REVEALED BELIEFS AND THE MARRIAGE MARKET RETURN TO EDUCATION*

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We develop a new methodology to estimate subjective beliefs from hypothetical-choice data. Our identification approach is based on the novel insight that by varying the amount of information on future realizations of stochastic variables, discrete-choice experiments can identify not only preferences but also subjective beliefs. We formally prove this result in a general setting and apply it to design a strategic survey instrument to measure Rajasthani parents' subjective beliefs over the joint distribution of girls' age of marriage, education, and marriage match quality. Our approach allows us to quantify the importance of perceived marriage market returns to education and youth, and perform various counterfactual simulation exercises. We find that eliminating the perceived marriage market return to education causes a 60% drop in the number of girls still in school at age 16, and almost none continue their education by age 18. Responses to our strategic survey instrument allow us accurately to predict realized schooling trajectories in follow-up data we collect from the same sample five years after our experimental data collection. *JEL codes:* I26, J12, C81.

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I. Introduction

It is widely recognized that educational investments depend on their perceived returns (Jensen 2012; Attanasio and Kaufmann 2014; Wiswall and Zafar 2015, 2021). In India, there are strong reasons to suspect that labor market returns are not the only relevant consideration. Between 2000 and 2020, Indian girls' secondary school enrollment more than doubled, while women's labor force participation shrunk by one-third.[1] Marriage has remained an important social institution over this period, yet the extent to which educational investments are motivated by the hope of securing a better marriage match is an open question.

In this article, we quantify the role that parents' beliefs about marriage market returns to schooling play in determining investments in girls' education in Rajasthan, India. Direct elicitation of beliefs is challenging in this context given the very low numeracy of the target population and the complex nature of the object of interest: namely, beliefs about marriage offer probabilities, and expected offer quality, at different ages and education levels of adolescent girls.[2] To make progress, we develop a new methodology: a hypothetical discrete-choice experiment that reveals beliefs from responses to scenarios that specify different amounts of information about future realizations of choice-relevant stochastic variables. Our revealed-belief methodology does not require respondents to express their beliefs as probabilities and can be easily deployed at scale. The structural belief and preference parameters that our approach yields are interesting in their own right and allow us to perform counterfactual simulation exercises to quantify the importance of beliefs for choice behavior.

We apply our approach to measure average preferences and beliefs about marriage market returns to youth and education for a sample of 4,500 caregivers with adolescent daughters in Rajasthan, India. We use our structural estimates to

1. Women's secondary school enrollment in India rose from 37% in 2000 to 75% in 2020, while women's labor force participation declined from 32% to 24% over the same period. See https://data.worldbank.org/indicator/SE.SEC.ENRR.FE?locations=IN and https://data.worldbank.org/indicator/SL.TLF.ACTI.FE.ZS?locations=IN.

2. Our study community is less educated than those in papers reviewed in Delavande, Giné, and McKenzie (2011) that directly elicited probabilities. Of our respondents, 78.9% have not attended a single year of school, and the average years of schooling was 1.5.

construct counterfactual schooling and age-of-marriage trajectories as we "turn off" returns to age and education in preferences and beliefs. This allows us to assess the economic significance of these different drivers of parents' choice. To validate the new methodology, we resurveyed respondents five years after the original data collection to collect information about the actual schooling and marriage choices they took for their daughters in the intervening years. This allows us to compare the schooling and marriage trajectories that transpired in reality with those predicted by our preference and belief estimates.

The revealed-belief methodology is based on a finite-horizon dynamic discrete-choice model with stochastic payoffs to a terminal action. The framework can capture the core features of Rajasthani parents' decisions concerning the schooling and marriage of daughters. The framework also nests a large class of optimal-stopping problems and can be applied beyond this context. We formally prove that by varying the amount of information on future realizations of stochastic variables provided to respondents, discrete-choice experiments can identify not only preferences but also subjective beliefs. We use this result to design two sets of discrete-choice experiments that present respondents with different hypothetical vignettes concerning a daughter's marriage and education.

In the first set of ex post experiments, respondents were presented with vignettes in which all choice-relevant information was revealed, that is, the vignettes provided a set of complete realized descriptions of a daughter's age and education at marriage and groom characteristics. Respondents were asked to choose which option was preferred from the set. Choices in the ex post experiment identify parental preferences over girls' age of marriage, education, and match characteristics (Wiswall and Zafar 2018).[3] In the second set of ex ante experiments, respondents were not given all choice-relevant information. Instead, they were presented with vignettes that presented take-it-or-leave-it marriage offers from different grooms.[4] In these experiments, respondents faced uncertainty over the realization of future marriage offers. Thus, the expected value of rejecting a marriage offer was influenced by parents' beliefs about the probability of receiving

3. See also Banerjee et al. (2013), who ask families to rank responses to matrimonial adverts to estimate the strength of caste preferences in marriage in India.

4. That is, we collect state-dependent stochastic choice data (Caplin 2016).

different qualities of marriage offers in the future (Sautmann 2017). We call the beliefs that reconcile choices made with and without uncertainty over future marriage offers revealed beliefs.

We use our approach to estimate parents' average preferences over adolescent girls' education, age of marriage, the characteristics of a marriage match, and their subjective beliefs about the marriage offer distribution. In principle, we could have used our approach to elicit individual-specific parameters. However, doing so is data demanding and we could only collect a small number of experimental rounds per respondent.[5] More broadly, the revealed-belief methodology is best suited to applications where heterogeneity in average preferences and beliefs across subgroups are the primary objects of interest. Our approach can be seen as the "belief complement" to discrete-choice experiments that elicit average preferences and how average preferences vary across specific subgroups.[6] Estimating individual preferences and beliefs would also have necessitated asking respondents about the choices they would make for their own daughters. Social-desirability bias would have been a major concern in this case given legal reforms and widespread social and political campaigns targeting child marriage (Borkotoky and Unisa 2014).

We find that parents care a great deal about securing a high-quality marriage match for their daughter. They place particular weight on whether the groom has a government job, the most well-paid and secure form of employment in the area. Perceived marriage market returns to education motivate a significant portion of parents' investments in girls' schooling, especially college education. Conditional on a given marriage match, we find that parents dislike college education. However, they perceive that

5. See our companion website for simulation and estimation code that explores the precision of individual-level beliefs using our approach by the number of rounds of experimental data collection. Researchers could employ new techniques of adaptive survey design to choose the sequence of choice scenarios to maximise information (see Drake et al. 2022).

6. Despite recent work to improve the efficiency of discrete-choice experiments by choosing the sequence of comparisons respondents face optimally (Drake et al. 2022), we note that most discrete-choice experiments used to measure preferences ask each respondent only a handful of comparisons. Although this is insufficient to pin down individual-level preferences with meaningful precision, it allows for precise estimation of average preferences and how they vary by observed characteristics (Mas and Pallais 2017; Folke and Rickne 2022).

college dramatically increases the likelihood of their daughter marrying a high-quality groom. In counterfactual simulations where we eliminate the perceived marriage market return to education, the proportion of girls still in school at 16 years old more than halves, and the proportion still in education at 18 years old collapses to near zero. Parents believe a girl's marriage market prospects worsen with age immediately after leaving formal education. We show that this directly generates pressure for early marriage among girls who are pushed out of formal schooling by shocks. Counterfactual simulations indicate that a shock that pushes a 17-year-old girl out of school doubles the chance she will get married that year.[7]

To validate our estimates, we compare observed real-life marriage and education choices made by the same sample measured five years after our experimental data collection with those that we would predict on the basis of our estimated structural parameters. We find no statistically significant difference between the observed proportion of girls in school between ages 13–18 and those we would predict on the basis of our preference and belief parameters. For example, 25% of our survey respondents' daughters were still in school at age 18 compared with a model prediction of 23%. We find no statistically significant difference between observed and predicted marriage rates at age 18.[8] Our preference and belief estimates also accurately capture the magnitude of observed heterogeneity in outcomes by whether a daughter complies with gender norms and enjoys schooling.

Our findings contribute to three main literatures. First, this article contributes to a growing body of work that develops strategic survey instruments to identify structural primitives (Ameriks et al. 2020; Almås, Attanasio, and Jervis 2024; Stantcheva 2022). Our key methodological innovation is to develop a new choice-based method for eliciting probabilistic beliefs. We show that varying the amount of information in vignettes presented as part of discrete-choice experiments provides a route to measure be-

7. This complements work showing the importance of economic shocks for early marriage in contexts where marriage payments are the norm (Corno, Hildebrandt, and Voena 2020).

8. We note that our experimental estimates slightly overpredict marriage rates after age 18. As we discuss in Section VI.D, this could be due to changes in norms and preferences over the five-year period or the COVID pandemic shock that occurred between our experimental data collection and follow-up that effectively froze marriage markets.

liefs.[9] Alam, Mookerjee, and Roy (2022) draw on a similar insight to estimate perceived gender differences in managerial quality. However, their approach is tailored to settings where one wants to elicit the expected value of a continuous random variable in a static setting and can elicit a continuous measure of willingness to pay.[10] We provide a practical design appendix (Online Appendix C), in addition to general simulation and estimation code in a companion website, to support researchers applying the methodology to new contexts.

Our approach is particularly useful when researchers want to quantify the role of beliefs in driving choice behavior; this requires estimates of preferences and beliefs to construct counterfactual choices because beliefs are varied. Our approach also provides an alternative method when direct elicitation of subjective beliefs is challenging. Creative methods have been developed to help individuals report subjective beliefs (Manski 2004; Delavande, Giné, and McKenzie 2011; Wiswall and Zafar 2018; Boneva and Rauh 2018; Attanasio, Cunha, and Jervis 2019; Delavande and Zafar 2019; Dizon-Ross 2019). However, respondents can still find it difficult to understand and respond to probabilistic statements, and direct probabilistic elicitation is rarely attempted with respondents with very low levels of education.[11] The revealed-belief approach is supported by findings that respondents perform more accurately on tasks that involve relative or comparative judgments (like discrete-choice experiments) rather being asked for representations of absolute magnitudes (e.g., reporting probabilities) (Stewart, Brown, and Chater 2005; Benjamin 2019; Giustinelli, Manski, and Molinari 2022a,

9. The literature on choice under incomplete scenarios has traditionally highlighted the problems that can arise when asking people about their future intentions if they do not have all decision-relevant information (Manski, Wolpin, and Weber 2000). While other papers have elicited choice behavior across scenarios with different amounts of information about realized states of the world, these publications have not attempted to exploit variation in observed behavior to identify beliefs (Giustinelli and Shapiro 2019; Hudomiet et al. 2021).

10. The normalization issue that Alam, Mookerjee, and Roy (2022) raise with identification from choice probabilities in their context is not a problem in our own because of the structure of our dynamic discrete-choice problem. See Section II.B.

11. Respondents in our context are much less educated than those in the papers surveyed by Delavande and Rohwedder (2011). 78.9% of our respondents have not attended a single year of school and the mean number of years of school was 1.5. This is substantially lower than almost all other contexts where subjective probabilities have been elicited.

2022b). There is also growing evidence that individuals often learn and store information about the world by accumulating information about optimal choice behavior (Gilboa and Schmeidler 1995; Camerer and Hua Ho 1999; Erev and Roth 1998; Charness and Levin 2005; Cerigioni 2021; Barberis and Jin 2023; Ilut and Valchev 2023).[12]

Second, we contribute to the growing literature on marriage market returns to education (Fisman et al. 2006; Hitsch, Hortaçsu, and Ariely 2010; Lafortune 2013; Attanasio and Kaufmann 2017; Chiappori, Dias, and Meghir 2018; Ashraf et al. 2020). Calvi, Farooqi, and Kandpal (2024) use a hypothetical-choice experiment among educated, urban parents in Pakistan to show that parents believe that completing secondary education increases the likely income of their future son-in-law and increases the likelihood of their daughter choosing a husband herself.[13] Buchmann et al. (2023) elicit expected marital transfers (i.e., prices) among matchmakers in Bangladesh to show a positive marriage return to education and working in a skilled occupation. We find a substantial marriage market return to women's education in a context where women's labor force participation is very low, where gender norms are conservative, and where women's ambition to work is negatively valued on the marriage market (Dhar 2023). Estimating the structural preference and belief primitives underlying parents' choices allows us to construct counterfactual schooling and age-of-marriage trajectories that enables us to demonstrate the existence of beliefs in a marriage market return to education and, importantly, to quantify its economic significance in affecting the marriage market choices made for adolescent girls.

Finally, we contribute to the literature on the drivers of education and marriage choices in contexts where traditional

12. This literature highlights that people's actions can take on board more information, and in a more sophisticated way, than what is contained in the subjective beliefs they report. It is not even necessary to assume that agents have well-defined and easily retrievable "beliefs" at hand for their actions to be "as if" they were acting in an expected-utility framework; instead, agents may learn a set of best-response actions that are consistent with such a belief (Nash 1951).

13. Our sample of respondents is substantially less educated than in Calvi, Farooqi, and Kandpal (2024): 66% of the women in their sample have completed at least nine years of education, while only 10% of respondents in our sample can read a complete sentence. This required us to take a different methodological approach.

gender roles are the norm. This literature highlights that schooling choices are deeply rooted in stringent gender norms and can be linked to marriage market transfers (Field and Ambrus 2008; Buchmann et al. 2018; Ashraf et al. 2020; Bergstrom and Özler 2021; Edmonds, Feigenberg, and Leight 2023; Dhar, Jain, and Jayachandran 2022). Our work directly estimates the underlying structural primitives in the parents' decision problem, allowing us to quantify the protective value of education against early marriage. Our results lead us to identify a group of young women who are at a particular risk of early marriage: those who have recently dropped out of school and whose marriage prospects are believed to be sharply declining in age. Our findings suggest that new programs to enable students to re-enroll after dropping out from school could have a sizable impact on the outcomes of adolescent girls in India who are neither in education nor married.[14]

II. Revealed Beliefs

We outline the general conceptual framework underlying our approach and state the formal identification results. Online Appendix B provides the identification proofs. Online Appendix C provides a set of practical design considerations to support researchers applying the methodology to new contexts. A companion website provides easily adaptable simulation and estimation code.[15]

II.A. Intuition

To provide some intuition for our approach, consider a simplified version of our setup applied to the marriage market problem of Rajasthani parents. Let parents have preferences over the timing of their daughter's marriage and the quality of the accepted marriage offer. Marriage offers can come from low- or high-quality grooms, $q \in \{L, H\}$. Parents must decide whether to accept a marriage offer for their daughter early or late, $t = \{1, 2\}$. Assume for

14. See O'Hagan (2021) for a discussion of gender disparities in school retention following COVID-19 school closures. There are various NGO-run models that have been developed for helping adolescent girls to reenter formal schooling, for example, the Aga Khan Foundation's Project Lehar and Pratham's Second Chance program.

15. Please see https://github.com/revealedbelief/revealedbelief.git for general code that researchers can adapt for their own applications.

now that parents will always accept the best offer they receive in the final period $t = 2$.[16] To decide whether to accept a marriage offer in the first period, parents take into account their beliefs about the quality of offers they expect at $t = 2$. Imagine that parents believe they will receive a high-quality marriage offer with probability π at $t = 2$.

We want to identify parents' preferences and π. Let $U(t, q)$ give the deterministic component of parents' utility of accepting a marriage offer of quality q at time t. Parents also receive i.i.d. preference shocks $\varepsilon_t(d_t) \sim N(0, \sigma^2)$ associated with choosing each action $d_t = \{\text{accept, reject}\}$ at each period t. $\varepsilon_t(d_t)$ is revealed to the decision maker in period t but is unobserved to the econometrician.

We develop two different experimental designs to identify preferences and beliefs: the ex post and ex ante experiments. In the ex post experiment, parents evaluate pairwise comparisons of feasible marriage timing–marriage quality options, for example, {early marriage, low quality} versus {late marriage, high quality}. Parents choose the option that maximizes their utility. The probability of choosing an option (t_j, q_j) over option $(t_{j'}, q_{j'})$ in the ex post experiment is:

$$p^P_{j,j'} = Pr\left(U(t_j, q_j) + \nu_j > U(t_{j'}, q_{j'}) + \nu_{j'}\right) \tag{1}$$

$$= \Phi\left(\frac{U(t_j, q_j) - U(t_{j'}, q_{j'})}{\sqrt{2}\sigma_\nu}\right), \tag{2}$$

where $\nu_j \equiv \varepsilon^j_1(d^j_1) + \varepsilon^j_2(d^j_2)$. Standard discrete-choice identification arguments imply that choice responses to the ex post experiment identify $U(t, q)$ and σ_ν subject to location and scale normalizations.

In the ex ante experiment, parents are asked if they would accept or reject a marriage offer of quality $q \in \{L, H\}$ in the first period. In this case, parents act to maximize their expected utility and so their choices will reflect their beliefs about the likelihood of a high-quality offer at $t = 2$. The design of the ex ante experiment is closer to the types of decision we commonly face in reality; we

16. In this simple two-period example we assume that the offer is always accepted in the second period. This means that the expected value of future preference shocks associated with chosen options are zero and, therefore, don't appear in the expression for choice probabilities. In the full application, we take account of the expected value of the preference shocks conditional on optimal choice.

are rarely offered deterministic paths through the future. Rather, we make decisions at each point in time given our beliefs about how actions today affect payoffs in the future.

The probability of accepting the marriage offer in the ex ante experiment is:

$$p_q^A = Pr\Big(U(1,q_j) + \varepsilon_1^j(accept_1) > \pi U(2,H) + (1-\pi)U(2,L) + \varepsilon_1^j(reject_1))\Big) \tag{3}$$

$$= \Phi\left(\frac{U(1,q) - \pi U(2,H) - (1-\pi)U(2,L)}{\sqrt{2}\sigma}\right). \tag{4}$$

Therefore, parents are more likely to accept an offer today if they are more pessimistic about receiving a high-quality offer in the next period. It is straightforward to show that conditional on preferences, variation in the likelihood of accepting low- and high-quality offers in the ex ante experiment identifies beliefs over the likelihood of a high-quality offer:

$$\pi = \frac{U(1,H) - U(2,L)}{U(2,H) - U(2,L)} - \frac{U(1,H) - U(1,L)}{U(2,H) - U(2,L)} \frac{\Phi^{-1}\left(p_H^A\right)}{\Phi^{-1}\left(p_H^A\right) - \Phi^{-1}\left(p_L^A\right)}. \tag{5}$$

Thus, given estimates of preferences from the ex post experiment, responses to the ex ante experiment, p_H^A and p_L^A, can be used to "reveal" beliefs.

II.B. Conceptual Framework

Our general setup is based on a finite-horizon dynamic discrete-choice model with stochastic payoffs to a terminal action. This framework nests a large class of optimal-stopping problems and can be widely applied beyond the Rajasthani marriage market context. We model the decision of an agent who makes a discrete choice at a discrete set of time periods where payoffs are affected by the realized value of a binary state variable, $q_t \in \{L, H\}$. We assume that one of the choices is terminal (i.e., marriage, in our application).[17] In Online Appendix B.4, we show how our primary experimental design can be amended to allow for a higher dimensional stochastic state variable (i.e., $dim(q) > 2$).

17. Terminal choices are commonly used in empirical applications of dynamic discrete choice. See the discussion in Arcidiacono and Ellickson (2011).

ASSUMPTION 1 (STATES AND ACTIONS). We consider a finite-horizon dynamic discrete-choice model with the following features:

(i) **Time.** Discrete time periods $t \in \{1, ..., T\}$, with $T \leqslant \infty$.
(ii) **Decisions.** Individuals make a decision $d_t \in \{0, 1, ..., D\}$ at each period t, where $d_t = 0$ is a terminal action.[18]
(iii) **States.** Flow payoffs depend on a vector of state variables $\omega_t = \{\bar{\omega}_t, q_t, \epsilon_t\}$, where:
  (a) $\bar{\omega}_t$ is a vector of time-invariant state variables, or those that are updated deterministically as a function of past choices and time (e.g., time, age, education);
  (b) $q_t \in \{L, H\}$ is a stochastic state variable (e.g., the quality of a marriage offer);
  (c) $\varepsilon_t = \{\varepsilon_t(0), \varepsilon_t(1), ..., \varepsilon_t(D)\}$ are state variables that are always unobserved by researchers and observed by an individual in period t but not before.[19]

Preferences are defined over the feasible sequences of realized states and actions taken over $t = 1, ..., T$. Let τ be the period where the terminal action is chosen, i.e. $d_\tau = 0$. We assume that the value of q_t is only utility relevant if the terminal action is chosen that period. This assumption is straightforward to relax but doing so introduces additional notation.[20] We express the observable utility-relevant aspects of feasible sequences as $\bar{\Psi} \equiv \{\tau, q_\tau, \bar{\omega}_\tau\}$.[21] Preferences over feasible sequences, $\bar{\Psi}$, and unobserved preference shocks are given as:

ASSUMPTION 2 (PREFERENCES). Preferences over a path through the model, $\Psi \equiv \{\tau, q_\tau, \bar{\omega}_\tau, \boldsymbol{\varepsilon}\}$, can be expressed as the sum of preferences over the observed path and the discounted sum of

18. After choosing $d_\tau = 0$ at period τ, individuals are constrained to take $d_t = 0$ in all $t > \tau$.

19. At period t, respondents have no information about the value of their idiosyncratic preference shocks in $t + 1$ onward.

20. This assumption requires that rejected offers are irrelevant for payoffs (i.e., an absence of regret). It would be straightforward to amend the proof to allow for the history of stochastic state variables to be utility relevant, but this would require describing the history of these variables in the choice experiments.

21. $\bar{\omega}_\tau$ can be defined to include its own history.

idiosyncratic preference shocks ($\boldsymbol{\varepsilon}$):

$$U(\tau, q_\tau, \bar{\omega}_\tau, \boldsymbol{\varepsilon}) = \bar{U}(\tau, q_\tau, \bar{\omega}_\tau) + \sum_{t=1}^{T} \beta^t \varepsilon_t(d_\tau), \tag{6}$$

where $\varepsilon_t(d_t) \sim N(0, \sigma_\varepsilon^2)$ and is independent of $\bar{\Psi} \equiv \{\tau, q_\tau, \bar{\omega}_\tau\}$.

Assumption 2 imposes additive separability of utility in unobservables and a distributional assumption on unobserved preference shocks. Normality is not required for nonparametric identification of utility (Matzkin 1992), but is rather a convenient functional-form assumption that we impose for estimation.

Finally, individuals have well-behaved beliefs over how state variables transition. We treat beliefs over the realization of q_t as a structural object of interest. $\bar{\omega}_t$ can include time/age as a state variable, allowing beliefs to be time-dependent.

ASSUMPTION 3 (BELIEFS). Individuals' have proper beliefs over $q_t \in \{L, H\}$, where $0 \leqslant \pi(\bar{\omega}_t) \leqslant 1$ is the belief that $q_t = H$ given deterministic state variables $\bar{\omega}_t$.

II.C. Experimental Design

1. *Ex Post Experiment and Identifying Preferences.* The ex post experiment is structured as a standard hypothetical-choice experiment and is designed to identify $U(\tau, q_\tau, \bar{\omega}_\tau)$. In every round of the experiment, we offer respondents a choice between two alternative paths that specify the period in which the terminal action is chosen (τ), and the value of q and other state variables, $\bar{\omega}_{\tau,j'}$, at that point: $\bar{\Psi}_j = \{\tau_j, q_{\tau,j}, \bar{\omega}_{\tau,j}\}$ and $\bar{\Psi}_{j'} = \{\tau_{j'}, q_{\tau,j'}, \bar{\omega}_{\tau,j'}\}$. We redraw $\bar{\Psi}_j$ and $\bar{\Psi}_{j'}$ for each individual and round from the set of all feasible paths $\bar{\boldsymbol{\Psi}}^{\boldsymbol{M}} = \left[\bar{\Psi}^0, \bar{\Psi}^1, ..., \bar{\Psi}^M\right]$. Because there is no uncertainty about the realization of q_t in the ex post experiment,[22] respondents choose the profile that maximizes their discounted utility. The probability that a respondent i chooses the first option (j) over the second (j') is:

$$p^P(\bar{\Psi}_j, \bar{\Psi}_{j'}) = \mathbb{P}\left[\bar{U}(\tau_j, q_{\tau,j}, \bar{\omega}_{\tau,j}) + \nu_{i,j} > \bar{U}(\tau_{j'}, q_{\tau,j'}, \bar{\omega}_{\tau,j'}) + \nu_{i,j'}\right], \tag{7}$$

where $\bar{\Psi}_j, \bar{\Psi}_{j'} \in \bar{\boldsymbol{\Psi}}^{\boldsymbol{M}} \times \bar{\boldsymbol{\Psi}}^{\boldsymbol{M}}$, and $\nu_{i,j} \equiv \sum_{t=1}^{T} \beta^t \varepsilon_{i,t,j}(d_{t,j})$ is the accumulated preference shock.

22. In our application, this corresponds to no uncertainty over the quality of marriage offers made at different points in time.

Theorem 1 provides a formal statement of the identification of preferences given these choice probabilities conditional on the standard location and scale normalization on utility.

THEOREM 1. IDENTIFICATION OF PREFERENCES. Let Assumptions 1–3 hold. $\bar{U}(\bar{\Psi})$, for $\bar{\Psi} = \{\tau, q_\tau, \bar{\omega}_\tau\}$, is constructively identified at all $\bar{\Psi} \in \bar{\boldsymbol{\Psi}}^M$ from ex post choice probabilities under the following assumptions:

(i) Ex post choice probabilities, $p^P(\bar{\Psi}_j, \bar{\Psi}_{j'})$, are observed for all $(\bar{\Psi}_j, \bar{\Psi}_{j'}) \in \bar{\boldsymbol{\Psi}}^{\boldsymbol{M}} \times \bar{\boldsymbol{\Psi}}^{\boldsymbol{M}}$.
(ii) Location and scale normalizations: $\bar{U}(\bar{\Psi}^0) = 0$ and $U(\bar{\Psi}^1) - \bar{U}(\bar{\Psi}^0) = 1$
(iii) The aggregated preference shocks $(\nu_{i,j'}, \nu_{i,j})$ are independent of one another and are distributed i.i.d. normal across i, j, and j' with mean zero and variance σ_ν^2. $(\nu_{i,j'}, \nu_{i,j})$ are independent of $\bar{\Psi}_j$ and $\bar{\Psi}_{j'}$ for all $(\bar{\Psi}_j, \bar{\Psi}_{j'}) \in \bar{\boldsymbol{\Psi}}^{\boldsymbol{M}} \times \bar{\boldsymbol{\Psi}}^{\boldsymbol{M}}$.

Proof. See Online Appendix B. □

2. *Ex Ante Experiment and Identifying Beliefs.* In the ex ante experiment, we situate respondents at a particular point in time, at a particular state of the world, and ask them to make a decision. In this case, we assume that respondents will choose the option that maximizes their discounted expected utility.

Define the conditional value function $v(q_t, \bar{\omega}_t, d_t)$ as the present discounted value of choosing d_t (net of ε_t) and choosing optimally in future periods. In the case of choosing the terminal action, $d_t = 0$, the value is known with certainty:

$$v(q_t, \bar{\omega}_t, d_t = 0) \equiv \bar{U}(t, q_t, \bar{\omega}_t). \tag{8}$$

The value of choosing $d_t \geqslant 1$ reflects the expected value of future opportunities:

$$\begin{aligned} v(\bar{\omega}_t, q_t, d_t) &= \pi(\bar{\omega}_{t+1})\bar{V}^H(\bar{\omega}_{t+1}) + (1 - \pi(\bar{\omega}_{t+1}))\bar{V}^L(\bar{\omega}_{t+1}) \\ &\text{s.t. } \bar{\omega}_{t+1} = \bar{\omega}'(\bar{\omega}_t, d_t), \end{aligned} \tag{9}$$

where $\bar{\omega}'(\cdot, \cdot)$ maps deterministic state variables and choices from period t to deterministic state variables in period $t+1$. $\bar{V}^q(\bar{\omega}_{t+1})$ is the expected value of being in observed state $\bar{\omega}_{t+1}$ with a realization of the stochastic state variable $q \in \{L, H\}$ at $t+1$ before

ε_{t+1} is revealed:

$$\bar{V}^q(\bar{\omega}_{t+1}) \equiv \sum_{d_\epsilon O(\omega_{t+1})} p^A(d_{t+1}=d|\bar{\omega}_{t+1},q)\big[v(\bar{\omega}_{t+1},q,d_{t+1}=d) + \beta^{t+1}E(\varepsilon_{t+1}(d)|d_{t+1}=d,\bar{\omega}_{t+1},q)\big], \tag{10}$$

where $O(\omega_{t+1})$ is the feasible set of actions in period $t+1$ given deterministic state variables ω_{t+1} and $p^A(d_{t+1}=d|\bar{\omega}_t,q_t)$ is the probability that d is the optimal choice in state $\{\bar{\omega}_{t+1},q_{t+1}\}$.

We can observe $p^A(d_{t+1}=d|\bar{\omega}_t,q_t)$ through our ex ante choice experiment. Formally, the probability of respondent i choosing option d when presented with state $\{\bar{\omega}_k,q_k\}\in\bar{\Omega}\times\{L,H\}$ in the ex ante experiment is given by:

$$p^A(d_{t(k)}=d|\bar{\omega}_k,q_k)=\mathbb{P}\left[v(\bar{\omega}_k,q_k,d_{t(k)}=d)+\beta^t\varepsilon_{i,k}(d) > v(\bar{\omega}_k,q_k,d_{t(k)}=d')+\beta^t\varepsilon_{i,k}(d') \quad \forall d'\neq d\right], \tag{11}$$

where $t(k)$ gives the time period specified in scenario k.

THEOREM 2. IDENTIFICATION OF BELIEFS. Let Assumptions 1–3 hold. $\pi(\bar{\omega}_t)$ and σ_ε^2, the variance of the idiosyncratic preference shocks, are constructively identified under the following assumptions:

(i) Ex ante choice probabilities, $p^A(d|\bar{\omega}_t,q)$ are observed for all $d\in\{0,...,D\}$, for all $\bar{\omega}\in\bar{\Omega}$ and $q\in\{L,H\}$, with $p^A(d|\bar{\omega},H)\neq p^A(d|\bar{\omega},L)$.
(ii) $\bar{U}(\bar{\Psi})$ is identified subject to the location and scale normalizations imposed by Theorem 1.

Proof. See Online Appendix B. □

The proof of Theorem 2 in Online Appendix B, proceeds in two steps. At step one, we invert the expressions for ex ante choice probabilities (equation (11) to identify the full set of conditional expected value functions, $v(\bar{\omega}_t,q_t,d_t)$. In the second step, we use the recursive relationship between conditional expected value functions (shown here in equations (9) and (10)) to identify $\pi(\bar{\omega}_t)$. In Online Appendix B.4, we show that identification of beliefs is possible when $dim(q)>2$ if there are "preference-shifting" instruments, $\mathbf{z}$. These are characteristics that affect utility payoffs but are excluded from beliefs, $\pi(\bar{\omega},\mathbf{z})=\pi(\bar{\omega})$.[23]

23. In our practical example, we use variation in whether the hypothetical daughter "likes school" to identify a model in which parents do not necessarily receive a marriage offer in every period.

III. Context

We apply the revealed-belief methodology to characterize the drivers of parents' investments in their daughters' schooling in Rajasthan, India. This is a context in which female labor force participation is very low, women have little economic autonomy, marriage by age 25 is nearly universal for women, and gender norms regulating women's behavior are patriarchal and conservative.[24] Women's education levels have been rising among recent cohorts but remain low: 40% of 16-year-old girls were already out of school in 2015–16 (NFHS 2015–16).

Women's primary economic unit is fundamentally that of the marital household, and the study area is patrilocal. Girls' parents search for potential grooms through extended family and subcaste networks.[25] The search process can be lengthy, and these frictions leave a role for uncertainty over the quality of future matches. Marriage is also a significant economic transaction for parents. In our study area, dowry payments are an important feature of most marriages and are typically substantial relative to household wealth, despite having been illegal since 1961 (Anderson 2003; Edlund 2006).[26] Furthermore, marriage before a girl is aged 18 has been illegal since 1978 in India, although survey evidence suggests that 1.5 million girls aged under 18 are married each year in the country.[27] These mismatches between

24. In the 2015–16 NFHS survey, more than 95% of 25-year-olds in rural Rajasthan were married; more than 99.5% of 30-year-olds were married. In the 2015–16 NFHS survey, 29% of women who were working aged had been employed over the previous 12 months, of whom 30% were unpaid workers. In our sample, 39% of mothers could not go to the market unaccompanied, and 92% did not own any asset they could dispose of at will (Table I). See Jeffery (2018) for accounts of women's attempts to navigate patriarchal social structures in northern India.

25. While preferences for within-caste marriage is very strong, because all castes share this preference, it has little impact on matching across other characteristics or efficiency (Banerjee et al. 2013).

26. Dowry is a transfer, typically made up of cash and gold or silver jewelry along with furniture, home appliances, and sometimes a vehicle, from the bride's family to the groom's family at the time of marriage (Bloch, Rao, and Desai 2004). See Online Appendix D for sources of the typical dowry range. See Anderson and Bidner (2015) for a discussion of the economic role played by dowry as a groom price. Respondents in our confidential focus groups gave a monetary range for dowry corresponding to between 3 and 10 times GDP per capita in Rajasthan, which is in line with previous estimates (Rao 1993; Bloch and Rao 2002).

27. Source: https://www.unicef.org/media/111381/file/Child-marriage-country-profile-India-2021.pdf.

legal norms and cultural practices creates a significant risk of social-desirability bias in the reporting of marriage practices.

III.A. Sample Descriptives

In our study communities, marriages are almost always arranged by parents. It is therefore the collective preferences and beliefs of parents that are our primary interest.[28] We draw a random sample of female caregivers of unmarried adolescent girls (almost always their mother) living across 120 villages in the Dhaulpur district of Rajasthan. Specifically, we randomly sampled 5,731 unmarried adolescent girls aged 12–17 years living in study villages in 2016.[29] Collectively, because of siblings in the data, these adolescent girls had 4,994 female primary caregivers. We tried to interview each female caregiver (regardless of whether the daughter was still unmarried) to collect information on preferences and beliefs in 2017–18. We have complete discrete-choice experiments for 4,582 (91.8% of the sample). We collected a further round of data on realized schooling and marriage decisions from the same sample in late 2022 (five years after our main experimental data) to validate our results.

Table I, column (1) reports the headline summary statistics for our analysis sample.[30] Our sample is drawn from an economically and socially disadvantaged population: 50.7% of respondents live in houses with a dirt floor, respondents have an average of just 1.5 years of education, and only 10.4% can read a complete sentence. While gender norms are conservative in the study area (Andrew et al. 2022), 94% of the sample reported that they had at least "some say" over when and to whom their children got

28. For example, only 12% of married adolescent girls in our survey communities had met and spoken to their husband alone before marriage, and only 13% of unmarried adolescent girls expected they would. We do not make a distinction between marriage and *gauna* as only 6% of married women under the age of 25 in India report their *gauna* being performed after they were first married (IHDS). Under *gauna*, a marriage is not consummated and the bride only moves in with their husband after some delay.

29. We ran our experiments as part of an end-line data collection for a cluster randomized controlled trial of a community-based gender-norms program for adolescent girls. Online Appendix Table A.10 confirms that treatment status does not shift either our preference or belief estimates. For more details on sampling, see Andrew et al. (2022).

30. Online Appendix Table A.1 further reports that respondents randomized to the ex post versus ex ante survey instruments look well-balanced across these characteristics.

TABLE I
SAMPLE SUMMARY STATISTICS

	Experimental sample (1)		In follow-up (2)	
	Mean	Std. dev.	Mean	Std. dev.
Age in years	41.92	8.366	42.04	8.486
Own age at marriage in years*	15.57	3.359	15.53	3.317
Years of school*	1.494	3.268	1.441	3.238
Can read complete sentence (in Hindi)*	0.104	0.305	0.0970	0.296
Number of sons*	2.117	1.113	2.136	1.120
Number of daughters*	2.447	1.321	2.467	1.326
Owns asset that can dispose of at will	0.132	0.339	0.129	0.335
Can go to market unaccompanied*	0.611	0.488	0.608	0.488
At least some say over when child gets married	0.963	0.189	0.961	0.193
At least some say over to whom child gets married	0.952	0.213	0.952	0.214
At least some say over when child leaves school	0.942	0.234	0.941	0.236
Has done any work (inc. on family farm) in last year	0.595	0.491	0.598	0.490
Has worked for cash in last year	0.344	0.475	0.345	0.475
Has child (male or female) who is married	0.363	0.481	0.360	0.480
House has dirt floor*	0.507	0.500	0.514	0.500
Scheduled caste or scheduled tribe*	0.352	0.478	0.361	0.480
Other Backward Caste or Economically Backward Class*	0.450	0.498	0.449	0.497
Hindu*	0.968	0.176	0.970	0.170
N	4,582		4,507	

Notes. The table reports descriptive statistics. Column (1): caregivers with complete data from the choice experiments; column (2): caregivers for whom we have complete five-year follow-up available for daughters' marriage and education outcomes. This latter sample comprises 4,211 caregivers who were in our experimental sample and 296 caregivers from whom we didn't collect experimental data (almost entirely because they were not available to participate in the end-line survey) but whom we did successfully recontact and collect follow-up data. An asterisk indicates that the variable was measured in the baseline survey during 2016. All other variables were collected in 2017–18 survey.

married and when they left school. Mothers do therefore have insight into the collective choices made by parents. Table I, column (2) gives the characteristics of the 4,507 primary caregivers whose daughters were reached in the five-year follow-up. The follow-up sample is similar to the experimental sample across all characteristics.

IV. Instrument Design

We apply Theorems 1 and 2 to design ex post and ex ante hypothetical-choice experiments that allow us to identify parents' preferences over the age of marriage, education, and marriage-match characteristics of a spouse and their beliefs over how the quality of a marriage offer varies with a girl's age and education level. We focus on a finite portion of the dynamic problem facing parents during a daughter's adolescence from when she is aged 13–22 but allow for a daughter to be unmarried after this age.[31] We specify multiple groom characteristics to avoid imposing a particular description of a low- versus high-quality groom.[32] We give the details of the vignettes and visual aids we designed to implement the ex post and ex ante experiments in our context before providing functional-form assumptions that we place on preferences and beliefs for estimation in Section V.A.

IV.A. Hypothetical Framing

The experiments that we implement are based on vignettes that describe choice scenarios faced by fictional families to limit social-desirability bias (Finch 1987). We began by stressing that a respondent's answers would not be used to make inferences about the choices they would make for their own children. The interviewer introduced the scenarios with the following statement:

> We are going to tell you some stories about parents and marriage of their children. These stories are purely hypothetical. We will ask you some questions about how you think the parents in the story will take decisions based on the given options. There are no right and wrong answers. All your answers are confidential and you are free to stop at any time.

Given that we ask respondents how they think the parents in the story would behave, we formally elicit respondents' beliefs about the expected behavior of parents in the community.[33]

31. Ninety-one percent of 22-year-old women are married in rural Rajasthan according to the 2014–15 National Family Health Survey.

32. In practice, whether a groom is described as having a government job is by the far the most important determinant of groom quality allowing us to treat quality as a binary state variable to estimate beliefs.

33. All the names we used to describe hypothetical parents and their daughter were Hindu. Our study area is predominantly Hindu and 97% of our mothers are Hindu (Table I). For this reason, all of the names we used in the vignettes were Hindu.

Marriage is nearly universal, public, and a much discussed topic in the community, so it is reasonable to assume that respondents have accurate perceptions of the expected behavior of a generic family in the community.[34]

IV.B. Vignette Design

1. *Ex Post Experiment.* The ex post experiment presented respondents with a choice between two options for a fictional daughter's adolescence that specified her completed education, age of marriage, and groom characteristics. A round of the experiment started with the interviewer describing the wealth of the household and the character traits of their 12-year-old daughter. They went on to describe the choice facing a respondent as follows:

> [The parents] are considering when and to whom they will get [their daughter] married and until when they will keep her in education. Imagine there are two possible options, for when [their daughter] will leave education and when and to whom she will get married.

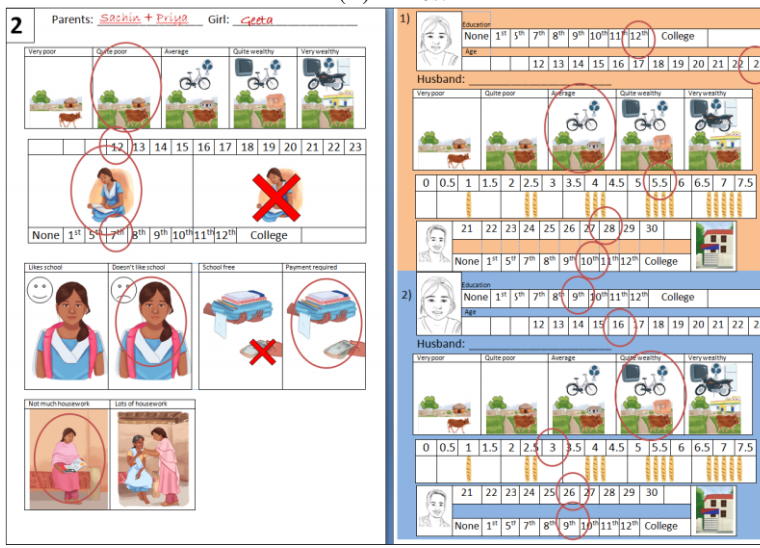
The interviewer described the two options, including information on when the daughter would marry, to whom (including the characteristics of the groom and his family, and the minimum dowry required), and how much education she would complete before marriage. To help respondents keep track of these characteristics, we designed the visual aid shown in Figure I, Panel A. Formally, each option corresponded to a specified path through the model, $\bar{\Psi}$. Therefore, respondents didn't need to form expectations over the likelihood of receiving good marriage offers in the future to evaluate an option.

Respondents were finally asked:[35] "Which option do you think [the parents] will choose for their daughter?" Given the low numeracy of our respondents and the scale of our data collection exercise, we ask respondents for a single choice prediction even though a probabilistic elicitation of choice behavior would have

34. Our framing is intended to capture respondents' perceptions of the current behavior of a generic family in the community. It thus allows us to capture information on the average prevailing preferences and beliefs in the community at the point of our data collection.

35. To ensure that respondents understood and took note of all relevant characteristics, each option was described twice and the relevant attributes were circled on the visual aids.

(A) Ex Post



(B) Ex Ante

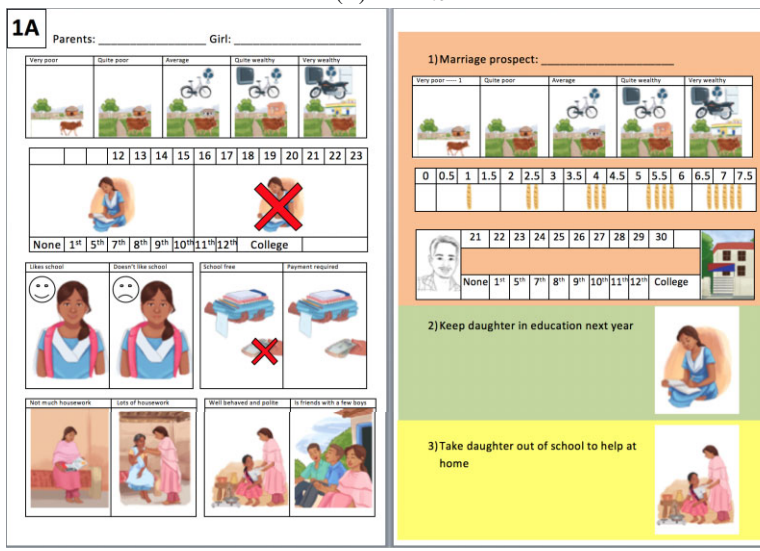


FIGURE I

Visual Aids

Panel A shows a translated visual aid for the ex post experiment. As the survey enumerator described the vignette to a respondent, they circled the relevant characteristics on the visual aid to help respondents keep track. The red circles give one example of a potential choice scenario. Panel B shows a translated visual aid for the ex ante experiment. This is shown without any mark-up.

been more informative.[36] Online Appendix Figure A.1 gives the English translation of an example script for the experiment (the underlined elements are those that were randomly changed between rounds).

2. *Ex Ante Experiment.* The ex ante experiments offered respondents a take-it-or-leave-it marriage offer for a daughter at a particular age but left them uncertain about what marriage offers might be received in the future. Figure I, Panel B gives the visual aid corresponding to this choice problem. As the pattern of future marriage offers was left unspecified, the relative value of each choice option partly reflects respondents' beliefs about the likelihood of receiving good marriage offers in the future.[37]

In the ex ante experiment, we randomly varied the age of the fictional daughter between rounds, ranging from age 13 to 22. Respondents were told that the family had received a take-it-or-leave-it marriage offer for their daughter. The offer was described using the same characteristics used in the ex post experiment. The interviewer told the respondent that the fictional parents needed to choose whether (i) to accept the marriage offer so that the daughter would get married in the next year to the groom described, (ii) to reject the offer and keep the daughter in school for another year, (iii) reject the offer and have their daughter leave school to help at home. Respondents were asked which option they thought the family would choose.

We randomized at the individual level whether respondents participated in the ex post or the ex ante experiment to prevent any confusion given the instruments' superficial similarity and to limit response burden. Each respondent carried out three rounds of the experiment they were assigned to, with the characteristics of the hypothetical family, daughter, and marriage options

36. Note that some of the problems of nonprobabilistic elicitation related to unresolvable uncertainty are not relevant in our context because we ask for predictions on current-period choice instead of predicting what the respondent or hypothetical family would do in the future.

37. We only attempt to elicit beliefs over the distribution of marriage offers. If one wanted to identify beliefs over other stochastic variables (e.g., the likelihood of a daughter working as a function of her education), one would also need to include variation in the realization of these variables in the ex ante vignettes.

randomly varying across rounds.[38] As a consequence, we use a between-individual design with the aim of estimating average preferences and beliefs for the generic family.

IV.C. Variation in Vignette Characteristics

The same set of core characteristics was enumerated in the ex post and ex ante experiments. These characteristics are summarized in Online Appendix Table A.2. Online Appendix Figures A.1 and A.2 give examples of the translated verbal descriptions used for each characteristic.

We specified five attributes of the hypothetical family and their daughter: (i) household wealth;[39] (ii) whether the mother needed extra assistance in the home; (iii) whether the daughter was currently in school; (iv) whether the daughter enjoyed school (for those still in school); and (v) the cost of schooling (for daughters described as being currently enrolled in school). In the ex ante experiments, we also included an indicator of whether a daughter complied with gendered norms, as this was frequently mentioned in the focus groups. Thus, we described some daughters as being "polite and well behaved" while others we described as being "friends with some boys and sometimes staying out of the house until late." When describing potential marriage options, the following five attributes were given: (i) wealth of groom's family; (ii) minimum dowry acceptable to the groom's family; (iii) completed education of groom; (iv) age of groom; and (v) whether groom has a government job (the most well-paid and secure form of employment in the area).

Vignette characteristics were drawn orthogonally across respondents, rounds, and options from the feasible set subject to three modifications. First, the minimum acceptable dowry described for a groom was allowed to loosely correlate with the groom's family wealth.[40] Second, in the ex post experiment, we

38. The experiments were run by female interviewers who had experience of working on large-scale household surveys. Interviewers were given two days of training on the experiments in addition to training on general interview skills. They carried out two more days of field practice before the start of data collection.

39. We anchored our descriptors of household wealth against the first, third, and fifth quintiles of the household asset ownership measured in the sample villages two years previously.

40. Dowry was randomly drawn between: 0.5 and 3 lakh for "poor" groom families, 1.5 and 6 lakh for "medium" groom families, and 2.5 and 7.5 lakh for "rich" groom families.

redrew characteristics to ensure that the daughter's age of marriage and education at marriage across two options in the same round were sufficiently different so that respondents found the choice meaningful. We ensured that respondents were never choosing between two options in the same round in which the daughter married younger than age 15 in both cases because such scenarios sometimes made respondents uncomfortable in piloting. Finally, in one round per respondent, we randomly replaced the characteristics of the hypothetical family with the characteristics of the respondent's own household and daughter to test whether the similarity of the vignette to the respondent's own experience affected choices (see Online Appendix Table A.11).

The vignettes painted a rich description of the hypothetical family and the options they faced, but we could not include all potentially relevant characteristics in the stories. For example, we did not specify a daughter's physical beauty or the presence of siblings (Banerjee et al. 2013). Respondents were prompted to assume that any unspecified characteristics were the same across options to limit potential concerns about Bayesian updating on the basis of specified characteristics.[41] Furthermore, some of the characteristics we specify might not be known with certainty early in a girl's adolescence (e.g., her liking school). The effect of these uncertain characteristics in real-life choice data will be attenuated relative to their effect in our experimental data to reflect this uncertainty.

V. Estimation

We use the hypothetical-choice data generated by the ex post and ex ante experiments to estimate parents' preferences and beliefs in our context. We map the formal assumptions in Section II to our applied setting.

Estimation Assumption 1 (States and Actions). We use our experimental data to estimate the parameters of a finite-

41. While a logical possibility, there is little evidence that respondents update their expectations about unspecified aspects of a scenario on the basis of included characteristics. For example, Hudomiet et al. (2021) find no evidence that respondents update their likely health status when asked to consider the probability that they will be working past age 70 under the scenario that they will earn a high wage.

horizon dynamic discrete-choice model with the following features:

(i) **Time.** Discrete time periods $t \in \{13, ..., 22\}$.
(ii) **Decisions.** Before marriage, individuals make a decision $d_t \in \{\text{School}, \text{Home}, \text{Marry}\}$ if they are still in school or $d_t \in \{\text{Home}, \text{Marry}\}$ if they are out of school. No further decisions are taken after a daughter is married.[42]
(iii) **States.** Flow payoffs depend on the vector of state variables $\omega_t = \{t, \mathcal{M}_t, Ed_t, Z, q_t, \varepsilon_t\}$, where $\mathcal{M}_t \in \{0, 1\}$ denotes whether the daughter is already married in period t; Ed_t gives the daughter's education at t; ε_t are time-varying idiosyncratic shocks to the payoffs associated with taking different actions in period t; Z contains observed characteristics that are constant over time, for example, wealth. $q_t = \{N, H, L\}$ gives the best marriage offer received: N, no offer received; H, a high-quality offer is received; L, a low-quality offer is received.

We estimate the collective preference of parents over the education and marriage outcomes achieved by their daughter.[43] Parents care about the education their daughter receives, the value of any home production she contributes to, when she gets married, and whom she marries. These preferences will reflect (in a reduced-form manner) a combination of altruism toward a daughter's future welfare in marriage or future grandchildren (Behrman et al. 1999; Jensen and Thornton 2003; Chari et al. 2017), social norms and psychological payoffs to one's daughter's education and marriage (Maertens 2013), the value of a connection to the groom's family, and the economic costs of dowry and the costs of keeping a girl in school or at home via the budget

42. A daughter can only be married if a marriage offer is received and marriage is an absorbing state with no possibility of divorce. Just 0.3% of ever-married women in India are currently divorced, according to the 2011 census. We also assume that once a daughter is taken out of education, she cannot reenter later, and girls cannot continue in education once married.

43. Assuming a single parental utility function is consistent with a unitary model of household decision making. It is also consistent with collective models where bargaining weights are not endogenous to the choice of marriage partner of the daughter. We note that it is possible that mothers' own preferences (which we do not measure) may differ from these collective preferences. We assume that mothers know the collective preferences of parents (see Section III).

constraint (Rosenzweig and Stark 1989; Corno, Hildebrandt, and Voena 2020; Bau et al. 2022).[44]

ESTIMATION ASSUMPTION 2 (PREFERENCES). We assume that parents' preferences take the following form:

$$U(\Psi;\theta^p) = \bar{U}(Age_\tau, Ed_\tau, q_\tau, Z) + \sum_{s=0}^{T} \beta^{s-t}\varepsilon_s^{d_s}, \tag{12}$$

where τ gives the age of marriage; if she remains unmarried at the end of the period, $\tau = 23$. $q_t \in \{L, H\}$ is a binary variable capturing whether a groom is low or high quality (which is a function of the groom-side characteristics given in the experiments), and Z are the demographic characteristics given about the family and daughter. θ^p is the vector of parameters indexing the function.

We assume parents hold well-defined expectations over the likelihood of receiving marriage offers from grooms of a given quality and how this varies with their daughter's age and education. Although the vignettes described multiple groom attributes, whether a groom was described as having a government job or not was the main determinant of groom quality in practice. We therefore discretize groom quality into two types (low versus high) and allow for the possibility of no offers arriving at all. We do not put structure on the search and matching process, nor the distribution of groom quality in the local marriage market, to give micro-founded expressions for these expectations but consider the beliefs as the objects of interest.

ESTIMATION ASSUMPTION 3 (BELIEFS). Respondents' have proper beliefs over the realization of the quality of marriage offers where $0 \leqslant \pi^j(\bar{\omega}_t) \leqslant 1$ and $\sum_j \pi^j(\bar{\omega}_t) = 1$ for $j \in \{N, H, L\}$. We assume that:

$$\pi^N(\bar{\omega}_r;\theta^a) = h(Norms_r) \tag{13}$$

$$\pi^H(\bar{\omega}_r;\theta^a) = (1 - h(Norms_r))g(Age_r, Ed_r) \tag{14}$$

$$\pi^L(\bar{\omega}_r;\theta^a) = (1 - h(Norms_r))(1 - g(Age_r, Ed_r)), \tag{15}$$

44. We do not ask mothers about the choices they would have chosen if they (or the daughter) had all the bargaining power. Therefore, we cannot comment on how different household members' utility functions are weighted in the collective preference.

where π^N gives the probability of no offer, π^H gives the probability of an offer from a high-quality groom, and π^L gives the probability of an offer from a low-quality groom. θ^a is the vector of parameters indexing these functions. Age_r and Ed_r give the age and education level of the daughter described in scenario r, and $Norms_r$ is an indicator of whether she is described as breaking gender norms.

Inattention rates in hypothetical-choice studies and surveys are often found to be high (Adams-Prassl et al. 2023; Stantcheva 2023; Jäger et al. 2024). We follow Mas and Pallais (2017) to allow a share of respondents, α, to be inattentive and choose randomly.

V.A. *Two-Step Estimation Procedure*

1. *Step 1.* We use the ex post data to estimate the set of preference parameters, θ^p, and the inattention share, α.[45] Let $\mathbf{y}^p$ give the vector of ex post choices stacked over individuals and rounds, where $y^p_{ir} = 1$ if respondent i chose the first option in round r and 0 otherwise. The sample likelihood of observing choices $\mathbf{y}^p$ in response to ex post experiment characteristics $\bar{\mathbf{\Psi}}$ is:

$$l(\mathbf{y}^p|\bar{\mathbf{\Psi}};\theta^p,\alpha) = \prod_{ir} y^p_{ir}\left(\frac{\alpha}{2} + (1-\alpha)\mathbb{P}^P\left(\Psi_{r1},\Psi_{r2;}\theta^p\right)\right) + (1-y^p_{ir})\left(\frac{\alpha}{2} + (1-\alpha)\left(1-\mathbb{P}^P\left(\Psi_{r1},\Psi_{r2;}\theta^p\right)\right)\right), \tag{16}$$

where

$$\mathbb{P}^P\left(\Psi_{r1},\Psi_{r2;}\theta^p\right) = \mathbb{P}\left[\bar{U}(\bar{\Psi}_{r1}) + \nu_{ir1} > \bar{U}(\bar{\Psi}_{r2}) + \nu_{ir2};\theta^p\right], \tag{17}$$

where $\nu_{irj} \sim N(0,\sigma^2_\nu)$.

We estimate (θ^p,α) by maximum likelihood, assuming a flexible functional form for the dependence of utility on a daughter's age of marriage, education, and match characteristics. Specifically, we include fixed effects for age of marriage and completed education, interactions between a daughter's years of education and whether she likes school and the cost of school variables, and the groom characteristics given in Section IV linearly. We normalize the coefficient on "Government Job" to one to facilitate

45. Intuitively, the share is identified from the upper asymptote $(1-\frac{\alpha}{2})$ and lower asymptote $(\frac{\alpha}{2})$ of the observed probability of choosing the first option over the second as the predicted difference in utilities associated with the options get very large (Mas and Pallais 2017).

comparison of the magnitude of effect sizes across our alternative specifications and estimate the variance of the idiosyncratic random error.

2. *Step 2.* Conditional on estimates $(\hat{\theta}^p, \hat{\alpha})$, we estimate by maximum likelihood the subjective beliefs over marriage-offer probabilities, the utility associated with having a daughter still unmarried at time $T+1$, and the variance of the additive idiosyncratic preference heterogeneity in the ex ante experiment. Given θ^a, the likelihood of observing the vector of ex ante choices $\mathbf{y}^a$ stacked over individuals and rounds is given by:

$$l(\mathbf{y}^a|\mathbf{t}, \bar{\boldsymbol{\omega}}, \mathbf{q}; \theta^a) = \prod_{ir} \left[\sum_j \mathbb{1}(y_{ir} = j) \times \mathbb{P}_j^A(\bar{\omega}_{ir}, q_{ir}; \theta^a) \right], \tag{18}$$

where

$$\begin{aligned} \mathbb{P}_j^A(\bar{\omega}_{ir}, q_{ir}; \theta^a) = \frac{\alpha}{J} + (1-\alpha)\mathbb{P}\big[& v(\bar{\omega}_{ir}, q_{ir}, y_{ir} = 1) + \beta^t \varepsilon_{irj} \\ & > v(\bar{\omega}_{ir}, q_{ir}, y_{ir} = j') + \beta^t \varepsilon_{irj'} \quad \forall j' \neq j; \theta^a \big], \end{aligned} \tag{19}$$

and where J is equal to the number of options in the choice set (two or three, depending on whether the daughter is still in school) and value functions are defined in equations (8) and (9). We use a particle swarm global optimization algorithm to find the $\hat{\theta}^a$ that maximizes the sample log-likelihood. In doing so, we solve the whole dynamic problem in every iteration.

We make a set of functional-form assumptions to facilitate estimation. We show robustness to altering these assumptions in Section VI.C. First, we impose a constant discount rate of $\beta = 0.95$. Second, we assume that the probability of receiving any marriage offer, $1 - \pi^N(\bar{\omega}) = \gamma_0(1 + \gamma_1 Norms)$, depends multiplicatively on whether the girl is described as breaking or conforming to gender norms, $Norms \in \{0, 1\}$, but is constant over time and across girls with different education levels.[46] Third, we assume that conditional on receiving an offer, the probability that it is from a high-quality groom is given by $\Phi\left(\mathbf{X}_r'\tau\right)$, meaning $\pi^H(\bar{\omega}_r) = \gamma_0(1 + \gamma_1 Norms)\Phi\left(\mathbf{X}_r'\tau\right)$, where $\mathbf{X}$ contains the age of a daughter, her education (with a separate dummy for college),

46. As discussed in Section II.C and expanded on in Online Appendix B, identification of a model where offers are not necessarily received every period is facilitated by the inclusion of preference-shifting instruments, in our case an indicator of whether the daughter "likes school."

their interaction, and a constant. Finally, we assume that the value of still being unmarried in $T+1$ is the sum of the utility associated with getting married to a low-type groom in period T and a constant, ϕ.

To construct standard errors, we use a continuous bootstrap on the whole procedure to ensure that sampling error in the first step is accounted for in the estimated standard errors for our belief estimates. We bootstrap at the respondent level to allow for correlation in how the same respondent answered different rounds of the experiment. To implement the continuous bootstrap procedure, we draw 100 sets of weights from the Dirichlet distribution with concentration parameter $\alpha = 1$ (Rubin 1981).[47]

VI. Results

VI.A. Reduced-Form Variation

Figure II, Panel A shows raw choice patterns for the ex post experiment. It gives the proportion of respondents picking an option conditional on its characteristics (i.e., age of marriage, occupation of groom, and education at marriage). For example, take the first bar in Panel A. This shows the percentage of respondents who picked an option where a daughter married at 13 years old to a groom without a government job (among rounds where this option was available). This occurred only 19.1% of the time, showing respondents rarely chose an option involving marriage at age 13 when this was available. As respondents chose between two options, the average of the proportions shown (weighted by the likelihood of that characteristic profile being drawn) is 0.5.[48] Figure II, Panel B shows choice patterns for the ex ante experiment, where we presented a single scenario and asked respondents whether the parents would accept the described marriage offer. We plot the proportion choosing to accept the marriage offer conditional on characteristics of the scenario (i.e., age of the daughter, whether she is still in school and whether the groom in question has a government job).

47. We use a continuous bootstrap to ensure that no observations receive zero weight in any round.

48. Because our aim here is to present the data with minimal structure, Figure II doesn't take into account the characteristics of the alternative option. This is possible as the two options were drawn orthogonally to one another subject to the three modifications listed in Section IV.C.

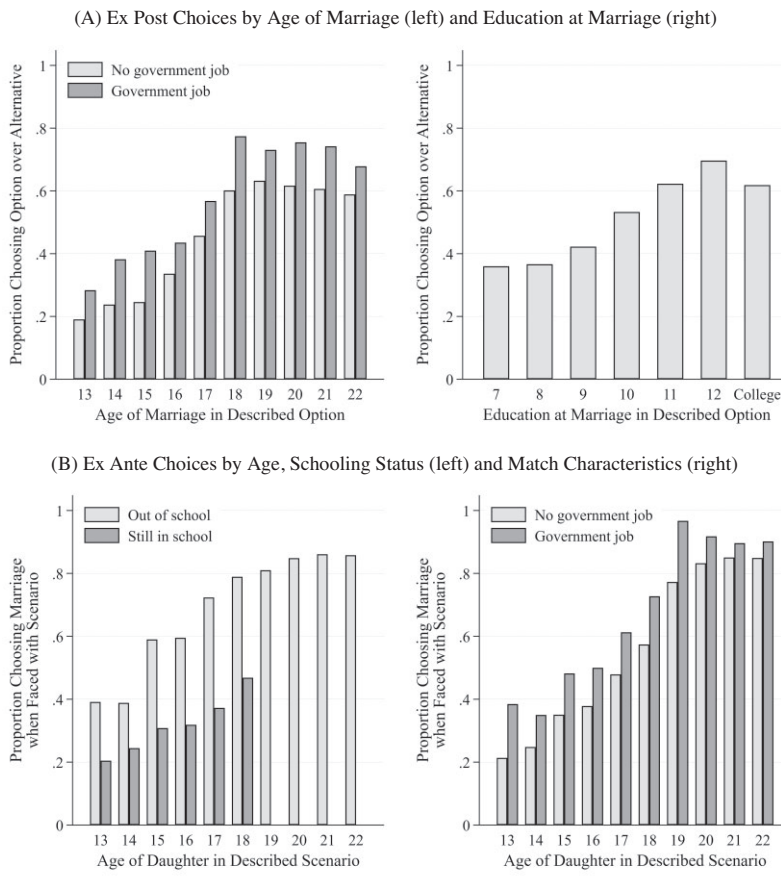


FIGURE II

Ex Post and Ex Ante Descriptives

The figure plots raw choice probabilities in the ex post and ex ante experiments. Panel A plots the proportion of respondents who chose a given option in the ex post experiment (conditional on having been presented it) by the age of marriage (left) and education at marriage (right) of the hypothetical daughter. The left graph plots how this pattern varied by whether the groom was described as having a government job. Panel B plots the proportion choosing to accept the marriage offer in hand by age in the ex ante experiment. The left graph splits by girls currently in education and those not. The right graph splits by whether the hypothetical groom has a government job.

In the ex post experiment, respondents were more likely to choose options where the age of marriage was at least 18. Beyond age 18, ex post choice probabilities don't appear to increase further with age. In the ex ante experiment, where respondents were left uncertain about the final marriage match if they rejected the offer in hand today, the proportion of respondents accepting a marriage offer increases with age up to and beyond age 18.

Turning to education, respondents in the ex post experiment were more likely to choose options in which a daughter had more education at marriage. However, this doesn't necessarily imply a significant preference for high education due to the positive correlation between age of marriage and education in the options presented to respondents.[49] Respondents to the ex ante experiments were substantially more likely to accept a marriage offer if the daughter was already out of school compared with when she was still in school. In both types of experiments, respondents were more likely to choose options associated with the daughter marrying a groom with a government job.

Finally, we check whether choices in the ex post and ex ante experiments were affected by the similarity of a vignette to a respondent's own situation. As discussed in Section IV.C, we randomly replaced the characteristics of the hypothetical family with the characteristics of the respondent's own household and daughter in one round per respondent. Online Appendix Table A.11 shows that vignette salience is not a significant predictor of choice behavior for either the ex post or ex ante experiments.

VI.B. Structural Results

1. *Preferences.* Table II presents our structural preference parameters under different functional-form specifications for age and education. Figure III presents the age and education coefficients from Table II, column (1). The coefficient on a groom having a government job is normalized to one to ease comparisons across specifications. Using our preferred specification (column (3)), we estimate an inattention rate of 37%, meaning that in 18.5% of experiments respondents choose the less preferred option, which is in line with other experimental settings (Mas and Pallais 2017).

We find that parents strongly prefer to delay a daughter's marriage until she is 18 years old. Their taste for delaying

49. Only older daughters can have acquired high levels of education.

TABLE II

STRUCTURAL PREFERENCE PARAMETERS

	(1)		(2)		(3)	
Groom characteristics						
Groom has government job	1.000		1.000		1.000	
Groom's age	−0.035	(0.014)	−0.035	(0.014)	−0.035	(0.014)
Groom's education	0.061	(0.016)	0.061	(0.016)	0.060	(0.016)
Groom college education	−0.020	(0.151)	−0.040	(0.151)	−0.021	(0.148)
Low wealth	0.000		0.000		0.000	
Medium wealth	0.242	(0.121)	0.228	(0.122)	0.232	(0.117)
High wealth	0.194	(0.138)	0.186	(0.139)	0.193	(0.137)
Dowry (lakh)	−0.056	(0.032)	−0.053	(0.032)	−0.052	(0.032)
Age of marriage (years)						
13	−3.604	(0.697)	−3.663	(0.702)		
14	−2.014	(0.404)	−2.082	(0.420)		
15	−1.782	(0.279)	−1.821	(0.284)		
16	−1.229	(0.226)	−1.254	(0.230)		
17	−0.691	(0.191)	−0.712	(0.193)		
18	0.000		0.000			
19	−0.009	(0.161)	0.003	(0.164)		
20	0.152	(0.189)	0.183	(0.198)		
21	0.163	(0.178)	0.197	(0.183)		
22	0.036	(0.180)	0.111	(0.202)		
Age					0.563	(0.076)
(Age − 18) × 1 (age ≥ 18)					−0.514	(0.086)

TABLE II
CONTINUED

	(1)		(2)		(3)	
Education at marriage (grade)						
7th	0.000		0.000			
8th	0.153	(0.153)	0.095	(0.155)		
9th	0.231	(0.167)	0.112	(0.177)		
10th	0.447	(0.158)	0.269	(0.172)		
11th	0.431	(0.172)	0.187	(0.197)		
12th	0.827	(0.199)	0.509	(0.217)		
College	0.296	(0.188)	−0.050	(0.228)	−1.094	(0.180)
Years of education − 7					0.105	(0.034)
Preference shifters						
"Daughter likes school" × years of schooling			0.072	(0.037)	0.073	(0.037)
"School is costly" × years of schooling			0.051	(0.039)		
"Help at home needed" × years before marriage			−0.035	(0.035)		
Fixed parameters						
σ_ν	1.253	(0.239)	1.213	(0.238)	1.202	(0.231)
Inattention share	0.354	(0.046)	0.361	(0.046)	0.367	(0.046)
Number of experiments	6,972		6,972		6,972	
Number of respondents	2,324		2,324		2,324	

Notes. The table presents structural preference parameter estimates and standard errors (in parentheses). Standard errors are calculated through a continuous bootstrap, resampling respondents with replacement, using 500 iterations. The value of a government job is normalized to one. Column (1) presents results from a model with only groom characteristics, age of marriage, and education at marriage. Column (2) additionally includes our three preference-shifting instruments. Column (3) is the specification we carry forward to the belief estimation, adopting a piecemeal linear specification for age and education and dropping the insignificant instruments.

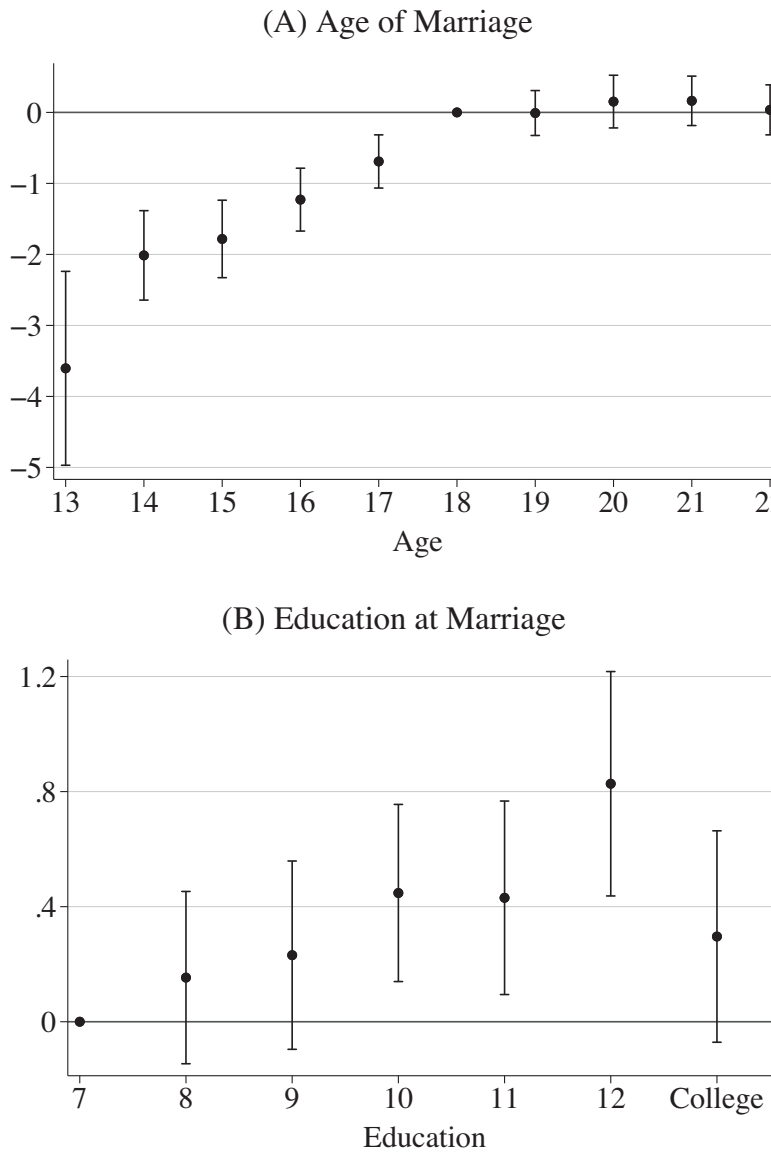


FIGURE III

Preferences over a Daughter's Age and Education at Marriage

The figure plots coefficients on age of marriage dummies (Panel A) and education at marriage dummies (Panel B) from column (1) in Table II. The 95% confidence intervals are given and were calculated using a continuous bootstrap with 500 iterations. The coefficient on "groom with a government job" is normalized at one.

marriage from age 16 to 18 is approximately the value they place on securing a groom with a government job. Beyond 18 years, the legal minimum age of marriage for women in India, parents show no preference for delaying marriage further. The discontinuity at age 18 suggests that parents incorporate the legal minimum age at marriage into their preferences despite evidence that the rules are often only laxly enforced.[50]

Parents prefer a daughter to obtain more education up until the end of high school (12th standard). They also prefer additional years in school if a daughter "likes school" (columns (2) and (3)).[51] However, tastes for education are weaker than preferences over age at marriage; the value that parents place on each additional year of schooling is only around 10% of the value they attach to securing a groom with a government job. Many of the individual education dummies in columns (1) and (2) are not statistically significantly different from zero. Furthermore, conditional on a given marriage market match, parents strictly prefer a daughter to finish high school than to complete college.[52] This could be due to the high financial cost of college compared with high school and the greater average distance needed to travel from the home to attend college. However, this effect is not due to concerns about overeducation and marriage market prospects as the characteristics of the groom are given.

Turning to determinants of match utility, we see that parents prefer more educated grooms, younger grooms, and grooms who don't come from a low-wealth family. However, whether a groom has a government job is the most important driver of groom quality. We estimate that parents value grooms with a government job four times as much as they value the groom coming from a medium- or high-wealth family (as opposed to a low-wealth

50. This discontinuity at the legal minimum age of marriage could be a result of the minimum age being a signal of what they believe others to find acceptable. For instance, Maertens (2013) finds a significant mass point at 18 years in the distribution of the socially acceptable age of marriage in rural India. Alternatively, it could reflect the legal risk of early marriage.

51. This corresponds closely to themes highlighted in our focus group discussions in which was stressed the importance of a daughter's motivation in forming her parents' views of how long she should stay in school. For example, one participant mentioned: "If the child is hardworking and good, the parents will not have to ask him/her to study or to go to school, they themselves do."

52. The p-value for equality of coefficients between completing 12th standard and college is .016 in column (1) and .014 in column (2).

family). The importance of having a government job also arose in our focus group discussions. For example, "So many boys are sitting at home after doing BA and have nothing to do, there are no jobs or even if they do (get a job), they are not secure. In that case, having a government job really matters" (Caregivers Focus Group 2, Online Appendix D).

In column (3), we impose a set of functional-form restrictions to increase the ease with which we can use our preference results to estimate subjective beliefs. Given the coefficients on the age dummies in columns (1) and (2), we impose a piecewise linear specification for age, with a potential kink at age 18. We impose that preferences for education are linear but allow preferences for college to differ through the inclusion of a dummy variable. Then we remove the two shifters of preferences that were not significant.

2. *Subjective Beliefs.* We use the structural preference parameters to estimate revealed beliefs over the likelihood of receiving good-quality marriage offers. As parents' preference for a groom with a government job is so large relative to other groom characteristics, it creates a discontinuous support for the groom-quality distribution among our fictional grooms (Online Appendix Figure A.3). Therefore we split grooms into those with and without a government job (high- versus low-quality grooms) and use the average value of match utility associated with these types to index preferences. As discussed in Section V.A, we allow the perceived probability of receiving an offer from a high-type groom to depend on a daughter's age, education, and whether her behavior conforms to gendered norms.

Figure IV plots parents' revealed beliefs. For each age (along the x-axis) and education (shown in different colors), we plot the perceived probability of getting a marriage offer from a high-quality groom. Table III provides the structural belief coefficients and standard errors underlying Figure IV. Looking first at beliefs around how marriage offer probabilities depend on a daughter's age, we see a striking contrast from parents' preferences. While parents prefer to delay a daughter's marriage until the end of adolescence, parents believe that the likelihood of a marriage offer from a high-quality groom is declining in her age once she is out of school. While the base coefficient on age is very close to zero, we estimate that the coefficient on age interacted with education

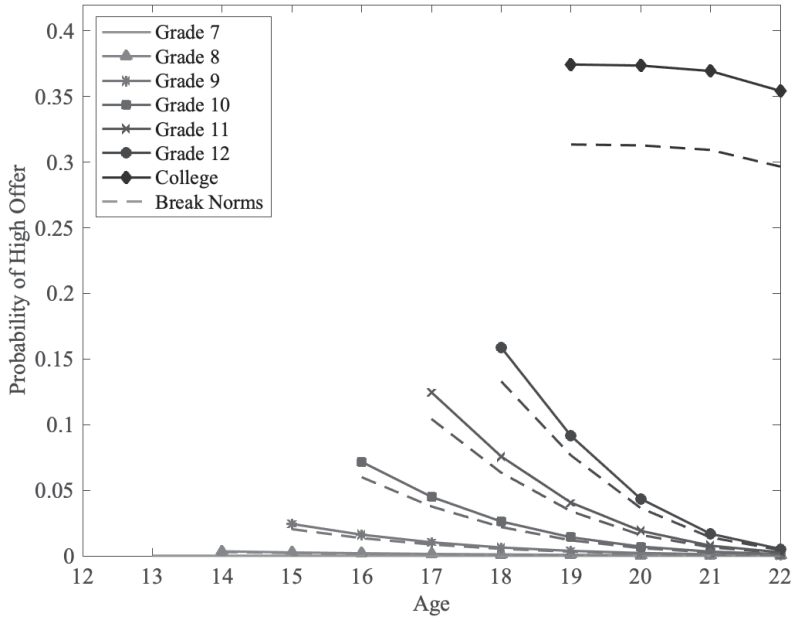


FIGURE IV

Probability of High-Quality Marriage Offer

The figure shows the subjective probability of receiving an offer from a high-quality groom at different ages and education levels of the daughter. Probabilities are calculated for a daughter who conforms to gender norms.

is negative and highly significant. For instance, take a daughter who has finished high school (grade 12) and who complies with gendered norms. Figure IV shows that we estimate that right after finishing school this daughter would have a 15.9% chance of receiving an offer from a groom with a government job, but this would fall to just 4.4% after two years.

Turning to education, we see that a daughter's level of schooling has a large effect on parents' perceptions of the likelihood of receiving high-quality marriage offers. We recover a belief of a large marriage market return to education because respondents are less likely to accept marriage offers when a girl is in school in the ex ante experiment than would be expected from the preference parameters alone. A strong expected marriage market return to education rationalizes these differences. If we consider 18-year-old daughters who comply with gendered norms, parents

TABLE III
STRUCTURAL BELIEF PARAMETERS

	(1)
Age	−0.001
	(0.010)
Education	1.243
	(0.176)
College	3.563
	(0.970)
Age × education	−0.100
	(0.026)
Constant	−3.398
	(0.100)
Offer probability	
Base probability (γ_0)	0.375
	(0.045)
Impact of breaking norms (γ_1)	−0.163
	(0.068)
Terminal value if unmarried at age 22	
ϕ	−5.926
	(1.573)
Preference shocks	
σ_ε	0.600
	(0.098)
Number of experiments	5,524
Number of respondents	2,258

Notes. The table provides the structural parameters and standard errors (in parentheses) obtained by bootstrapping the whole two-step estimation procedure 100 times.

believe that they will have a 15.9% chance of an offer from a high-quality groom if a daughter finishes high school, a 7.6% chance if they finish 11th standard, and only a 2.6% chance if they finish 10th standard.[53]

53. This finding complements recent work on the marriage market penalties to women's work in India (Dhar 2023). We also note that our empirical findings are consistent with themes arising from our qualitative focus groups. For example, "Anpad ke liye nahi milta hai ladka, padhi likhi ladkiyon ke liye mil jaata hai...ladke bol dete hai ki humein ladki padhi likhe chahiye, angoothachaap nahi" (A match is not found for an uneducated girl and it is easier to find a suitable match for an educated girl as boys these days make it clear that they do not want to get married to a girl who cannot even do her signatures). However, Beauchamp, Calvi, and Fulford (2021) estimate a dynamic, general equilibrium, two-sided matching model of the Indian marriage market and find that men do not prefer highly educated women. Our identification approaches are very different;

Finally, parents perceive a significant marriage market penalty to behavior that violates social norms. A girl described as "friends with some boys and sometimes stays out of the house until late" is perceived to receive marriage offers at a rate 16.3% lower than daughters who "are polite and well behaved."

VI.C. Robustness

The patterns in our estimated preferences and beliefs are all robust to altering the assumptions we made in estimation. Online Appendix Table A.3 and Online Appendix Table A.4 (column (2)) show that all important patterns in preferences and beliefs remain if we assume all respondents are perfectly attentive. Online Appendix Table A.4 columns (3)–(8) show that beliefs are robust to relaxing the key assumptions made in Section V.A. Namely, (i) increasing the discount factor to 0.99; (ii) dropping the dependence of the marriage offer probability on whether a daughter complies with norms; (iii) allowing for the education to affect beliefs in a nonlinear manner (quadratic); (iv) altering the specification of the terminal expected value function; and (v) allowing the no-offer rate to depend on the age of the daughter.

A key assumption throughout our application is that our respondents know the collective preference of typical parents in the marriage market. In Section III, we show evidence that mothers in our experiment are involved in schooling and marriage decisions, which we take as evidence that they have knowledge of the collective decision-making process. In Online Appendix Table A.11, we show that responses to the ex post and ex ante experiments do not vary with vignette salience, that is, how similar the fictional daughter described in a scenario was to a respondent's own daughter. In Online Appendix Table A.9, we test directly for heterogeneity in our preference and belief estimates by whether the respondent in question has at least one married child (who could be a son or daughter) to assess whether learning about the marriage market through participation shifts perceptions. We do not find any evidence of meaningful heterogeneity along this margin.

Beauchamp, Calvi, and Fulford (2021) uses variation in district-level sex ratios to identify preferences on both sides of the marriage market, whereas we construct survey instruments and vary the information in vignettes. We designed our instruments specifically to identify the marriage market return to education as a key parameter.

VI.D. Validation

Given the novelty of our method, we complement the core experimental results with three validation exercises. First, we compare realized age of marriage and schooling trajectories for daughters of our survey respondents (measured five years after our experimental data collection) with those that we would predict on the basis of our structural belief and preference estimates. This is an out-of-sample validation exercise; our structural belief and preference parameters are estimated only on the basis of the experimental data. Second, we compare the consistency of our revealed beliefs with a measure of directly elicited beliefs. Third, we assess whether our revealed beliefs are consistent with preferences elicited from the groom's side of the marriage market.

1. *Comparing Observed Versus Predicted Marriage and Schooling Trajectories.* We collected follow-up data on the realized educational outcomes and age of marriage of respondents' daughters five years after our experimental data collection (Section III). We use these reports to construct completed schooling and marriage trajectories for respondents' daughters. For example, if at follow-up a respondent reported that their daughter was married at 19 and had completed 12th grade at school, we would record that girl as (i) "in-school" for ages 13–17; (ii) "out-of-school and unmarried" at age 18; and (iii) "married" from age 19 onward. We calculate the observed proportion of girls in these three states at every age 13 to 22.[54] We consider college completion as leaving school at age 18, as we did not capture the number of years spent in college.

We compare these observed proportions to those that we would predict on the basis of the estimated structural parameters. We construct these predictions by simulating choice behavior for girls who are in school and unmarried at age 12. Specifically, we use our model to calculate choice probabilities at each age-education–in school combination for ages 13–22. In particular, conditional on the marriage offer (no offer, high, low), we calculate the probability of choosing school, home, or marriage. We

54. Note that respondents' daughters were aged 13–19 years old at the point we administered our survey experiments. Therefore, at the time of the follow-up, these girls were aged 18–25. At ages 18 or less, our observed proportions are estimated based on all girls in the sample. For ages 19 and over, the proportions are estimated using the girls who are past that age.

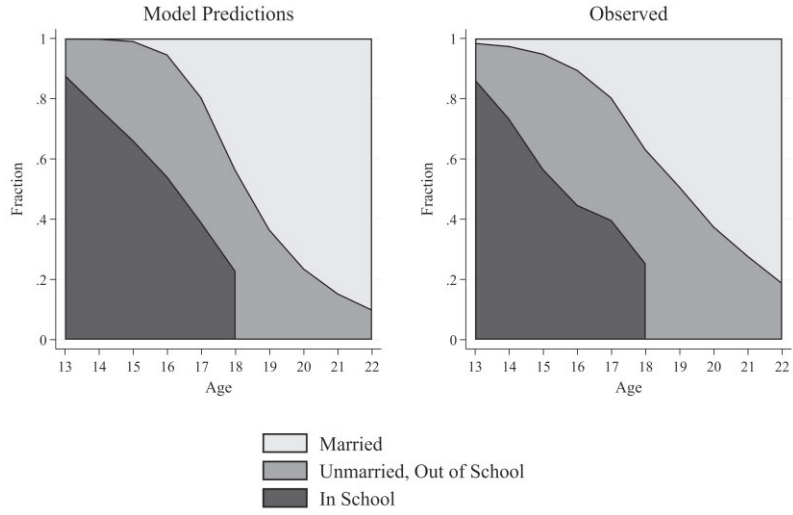


FIGURE V

Predicted Versus Observed Trajectories

The figure plots, at each age between 13 and 22, the fraction of girls falling into each of three categories—(i) married, (ii) unmarried but out of school, (iii) in school—as predicted by our model (left) and as observed in the medium-run follow up of respondents (right).

use our estimated beliefs to construct the overall probability that an unmarried girl at each state will end up married, out of school, or will still be in school at the end of the period. We recursively loop through each age to estimate the proportion of girls of that age in a given state (as defined by their age-education–in school–marriage variables).

Figure V gives the observed and predicted schooling and marriage trajectories. Online Appendix Figure A.5 gives deviations between the observed and predicted schooling and marriage rates and confidence levels. Remarkably, the trajectories predicted by the structural parameters estimated on our experimental data closely match the realized trajectories that we observe in the follow-up data five years later. Consider, for example, outcomes at age 18. In the observational data, 25.3% of girls are still in school compared to our model prediction of 22.7% (p-value on the difference = .7810). At age 18, 36.8% of girls are married, compared with our model prediction of 43.7% (p-value on the difference = .1847).

We also closely match heterogeneity in the trajectories by the two individual characteristics of girls that we built into our experiment: whether the girl likes school and whether she complies with prevailing gender norms. Consider first whether a girl breaks gender norms. We classify a respondent's own daughter (at the time of experimental data collection) as breaking social norms if they indicate that she (i) is not "always" polite and respectful of their parents, (ii) sometimes arrives home late, or (iii) has friends they disapprove of.[55] Our ex ante vignette either described a hypothetical girl as "polite and well behaved" or as "friends with some boys and sometimes staying out of the house until late." Figure VI, Panel A gives the observed and predicted schooling trajectories for girls who conform or break with traditional norms.[56] Online Appendix Figure A.6 gives the difference between and confidence interval on the observed and predicted schooling profiles and shows that there is no statistically significant difference between them.[57] Averaged across ages 13 to 18, girls whose mothers describe them as breaking social norms are 5.9 percentage points less likely to be in school; on the basis of our structural parameters, we predict a 9.5 percentage points schooling gap over the same age range. This exercise confirms that the direction and magnitude of the offer-probability penalty associated with breaking norms that we estimate is plausible.

We consider heterogeneity by whether a girl likes school. At the time of the experimental data collection, respondents were asked about their daughter: "how hardworking is your child?" Figure VI, Panel B shows the observed schooling trajectories split by whether a respondent reports that their daughter is at least "above average" in how hardworking she is.[58] Although the experimental and observational questions are not identical, the

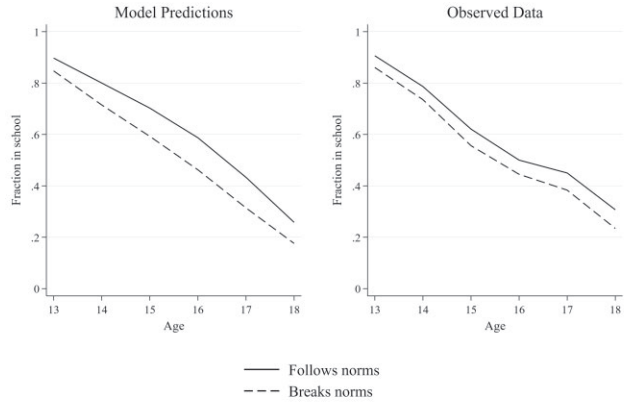
55. Thirty-seven percent of respondents report that their daughter breaks social norms on this measure.

56. Online Appendix Figure A.4 gives the marriage trajectories. Online Appendix Figure A.7 gives the confidence intervals on the difference between observed and predicted heterogeneity in marriage rates.

57. Our interest is in whether our estimates accurately reflect heterogeneity in schooling and marriage trajectories. We calculate the difference in schooling rates between girls who break gender norms and those who adhere to them in the observed and predicted trajectories. We analyze whether these differences significantly deviate.

58. Thirty-three percent of respondents report that their daughter is hardworking on this measure.

(A) Heterogeneity by whether or not parents are worried that daughter's behavior conflicts with gender norms (gets home late and has unsuitable friends)



(B) Heterogeneity by whether or not girl likes school (in the choice experiments) and whether or not mother reported girl is hardworking (observational data)

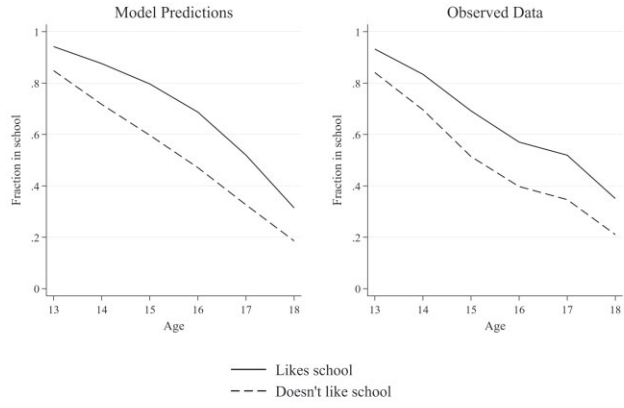


FIGURE VI

Predicted Versus Observed Heterogeneity: Preference and Belief Shifters

The figures plot the predicted (left) and observed (right) proportion of girls in school at each age, split by whether a daughter follows gender norms (Panel A) or whether a daughter likes school (predicted) or is hardworking (observed) (Panel B). Online Appendix Figure A.6 gives the difference between and confidence interval on the observed and predicted schooling profiles.

comparison helps us to assess whether the estimates of how a daughter's attitude toward school influences her parents' preferences are plausible in direction and magnitude. Figure VI, Panel B gives the predicted profiles for girls described as liking versus disliking school. We predict that girls who like school are 16.5 percentage points more likely to be in school across their adolescence on average; in our observational data, girls described as hardworking are 14.9 percentage points more likely to be in school over this age range.[59]

Our model is not quite as good at capturing marriage rates in late adolescence. We predict slightly higher marriage rates among girls in their early twenties than we observe in reality, and this deviation is statistically significant. There are at least two factors that could explain this. First, age 23 was the oldest age listed on our visual aids (Figure I), which could have made marriage by this age particularly salient. In addition, the COVID-19 pandemic occurred between our experimental data collection and follow-up. Pandemic-related disruption increased frictions in the marriage market and unexpectedly delayed the marriage of some girls relative to prepandemic beliefs (Batheja et al. 2022).

2. *Consistency with Stated Expectations.* To provide an experimental check of the plausibility of our estimates, we directly elicited how expected match quality varied with the characteristics of a potential bride. Delavande, Giné, and McKenzie (2011) finds a strong correlation between answers to "what do you expect" questions and the mean of elicited subjective belief distributions, albeit with systematic overoptimism. We provided information on the age, education, and wealth of a hypothetical bride and asked respondents to describe the attributes of the most likely groom they believed such a girl would marry if her parents wished to marry her at this point. Online Appendix Figure A.8 gives the visual aid we designed for this exercise.

Online Appendix Figure A.9 shows the proportion of respondents predicting a match with a government job by the education level of the hypothetical daughter. We find a strong relationship between a daughter's education and the likelihood of predicting a match with a government job. This is broadly consistent with our

59. Online Appendix Figure A.6 gives the difference between and confidence interval on the observed and predicted profiles and shows that there is no statistically significant difference between them.

revealed-belief estimates.[60] The importance of a girl's education survives controlling for other vignette characteristics in a linear probability model; indeed, age controls (conditional on education) are insignificant (see Online Appendix Table A.6).

However, the probability levels implied by our revealed-belief measures are more plausible than those arising from the direct expectations experiment. In the direct expectations experiment, respondents predicted a groom with a government job in 70% of rounds involving an 18-year-old girl. Yet less than 10% of men aged 21 to 30 have a professional job in Rajasthan (NFHS-4). This is consistent with findings in other settings that find the gradient of subjective expectations in different characteristics is more accurate than their level (Delavande and Rohwedder 2011). Correctly identifying the level of subjective beliefs (and not just their gradient) is important for any calibration of marriage market dynamics on the basis of structural preference and belief results.

3. *Consistency with Groom-Side Preferences.* The likelihood of receiving a marriage offer from a high-quality groom depends on grooms' preferences over bridal characteristics in addition to the degree of search frictions. We also elicited groom-side preferences over the characteristics of brides in a simplified version of our ex post choice experiments to assess whether they are consistent with our belief estimates. Specifically, we presented respondents with a vignette of a hypothetical family who is looking to marry their son, specifying the same groom-side attributes as discussed in Section IV (see Online Appendix Figure A.10 for the visual aid). We presented respondents with two potential marriage options and asked them to select the one they believed the hypothetical family would prefer.

Online Appendix Table A.5 presents the determinants of choices in this experiment. We find a strong increasing preference for women's education among grooms with a government

60. However, we note that the two sets of results are not directly comparable: while the revealed beliefs give the average conditional probability that respondents attach to a young woman getting an offer from a high-quality groom, the expected match results provide information on how whether a respondent "expects" that the accepted match will have a government job varies with a young woman's characteristics. We would anticipate that respondents answer that they "expect" the accepted match to have a government job if they perceive the probability to be greater than 50%, although we are not aware of any research that explicitly assesses this assumption.

job and the coefficient on women's college education is large and highly significant. This is consistent with the patterns recovered in the revealed-belief estimation, which also implied a much higher probability of matching with a groom with a government job if the daughter was educated to a college level. Interestingly, we do not observe the same preference for women's college education among families of grooms without government jobs. We also see that families of grooms dislike potential brides who have male friends. This is consistent with our revealed-beliefs estimates that these young women are perceived to be less likely to receive high-quality marriage offers.

VI.E. Heterogeneity

Finally, we consider evidence for heterogeneity in preferences and beliefs across our respondents. This application of our method was not designed to capture rich individual heterogeneity given that our study context necessitated asking respondents about the behavior of a hypothetical family rather than their own. Nevertheless, respondents may have different reference points for the preferences and beliefs that they think a typical couple described in the vignette would have. To explore this possibility, we spilt the sample along key dimensions of respondents' observable heterogeneity and structurally estimate preference and belief parameters by subgroup using the method outlined in Section V.A.

We first consider heterogeneity by the education and socioeconomic status of respondents and their families. Online Appendix Table A.7 gives the structural age and education parameters characterizing preferences and beliefs by whether (i) a respondent achieved at least primary education, and (ii) a respondent's husband achieved at least primary education. Online Appendix Table A.8 shows the results of a similar exercise where we compare coefficients across whether a respondent's household (i) belongs to a scheduled caste or tribe, or (ii) lives in a dwelling with a dirt floor. We find little evidence of any systematic differences in elicited preferences and beliefs across these dimensions. The only exception is that respondents with lower socioeconomic status (measured by caste and housing quality) have a somewhat weaker preference for delaying marriage in age.

In Table IV we consider heterogeneity in preferences and beliefs by the realized choices that each respondent's family made with regard to their own daughter's marriage and education that

TABLE IV

DIFFERENCES IN STRUCTURAL PARAMETERS BY REALIZED TRAJECTORIES OF RESPONDENTS' DAUGHTERS

	Own daughter in school at 16					Own daughter married at 17				
	Yes		No		p	Yes		No		p
Panel A: Preferences										
Age	0.493	(0.061)	0.586	(0.050)	.237	0.635	(0.083)	0.533	(0.047)	.286
(Age 18) × 1(age ≥ 18)	−0.407	(0.094)	−0.541	(0.075)	.262	−0.545	(0.126)	−0.479	(0.071)	.645
Years of education − 7	0.171	(0.040)	0.075	(0.035)	.071	−0.022	(0.058)	0.148	(0.030)	.009
College	−0.792	(0.246)	−0.340	(0.217)	.169	−0.441	(0.359)	−0.540	(0.186)	.808
Number of experiments	2,760		3,747			1,428		4,968		
Number of respondents	920		1,249			476		1,656		
Panel B: Beliefs										
Age	0.000	(0.011)	0.000	(0.008)	.992	0.000	(0.007)	−0.001	(0.008)	.904
Education	1.352	(0.214)	1.199	(0.276)	.661	1.542	(0.232)	1.195	(0.338)	.397
College	3.426	(0.461)	4.042	(0.498)	.364	3.033	(0.641)	3.951	(0.507)	.262
Age × education	−0.112	(0.021)	−0.105	(0.026)	.832	−0.130	(0.027)	−0.102	(0.034)	.524
Constant	−3.414	(0.109)	−3.405	(0.077)	.947	−3.412	(0.069)	−3.399	(0.076)	.901
Number of experiments	2,387		2,790			987		4,098		
Number of respondents	945		1,169			414		1,665		

Notes. The table presents preference and belief structural parameters related to a daughter's age at marriage and education, estimated separately by whether respondents' own daughter was in school at 16 and whether her own daughter was married at 17. In doing so, we hold all other preference parameters constant at the values in Table II, column (3), and all other belief parameters constant at the values in Table III. p-values are testing the null hypothesis that the coefficients are the same across groups. p-values and standard errors (in parentheses) are estimated using a bootstrap, resampling respondents with replacement.

we observe in our five-year follow-up. We split the sample and estimate our structural parameters separately by whether a respondent's own daughter was (i) out of school at age 16 (i.e., before high school completion age), or (ii) married at age 17 (i.e., before the legal minimum age of marriage). We find evidence that respondents whose daughters married before the legal minimum and those whose daughters did not complete high school have a significantly weaker preference for girls' education (Panel A). Respondents with a daughter married at 17 years old dislike all levels of schooling, particularly college. However, those whose daughter is unmarried at the legal minimum believe the typical couple prefers more schooling to less but still prefers high school completion over college. Those whose daughter is still in school at 16 also have a significantly larger preference for additional years of schooling. We find no heterogeneity in beliefs along these dimensions. The lack of any significant heterogeneity in estimated beliefs might reflect that these are driven by a common understanding of the local marriage market norms and are less sensitive to a respondent's own situation.[61]

VII. Counterfactual Simulations and Discussion

We use our structural results to quantify the economic significance of different drivers of parents' choice. Specifically, we construct counterfactual schooling and age-of-marriage trajectories under different assumptions about returns to age and education in preferences and beliefs. Figure VII gives the schooling trajectories implied by our preference and belief estimates as we remove the positive perceived marriage market return to education in beliefs;[62] remove any preference for education in preferences;[63] remove the negative perceived marriage market return to age in beliefs once a girl is out of school;[64] and remove the positive preference for delaying marriage until age

61. This is consistent with evidence we presented in Section VI.C and Online Appendix Table A.9 that respondents' beliefs about the marriage market do not vary by whether they had any married child.

62. We assume a constant probability of receiving a high-quality marriage offer (which we set at the level for a "good girl" aged 16, which is approximately the average likelihood at the age and education combinations we consider).

63. We set all preference parameters relating to education to zero.

64. Here we assume that the probability of a good marriage offer does not decline in age once a girl is out of school.

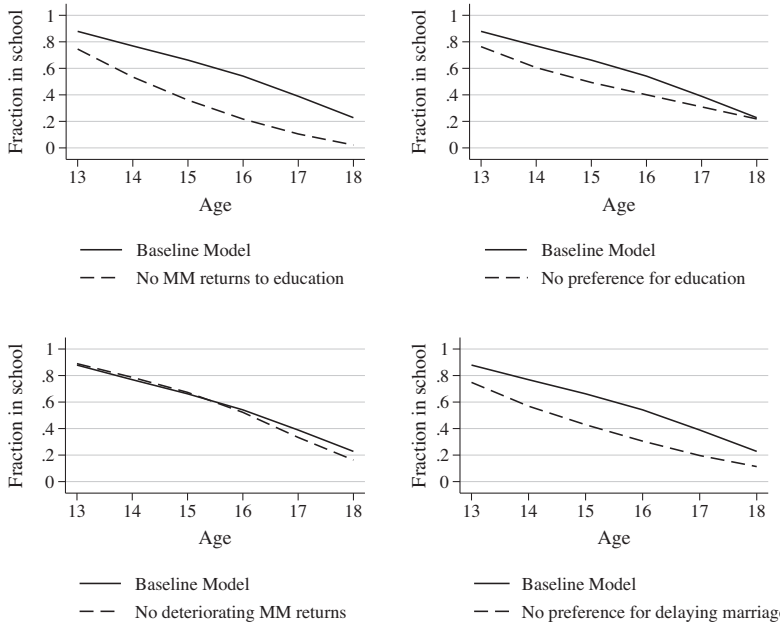


FIGURE VII

Counterfactual Schooling Profiles

The graphs show baseline and counterfactual patterns for the proportion of girls in school by age for four different counterfactuals. (Top left) Parents perceive no marriage market return to education; (top right) parents have no preference for a daughter's education; (bottom left) parents perceive no deteriorating marriage market returns to age; and (bottom right) parents have no preference for delaying marriage.

18.[65] Online Appendix Figure A.11 gives the marriage trajectories implied by these counterfactual simulations.

The results confirm that the perceived marriage market return to education is a quantitatively important driver of women's secondary schooling in our context. The counterfactual simulations demonstrate that if parents perceived no marriage market return to education, 32.4 percentage points fewer girls would be in school at age 16, compared with a baseline schooling rate of 54.1% in our main model. If parents' preferences are modified to be independent of a girl's education level, the fraction of girls in

65. We set all preference parameters relating to age to zero.

school at 16 years old would fall by 14.1 percentage points relative to the baseline. This is approximately half the impact compared with shutting down the beliefs channel.

These patterns reflect that while parents place intrinsic value on a daughter's education up until the end of high school, this is quantitatively less important than the sizable marriage market return they perceive to a daughter's education. In our context, this return is generated by education shifting the relative likelihood of a marriage offer toward one from a high-quality groom. There are many reasons grooms and their families might value educated brides, including valuing her parenting skills and ability to effectively run a household. This perceived marriage market return to education may be important in understanding why women's education in India has continued to increase while women's labor force participation has fallen from an already low base (Pande et al. 2017).

Relative to our baseline model, removing parents' distaste for marriage before 18 has a larger impact on simulated choice behavior than removing the perceived negative marriage market return to age once a girl is out of school. The fraction of girls still in school at 16 is 24.1 percentage points lower when parents have no preference for delaying marriage but is essentially unchanged when beliefs are altered.

We finally consider the protective value of schooling. There are many shocks that might push girls out of school even if her parents would have preferred for her to continue her education, and we captured these in our model as idiosyncratic preference shocks. Online Appendix Figure A.12 shows the fraction of girls marrying at each age among those who are either still in school or who start that period newly dropped out of school. The difference between the marriage rates by schooling status identifies the protective value of education implied by our preference and belief estimates. At very young ages, parents' distaste for early marriage implies only a small gap in marriage rates by schooling status, but as girls age, this gap gets larger. At age 17, the gap in marriage rates between those in school and those newly dropped out is 9.5 percentage points. Policies ensuring that girls have safe and affordable access to high-quality schooling, and those that insulate adolescent girls from shocks that might otherwise cause premature school dropout, can therefore be instrumental in reducing rates of early marriage.

VIII. Conclusion

We develop a new methodology to estimate subjective beliefs from hypothetical-choice data. Our identification approach is based on the novel insight that by varying the amount of information on future realizations of stochastic variables, discrete-choice experiments can identify not only preferences but also subjective beliefs. We formally prove this result in a general setting and apply it to design a strategic survey instrument to identify Rajasthani parents' subjective beliefs over the joint distribution of girls' age of marriage, education, and marriage match quality. This approach allows us to quantify the importance of perceived marriage market returns to education and youth for schooling and marriage decisions and to perform various counterfactual simulation exercises.

In a sample of 4,500 women in Rajasthan, India, we find that parents perceive a significant marriage market return to girls' education and that this is a quantitatively significant driver of their investment in their daughters' schooling. While parents would prefer to delay a daughter's marriage until at least age 18, a belief that marriage market prospects quickly deteriorate with age once a daughter is out of school generates an incentive to accept early marriage offers. The perceived marriage market return to education may be important in understanding why women's education in India has continued to increase while women's labor force participation has fallen (Pande et al. 2017). Our counterfactual simulations also show that shocks pushing adolescent girls out of school are an important contributor to their early marriage and suggest that programs such as helping young women re-enroll in formal education could have substantial effects.[66]

To validate our revealed-belief methodology, we resurveyed respondents five years after the original data collection to collect information about the actual schooling and marriage choices that they took for their daughters in the intervening years. This allows us to undertake an out-of-sample validation exercise and compare

66. After our experimental data collection took place, the government of India introduced a nationwide campaign (Kanya Shiksha Pravesh Utsav) that aims to re-enroll out-of-school girls aged 11–14 back into the education system. While this scheme may hopefully ease the pathway for younger adolescent girls to reenter school, there have been concerns about the effectiveness of the campaign in practice with administrative data, with no re-enrollments under the scheme having been recorded for Rajasthan at the time of writing.

the schooling and marriage trajectories that took place in reality with those predicted by our structural preference and belief estimates. This exercise demonstrates that our methodology yields structural parameters that accurately predict the level of and heterogeneity in schooling and marriage outcomes. We show that our revealed beliefs are also consistent with experimentally elicited groom-side preferences and responses to direct "expected match" questions.

Our methodology provides a nice complement to recent work that establishes creative tools to improve the direct measurement of subjective beliefs. Our approach is easily deployed at scale and bypasses concerns over whether respondents are comfortable expressing their beliefs as probabilities and whether, in doing so, they make systematic errors. Our validation exercises also demonstrate that the probability levels implied by our revealed-belief measures are somewhat more plausible than those arising from directly eliciting the expected characteristics of realised marriage market matches. An important limitation of our approach, however, is that it is not well suited to recovering individual-level beliefs. Rather, the methodology is best suited to applications where heterogeneity in average preferences and beliefs across subgroups are the primary objects of interest. Our approach can be seen as the belief complement to discrete-choice experiments that elicit average preferences and how average preferences vary across specific subgroups.

This methodology may be useful in a range of scenarios where researchers are interested in estimating average beliefs in an intuitive, low-cost manner. For instance, labor market search problems share many of the fundamental aspects of the marriage market search problem we set up here. Our methods could be adapted to assess, for instance, job-seekers' beliefs about the likelihood of receiving different types of job offers and how this depends on different investments (e.g., education or training). While we focused on how two endogenous choice variables—age and education—determined the likelihood of receiving marriage offers, our method could be adapted to expand the set of endogenous determinants. It would be natural, for instance, to measure beliefs about the returns to search effort by designing ex post vignettes that included information on the amount of search effort expended by parents and marriage market outcomes and designing ex ante vignettes that included a choice over search effort actions.

Supplementary Material

An Online Appendix for this article can be found at *The Quarterly Journal of Economics* online.

Data Availability

The data underlying this article are available in the Harvard Dataverse, https://doi.org/10.7910/DVN/KLOCAL (Andrew and Adams 2025).

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