Accounting for Age in Marital Search Decisions: Online Appendix

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1 Introduction

This online appendix accompanies the manuscript titled "Accounting for Age in Marital Search Decisions." In Section 2, we examine alternative measures of spouse quality, including finer measures of education and average earnings. In Section 3, we replicate each of the figures from the paper which were only performed for the 1960 cohort. In Section 4, we depict our calibration results under alternative values for σ, the standard deviation of intangible quality. Section 5 provides evidence that declining spouse quality is not driven by selection. Section 6 includes measures of assortative matching, following Liu and Lu (2006).

2 Alternative Quality Measures

In the paper, we have relied on educational attainment as our observable measure of quality. In particular, the discrete measure of whether or not one earns a college degree greatly simplifies our model as well as the presentation of our results for individuals of different types. Even so, we could have employed a variety of other measures as a proxy for spouse quality using the same ACS data. In this section, we establish that alternate quality measures follow the same trend with respect to the age at marriage, with women married in their mid twenties obtaining the highest quality husbands. For men, spouse quality is much flatter under the alternate measures, and generally peaks in the thirties.

First, we could employ a more nuanced measure of educational attainment, such

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as years of education.[1] In the text, we use college graduation as a discrete measure of quality, and control for one's own quality by only examining college graduates. Since we add more categories of educational attainment here, we use a regression to control for one's own years of education. In particular, we estimate the following equation (separately for men and women of each birth cohort):

$$Y_i = \sum_{j=22}^{52} \alpha_j \cdot M_{ij} + \beta_E \cdot YE_i + \epsilon_i. \tag{1}$$

Here Y_i represents the spouse's years of education as the dependent variable. A set of indicator variables for each value of one's own years of education is captured by YE_i. We also provide M_{ij} as an indicator variable for each age at marriage from $j = 22$ to 52. Since marriage at age 21 is the omitted category, the coefficients α_j indicate the relative difference in average quality if married at a later age.

Figure 1 plots the estimate α_j coefficients for women (left) and men (right) for each cohort. Note that the regression controls for educational status, so we do not plot college and non-college individuals separately. For example, in the 1970 cohort, the husband of a woman married at age 24 will have on average 0.44 more years of education than that of a woman married at age 40, even when both women have the same educational attainment. Note the overall trend is the same as in the text, peaking in the mid twenties. For men, the trend is much flatter but still peaks in the mid twenties.

Another measure of spouse quality is his or her income.[2] We repeat an estimation of Equation 1, using spouse income as the dependent variable Y_i. We still use one's own educational attainment as the variable YE_i, since this provides a control for one's own quality even if not currently employed.

The estimated coefficients α_j of this regression are depicted in Figure 2 for each gender, cohort, and age at marriage. Again examining the 1970 cohort, the husband of a women married at age 27 earns approximately $19,700 more than the husband of a similarly educated woman who married at age 40. For men, the trend is again much flatter and peaks in the thirties.

Even more surprising is that the same income trend persists even after controlling for all observable traits of the spouse. That is, even when a husband is compared to men of similar age, location, and occupation, women married in their mid twenties tend to obtain men of higher income than women married earlier or later. For

[1]The ACS measure of education identifies years of education through grade 12 but shift to degree attained after grade 12. To provide a continuous measure of spousal quality, we map the ACS education variable into years of education (indicated in parentheses): 12th grade, with or without a high school diploma (12), some college but no degree (13), associate's degree (14), bachelor's degree (16), master's or professional degree (17).

[2]The individual respondent's income includes revenue from all source reported within the ACS, including (but not limited to) wage income, social security, business revenue, welfare receipt, retirement benefits directly attributed to the individual.

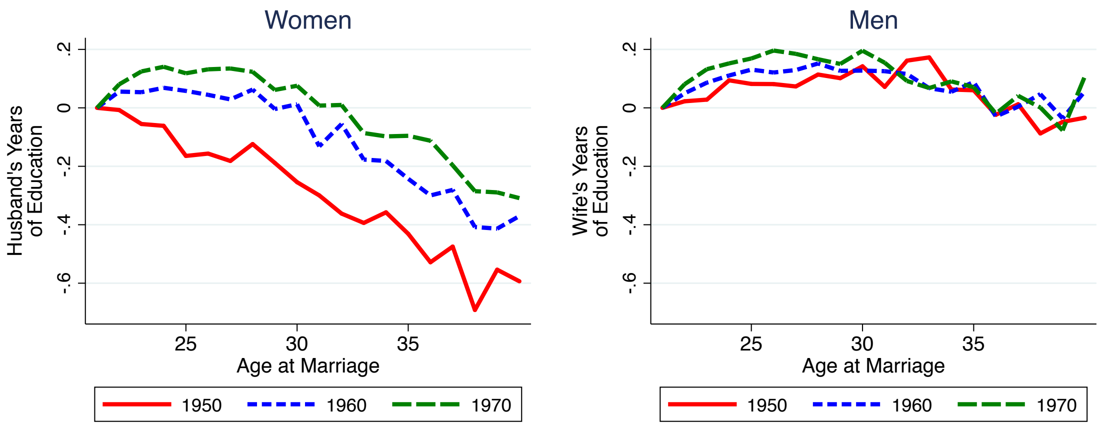

Figure 1: **Spouse Educational Attainment**. Spouse's additional years of education (relative to the spouse of a person married at age 21), depending on gender, birth cohort, and age at marriage, after controlling for one's own educational attainment.

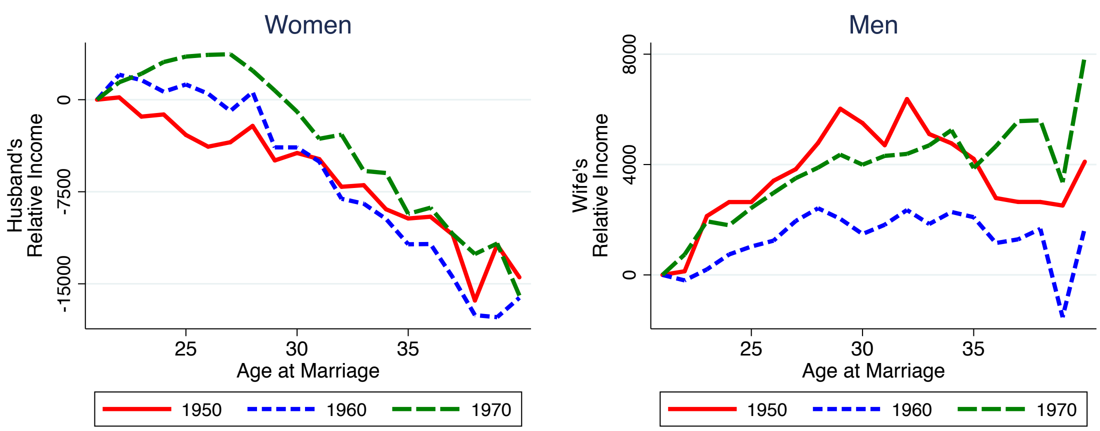

Figure 2: **Spouse Income**. Spouse's additional income (relative to the spouse of a person married at age 21), depending on gender, birth cohort, and age at marriage, after controlling for one's own educational attainment.

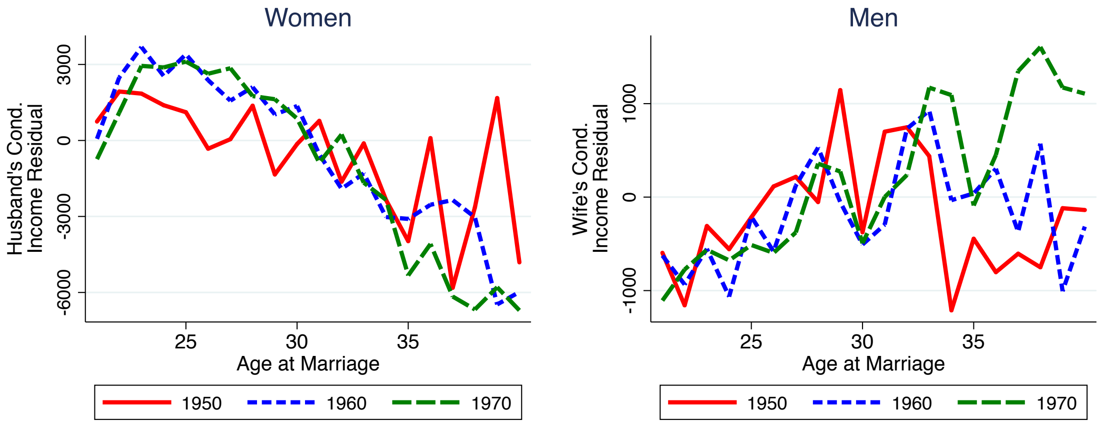

Figure 3: **Spouse Income with Controls**. Spouse's additional income (relative to the average person with similar age and demographic characteristics), depending on gender, birth cohort, and age at marriage.

instance, a twenty-five year-old bride is more likely to marry a lawyer (than a forty year-old bride), but she is also more likely to marry one of the better-paid lawyers.

To demonstrate this, we begin with the full ACS data set (before eliminating observations based on marital status and marriage pairings) and regress each individual's income on a set of observable characteristics, separately for each gender and birth cohort, estimating the following equation:

$$Income_i = \sum_{j=22}^{52} \alpha_j \cdot Age_{ij} + \beta_2 \cdot X_i + \epsilon_i. \tag{2}$$

Here, Age_{ij} denotes a vector of indicator variables, equalling 1 if j is the age of individual i in 2011, and 0 otherwise. Thus, α_j is an age-specific effect on income. X_i includes all other demographic controls, including indicator variables for each value of years of education, state of residence, and 43,052 industry-occupation combinations.

This regression generates a residual ϵ_i for each individual in the ACS, indicating how far his or her income deviates from the average individual of his or her type. We then restrict the data set to married couples and, for each gender, cohort, and age at marriage, we compute the average residual, $\bar{\epsilon}$, of the spouses.

The result is depicted in Figure 3. For women, the same age-profile appears, though the magnitudes are 50 to 60% smaller than in Figure 2, where we do not control for demographic attributes of the spouse. For men, the wife's average income residual is increasing through age 30; thereafter, the trend is essentially flat though highly noisy. This lacks the subsequent decline seen in other measures, but the likely cause is that women married at older ages are much more likely to participate in the labor force. The same is not true of men married at older ages.

3 Analysis for Other Cohorts

For brevity in the paper, we analyzed only the 1960 cohort in many instances. We here present the similar analysis for the other cohorts.

3.1 Marriage Age Distribution

In Figure 4, we present histograms indicating age at marriage among women in the ACS sample. Looking across cohorts, one can see that more recent cohorts have been marrying at successively older ages. This differs with Table 1 in the paper (where the average age at marriage was roughly constant at 27) because those summary statistics were for our sample married between 21 and 40, shown in the grey bars of the histograms.

The average age gap between women and their husbands has risen from 1.5 to 2 to 2.5 years across the successive cohorts. In each, the average age gap tends to drop about one year over the lifecycle. This is pictured in Figure 5 for the 1950 and 1970 cohorts.

The distribution across age gaps is quite similar across cohorts, displayed in Figure 6 for the 1950 and 1970 cohorts. In each, the typical age gap constitutes about 65 to 70% of marriages in the early twenties, but this shrinks to 30 to 40% of marriages by age 40. Younger and older marriages start out with similar shares, and each claim a larger share as age at marriage increases, slightly favoring younger marriages in most instances.

3.2 Choice versus Luck

Next, Figure 7 repeats the Choice versus Luck experiment described in Section 4.2 of the paper and pictured in Figure 9 of the paper (which is repeated here in the middle row). Comparing across cohorts, it appears that choice has played an increasingly important role in more recent cohorts, as the gap between the data and luck only lines have widened. College women in the 1950 look different because their reservation quality is monotonically decreasing as they age; hence, their choices actually give them worse outcomes than luck alone would produce.

3.3 Marginal Contributions

Finally, we consider the marginal contribution of each friction in explaining the change in observed spouse quality over the lifecycle. Figure 8 replicates for the 1950 and 1970 cohorts the experiment presented in Figure 11 of the paper for the 1960 cohort. Table 1 reports the average change in spouse quality when one of the frictions is held

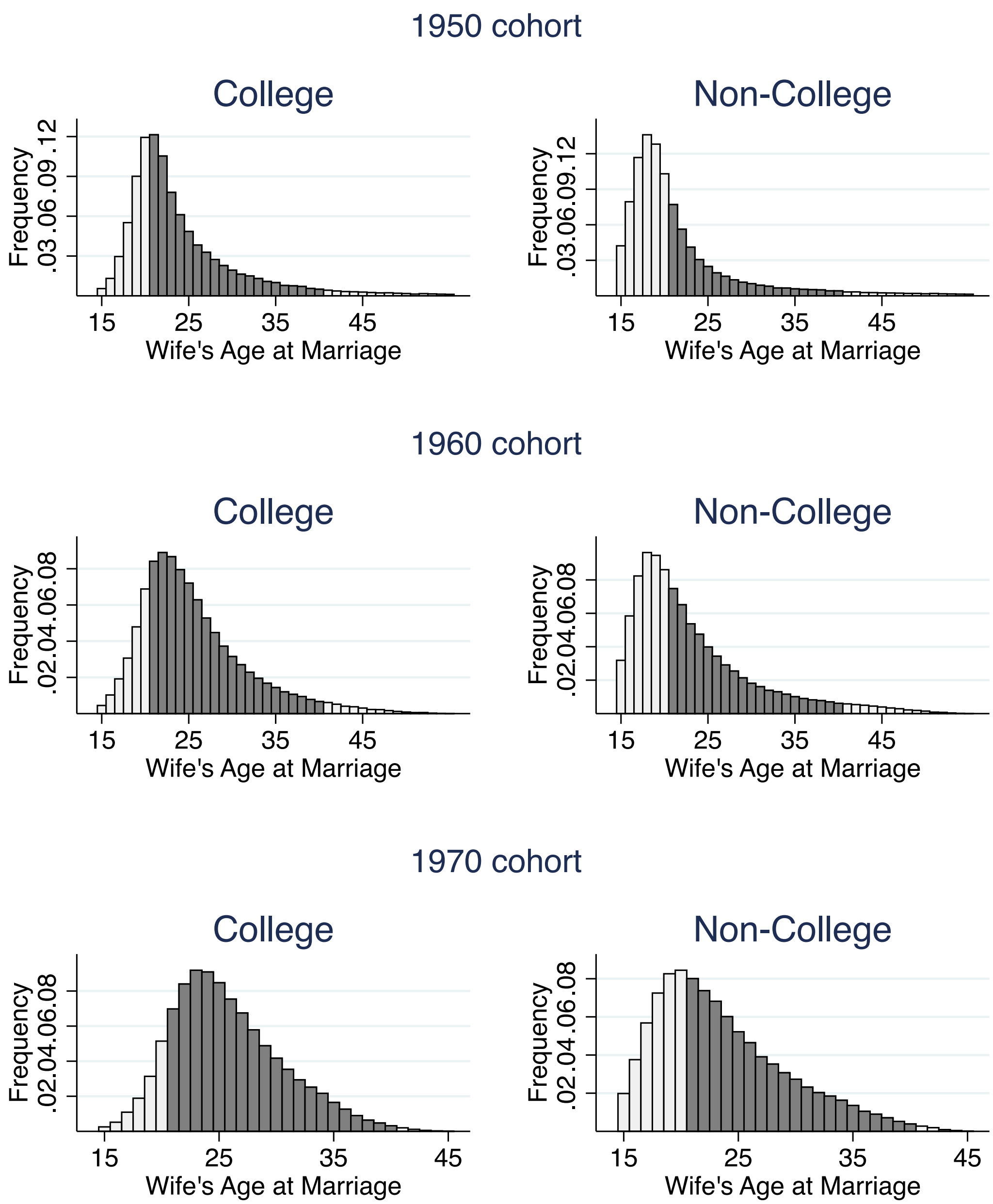

Figure 4: **Age at marriage, by Cohort**. For each cohort, the left panel indicates the fraction of marriages at each age for college women; light bars indicate ages that are excluded from our analysis. The right panel indicates the same for non-college women.

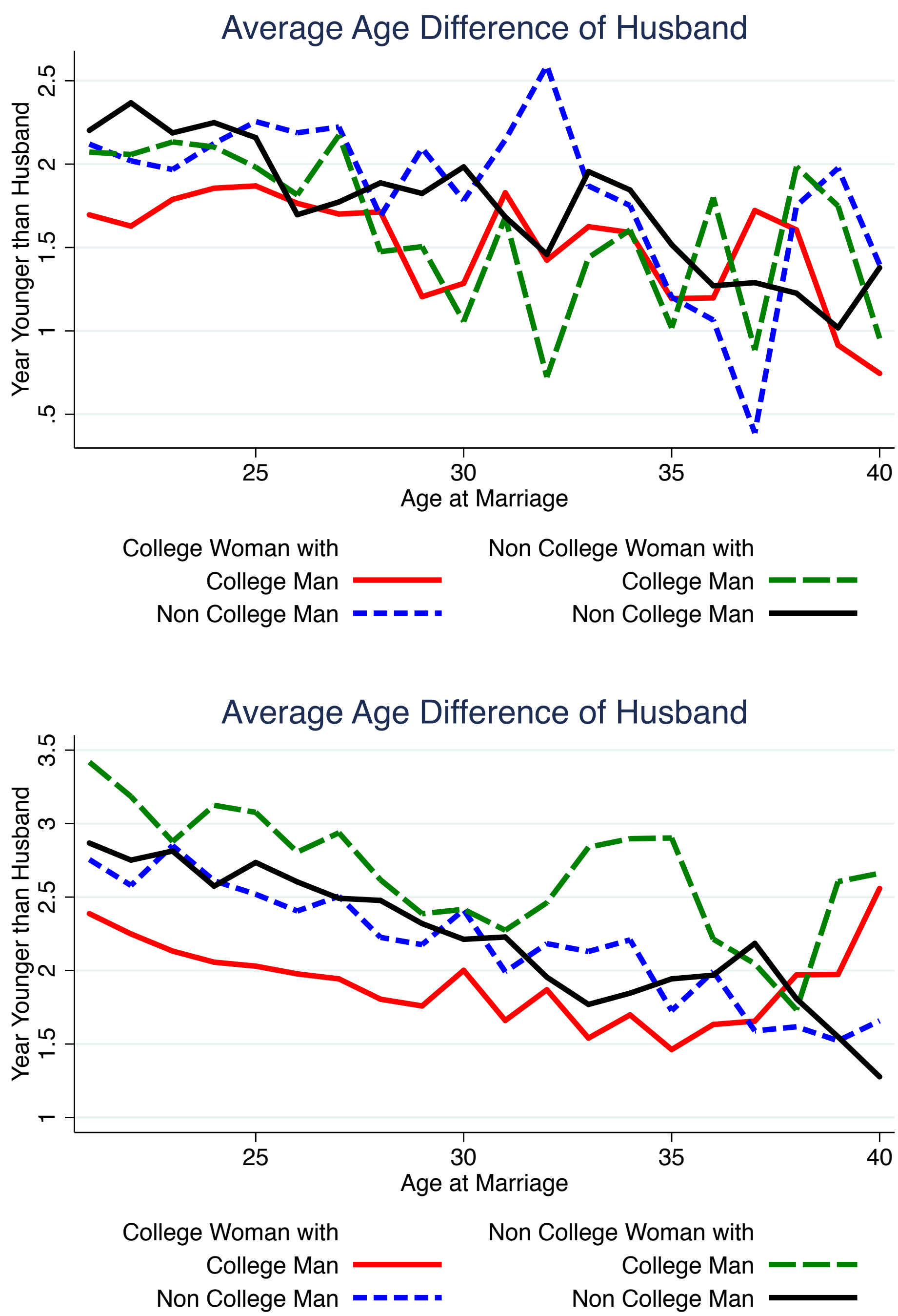

Figure 5: **Average Age Gap**. Difference between age of husband and wife, depending on cohort, wife's age at marriage, and educational status of each.

Figure 6: **Distribution in Age Gap**. Fraction of marriages in three categories of age gaps, depending on cohort, wife's age at marriage, and educational status of each.

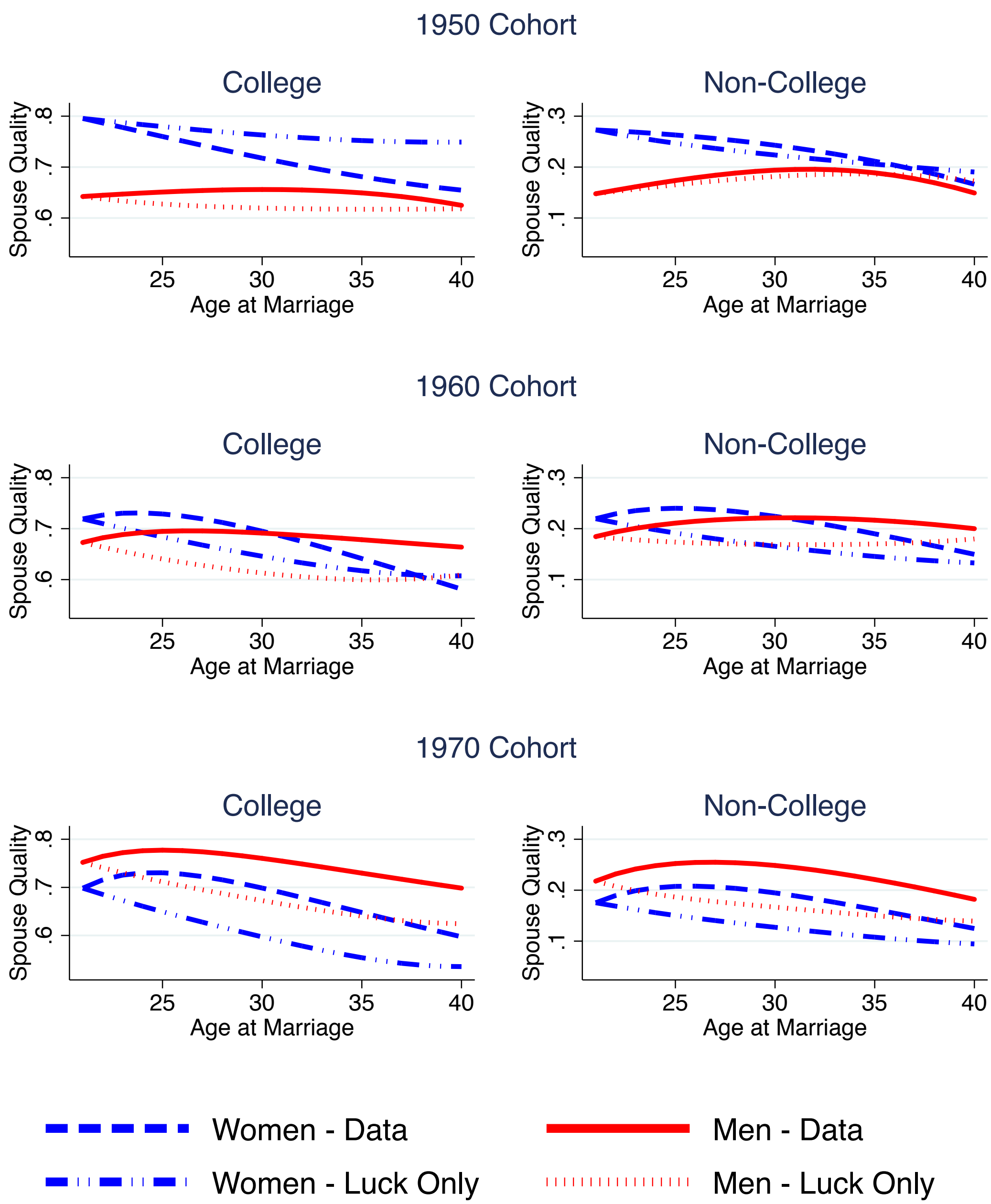

Figure 7: **Choice versus Luck, by Cohort**. For each cohort, the solid and dashed lines report the average quality of spouse as observed in the data for each cohort, educational status, and gender, conditional on the age at marriage. The dotted and dash-dotted lines indicate the quality that would have been realized had the reservation quality been held at R_{21}^{gi}. The gap between them reflects the role of choice in observed outcomes.

constant, separately for each cohort, including a repetition of the 1960 cohort from Table 4 in the paper.

Table 1: Marginal Contribution of Each Friction to Observed Spouse Quality

Friction	College		Non-college	
	Women	Men	Women	Men
1950 Cohort				
Suitor arrival rate (λ)	-1.2%	-1.3%	-0.5%	-0.2%
Suitor distribution (γ)	-2.0%	-1.2%	-0.9%	0.2%
Single-life benefits (b)	-0.6%	4.6%	7.1%	10.8%
1960 Cohort				
Suitor arrival rate (λ)	-4.8%	-2.5%	0.7%	2.6%
Suitor distribution (γ)	-4.3%	-2.3%	-2.1%	-0.4%
Single-life benefits (b)	5.6%	4.3%	3.4%	1.4%
1970 Cohort				
Suitor arrival rate (λ)	-3.3%	-6.4%	0.8%	-2.0%
Suitor distribution (γ)	-6.7%	-5.6%	-1.9%	-2.0%
Single-life benefits (b)	5.3%	6.5%	4.9%	8.9%

Notes: Each cell reports the average change in spouse quality when the listed friction (rows) is held constant.

In most cases the absolute contribution of each friction has increased across successive cohorts. This simply reflects the fact that the calibrated frictions vary more over the lifecycle in recent cohorts; thus, holding one of the frictions constant will have greater impact. It is also interesting to compare the relative contribution of each friction across the cohorts. For almost all groups and cohorts, changes in single-life benefits account for the largest fraction of changing spouse quality. The exception is with college women; in the 1950 and 1970 cohorts, changes in the quality of suitors have a larger impact, and even in the 1960 cohort, its effect is rather large. With college men, the suitor arrival rate consistently makes the second largest contribution, nearly equaling the contribution of single-life benefits in later cohorts.

These trends indicate that even though college women react the most to decreases in suitor quality over the lifecycle, for more recent cohorts, utility from remaining single has played an increasingly important role. College men in the recent cohorts, on the other hand, have become more sensitive to changes in the arrival rate, perhaps due to the relative abundance of single college educated women in the market.

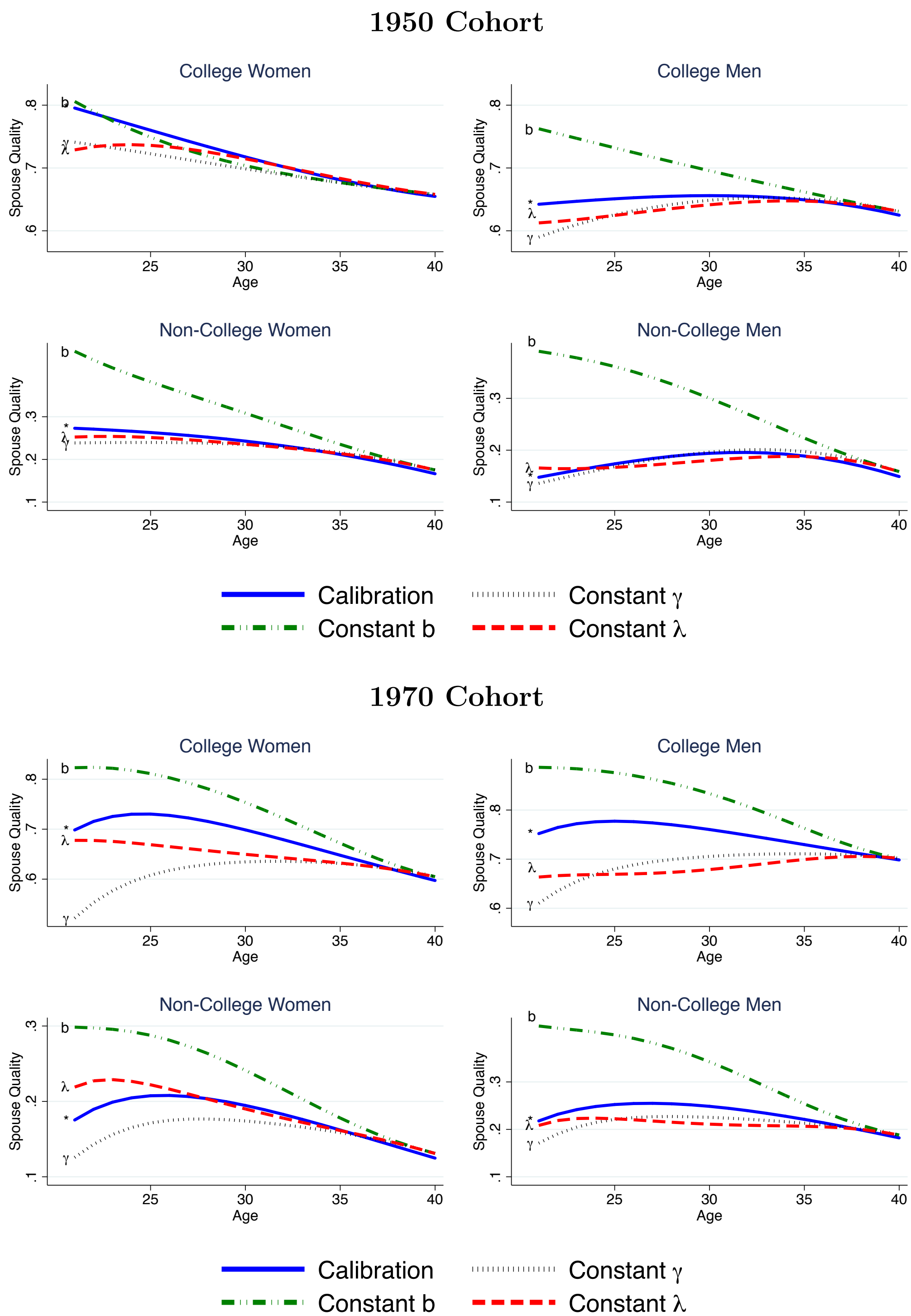

Figure 8: **Marginal Effect of Each Friction**. These graphs report the average spouse quality under various search frictions, by gender, educational status, and age. For the solid lines, the calibrated frictions are used, thus replicating the observed data. For the remaining lines, the same frictions are used, except that the noted parameter is held constant at the calibrated value for age 40.

4 σ Robustness

4.1 Higher Variance

As stated in the paper, it is inherently difficult to precisely calibrate σ, as it represents the variance of intangible quality that is not observable. However, we demonstrate here that alternative values for σ produce the same qualitative results for the calibrated frictions. We have repeated the calibration across a wide variety of values for σ; in Figure 9, we demonstrate the results when $\sigma = 0.55$, which is 10% higher than in the paper and is representative of other increases we have performed.

First, consider the arrival rate. For each cohort and gender, the peak occurs as the same age as in Figure 3 of the paper, regardless of σ. A larger σ leads the calibration to a larger λ, but it scales up nearly proportionately. Single-life benefits also look nearly the same for each of the three calibrations. Using a larger σ reduces the estimated single-life benefit by a minor amount, but the overall trend remains the same. Reservation quality increases by roughly 0.1 to 0.15 in each group under this higher σ, but it again retains the same shape and peak.

4.2 Decreasing Variance with Age

Another extension to the model is to allow that as singles age, the value of education a may vary relative to intangible qualities z. This can be done either by adjusting the value of education directly (1 for a college spouse, 0 for a non-college spouse) or adjusting the variance of intangible attributes (σ). There is a certain equivalency of these: an increase of the value of a college degree to 1.5 will make it far less likely that a non-college suitor will be better than the average college suitor. But one could also reduce the standard deviation of intangibles and have a similar effect. The only difference between these adjustments will be seen in single-life benefits, which are always relative to the value of a college suitor.

First, consider a steady decline in the standard deviation with age, starting with $\sigma_{20} = 0.6$ and reaching $\sigma_{40} = 0.4$. This might reflect the fact that younger singles have more varied preferences about personalities or looks, but these become more homogenous with age. Alternatively, they might just be better at discerning the long run value of a suitor, getting a more precise estimate of his total quality. Under this assumption, we calibrate the model to the 1960 cohort in the ACS, with the results depicted in Figure 10.

The calibrated reservation qualities react predictably to the change in σ: they are higher when σ is higher (before age 30), and lower when σ is lower. This is because greater variance creates more overlap in the distribution of total quality of college versus non-college suitors. To reconcile the observed fraction of marriages to college spouses f_t with the observed fraction of college singles, suitors must be held to a higher standard. This shift leads to a steeper decline in reservation quality and an earlier peak, relative to the constant σ calibration. The calibrated arrival rates

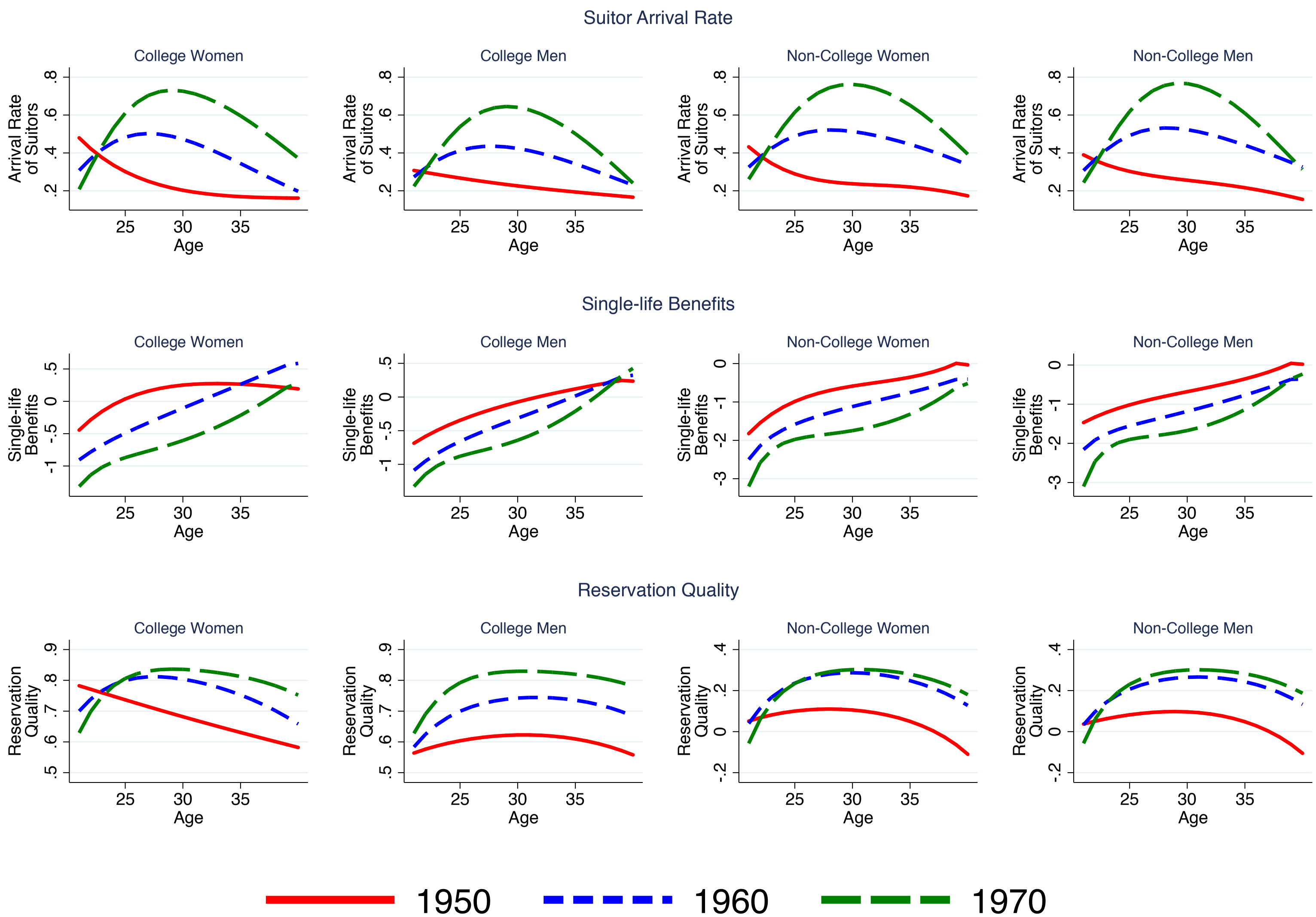

Figure 9: **Results Across Cohorts,** $\sigma = 0.55$.

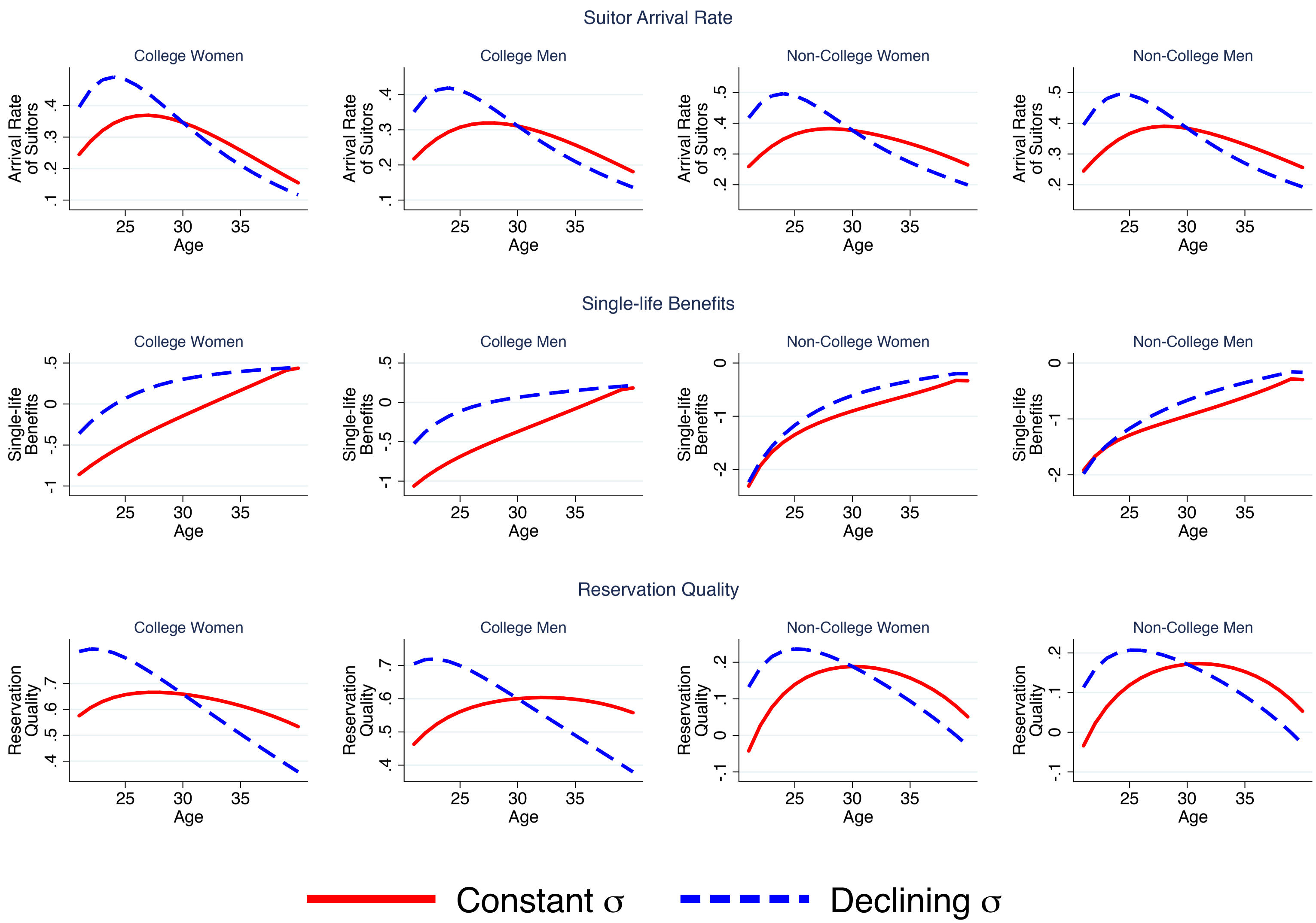

Figure 10: **Results, 1960 Cohort, Constant vs. Decreasing Variance**.

shift similarly, because higher reservation qualities imply rejecting more marriage opportunities; so to match the observed marriage hazard rates, the arrival rates must be higher.

Interestingly, the calibrated single-life benefits are not as dramatically altered by declining variance. Indeed, they are nudged only slightly higher for non-college singles, relative to constant variance. In other words, the value of their marriage search is not dramatically altered (even with large changes in the reservation strategy). College singles, in contrast, would need greater single life utility to justify their higher level of selectivity. This flattens their utility-age profile, with nearly the same in age 40 as under constant variance.

4.3 Increasing Educational Value

Alternatively, we could let the value of college steadily increase in age, starting with the average quality of a college suitor as 0.8 at age 20 and increasing to 1.2 by age 40. We hold the average quality of a non-college suitor at 0. This shift in preferences could represent that a spouse's earning power becomes more important than personality traits in later life. Not surprisingly, this closely mimics the results of shifting σ. The calibrated frictions are reported in Figure 11.

5 Selection

While our model provides one explanation for why spouse quality declines with age (namely, changing utility and/or worsening prospects), another potential explanation is that this is a consequence of selection. That is, all the best candidates marry early, so those who marry late are less desirable themselves, and hence match with less desirable spouses. Of course, we have controlled for one dimension of candidate quality (*i.e.* own educational attainment); so this selection would have to take place on intangible qualities.

To address this concern, we look to another data set which can shed additional light on intangible qualities: the Wisconsin Longitudinal Survey (WLS). The WLS follows a single cohort of 10,317 men and women who graduated from Wisconsin high schools in 1957, in repeated interviews over the following 50 years. The data provide similar measures of income and educational attainment, but offer three additional measures: IQ, body mass index (BMI), and an attractiveness rating.[3] All three measures were generated while the subject was in high school. The latter two can change over time, of course, but the former is generally thought to persist throughout one's life.

[3] Attractiveness was determined by a panel of six men and six women of similar age to the studied cohort. Each panelist was asked to rate the high school yearbook photos on an 11-point scale. Each panelist's attractiveness ratings were normalized to mean zero. We present the average of those scores across all twelve judges.

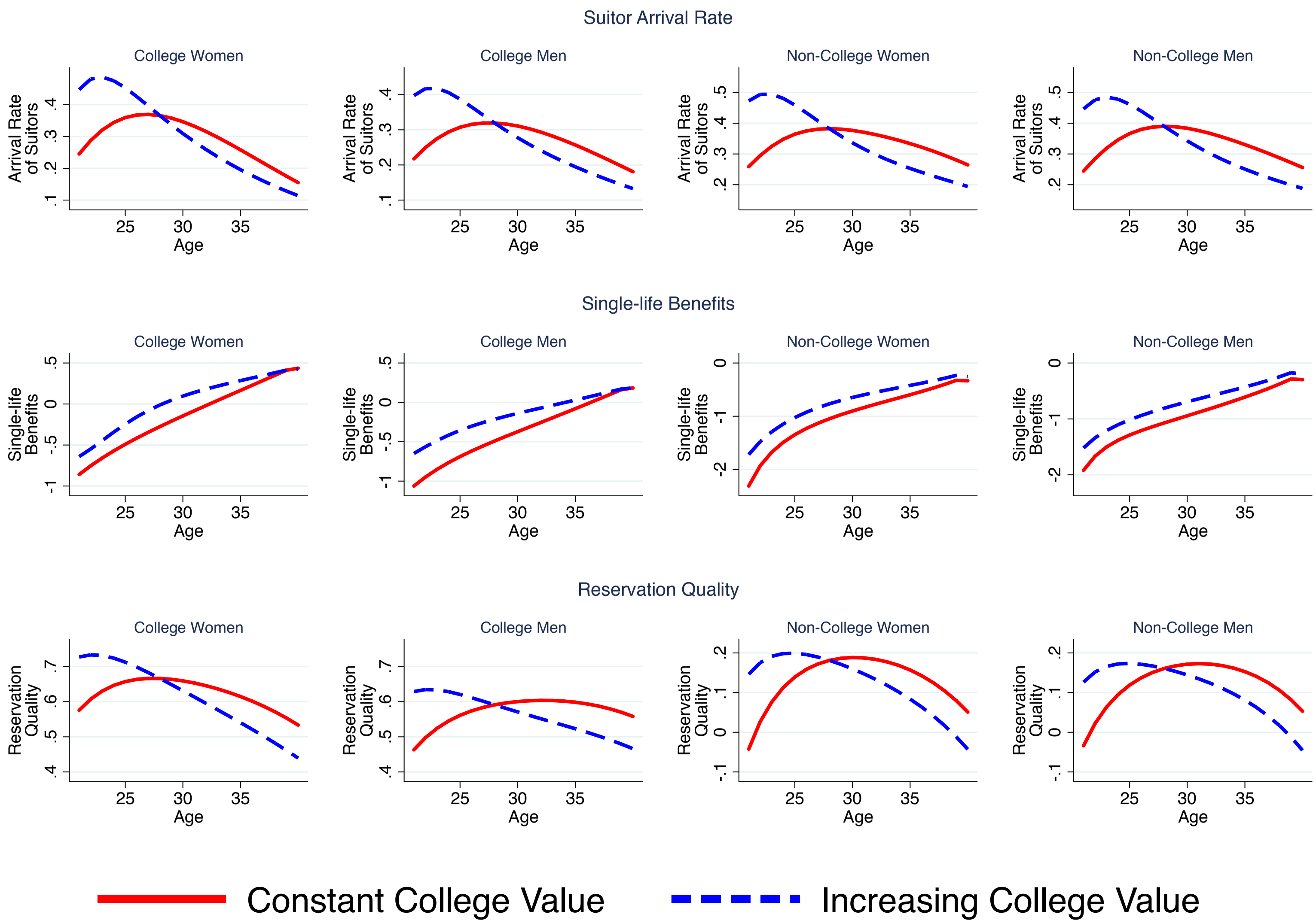

Figure 11: **Results, 1960 Cohort, Constant vs. Increasing Educational Value**.

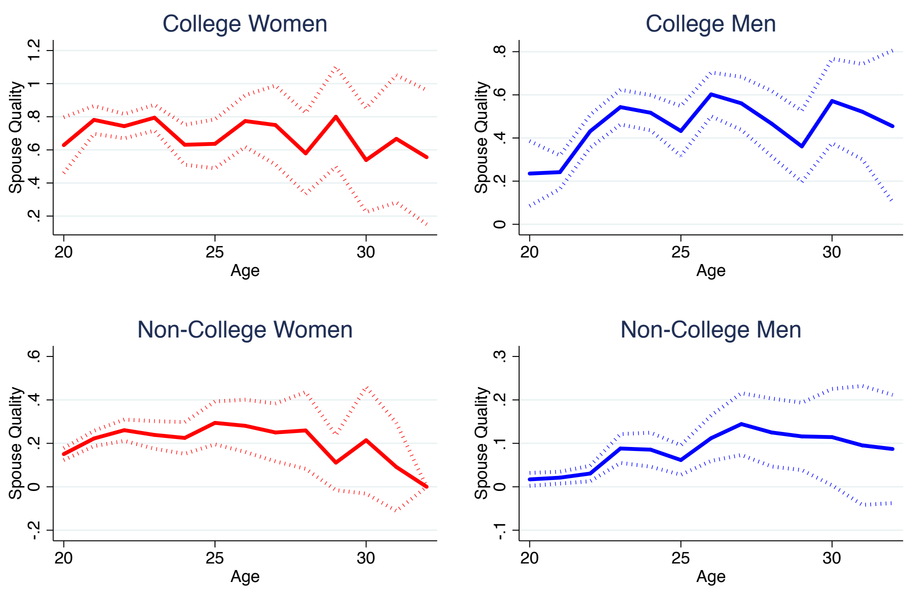

Figure 12: **Average Spouse Quality, WLS**. Fraction of those married at a given age whose spouse is college educated (by gender, educational status, and age at marriage). Dotted lines indicate 95% confidence intervals.

First, we note that the relationship between spouse quality and age at marriage still holds among this sample, as depicted in Figure 12. The hump-shape seems to be present, though the smaller sample generates much greater noise, particularly in the late twenties (as indicated by the confidence intervals).

We then examine how age of marriage is correlated to one's *own* quality, to see if there is any evidence that early brides or grooms are systematically more attractive or intelligent than those married later in life. The results are depicted in Figure 13; these indicate essentially constant quality with respect to ones own age at marriage.

In the top row of Figure 13, we see a slight decline for women of less than half a point on an 11-point scale; men remain roughly constant at the mean of 0. In both cases, the difference from 0 (the average attractiveness rating) is not statistically significant at most ages. In the middle row of Figure 13, we observe that an individual's body mass index is roughly constant regardless of the age at marriage. In the bottom row of Figure 13, we see that average IQ fluctuates by about 5 points over the various ages at which people are married, but not with a clear trend in either direction. Again, confidence intervals indicate that for the most part, these fluctuations are not significantly different from the average IQ of 112 for college graduates or 98 for non-college individuals.

This suggests that individuals married later in life are not less attractive or intelligent than those married at young ages. Of course, we cannot rule out that they are selected on other characteristics (such as personality) that are observed by potential suitors but not the econometrician. If tastes are idiosyncratic regarding personality, then this component would be match-specific (as our model assumes) anyhow: some people may bristle at a particular sense of humor that others find delightsome. Thus, we can plausibly conclude that z maintains the same mean throughout life; intangible qualities do not seem to be worsening with age.

6 Measure of Assortative Mating

In Footnote 10 of the paper (pg. 12), we discuss the formal measure of assortative mating proposed by Liu and Lu (2006). This has the advantage of being comparable across samples in which the underlying distribution of education may change. Here we compute this measure for each cohort and age at marriage. Our calculations indicate that, overall, the degree of assortativity has increased in the 1970 cohort. Furthermore, although the 1950 cohort shows declining assortativity over the lifecycle, this is almost constant across age of marriage for the 1970 cohort.

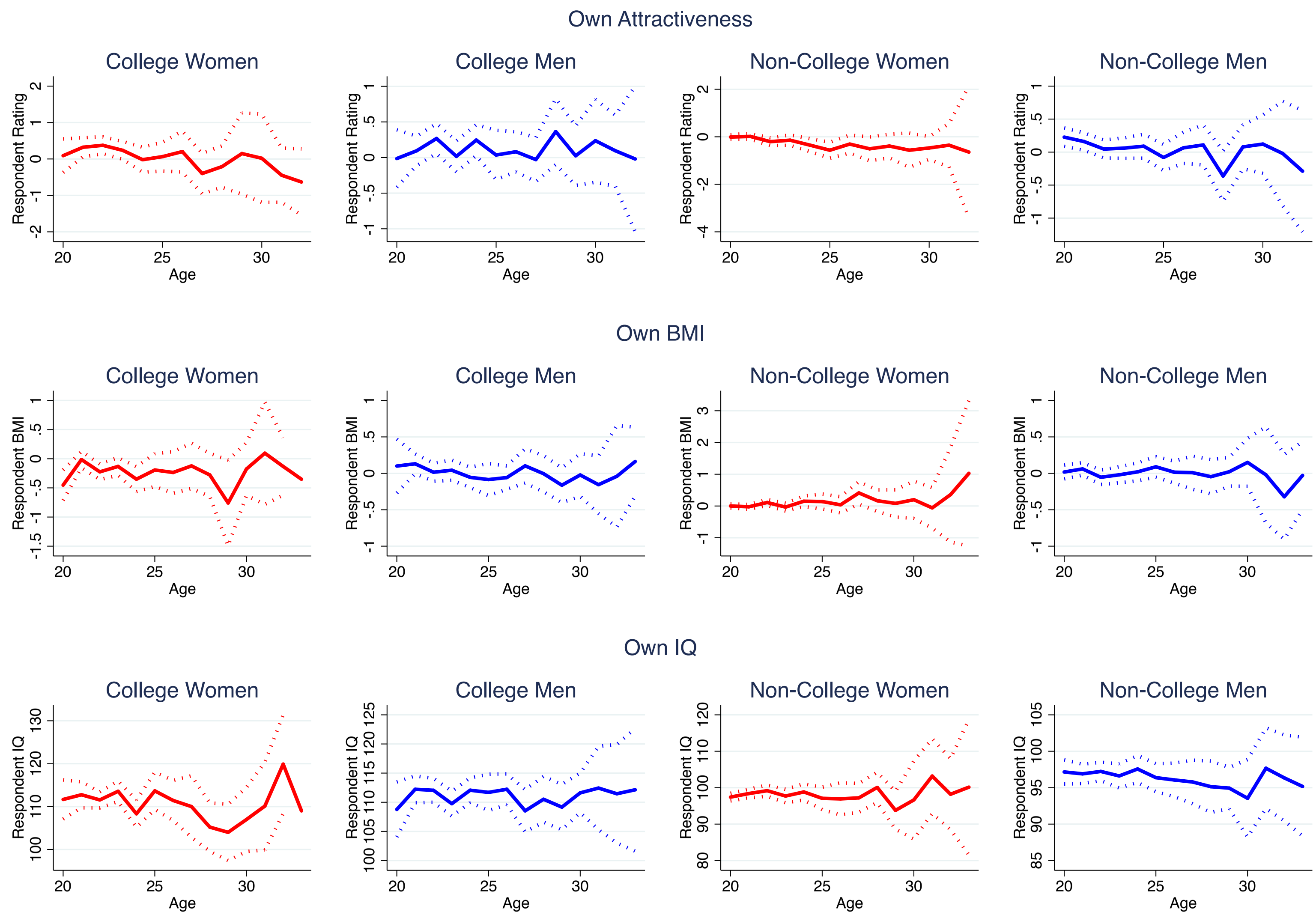

Figure 13: **Respondent's Own Characteristics, by age of marriage.**

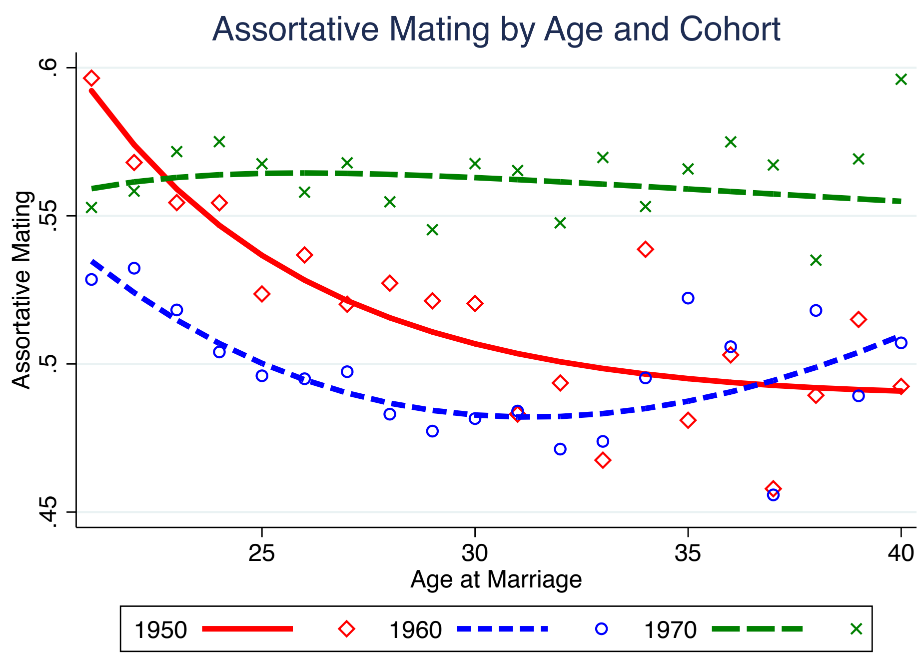

Figure 14: **Assortative Mating**, using the Liu and Lu (2006) measure, reported by birth cohort and age at marriage.