Pricing the Biological Clock: The Marriage Market Costs of Aging to Women

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This paper uses an innovative experiment to quantify the causal negative impact of age on women's marriage market value, and thus the economic costs of time-consuming human capital investments that delay marriage. In the experiment, real online daters rate hypothetical profiles with randomly assigned ages. Truthfulness is incentivized through the experiment's compensation—participants receive dating advice that is customized based on their ratings. The experiment shows that for every year a woman ages, she must earn $7,000 more annually to remain equally attractive to potential partners. I demonstrate this preference is connected to women's differential fertility decline with age by showing it is only present for men who have no children and have accurate knowledge of the age–fertility tradeoff.

JEL Codes: J12, J13, J16, C78, C93

1 Introduction

While there is a large literature showing the tradeoff women make between their family and career goals, the issue of the ticking biological clock has mostly been thought of as a tradeoff between financial benefits and personal costs.[1] However, if being older on the marriage market reduces match quality, which affects financial wellbeing, then the cost of delaying childbearing in favor of career investments is as much an economic one as a personal one. This paper isolates the causal negative impact of aging on women's marriage market attractiveness and provides a monetary measurement of its cost for the first time: the equivalent of $7,000 of annual earnings per year delay. I furthermore provide direct evidence linking this penalty to women's fertility decline with age.[2] This provides a benchmark for firms in

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[1] E.g., see Adda, Dustmann and Stevens (2017); Kleven, Landais and Sogaard (2019).

[2] Aging affects men's and women's ability to have children drastically differently. Whereas men experience a reproductive decline with age that is proportional to the decline in other bodily systems, women experience

thinking about the economic costs to women of career investments that delay marriage and childbearing. If these investments are unlikely to yield at least a $7,000 increase in salary, they would lead to marriage market costs that may hurt women financially, in addition to the personal loss of lower expected fertility and potentially invasive fertility-extending medical procedures.

Quantifying the causal effect of aging for women requires separating it from other factors that confound observational data on who marries whom, including women's own preferences over partners, social norms, and meeting opportunities. Economics literature has improved on this by using data from either online dating sites or speed dating to measure one-sided preferences, rather than equilibrium matches (Fisman et al., 2006; Hitsch, Hortaçsu and Ariely, 2010; Belot and Francesconi, 2013). However, by the nature of using preferences over real individuals, these studies cannot disentangle age from correlated traits with components the researcher cannot observe or control for. In the case of speed dating, participants interact before submitting their preferences, thus observing many more traits than the researcher does. In the case of dating sites, the profile communicates many age-correlated things, including photographs.

This paper breaks out of this fundamental dilemma by using a novel incentive-compatible "framed field experiment" (Harrison and List, 2004) where age is randomly assigned to dating profiles. The experiment's key innovation is in creating an environment where the value of personal characteristics can be disentangled through randomization, while maintaining contextually relevant subjects and real stakes. Real daters in their 30s are recruited using Google ads on online dating sites and dating-related keywords (since presumably the dating success of women in their 30s is not determined by undergraduate students). These subjects are asked to rate hypothetical profiles with randomly assigned age, but incentivized through the experiment's compensation. For their participation, they receive advice from a dating coach customized to attract the type of partners they are interested in, based on their ratings in the study. This compensation increases in value as ratings more closely reflect the rater's true preferences, incentivizing honest and careful responses. This method of incentivizing responses to profiles with randomly assigned traits without deception has since been modified to provide an alternative to resume audit studies in Kessler, Low and

a separate process—menopause—where reproductive capacity declines non-linearly to zero before age 50 (Frank, Bianchi and Campana, 1994).

Sullivan (2019).

By holding the photo constant and varying age, I isolate the explicit optimization over partner age from information correlated with age communicated visually, which has been pointed to as the driver of men's preference for age in sociology research (England and McClintock, 2009; Hakim, 2010). Even if age is seen as a statistical indicator of other factors, it is important to separate the partner's use of age itself as a criteria from correlated factors observed directly, in the same way the discrimination literature's use of audit studies determined that race was used for selection purposes, rather than simply being correlated with factors that interviewers could observe but researcher could not (Bertrand and Mullainathan, 2004). This experiment provides a framework for research in any matching market to isolate preferences for individual traits in a way not previously feasible in a deception-free incentivized setting.

The experiment shows that men, but not women, have a substantial negative preference for age. This preference is robust to multiple adjustments in sample inclusion, checks for attention, and controls. I quantify the preference through the use of randomly assigned income, which becomes a "numeraire" in interpreting preferences. Calculating the marginal rate of substitution between income and age in partner's preferences shows that for every year a woman ages, she must earn an additional $7,000 to receive the same rating, providing a quantitative measure of the marriage-market tradeoff in making time-costly human capital investments.

I then replicate my experiment using a different and larger sample to both show that results are externally valid and test possible mechanisms. Subjects for this second sample were recruited by Qualtrics research from their panel of survey takers. These subjects were similarly restricted to be single men and women in the relevant age category who were actively seeking to date. Although they were also compensated with customized dating advice for participating in the survey, they were not primarily recruited using advertisement of this benefit, and thus provide a good test of external validity. It is reassuring that the point estimates for age are nearly identical between the two samples.

I hypothesize that men's preference over experimentally varied age is driven by a preference for fertility. Using the larger sample in the Qualtrics data, I can test for this and rule out other candidate explanations for an asymmetry in partner age preferences between men and women by exploiting individual heterogeneity in the individual response to age.

As potential alternate explanations, men and women could have an asymmetric reaction to age differences, or to a female partner being older in violation of social norms. I control for both potential channels, and find they do not drive men's negative preference for age. I do find, however, that *women's* apparent positive preference for age is entirely explained by a preference for the "social norm" two-year difference between men and women.

The remaining possibility is that age is correlated with expectations about personality or lifestyle traits that are either different, or differently valued, between men and women. To rule this out while providing support for the fertility hypothesis, I demonstrate that multiple factors that should increase men's preference for fertility, but not other youth-related traits, strengthen the negative preference for age. Men who are more interested in marriage and want kids have significantly stronger negative tastes for older partners. This heterogeneity runs counter to what one would expect to find if, for example, the preference for age was driven by a preference for carefree youth, in which case we would expect a weaker preference among those seeking to marry.

Most compellingly, men who already have children and thus have less reason to seek a fertile partner exhibit no preference over age. Moreover, men who believe that the fertility decline does not start until after age 45 have no negative preference over the ages in the study, which range from 30-40. These two results clearly indicate that residual beliefs about other traits correlated with age do not drive the age penalty, as men who already have children or who misreport the timing of the fertility decline would also respond to other correlated traits. Finally, I show that non-linearity in the age preference aligns with a stronger negative preference closer to the fertility decline. Together, this provides evidence that when age is randomly assigned, the substantial negative preference for it that remains is driven by fertility desires.

My experiment thus adds to literature suggesting fertility is an important marriage market trait (Edlund, 2006; Edlund and Korn, 2002; Grossbard-Shechtman, 1986; Arunachalam and Naidu, 2006), which is taken as a given in other disciplines such as evolutionary biology (Trivers, 1972) and anthropology (Bell and Song, 1994). Separating age itself from correlated attractiveness is important because while men having tastes for women who *look* younger may nonetheless be rooted in an evolutionary-driven desire for fertility, it would have starkly different policy implications than a true preference for age.[3]

[3]Easier access to assisted reproductive technologies would help reduce a fertility tradeoff, whereas if

This paper also contributes to the growing body of evidence that women's loss of fecundity with age affects them in multiple ways, including impacting marriage timing and human capital investments (Low, 2019; Gershoni and Low, 2021a; Buckles, 2007; Abramowitz, 2017; Gershoni and Low, 2021b). The experiment presented here provides evidence that in addition to their own preferences to have children, women must contend with potential partners' preferences for younger and more fertile spouses, adding to the economic costs of aging to women. This asymmetric marriage market penalty exacerbates the human capital - time tradeoff that women face, which has broad-reaching policy implications for managers and policymakers.

2 Methodology

The experimental design aims to overcome the fact that personal characteristics are naturally correlated in real people. While speed dating experiments such as Fisman et al. (2006) offer the researchers more control, they still face this challenge in isolating correlated characteristics, especially because, as in job interviews, many things are observable to the decision maker that are not quantifiable by the researcher. To truly separate age from other factors, such as attractiveness, one wants the ability to randomly assign age. But, when age is randomly assigned, potential dating partners cannot be real, and so the incentives present in a speed-dating experiment would be absent. While one could in theory simply ask real daters to evaluate hypothetical profiles, it would not have the validity of an incentive-compatible experiment. And, if the profiles were instead presented as real, it would violate the norm in experimental economics against deceptive practices (see, e.g., Hertwig and Ortmann (2001)), introducing a host of issues related to subject pool contamination, rational expectations, and experimental ethics.

To solve this problem, I employ a unique hybrid of a field and lab experiment. Real online daters were recruited to rate profiles to which age was randomly assigned. Participants were informed that the profiles themselves were hypothetical, but that their ratings would be used to customize professional dating advice on how to attract partners that fit their preferences.

Because recruitment ads promoted this compensation, and participants spend their time on the study in expectation of receiving it, it can be assumed they place value on the dating

the age penalty were driven entirely through attractiveness, policymakers might consider a botox subsidy instead.

advice and therefore want to increase its quality. The best way to do so is to respond accurately regarding their preferences over the hypothetical profiles. Thus, researcher and subject incentives are aligned. This type of non-monetary incentive structure for rating hypothetical objects has been expanded to study employer preferences in Kessler, Low and Sullivan (2019), where employers rated hypothetical resumes and then received recommendations of real candidates in return, in lieu of a deceptive audit study. The model of using advice to incentivize truthful survey answers could be used to provide incentives for experiments in many other settings, ranging from investment portfolio choice to real estate tastes to job seeker valuations of firm amenities.

For the initial sample, subjects were recruited using online ads, placed on dating sites such as Match.com or OKCupid, or linked to searches of dating-related keywords. A sample Google ad is shown below:

A Better Dating Profile

Single & 30-40? Take this survey &

get expert dating profile advice!

www.columbiadatingstudy.com

Following the implementation of this initial experiment, I conducted a second experiment with a larger sample in order to test for heterogeneity in men's preferences for age. In order to recruit the larger sample and test the external validity of my results, I enlisted a survey firm, Qualtrics, to recruit respondents. This second population was also incentivized with the free dating advice, but may have valued it less due to being offered other incentives Qualtrics typically gives to survey respondents on their panels (e.g., frequent flyer miles, gift certificates, raffles). As these respondents were not exclusively interested in receiving dating advice, they may be a more general population than the initial sample.

Subjects were recruited to be single, heterosexual, between the ages of 30 and 40, and white. The ages of 30-40 were chosen because the profiles were going to be in this age range. White raters (and profiles) were chosen to avoid the noise from cross-racial ratings. In the initial recruitment, which I will call the "Web Ad sample," 151 men and 168 women rated at least one profile. However, I restrict my main analysis to those who completed all 40 ratings and reached the post-survey, as well as those meeting the race and age eligibility requirement, leaving 36 men (1440 observations) and 45 women (1800 observations), and

show robustness to other sample decisions. The Qualtrics sample contains only completed responses, comprising 202 men (8080 observations) and 101 women (4040 observations).[4]

To generate the hypothetical dating profiles, I purchased stock photos that were similar in appearance to photos on dating websites, and of ambiguous age, meaning no balding or gray hair, no obvious facial wrinkles, and no overly youthful hairstyles or clothing. I then had 120 undergraduate students rate each photo's physical attractiveness and guess the age of the individual in the photo.[5] The final 40 photos of each gender were selected to balance attractiveness and visually perceived age between the male and female profiles (with photos with a visually perceived age outside 30-40 removed).

A random username, height, and three interests were then assigned to the photos to create 40 male and 40 female dating profiles. The usernames were assigned by using the top 40 names for men and women from the decade of birth for 30-40-year-olds, then assigning a random three-digit number. The heights were assigned randomly from a normal distribution using the mean and standard deviation of heights for white men and women. Gender-neutral interests were assigned from a list of top hobbies, with more popular interests being assigned more frequently. All profiles listed the person as "looking for: serious relationship," in order to signal that the rater should consider this person as a potential long-term partner. Each of these characteristics were assigned to the profile and remain fixed throughout the experiment.

Then, as each profile was shown, age and income were randomly assigned at the rater-profile level: age between 30 and 40 (inclusive), and an income range from roughly the 25th to 95th percentile for single individuals with at least an associate's degree in the 2010 Census. Each respondent would see the same picture and other profile details, but paired with a different income and age. The random variation in age isolates it from other factors that may be correlated with it, such as physical attractiveness. Income also being randomly assigned provides a "numeraire" by which to quantify the preference for age.

The experiment proceeded as follows: After reviewing a consent form, respondents were

[4]In order to test for heterogeneity in men's preferences, male respondents in the Qualtrics sample were enrolled at a 2:1 ratio to female respondents. The extra sample was drawn from the higher end of the income distribution, with the objective of better mirroring the general population (Qualtrics respondents, in absence of this sampling concentration, tended to be lower-income). Additionally, 1 man in the Web Ad sample, 5 men in the Qualtrics sample, and 3 women in the Qualtrics sample were dropped due to using a javascript blocker, which blocked the random assignment of age and income to the profiles.

[5]This guessed age is also used to construct the "*Visual age* − *age*" variable. Students were recruited from an introductory econometrics class and given course credit for their participation.

shown a series of dating profiles, and asked for each one, "How interested would you be in dating this person, on a scale from 1 (not interested) to 10 (very interested)?" After 10 profiles, respondents were asked to rank the previous 10 profiles in terms of who they were most interested in, both to provide a break between rating sessions, and as an attention check. The correlation between the ratings and rankings is high, providing validation of the incentives for careful rating being operative. Moreover, as a robustness check, I exclude responses with a low correlation. Following rating all 40 profiles, respondents completed a brief post-survey including demographic information, dating preferences, and, finally, their knowledge of age-fertility limits for men and women. For additional details on the experimental methodology, as well as data summary statistics and histograms of ratings, see Appendix A.

I identify the effect of randomly assigned ages on ratings for men rating women and women rating men, using the specification:

$$Rating_{ij} = \beta_0 + \beta_1 age_{ij} + \beta_2 income_{ij} + \alpha_i + \theta_j + u_{ij},$$

where $Rating_{ij}$ is the rating on a 1-10 scale that individual i gives profile j. Age and income are assigned at the rater–profile level. Because each individual rates 40 profiles, and each profile is seen by multiple individuals, both rater, α_i, and profile, θ_j, fixed effects can be accounted for.[6]

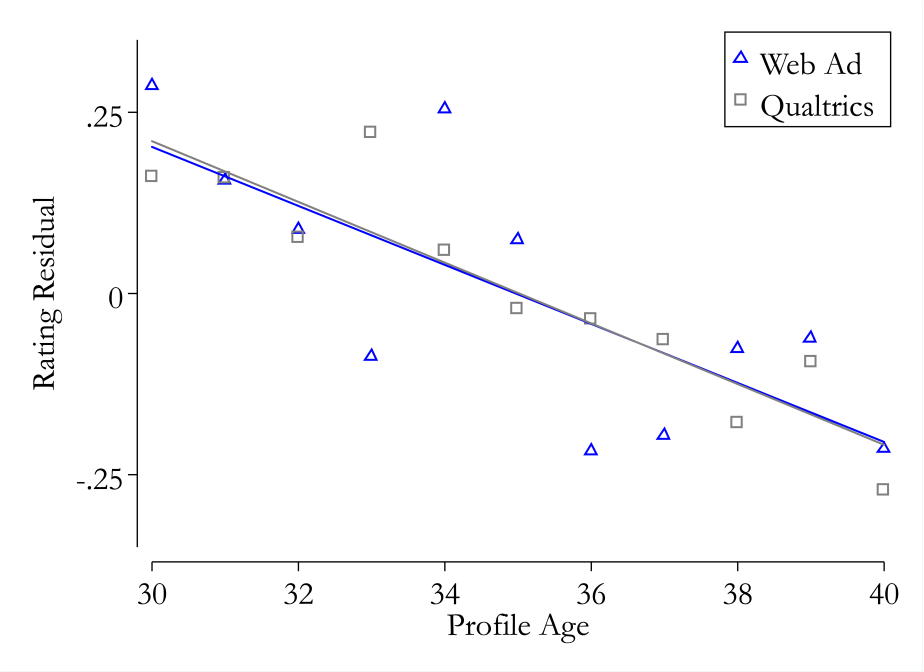
3 Men's Preferences Over Age

Figure 1 shows men's preferences for age by first regressing ratings on rater and profile fixed effects, to remove noise, and then plotting the average rating residual versus each age shown. Ratings are on average about a half point lower for a profile with a listed age of 40 versus one with a listed age of 30. This preference is present—and nearly identical—in both the Web Ad sample and the Qualtrics sample. I first discuss results from the Web Ad sample in more detail.

Table 1 shows a regression of ratings on randomly assigned profile age and income in

[6]Where no interactions are included between rater and profile characteristics, I present heteroskedasticity-robust standard errors, since "group status"—the rater—is not correlated with the x variable of interest, age, due to the random assignment. When examining heterogeneity among respondents, I present standard errors clustered at the respondent level. See: Angrist and Pischke (2008), page 311.

Figure 1: Men's Preferences for Women's Age



Notes: Web Ad data from 36 men (1440 observations) and Qualtrics data from 202 men (8080 observations). Ratings, on a 1-10 scale, are regressed on rater and profile fixed effects, with the residuals plotted against profile age.

the Web Ad sample. Column (1) shows that for male raters, each year of women's age is associated with a 0.044 decrease in rating, significant at the 1% level. Thus, if a woman is 10 years older, she will be rated almost a half point lower on average. A woman who is $10,000 poorer is rated 0.06 points lower; thus to make up for each additional year of age, a woman must earn approximately $7,000 more.

Column (2) shows the sharp contrast between men's and women's preferences for age: while men rate women lower when the profile is presented with a higher age, women rate men more highly when a higher age is shown. The large effect size on women's age preference may stem from their higher variance ratings. Whereas men display essentially a normal distribution in ratings with a mode of 6, women have a bi-modal distribution with peaks at 1 and 5, as shown in Appendix Figure A4.

The contrasting results for men versus women demonstrate that the negative relationship between a female profile's listed age and the rating cannot only be a "lemons" effect, where older women still on the market are expected to be less appealing. If men's negative

preference were explained by this channel, we would expect women rating men to show a similar aversion to age, although potentially less intense because men marry later.

Moreover, women's positive view of a male partner's age is consistent with a model where women know their own fertility time window is limited, and thus seek a partner who is equally ready to start a family as they are. If this is the case, we would see the preference be mostly driven by a preference for age homophily, or for a male partner who is a small amount older, consistent with the average marriage age gap, which I examine in Section 4.

Table 1: Age-Rating Relationship for Men vs. Women: Web Ad Sample

	Dependent variable: Profile rating					
Subjects:	Men	Women	Men			
	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.044***	0.131***	-0.024**	-0.049***	-0.048***	-0.087***
	(0.015)	(0.015)	(0.010)	(0.016)	(0.016)	(0.023)
Income ($0,000s)	0.061***	0.134***	0.023**	0.069***	0.069***	0.061***
	(0.016)	(0.016)	(0.011)	(0.018)	(0.017)	(0.016)
Visual age > age						-0.434***
						(0.161)
Constant	6.252***	-0.160	5.811***	6.426***	6.337***	8.099***
	(0.662)	(0.692)	(0.467)	(0.710)	(0.711)	(0.965)
Observations	1440	1800	3752	1280	1280	1440
R-Squared	0.471	0.394	0.487	0.460	0.446	0.474
Sample:	Eligible	Eligible	All	Opt in	High corr	Eligible

Notes: Regression of profile rating on randomly assigned age and income from Web Ad data. All columns contain rater and profile fixed effects. Columns (1) and (2) contain all respondents who rated 40 profiles, and are between 30 and 40 and white. Column (3) contains all male respondents who rated at least one profile. Column (4) restricts among the eligible sample from column (1) to those who did not opt out of having their email shared with the dating coach. Column (5) restricts among the eligible sample to those with a greater than 0.5 correlation between their ratings and rankings (this would not be expected to be perfect, since ratings can be repeated whereas rankings had to be 1-10). The sample for column (6) is the same as for column (1), with "Visual age" rated by undergraduate students. Robust standard errors in parentheses.

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

Columns (3)-(6) display several robustness checks for the men's results. First, I include all responses, including incomplete ones, and ones from men not meeting the age and race requirements. The coefficient on age remains negative and significant, although somewhat attenuated, possibly due to less interested or attentive responses from those who only partially completed the survey. Next, I restrict to only those who opted in to having their email address shared to receive the dating advice, at the end of the survey. This restricts to the group that is most motivated by the offered compensation. The coefficient on age is largely unaffected. Next, I use the correlation between the profile ratings and the "rankings" at

the end of each section as an attention check, and restrict to only those with a correlation above 0.5. This again has little effect on the coefficient.

Finally, I check whether photographic appearance versus reported age may be influencing the results. Photos likely *look* a certain age, and so when these photos are paired with higher ages, the person looks "good for their age," whereas when paired with lower ages the person looks "bad for their age." The appearance of the photograph itself is already controlled for through the profile fixed effect, but by adding a control for "Visual age > age," I control for the interaction between the photo's age and the reported age.[7] Indeed, having an appearance older than reported age has a negative and significant effect, and controlling for this only strengthens the main age effect.

Table 2: Age-Rating Relationship for Men vs. Women: Qualtrics Sample

	Dependent variable: Profile rating					
Subjects:	Men	Women	Men			
	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.043***	0.028***	-0.062***	-0.046***	-0.053***	-0.047***
	(0.006)	(0.010)	(0.009)	(0.010)	(0.008)	(0.009)
Income ($0,000s)	0.032***	0.036***	0.007	0.025**	0.035***	0.032***
	(0.007)	(0.010)	(0.009)	(0.011)	(0.009)	(0.007)
Visual age > age						-0.044
						(0.067)
Constant	6.250***	3.340***	7.475***	6.585***	9.999***	7.226***
	(0.435)	(0.552)	(0.426)	(0.468)	(0.356)	(0.407)
Observations	8080	4040	4040	3160	4960	8080
R-Squared	0.490	0.463	0.479	0.489	0.476	0.490
Sample:	Eligible	Eligible	Natural	Opt in	High corr	Eligible

Notes: Regression of profile rating on randomly assigned age and income from Qualtrics data. All columns contain rater and profile fixed effects. Columns (1) and (2) contain all respondents who rated 40 profiles, and are between 30 and 40 and white. Column (3) restricts male respondents to those who were in the "natural" income distribution, excluding those over-sampled based on high income. Column (4) restricts among the eligible sample from column (1) to those who did not opt out of having their email shared with the dating coach. Column (5) restricts among the eligible sample to those with a greater than 0.5 correlation between their ratings and rankings (this would not be expected to be perfect, since ratings can be repeated whereas rankings had to be 1-10). The sample for column (6) is the same as for column (1), with "Visual age" rated by undergraduate students. Robust standard errors in parentheses.

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

Next, I examine whether these same preferences hold in the second, larger sample gathered from Qualtrics, before using this larger sample to examine the drivers of men's preferences.

[7] "Visual age" was rated by undergraduate students.

Table 2 exhibits the same tradeoff between age and rating for male respondents, despite the different recruitment technique. In fact, the coefficient on age is remarkably similar between the two samples. The contrasting positive coefficient for women is also present in this sample.

Again, I conduct some robustness checks, first limiting the sample to the "natural" sample without oversampling high-income men in column (3), which slightly increases the size of the coefficient.[8]

Column (4) restricts to those who opted in to receiving the dating advice, which in the case of the Qualtrics sample drops a large number of respondents. The similarity between columns (1) and (4) confirms that even those who were not motivated by the dating advice appeared to rate profiles carefully, and share similar preferences. Dropping those with a low correlation between rating and ranking cuts the sample but does not alter the coefficient or its significance. And, controlling for "Visual age > age" does not change the significance of the main coefficient, although in this case it does not have a significant effect itself.

This robust negative preference for age by men on the marriage market shows that aging carries not just a personal cost to women, but an economic one, impacting the quality of partner they can attract for the same level of other positive attributes, such as income. In the next section, I delve further into the drivers of men's preferences.

4 Drivers of Preference

Having isolated age from other characteristics and demonstrated that men exhibit a robust negative preference over it, I now dive into mechanisms for this preference. My main candidate preference is fertility, as fertility changes asymmetrically between men and women with age, and naturally relates to marriage market surplus. In this section, I rule out some potential alternative explanations for men's negative preference for partner age, before providing evidence that this preference stems from fertility, using the larger Qualtrics sample. To do this, I use rater characteristics to examine how different rater traits interact with or impact the preference for age.

[8]Looking at this lower-income sample sheds some light on the one difference between the Qualtrics and Web Ad results: the Qualtrics sample places a lower value on income. When we restrict to the low-income portion of the Qualtrics sample, the coefficient on income reduces further, demonstrating that perhaps this lower valuation on income comes from the Qualtrics sample containing more very low-income men than the Web Ad sample (and preferences for income being of the super-modular form, where the valuation of partner income increases in own income).

I first examine how the interaction between rater age and profile age may impact preferences, and thus whether preference for age homophily or other social norms explain the apparent distaste for age for either men or women. We know that it is socially normal for husbands to be older than wives, and in fact for husbands to be approximately two years older than wives, both in observational data, and as estimated in preference decompositions (Hitsch, Hortaçsu and Ariely, 2010; Choo and Siow, 2006; Buss, Shackelford and LeBlanc, 2000). Table 3 first controls for the profile age being older than the rater's age, for men (column 1), or younger than the rater's age, for women (column 4). This coefficient is not significant in either case, although for women including it does halve the main effect of *Age*, demonstrating the importance of relative age in women's preferences, and absolute age for men.

Table 3: Relative Age Preferences: Qualtrics Sample

	Dependent variable: Profile rating					
	Men			Women		
	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.051***	-0.040***	-0.024**	0.019	0.036**	0.004
	(0.012)	(0.009)	(0.010)	(0.016)	(0.015)	(0.012)
Income ($0,000s)	0.032***	0.032***	0.032***	0.036**	0.035**	0.035**
	(0.009)	(0.009)	(0.009)	(0.014)	(0.014)	(0.014)
Age > rater age	0.084					
	(0.076)					
Age < rater age				-0.098		
				(0.134)		
(Age diff)^2		-0.004***			-0.008***	
		(0.001)			(0.002)	
(Age diff $\pm$ 2)^2			-0.004***			-0.008***
			(0.001)			(0.002)
Observations	8080	8080	8080	4040	4040	4040
R-Squared	0.490	0.491	0.491	0.463	0.468	0.468

Notes: Regression of profile rating on randomly assigned age and income from Qualtrics data. All columns contain rater and profile fixed effects. Columns (1) and (4) control for the random profile age being older, for men, or younger, for women, than the rater. Columns (2) and (5) control for profile age minus rater age, squared. Columns (3) and (6) control for profile age minus rater age plus two, for men, or minus two, for women, squared. Robust standard errors in parentheses, clustered at the rater level.

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

Next, I examine whether the taste could, instead, be for similarly aged partners, rather than a secular negative preference for age. Column (2) controls for the age difference squared (i.e., a quadratic loss function in distance from equal ages), and finds that indeed this is significantly negative for men, but controlling for it has no impact on the coefficient on age

itself. The coefficient is also negative and significant for women (column 5), and twice the size. I next perform a rescaling, instead controlling for the profile age minus the rater age plus two, for male raters, or minus two, for female raters, squared–i.e., the distance from the "socially ideal age difference," squared. Note that the coefficient on this variable will be identical to that measured in the previous exercise, but rescaling it in this way accounts for the impact on the main age coefficient, removing two years of age difference from the coefficient on age. Accounting for this reduces the coefficient for men, mechanically, but does not eliminate its significance. In other words, men may prefer a women two years younger than himself, but they prefer even younger women more.

In the case of women, we see that accounting for the "ideal" two-year age difference is enough to completely eliminate the apparent preference for older partners. Thus, this apparent preference for older men can be entirely accounted for by preferences over *relative*, rather than absolute, age. This preference could itself be driven by a personal awareness of time-limited fertility, and thus the need to seek a partner on a similar timeline for starting a family. Appendix Table A2 shows that a strong preference for age similarity by female raters also explains the apparent positive preference for age by women in the Web Ad sample.

Now that I have ruled out age homophily as the driver of men's negative age preference, I establish evidence that tastes over fecundity are, in fact, the source of this preference, as well as ruling out that the preference reflects beliefs about youth-correlated personality traits. The first strategy I use to do this is to interact age with rater characteristics that may make men care more or less about fertility, with potentially asynchronous impacts on preferences for other youthful traits. The characteristics examined are wanting to get married, *Want marr*, wanting kids, *Want kids*, having no children, *No kids*, and having accurate knowledge of the age–fertility tradeoff, *Knowledge*. These variables create different cuts of the data, grouping men together who are dissimilar in other ways, but each with reason to care more about fertility in a potential partner. The first two, wanting marriage and wanting kids, might be expected to be correlated with a lower preference for a youthful personality.

Each of these are interacted with the main explanatory variable, *Age*, while the main effect for each rater characteristic is absorbed by the rater fixed effects. Table 4 demonstrates that when each of these characteristics is interacted with profile age, the interaction is negative and significant, while the main effect gets smaller. First, in column (1), we see that men who want to get married dislike age *more* than men who may be looking for

more casual relationships. This provides some evidence of fertility as a driver, since if the preference was for the amenity value of younger women, we may expect men who do not want to get married to value it more. Similarly, in column (2), we see that men who want children soon also demonstrate a stronger preference for younger partners.

These both provide evidence for the fecundity channel over age-correlated personality traits, since those wishing to marry and have children might be expected to value maturity over a wild, carefree personality, and yet we see that they actually value younger partners more strongly.

Table 4: Fertility Mediators: Qualtrics Sample

	Dependent variable: Profile rating (Male subjects)					
	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.028**	-0.033***	0.002	-0.007		
	(0.011)	(0.009)	(0.019)	(0.010)		
Income ($0,000s)	0.032***	0.032***	0.032***	0.032***	0.033***	0.033***
	(0.009)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)
Want marr × age	-0.032*					
	(0.019)					
Want kids × age		-0.055*				
		(0.032)				
No kids × age			-0.055**			
			(0.021)			
Knowledge × age				-0.057***		
				(0.017)		
Age − cutoff					-0.043***	-0.013
					(0.010)	(0.013)
Age − cutoff, −10 to 0						-0.054***
						(0.020)
Observations	8080	8080	8080	7800	7600	7600
R-Squared	0.490	0.491	0.491	0.488	0.479	0.480

Notes: Regression of profile rating on randomly assigned age and income from Qualtrics data. All columns contain rater and profile fixed effects. Column (1) interacts profile age with whether the rater wants to get married. Column (2) interacts age with whether the rater wants kids. Column (3) interacts age with whether the rater has no children currently. Column (4) interacts age with whether the rater is aware that fertility declines for women before age 45. Column (5) uses as the independent variable profile age minus the rater's estimated age at which fertility declines for women. Column (6) allows the impact of this variable to be differential between the time period of ten to zero years before the fertility decline. Robust standard errors in parentheses, clustered at the rater level.

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

In column (3), I look at whether men already have children, as having no children currently may be a stronger indicator of seeking the option value to have kids than stated preferences. As expected, men with no kids have a very strong preference for younger women. In fact, with this interaction term inserted, the main effect of age becomes zero,

indicating that men who already have children have *no preference* over randomly assigned age. This provides strong evidence that the preference being identified is really a preference over fertility, as other possible factors would be unlikely to diverge so strongly between men who have children and those who do not.

Column (4) interacts age with knowledge about fertility. The variable "Knowledge" represents the rater being aware that women's fertility begins to decline before age 45, from the question, "At what age does it become biologically difficult for a woman to conceive?" in the post-survey.[9] For men who lack such knowledge, there is again *no preference* over age—the main effect is statistically zero—whereas for the knowledgeable men the negative perception of age is much stronger. Taken together, this table shows that the age preference found by this experiment is driven by men who have reason to care about fertility and have the knowledge to connect age to fertility.

Together, these results suggest that at least some of the observed preference for younger partners stems from preferences for fertility. If the negative coefficient on age instead captured a latent preference for attractiveness or other youthful qualities, whether or not the man wants to have children or knows about the age-fertility relationship should have no bearing on the strength of his preference. The zero coefficient for those who already have children and those with inaccurate knowledge rules out that there are other asymmetrically valued age-correlated traits that drive the negative age preference, since there is no reason these particular groups should value those other features less. These findings are consistent with a model of agents rationally maximizing utility: those with stronger preferences for children and more knowledge to act on these preferences penalize older partners more.

Columns (5) and (6) take advantage of the heterogeneity in men's stated beliefs as to when female fecundity begins to decline to create a metric of how many year's "past infertile" the profile is in the rater's mind. For example, if the profile's age is 30 and the rater believes fertility declines at 50, the age minus the cutoff is -20. Column (5) shows that this variable has a similar coefficient as that on age.

The advantage of this variable is that it has a much larger range, as the 30-40 year age range of the profiles may not have been large enough to show any non-linearity that would

[9] Although fertility declines earlier than 45, the idea is to separate those who hold beliefs who are close to accurate and for whom the age range 30-40 would be relevant in terms of fertility from those who believe age in that range would not yet impact fertiity.

be associated with the fertility decline. If fertility is driving the negative age preference, we would expect aging that takes place closer to the time when a woman may begin to have difficulty conceiving to be viewed more negatively than aging that is far before or far after this threshold. Column (5) shows exactly the expected non-linearity, by allowing *Age − Cutoff* to have a different slope when between the years -10 to 0, i.e., when approaching the fertility decline.[10] This coefficient is negative and significant, and larger than the main age effect—when it is included, the effect of age outside this range remains negative, but becomes insignificant.

Appendix Figure A5 graphically shows the non-linearity in the relationship between ratings and years to the fertility cutoff, using a lowess function. Interestingly, when more than ten years from the fertility cutoff, the lowess is actually upward sloping, then steeply negative from -10 to zero, and finally it levels off past zero, with further increases in ages not further decreasing ratings. Together, this evidence paints a strong picture that the negative preference for age when it is randomly assigned stands in for fertility preferences, and thus that fertility plays a large role in men's negative preference for age in female partners more generally.

5 Conclusion

From Hollywood films to online dating site data[11] it seems evident that men prefer younger women. And, given that having children may be one reason that people marry, it is natural to think that fecundity might affect women's marriage market appeal. However, since individuals' incomes, lifestyles, and appearances also change with age, it is difficult to separate fertility from other factors. Thus, I designed an experiment specifically to measure the causal impact of age on men's marriage market preferences, separate from other factors that change with age in observational data.

Through this experiment, I find that for every year a woman ages past 30, she must make an additional $7,000 to receive equally high ratings from potential male partners. The experiment's unique design also controls for attractiveness, by randomly assigning age to dating profiles where the picture is held constant. Moreover, I show that this preference

[10] It should be noted that this analysis is only suggestive, as the extreme values of the *Age − Cutoff* variable are necessarily driven by those who have extreme answers to when they believe the fertility decline begins, either very high or very low.

[11] OK Trends, "The Case for an Older Woman," February 16th, 2010.

over age is only present for men who have no children of their own, and have accurate knowledge of the age-fertility tradeoff, further connecting it to fertility.

This finding indicates that men also hear the ticking of the biological clock. Seeking to marry and have children, they naturally prefer more fertile partners. Women thus face a tradeoff: human capital investments increase earnings, but take up crucial time during the reproductive years, as it is difficult to co-process career investments and family formation. This loss of reproductive capital may cost them real economic returns on the marriage market, despite human capital itself being a positive trait. This tradeoff for women pursuing time-consuming human capital investments could potentially be alleviated through policies focused on making it easier to co-process career investments and children, extending the fertility time window, and making career re-entry and investments possible later in life.

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Online Appendix

A Methodology

Figure A1 shows the instructions participants saw and how the dating advice was described to them.

Figure A2 and Figure A3 shed more light on the experimental design by showing the profile and rating screen shown to participants, as well as a sample of the photos used to create the dating profiles. In addition to the rating screen, after rating 10 profiles, respondents were asked to rank them, as an attention check for their ratings. Finally, after completing rating 40 profiles, respondents were asked to complete a post-survey about their own characteristics as well as their age targets in a potential mate and expectations about fertility.

Figure A1: Instruction Screen

Thanks for participating! When you click ">>" on this screen, a profile of a hypothetical partner will appear. You will be asked to rate that profile on a scale of 1 to 10 indicating how interested you would be in dating that person. A 1 is not interested at all, and 10 means very interested. Please carefully consider your level of interest in the profile presented before choosing an answer. At the end of 10 profiles, you will be asked to order the profiles according to who you would prefer to date most and who you would prefer to date least. This procedure will continue until you have rated 40 profiles, at which point you will move on to the background and dating preferences questions.

As part or your compensation, you are being offered customized advice from a professional dating coach on optimizing your online dating site profile to appeal to the type of partner you want, as well as a 30-minute phone consultation with the dating coach. This personalized advice will be based on your ratings in this study, so it's important that you rate according to your own preferences, thinking carefully about how interested you would be in the person depicted.

Click >> when you're ready to start!

Instructions shown to participants immediately prior to rating profiles.

Table A1 presents summary statistics for the post-survey, for my target sample of white

Figure A2: Sample Profile Image and Rating Screen

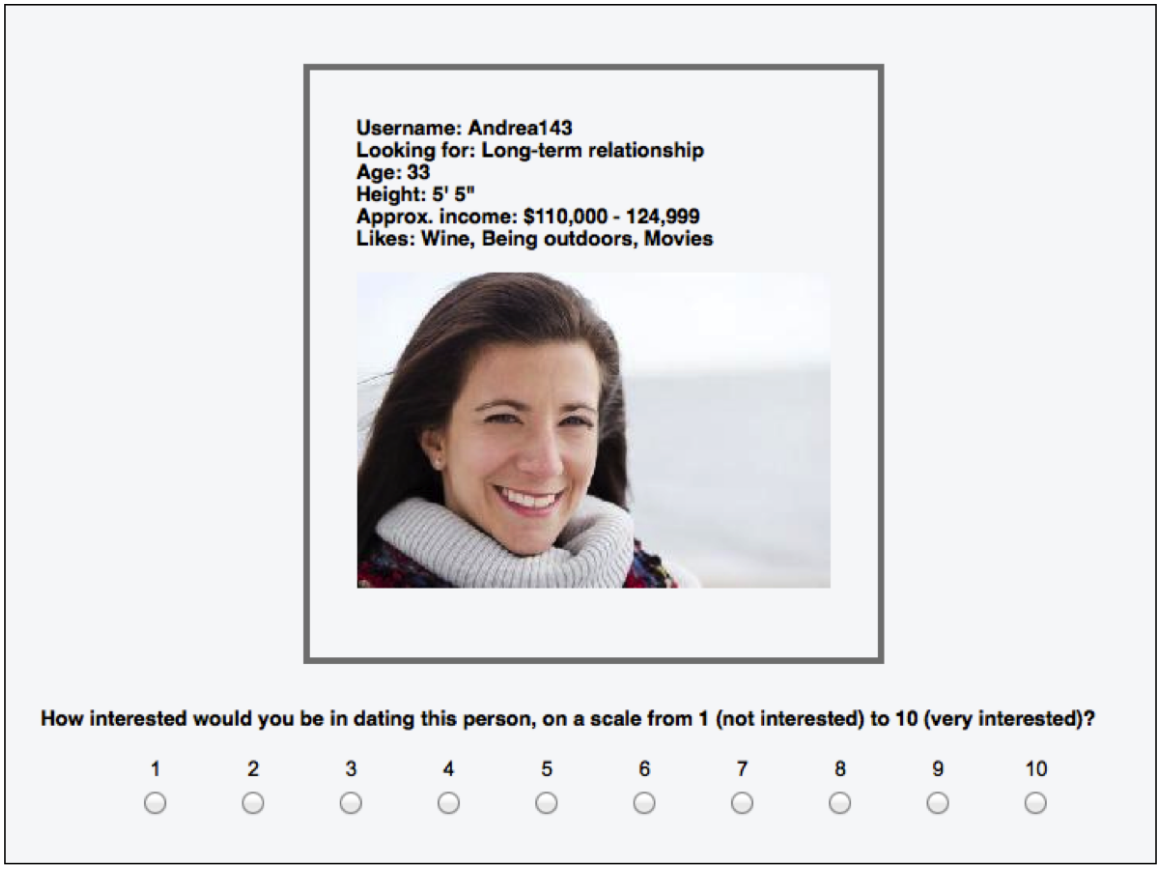


Image depicting profiles shown to study participants. Age and income are randomly assigned for each rater - profile pair, while other characteristics are initially randomly combined, and then fixed to a profile.

individuals between 30 and 40.[12] Without these restrictions, in the initial sample 77% of male and 78% of female participants are white, and 74% fall within the targeted age range. In the Qualtrics sample all individuals are white and within the specified age range, due to pre-screening by Qualtrics.

Men and women taking the survey display similar characteristics, although the men are more likely to be high-income, defined as income over $65,000 per year, in the initial sample. Where men and women differ substantially is their stated preferences for the age

[12]The consent form required respondents to certify that "I am between 30 and 40 years old, currently single, and seeking a partner of the opposite gender." However, in the post survey, some initial-sample respondents listed birth years outside the 30-40-year-old range. In my main specification, I exclude these responses. Also, although the profiles feature only white men and women, I did not restrict the race of respondents, so I also exclude non-white respondents during the analysis phase, since cross-racial rankings may be driven by different factors. For the Qualtrics sample, respondents were pre-screened based on race, relationship status, and age.

Figure A3: Example Profile Photos

(a) Women

(b) Men

Notes: Samples of the stock images used to create dating profiles. Photos were chosen to be of ambiguous age in the 30-40 range, purchased from stock photo websites.

Table A1: Summary Statistics

	Web Ad Sample				Qualtrics Sample			
	Men N=36		Women N=45		Men N=202		Women N=101	
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Age	35.28	3.67	35.93	3.51	34.72	3.02	34.42	3.23
High Income	0.50	0.51	0.36	0.48	0.40	0.49	0.16	0.37
College Grad	0.67	0.48	0.69	0.47	0.49	0.50	0.47	0.50
Has kids	0.36	0.49	0.43	0.50	0.19	0.40	0.43	0.50
Wants (more) kids now	0.25	0.44	0.16	0.37	0.18	0.39	0.18	0.38
Wants marriage	0.47	0.51	0.43	0.50	0.47	0.50	0.44	0.50
Date lowest age	25.86	3.62	32.95	3.93	24.89	4.36	30.09	4.13
Date highest age	40.86	5.49	46.86	6.92	41.64	6.13	44.17	7.38
Preferred low	28.58	3.74	35.30	4.32	27.06	4.73	32.62	4.38
Preferred high	37.28	4.60	44.20	6.34	37.49	5.58	41.38	6.73
Fem Fert cutoff?	1.00	0.00	1.00	0.00	0.97	0.16	0.99	0.10
Fem cutoff age	41.36	6.37	39.67	4.72	43.13	7.18	41.13	6.31
Male fert cutoff?	0.89	0.32	0.77	0.43	0.83	0.38	0.80	0.40
Male cutoff age	54.09	8.70	55.45	8.46	51.99	9.02	56.88	8.87

Notes: Summary statistics for in-sample men and women from online dating experiment. High income is classified as earning over $60,000 annually. The fertility variables ask if there is an age at which it becomes biologically difficult for women or men to conceive, and then what that age is.

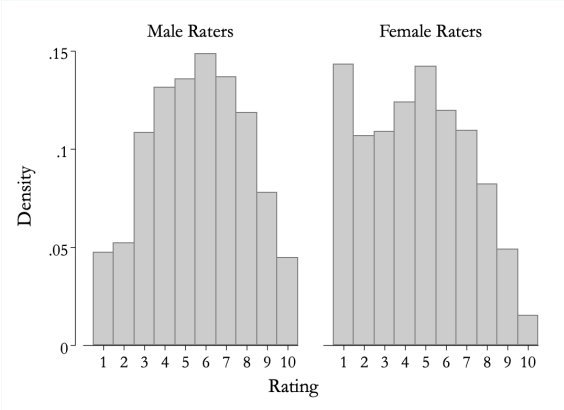
of their partner. In the initial sample, men state on average that the youngest they would date is a 26-year-old and the oldest is a 41-year-old, whereas women state averages of 33 and 47. When it comes to their preferred dating range, men look for women aged 29 to 37, whereas women seek partners between the ages of 35 and 44. This pattern provides some preliminary evidence that men have differential preferences over their partner's age, compared to women.

The final questions on the survey ask men and women at what age they believe it becomes biologically difficult for members of each gender to conceive a child. 100% of initial-sample respondents believe there is a cutoff for women (97% of men and 99% of women in the Qualtrics sample), indicating that there is some knowledge of differential fertility decline, whereas 89.2% of men and 76.7% of women believe that such a cutoff exists for men. Female respondents put the start of the fertility decline for women somewhat earlier than male respondents, at 39.7 years, as compred to 41.2 for men. Both male and female respondents, conditional on thinking there *is* a cutoff, believe the cutoff to be higher for men.

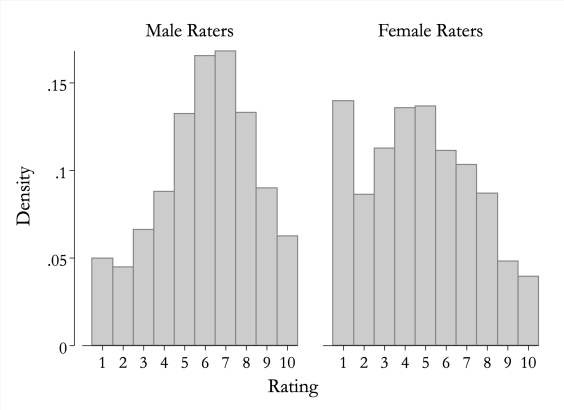
Figure A4 shows histograms of men's and women's ratings in both samples. Men's

Figure A4: Rating histogram for male and female raters

(a) Web Ad data



(b) Qualtrics data



Notes: Web Ad data from 36 men (1440 observations) and 45 women (1800 observations). Qualtrics data from 202 men (8080 observations) and 101 women (4040 observations).

ratings are roughly normally distributed while women's ratings contain some stacking at the lowest rating of "1."

B Additional Results

B.1 Drivers of preferences in the Web Ad sample

This section repeats the analysis from Section 4 with the Web Ad sample, showing consistent results. The smaller sample makes these results noisier than with the Qualtrics sample.

Table A2 shows that preference for age similarity does not explain the negative preference for age by male raters in the Web Ad sample. It does, however, explain the positive preference by female raters. Once the quadratic loss function for distance from the two-year "socially normal" age gap is accounted for, the female age preference is much smaller and no longer statistically significant. This preference would be consistent with women seeking partners similarly interested in starting a family as they are, aware of their own ticking biological clocks.

Table A3 shows that some of the fertility heterogeneity results also hold in the Web Ad sample, although with the exception of knowledge over the fertility decline, the interactions are not significant (as might be expected when examining heterogeneity in a smaller sample). The interaction on "Want marr" is the wrong sign in this sample, but with a large standard error. We still see, however, that age is penalized significantly more within ten years of the rater's subjective "cutoff age" when female fertility declines.

Table A2: Relative Age Preferences: Web Ad Sample

	Dependent variable: Profile rating					
	Men			Women		
	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.032*	-0.044**	-0.037**	0.117***	0.100***	0.033
	(0.018)	(0.018)	(0.018)	(0.040)	(0.024)	(0.026)
Income ($0,000s)	0.060***	0.061***	0.061***	0.134***	0.136***	0.136***
	(0.021)	(0.022)	(0.022)	(0.023)	(0.023)	(0.023)
Age > rater age	-0.152					
	(0.172)					
Age < rater age				-0.169		
				(0.239)		
(Age diff)^2		-0.002			-0.017***	
		(0.002)			(0.003)	
(Age diff $\pm$ 2)^2			-0.002			-0.017***
			(0.002)			(0.003)
Observations	1440	1440	1440	1800	1800	1800
R-Squared	0.471	0.471	0.471	0.394	0.418	0.418

Notes: Regression of profile rating on randomly assigned age and income from Web Ad data. All columns contain rater and profile fixed effects. Columns (1) and (4) control for the random profile age being older, for men, or younger, for women, than the rater. Columns (2) and (5) control for profile age minus rater age, squared. Columns (3) and (6) control for profile age minus rater age plus two, for men, or minus two, for women, squared. Robust standard errors in parentheses, clustered at the rater level.

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

B.2 Non-linearity in preferences over age

Figure A5 examines non-linearity in men's preferences over their partners' ages, using the heterogeneity in men's responses to the question "at what age do you think it becomes biologically difficult for a woman to conceive?" in the Qualtrics sample. First, ratings are regressed on profile and rater fixed effects, and residuals are captured. I then lowess-smooth the plot of residuals against profile age minus the rater's expected fertility cutoff. The graph reveals that years at least ten years before the fertility cutoff have a positive relationship with ratings. There is then a steeply negative relationship from ten years before up to the fertility cutoff. A few years after the fertility cutoff, the relationship becomes flat, with additional years no longer decreasing ratings. Note, these results should be taken as suggestive only, given that very high and very low values on the x-axis can only occur when individuals have outlier views of the age of fertility decline.

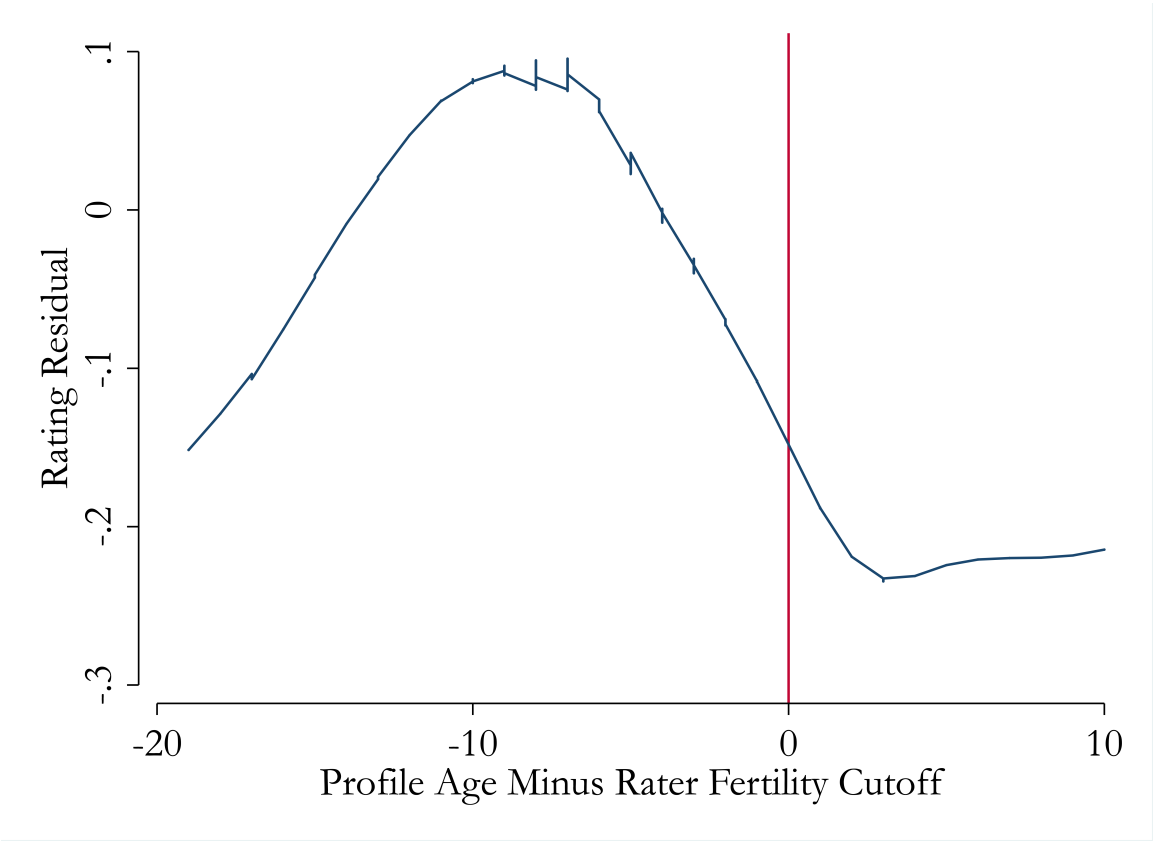
Table A3: Fertility Mediators: Web Ad Sample

	Dependent variable: Profile rating (Male subjects)					
	(1)	(2)	(3)	(4)	(5)	(6)
Age	-0.053***	-0.031	-0.029	0.015		
	(0.017)	(0.021)	(0.036)	(0.026)		
Income ($0,000s)	0.061***	0.062***	0.062***	0.061***	0.061***	0.061***
	(0.021)	(0.022)	(0.021)	(0.021)	(0.022)	(0.021)
Want marr × age	0.019					
	(0.036)					
Want kids × age		-0.048				
		(0.047)				
No kids × age			-0.022			
			(0.041)			
Knowledge × age				-0.079**		
				(0.036)		
Age − cutoff					-0.044**	0.030
					(0.018)	(0.022)
Age − cutoff, -10 to 0						-0.108***
						(0.038)
Observations	1440	1440	1440	1440	1440	1440
R-Squared	0.471	0.472	0.471	0.473	0.471	0.474

Notes: Regression of profile rating on randomly assigned age and income from Web Ad data. All columns contain rater and profile fixed effects. Column (1) interacts profile age with whether the rater wants to get married. Column (2) interacts age with whether the rater wants kids. Column (3) interacts age with whether the rater has no children currently. Column (4) interacts age with whether the rater is aware that fertility declines for women before age 45. Column (5) uses as the independent variable profile age minus the rater's estimated age at which fertility declines for women. Column (6) allows the impact of this variable to be differential between the time period of ten to zero years before the fertility decline. Robust standard errors in parentheses, clustered at the rater level.

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

Figure A5: Nonlinearity in Ratings over Time to Infertility



Notes: Qualtrics data from 202 men (8080 observations). Lowess estimation of residuals from ratings regressed on profile and rater fixed effects, over time to rater-specific infertility cutoff.