72% of married couples in the sample). Second, IPUMS can retrieve spouse characteristics if the spouse lives with the household at the time of the survey, but this precludes cases where the spouse

[4]The same analysis can be done for other cohorts, but earlier generations would be at least 66 years old in in the 2011 survey period; thus, the sample is likely to be increasingly biased due to mortality. On the other hand, more recent cohorts since the 1980s are unlikely to have completed their marriage search, as they are at most 35 years old in the survey period.

is absent, separated, or has passed away (eliminating another 7% of respondents). Third, we use observed educational attainment as a proxy for the observable quality of individuals. Education is measured as of 2011, rather than at the time of marriage; this provides a more stable long-run measure, since everyone in our sample is over 36 by 2011.

The individual's age at marriage provides rich variation in the data, as illustrated in Figure 1 for the 1970 cohort. The left (right) panel plots the distribution of ages at which college (non-college) women entered their first marriage; the density is unimodal and skewed to the left, with the peak at age 23 for college women and 20 for non-college women. For other cohorts (included in the technical appendix), the distribution is quite similar except shifted a year earlier for the 1960 cohort and two years earlier for the 1950 cohort. The distribution for college-educated men (not pictured) is very similar, though shifted two years higher. Indeed, husbands are on average two years older than their wives, with a standard deviation of four years. For convenience, we plot all figures in terms of the woman's age at marriage — that is, a plot for women can be read literally, while a plot for men is shifted two years earlier to match the age of the woman he will typically marry.

One readily notes that the overwhelming majority of marriages take place between ages 21 and 40 (shaded with darker bars). Across women in the 1970 cohort of either educational status, only 0.64% of marriages take place at older ages, making estimates for these ages highly noisy. On the other hand, 19.9% of marriages take place before age 21; for these we have sufficient data, but we believe that our model is less applicable to their marriage decisions. At young ages, the final educational attainment of a potential mate is still uncertain; our model assumes this quality is perfectly known. Furthermore, early marriages could also be influenced by factors outside the model, such as religious preferences or out-of-wedlock conception. Thus, we limit our analysis to marriages where the respondent was between age 21 and 40.

Table 1 shows summary statistics for our samples of married individuals, separated by gender and educational status. For all cohorts, we observe that the average age at marriage is about 27, though there is a slight increase across cohorts. Note that the percentage of college women with a college husband has fallen from 75% in the 1950 cohort to 71% in the 1970 cohort, while the opposite occurs for men, rising from 65% to 77%, respectively. Non-college women experienced a similar decline in spouse quality.

Table 1: Summary Statistics: Married Sample

College						
Cohort	1950		1960		1970	
	Female	Male	Female	Male	Female	Male
Age	59.86	60.19	50.18	50.30	40.35	40.48
	[2.82]	[2.84]	[2.85]	[2.86]	[2.81]	[2.82]
Age at Marriage	26.44	26.78	27.06	27.61	27.09	27.77
	[4.54]	[4.48]	[4.46]	[4.49]	[4.11]	[4.17]
Spouse has	.75	.65	.71	.69	.71	.77
College Degree	[.43]	[.48]	[.45]	[.46]	[.45]	[.42]
Observations	44,076	66,530	77,940	90,369	105,130	104,121

Non-College						
Age	60.11	60.21	50.22	50.28	40.60	40.58
	[2.89]	[2.89]	[2.82]	[2.83]	[2.85]	[2.84]
Age at Marriage	26.76	26.63	27.25	27.62	27.19	27.71
	[4.88]	[4.66]	[4.82]	[4.85]	[4.50]	[4.53]
Spouse has	.25	.17	.22	.20	.20	.24
College Degree	[.44]	[.38]	[.42]	[.40]	[.40]	[.43]
Observations	50,740	77,699	90,471	122,129	94,919	127,102

Notes: Means are reported with standard deviations in brackets, by gender, birth cohort, and whether a college degree was earned by 2011. The table includes only respondents who are in his/her first marriage, which began between age 21 and 40. Source: ACS 2011 (IPUMS).

Table 2: Summary Statistics: Single Sample

Cohort	1950		1960		1970	
	Female	Male	Female	Male	Female	Male
Age	59.88	59.68	50.29	50.17	40.30	40.31
	[2.80]	[2.77]	[2.83]	[2.82]	[2.88]	[2.88]
Has College	.34	.29	.30	.21	.31	.22
Degree	[.47]	[.45]	[.46]	[.41]	[.46]	[.42]
Observations	43,496	46,313	74,479	95,317	90,873	117,743

Notes: Means are reported with standard deviations in brackets, by gender and birth cohort. The table only includes respondents who have never been married by 2011. Source: ACS 2011 (IPUMS).

Our analysis also requires information on the single population in order to determine the rate at which marriages occur as well as the distribution of educational attainment among the pool of potential suitors. Table 2 provides summary statistics for our samples of individuals who were still single in 2011. We observe that, for each cohort, there are more single college-educated females than males, and this gap has widened in recent cohorts.

2.1 Average Spouse Quality

We begin by examining the average quality of one's spouse, conditional on age at marriage. In this section and the subsequent theoretical analysis, we use a discrete measure of quality: whether the spouse eventually obtains a college degree. For brevity, we refer to highly-educated individuals as a *college man* or *college woman*. Of course, the data offer other measures, such as income, occupation, and employment status; yet each measure produces similar trends with respect to age (as documented in our Technical Appendix).

For this discrete measure, we compute the percentage of those married at a given age who have a college-educated spouse, separately for each gender, educational status, cohort, and age at marriage of the reference person. These are displayed in Figure 2, with each point reporting the literal fraction computed from the data. Each line indicates the trend with respect to age at marriage (separately by gender, educational status, and cohort), as computed in a fractional polynomial regression.[5]

For instance, among college women in the 1970 cohort, 73% of brides at age 25 married a college man. This percentage falls markedly to 60% at age 40. Indeed, each cohort of women experienced a decline of 12 to 13 percentage points over that age range. For college men in the 1970 cohort, the decline is less pronounced, falling from 78% at age 25 to 70% at age 40. The decline is further muted in prior cohorts. In other words, the quality of a man's wife is only weakly associated with his age at marriage.

Comparing across cohorts, we note that a college woman in the 1950 cohort was more likely than later cohorts to marry a college man. For college men, on the other

[5]This performs a regression of the following form: $y = \beta_0 + \beta_1 x^{p_1} + \beta_2 x^{p_2} + \epsilon$. This allows more flexibility than a quadratic polynomial, instead choosing powers p_i from the set $\{-2, -1, -0.5, 0, 0.5, 1, 2, 3\}$ to minimize the sum of squared errors (Royston and Altman, 1994). Observations were weighted by the number of marriages at that age.

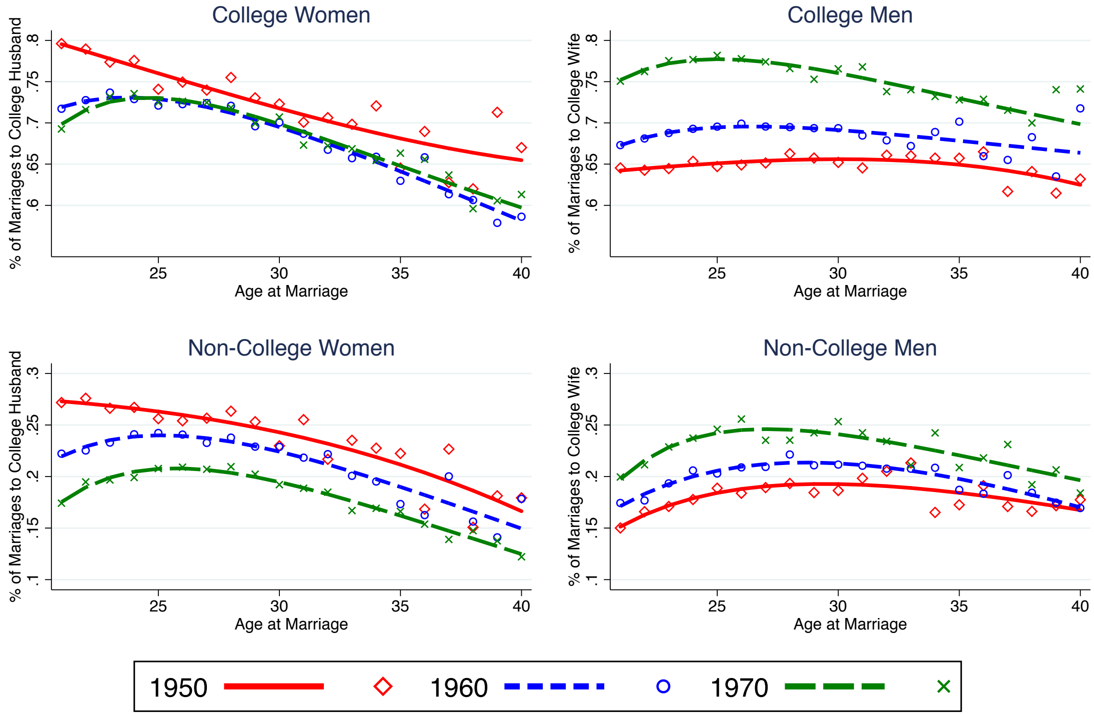

Figure 2: **Average Spouse Quality**. Each point depicts the fraction of those married at a given age (separately by gender, educational status, and birth cohort) who have a college-educated spouse. The associated line for a given cohort depicts the smoothed estimate from a fractional polynomial regression.

hand, the reverse is true; each successive cohort was 3 to 7 percentage points more likely to marry a college woman.

Comparing across educational status, we see strong assortative mating: non-college individuals are much less likely to marry a college spouse than college individuals are. For example, among 25 year olds in the 1970 cohort, only 20% of non-college women marry college men and 24% of non-college men marry college women. Note that the non-college trend with respect to age closely mirrors the decline among college individuals, with a marked decline for women and a slight reduction for men. The trend across cohorts is also quite similar, with the exception that non-college women are about 5% less likely to marry a college husband in the 1970 cohort than the 1960 cohort, while these were nearly equal for college women.

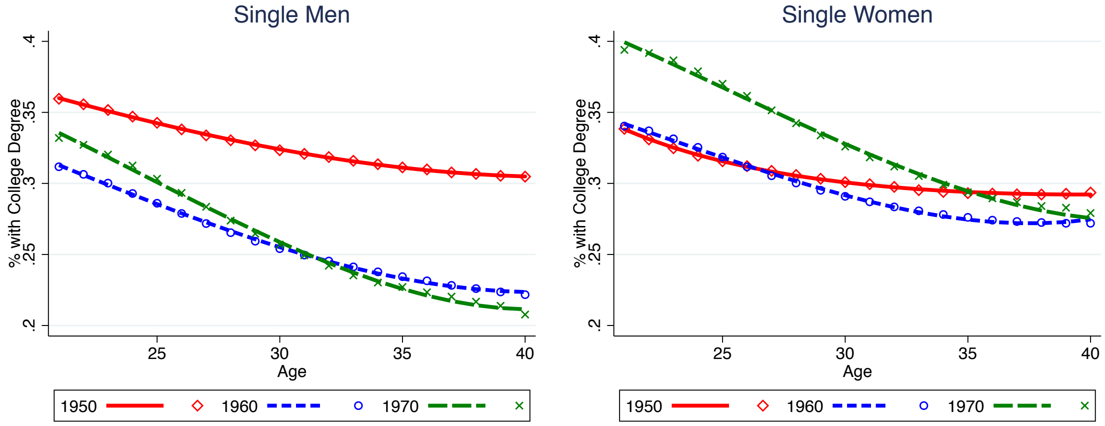

Figure 3: **Quality in the Single Population**. Each point depicts the fraction of singles (by age, birth cohort, and gender) who obtain a college degree by 2011, as computed from ACS data. The associated line for a given cohort depicts the smoothed estimate from a fractional polynomial regression.

2.2 Average Singles Quality

We next consider the average quality of singles, as an indication of how the distribution of potential suitors evolves with age and across cohorts. We obtain this from the same ACS population by reconstructing how many of them were single (with and without degrees) at each age. We start by looking at the oldest singles (for instance, 45 years old in the 1970 cohort), and tally the number of college and non-college singles among them. Then, to determine the single population when they were 44 years old, we increase these tallies by the number of college and non-college individuals (respectively) who were married at age 45. The process is repeated until there are no marriages in the sample that occur at a younger age.

In Figure 3, we report the percentage of singles who are college educated for each gender, cohort, and age. Within each cohort and gender, one can see that the fraction of degree-holding singles declines by 5 to 12 percentage points from age 20 to age 40. Comparing across genders, college graduates were equally plentiful in the 1950 cohort, but diverged thereafter. Men held fewer degrees in later cohorts, while women held more. Indeed, single women in the 1960 and 1970 cohort consistently hold 5 to 6 percentage points more degrees than men at each age.

Comparing Figures 2 and 3, one immediately takes note of the high degree of assortative matching. If matches were simply random, college graduates would marry college graduates in the same proportion as they occur in the full population. Instead, the fractions in the top row of Figure 2 are at least double those in Figure 3 at every age. Given our sample size, a χ^2 test easily rejects the hypothesis that observed matches happened randomly. At the same time, the assortative matching is not perfectly segregated (as there are non-college/college couples), nor is it constant with age.

The comparison of these figures may also tempt one to ascribe the decline in spouse quality to the decline in suitor quality. However, even on its face this cannot be the whole story. Note that spouse quality is hump shaped, while single quality is steadily declining. Also, spouse quality continues to decline through the late thirties, even as the quality of the single population levels out. While the quality of potential suitors is undoubtedly important to the analysis, it cannot in isolation explain the quality decline.

2.3 Hazard Rates

Finally, we consider the timing of marriage, which we compute in terms of age-specific hazard rates. The data indicate how many people in our sample are married at each age (the numerator in the fraction singles who marry per year), and we obtain the total number of singles of that age (the denominator) from our reconstructed population described in the preceding subsection. Figure 4 reports the resulting hazard rates of marriage for each gender, educational status, birth cohort, and age.

First, we consider college individuals. For the 1970 cohort, the rate rapidly doubles over six years. By the peak age of 27, more than one in eight single college women marry each year. Thereafter, the marriage rate cuts in half over the next 13 years. This pattern is virtually identical across genders. The 1960 cohort shows a similar pattern, though with an earlier peak and less variation over time. Hazard rates are strictly declining for the 1950 cohort, with a strong majority of marriages happening at earlier ages.

The marriage hazard rates of non-college individuals tend to be lower than their college counterparts during their early years, but the rates for both education types converge by age 35. For example, non-college women in the 1970 cohort exhibit an almost flat hazard rate at around 6% at each age of marriage, substantially lower

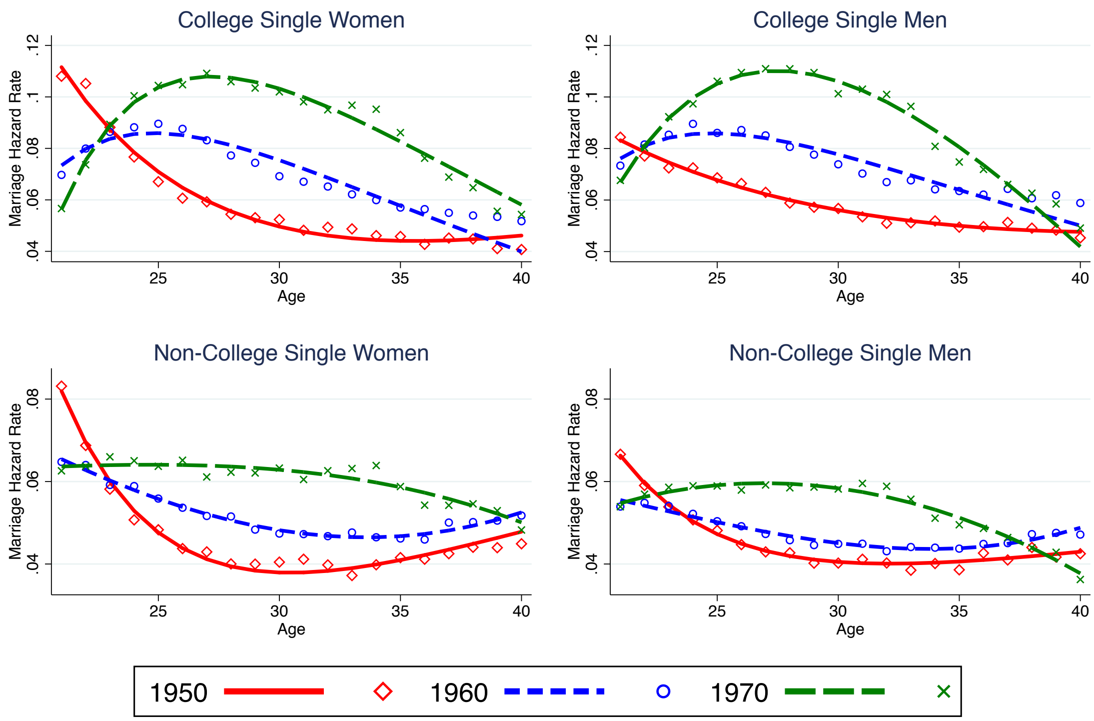

Figure 4: **Marriage Hazard Rates**. Each point depicts the fraction of singles (by age, education status, birth cohort, and gender) who marry on an annual basis, computed from ACS data. The associated line for a given cohort depicts the smoothed estimate from a fractional polynomial regression.

than college women though their mid thirties. Non-college men also have a flatter and lower profile than college men as they age. Moving to earlier cohorts, we still see lower levels among non-college individuals, but the difference is more muted.

Figures 2 through 4 constitute the facts from data that we ask our theoretical model to explain. In essence, the equilibrium conditions of our search model will place discipline on the dynamic search frictions so that the choices of singles will replicate the observed data targets. The next section describes this process in detail.

3 Model

Our goal is to quantify the search frictions that govern the observed choices of men and women in the marriage market. To give structure for the analysis, we use a non-stationary model of sequential search for a marriage partner.

Our model has much in common with that in Wolpin (1987), which employs a discrete-time search model to understand decisions to accept a first job after graduation. An important feature there is that wage offers are imperfectly observed by the econometrician; without this, one would have to conclude that the lowest accepted wage is the reservation wage. We employ this concept to our quality measures: an educated woman might accept a less-educated spouse even though she has a high reservation quality if he has exceptional intangible qualities. As in Wolpin's analysis, by imposing some structure on the distribution of both dimensions of quality, we can identify how underlying parameters must evolve with age to best fit observed trends.

One important distinction is that we consider an equilibrium model, where both members of a pair must accept the other for the marriage to occur. In contrast, the partial equilibrium model in Wolpin (1987) only considers the worker's decision process; the firms they match with are willing to accept any worker.

3.1 Non-stationary Search in the Marriage Market

Consider the search problem of a single person, who is either a man or woman (m or w), and either college-educated or not (c or n). While the search problems of all four types must be solved in equilibrium, consider the search problem of a college woman, for example. In each period t, with probability λ_t^{wc} she randomly encounters a suitor, which should be thought of as a serious prospect for marriage (rather than simply going on a date). If she fails to encounter a suitor or if either party rejects the match, she has no more marriage opportunities for that period and discounts utility from the next period by factor β.

Upon encountering a suitor, she observes a measure q of his quality, and he similarly observes her quality. If she marries the current suitor, she obtains utility q each period thereafter, which imposes that utility is nontransferable. For simplicity, we do not consider divorce at this point, but discuss how this affects our computations in Section 5.2.

The quality measure q consists of two parts, distinguished by whether they are publicly or privately observed. The public component, a, indicates the educational attainment of the suitor, with $a = 1$ for those who are at least college educated and $a = 0$ for those with less than a college degree. This quality measure is commonly agreed upon, meaning all individuals prefer a more highly-educated spouse. Let γ_t^{wc} denote the probability that her suitor is college educated.

The private component, z, indicates a match-specific quality of this suitor. This captures personality and other intangible qualities (unobservable by the econometrician) that might make a particular paring better or worse than average, depending on the specific idiosyncratic tastes of the individual. We assume that z is a normally distributed random variable with mean 0 and standard deviation σ, and is not persistent from one match to the next.[6]

After observing the total quality of the suitor, $q = a + z$, the woman must decide whether to marry him. Rejection is final; she is not able to resume dating past suitors. Her decision at age t is characterized by a reservation quality R_t^{wc}, where she accepts a proposal if and only if $a + z \geq R_t^{wc}$. At the same time, her suitor must decide whether to marry her based on his reservation quality, R_t^{mc} for a college-educated man or R_t^{mn} otherwise.

We represent the standard normal density function by $\phi_n(z) \equiv (1/\sqrt{2\pi}\sigma)e^{-\frac{z^2}{2\sigma^2}}$ and the normal distribution function with a mean of 1 by $\phi_c(z) \equiv (1/\sqrt{2\pi}\sigma)e^{-\frac{(z-1)^2}{2\sigma^2}}$, which provide the distribution of suitor quality conditional on the suitor's non-college or college status, respectively. Similarly, $\Phi_n(z)$ and $\Phi_c(z)$ denote their cumulative density functions. Thus, the probability that a man of educational status $j \in \{c, n\}$ is willing to accept a woman of educational status $i \in \{c, n\}$ at time t is denoted

$$\alpha_{it}^{mj} \equiv 1 - \Phi_i(R_t^{mj}). \tag{1}$$

The probability for a woman is equivalent, only interchanging m for w.

While she remains single, the woman receives utility b_t^{wc} each period, which can be thought of as the direct benefit from the social scene while single. Note that this utility flow is measured relative to the value of being married. Thus, $b_t^{wc} = 0$ would provide the same annual utility as if she were married to a non-college man ($a = 0$) who is exactly average ($z = 0$), or to a college man ($a = 1$) who is $1/\sigma$ standard deviations below average ($z = -1$). Thus, b_t^{wc} represents the benefits (or disadvantages, if negative) associated with being single relative to being married to the average non-college graduate. Indeed, low single-life benefits can be thought of

[6] In our Technical Appendix, we demonstrate what occurs when the variance of intangible characteristics or the relative value of education change as individuals age.

as a search cost.

As in Wolpin (1987) or van den Berg (1990), we assume there exists an age T such that for all $t \geq T$, all search frictions remain constant.

Let V_t^{wi} denote the present expected value of utility for a single woman at age t with educational status $i \in \{c, n\}$. The search problem can be summarized in recursive form as follows:

$$\begin{aligned} V_t^{wi} = b_t^{wi} + \max_{R_t^{wi}} \quad & \lambda_t^{wi} \int_{R_t^{wi}}^{\infty} \frac{q}{1-\beta} \left(\gamma_t^w \alpha_{it}^{mc} \phi_c(q) + (1-\gamma_t^w) \alpha_{it}^{mn} \phi_n(q)\right) dq \\ & + \Big[\lambda_t^{wi} \gamma_t^w \left(1 - \alpha_{it}^{mc} \cdot \left(1 - \Phi_c(R_t^{wi})\right)\right) \\ & + \lambda_t^{wi} (1-\gamma_t^w) \left(1 - \alpha_{it}^{mn} \cdot \left(1 - \Phi_n(R_t^{wi})\right)\right) \\ & + \left(1 - \lambda_t^{wi}\right) \Big] \beta V_{t+1}^{wi}. \end{aligned} \tag{2}$$

The first line includes the utility from being single, as well as the expected utility if a marriage does occur. The first term in parenthesis indicates the likelihood of meeting and being accepted by a college man of quality q, while the second term does the same for a non-college man. The second line provides the probability that a meeting with a college man is rejected by either party, while the third does the same for a non-college man. Finally, the last line indicates the probability that no suitor was encountered. For any of the last three cases, search continues to the next period.

The reservation quality will be chosen so as to accept whenever the flow of value from marriage exceeds the flow of value from continued search. In particular, turning down an offer q during period t sacrifices $\frac{q}{1-\beta}$ in favor of V_{t+1}^{wi}. The reservation quality must make the single person indifferent; hence,

$$V_{t+1}^{wi} = \frac{R_t^{wi}}{1-\beta}. \tag{3}$$

Note that the woman takes as given the men's acceptance rates α_{it}^{mc} and α_{it}^{mn}, though in equilibrium, these must be consistent with the strategies R_t^{mc} and R_t^{mn} used by the men.

3.2 Equilibrium

In this dynamic search problem, the sources of uncertainty are whether the individual meets a suitor in a given period and what his or her total quality is. In equilibrium, singles correctly anticipate the behavior of other singles and its impact on future opportunities. Of course, any one individual decision has negligible effect on tomorrow's population; thus the individual can consider the distribution of singles represented by γ_t^g as given. However, equilibrium requires consistency between the individual decision (such as R_t^{wc}) and the aggregate consequence if all singles of that type behave similarly (α_{it}^{wc}). For instance, if college women collectively accept few college men, it must be that each one of them is holding a very high standard; otherwise, an individual deviation to accept lower quality suitors would be profitable.

Formally, an equilibrium in this dynamic search problem consists of reservation qualities $R_t^{gi} \in \mathbb{R}$, expected utility $V_t^{gi} \in \mathbb{R}$, and acceptance rates $\alpha_{it}^{gj} \in (0, 1)$ for each time t, both genders $g \in \{w, m\}$, and both educational states $i, j \in \{c, n\}$, such that:

1. Aggregate acceptance rates are consistent with individual choices (Eq. 1).

2. Expected utilities correctly anticipate future opportunities (Eq. 2).

3. Reservation qualities are chosen optimally (Eq. 3).

The solution process for equilibrium is straightforward, since one can reduce the system to four equations at each period t. This is done in the Bellman equation (Eq. 2) by substituting for α_{it}^{gj} using Eq. 1 and V_t^{gi} using Eq. 3. This gives four equations in terms of four unknowns R_t^{gi}, taking γ_t^g as given.

Because the search problem is stationary for $t > T$, we can replace t and $t+1$ with T in the four Bellman Equation. This yields four equations and four unknowns that are relatively simple to solve for the four R_T^{gi} numerically. From there, earlier reservation values are found by backwards induction (*e.g.* solving for the four reservation qualities R_{T-1}^{gi} simultaneously, and similarly for earlier periods).

3.3 Population Law of Motion

In our data, we observe a snapshot of individuals in 2011, including those who are still single at that time. However, we want to know what the single population looked like each year during their marital search, which we reconstructed as described in Section 2.2. This process can be expressed theoretically as follows. Let s_t^{gi} denote the population of gender $g \in \{w, m\}$ and educational status $i \in \{c, n\}$ at age t. Then the number of single women of education i follows the law of motion:

$$s_{t+1}^{wi} = \left(1 - \lambda_t^{wi}\gamma_t^w \alpha_{it}^{mc}\alpha_{ct}^{wi} - \lambda_t^{wi}(1-\gamma_t^w)\alpha_{it}^{mn}\alpha_{nt}^{wi}\right) s_t^{wi}. \tag{4}$$

The negative terms in parenthesis capture the probability that a woman of education i married a college or non-college suitor, respectively. Thus, the single population change $s_t^{wi} - s_{t+1}^{wi}$ is simply those who actually were married in period t. The same can be computed for men by interchanging w and m.

3.4 Calibration Process

Our primary goal is to uncover the underlying frictions that influenced individuals to marry when and who they did. The data facts presented in Figures 2 through 4 present some distinctive features, such as a high level of assortative mating and an increasing fraction of women holding college degrees in recent cohorts, but to go beyond these qualitative descriptions, we require more structure to identify the forces at work and assess their relative importance.

Our model provides that structure by formalizing the frictions into one of three sources: the distribution of suitors (γ_t^g), the arrival rate of suitors (λ_t^{gi}), and single-life benefits (b_t^{gi}). The first is directly constructed from the data, but the latter two must be calibrated so as to replicate our observed outcomes. In the remainder of this section, we derive the theoretic equivalents to our observed calibration targets and describe the calibration process, which is summarized in Table 3.

For expositional purposes, consider the process used to calibrate these parameters for single women at age t with educational status $i \in \{c, n\}$. For women of type i who married at age t, let f_t^{wi} denote the fraction who married a college man, which is depicted in Figure 2. Also, Figure 3 reports the fraction of single men of age t who hold degrees, which we use as women's expected distribution of male suitors, γ_t^w. Recall that α_{jt}^{gi} is the (endogenous) probability that a person of gender g and education i would accept a suitor of education j. With this notation, the model predicts that the fraction of marriages to college-educated men would be:

$$f_t^{wi} = \frac{\gamma_t^w \alpha_{ct}^{wi}\alpha_{it}^{mc}}{\gamma_t^w \alpha_{ct}^{wi}\alpha_{it}^{mc} + (1-\gamma_t^w)\alpha_{nt}^{wi}\alpha_{it}^{mn}}. \tag{5}$$

Table 3: Calibration Procedure

Parameter	Description	Target
σ	Variance within type	% of non-college who exceed average college income
γ_t^g	Quality distribution across types	% of college-educated singles
R_t^{gi}	Reservation quality threshold	% of marriages to a college-educated spouse
λ_t^{gi}	Probability of encountering a suitor	% of singles who marry each year
b_t^{gi}	Single-life utility	Bellman Equation 2

Notes: Although R_t^{gi} is endogenous, we determine what value is needed to replicate the observed quality of marriages, then find the values of b_t^{gi} such that R_t^{gi} is optimal in equilibrium.

The same can be derived for men, interchanging the w and m superscripts.[7] In the numerator, we see that an education i woman and a college man will marry only if three conditions occur (with probabilities shown in parentheses): she must meet such a suitor (γ_t^w), his match-specific quality must be high enough to satisfy her reservation quality (α_{ct}^{wi}), and her match-specific quality must likewise be high enough to meet his reservation quality (α_{it}^{mc}). The denominator includes all those marriages, plus those to non-college men, which occur meets such a suitor ($1-\gamma_t^w$), his match-specific quality is sufficiently high (α_{nt}^{wi}), and hers likewise satisfies him (α_{it}^{mn}).

Our model provides some additional structure in that a college woman uses the same reservation quality in judging a college or a non-college man (though the latter is less likely to meet that threshold). Specifically, $\alpha_{ct}^{wi} \equiv 1 - \Phi_c(R_t^{wi})$ and $\alpha_{nt}^{wi} \equiv 1-\Phi_n(R_t^{wi})$. Thus, after substituting for all α_{jt}^{gi} in Equation 5 and repeating for both genders and both education levels, we obtain four equations at a given t and four unknowns (R_t^{gi}). However, note that Equation 5 is homogenous of degree 0 in α: if all acceptance rates were doubled, f would not change. Thus, these equations can pin down three of the acceptance probabilities *relative* to the fourth. To determine the *absolute* level of acceptances, we need an additional identifying assumption.

[7]This assumes that an age-t woman only encounters suitors of age-t (that is, men who are two years older). This assumption allows us to calibrate the four reservation qualities and arrival rates at a given age independently of other ages.

For this purpose, we adopt a proportionality assumption; namely, that reservation qualities are proportional across genders and type:

$$\frac{R_t^{wc}}{R_t^{mc}} = \frac{R_t^{wn}}{R_t^{mn}}. \tag{6}$$

Our results are not sensitive to this rule, however. One alternative would be to assume that non-college singles are willing to accept virtually all college suitors, while still optimally choosing a reservation quality for meetings with a non-college suitor. This alternative assumption preserves the trends of our calibrated frictions, with only minor effect on their levels.[8] With Equation 6 in place, we can numerically solve for the four reservation quality thresholds which are consistent with the observed facts. Effectively, this calibration reveals how selective singles are at each age.

We continue the calibration by examining the connection between marriage hazard rates and suitor arrival rates. Figure 4 provides the hazard rate of marriage, which we denote p_t^{wi}; that is, the probability that a woman gets married at age t, conditional on being unmarried at age $t-1$. This depends both on the arrival rate of suitors, λ_t^{wi}, as well as the probability that a given match is acceptable to both partners. Combining these, the marriage hazard rate is given by:

$$p_t^{wi} = \lambda_t^{wi} \left(\gamma_t^w \alpha_{ct}^{wi} \alpha_{it}^{mc} + (1 - \gamma_t^w) \alpha_{nt}^{wi} \alpha_{it}^{mn} \right). \tag{7}$$

The same applies for men if the w and m superscripts are interchanged. This provides four equations for each period t, and since the match probabilities (αs) have been inferred from the previous step, this leaves four unknowns (λ_t^{gi}s) for which we can easily solve.

Finally, we use the Bellman function (Eq. 2) to compute b_t^{wi}. Since we have the reservation quality, we can use the optimality condition (Eq. 3) to determine the value of search. Because all other parameters have been determined, b_t^{wi} becomes a residual, set such that R_t^{wi} is optimal given R_t^{mi}, λ_t^{wi} and γ_t^w. We use $\beta = 0.95$, taking the model period to be one year.

[8] In particular, if an alternative identifying assumption leads to higher absolute acceptance levels, this in turn reduces the absolute level of suitor arrival rates when calibrated using Eq. 7, but single-life utility is largely unchanged.

4 Results

4.1 Calibrated Frictions

In the previous section, we presented our dynamic search model and derived the theoretical analogs to our data targets: the observed average spouse quality, the hazard rate of marriage, and the quality distribution of singles.[9] Using those equilibrium conditions, we can recover the underlying frictions of the offer arrival rate and the utility from single life, which we report here. In addition, we compute the reservation qualities that must be optimal given the calibrated frictions. Figures 5 through 7 present the results for all three cohorts, separately by gender and education status.

4.1.1 Variance of Intangible Qualities

To begin, we must set the variance in intangible qualities, σ, which we hold constant over the lifecycle. This is inherently difficult to match, since these qualities are by definition unobservable. However, this parameter essentially determines the likelihood that a non-college suitor would be judged more desirable than a college suitor. For instance, since the average college suitor has quality $q = 1$, a non-college suitor would need intangibles $z = 1$ to be judged equally desirable. Thus, only $1 - \Phi_n(1)$ percent of non-college suitors are more desirable than college suitors, with $\Phi_n(1)$ depending on the parameter σ.

To find an empirical analog to this statistic, we examine other factors reported in the data that may contribute towards desirability, beginning with total income. Clearly incomes are strongly correlated with holding a college degree, but even after controlling for education, a wide variation in incomes remains. In our data on men in the 1970 cohort, 4.2% of non-college graduates earn more than the average college graduate, which is consistent with $\sigma = 0.57$. This percentage is identical for men in the 1960 cohort but slightly higher (6.1%) for the 1950 cohort, and even larger for women (9.4 to 9.9% across cohorts). Of course, labor force participation is lower among women of all cohorts and among men in the 1950 cohort (who are beginning to retire in the 2011 survey year), so their realized income may be somewhat disconnected from earning potential. We repeated this procedure with several mea-

[9] In the calibration, we use the smoothed trend lines as our targets. Using the discrete data points as in the graphs would provide nearly identical results, except with noise around the lines we present in the following figures.

sures of occupational prestige[10] available in the ACS, finding σ between 0.45 and 0.6 depending on the measure.

For simplicity of interpretation, we use $\sigma = 0.5$ throughout the remainder of the paper, meaning the average college graduate is equally desirable as a non-college suitor who is two standard deviations better than average. As a robustness check, we have recomputed our results with alternate values (which we include in our Technical Appendix), but the effects on our remaining calibrations and results were minimal. Indeed, a larger σ merely scales up the calibrated arrival rate of suitors and reservation quality threshold without altering its shape, and has virtually no effect on single-life benefits.

4.1.2 Arrival Rates

We now examine arrival rates of potential suitors, reported in Figure 5. Note that, this is not the frequency of dating (which we examine in Section 5.1); rather, it indicates the frequency at which the person meets a reasonable candidate for marriage.[11] Our findings indicate that both genders see a rapid increase in marriage opportunities through their twenties, followed by a decline in their thirties. For instance, among the 1970 cohort, a college woman has a 17% chance of a marriage opportunity while age 21, but this triples to 53% by age 30, then and falls to 28% by age 40. Levels are similar for non-college women and men, but are lower for college men by as much as 6 percentage points.[12]

In comparing cohorts, we see that the age at which the arrival rate peaks is later for recent cohorts. To be specific, for both genders, the peak occurs at age 21 for the 1950 cohort, 28 for the 1960 cohort, and 30 for the 1970 cohorts. This dramatic shift in the timing of courtship mimics but is not identical to the shift in marriage hazard rates observed in the data (Figure 4), which peaks several years earlier and has a less

[10]Examples include the Occupational Income Score, which computes the median income across all individuals with that occupation, and the Siegel Occupational Prestige Score, based on public opinion surveys rating the social standing of the occupation on a 1-to-10 scale. For our purposes, these allow us to compute the fraction of non-college people who obtain occupations better than the average college graduate.

[11]Our arrival rate for the 1960 cohort, averaged over the lifecycle (0.29), is just below that in Rotz (2011), where marriage proposals are calibrated to arrive with probability 0.33. The 1950 and 1970 cohort averages are lower and higher, respectively, by 0.1.

[12]The arrival rate need not be equal across genders, as it is computed for a *college* woman meeting *any* man, and a *college* man meeting *any* woman. The difference would arise from non-college men or women facing a different arrival rate than their college counterparts.

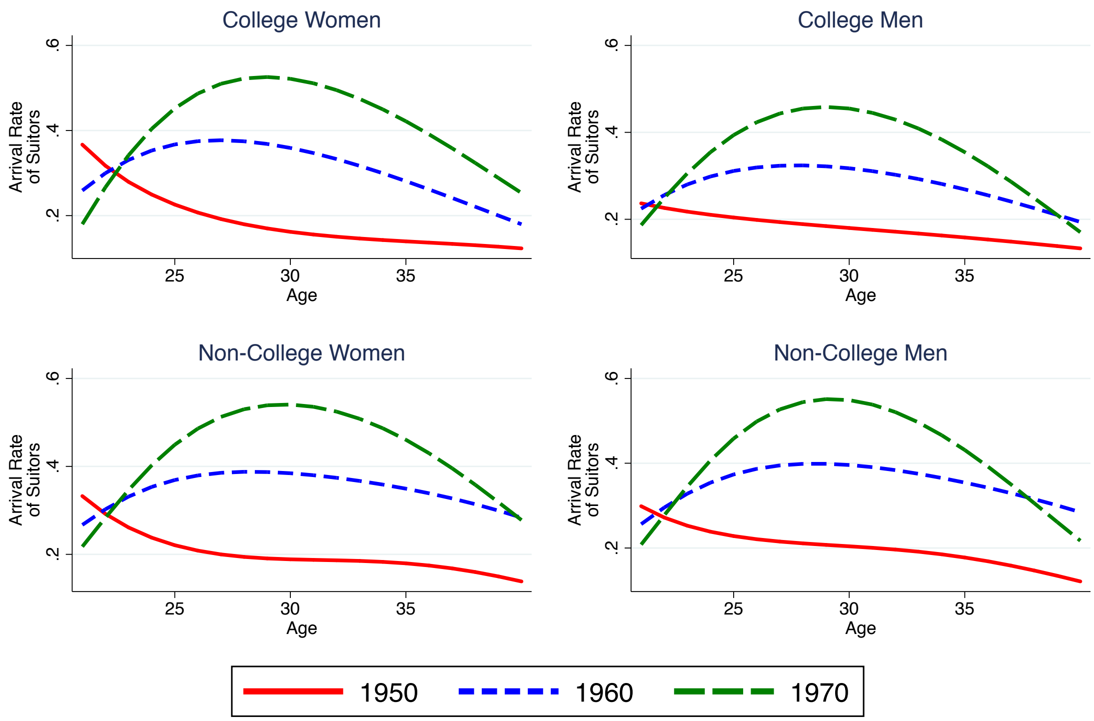

Figure 5: **Inferred Suitor Arrival Rates**. For each gender, education level, cohort, and age, the graphs indicate the arrival rate of potential suitors necessary to replicate the observed choices.

dramatic rise and fall.

The hump-shaped arrival rates most likely reflect two competing factors: first, people tend to give more serious attention to marriage as they age. While they may have a vibrant social life in their early twenties, most of these interactions are informal and only occasionally lead to serious marriage prospects. This gives way to more formal dating and courtship as they age. Second, age tends to shrink one's social circle on net: friends from high school and college disperse, and are primarily replaced by co-workers. Our cross-cohort comparison suggests that the first effect has grown in importance; recent cohorts have been slower to give serious attention to formal dating. We provide evidence of this in Section 5.1.

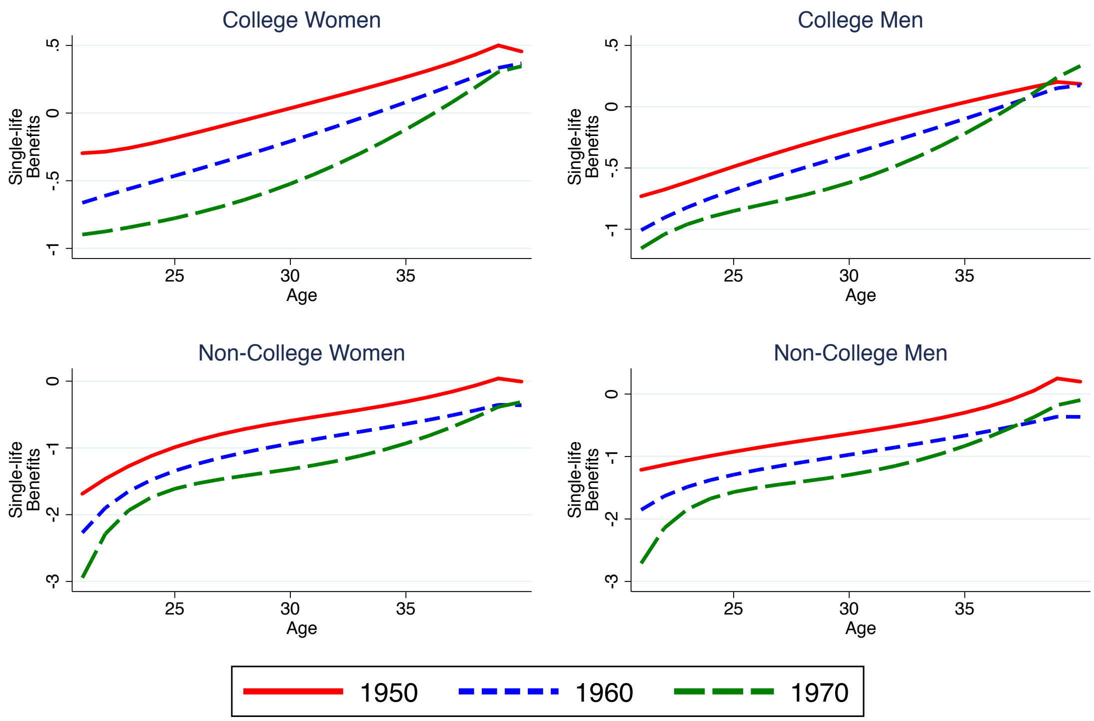

Figure 6: **Inferred Single-life Benefits**. For each gender, education level, cohort, and age, the graphs indicate the utility from single life necessary to replicate the observed choices.

4.1.3 Single-life Benefits

The benefits from single life, b_t, are computed as a residual from the Bellman Equation. While estimated utilities are mostly negative, this does not mean single individuals should accept the first suitor they encounter; this is the cost of staying single and searching for one more period. Turning down a current suitor not only delays the benefits of marriage but can cause some disutility. This is still optimal because suitors arrive somewhat frequently and the distribution promises better opportunities in the future relative to the the current match.

For each gender and educational status, b_t improves steadily with age. In interpreting these results, one should recall that these utilities are relative to the benefit of being married. Thus, a higher b_t as one ages could reflect more enjoyment from being single, or less value placed on marriage (for instance, lower importance on committed companionship or having children).[13] This trend could arise from several plausible sources. For instance, if marriage is partially motivated by a desire for children, then early marriages would provide higher utility than those later in life, even if to the same quality man, since fertility generally declines with age. Alternatively, it could be that the transition into marriage is more costly as one ages, since a single person has a more developed career and thus has more to lose if marriage necessitates employment changes for relocation or family care.

These single-life benefits differ the most across genders in the 1950 cohort, where they are 0.4 to 0.5 higher for college women than college men. With subsequent cohorts, men and women appear to be converging in their underlying preferences about marriage/single life — becoming nearly identical by the 1970 cohort. This seems consistent with the improvement in labor market opportunities for women and increased participation by fathers in child-rearing activities that have happened contemporaneously.

Non-college individuals experience consistently lower single-life benefits at each age than college individuals, and this disparity has widened with more recent cohorts. This suggests that the returns to marriage are higher for individuals of lower education status, perhaps supporting the idea that pooling incomes in marriage is a more important motive for this group.

4.1.4 Reservation Quality

Finally, we examine the path of reservation quality chosen by singles in response to these frictions. The general pattern here is hump-shaped with respect to age, meaning individuals become increasingly selective through about age 30, then lowering their standards thereafter.

For the college individuals in the 1970 cohort, we observe that men and women are equally selective till age 36, from then on, women reduce their reservation quality more than men. In interpreting these reservation values, we note that these are indexed relative to the average non-college single, whose quality is $q = 0$. Thus, when women in the 1970 cohort choose $R_{40} = 0.57$, for instance, this means she is willing to accept $1 - \Phi_n(R_{40}) \approx 13\%$ of non-college men, and $1 - \Phi_c(R_{40}) \approx 81\%$ of college men.

[13] This finding is contrary to the theory of marriage as a risk-sharing arrangement (as in Kotlikoff and Spivak, 1981), which posits that older people benefit from marriage more, because they reap the benefits of sharing the spouse's income if, for example, health shocks take away their own income.

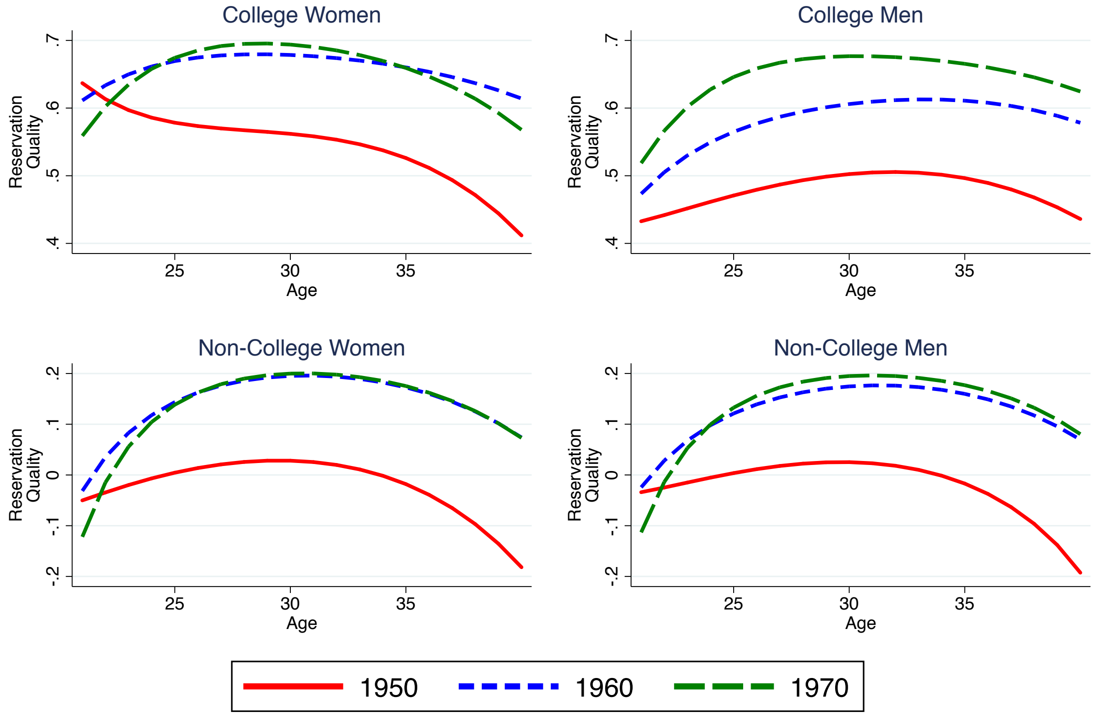

Figure 7: **Inferred Reservation Quality**. For each gender, education level, cohort, and age, the graphs indicate the optimal reservation quality threshold used by these individuals.

This is a lower standard than women at age 30, who accept only 8% of non-college men and 73% of college men.

Note that the standards of college men in the 1960 cohort are lower than their 1970 counterparts. Moreover, the 1960 men are less selective at every age than 1960 women (willing to accept about 6% more of suitors they encounter). Standards are even lower for the 1950 cohort. There, women's reservation quality is highest at the age of 21, continually declining thereafter, whereas men maintain roughly similar standards as they age.

Comparing across educational status, we find that non-college individuals have significantly lower reservation qualities and a more pronounced hump shape. For example, a non-college woman of age 30 in the 1970 cohort accepts 34% of non-college men (as opposed to 8% for a college-woman), but at 21, she is willing to accept 60% of non-college men. In addition, non-college men hardly changed their standards between the 1960 and 1970 cohorts, in contrast to the sizable increase among college men.

Across cohorts, we note that there has been significant convergence between genders in how selective they are. Women of the 1950 cohort seem particularly rushed to accept marriage proposals beyond their mid twenties, while women of more recent cohorts are quite similar in selectivity to their male counterparts. In spite of low reservation quality, the women of the 1950 cohort still obtain the highest quality spouses because they face the best distribution of single men.

It is instructive to consider these calibrated frictions jointly to understand the causes of our observed data facts. For instance, suitor quality declines throughout, yet spouse quality is initially increasing. This incongruity occurs because suitors are arriving more frequently and single life becomes more enjoyable; therefore singles can afford to be increasingly selective through age 30. However, by age 25, the falling suitor quality dominates the increasing selectivity in reservation quality, so that average spouse quality begins to fall. Moreover, as suitors arrive less frequently beyond age 30, singles can no longer afford to be as selective; this exacerbates the decline in suitor quality to yield even lower spouse quality. This reduction is more severe for women than men, because suitor quality declines more for women than men.

This analysis underscores the interactions among frictions and choices, external environment and endogenous decisions. In the next subsection, we disentangle these effects, asking to what extent the observed spouse quality is driven by changes in selectivity, as opposed to the age-specific circumstances (in suitor quality and arrival rate) that one faces.

4.2 Choice versus Luck

Our calibration reveals that the underlying frictions of suitor quality and availability are shifting significantly with age, and these changes naturally affect marriage outcomes. At the same time, individuals in our model optimally anticipate those changing frictions by adjusting their reservation quality, which could exacerbate or moderate the direct effect of the friction. Here, we disentangle the direct impact from the equilibrium response, illustrating just how consequential these endogenous choices are to the observed marriage outcomes.

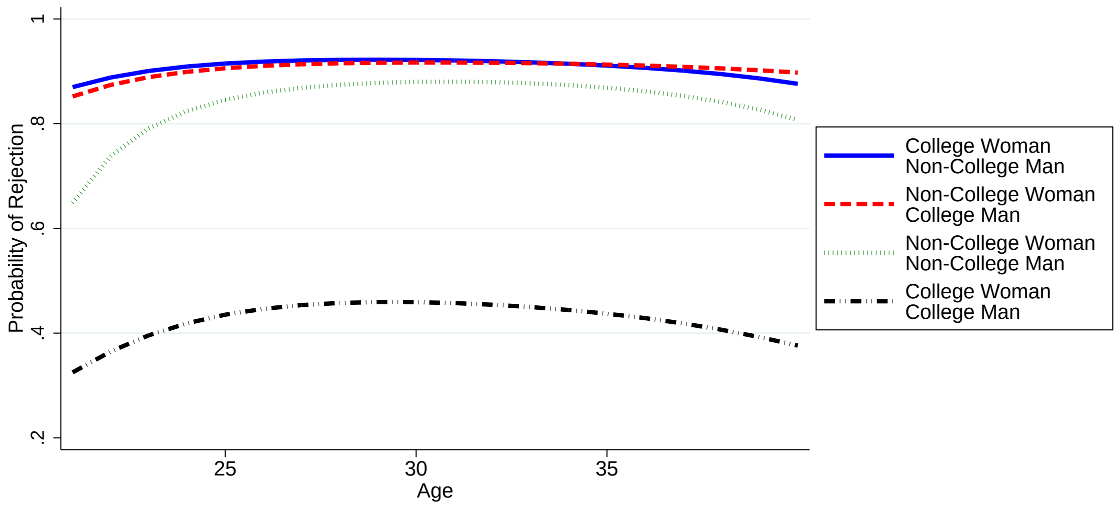

Figure 8: **Computed Rejection Rates, conditional on meeting**. Each point indicates the fraction of meetings that result in rejection by one of the parties, conditional on the educational status of the pair, in the 1970 cohort.

First, we note that singles are rather selective, rejecting a fair number of potential suitors. One advantage of the calibrated model is that it allows us to quantify these forgone opportunities which are not directly observable in the data. For instance, when two college singles are paired together, one or both will reject the match with probability $1-(1-\Phi_c(R_t^{wc}))(1-\Phi_c(R_t^{mc}))$. In Figure 8, we plot this rate of rejection at each age, using reservation qualities from the 1970 cohort. This reveals that 32 to 46% of pairings between college singles are rejected, with the highest likelihood of rejection at age 29.

Pairings of a college single with a non-college suitor are the least likely to succeed, averaging a 90.7% rejection rate. Surprisingly, pairings of two non-college singles are also frequently rejected (at an average rate of 83.9%), indicating that non-college singles are still fairly selective. In terms of success rates, though, a non-college person is nearly twice as likely to marry when paired with a non-college suitor than with a college suitor. In addition, non-college singles are more plentiful and thus more frequently encountered.

Having uncovered the rate at which singles reject each other, we can evaluate how these decisions affect quality outcomes. To assess this, we ask what would have occurred if the individual had applied the same reservation quality R_{21}^{gi} throughout his

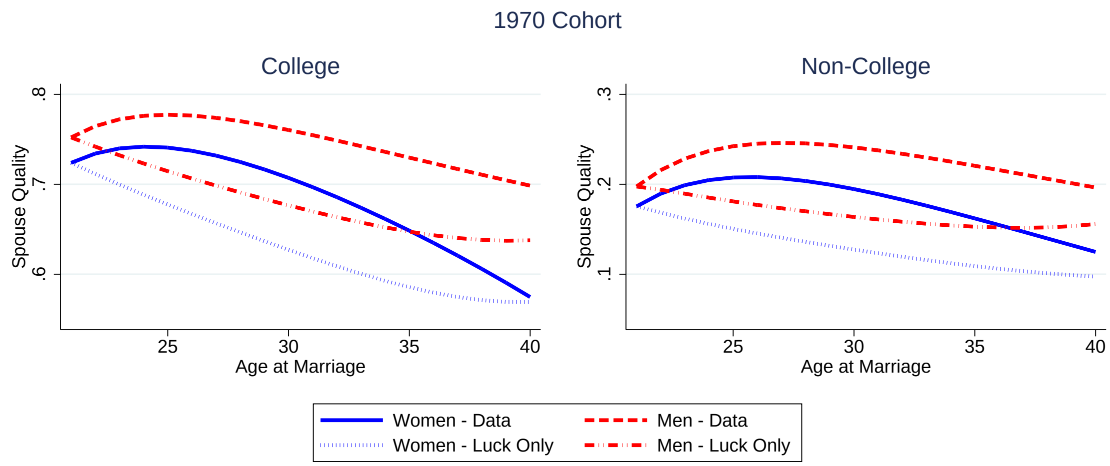

Figure 9: **Choice versus Luck**. The solid and dashed lines report the average quality of spouse for women and men, respectively, as observed in the data for the 1970 cohort, conditional on the age at marriage. The dotted and dash-dotted lines indicate for each gender the quality that would have been realized had the reservation quality been held at R_{21}^{gi}. The gap between them reflects the role of choice in observed outcomes.

or her life span. Of course, these are not the optimal reservation values (effectively, it ignores b_t^{gi}), but this counterfactual experiment allows us to see what would have occurred if choice is removed from consideration; all remaining effects arise due to external changes in γ_t^g and λ_t^{gi}.[14] We present the results for the 1970 cohort, but other cohorts have a similar appearance, and are included in the Technical Appendix.

Changes in R_t^{gi} have a significant impact on who individuals marry. In Figure 9, the solid and dashed lines depict the average quality of spouse for women and men, respectively, as observed in the data. The dotted and dash-dotted lines report the counterfactual quality of spouses under a constant reservation quality. When choice is removed from the outcome (dotted lines), the average spouse quality is no longer hump-shaped, but steadily declines. This path closely mimics the decline in average suitor quality (Figure 2).

We find that the initial rise in spouse quality observed in the data is due to choice, as luck would have produced steadily worse outcomes. From age 25 to 35, the role of

[14]In this and subsequent experiments, we do not endogenously adjust the population distribution γ_t^g in response to the changed reservation quality. This isolates the direct effect of a given frictional change, and thus makes for cleaner interpretation of the results.

choice remains roughly constant, improving quality achievement by 7% above what luck alone would produce. Comparing across educational status, we note that spouse quality levels are much lower for non-college individuals, but this is due to luck, not choice. Indeed, their reservation quality choices make almost the same contribution to their spouse quality.

4.3 Competition for Educated Men

Our calibration exercise revealed that, for the 1960 and 1970 cohorts, men achieve a higher spouse quality than women, mainly because men face a better suitor quality distribution over their lifecycle — there are a higher fraction of college-educated women than men at any age. In addition, the 1970 cohort has the largest percentage of single college-educated women compared to the other cohorts, yet their achieved husband quality is the lowest among the cohorts. These two observations clearly suggest that the relative abundance of educated women (and scarcity of educated men) in the marriage market has pushed women to reduce their standards, both at older ages of marriage and through the decades.

In order to test this competition hypothesis, we ask how outcomes would have changed for the 1970 cohort if there were fewer educated single women. That is, we change the quality distribution faced by men, γ_t^m, to match their 1950 levels, then compute the equilibrium reservation qualities and the average spouse quality that would result. Our results are illustrated in Figure 10.

For example, college women in the 1970 cohort were on average 8 percentage points less likely to marry a college husband than college women in the 1950 cohort. If the distribution of women had not changed over those two decades, a college woman in the 1970 cohort would have been 5.5 percentage points less likely to marry a college husband. That is, the rise in college graduation rates by women decreased spouse quality by 2.5 percentage points (38% of the total change in spouse quality), while the rest of the change ascribed to other frictions shifting over two decades. The effect of women's graduation rates on non-college women is nearly of the same magnitude (2.3%), but this constitutes a smaller fraction of the total decline in spouse quality (20%).

Men of either educational status would be considerably worse off with fewer educated women, particularly at early ages. The marginal effect of fewer single college

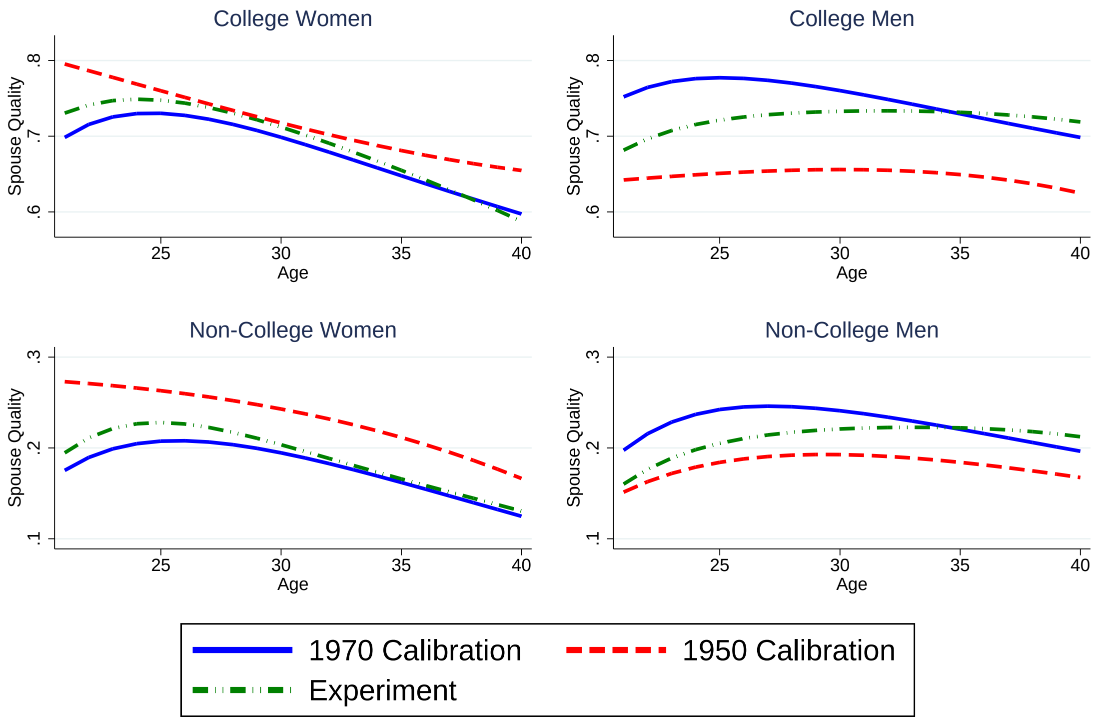

Figure 10: **Equalized Education**. The solid and dashed lines report the average quality of spouse as observed in the data for the 1970 and 1950 cohorts (respectively), conditional on gender, educational status, and age at marriage. The dash-dotted lines indicate what spouse quality would have been if the fraction of college educated women had been reduced to their 1950 levels, holding all other parameters at 1970 levels.

women explains 60% of the change in spouse quality for college men, and 55% for non-college men.

This experiment nicely underscores the dynamics at work in the marriage market. As soon as college-educated women become scarce in the market, they gain relative to men. Thus, we conclude that although increased college enrollment and graduation rates enabled women to attain economic freedom, this came at a cost: these educated women settled for less-educated husbands overall.

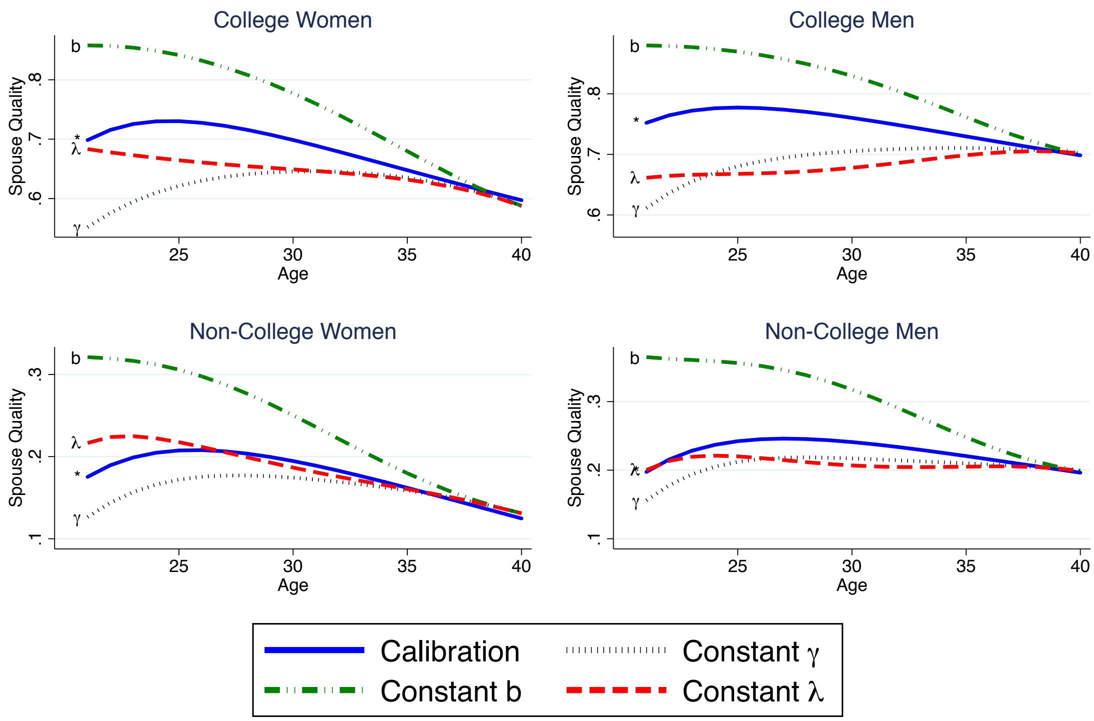

Figure 11: **Marginal Effect of Each Friction, 1970 Cohort**. These graphs report the average spouse quality under various search frictions, by gender, educational status, and age. For the solid lines, the calibrated frictions are used, thus replicating the observed data. For the remaining lines, the same frictions are used, except that the noted parameter is held constant at the calibrated value for age 40.

4.4 Marginal Effects

Our preceding analysis identifies how frictions must have varied (across age, gender, and cohort) to rationalize observed marriage choices. However, all three frictions are changing with age, which can obscure their individual impact. We now quantify the marginal effect of each friction with a counterfactual experiment: what would have happened if one of the frictions had been constant through the lifecycle?

Specifically, we hold one friction constant to its value at age 40 and leave all others as in the calibration, then recompute the optimal reservation values for men and women at each age. We report our results for the 1970 cohort in Figure 11. Additionally, we quantify these marginal effects by computing the average change in the spouse quality, reported in Table 4.

Table 4: Marginal Contribution of Each Friction to Observed Spouse Quality, 1970 Cohort

Friction	College		Non-college	
	Women	Men	Women	Men
Suitor distribution (γ)	-5.9%	-5.6%	-1.9%	-2.0%
Suitor arrival rate (λ)	-3.6%	-6.5%	0.5%	-1.7%
Single-life benefits (b)	7.0%	6.1%	5.8%	7.1%

Notes: Each cell reports the average change in the fraction of marriages to a college spouse when the listed friction (rows) is held constant.

First, we analyze the marginal effect of the arrival rate. If this were constant rather than hump-shaped, the resulting lower arrival rate would make singles slightly less selective due to fewer future opportunities for marriage. Both college women and college men are less likely to marry college spouses (on average, by 3.6 and 6.5 percentage points, respectively). This has a smaller effect on non-college men (a 1.7 percentage point reduction), while for non-college women, the arrival rate has negligible effect at most ages except in the early 20s.

Suppose instead that the distribution of suitors (γ) were held constant, rather than steadily declining with age. This reduces the quality of singles by an average of 5%, but it also leads to lower reservation quality; for college individuals, this amplifies the decline in spouse quality to 6%. For non-college individuals, this decline is only 2%, since their likelihood of marrying a college spouse was low to begin with.

Finally, if single-life benefits (b) were held constant at their highest value (at age 40), rather than steadily rising with age, individuals would be far more selective, particularly in early life. As a consequence, average quality rises by 6 to 7 percentage points for all individuals.

In summary, it is not surprising that the underlying suitor quality has a large impact on observed spouse quality, but it is noteworthy that changes in single life benefits are also important. Indeed, the latter are more crucial in understanding choices of non-college individuals. From their perspective, having more college suitors who will frequently reject them is of little help, while being more patient (due to utility in single life) is far more consequential.

5 Extensions

5.1 Dating and Arrival Rates

Our analysis indicates that the arrival rates of suitors (Figure 5) vary remarkably over the lifespan; for instance, among the 1960 cohort of college women, it rises as high as 0.38 by age 28 but eventually falls to 0.15. This hump shape is somewhat surprising, as one might expect the college years to be the most socially active, with fewer opportunities thereafter; indeed, such a story would explain the arrival rates for the 1950 cohort. However, later cohorts seem to have sought different activities while in college, with fewer true prospects for marriage in those early years.

To provide some validation of these inferred arrival rates, we examined dating activity reported in the National Longitudinal Survey of Youth (NLSY) for the 1979 wave, which corresponds to our 1960 birth cohort. The NLSY offers equivalent variables to those we used from the ACS and shows the same hump shape in average spouse quality (depicted later in Figure 12). Yet it offers the added advantage of reporting recent dating activities: unmarried women were asked biannually from 1992 to 2010 how frequently they had gone on a date over the prior year.[15] Since birth years vary from 1957 to 1964, these interviews reflect dating practices of women as young as 28 to as old as 53. Another strength of the data set is its longitudinal nature, allowing us to follow the responses of the same woman as she ages. The disadvantage is that the sample is much smaller; only 508 college women in the sample were single for one of these interviews.

The data generate a very clear downward trend over these two decades. College women start with 3.3 dates/month at age 28 and reach 1.5 dates/month by age 46, and remain roughly level thereafter. In a regression of dates per month on age (between ages 28 and 46), we find that dates per month decline by 0.1 each year with a t-stat of 9.94 and an R^2 of 0.85. Similar trends occur among the 2,320 non-college women who responded to these questions: they start with 2.6 dates/month and steadily decline to 1.2 dates/month by age 46. This decline in dating activity with age is likely the causal force behind the falling arrival rate of marriage opportunities. Dating is practically a

[15] The question classifies answers in one of 5 categories, which we translate to a numerical value as follows: "Not at all" = 0 dates/month, "Less than once a month" = 0.5 dates/month, "Once or twice a month" = 1.5 dates/month, "Once or twice a week" = 6 dates/month, and "Almost every day" = 15 dates/month. The results are not sensitive to the scale of these translated values; in particular, the last category is only reported 8 times and has almost no effect on the average.

necessary condition to encounter new marriage prospects, even if the quality of any given date may vary from serious to casual.

Moreover, this trend is not driven by selection, *i.e.* it is not that the most social women get many dates early and then leave the sample by getting married, so that only those who got few dates all along remain. If we restrict ourselves to the 98 college women who were never married by the 2010 interview, we can follow their answers longitudinally over two decades. The same pattern emerges, beginning with 2.8 dates/month at age 28 and falling at a rate of 0.07 each year. This generates a lower t-stat of 3.07 due to the smaller sample. This also holds among the 376 non-college women who have never married by 2010; they have 2.2 dates/month at age 28, and it falls 0.066 each year. In short, the same woman gets fewer dates as she ages.

Unfortunately, the question on dating was not asked before 1992, preventing us from considering early dating dynamics for this cohort. However, by looking to the 1997 wave of the NLSY, we can get some sense of what these early years look like. Respondents there were born between 1980 and 1984; they were asked about their dating practices annually from 1998 to 2008.[16] This allows us to consider dating at ages 14 through 28, though we focus on what occurs after age 20, which leaves a sample of 538 men and 636 women who were single for one of these interviews and had obtained a college degree by 2010.

Both genders average 4 dates/month at age 20, and this steadily rises by 0.70 per year for men and 0.89 for women (with t-stats of 8.30 and 11.53 and R^2 of 0.90 and 0.95, respectively). These levels are much higher than those in the 1960 cohort, which could be due to a difference in the way the questions were asked (see footnote 16), or due to generational differences in what constitutes a date or how frequently one dates. In any case, this evidence clearly points to a strongly increasing frequency of dates over the twenties. This is all the more striking when one remembers that these are all college graduates, and thus had the college social scene available in their early twenties; nevertheless, within 5 years of the typical age of graduation they are dating twice as frequently as when they graduated. The same trends hold for the 1,725 non-college men and 1,253 non-college women who were single in this sample.

[16] Before 2002, the question was posed similarly to the 1979 approach except requesting a yearly amount rather than a monthly amount. Thereafter, respondents were allowed to state a number of dates per year. For consistency, we force the latter into the bins of the former and then translate that bin to a number as in the previous footnote.

Both genders average 6 dates/month at age 20, rising 0.9 per year. For both genders and both educational levels, the number of dates decelerate starting at age 25.

Combined, this dating evidence is strongly supportive of our imputed arrival rate of suitors. Singles date more frequently as they age, up through their late twenties, and then begin a steady decline. Naturally, plausible candidates for marriage come more frequently when singles date more actively.

5.2 Divorce

To this point, our model and calibration have ignored the potential for divorce; for this reason, we restricted our data to individuals entering their first marriage. However, because the ACS data only reports details of the individual's current marriage, we are only able to include first marriages that were still intact in 2011. If marriages that dissolved before 2011 differ (on age of marriage or educational status) from those that survived, this could bias the targets of our calibration.

To address this concern, we again turn to the 1979 NLSY; there, the current marital status and spouse characteristics are updated annually or biannually. This allows us to identify each survey participant's first marriage, even if that marriage later dissolved. The disadvantage of this data is the smaller sample size, with only 12,000 first marriages, all of whom are part of the 1960 cohort. Thus, we use this data to validate our ACS analysis, rather than replace it. To do this, we first reconstruct our calibration targets from the NLSY, restricted to those couples whose first marriages survived till 2011, as was necessary with ACS data. We then compute the same targets including all first marriages.

For example, in Figure 12, we report the average quality of the first spouse. The solid lines report the fraction married to a college spouse among couples whose marriage survived through 2011; note that the shape and levels are very close to that observed for the 1960 cohort in the ACS data (Figure 2). The dashed lines compute the same fraction among all first marriages, including those that dissolved before 2011. The latter is lower (by 4% percentage points on average for women and 2% for men), but retains the same shape and peak.

In Figure 13, we compute the distribution of the single population at each age who held a college degree. Here, we want to limit ourselves to singles with no prior marriages (that is, exclude divorcees). In the solid line, we include an individual in

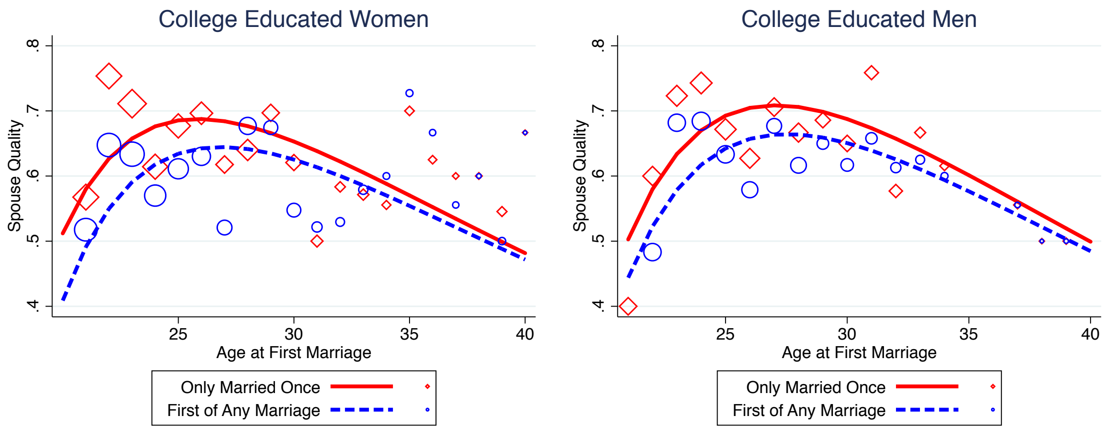

Figure 12: **Average Spouse Quality, 1960 cohort, NLSY**. Each point depicts the fraction of those married at a given age (separately by gender) who have a college-educated spouse. The size of point denotes the relative number of observed marriages at that age. The associated line for a given cohort depicts the smoothed estimate from a fractional polynomial regression. Solid lines include those who remained married to their first spouse through 2011, while dashed lines include all first marriages, including those that dissolved by 2011.

the calculation only if he has not been married by that age and does not divorce by 2011. This would reflect the same population as we calculated for the ACS data in Figure 3. In the dashed line, we include an individual in the calculation if he has not been married by that age, regardless of future marriage or divorce. In either calculation, current divorcees are not included in the single population. Education levels for women in the NLSY sample are 3% lower than for the 1960 cohort of women in the ACS data (Figure 3), and about 5% lower for men, but the trend is nearly identical.

We see a similar adjustment in the hazard rate of marriage, shown in Figure 14. Here, we compute the number of first marriages in a given year divided by the number of singles in that year. In the solid line, the numerator includes only those marriages that survive through 2011, and the denominator includes only singles who never divorced by 2011. In the dashed line, the numerator includes all first marriages (including those that dissolve), and the denominator includes all singles who have never married (including those that will later divorce). Here, the solid line mimics the 1960 cohort in Figure 4 but is 2% higher on average; the dashed line is an additional

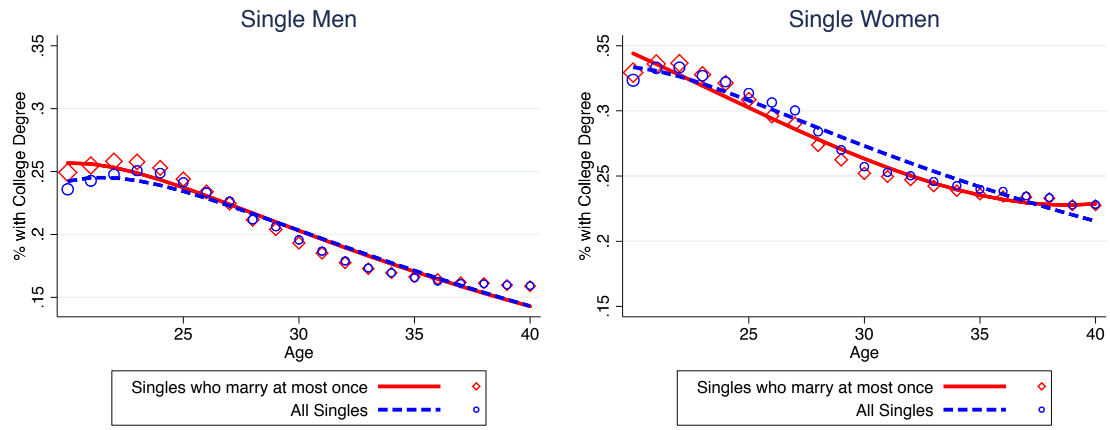

Figure 13: **Quality in the Single Population, 1960 cohort, NLSY**. Each point depicts the fraction of singles (by age and gender) who eventually obtain a college degree. The associated line for a given cohort depicts the smoothed estimate from a fractional polynomial regression. The solid line considers singles who never marry, or marry later but never divorce; the dashed line includes all singles who have never married before.

1.5% percentage points higher than that.

On net, we can conclude that the calibration targets have slightly different levels when marriages that dissolve are included, but the overall trends remain the same. If used in our calibration, this simply shifts the level of parameter values without affecting their shape. Indeed, we view these parameters as being most informative relative to each other; the absolute levels are not our primary interest.

The difference in levels arises because marriages between younger or less educated singles are more likely to end in divorce. Table 5 reports the difference in the divorce hazard rate, computed as the fraction of marriages that end in divorce before the tenth anniversary. One can see that a marriage with two college graduates is half as likely to divorce as a couple where neither holds a college degree. Also, those married after their twenties are about a third as likely to divorce as those married in their early twenties.

We could also incorporate the potential for divorce to affect marriage decisions. Instead of obtaining utility $\frac{q}{1-\beta}$ after marriage, the utility from marriage is recursively

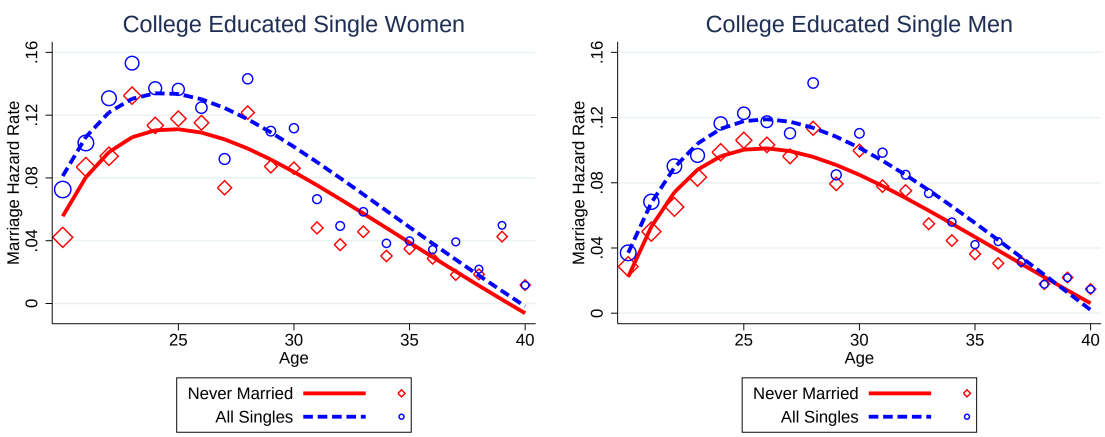

Figure 14: **Marriage Hazard Rates, 1960 cohort, NLSY**. Each point depicts the fraction of college-educated singles (by age and gender) who marry on an annual basis. The associated line for a given cohort depicts the smoothed estimate from a fractional polynomial regression. Solid lines consider marriages which remained intact through 2011 divided by all previously unmarried singles that never divorce later, while dashed lines include all first marriages divided by all previously unmarried singles.

Table 5: Divorce Hazard Rate (10 year), by couple degree status and age at marriage

Wife's Age at Marriage	Non-College Wife		College Wife	
	Non-college Husband	College Husband	Non-college Husband	College Husband
20-22	29.8%	25.5%	20.9%	16.0%
23-25	26.0	23.4	18.9	11.6
26-28	27.3	21.8	16.7	10.8
29-	20.1	13.5	12.2	10.4

Notes: Each cell reports the fraction of first marriages that end in divorce within ten years, conditional on the education status of both partners and the age of the woman at time of marriage, computed from the NLSY 1979.

defined for individual $i \in \{m, w\}$ as:

$$W_t^{gi}(q) = q + \beta \left(\delta_t^{gi} V_{t+1}^{gi} + (1 - \delta_t^{gi}) W_{t+1}^{gi}(q) \right), \tag{8}$$

where δ_t^{gi} is the annual hazard rate of divorce, and the reservation quality is then defined by $V_t^{gi} = W_t^{gi}(R_t^{gi})$.

Note that as written, the continuation value for a divorcee is the same as for a never-married single, meaning that they will draw from the same distribution of suitors and with equal frequency. This is a strong assumption, and could be exchanged for some alternate search process for divorcees if, for example, their pool of suitors is smaller or of lower quality.

Empirically, however, we cannot separately identify the pool that divorcees face from the pool the rest of the population faces (unless we required that divorcees only date and marry other divorcees). For a first approximation, then, we assume they draw from the same pool as other singles their age. Even so, this pool will have lower average quality than the one from which they chose their first spouse, since suitor quality is declining with age.

The other challenge of incorporating divorce in the empirical strategy is that the ACS data identify those who have been divorced, but does not report when the divorce occurred. Thus, we cannot back out the hazard rate of divorce as we did with the hazard rate of marriage. However, this information is available in the NLYS data, and we report our computations in Figure 15.

For both genders at age 28, 2% of marriages dissolve each year; this gradually declines to nearly half that by age 40. At earlier ages, the divorce rate among college men slightly rises with age, but falls rather dramatically for women. Note that these need not be equal if college women are more likely to divorce a non-college husband, as seems to be the case in this sample. Note also that these early divorce rates are less precise as there are fewer marriages at young ages.

We can then conduct the same calibration technique as before. Indeed, divorce has no direct effect on the theoretical relationship between suitor quality and spouse quality in Equation 5, nor does it change the relationship between suitor arrival rates and marriage hazard rates in Equation 7. Thus, calibration will produce the same λ_t^{gi} and R_t^{gi} as before. The divorce hazard rates (which are used as the estimate for δ_t^{gi}) will only appear in the Bellman equation, which is used in the computation of

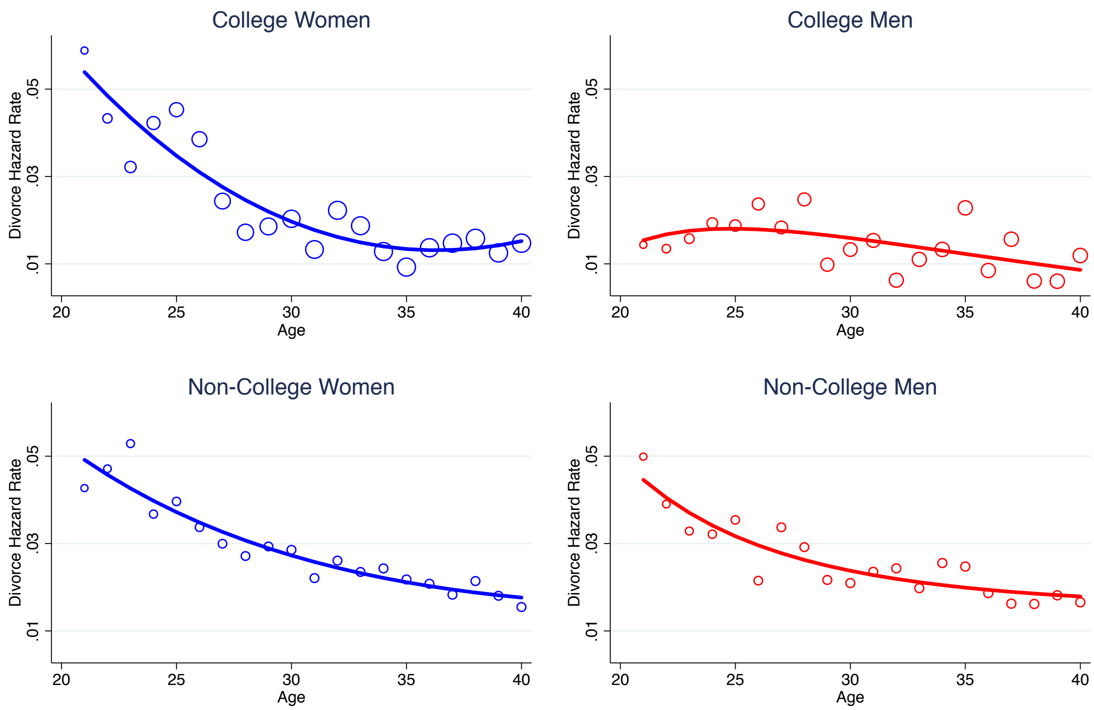

Figure 15: **Hazard Rate of Divorce, NLSY**. Each circle depicts the fraction of married women or men in the 1960 cohort who divorce at that age; the size of the circle denotes the relative fraction of divorces at that age. The associated line depicts the smoothed estimate from a fractional polynomial regression.

the benefits of single life.

Predictably, since divorce reduces expected flow of benefits from marriage, the calibrated single-life benefits must be lower so that singles are equally willing to marry as they were with no possibility of divorce. This reduction is greater for younger women since their divorce rate is higher. Indeed, this reduces women's single-life benefits enough to essentially match that of men, in contrast to Figure 6 where, in the 1960 cohort, women's benefits are 0.3 units higher than men's at each age.

6 Conclusion

In this paper, we first establish facts regarding marriage outcomes in the US, with particular focus on how spouse quality changes depending on an individual's age at marriage. Using the American Community Survey data, we examine the experiences of three different cohorts: those born in the 1950s, 1960s, and 1970s.

The data reveal several important facts. Spouse quality, as measured by educational attainment, is hump-shaped, peaking during the mid-twenties. The decline at later ages of marriage is more pronounced for women than men. Also, in sharp contrast to men, recent cohorts of women have experienced a lower spouse quality regardless of age at marriage.

To understand these differences in the dynamic decisions across genders and cohorts, we set-up a non-stationary sequential search model, in the spirit of Wolpin (1987), which is then calibrated to US data on marriages. This process reveals the underlying search frictions which lead to the observed marriage choices. For college graduates, we find that the decline in the quality of suitors and the increase in the utility from single life are of equal importance in explaining spouse quality outcomes. For non-college individuals, on the other hand, the change in single life benefits is of far greater importance.

We also consider how increasing educational attainment by women in recent cohorts has led to greater competition among them for educated husbands in the marriage market. This has given college men a relative advantage, inducing educated women to reduce their reservation quality faster as they age.

More broadly, we demonstrate that the observed decline in spouse quality is not merely a consequence of worsening circumstances in the marriage market. Individual choice plays at least as big a role, with singles changing their selectivity over the course of their lifespan. This conclusion is particularly important when considering how public policy might affect the timing and quality of marriages. Tax or welfare benefits can easily impact the perceived utility of remaining single versus getting married; our work indicates a reasonably high degree of elasticity to such incentives.

References

Becker, Gary. (1973) "A Theory of Marriage: Part I," *Journal of Political Economy* **81**, 813-846.

Becker, Gary. (1974) "A Theory of Marriage: Part II," *Journal of Political Economy* **82**, S11-S26.

Bergstrom, C. Theodore and M. Bagnoli. (1993) "Courtship As A Waiting Game," *Journal of Political Economy* **101**, 185-202.

Boulier, Bryan, and M. Rosenzweig. (1984) "Schooling, Search, and Spouse Selection: Testing Economic Theories of Marriage," *Journal of Political Economy* **92**, 712-732.

Burdett, Ken, and M. Coles. (1997) "Marriage and Class," *Quarterly Journal of Economics* **112**, 141-168.

Bureau of Labor Statistics, U.S. Department of Labor. National Longitudinal Survey of Youth 1979 cohort, 1979-2010 (rounds 1-24) [computer file]. Produced and distributed by the Center for Human Resource Research, The Ohio State University. Columbus, OH: 2012.

Bureau of Labor Statistics, U.S. Department of Labor. National Longitudinal Survey of Youth 1997 cohort, 1997-2010 (rounds 1-14) [computer file]. Produced by the National Opinion Research Center, the University of Chicago and distributed by the Center for Human Resource Research, The Ohio State University. Columbus, OH: 2012.

Caucutt, Betsy, N. Guner, and J. Knowles. (2002) "Why Do Women Wait? Matching, Wage Inequality, and the Incentives for Fertility Delay," *Review of Economic Dynamics* **5**, 815-855.

Chade, Hector. (2001) "Two-sided Search and Perfect Segregation with Fixed Search Costs," *Mathematical Social Sciences* **42**, 31-51.

Chari, V. V., P. J. Kehoe, and E. McGrattan. (2006) "Business Cycle Accounting," *Econometrica* **75**, 781-836.

Coles, Melvyn, and M. Francesconi. (2011) "On the Emergence of Toyboys, the Timing of Marriage with Aging, and Uncertain Careers," *International Economic Review* **52**, 825-853.

Diaz-Gimenez, Javier, and E. Giolito. (2013) "Accounting for the Timing of First Marriages,"*International Economic Review*, **54**, 135-158.

Fernandez, Raquel, and J. C. Wong. (2011) "The Disappearing Gender Wage Gap: The Impact of Divorce, Wages, and Preferences on Education Choices and Women's Work," IZA Working Paper No. 6046.

Goldin, Claudia, L. F. Katz, and I. Kuziemko. (2006) "The Homecoming of American College Women: The Reversal of the Gender Gap in College," *Journal of Economic Perspectives*, **20**, 133-156.

Guvenen, Fatih, and M. Rendall. (2013) "Women's Emancipation Through Education: A Macroeconomic Analysis," NBER Working Papers 18979, National Bureau of Economic Research.

Keeley, Michael. (1979) "An Analysis of the Age Pattern at First Marriage," *International Economic Review* **20**, 527-544.

Kotlikoff, Laurance J., and A. Spivak. (1981) "The Family as an Incomplete Annuities Market," *Journal of Political Economy* **89**, 372-391.

Krusell, Per, T. Mukoyama, R. Rogerson, and A. Sahin. (2010) "Aggregate Labor Market Outcomes: the Roles of Choice and Chance," *Quantitative Economics*, **1**, 97-127.

Loughran, David. (2002) "The Effect of Male Wage Inequality on Female Age at First Marriage," *Review of Economics and Statistics* **84**, 237-250.

Rotz, Dana. (2011) "Why Have Divorce Rates Fallen? The Role of Women's Age at Marriage," Working Paper, Harvard University.

Royston, Patrick, and D. Altman. (1994) "Regression Using Fractional Polynomials of Continuous Covariates: Parsimonious Parametric Modeling," *Journal of the Royal Statistical Society. Series C (Applied Statistics)* **43**, 429-467.

Ruggles, Steven, T. Alexander, K. Genadek, R. Goeken, M. Schroeder, and M. Sobek. Integrated Public Use Microdata Series: Version 5.0 [Machine-readable database]. Minneapolis: University of Minnesota, 2011.

Shimer, Robert, and L. Smith. (2000) "Assortative Matching and Search," *Econometrica* **68**, 343-369.

Siow, Aloysius. (1998) "Differential Fecundity, Markets, and Gender Roles," *Journal of Political Economy* **106**, 334-354.

Smith, Lones. (2006) "A Marriage Model with Search Frictions," *Journal of Political Economy* **114**, 1124-1144.

Spivey, Christy. (2011) "Desperation or Desire? The Role of Risk Aversion in Marriage," *Economics Bulletin* **48**, 499516.

van den Berg, Gerard. (1990) "Nonstationarity in Job Search Theory," *Review of Economic Studies* **57**, 255-277.

Wolpin, Kenneth. (1987) "Estimating a Structural Search Model: The Transition from School to Work," *Econometrica* **55**, 801-817.