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Revealed beliefs and the marriage market return to education

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Revealed Beliefs and the Marriage Market Return to Education*

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Abstract

This paper develops a new methodology to analyze how parents in Rajasthan, India make choices about their daughters' schooling and marriage. We specify a dynamic discrete choice model in which parents face uncertainty about the quality of their daughter's future marriage offers. Parents' choices are thus partially driven by their beliefs about the likelihood of receiving high-quality marriage offers in the future and how this varies with age and education. We identify this model by creating a hypothetical-choice tool that enables us to identify preferences and probabilistic beliefs without directly eliciting probabilities. Parents perceive a significant marriage-market return to girls' education and this drives much of their investment in their daughters' schooling. While parents would prefer to delay a daughters' marriage until at least age 18, a belief that marriage-market prospects quickly deteriorate with age once a daughter is out of school creates an incentive to accept early marriage offers.

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1 Introduction

When to leave school? When to marry? Who to marry? These are some of life's most consequential decisions. Together, they profoundly shape economic and mental wellbeing. They are also fundamental in shaping gender inequalities. Early marriage and low education leave women vulnerable to poverty, poor mental and physical health, low decision-making power, and economic dependence on men (Duflo, 2012; Jensen and Thornton, 2003). In rural India, the context of this paper, parents typically make schooling and marriage decisions for their daughters. Thus, understanding the drivers of parents' choices is crucial for understanding the processes that sustain India's exceptionally high levels of gender inequality across many dimensions of welfare.

This paper is the first to examine the role that beliefs about the marriage market play in shaping parents' decisions about whether to keep their daughters in education and when, and to whom, to get them married. Do parents invest in their daughter's education in the expectation of securing her a better groom? Does a belief that good marriage offers might not be forthcoming in the future prompt parents to accept offers that arrive early in a daughter's adolescence? If we removed uncertainty about a daughter's marriage market match, what would parents prefer regarding her education and age of marriage?

Identifying the role of beliefs about marriage market returns is challenging. With observational choice data, identifying beliefs separately from preferences is not possible without strong assumptions (Manski, 2004). To overcome these challenges, we develop a novel set of strategic survey instruments motivated by a flexible dynamic discrete choice model of parents' decisions concerning the schooling and marriage of their daughter. In the model, marriage offers of varying qualities arrive stochastically with a likelihood that depends on the age and education of the daughter. 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 and use it to design a set of discrete choice experiments that we employ with a sample of 4,500 caregivers of adolescent girls living in the Dhaulpur district of Rajasthan. We use respondents' choices to these instruments to estimate parental beliefs and preferences while relying on far fewer assumptions than would be required if estimating such a model from observational data.

More specifically, our novel discrete choice methodology uses respondents' choices to two sets of discrete choice experiments that present different hypothetical vignettes concerning a daughter's marriage and education. Crucially, these two sets of experiments provide different information about the realization of future marriage offers. This allows us to identify parents' preferences over daughters' age of marriage, completed education, and marriage match quality *and* their subjective beliefs about how the quality of marriage offers varies with a young woman's age and education. In the first set of experiments, which we call "ex-post" experiments, respondents were presented with vignettes describing a set of complete realized descriptions of a daughter's age and education at marriage and groom characteristics. In these experiments, the marriage offers at future time points are known with certainty. Respondents are asked to choose which option is 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).[1]

In the second set of "ex-ante" experiments, we collect state-dependent stochastic choice data (Caplin, 2016). We elicit respondents' behavior with vignettes that present take-it-or-leave-it marriage offers from different grooms, potentially when a daughter is still in school. In the ex-ante experiments, there is uncertainty over the realization of future marriage offers. Thus, the expected value of rejecting the marriage offer is shaped not only by parents' preferences but also by their beliefs about the probability of receiving different qualities of marriage offers in the future (Sautmann, 2017). We prove formally that choices to the ex-ante and ex-post experiments identify beliefs about how the quality of marriage offers varies with a daughter's age and education. We term the beliefs that reconcile choices made with and without uncertainty over future marriage offers "revealed beliefs".

Varying the information contained in vignettes provides an intuitive way of eliciting beliefs that does not require directly asking respondents for point probabilities. This has many advantages in our setting. First, it has clear benefits when respondents are unfamiliar with probabilistic concepts or have low numeracy. Second, even respondents with a sophisticated theoretical understanding of probability make systematic errors when reporting probabilistic beliefs (Tversky and Kahneman, 1974). Our approach is well suited to contexts where individuals do not have easily retrievable beliefs over the realization of

[1] See also Banerjee et al. (2013) that asks families to rank responses to matrimonial adverts to estimate the strength of caste preferences in marriage in India.

different states, but rather adopt a set of state-contingent decision rules that are "as if" they were acting on a well-defined set of beliefs.[2] Third, our approach works well when eliciting beliefs over high-dimensional constructs – such as groom quality – that are formed of multiple components, combined in a manner that is unknown to the researcher ex-ante.

We apply our approach on a sample of 4,500 caregivers in rural Rajasthan. We estimate parents' preferences over their daughters' education, age of marriage and marriage match, in addition to their subjective beliefs about the marriage offer distribution. In particular, we estimate beliefs over the likelihood of receiving marriage offers from grooms of different quality levels as a function of a daughter's age and education. We find that parents care a great deal about securing a high-quality marriage match for their daughter. They place particular weight on whether or not the groom has a government job, the most well-paid and secure form of employment in the area. This preference, in turn, motivates parents' pre-marital choices as they seek to increase the chance of their daughter receiving high-quality marriage offers.

We find that the perceived marriage market return to education is a key driver of pre-marital investment in girls' education. This is especially the case for college education. Conditional on a given marriage match, we find that parents dislike college education. However, they perceive that college dramatically increases the likelihood of their daughter marrying a high-quality groom. For instance, parents believe that a 19 year old daughter with a college degree has a 26% chance of receiving a marriage offer from a high-quality groom, a 12% chance if she finished high school and a less than 1% chance if she only has primary education. Our subjective belief estimates pass several validation checks: they are qualitatively consistent with preferences over brides' characteristics that we elicit on the groom's side of the marriage market; they exhibit qualitatively similar trends to what we observe when explicitly eliciting respondents' expected marriage match; and they are consistent with patterns of assortative matching on education that we observe in national survey data.

Regarding age at marriage, we find that parents prefer to delay a daughter's marriage until the age of eighteen, the legal minimum, but have no preference for delaying further. In contrast, we find that

[2]Such models are feature in both economics and psychology literatures on learning Charness and Levin (2005). Nash proposed a model in his PhD thesis Nash (1951). We provide a further discussion of the relation of our approach to these types of models in Section 3.

parents believe a girl's marriage market prospects worsen with age immediately after leaving formal education. These decreasing marriage market returns to age incentivize parents to accept marriage offers earlier than they would otherwise prefer since they anticipate that they are unlikely to receive high-quality marriage offers in the future. This feature implies that shocks that push girls out of school can lead to early marriage since families perceive that their daughters' marriage market prospects will worsen with every year they wait.

Our findings have implications for policy and program design. Many of the programs seeking to promote later marriage have primarily targeted adolescent girls and their families (Buchmann et al., 2017; Edmonds et al., 2021; Bergstrom and Özler, 2021). Our results show that programs targeted at young men to loosen the stringent gendered expectations to which prospective brides are held might also be fruitful in reducing rates of early marriage. Our results also highlight the protective value of education against early marriage. They identify a group of young women at 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. Shocks that cause young women to drop out of school thus also create pressures for their marriage. Our results thereby complement work showing the importance of economic shocks for early marriage in contexts where marriage payments are the norm (Corno et al., 2020).

Our findings contribute to three main literatures. First, we contribute to the literature on the drivers of education and marriage choices in contexts where traditional gender roles are the norm. Much of what we know about the drivers of these choices comes from interpreting the effects of standalone programs or policies (see Bergstrom and Özler (2021) for a review). This literature has highlighted that schooling choices are deeply rooted in stringent gender norms (Edmonds et al., 2021; Buchmann et al., 2017; Dhar et al., 2022). Our work complements this existing literature by directly estimating the underlying structural primitives in the parents' decision problem.

Second, this paper contributes to the growing literature on marriage market returns to education. Existing empirical work on marriage market returns to education has primarily focused on societies with high female labor force participation and typically finds large and positive marriage market returns to female education (Chiappori et al., 2018; Lafortune, 2013), although there are instances of negative returns to very high levels of education and professional ambition (Fisman et al., 2006; Hitsch et al., 2010). Our results suggest that a substantial marriage market return to women's education also exists in this very different context: one where women's labor force participation is very low and gender norms are much more conservative (Dhar et al., 2022). Indeed, we find that marriage market returns provide the primary motivation for investing in a daughter's college education in our context.

Finally, this paper contributes to a growing body of work that develops theory-driven strategic survey instruments to identify structural primitives under far fewer assumptions than would be required for identification from observational data (Ameriks et al., 2020; Attanasio, 2021). Specifically, we design and use tools to identify both preferences and subjective beliefs within the context of a dynamic discrete choice model of the marriage market. Our key methodological innovation is to develop a new choice-based method for eliciting beliefs. Directly measuring subjective beliefs is increasingly popular. Recent work has, for example, directly measured beliefs over: returns to education (Delavande and Zafar, 2019; Wiswall and Zafar, 2018; Boneva and Rauh, 2018), the drivers of child development (Attanasio et al., 2019), and children's ability (Dizon-Ross, 2019). We show, for the first time, that by adapting standard discrete choice experiments, which are increasingly popular in measuring preferences, it is also possible to identify subjective beliefs.[3]

In principle, our approach could be used to elicit individual-specific preferences and beliefs. Unfortunately this is not possible in this paper given the cultural context of our application. Age of marriage is a sensitive topic in our study area, and thus misreporting of age of marriage is common (Borkotoky and Unisa, 2014). Social desirability bias would be a major concern if we asked respondents about their own choices given legal reforms and widespread social and political campaigns targeting child marriage. To reduce systematic bias in reported choices and to avoid putting respondents in an uncomfortable position, we thus employ a hypothetical framing throughout the implementation of our approach: we ask respondents about the choices they think a hypothetical couple would make for their daughter.[4] As a consequence of this hypothetical framing, we formally identify respondents' perceptions of average preferences and average beliefs in the precise application in this paper.[5] We provide a number of

[3]Delavande and Zafar (2019) and Arcidiacono et al. (2012) combine directly elicited beliefs and choice data to estimate dynamic structural models but do not make use of comparisons of choice with and without uncertainty to identify beliefs themselves. Our approach is similar to work that identifies people's subjective beliefs by choices over different state-contingent lotteries, conditional on knowledge of their preferences (Andersen et al., 2014).

[4]This use of hypothetical vignettes also limits the role of unobserved characteristics in driving respondents' decisions.

[5]While systematic bias in perceptions of average preferences can be an important issue for rare events (Bursztyn et al.,

robustness checks for systematic bias in these objects and find that partial knowledge of true average preferences and beliefs is not a first-order concern in our context. Thus, we consider that respondents' perceptions are unlikely to be systematically wrong and thus refer simply to "average preferences" and "average beliefs" throughout.

This paper proceeds as follows. Section 2 describes the key features of the marriage market, and the interaction between marriage and education decisions, in rural Rajasthan. We then develop a dynamic discrete choice model of parents' decisions about the education and marriage of their daughter that recognizes the uncertainty they face over future marriage offers. In Section 3, we use our model to guide the design of the ex-post and ex-ante choice experiments. Section 4 shows how the combination of choice data from the ex-post and ex-ante experiments enables the identification of beliefs about the likelihood of marriage offers from high quality grooms as a function of the age and education of a young woman. Section 5 presents the key sources of variation present in choices to our instruments before giving our revealed belief results and validation exercises. Section 6 concludes.

2 Theoretical Framework

We begin by setting out a dynamic partial equilibrium model that captures the key contextual features of the marriage market. Parents' choice of whether to accept a marriage offer for their daughter and how much education she acquires are dynamic decisions made under uncertainty. Optimal choice depends not only on parents' preferences over their daughter's age and education at marriage but also on their beliefs about how the quality of marriage offers depends on a daughter's age and education.

2.1 Context

There are four key contextual features of the marriage market that we embed in our model. First, we treat marriage and schooling as decisions made by parents rather than adolescent girls themselves. In our study communities, marriages are almost always arranged by parents. Young women have little

2020), it is unlikely to be a first-order concern in our study as, in our setting, marriage is near universal, marriage arrangements are public and the subject of much discussion within the community. We find no systematic differences in response patterns between respondents who have children who have already gone through the process of marriage for one of their children and those who haven't, nor by how similar a vignette is to respondents' own circumstances.

control over either the timing of their marriage or the choice of spouse.[6] 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.

Second, parents face uncertainty about the quality of potential grooms. The study area is patrilocal, meaning that women join their husband's natal community, and usually their natal home, upon marriage. The norm is for the husband's natal community to be at least 10km away from the bride's.[7] Parents search for potential grooms through extended family and sub-caste networks.[8] The search process can be lengthy and these frictions leave a role for uncertainty over the quality of future matches.

Third, we do not explicitly model the relationship between a daughter and her parents after marriage. Although marital ties create extended family networks that can be important for risk-sharing, job search and migration (Rosenzweig and Stark, 1989), married women's primary economic unit is fundamentally that of the marital household. Married women often have little autonomy to maintain independent economic connections with their natal family.[9] Indeed, it is rare for younger women in our study area to work outside the home or in family businesses. In our sample, only 37% of mothers had worked for cash in the past year (Table 1).

Finally, marriage is a significant economic transaction. Despite having been illegal since 1961, dowry payments remain an important feature of most marriages in this part of India. 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. Within our study communities, dowry is primarily viewed as a "groom price" (Anderson and Bidner, 2015).[10] The value of

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[6]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.

[7]Focus group discussion (FGD) respondents mentioned this distance should be at least 10km (see FGD 2, Appendix E).

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

[9]In our sample, 39% of mothers can't go to the market unaccompanied, while 92% do not own any asset they could dispose of at will making it difficult for them to maintain an independent economic connection with their natal family.

[10]One focus group participant commented that: "Dowry is directly proportional to what kind of boy one is looking (for), if one is seeking a boy who is educated, has fields and a good house and family then the dowry is always higher" (FGD 3,

dowry is substantial relative to household wealth in our study communities. Respondents in our confidential focus groups gave a monetary range corresponding to \$4,700 to \$15,600 or between 3 and 10 times current GDP per capita in Rajasthan (Researve Bank of India, 2017), a ratio which is in line with previous estimates (Rao, 1993; Bloch and Rao, 2002).[11] Since we will be working in a partial equilibrium framework, we do not directly model dowry bargaining but instead view dowry as a component of groom quality.

2.2 Model

States, Actions and Option Sets We model a finite portion of the dynamic problem facing parents during a daughter's adolescence from when she is aged 13 to 22.[12] In periods before marriage, parents can take the actions, d_t:

$$d_t = \begin{cases} S & \text{if the daughter is kept in education,} \\ H & \text{if the daughter is kept at home,} \\ M & \text{if the daughter is married.} \end{cases} \tag{1}$$

The actions available in parents' option sets, and their payoffs from these actions, depend on a vector of state variables $\omega_t = \{t, \mathcal{M}_t, Ed_t, Z_t, q_t, \varepsilon_t\}$. $\mathcal{M}_t$ denotes whether the daughter is already married in period t ($\mathcal{M}_t = 1$) or not ($\mathcal{M}_t = 0$). Ed_t gives the daughter's current level of education. q_t summarises information on the best marriage offer received in period t. If a marriage offer is received, $q_t \in \{Q^0, ..., Q^K\}$, where Q^i represent finite groom quality types. If no marriage offer is received, then $q_t = N$. Z_t contains other factors, such as a daughter's particular enjoyment of school or the household's financial situation, that may influence the parents' payoffs and that are constant over time and known to both parents and the econometrician. Finally, ε_t represents time-varying idiosyncratic shocks to the payoffs associated with taking different actions in period t.

Marriage offer qualities, q_t, and the idiosyncratic preference shocks, ε_t, are unknown in advance of

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Appendix E).

[11] 2018 price level. See FGD 3, Appendix E. Further, in addition to dowry transfers to the groom's family the bride's family also covers the cost of the wedding, which may be elaborate (Bloch et al., 2004).

[12] 91% of 22 year old women are married in rural Rajasthan according to the 2014/15 National Family Health Survey.

period t. We abstract from all other sources of uncertainty. Therefore, the vector of deterministic state variables, which are either time-invariant or are updated deterministically as a function of past choices, is: $\bar{\boldsymbol{\omega}}_t = \{t, \mathcal{M}_t, Ed_t, Z_t\}$.[13]

The options available to parents at t are given by the set $O_t(\omega_t)$. A daughter can only be married if a marriage offer is received. We assume that once a daughter is taken out of education, she cannot re-enter later and girls cannot continue in education once married. Furthermore, girls cannot continue in education after age 20, the typical age for finishing college. We abstract from the possibility of divorce during the time-period covered by the model given its rarity in India.[14] In what follows, we will keep the dependence of the option set on past actions implicit.

Preferences Parents care about the education their daughter receives, the value of any home production she contributes to, when she gets married, and who she gets married to. These preferences will reflect a combination of altruism towards a daughter's future welfare within marriage or future grandchildren (Jensen and Thornton, 2003; Behrman et al., 1999; Chari et al., 2017), social norms and psychological payoffs to one's daughter's education and marriage (Maertens, 2013), economic costs of dowry and the costs of keeping a girl in school or at home (Corno et al., 2020; Bau et al., 2022), and the economic value of a connection to the groom's family (Rosenzweig and Stark, 1989).

Preferences are defined over the sequences of realized states and actions taken over a daughter's adolescence. Let a potential sequence, or path, through the model from period t onwards be given as $\Psi_t = \{\omega_\tau, d_\tau\}_{\tau=t,\ldots,T}$. A path contains all information about every state reached and every action taken. Parents' preference over a path is given by their utility function $U_t(\Psi_t)$. We place the following assumptions on the underlying structure of preferences:

A1. Additive separability over time: Preferences over paths can be represented as the (discounted) sum of payoffs accrued in different periods of the model with additive separability over time.

A2. Constant discount factor: The discount factor, β, used to discount future payoffs is constant across time.

[13]For example, education evolves according to: $Ed_{t+1} = Ed_t + \mathbf{1}\,(d_t = S)$.

[14]Just 0.3% of ever-married women in India are currently divorced according to the 2011 census.

A3. Irrelevance of rejected marriage offers: Marriage offers only enter payoffs if they are accepted.

This rules out features like regret, which would allow rejected offers to impact welfare.

Together, assumptions A1, A2, and A3 imply that $U_t(\Psi)$ can be expressed as the discounted sum of flow payoffs, $v(\boldsymbol{\omega}_t, d_t)$:

$$U_t(\Psi_t) = \sum_{\tau=t}^{T} \beta^{\tau-t} v(\boldsymbol{\omega}_\tau, d_\tau) \tag{2}$$

where $v(\boldsymbol{\omega}_\tau, d_\tau)$ is the per-period payoff in period τ, which is a function only of that period's state variables and that period's actions.[15]

Our object of interest is $U_t(\Psi_t)$ (and, in particular is $U_0(\Psi_0)$) rather than the flow payoffs $v(\boldsymbol{\omega}_\tau, d_\tau)$. Taking preferences over education, for example, we do not attempt to separate out whether preferences for education come from flow payoffs during years in which a daughter is in school or from preferences over the completed stock of education after her schooling is complete. Importantly, our identification results for subjective beliefs are not sensitive to what portion of preferences are accrued across different time periods; they only require that payoffs accrued in different periods are summed additively with a constant discount factor.

Idiosyncratic Preference Shocks ε_t describe idiosyncratic preference shocks faced by parents. We adopt a structure of additive idiosyncratic shocks that is common in the discrete dynamic choice literature. We assume that these shocks vary randomly across periods and assume that in period t, parents have no information about the value of their idiosyncratic preference shocks in $t+1$ onwards. We assume that flow payoffs $v(\boldsymbol{\omega}_\tau, d_\tau)$ are additively composed of a non-random component, $\bar{v}(\bar{\boldsymbol{\omega}}_\tau, q_\tau, d_\tau)$, which depends on the current deterministic state variables ($\bar{\boldsymbol{\omega}}_\tau$), current marriage offer, and current

[15] Assumption A3 implies that $v(Q^k, \bar{\boldsymbol{\omega}}_\tau, H) = v(Q^{k'}, \bar{\boldsymbol{\omega}}_\tau, H), \forall k \neq k'$ and $v(Q^k, \bar{\boldsymbol{\omega}}_\tau, S) = v(Q^{k'}, \bar{\boldsymbol{\omega}}_\tau, S), \forall k \neq k'$.

action, plus an idiosyncratic preference shock, $\varepsilon_\tau^{d_\tau}$ where $\bar{\Psi}_t \equiv \{\{\bar{\boldsymbol{\omega}}_t, q_t, d_t\}, ...\{\bar{\boldsymbol{\omega}}_T, q_T, d_T\}\}$:

$$U_t(\Psi_t) = \sum_{\tau=t}^{T} \beta^{\tau-t} \left[\bar{v}(\bar{\boldsymbol{\omega}}_\tau, q_\tau, d_\tau) + \varepsilon_\tau^{d_\tau}\right] \tag{3}$$

$$= \bar{U}_t(\bar{\Psi}_t) + \sum_{\tau=t}^{T} \beta^{\tau-t} \varepsilon_\tau^{d_\tau} \tag{4}$$

Marriage Offer Uncertainty Parents do not know whether they will receive marriage offers in future periods nor the quality of any offers received. 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. We assume that, in each period, parents believe they will be in marriage offer state $q \in \{Q^0, ..., Q^K, N\}$ with probability $\pi(\bar{\boldsymbol{\omega}}_t, q)$. While we can allow for $\pi(\cdot)$ to depend on all deterministic state variables, in practise we will focus on age and education. These offer probabilities, $\pi(\cdot)$, will depend on the preferences of grooms and the distribution of groom quality in the local marriage market. However, we do not put structure on the search and matching process to give microfounded expressions for $\pi(\cdot)$ in terms of these structural primitives. This theoretical framework aims rather to provide a basis for the design of a set of experiments to identify subjective beliefs over the distribution of match quality, age, and education, conditional on preferences.

Choice Parents act to maximize their discounted expected utility. Specifically, they adopt optimal decision rules δ to solve:

$$\max_{\delta} \mathbb{E}\left[U_t(\Psi_t)|\boldsymbol{\omega}_t\right] \tag{5}$$

where δ is the set of decision rules that define actions that parents will take at every possible state from t onwards that they may find themselves in. When the probability of receiving good quality marriage offers in the future depends on the education and age of their daughter, parents must account for the impact of their decisions today on their daughter's future marriage options; optimal choices will not simply reflect their own preferences but also beliefs about the likelihood of different states.

3 Methods and Instrument Design

Our aim is to estimate the preferences and beliefs that characterize the parents choice problem. We design two sets of strategic survey questions that vary the information that parents have about future marriage offers to do so: the "ex-post" and "ex-ante" experiments. In this section, we describe the design of these instruments in detail. In Section 4, we show formally how they facilitate the identification of the structural functions of interest.

3.1 Identification Challenge

Researchers face a fundamental identification problem in attempts to identify separately preferences from beliefs from observed choice data (Manski, 2004). Without strong assumptions, one can usually rationalize behavior by multiple combinations of utility and beliefs. In this context, early marriage could be rationalized by parents intrinsically preferring to marry daughters at a young age or by a belief that high-quality marriage offers are unattainable for older women. Further, marriage and education choices in observational data are affected by many factors that are unobserved by the researcher that could potentially bias results. Finally, social desirability bias in our context often creates systematic mismeasurement in the observed age of marriage.

These challenges lead us to develop theory-driven strategic measurements to identify the structural primitives of our model under less restrictive assumptions than would be required for identification from observational data. Our main measurement innovation is to adapt stated-choice methods also to identify beliefs.[16] In so doing, this paper provides a new tool for the growing agenda around the measurement of subjective beliefs. Not directly asking respondents about probabilities, we contend, brings several advantages. Many people find it difficult to understand and respond to probabilistic statements. Although creative methods have been developed to help individuals respond to probabilistic statements (Manski, 2004; Delavande et al., 2011), this remains a particular concern in contexts such as ours where respondents have low numeracy – our average respondent had 1.5 years of schooling.

However, the concern is somewhat deeper. There is evidence that the subjective probabilities people

[16]In adapting a stated-preference experiment to identify objects other than preferences, our work relates to Delavande and Zafar (2019) who elicit students' stated choices over colleges with and without financial constraints, allowing them to identify the constraints.

report contain systematic inconsistencies even when they understand abstract probability concepts (Tversky and Kahneman, 1974; Giustinelli et al., 2020).[17] To the extent that reported probabilities, be they inconsistent or not, are accurate representations of the beliefs that causally shape agents' actual decisions, this is not a problem. However, if people's actions are more sophisticated than the subjective beliefs that they report, then taking self-reported beliefs at face value would lead us to mispredict actions (Giustinelli et al., 2020).[18] Experimental studies on decision making under uncertainty highlight that people's actions can take on board more information, and in a more sophisticated way, than what is contained within the subjective beliefs they report (Charness and Levin, 2005). Indeed, it is not even necessary to assume that agents have a well-defined and easily-retrievable "beliefs" to 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). In this light, an attractive feature of our choice-based approach is that it is not reliant on parents making decisions about their daughters' futures based on beliefs that are easy for them to retrieve and report to an interviewer in the form of probabilities.

A final dimension of our approach that is appealing in our setting is its ability to measure beliefs over a one-dimensional match-quality index when the index is driven by multiple components of quality but the importance of the different components are not known ex-ante. In our case, we hypothesized that several features of marriage matches might be important, such as a groom's age, education, occupation, and family wealth. However, we didn't know ex-ante how parents would combine these different dimensions into a single index of groom quality. To collect data on beliefs probabilistically, we would have had to elicit respondents' beliefs over the joint distribution of grooms' age, education, occupation, and wealth. It is well known that eliciting beliefs about multidimensional objects is challenging and time-consuming.

[17] For example, reported subjective beliefs can be insufficiently sensitive to the prior probability of different outcomes and based on immediately re-callable reference groups (Tversky and Kahneman, 1974).

[18] Indeed, Ramsey (1926) argued that one should measure beliefs based on the actions that individuals take: "the degree of a belief is a causal property, which we can express vaguely as the extent to which we are prepared to act on it... Our judgment about the strength of our belief is really about how we should act in hypothetical circumstances."

3.2 Instrument Overview

Our instruments are based on hypothetical vignettes that describe choice scenarios faced by fictional families. The hypothetical framing alleviates social desirability bias and the role of unobserved characteristics (Finch, 1987). Parents are given different amounts of information about the realization of marriage offers at different points in time in the two experiments. Comparing choices made in these different information environments provides a simple choice-based method to estimate beliefs about the distribution of marriage offers facing adolescent girls of a given age and education.

In the ex-post experiment, respondents are told the story of a hypothetical family with a twelve-year-old daughter. Respondents are told to imagine that there are two options for when the daughter can leave school, and when, and to whom, she can get married. Respondents are then asked what option they think the hypothetical family would choose for their daughter. Formally, the choice scenario in the ex-post experiment corresponds to a decision over different discounted utility profiles, $\bar{U}_0\left(\bar{\Psi}_0\right)$.

In the ex-ante experiments, respondents are presented with scenarios in which hypothetical families receive a marriage offer when their daughter is a specific age. Respondents decide whether the family would accept the marriage offer or reject it in favor of keeping the daughter in school or having her help in the home. As the pattern of future marriage offers was left unspecified, choices reflect both preferences *and* beliefs about the likelihood of future marriage offers, $\pi(\cdot)$. Formally, the choice scenario corresponds to the decision facing a family in some state $\boldsymbol{\omega}_t$ (Equation 5).

3.3 The Sample

We administered our survey instruments on a sample of 4,605 female caregivers of adolescent girls who live across 120 villages in the Dhaulpur district of Rajasthan.[19] Data collection took place in respondents' homes and, whenever possible, in a quiet and private environment. Each respondent was randomized into being asked about *either* about the ex-post or the ex-ante instrument given time constraints. The sample is representative of primary caregivers, almost always mothers, of unmarried adolescent girls in

[19]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. Appendix Tables A.4 and A.5 confirm that treatment is not a predictor of choice to our instruments.

Table 1: Sample Summary Statistics

	Mean	Standard Deviation	N
Age in years	41.92	8.365	4464
Own age at marriage in years*	15.57	3.361	4423
Years of school*	1.492	3.267	4605
Can read complete sentence (in Hindi)*	0.104	0.305	4353
Number of sons*	2.118	1.112	4343
Number of daughters*	2.447	1.320	4343
Owns asset that can dispose of at will	0.132	0.339	4604
Can go to market unaccompanied*	0.611	0.488	4463
At least some say over when child gets married	0.963	0.190	4536
At least some say over to whom child gets married	0.952	0.213	4532
At least some say over when child leaves school	0.942	0.235	4534
Has done any work (inc. on family farm) in last year	0.595	0.491	4604
Has worked for cash in last year	0.344	0.475	4604
Has child (male or female) who is married	0.364	0.481	4576
House has dirt floor*	0.507	0.500	4603
Scheduled caste or scheduled tribe*	0.352	0.478	4581
Other Backward Caste or Economically Backward Class*	0.451	0.498	4581
Hindu*	0.968	0.177	4602

Notes: Table reports descriptive statistics for our sample of 4,605 caregivers with complete data from the choice experiments. *Variable measured in baseline survey during 2016. All other variables collected in 2017/18 endline survey.

the study communities.[20] Table 1 reports the headline summary statistics for our analysis sample. The 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 married and when they left school.

3.4 Introducing the Scenarios

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 to limit social desirability bias. The interviewer introduced the scenarios with the following statement:

[20] Data collection was carried out between December 2017 and March 2018. In 2015, a random sample of unmarried adolescent girls aged 12-17 years was drawn from complete lists of all adolescent girls in the villages. At endline in 2017/18, we attempted to re-interview all adolescent girls and all primary caregivers. Of the 4,994 caregivers interviewed at baseline, we re-interviewed 93.4% and we have complete discrete choice experiments for 93.0% of the original sample. For more details on sampling see Andrew et al. (2022).

> "*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, formally, this method allows us to elicit respondents' beliefs about the expected behavior of parents in the community under the scenario described. As marriage is a universal, public, and much discussed topic within the community, we do not consider the assumption that respondents have accurate perceptions of expected behavior to be an incredible one.[21]

3.5 Vignette Characteristics

The stories underpinning the ex-post and ex-ante experiments provided a rich description of the hypothetical family and their daughter, and prospective marriage market matches. The same set of core characteristics was enumerated in both the ex-post and ex-ante experiments. These characteristics are summarized in Appendix Table A.1. Appendix Figures A.1 and A.2 give examples of the translated verbal descriptions used for each characteristic.

Drawing on the existing literature and insights from our focus group discussions, we specified five attributes of the hypothetical family and their daughter: (i) Household wealth; (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); (v) The cost of schooling (for daughters described as being currently enrolled in school).

Wealth was included given the large literature on positive assortative matching on wealth in marriage markets (Siow, 2015; Becker, 1973). Descriptions of the different wealth levels were calibrated to the top, middle and bottom quintiles of an asset index estimated on data from a previous survey of this sample. For example, our description of the situation faced a family of "average wealth", the middle quintile, was:

> *"Their house has two rooms with a dung floor. They own one bigha of land and two cows. They own an electric fan and a bicycle but not a TV."*

[21] For rare events, it may be more likely for individuals to misperceive social norms (Bursztyn et al., 2020).

The cost of schooling is an important determinant of education decisions, while a girl's enjoyment of school was frequently mentioned in our qualitative work as a key factor explaining why she is still in school or had been allowed to drop out. Whether the mother requires help at home was specified to create variation in the value of home production.

In the ex-ante experiments, we also included an indicator of whether a daughter complied with gendered norms. Focus group participants frequently brought up that girls whose behavior conflicted with norms should be married as soon as possible since they would not receive good offers in the future. 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; (v) Whether groom has a government job (the most well paid and secure form of employment in the area). Wealth, education and occupation were included given the large literature on positive assortative matching discussed above and as a result of focus group interviews. Despite having been illegal since 1961, the payment of dowry remains an important feature of most marriages in this part of India.

While our vignettes painted a rich description of the hypothetical family and the options they faced, due to time and memory constraints we could not include all potentially relevant characteristics in the stories. For example, we did not specify a daughter's physical beauty nor the presence of siblings (Banerjee et al., 2013). However, respondents were prompted to assume that any unspecified characteristics were the same across options were the same, to limit potential concerns about Bayesian updating on the basis of specified characteristics.

3.6 Varying Uncertainty about the Future

The ex-post and ex-ante experiments differ in terms of what is left unstated about the future. This is crucial for our method to separately identify preferences from beliefs. In particular, in the ex-post experiment, there is no uncertainty over the realization of marriage offers; respondents choose between two options that both specify all information relevant to the fictional parents' utility (how long the daughter stays in education, when she marries, and who she marries). By contrast, in the ex-ante experiment, respondents are asked to choose between accepting or rejecting a take-it-or-leave-it marriage offer in the current period. Importantly, the value of rejecting the marriage offer is uncertain as it depends on what future marriage offers materialize; the expected value of rejecting a marriage offer in hand depends on the perceived likelihood that a daughter will receive a good marriage offer in the future.

Ex-Post Experiment The ex-post experiment presented respondents with a choice between two options for the fictional daughter's adolescence, both of which contained sufficient information for the fictional parents to evaluate, up to the value of the idiosyncratic preference shocks, the value of each option. Formally, each option corresponded to a specified path through the model, $\bar{\Psi}_0$ (starting at the beginning of adolescence). In practice, this meant that the ex-post vignettes always described a daughter as being twelve years old and each choice option fully specified the evolution of a daughter's education and marriage until age 22. The exercise was described to respondents 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."*

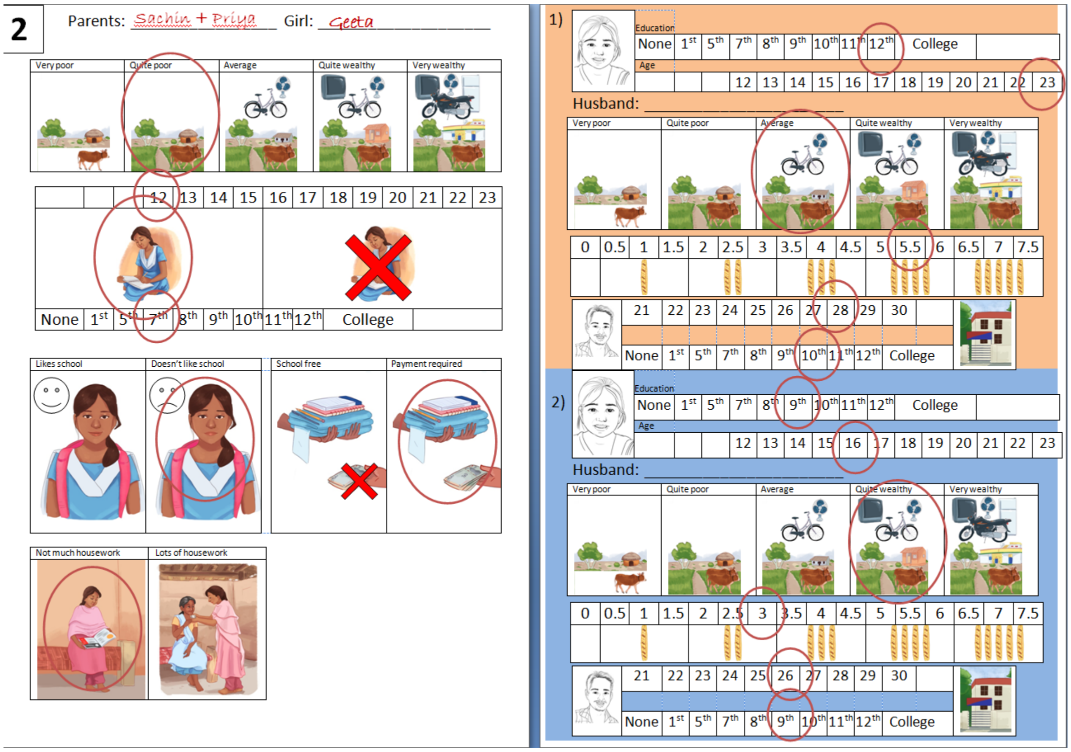
The interviewer then went on to describe the options, each of which specified when the daughter would marry, to whom (including the characteristics of the groom and his family as well as the minimum dowry required), and how much education she would complete prior to marriage. In other words, the options specified everything (other than the idiosyncratic preference shocks) relevant to parents' utility as defined by our model. Thus, there was no need for respondents to form expectations over the likelihood of receiving good marriage offers at different points in time.

After the interviewer described the scenario and two options, she asked the respondent:[22] *"Which option do you think [the parents] will choose for their daughter?"* Figure 1 (a) shows the visual aid used in the ex-post experiment while 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.

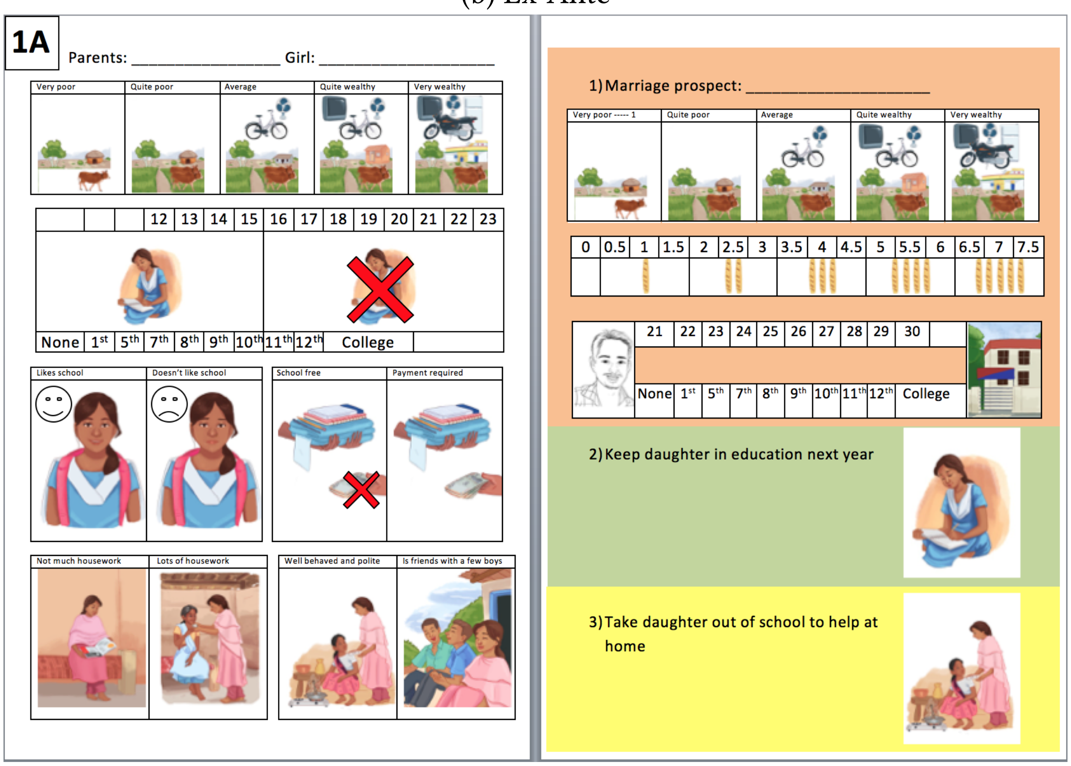
[22]To ensure that respondents understood and took note of all relevant characteristics, each option was described twice and the relevant attributes were circled on the visual aids.

Figure 1: Visual Aids

(a) Ex-Post



(b) Ex-Ante



Notes: 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.

Ex-Ante Experiment In contrast to the ex-post experiment, the ex-ante experiments offered respondents a take-it-or-leave-it marriage offer that left respondents uncertain about what marriage offers might be received in the future. Figure 1 (b) gives the visual aid corresponding to this choice problem. As the pattern of future marriage offers was left unspecified, the relative value of the various options reflects not only preferences but also beliefs about the likelihood of receiving good marriage offers in the future. Formally, the choices corresponded to a decision made in some state $\boldsymbol{\omega}_t$ over the alternatives in the feasible choice set O_t ((Equation 5).

In the ex-ante experiment, we randomly varied the age of the fictional daughter between rounds, ranging from age 13 to age 22 (the end of model time). After the interviewer described the hypothetical family, 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, namely, it specified the groom's and his family's characteristics and the dowry. The interviewer told the respondent that the fictional parents needed to make a decision now: whether their daughter would get married in the next year to the groom described, whether the parents would keep her in school for another year, or whether their daughter would leave school to help at home. Respondents again had to decide which option they thought the family would choose.

3.7 Variation in Scenario Characteristics

We randomized at the individual level whether respondents participated in the ex-post experiment or the ex-ante experiment to prevent any confusion given the instruments' apparent similarity. Each respondent carried out three rounds of the experiment they were assigned to, with the characteristics of the hypothetical family, daughter, and marriage options randomly varying across rounds.[23] Scenario characteristics were drawn orthogonally across respondents, rounds, and options subject to the modifications described below.

Infeasible/Perverse Options The completed education of a daughter was truncated at the maximum feasible for a described age of marriage, i.e. an option in which a daughter is described as being thirteen

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

at marriage could not have higher than Grade 8 education. The minimum acceptable dowry was allowed to loosely correlate with the wealth of the groom's family.[24] Note that the realism of the scenarios described is, however, irrelevant for identification purposes so long as respondents are able to rank the various options.

Sufficient Differences In the ex-post experiment, we re-drew characteristics to ensure that the two options within the same round were sufficiently different from one another in terms of the daughter's age of marriage and education at marriage so that respondents found the choice meaningful. We also ensured that respondents were never choosing between two options in the same round in which the daughter married younger than fifteen in both cases because such scenarios sometimes made respondents uncomfortable in piloting.

Salient Vignette We randomly replaced the characteristics of the hypothetical family, and in the ex-post experiment, the description of the daughter at marriage in one option, in one round with the characteristics of the respondent's own household and daughter in order to test whether the similarity of the vignette to the respondent's own experience affected choices.

4 Identification & Estimation

In this section, we prove that choices to the ex-post and ex-ante instruments allow us to identify the primitives of the theoretical framework in Section 2.

4.1 Identifying Preferences

Formally, in each round r of the ex-post experiment, respondents were offered a choice between two profiles, $\bar{\Psi}_{r1}$ and $\bar{\Psi}_{r2}$, that specified a daughter's age of marriage (A), the quality of the accepted marriage offer (q_A) and the value of all deterministic state variables at marriage ($\bar{\boldsymbol{\omega}}_A$). Since the daughter was always aged 12 in the ex-post experiment, respondents were asked to compare these profiles from

[24]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.

the start of model time. Let $\bar{\boldsymbol{\Psi}}^{\boldsymbol{M}} = \left[\bar{\Psi}^0, \bar{\Psi}^1, ..., \bar{\Psi}^M\right]$ give the set of all possible profiles of a daughter's adolescence starting from period 0 in which she marries at or before the final period T.

The probability that the first option is chosen in some round r be given as $P(\bar{\Psi}_{r1}, \bar{\Psi}_{r2})$. As there is no uncertainty about the realisation of marriage offers in the ex-post experiment, respondents choose the profile that maximizes discounted utility:

$$P(\bar{\Psi}_{r1}, \bar{\Psi}_{r2}) = Pr\left[\bar{U}_0(\bar{\Psi}_{r1}) + \nu_{ir1} > \bar{U}_0(\bar{\Psi}_{r2}) + \nu_{ir2}\right] \tag{6}$$

where $\bar{\Psi}_{r1}, \bar{\Psi}_{r2} \in \bar{\boldsymbol{\Psi}}^{\boldsymbol{M}} \times \bar{\boldsymbol{\Psi}}^{\boldsymbol{M}}$ and $\nu_{irj} \equiv \sum_{\tau=0}^{T} \beta^{\tau} \varepsilon_{irj\tau}^{d_{\tau}}$, i.e. the accumulated preference shock associated with taking path $\bar{\Psi}_{irj}$.

Theorem 1 provides a formal statement of identification of parents' utility function given these choice probabilities. Theorem 1 Condition 1 states that we treat choice probabilities as known at all possible combinations of adolescent profiles ending in marriage. This is a natural assumption in an experimental setting where we can generate sufficient variation in option characteristics. The second condition imposes a location and scale normalization on utility. The third assumption gives the distributional assumption that we impose on the preference heterogeneity. Note that the assumption of normality is not required for non-parametric identification of utility (Matzkin, 1992), but is rather a convenient functional form assumption for estimation.

Theorem 1. *Identification of Preferences:* $\bar{U}_0(\bar{\Psi})$ is constructively identified at all $\bar{\Psi} \in \bar{\boldsymbol{\Psi}}^M$ from ex-post choice probabilities under the following assumptions:

1. Ex-post choice probabilities, $P(\bar{\Psi}, \bar{\Psi}')$, are observed for all $(\bar{\Psi}, \bar{\Psi}') \in \bar{\boldsymbol{\Psi}}^{\boldsymbol{M}} \times \bar{\boldsymbol{\Psi}}^{\boldsymbol{M}}$.

2. Location and scale normalizations: $\bar{U}(\bar{\Psi}^0) = 0$ and $U(\bar{\Psi}^1) - \bar{U}(\bar{\Psi}^0) = 1$

3. The aggregated preference shock is distributed i.i.d normal, $\nu_{irj} \sim IN(0, \sigma_{\nu}^2)$, and is independent of $\bar{\Psi}_{rj}$ for all $\bar{\Psi}_{rj} \in \bar{\Psi}^M$.

Proof. See Appendix B.

4.2 Identifying Beliefs

In the ex-ante experiment, only information the current state of the world, in particular $\bar{\boldsymbol{\omega}}_t$ and q_t, is specified and respondents make choices under uncertainty about future marriage offers.

Defining the Value Functions To proceed with a formal proof of identification, we must define the value functions associated with the parents' problem. Somewhat unusually, we define all value functions as being evaluated from the point of view of period $t = 0$. We do this to avoid taking a stance on the allocation of payoffs across periods.[25] The value function for parents with an unmarried daughter at period t with deterministic state variables $\bar{\omega}_t$ when they have received a marriage offer of quality q_t and a draw from the idiosyncratic preference shock distribution of ε_t is defined as:

$$V(t, \bar{\omega}_t, q_t, \varepsilon_t) = \max_{\delta} \mathbb{E}\left[U_0(\Psi)|t, \bar{\omega}_t, q_t, \varepsilon_t\right] \tag{7}$$

$$= \max_{\delta} \mathbb{E}\left[\bar{U}_0(\bar{\Psi}) + \sum_{\tau=0}^{T} \beta^{\tau} \varepsilon_{\tau}^{d_{\tau}} |t, \bar{\omega}_t, q_t, \varepsilon_t\right] \tag{8}$$

where δ is the set of all possible decision rules defining actions at every possible state that parents may find themselves in.

The expected value function, with expectations taken over both stochastic state variables (the idiosyncratic preference shocks, ε_t, and marriage offers, q_t), is given as:

$$EV(t, \bar{\omega}_t) = \mathrm{E}_{q_t, \varepsilon_t}\left[V(t, \bar{\omega}_t, q_t, \varepsilon_t)\right] \tag{9}$$

Finally, we define choice-specific value functions. These describe the value obtained conditional on being in state ω_t in period t, choosing action d_t and then choosing optimally in all periods thereafter.

[25] i.e. this is the current discounted value of being in period 0 but knowing that period t's state variables will be $\boldsymbol{\omega}_t$. All information needed to form payoffs that occur between period 0 and $t-1$ can be reconstructed from the period t deterministic state variables. There is thus a straightforward relationship between value functions defined from the point of view of period 0, $V(t, \boldsymbol{\omega}_t)$, and those defined from the point of view of period t ($V_t(t, \boldsymbol{\omega}_t)$). In particular: $V(t, \boldsymbol{\omega}_t) = \sum_{\tau=0}^{t-1} \beta^{\tau} v(\boldsymbol{\omega}_{\tau}, d_{\tau}|_{\boldsymbol{\omega}_t}) + \beta^t V_t(t, \boldsymbol{\omega}_t)$ where $d_{\tau}|_{\boldsymbol{\omega}_t}$ is the action at τ implied by $\boldsymbol{\omega}_t$.

The choice-specific value function associated with choosing marriage in period t is:

$$\tilde{V}(t, \bar{\omega}_t, q_t, \varepsilon_t^M, d_t = M) = u(t, \bar{\omega}_t, q_t) + \beta^t \varepsilon_t^M \tag{10}$$

where $u(t, \bar{\omega}_t, q_t)$ is a restatement of the deterministic component of utility as a function of the age at marriage, the best quality marriage offer that period, and $\bar{\boldsymbol{\omega}}$ that gives the deterministic state variables at marriage. The choice specific value functions associated with choosing either school or home are simply equal to the expected value of still being unmarried in period $t+1$ with an education level updated to reflect period t's schooling choice plus the value of the idiosyncratic preference shocks.

$$\tilde{V}(t, \bar{\omega}_t, q_t, \varepsilon_t^H, d_t = H) = EV(t, \bar{\omega}_{t+1}(\bar{\omega}_t, d_t = H)) + \beta^t \varepsilon_t^H \tag{11}$$

$$\tilde{V}(t, \bar{\omega}_t, q_t, \varepsilon_t^S, d_t = S) = EV(t, \bar{\omega}_{t+1}(\bar{\omega}_t, d_t = S))) + \beta^t \varepsilon_t^S \tag{12}$$

where $\omega_{t+1}(\bar{\omega}_t, d_t = S))$ is the mapping of deterministic state variables in time t to those in time $t+1$, conditional on period t's actions. The probability that parents choose an action $d_j \in O_t(\boldsymbol{\omega}_r)$ is then given by:

$$p_j(t, \bar{\boldsymbol{\omega}}_t, q_t) = Pr\left[\tilde{V}(t, \bar{\omega}_t, q_t, \varepsilon_t^j, d_t = j) > \tilde{V}(t, \bar{\omega}_t, q_t, \varepsilon_t^{j'}, d_t = j') \quad \forall j' \neq j \quad\right] \tag{13}$$

Identification To gain insight into the intuition for our identification result, in the main text we consider a simplified example where parents always receive at least one marriage offer per period from one of two groom types: a high quality groom ($q = 1$) or a low quality groom ($q = 0$). Let π_t be the probability that parents receive an offer from a high quality groom at time t and, thus, let $1 - \pi_t$ be the probability that they receive an offer only from a low quality groom. We further consider states where a daughter is already out of school and therefore parents are simply making a choice of whether to accept the marriage offer of quality q that they have received. We suppress dependence on all deterministic state variables (including education) other than age for ease of notation. In Appendix C, we prove identification for the full model.

Identification proceeds in two steps. In step one, we invert choice probabilities to identify the expected value of still being unmarried at every future unmarried state. In step two, we show how the recursive relationship between expected value functions identifies the beliefs over offer probabilities.

Step one. Identifying value functions from choice probabilities For tractability, we assume idiosyncratic preference heterogeneity is normally distributed with mean 0 and standard deviation σ. This is not required for identification but it allows us to derived closed form expressions for choice probabilities that help make our approach clear. The probability that respondent i chooses the marriage option at time t faced with a groom of quality i is:

$$
\begin{aligned}
p_M(t, q=i) &= Pr\left[\tilde{V}(t, q=i, \varepsilon^M_{irt}, d_t = M) > \tilde{V}(t, q=i, \varepsilon^H_{irt}, d_t = H)\right] && (14)\\
&= Pr\left[u(t,i) + \beta^t \varepsilon^M_{irt} > EV(t+1) + \beta^t \varepsilon^H_{irt}\right]\\
&= \Phi\left(\frac{u(t,i) - EV(t+1)}{\beta^t \sqrt{2}\sigma}\right) && (15)
\end{aligned}
$$

We can invert this expression and rearrange to identify the standard deviation of the preference shocks and the value associated with being unmarried at period $t+1$:

$$
\begin{aligned}
EV(t+1) &= u(t,i) + \sigma\beta^t\sqrt{2}\Phi^{-1}(p_M(t, q=i)) && (16)\\
\sigma &= \frac{u(t,1) - u(t,0)}{\beta^t\sqrt{2}\left[\Phi^{-1}(p_M(t,q=1)) - \Phi^{-1}(p_M(t,q=0))\right]} && (17)
\end{aligned}
$$

These expressions are functions of (known) choice probabilities and preference parameters.

Having identified the value of being at each unmarried state and the variance of the additive preference shocks, we can identify the expected value of future preference shocks conditional on different choices being optimal. In particular, we can identify the expected value of ε^M_{irt} conditional on marriage being optimal in period t and the expected value of ε^H_{irt} conditional on home being optimal:[26]

$$
\begin{aligned}
E\left(\varepsilon^M_{irt} | d^*_t = M, t, q\right) &= E\left(\varepsilon^M_{irt} | u_0(t,q) + \beta^t \varepsilon^M_{irt} \geq EV(t+1) + \beta^t \varepsilon^H_{irt}\right) && (18)\\
E\left(\varepsilon^H_{irt} | d^*_t = H, t, q\right) &= E\left(\varepsilon^H_{irt} | u_0(t,q) + \beta^t \varepsilon^M_{irt} \leq EV(t+1) + \beta^t \varepsilon^H_{irt}\right) && (19)
\end{aligned}
$$

Step two. Going from value functions to beliefs Having identified the expected value functions associated with being unmarried at every state, we can use the recursive relationship between expected

[26]In Appendix C, we show that under normality this has a closed-form solution for two-way choices.

value functions to identify beliefs. If parents enter period t with an unmarried daughter, one of four outcomes might arise: (1) they get a low quality marriage offer and accept it; (2) they get a high quality marriage offer and accept it; (3) they get a low quality marriage offer and reject it; (4) they get a high quality marriage offer and reject it. Thus, the expected value of having an unmarried daughter at period t is equal to the mean of the expected value of each of these eventualities, weighted by the probability that that eventuality will occur:

$$\begin{aligned} EV(t) = & \underbrace{(1-\pi_t)p_M(t, q=0)\left[u(t, q=0) + E(\varepsilon_t^M | d_t^* = M, t, q=0)\right]}_{\text{low offer, accept}} \\ & + \underbrace{\pi_t p_M(t, q=1)\left[u(t, q=1) + E(\varepsilon_t^M | d_t^* = M, t, q=1)\right]}_{\text{high offer, accept}} \\ & + \underbrace{(1-\pi_t)(1-p_M(t, q=0))\left[EV(t+1) + E(\varepsilon_t^H | d_t^* = H, t, q=0)\right]}_{\text{low offer, reject}} \\ & + \underbrace{\pi_t(1-p_M(t, q=1))\left[EV(t+1) + E(\varepsilon_t^H | d_t^* = H, t, q=1)\right]}_{\text{high offer, reject}} \end{aligned} \tag{20}$$

Everything in Equation 20 is already identified other than π_t, the probability of receiving an offer from a high quality groom, so we can simply rearrange to constructively identify subjective beliefs. Theorem 2 expresses this result formally.

THEOREM 2. *Identification of Beliefs:* $\pi(\cdot)$, the probability of receiving an offer from a high quality groom, and σ^2, the variance of the idiosyncratic preference shocks, are constructively identified under the following assumptions:

1. Ex-ante choice probabilities, $p_j(\bar{\boldsymbol{\omega}}, q)$ for $j \in \{M, S, H\}$, are observed for all $\bar{\boldsymbol{\omega}} \in \Omega$ and $q \in Q$, with $p_j(\bar{\boldsymbol{\omega}}, Q^k) \neq p_j(\bar{\boldsymbol{\omega}}, Q^{k'})$ for $k \neq k'$.

2. The idiosyncratic preference shocks are distributed i.i.d normal, $\varepsilon_{irj} \sim IN(0, \sigma^2)$, and is independent of $(\bar{\boldsymbol{\omega}}, q) \in \Omega \times Q$.

3. $\bar{U}_0(\bar{\Psi})$ is identified and satisfies Assumptions A1-A3.

Proof. See Appendix C.

The identification argument set out here holds true conditional on every level of education and thus we can identify beliefs at every age-education combination when a daughter is already out of school. In Appendix C, we show that the same steps hold for all periods when a daughter is in school and thus parents are making a three-way choice; this identifies beliefs about offer probabilities at states where a daughter is still in school. In Appendix C, we also show that identification of beliefs is possible when there are more than two groom types and when parents do not always receive a marriage offer in every period if there are "preference-shifting" instruments. These are characteristics that affect payoffs but are excluded from beliefs about offer probabilities. In practice, we use variation in whether or not the hypothetical daughter "likes school" to identify a model in which parents do not necessarily receive a marriage offer in every period.

4.3 Estimation

We estimate our structural preference and belief parameters through Maximum Likelihood. In doing so, follow a two-step procedure. First, we estimate the preference parameters governing $\bar{U}_0(\Psi)$ for $\bar{\Psi} \in \bar{\mathbf{\Psi}}^M$ using choice data from the ex-post experiment. Next, we estimate beliefs using choice data from the ex-ante experiment, taking preferences as given. To construct standard errors, we bootstrap the whole procedure to ensure that sampling error in the first step is accounted for in our estimated standard errors for our belief estimates. We resample at the respondent level to allow for correlation in how the same respondent answered different rounds of the experiment.

Preferences Recall the probability that the first option is chosen in some round r, $P(\bar{\Psi}_{r1}, \bar{\Psi}_{r2})$, is given as the following with $\nu_{irj} \sim N(0, \sigma_\nu^2)$:

$$P(\bar{\Psi}_{r1}, \bar{\Psi}_{r2}) = Pr\left[\bar{U}_0(\bar{\Psi}_{r1}) + \nu_{ir1} > \bar{U}_0(\bar{\Psi}_{r2}) + \nu_{ir2}\right] \tag{21}$$

We estimate the parameters of $\bar{U}_0(\cdot)$ by Maximum Likelihood, assuming a flexible functional forms for the dependence of utility on a daughter's age of marriage, education, and match characteristics. We normalize the coefficient on "Government Job" to one to facilitate comparison of the magnitude of effect sizes across our alternative specifications and estimate the variance of the idiosyncratic random error. To investigate the importance of observed preference heterogeneity, we analyse the impact of a rich set of respondent demographics on reduced form choice probabilities with a Lasso model (Section 6.1).

Beliefs We estimate subjective beliefs over marriage offer probabilities, in addition to the utility associated with having a daughter still unmarried at time $T+1$ (i.e. $EV(T+1)$) and the variance of the additive idiosyncratic preference heterogeneity by maximum likelihood, taking preferences as given. In this procedure, we also impose a constant discount rate of $\beta = 0.95$.

We place a set of functional form assumptions on the probability of receiving marriage offers to facilitate estimation. First, we restrict the number of marriage offer states to three: receive an offer from a high quality groom; receive an offer from a low quality groom; receive no marriage offer. We assume that the probability of receiving no marriage offer, $\pi(\bar{\omega}, N)$, is constant over time and across girls with different education levels. Second, we assume that, conditional on receiving an offer, the probability that it is from a high-quality groom is given by:

$$\pi(t, Ed_t) = \Phi\left(\mathbf{X}'\tau\right) \tag{22}$$

where $\mathbf{X}$ contains a flexible set of age and education controls. Finally, we assume that the value of still being unmarried in $T+1$ is constant across all education levels. To find the belief parameters that maximize the likelihood of observing the actual choices that respondents made, we solve the whole model recursively in each iteration.

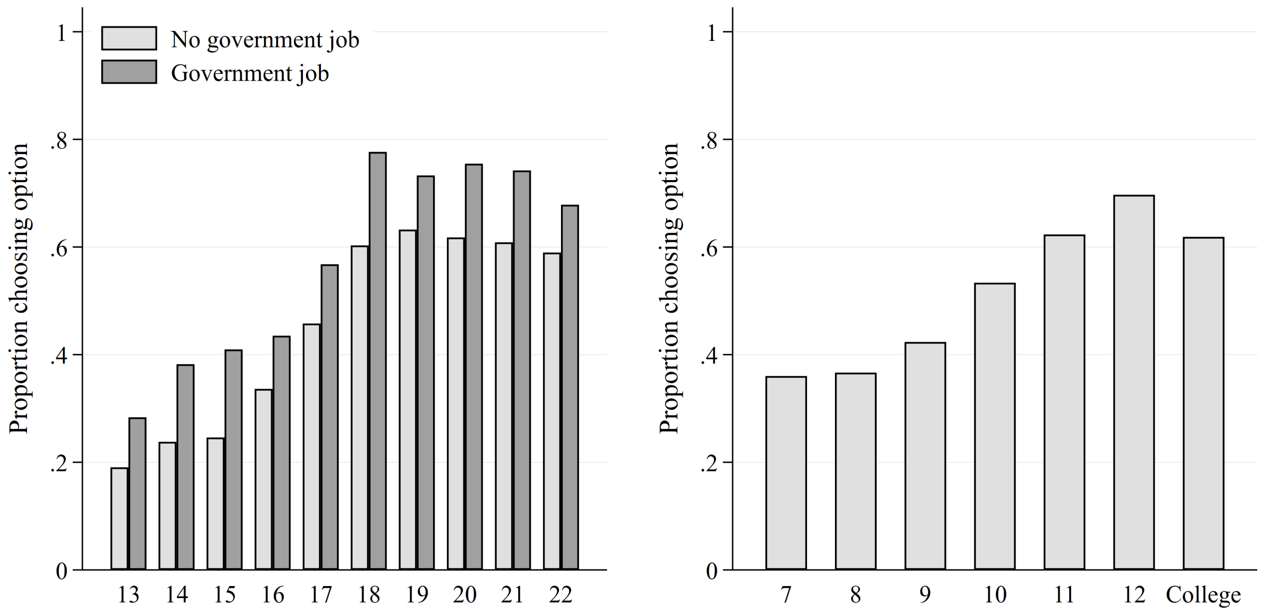
5 Results

Reduced Form Variation We first describe response patterns to our two choice experiments. Figure 2 (a) shows how the probability that an option was chosen in the ex-post experiment varied with the age and education of a daughter, and with the characteristics of potential grooms. Figure 2 (b) shows how the probability that the marriage option was chosen in the ex-ante experiment varied with vignette characteristics.

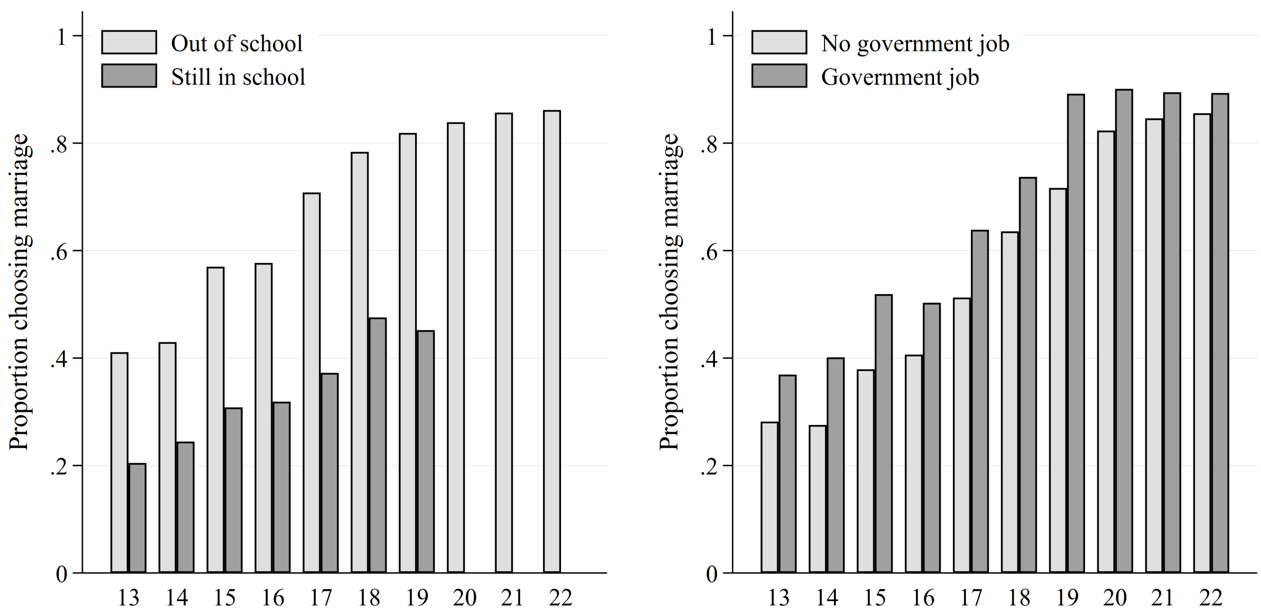
In the ex-post experiment, respondents were more likely to choose options where the age of marriage was at least 18 but, beyond age 18, choice probabilities don't appear to increase further with age. In the ex-ante experiment, where respondents were left uncertain about the final marriage match if they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

Figure 2: Ex-Post and Ex-Ante Descriptives

(a) Ex-Post Choices by Age of Marriage (left) and Education at Marriage (right)



(b) Ex-Ante Choices by Age, Schooling Status (left) and Match Characteristics (right)



Notes: Figure plots raw choice probabilities in both experiments. Panel (a) plots the proportion of respondents who chose a given option in the ex-post experiment by the age of marriage (left) and education at marriage (right) of the hypothetical daughter. The left hand graph also plots how this pattern varied by whether or not the groom was described as having a government job. Panel (b) plots the proportion choosing to accept the marriage offer in hand by age. 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.

offer increases with age both up to and beyond age 18. The different pattern of choice probabilities with age of marriage across the two experiments *could* be driven by respondents believing that good marriage offers become less likely as girls get older. By bringing together the choice patterns in the two experiments within the structure of the model, we will shed light on whether this is in fact the case.

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.[27] Respondents to the ex-ante experiments were substantially more likely to accept a marriage offer if the daughter was already out of school compared to when she was still in school. Indeed, the impact of still being in school on the likelihood of selecting the marriage option is striking: respondents were as likely to accept the marriage offer for a 13 year old daughter who was already out of school as for a 19 year old daughter who was still in school.

Finally, in both types of experiments, respondents were more likely to choose options associated with the daughter marrying a groom with a government job, the most well-paid and secure form of employment in the area.

Heterogeneity on Observables Before proceeding to our structural estimation, we examine whether reduced-form response patterns differ by respondents' observed characteristics to inform our decision about whether and how to allow structural parameters to differ by observed characteristics. It is important to note that as respondents were instructed to consider the behavior of hypothetical families, we did not anticipate substantial heterogeneity by the observed characteristics of the respondent. Nevertheless, respondents may have different reference points for the preferences and beliefs that they think a typical couple described in the vignette would have.

In practice, we test for the importance of observed heterogeneity by regressing (using a linear probability model) indicators of respondents' choices on age of marriage, education at marriage, and all groom characteristics, while interacting all scenario characteristics with the set of eighteen respondent characteristics presented in descriptive Table 1. To prevent over-fitting, we employ a Lasso model to assess the most important predictors of heterogeneity. Lasso minimizes the mean-squared error of the

[27] Only older daughters can also acquire high levels of education.

prediction subject to a penalty on the absolute size of the estimated coefficients. Both the Extended Bayesian Information Criterion (EBIC) and Rigorous Lasso methods for selecting the optimal tuning parameter agree that no interaction terms should be included in the model and thus that there is no evidence of substantial heterogeneity in response patterns by observed characteristics. Appendix D gives full details of our approach.

We also test whether the similarity of a vignette to the respondent's own experience affected choices. To do so, we randomly replaced the characteristics of the hypothetical family, and in the ex-post experiment, the description of the daughter at marriage in one option, in one round with the characteristics of the respondent's own household and daughter (see Section 3). Appendix Tables A.2 and A.3 show the results of this exercise: we find no significant impact of vignette salience. Given these findings, we will abstract from observed respondent heterogeneity in our structural estimation of parental preferences and beliefs.

5.1 Structural Results

Preferences Table 2 presents our structural preference parameters estimated under a number of different specifications. Across all specifications the coefficient on a groom having a government job is normalized to one to ease comparisons. Figures 3(a) and 3(b) graphically presents the coefficients (from the first specification) on the age of marriage and education level of a daughter, along with the 95% confidence intervals. Across all specifications, parents strongly prefer to delay a daughter's marriage up until she is eighteen years of age. Indeed, we estimate that before the age of 18, the value that parents place on delaying marriage by each additional year is between one half and one times the value they place on securing a groom with a government job. Beyond eighteen years of age, which is the legal minimum age of marriage for young women in India, parents show no preference for delaying marriage further. The discontinuity at age 18 is suggestive of parents incorporating the legal minimum age at marriage into their preferences despite evidence that the rules are often only laxly enforced.

Preferences over education suggest that parents prefer a daughter to obtain more education up until the end of high school (12th Standard). Parents also prefer additional years in school if a daughter "likes school" (Columns 2 and 3).[28] Preferences for education appear, however, weaker than preferences over

[28]This corresponds closely to themes highlighted in our focus group discussions in which the importance of a daugh-

age at marriage. For example, we estimate that the value that parents place on each additional year of schooling is only around 14% of the value they attach to securing a groom with a government job. Many of the individual dummies are not statistically significantly different from zero. However, a linear trend in education (excluding college) is statistically significant (Column 3). That being said, conditional on a given marriage market match, parents strictly prefer a daughter to finish high school than to complete college. This might be driven by the higher financial cost of college compared to high school. Indeed, one participant in our focus group discussions remarked that "till class 12th, the expenditure is a little less [on education] but after that it is quite a lot". Note that, as the characteristics of the groom are given, this effect is not due to concerns about "over-education" and marriage market prospects.

Turning to "match utility", parents prefer more educated grooms, younger grooms, and grooms who don't come from a "low wealth" family. However, it is whether a groom has a government job that is the most important driver of groom quality. We estimate that parents value grooms having 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 family). The importance of government job we uncover here echoes the views of participants in focus group discussions, one of whom commented that "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."[29]

In Column (4), 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 and discontinuity 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. Third, we remove the two shifters of preferences that were not significant.

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ter's own motivation in forming her parents' views of how long she should stay in school was stressed. 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".

[29]Caregivers Focus Group 2, Appendix E.

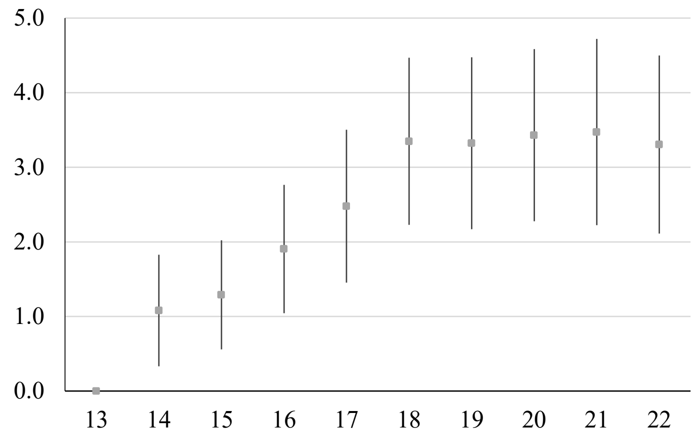
Table 2: Structural Preference Parameters

	(1)		(2)		(3)	
Groom characteristics						
Groom has government job	1.000		1.000		1.000	
Groom's age	-0.037	(.015)	-0.037	(.015)	-0.037	(.014)
Groom's education	0.061	(.019)	0.061	(.019)	0.062	(.018)
Groom college education	0.025	(.159)	0.025	(.159)	0.025	(.159)
Low wealth	0.000		0.000		0.000	
Medium wealth	0.227	(.12)	0.220	(.121)	0.220	(.128)
High wealth	0.168	(.14)	0.165	(.145)	0.164	(.153)
Dowry (lakh)	-0.059	(.031)	-0.059	(.033)	-0.059	(.034)
Age of Marriage						
13	0.000		0.000			
14	1.079	(.382)	1.082	(.374)		
15	1.291	(.372)	1.295	(.363)		
16	1.904	(.439)	1.923	(.407)		
17	2.478	(.522)	2.505	(.48)		
18	3.348	(.572)	3.388	(.552)		
19	3.322	(.588)	3.368	(.566)		
20	3.428	(.588)	3.488	(.583)		
21	3.472	(.637)	3.540	(.58)		
22	3.305	(.609)	3.381	(.572)		
Age-13					0.511	(.094)
1(Age $\geq$ 18)					2.969	(.517)
(Age-13) x 1(Age $\geq$ 18)					-0.504	(.101)
Education at Marriage						
7th	0.000		0.000			
8th	0.136	(.148)	0.080	(.157)		
9th	0.265	(.202)	0.152	(.185)		
10th	0.450	(.184)	0.279	(.197)		
11th	0.546	(.184)	0.311	(.216)		
12th	0.906	(.175)	0.601	(.231)		
College	0.246	(.155)	-0.111	(.238)	-0.697	(.198)
Education (cont.)					0.132	(.038)
Preference shifters						
'Daughter likes school' x Years of schooling			0.074	(.04)	0.075	(.039)
'School is costly' x Years of schooling			0.047	(.04)		
'Help at home needed' x Years before marriage			-0.019	(.03)		
Preference shocks						
σ_{ν}	2.636	(.376)	2.636	(.376)	2.649	(.369)
Shifters			Y		Y	
Number of experiments	6971		6971		6971	
Number of respondents	2324		2324		2324	

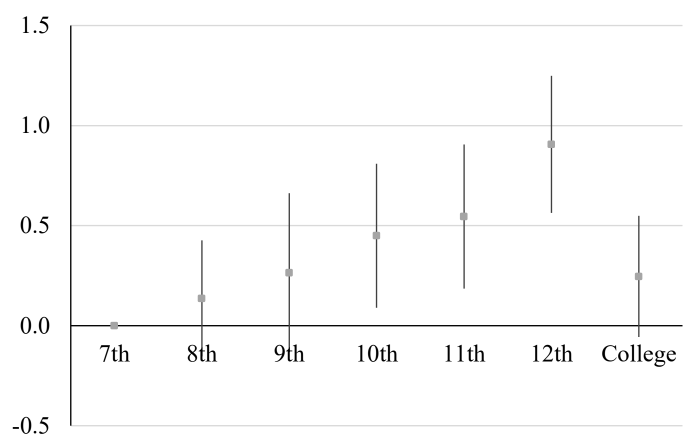
Notes: Table presents structural preference and standard errors (in parentheses). Standard errors calculated through bootstrap, re-sampling respondents with replacement, using 250 iterations. Value of a government job normalized to 1. Column (1) presents results from a model with only groom characteristics, 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 3: Preferences over a Daughter's Age and Education at Marriage

(a) Age of Marriage



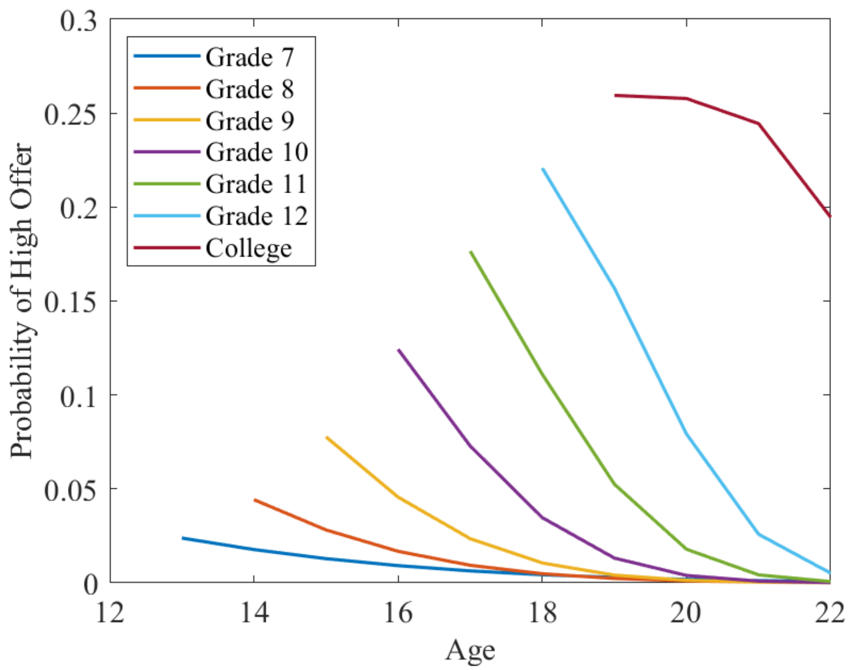
(b) Education at Marriage



Notes: Figure plots coeficients on age of marriage dummies (left) and education at marriage dummies (right) alongside 95% confidence intervals. Estimates taken from specification (1) in Table 2.

Subjective Beliefs To estimate revealed beliefs over the likelihood of receiving good quality marriage offers, we discretize groom quality into two levels on the basis of our estimated preference parameters. The value placed on a groom having a government job is so large relative to other groom characteristics that it creates a discontinuous support for the groom quality distribution amongst our fictional grooms (Appendix Figure A.3). We therefore split grooms into those with a government job ("high" quality grooms) and those without ("low" quality grooms). From both types of grooms, we use the average value of match utility associated with that type to index preferences. The probability of receiving an

Figure 4: Revealed Beliefs



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

offer from a high type groom is allowed to depend flexibly on a daughter's age, her education, and whether or not her behavior conforms to gendered norms. We assume a constant probability that the parents receive no marriage offer in a given period.[30]

Figure 4 plots the revealed beliefs that are implied by our structural parameters over the likelihood of a daughter receiving a marriage offer from a high quality groom for a daughter whose behavior conforms to gendered norms. Table 3 provides the structural belief coefficients and standard errors. Looking first at beliefs around how 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. The coefficient on age is negative and highly significant. We estimate that this deterioration in offer prospects with age is particularly acute for daughters with

[30]As discussed in Section 4.2 and expanded on in Appendix C, 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 or not the daughter "likes school".

Table 3: Structural Belief Parameters

	(1)	
Age	-0.160	(.067)
Education	0.513	(.356)
Education^2	0.147	(.044)
College	1.708	(.335)
Age*Education	-0.123	(.028)
Daughter conforms to gender norms	0.306	(.137)
Constant	-1.475	(.423)
Offer Probability	0.260	(.026)
V(T+1)	-1.995	(1.035)
σ_ε	1.083	(.227)
Number of experiments	5524	
Number of respondents	2258	

Notes: Table provides the structural parameters and standard errors obtained by bootstrapping the whole 2-step estimation procedure 250 times.

more schooling, as seen through the significantly negative interaction between age and education. Take a daughter who has finished high school (grade 12) for instance. Figure 4 shows that we estimate that right after finishing school this daughter would have a 20% chance of receiving an offer from a groom with a government job but that this would fall to just 5% after two more years. These deteriorating marriage market returns to age are important because they imply that parents perceive that there is only a short window of opportunity for daughters to receive high quality marriage offers after they've left school. This creates incentives for parents to marry daughters as soon as possible after they leave education and thus contribute to instances of early marriage.

Turning next to education, we see that a daughter's level of schooling has a huge effect on how likely her parents think it is that they will receive high quality marriage offers for her. 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. Table 3 shows that both the linear and quadratic terms in education are positive and, on top of that, a dummy for college education is also large and highly significant. This suggests that there are particularly high returns to higher levels of education. We see this in Figure 4. If we consider 18 year old daughters, we see that parents perceive that they will have a 20% chance of an offer from a high quality groom if they've finished high school, an 8% chance if they've finished 11th standard and only a 2% chance if they've finished 10th standard.

A further feature of the beliefs we estimate is that parents perceive that daughters who break social norms, as described by the statement "she is friends with some boys and sometimes stays out of the house until late", will receive lower quality marriage offers than daughters who "are polite and well behaved". This suggests that stringent expectations regarding the proper behavior of young unmarried women can contribute to early marriage in this context; when parents worry that their daughter might behave in a way that would damage her marriage prospects, they are inclined to secure her marriage rapidly.

5.2 Belief Validation

Given the novelty of our method, and the fact that our subjective expectations are structurally inferred rather than measured directly, we complement the results from our ex-ante experiment with two validation experiments.

Groom Side Preference Experiment The likelihood of receiving a marriage offer from a high quality groom depends on the preferences of grooms over bridal characteristics. We therefore also elicit "groom side" preferences over the characteristics of brides in a manner akin to 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 3 (see Figure A.5 for the visual aid). We presented respondents with two potential marriage options and asked them to select the one that they believed the hypothetical family would prefer. We included all verifiable bride side attributes (i.e. we do not describe whether the mother of the bride requires help at home or the attributes relating to the cost and enjoyment of schooling) and the highest dowry that the bridal family is willing to pay.

Figure 5 (a) gives the key result from the groom-side experiment, showing the coefficients on a set of education dummies from a probit of option choice on vignette characteristics (see Appendix Table A.6 for all coefficients). We find a strong increasing preference for female education amongst grooms with a government job and the coefficient on female college education is large and highly significant for these families. 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 college level. Interestingly, we do not observe the same preference for female college education amongst families of grooms without government jobs. This might indicate that for these grooms the benefits of a highly educated wife might be outweighed by her negotiating a greater share of household resources once married (Anderson and Bidner, 2015). Likewise, we 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.

Expected Match Experiment We directly elicit how expected match quality varies with the characteristics of a potential bride.[31] To do so, we provided respondents with 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 (see Figure A.4 for the visual aid).

When asked to predict the characteristics of the best groom offer that girls of different characteristics would get, one observes a strong effect of a daughter's education on the likelihood that a respondent predicts a match with a government job, while age controls (conditional on education) are insignificant. Figure 5 (b) shows the coefficient on daughter's education for a linear probability model with whether a respondent describes a likely groom as having a government job as the dependent variable and education dummies as the explanatory variables (see Appendix Table A.7 for all coefficients). There is a linear relationship between a daughter's education and the likelihood of predicting a match with a government job, which is broadly consistent with our revealed belief estimates.[32]

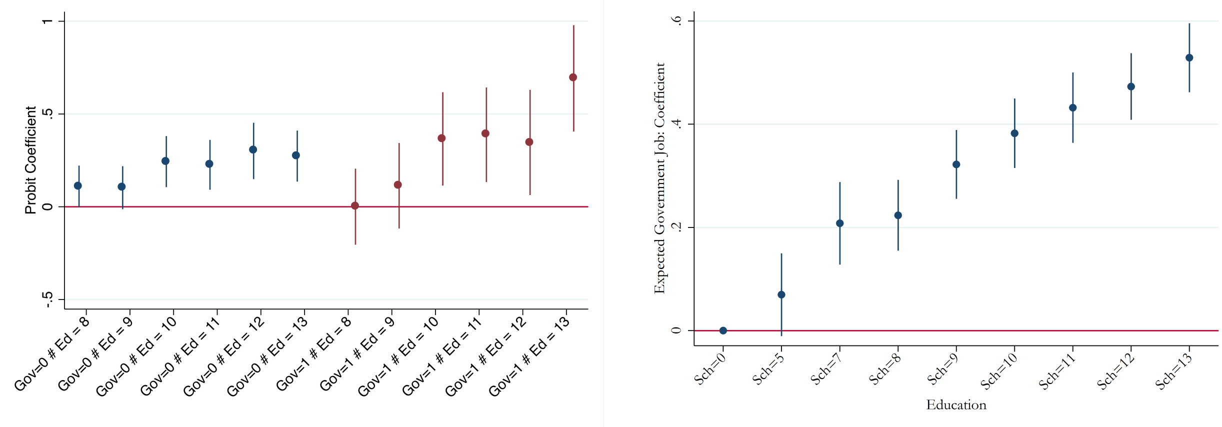
[31]Delavande et al. (2011) find a strong correlation between answers to "what do you expect" questions and the mean of elicited subjective distributions although there is often a systematic overoptimism in responses to these questions.

[32]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 or not 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

Figure 5: Validation Results

(a) Groom-Side Experiment
Groom Preferences over Age & Education

(b) Expected Match Experiment
Education & Groom with Government Job



Notes: Panel (a) plots coefficients on the education of a potential bride interacted with whether the groom has a government job and 95% confidence interval from a reduced form probit regression of whether the first option was chosen in the groom-side experiment on the characteristics of the hypothetical groom, groom's family and the potential bridal matches. Full set of coefficients given at Table A.6. Panel (b) plots coefficients on the education of a hypothetical daughter and 95% confidence interval from a linear regression of whether a match with a government job was predicted in the direct expectations experiment on the characteristics of the hypothetical daughter and her family. Full set of coefficients at Table A.7.

The probability levels implied by our revealed belief measures are also more plausible than those arising from our direct expectations experiment. The share of respondents stating that a daughter could expect a match with a government job is implausibly high. Less than 10% of men aged between 21 and 30 have a professional job in Rajasthan but in our direct expectations experiment in 70% of rounds involving an 18 year old girl, respondents predicted a groom with a government job. This is consistent with findings in other settings in which the gradient of subjective expectations in different characteristics is more accurate than their level (Delavande and Rohwedder, 2011).

Finally, our revealed belief results are qualitatively consistent with representative data on marriage matching patterns in the community and also with observations from our focus group discussions in which caregivers were optimistic that having a more educated daughter would mean that she married a more educated and better quality groom, one commenting that: "[if] a girl is educated she will go to a good house and will lead a good life".[33] Other women commented directly on the assortative nature of matching in the area: "If our daughter is a graduate, we will look for a match for her who is a graduate

are not aware of any research that explicitly assesses this assumption.

[33]FGD 2, Appendix E

as well."[34] Appendix Table A.8 gives the realized marriage matching patterns on education for India as a whole and Rajasthan specifically in 2015/16. We observe strong assortative matching on education with 41% of grooms with a professional job marrying a woman with higher education.

6 Conclusion

In this paper, we develop a novel methodology to identify parents' subjective beliefs over the marriage market return to girls' schooling and age and their preferences over female education and age at marriage. We administered our experiments with 4,605 female caregivers living in 120 villages in rural Rajasthan, a context with rigid patriarchal gender norms.

Drawing on the growing use of hypothetical choice experiments in economics to identify preferences, we offered respondents choices between randomly drawn options to identify average parental preferences over a daughter's age of marriage, education and marriage match characteristics in the absence of uncertainty over future marriage offers. We then extended the hypothetical choice approach by also offering respondents choices over whether or not to accept a given marriage offer in situations where there was uncertainty about which future offers would be received. Within a standard dynamic choice framework, these choices identify subjective beliefs over the joint distribution of age of marriage, education, and match quality. Our structural approach enables us to identify "revealed beliefs" that reconcile choices made with and without uncertainty, without directly eliciting probabilities from respondents.[35] This was an important benefit given our respondents had very low levels of literacy and numeracy and the experiments were carried out by non-specialist enumerators in a large field survey. Furthermore, the approach is well suited to elicit beliefs over continuous and multi-dimensional objects which is often challenging with existing approaches. Our revealed belief estimates are qualitatively consistent with estimates of groom-side preferences, directly elicited expected matches, and assortative matching patterns in observational data.

Our results suggest that the perceived marriage market return to education is the primary driver of female secondary schooling in our context. While parents place intrinsic value on a daughter's

[34] FGD 1, Appendix E

[35] In future work we will experimentally validate our belief measures in a more simple and controlled environment in which we can compare our structurally derived measures with those gained through more standard elicitation methods.

education up until the end of high school, this preference is small in magnitude and decreasing in post-secondary education. However, our revealed belief estimates indicate that parents believe that the likelihood of a daughter receiving an offer from a high quality groom increases substantially with education, particularly so with college education. This creates a sizeable perceived marriage market return to a daughter's education. There are many reasons why grooms and their families might value educated brides. Some, such as valuing her labor income break with traditional gender roles, while others, such as valuing parenting skills, are compatible with these. This perceived marriage market return to education may be important in understanding why female education in India has continued to increase while female labor force participation has fallen further from an already low base (Pande et al., 2017).

Although parents have a strong distaste for marrying a daughter before age eighteen, a belief that a girl's marriage prospects will start to deteriorate when she drops out of school can create a mechanism for early marriage. Indeed, our respondents were twice as likely to accept a marriage offer for a 16 year old daughter if the girl was not in school, and were equally likely to accept a given marriage offer made to a 13 year old girl out of school as for a 19 year old girl who was still in school. The beliefs we identify suggest that policies that ensure 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 will be fundamental in reducing rates of early marriage.

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Online Appendix

A Additional Figures & Tables

Table A.1: Summary of Vignette Characteristics

Characteristic	Support
Characteristics of the Bride and Bride's Family	
Wealth	{Very Poor, Average, Very Wealthy}
Age of Daughter	Ex-Post: Always 12
	Ex-Ante: {13, 14, ..., 21, 22}
Currently in School	{In School, Out of School}
Likes School	{Like, Dislike}
School Costs	{Free, Costly}
Chores	{Relax, Help Needed}
Comply with Norms (Ex-ante only)	{Polite and Well Behaved, Friends with Boys}
Age and Education at Marriage	
Age at Marriage (girl)	{13, 14, ..., 21, 22}
School Grade at Marriage	{7, ..., 12, College}
Characteristics of the Marriage Match	
Wealth	{ Very Poor, Average, Very Wealthy}
Age at Marriage	{21, 22, ..., 29, 30}
School Grade at Marriage	{None, 1, 5, 7, ..., 12, College}
Occupation	{Government Job, No Gov Job}
Minimum Dowry Acceptable to Groom (lakh)	{0, 0.5, 1, ..., 7, 7.5}

Notes: Table gives the support of the different characteristics described in the hypothetical vignettes.

Table A.2: Importance of Vignette Salience in Ex-Post Experiment

Option is Like Respondent's Daughter	0.0716*	(0.0387)	0.0273	(0.0486)
Daughter's Age at Marriage=14	0.2298**	(0.1093)	0.2035*	(0.1225)
Daughter's Age at Marriage=15	0.3336***	(0.1077)	0.2827**	(0.1201)
Daughter's Age at Marriage=16	0.4992***	(0.1077)	0.5699***	(0.1339)
Daughter's Age at Marriage=17	0.6388***	(0.1104)	0.6900***	(0.1453)
Daughter's Age at Marriage=18	0.8870***	(0.1117)	0.9424***	(0.1370)
Daughter's Age at Marriage=19	0.8889***	(0.1101)	0.9389***	(0.1407)
Daughter's Age at Marriage=20	0.9785***	(0.1170)	0.9945***	(0.1754)
Daughter's Age at Marriage=21	0.9851***	(0.1176)	0.9139***	(0.1756)
Daughter's Age at Marriage=22	0.9885***	(0.1229)	1.0505***	(0.1977)
Daughter's Education =8	-0.0019	(0.0431)	-0.1363	(0.2211)
Daughter's Education =9	0.0024	(0.0475)	-0.0240	(0.2149)
Daughter's Education =10	0.0277	(0.0536)	0.1773	(0.2038)
Daughter's Education =11	0.0288	(0.0605)	-0.0455	(0.2035)
Daughter's Education =12	0.0982	(0.0671)	-0.0514	(0.2036)
Daughter's Education =13	-0.1248*	(0.0710)	-0.2225	(0.1890)
Daughter Likes School*Years in School	0.0206**	(0.0097)	0.0212**	(0.0098)
Cost of School Covered*Years in School	0.0123	(0.0096)	0.0115	(0.0096)
Help in Home*Years at Home	-0.0233**	(0.0103)	-0.0233**	(0.0104)
Groom's Age	-0.0095**	(0.0038)	-0.0095**	(0.0038)
Groom's Education	0.0158***	(0.0033)	0.0162***	(0.0033)
Government Job	0.2731***	(0.0335)	0.2725***	(0.0337)
Dowry	-0.0172*	(0.0090)	-0.0179**	(0.0090)
Groom's Wealth = Poor	-0.0456	(0.0324)	-0.0422	(0.0325)
Groom's Wealth = Wealthy	-0.0024	(0.0312)	0.0050	(0.0314)
Daughter Options	yes		yes	
Match Characteristics	yes		yes	
Age × Education Interactions	no		yes	
Number of Choice Experiments	6320		6320	

Notes: Table presents coefficients and standard errors for a probit regression of the following form: $Y_{ir} = 1\left(\lambda \triangle H_{ir} + \beta I_{ir} + \zeta_{ir} > 0\right)$ where Y_{ir} is equal to 1 if the respondent chose option 1 over option 2 in the ex-post experiment and where $\triangle H_{ir} = H_{ir1} - H_{ir2}$ and H_{irj} gives the characteristics of option $j = \{1, 2\}$ and $\zeta_{ir} \sim IN(0,1)$. Included within H_{irj} is an indicator of whether the daughter described in that option is the same age and education (at marriage) as the respondents' daughter currently was. In the second column, age-by-education interactions are included but coeficients are not shown. Standard errors in parentheses. Significance of coefficients indicated by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.3: Importance of Vignette Salience in Ex-Ante Experiment

	(1)		(2)		(3)	
.						
Scenario Characteristics like Respondent's Daughter	0.0109	(0.0397)	0.0091	(0.0399)	0.0079	(0.0399)
Currently in School=0 × Daughter's Age=13	0.0000	(.)	0.0000	(.)	0.0000	(.)
Currently in School=0 × Daughter's Age=14	0.0524	(0.1315)	0.0498	(0.1329)	0.0518	(0.1329)
Currently in School=0 × Daughter's Age=15	0.4044***	(0.1244)	0.4259***	(0.1260)	0.4272***	(0.1260)
Currently in School=0 × Daughter's Age=16	0.4273***	(0.1248)	0.4363***	(0.1261)	0.4372***	(0.1262)
Currently in School=0 × Daughter's Age=17	0.7782***	(0.1214)	0.8026***	(0.1226)	0.8029***	(0.1227)
Currently in School=0 × Daughter's Age=18	1.0185***	(0.1217)	1.0404***	(0.1231)	1.0409***	(0.1231)
Currently in School=0 × Daughter's Age=19	1.1429***	(0.1215)	1.1792***	(0.1222)	1.1783***	(0.1222)
Currently in School=0 × Daughter's Age=20	1.2292***	(0.1245)	1.2513***	(0.1254)	1.2482***	(0.1254)
Currently in School=0 × Daughter's Age=21	1.3034***	(0.1287)	1.3136***	(0.1300)	1.3128***	(0.1300)
Currently in School=0 × Daughter's Age=22	1.3254***	(0.1275)	1.3611***	(0.1292)	1.3594***	(0.1292)
Currently in School=1 × Daughter's Age=13	-0.5088***	(0.1544)	-0.4957***	(0.1558)	-0.5382***	(0.1628)
Currently in School=1 × Daughter's Age=14	-0.3958***	(0.1272)	-0.3792***	(0.1283)	-0.4178***	(0.1346)
Currently in School=1 × Daughter's Age=15	-0.1918	(0.1285)	-0.1862	(0.1304)	-0.2208	(0.1352)
Currently in School=1 × Daughter's Age=16	-0.1772	(0.1288)	-0.1604	(0.1302)	-0.1860	(0.1333)
Currently in School=1 × Daughter's Age=17	-0.0323	(0.1267)	-0.0251	(0.1279)	-0.0445	(0.1293)
Currently in School=1 × Daughter's Age=18	0.2512*	(0.1304)	0.2728**	(0.1319)	0.2673**	(0.1320)
Currently in School=1 × Daughter's Age=19	0.1755	(0.1573)	0.1814	(0.1587)	0.1744	(0.1588)
Own Wealth = Poor	-0.0009	(0.0408)	-0.0076	(0.0412)	0.0104	(0.0434)
Own Wealth = Wealthy	-0.0640	(0.0408)	-0.0680*	(0.0410)	-0.0499	(0.0440)
Cost of School Covered	0.0406	(0.0503)	0.0431	(0.0504)	0.0431	(0.0504)
Daughter Likes School	-0.1986***	(0.0504)	-0.2043***	(0.0507)	-0.2032***	(0.0506)
Help in Home	0.0108	(0.0334)	0.0126	(0.0336)	0.0125	(0.0336)
Daughter has Male Friends	0.0995***	(0.0359)	0.0988***	(0.0362)	0.0998***	(0.0361)
Groom's Age			-0.0174***	(0.0065)	-0.0173***	(0.0065)
Groom's Education			0.0208***	(0.0052)	0.0188***	(0.0057)
Government Job			0.2773***	(0.0476)	0.2723***	(0.0479)
Dowry			-0.0079	(0.0120)	-0.0108	(0.0093)
Groom's Wealth = Poor			0.0053	(0.0439)		
Groom's Wealth = Wealthy			-0.0147	(0.0437)		
Wealth Disparity					-0.0538	(0.0432)
Groom Less Educated					-0.0573	(0.0653)
Constant	-0.2879**	(0.1126)	-0.0647	(0.2109)	0.0153	(0.2271)
Daughter Options	yes		yes		yes	
Match Characteristics	no		yes		yes	
Interactions	no		no		yes	
Number of Choice Experiments	6836		6836		6836	

Notes: Table presents coefficients and standard errors for a probit regression of a binary indicator of whether the respondent choose the marriage option in the ex-ante experiment on characteristics of the hypothetical daughter, the hypothetical family, the hypothetical match and whether or not the option was based on the characteristics of the respondents' own daughter. All inference clustered at the respondent level. Standard errors in parentheses. Significance of coefficients indicated by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: Effect of RCT Treatment Status on Ex-Post Experiment

Girl Only × Daughter's Age at Marriage=14	-0.1436	(0.2587)
Integrated × Daughter's Age at Marriage=14	-0.0690	(0.2725)
Girl Only × Daughter's Age at Marriage=15	0.0523	(0.2559)
Integrated × Daughter's Age at Marriage=15	0.0856	(0.2678)
Girl Only × Daughter's Age at Marriage=16	-0.0349	(0.2563)
Integrated × Daughter's Age at Marriage=16	0.0464	(0.2682)
Girl Only × Daughter's Age at Marriage=17	0.0770	(0.2635)
Integrated × Daughter's Age at Marriage=17	0.1482	(0.2736)
Girl Only × Daughter's Age at Marriage=18	-0.1479	(0.2629)
Integrated × Daughter's Age at Marriage=18	-0.1396	(0.2793)
Girl Only × Daughter's Age at Marriage=19	0.0087	(0.2630)
Integrated × Daughter's Age at Marriage=19	-0.1517	(0.2723)
Girl Only × Daughter's Age at Marriage=20	0.1741	(0.2774)
Integrated × Daughter's Age at Marriage=20	-0.1475	(0.2881)
Girl Only × Daughter's Age at Marriage=21	-0.1691	(0.2809)
Integrated × Daughter's Age at Marriage=21	-0.3384	(0.2903)
Girl Only × Daughter's Age at Marriage=22	-0.0538	(0.2956)
Integrated × Daughter's Age at Marriage=22	-0.1734	(0.3022)
Girl Only × Daughter's Education =8	-0.0781	(0.1067)
Integrated × Daughter's Education =8	0.0552	(0.1021)
Girl Only × Daughter's Education =9	-0.1943*	(0.1175)
Integrated × Daughter's Education =9	-0.0147	(0.1112)
Girl Only × Daughter's Education =10	-0.2137	(0.1313)
Integrated × Daughter's Education =10	-0.0338	(0.1257)
Girl Only × Daughter's Education =11	-0.2835*	(0.1457)
Integrated × Daughter's Education =11	-0.0459	(0.1409)
Girl Only × Daughter's Education =12	-0.0536	(0.1631)
Integrated × Daughter's Education =12	-0.0200	(0.1568)
Girl Only × Daughter's Education =13	-0.2280	(0.1732)
Integrated × Daughter's Education =13	0.0869	(0.1677)
Girl Only × Daughter Likes School*Years in School	0.0318	(0.0242)
Integrated × Daughter Likes School*Years in School	0.0198	(0.0237)
Girl Only × Cost of School Covered*Years in School	0.0211	(0.0236)
Integrated × Cost of School Covered*Years in School	0.0186	(0.0232)
Girl Only × Help in Home*Years at Home	-0.0347	(0.0254)
Integrated × Help in Home*Years at Home	-0.0083	(0.0251)
Girl Only × Government Job	-0.1268*	(0.0737)
Integrated × Government Job	-0.1734**	(0.0731)
Number of Choice Experiments	6320	

Notes: Table presents coefficients and standard errors for a probit regression of the following form: $Y_{ir} = 1\left(\lambda T_i \triangle H_{ir} + \beta I_{ir} + \zeta_{ir} > 0\right)$ where Y_{ir} is equal to 1 if the respondent chose option 1 over option 2 in the ex-post experiment and where $\triangle H_{ir} = H_{ir1} - H_{ir2}$ and H_{irj} gives the characteristics of option $j = \{1, 2\}$ and $\zeta_{ir} \sim IN(0, 1)$. T_i is a vector of treatment indicators. Base levels are included in the regression but coefficients are not displayed. RCT treatment arms include: control, girl only (life skills and knowledge for adolescent girls) and integrated (with additional community component). Details of intervention given in Andrew et al. (2022). Standard errors in parentheses. Significance of coefficients indicated by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Effect of RCT Treatment Status on Ex-Ante Experiment

	(1)		(2)		(3)	
Control	0.0000	(.)	0.0000	(.)	0.0000	(.)
Girl Only	-0.0092	(0.0482)	-0.0075	(0.0479)	-0.0083	(0.0483)
Integrated	0.0976**	(0.0469)	0.0969**	(0.0465)	0.0983**	(0.0469)
Currently in School=0 × Daughter's Age=13	0.0000	(.)	0.0000	(.)	0.0000	(.)
Currently in School=0 × Daughter's Age=14	0.0472	(0.1330)	0.0490	(0.1318)	0.0457	(0.1329)
Currently in School=0 × Daughter's Age=15	0.4188***	(0.1260)	0.3969***	(0.1246)	0.4174***	(0.1259)
Currently in School=0 × Daughter's Age=16	0.4331***	(0.1261)	0.4244***	(0.1248)	0.4323***	(0.1260)
Currently in School=0 × Daughter's Age=17	0.7993***	(0.1224)	0.7751***	(0.1213)	0.7983***	(0.1223)
Currently in School=0 × Daughter's Age=18	1.0399***	(0.1225)	1.0177***	(0.1211)	1.0386***	(0.1224)
Currently in School=0 × Daughter's Age=19	1.1717***	(0.1223)	1.1368***	(0.1216)	1.1723***	(0.1222)
Currently in School=0 × Daughter's Age=20	1.2406***	(0.1257)	1.2213***	(0.1249)	1.2427***	(0.1256)
Currently in School=0 × Daughter's Age=21	1.3085***	(0.1301)	1.2995***	(0.1288)	1.3094***	(0.1300)
Currently in School=0 × Daughter's Age=22	1.3542***	(0.1293)	1.3207***	(0.1277)	1.3555***	(0.1292)
Currently in School=1 × Daughter's Age=13	-0.5498***	(0.1629)	-0.5237***	(0.1544)	-0.5123***	(0.1556)
Currently in School=1 × Daughter's Age=14	-0.4114***	(0.1300)	-0.3897***	(0.1222)	-0.3752***	(0.1232)
Currently in School=1 × Daughter's Age=15	-0.2199*	(0.1323)	-0.1915	(0.1255)	-0.1878	(0.1272)
Currently in School=1 × Daughter's Age=16	-0.1851	(0.1301)	-0.1767	(0.1254)	-0.1618	(0.1268)
Currently in School=1 × Daughter's Age=17	-0.0482	(0.1267)	-0.0349	(0.1241)	-0.0294	(0.1252)
Currently in School=1 × Daughter's Age=18	0.2610**	(0.1293)	0.2458*	(0.1277)	0.2653**	(0.1291)
Currently in School=1 × Daughter's Age=19	0.1710	(0.1520)	0.1742	(0.1507)	0.1780	(0.1519)
Cost of School Covered	0.0431	(0.0505)	0.0403	(0.0504)	0.0429	(0.0505)
Daughter Likes School	-0.2045***	(0.0506)	-0.1992***	(0.0504)	-0.2047***	(0.0507)
Help in Home	0.0114	(0.0336)	0.0094	(0.0334)	0.0112	(0.0336)
Daughter has Male Friends	0.1011***	(0.0361)	0.1005***	(0.0359)	0.0997***	(0.0362)
Groom's Age	-0.0176***	(0.0065)			-0.0177***	(0.0065)
Groom's Education	0.0190***	(0.0057)			0.0209***	(0.0052)
Government Job	0.2730***	(0.0480)			0.2770***	(0.0476)
Dowry	-0.0105	(0.0093)			-0.0081	(0.0120)
Wealth Disparity	-0.0629	(0.0400)				
Groom Less Educated	-0.0527	(0.0651)				
Groom's Wealth = Poor					0.0051	(0.0438)
Groom's Wealth = Wealthy					-0.0114	(0.0437)
Constant	-0.0155	(0.2264)	-0.3306***	(0.1133)	-0.1034	(0.2108)
Daughter Options	yes		yes		yes	
Match Characteristics	yes				yes	
Interactions	yes					
Number of Choice Experiments	6836		6836		6836	

Notes: Table presents coefficients and standard errors for a probit regression of a binary indicator of whether the respondent choose the marriage option in the ex-ante experiment on characteristics of the hypothetical daughter, the hypothetical family, the hypothetical match and on indicators of RCT treatment status. RCT treatment arms include: control, girl only (life skills and knowledge for adolescent girls) and integrated (with additional community component). Details of intervention given in Andrew et al. (2022) Standard errors in parentheses. Significance of coefficients indicated by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.6: Determinants of Groom Choices: Reduced Form Probit

	(1)		(2)		(3)	
Bride's Age at Marriage=14	0.1021	(0.0765)	0.1173	(0.0769)	0.1429*	(0.0866)
Bride's Age at Marriage=15	0.2030***	(0.0710)	0.2191***	(0.0715)	0.2410***	(0.0813)
Bride's Age at Marriage=16	0.2563***	(0.0717)	0.2755***	(0.0722)	0.3329***	(0.0815)
Bride's Age at Marriage=17	0.2581***	(0.0716)	0.2678***	(0.0721)	0.3117***	(0.0810)
Bride's Age at Marriage=18	0.5207***	(0.0700)	0.5345***	(0.0704)	0.5976***	(0.0793)
Bride's Age at Marriage=19	0.5871***	(0.0750)	0.6062***	(0.0753)	0.6620***	(0.0851)
Bride's Age at Marriage=20	0.5850***	(0.0726)	0.6042***	(0.0731)	0.6790***	(0.0823)
Bride's Age at Marriage=21	0.5789***	(0.0697)	0.5933***	(0.0702)	0.6685***	(0.0793)
Bride's Age at Marriage=22	0.6506***	(0.0754)	0.6625***	(0.0759)	0.7612***	(0.0863)
Bride's Education =8	0.0854*	(0.0491)	0.0917*	(0.0499)	0.1098*	(0.0572)
Bride's Education =9	0.1023**	(0.0501)	0.1165**	(0.0521)	0.1028*	(0.0591)
Bride's Education =10	0.2611***	(0.0579)	0.2829***	(0.0607)	0.2435***	(0.0702)
Bride's Education =11	0.2456***	(0.0556)	0.2715***	(0.0596)	0.2261***	(0.0686)
Bride's Education =12	0.2876***	(0.0622)	0.3168***	(0.0678)	0.3009***	(0.0776)
Bride's Education =13	0.3117***	(0.0514)	0.3532***	(0.0621)	0.2731***	(0.0701)
Bride has Male Friends	-0.3283***	(0.0306)	-0.3248***	(0.0307)	-0.3343***	(0.0344)
Dowry	0.0598***	(0.0103)	0.0591***	(0.0103)	0.0552***	(0.0117)
Bride's Wealth = Poor	0.0071	(0.0374)				
Bride's Wealth = Wealthy	-0.0192	(0.0365)				
Bride's Wealth = Poor, Groom's Wealth = Poor			-0.0361	(0.0634)	0.0177	(0.0716)
Bride's Wealth = Wealthy, Groom's Wealth = Poor			-0.2571***	(0.0602)	-0.2509***	(0.0682)
Bride's Wealth = Poor, Groom's Wealth = Average			-0.0209	(0.0600)	-0.0138	(0.0663)
Bride's Wealth = Wealthy, Groom's Wealth = Average			0.0101	(0.0609)	0.0342	(0.0671)
Bride's Wealth = Poor, Groom's Wealth = Wealthy			0.0875	(0.0601)	0.0531	(0.0682)
Bride's Wealth = Wealthy, Groom's Wealth = Wealthy			0.2262***	(0.0624)	0.2246***	(0.0713)
Bride More Educated			-0.0483	(0.0428)	-0.0229	(0.0477)
Gov = 1 & Bride's Age = 14					-0.1068	(0.1914)
Gov = 1 & Bride's Age = 15					-0.0608	(0.1738)
Gov = 1 & Bride's Age = 16					-0.2081	(0.1798)
Gov = 1 & Bride's Age = 17					-0.1923	(0.1810)
Gov = 1 & Bride's Age = 18					-0.2279	(0.1763)
Gov = 1 & Bride's Age = 19					-0.2037	(0.1865)
Gov = 1 & Bride's Age = 20					-0.3089*	(0.1841)
Gov = 1 & Bride's Age = 21					-0.3137*	(0.1745)
Gov = 1 & Bride's Age = 22					-0.4170**	(0.1852)
Gov = 1 & Bride's Ed = 8					-0.1095	(0.1192)
Gov = 1 & Bride's Ed = 9					0.0105	(0.1316)
Gov = 1 & Bride's Ed = 10					0.1224	(0.1463)
Gov = 1 & Bride's Ed = 11					0.1619	(0.1471)
Gov = 1 & Bride's Ed = 12					0.0459	(0.1642)
Gov = 1 & Bride's Ed = 13					0.4192***	(0.1622)
Gov = 1 & Bride has Male Friends					0.0486	(0.0773)
Gov = 1 & Dowry					0.0195	(0.0252)
Gov = 1 & Bride's Wealth = Poor, Groom's Wealth = Poor					-0.2537	(0.1584)
Gov = 1 & Bride's Wealth = Wealthy, Groom's Wealth = Poor					-0.0231	(0.1473)
Gov = 1 & Bride's Wealth = Poor, Groom's Wealth = Average					-0.0616	(0.1585)
Gov = 1 & Bride's Wealth = Wealthy, Groom's Wealth = Average					-0.0917	(0.1625)
Gov = 1 & Bride's Wealth = Poor, Groom's Wealth = Wealthy					0.1683	(0.1465)
Gov = 1 & Bride's Wealth = Wealthy, Groom's Wealth = Wealthy					0.0181	(0.1493)
Gov = 1 & Bride More Educated					-0.2075	(0.1351)
Daughter Options	yes		yes		yes	
Match Characteristics	no		yes		yes	
Interactions	no		no		yes	
Number of Choice Experiments	4596		4596		4596	

Notes: Table presents coefficients and standard errors for a probit regression of the following form: $Y_{ir} = 1\left(\lambda \triangle H_{ir} + \zeta_{ir} > 0\right)$ where Y_{ir} is equal to 1 if the respondent chose option 1 over option 2 in the groom's side experiment and where $\triangle H_{ir} = H_{ir1} - H_{ir2}$ and H_{irj} gives the characteristics of option $j = \{1, 2\}$ and $\zeta_{ir} \sim IN(0, 1)$. Standard errors in parentheses. Significance of coefficients indicated by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.7: Determinants of Expected Match

	(1) Education		(2) Government Job		(3) Wealth		(4) Dowry		(5) Dowry		(6) Quality	
Age=13	0.0000	(.)	0.0000	(.)	0.0000	(.)	0.0000	(.)	0.0000	(.)	0.0000	(.)
Age=14	0.3276	(0.3188)	0.0586	(0.0724)	0.0379	(0.0728)	-0.3232	(0.2188)	-0.3900*	(0.2013)	0.0274	(0.0221)
Age=15	0.1562	(0.2912)	-0.0435	(0.0622)	0.0302	(0.0663)	-0.1468	(0.1939)	-0.1670	(0.1788)	-0.0075	(0.0190)
Age=16	0.3952	(0.2838)	-0.0134	(0.0611)	0.0053	(0.0655)	-0.1423	(0.1906)	-0.1693	(0.1754)	0.0059	(0.0187)
Age=17	0.3439	(0.2838)	0.0469	(0.0594)	-0.0001	(0.0640)	-0.0449	(0.1851)	-0.0931	(0.1700)	0.0183	(0.0182)
Age=18	0.3358	(0.2822)	0.0575	(0.0583)	0.0156	(0.0627)	-0.0190	(0.1830)	-0.1010	(0.1678)	0.0168	(0.0179)
Age=19	0.2987	(0.2827)	0.0034	(0.0586)	0.0074	(0.0629)	0.0717	(0.1831)	-0.0082	(0.1682)	-0.0043	(0.0180)
Age=20	0.4383	(0.2779)	0.0636	(0.0579)	0.0324	(0.0624)	-0.0165	(0.1827)	-0.1755	(0.1693)	0.0090	(0.0178)
Age=21	0.4442	(0.2801)	0.0626	(0.0578)	0.0508	(0.0627)	-0.0641	(0.1824)	-0.2701	(0.1727)	0.0029	(0.0178)
Age=22	0.4067	(0.2792)	0.0641	(0.0579)	0.0253	(0.0627)	0.0326	(0.1815)	-0.1837	(0.1726)	-0.0042	(0.0178)
Sch=0	0.0000	(.)	0.0000	(.)	0.0000	(.)	0.0000	(.)	0.0000	(.)	0.0000	(.)
Sch=5	1.1546***	(0.2305)	0.0696*	(0.0409)	0.0317	(0.0419)	-0.0099	(0.1262)	-0.1286	(0.1242)	0.0417***	(0.0135)
Sch=7	1.7528***	(0.2235)	0.2080***	(0.0408)	0.0799*	(0.0436)	0.2600**	(0.1262)	0.0295	(0.1263)	0.0870***	(0.0132)
Sch=8	1.9991***	(0.2174)	0.2235***	(0.0350)	0.0582	(0.0367)	0.1408	(0.1055)	-0.1032	(0.1085)	0.0972***	(0.0117)
Sch=9	2.4154***	(0.2164)	0.3220***	(0.0341)	0.1136***	(0.0362)	0.3333***	(0.1060)	-0.0011	(0.1117)	0.1296***	(0.0114)
Sch=10	2.7225***	(0.2167)	0.3823***	(0.0343)	0.1112***	(0.0376)	0.4146***	(0.1095)	0.0390	(0.1178)	0.1501***	(0.0115)
Sch=11	3.0420***	(0.2160)	0.4320***	(0.0347)	0.1183***	(0.0395)	0.5162***	(0.1144)	0.0918	(0.1239)	0.1679***	(0.0116)
Sch=12	3.2783***	(0.2150)	0.4730***	(0.0330)	0.1435***	(0.0374)	0.5835***	(0.1087)	0.1117	(0.1202)	0.1817***	(0.0112)
Sch=13	3.3834***	(0.2156)	0.5287***	(0.0342)	0.1797***	(0.0423)	0.7177***	(0.1278)	0.2034	(0.1382)	0.2005***	(0.0115)
Wealth of Bride's family=1	0.0000	(.)	0.0000	(.)	0.0000	(.)	0.0000	(.)	0.0000	(.)	0.0000	(.)
Wealth of Bride's family=2	0.0148	(0.0488)	0.0716***	(0.0162)	0.2441***	(0.0185)	1.1221***	(0.0515)	0.9465***	(0.0514)	0.0011	(0.0048)
Wealth of Bride's family=3	0.1573***	(0.0478)	0.1571***	(0.0155)	0.6446***	(0.0194)	2.5414***	(0.0570)	2.0778***	(0.0645)	0.0028	(0.0047)
Daughter Has Male Friends	0.0113	(0.0416)	0.0119	(0.0138)	0.0095	(0.0162)	-0.0381	(0.0504)	-0.0532	(0.0488)	0.0032	(0.0041)
Expect Match with Gov Job									0.2849***	(0.0504)		
Expected Age of Match									0.0491***	(0.0147)		
Expected Education of Match									0.0723***	(0.0172)		
Expected Wealth of Match									0.6260***	(0.0474)		
Constant	8.9729***	(0.3287)	0.2369***	(0.0579)	1.8411***	(0.0638)	1.3460***	(0.1784)	-1.5747***	(0.3817)	0.0074	(0.0183)
Observations	4599		4599		4599		4599		4599		4599	

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Table presents coefficients and standard errors for OLS regressions of characteristics of the 'expected match' given by respondent on characteristics of hypothetical daughter. Standard errors in parentheses. Significance of coefficients indicated by: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.8: Population Matching Patterns by Husband's Occupation

All India (N=15,440)	*Wife's Education*			
Husband's Occupation	No Education	Primary	Secondary	Higher
Professional/Technical/Managerial/Clerical (7.51%)	5.78%	6.21%	49.01%	39.00%
Other (92.49%)	24.17%	14.93%	52.94%	7.96%
Rajasthan (N=1,091)	*Wife's Education*			
Husband's Occupation	No Education	Primary	Secondary	Higher
Professional/Technical/Managerial/Clerical (9.53%)	8.65%	14.42%	35.58%	41.35%
Other (90.47%)	36.27%	17.53%	35.97%	10.23%

Notes: Table presents the distribution of wives' education by husband's occupation type for couples where the husband is aged 21 to 30 in both the whole of India (top panel) and Rajasthan (bottom panel) from the NFHS-IV (2015/16).

Figure A.1: Ex Post Experiment: Example Script

Background
Please imagine a mother and father named Ramesh and Rita, they live in a village similar to your village. Ramesh and have a daughter named Sita.

Compared to other households in the village, Ramesh and Rita's household is of average wealth. Their house has two rooms with a dung floor. They own one bigha of land and two cows. They own an electric fan and a bicycle but not a TV.

Sita's age is 12. Sita's currently studying in 7th standard. Sita is getting average grades at school and really enjoys going. At Sita's school there is a scheme that covers all the costs of Sita's education, including stationary, uniforms and transport.

Sita's mother, Rita, really struggles to take care of all the work that needs doing at home. So Sita's help with cooking, cleaning, and taking care of elderly relatives is very useful.

Ramesh and Rita are considering when and to whom they will get Sita married and until when they will keep her in education. Imagine there are two possible options, for when Sita will leave education and when and to whom she will get married.

Option 1
Sita completes standard 9 at school. Sita marries at age 16.

She marries Rahul. Rahul is 24 years old. Rahul attended College and has a government job.

Compared to other household in the village, Rahul's household is very wealthy. Their house has three rooms with a cement floor. They own four bighas of land and two cows. As well as an electric fan and a TV they also own a refrigerator and a motorcycle. Rahul's parents expect at least 6 lakhs in marriage gifts.

Option 2
Sita completes standard 12 at school. Sita marries at age 19.

She marries Bharat. Bharat is 22 years old. Bharat attended school until 10th standard.

Compared to other household in the village, Bharat's household is very poor. The whole household live in one room with a dung floor and they don't own any land. They have one cow. They own very other few assets, for example, they don't own an electric fan, a TV or a bicycle. Bharat's parents expect at least 2.5 lakhs in marriage gifts.

Choice
Which option do you think Ramesh and Rita will choose for their daughter?

1. Keep Sita in education until she has finished standard 9 and then marry her to Rahul when she is age 16

2. Keep Sita in education until she has finished standard 12 and then marry her to Bharat when she is age 19

Figure A.2: Ex Ante Experiment: Example Script

Background
Please imagine a mother and father named Raj Kumar and Aarti, they live in a village similar to your village. Raj Kumar and Aarti have a daughter named Jyoti.

Compared to other households in the village, Raj Kumar and Aartis' household is of average wealth. Their house has two rooms with a dung floor. They own one bigha of land and two cows. They own an electric fan and a bicycle but not a TV.

Jyoti's age is 15. She is currently studying in 10th standard.

Jyoti is getting average grades at school but does not enjoy school. Jyoti's parents have to pay for the full cost of Jyoti's education, including stationary, uniforms and transport.

Jyoti's family have no particular need for Jyoti to spend lots of time helping at home. When Jyoti is at home she spends lots of her time sitting and relaxing.

Raj Kumar and Aart are worried about Jyoti as she is friends with some boys and sometimes stays out of the house until late.

Offer in Hand
Raji Kuma and Aarti are considering whether they will get Jyoti married in the next year, whether they will keep her in school for another year or whether Jyoti will leave school to help her parents at home.

Raj Kumar and Aarti know of a potential suitor for Jyoti, Amit.

Compared to other households in the village, Amit's household is very poor. The whole household live in one room with a dung floor and they don't own any land. They have one cow. They own very other few assets, for example, they don't own an electric fan, a TV or a bicycle.

Amit's parents expect at least 4 lakhs in marriage gifts.

Amit is 24 years old. Amit attended school until 11th standard.

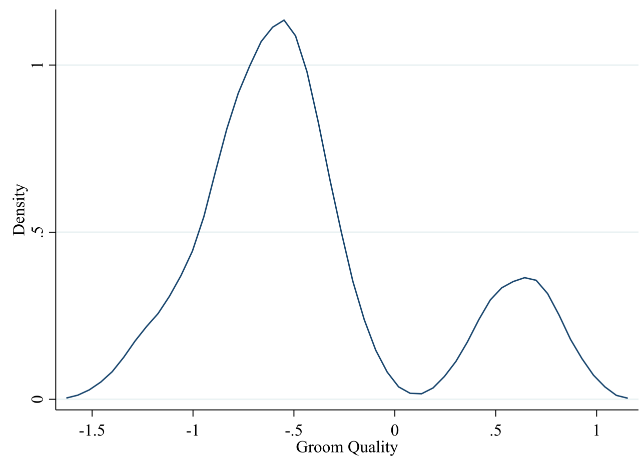
Choice
Which option do you think Raj Kumar and Aarti will choose for their daughter?

1. Marry Jyoti to Amit this year

2. Keep Jyoti in school this year

3. Take Jyoti out of school so she can help in the home this year

Figure A.3: Kernel density plot of groom quality



Notes: Figure plots kernel density of estimated groom quality index, $\mathbf{X}_{irj}\alpha$, over the potential grooms that we presented to respondents in the ex-post experiments.

Figure A.4: Validation Experiments: Expected Match Visual Aid

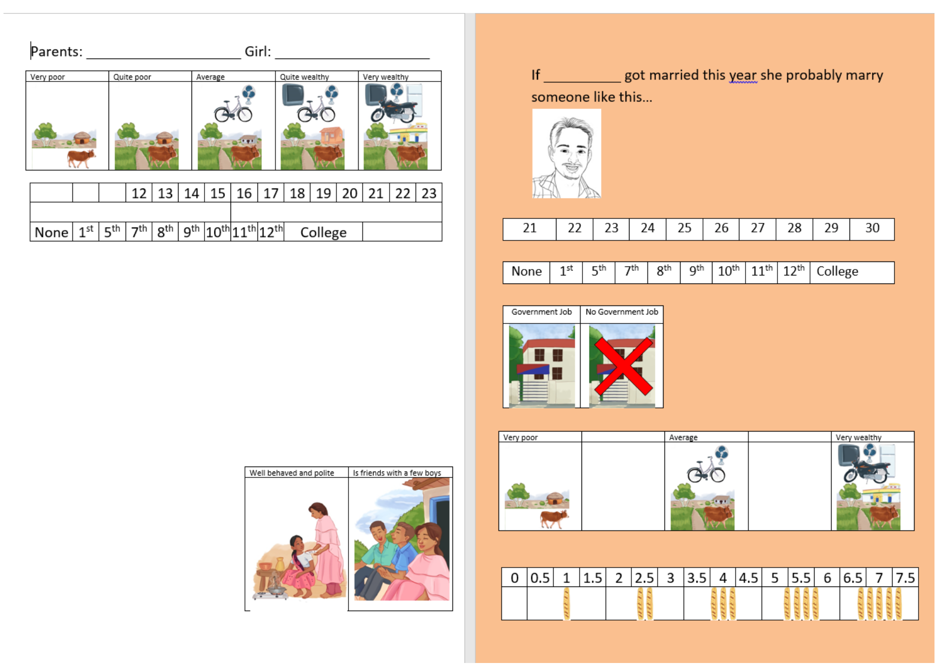


Figure A.5: Validation Experiments: Groom Experiment Visual Aid

B Identification of Preferences

Proof of Theorem 1. From the point of view of period 0, parents have preferences over complete paths, $\bar{\Psi}$, that a daughter's adolescence might take. The non-stochastic component of these preferences are described by utility function $\bar{U}_0(\bar{\Psi})$. Let $\mathbf{P}$ give the $M(M-1)/2$-vector of choice probabilities (that the first option is chosen) at the possible combinations of paths presented in the ex-post experiment. Inverting the expression for ex-post choice probabilities (Equation 6) and leveraging our assumption on the error term gives:

$$\sqrt{2}\Phi^{-1}(\mathbf{P}) = BU_0 \tag{23}$$

where

$$\Phi^{-1}(\mathbf{P}) = \begin{bmatrix} \Phi^{-1}(P(\bar{\Psi}^0, \bar{\Psi}^1)) \\ \Phi^{-1}(P(\bar{\Psi}^0, \bar{\Psi}^2)) \\ \vdots \\ \Phi^{-1}(P(\bar{\Psi}^{M-1}, \bar{\Psi}^M)) \end{bmatrix} \quad , \quad \mathbf{U}_0 = \begin{bmatrix} 1/\sigma_\nu \\ \bar{U}_0(\bar{\Psi}^2)/\sigma_\nu \\ \vdots \\ \bar{U}_0(\bar{\Psi}^M)/\sigma_\nu \end{bmatrix}$$

and

$$B = \begin{bmatrix} -1 & 0 & \cdots & 0 \\ 0 & -1 & ... & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 1 & -1 & ... & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & \cdots & 1 & -1 \end{bmatrix}$$

That is, $\Phi^{-1}(\mathbf{P})$ is an $M(M-1)/2$-vector of the quantiles of the normal distribution at the observed choice probabilties, U_0 is the $M-1$ vector of utility values (relative to the path $\bar{\Psi}^0$ and scaled by the standard deviation of the experimental error), and B is the design matrix that gives every unique combination of utility differences. Pre-multiplying both sides of Equation 23 by B' and then inverting we get:

$$U_0 = \sqrt{2}(B'B)^{-1}B'\Phi^{-1}(\mathbf{P}) \tag{24}$$

Thus, utility relative to path $\bar{\Psi}^0$ can be identified from the observed ex-post choice probabilities.

C Identification of Beliefs

We structure our discussion of the identification of beliefs in three parts. First, we consider the case when marriage offers are received every period (i.e. $\pi(\bar{\omega}, N) = 0$ for all $\bar{\omega}$). Proving identification of subjective beliefs in this case is straightforward and will often be the most relevant in alternative settings where this methodology is applied.

Second, we analyse the case where we allow for no marriage offers to be received, i.e. $\pi(\bar{\omega}, N) \geq 0$ and utility is identified at all $\bar{\Psi} \in \bar{\mathbf{\Psi}}$. Finally, we analyse the case where we allow for no marriage offers to be received, i.e. $\pi(\bar{\omega}, N) \geq 0$ *and* utility is only identified for paths that end in marriage, i.e. $\Psi \in \mathbf{\Psi}^M$. This final case will not be generally relevant for researchers hoping to apply our methodology and is only included because we did not elicit choice behaviour over options in which a daughter remained unmarried at 23 in the ex-post experiment.

We first show how beliefs are identified with with two marriage qualities. We next show how the presence of instruments which affect flow payoffs but not beliefs permit the identification of more types. Finally, we discuss the special case where we allow for the case that an offer may not be received at all.

C.0.1 Setup and notation

As in the main text we define the non-stochastic component of utility simply as a function of the state at marriage for $\Psi \in \mathbf{\Psi}^M$:

$$u_t(A, q_A, \bar{\omega}_A) \equiv \bar{U}_t(\bar{\Psi}_t) \tag{25}$$

Value functions, $V(.)$, expected value functions $EV(.)$, and choice-specific value functions, $\tilde{V}(.)$, are also defined as in the main text:

$$V(t,\bar{\omega}_t,q_t,\varepsilon_t) = \max_{\delta} \mathbb{E}\left[\bar{U}_0(\bar{\Psi}) + \sum_{\tau=0}^{T} \beta^{\tau}\varepsilon_{\tau}^{d_{\tau}} | t,\bar{\omega}_t,q_t,\varepsilon_t\right] \tag{26}$$

$$EV(t,\bar{\omega}_t) = \mathrm{E}_{q_t,\varepsilon_t}\left[V(t,\bar{\omega}_t,q_t,\varepsilon_t)\right] \tag{27}$$

$$\tilde{V}(t,\bar{\omega}_t,q_t,\varepsilon_t^M,d_t=M) = u(t,\bar{\omega}_t,q_t) + \beta^t\varepsilon_t^M \tag{28}$$

$$\tilde{V}(t,\bar{\omega}_t,q_t,\varepsilon_t^H,d_t=H) = EV(t,\bar{\omega}_{t+1}(\bar{\omega}_t,d_t=H)) + \beta^t\varepsilon_t^H \tag{29}$$

$$\tilde{V}(t,\bar{\omega}_t,q_t,\varepsilon_t^S,d_t=S) = EV(t,\bar{\omega}_{t+1}(\bar{\omega}_t,d_t=S))) + \beta^t\varepsilon_t^S \tag{30}$$

For ease of notation, we drop dependence on deterministic state variables other than education.

C.1 Case 1: $\pi(\bar{\omega},N)=0$ and $K=2$

Step 1: Identifying Expected Value Functions and Distribution of Preference Shocks Consider any generic period t in which parents are making a two-way choice between keeping a daughter at home another year or marrying her (i.e. where she is already out of school denoted by out). Under the assumption $\varepsilon_t^d \sim N(0,\sigma^2)$, acceptance probabilities are described by:

$$\begin{aligned} p_M(t,Ed,out,q=0) &= Pr(u(t,Ed,q=0) + \beta^t\varepsilon_t^M > EV(t+1,Ed,out) + \beta^t\varepsilon_t^H) \\ &= \Phi\left(\frac{u(t,Ed,q=0) - V(t+1,Ed,out)}{\beta^t\sqrt{2}\sigma}\right) \end{aligned}$$

$$\begin{aligned} p_M(t,Ed,out,q=1) &= Pr(u(t,Ed,q=1) + \beta^t\varepsilon_t^M > EV(t+1,Ed,out) + \beta^t\varepsilon_t^H) \\ &= \Phi\left(\frac{u(t,Ed,q=0) - V(t+1,Ed,out)}{\beta^t\sqrt{2}\sigma}\right) \end{aligned}$$

Inverting identifies σ and $EV(t,Ed,out),\ \ \forall t=2,....T+1$, for all states where the daughter has been out of school for at least one period already.

For daughters still in school (denoted by in), marriage probabilities take the form:

$$p_M(t,Ed,in,q) = Pr\begin{bmatrix} u_0(t,Ed,q)+\beta^t\varepsilon_M > EV(t+1,Ed,out)+\beta^t\varepsilon_H, \\ u_0(t,Ed,q)+\beta^t\varepsilon_M > EV(t+1,Ed+1,in)+\beta^t\varepsilon_S \end{bmatrix} \tag{31}$$

$$p_S(t,Ed,in,q) = Pr\begin{bmatrix} EV(t+1,Ed+1,in)+\beta^t\varepsilon_S > u_0(t,Ed,q)+\beta^t\varepsilon_M, \\ EV(t+1,Ed+1,in)+\beta^t\varepsilon_S > EV(t+1,Ed,out)+\beta^t\varepsilon_H \end{bmatrix} \tag{32}$$

Although closed form solutions do not exist, these expressions allow us to identify $EV(t,Ed,.)$ for all states when a daughter is still in school or states one period after a daughter has left school.

Having identified all value functions and the variance of the idiosyncratic preference heterogeneity, we can form expressions for the expected value of idiosyncratic preference shocks conditional on optimal actions ($E(\varepsilon_t^d|d^*,.)$> In two-way choices, these expressions have closed form solutions, for example:

$$E\left(\varepsilon_t^M|d_t^*=M,t,Ed,out,q\right) = E\left(\varepsilon_t^M|u_0(t,Ed,q)+\beta^t\varepsilon_t^M \geq EV(t+1,Ed,out)+\beta^t\varepsilon_t^H\right) \tag{33}$$

$$= E\left(\varepsilon_t^M|\varepsilon_t^M-\varepsilon_t^H \geq \frac{EV(t+1,Ed,out)-u_0(t,Ed,q)}{\beta^t}\right) \tag{34}$$

$$= \frac{1}{\sqrt{2}}\sigma_\varepsilon \frac{\phi\left(\frac{EV(t+1,Ed,out)-u_0(t,Ed,q)}{\beta^{T-1}\sqrt{2\sigma_\varepsilon^2}}\right)}{1-\Phi\left(\frac{EV(t+1,Ed,out)-u_0(t,Ed,q)}{\beta^{T-1}\sqrt{2\sigma_\varepsilon^2}}\right)} \tag{35}$$

where we use the fact that if ε^M and ε^H are independent and follow identical normal distributions. These are similarly defined in the three-way choices although no closed forms exist.

Step 2: Going from Value Functions to Beliefs After having identified the value functions for the value of being unmarried at every state, we can use the recursive relationship between expected value functions to identify beliefs. In particular, the value of being unmarried and out of school (denoted by out) at period t is equal to:

$$
\begin{aligned}
&EV(t,Ed,out)\\
&\quad=\underbrace{(1-\pi(t,Ed))p_M(t,Ed,q=0)\left[u(t,Ed,q=0)+E(\varepsilon_t^M|d_t^*=M,t,Ed,out,q=0)\right]}_{\text{low offer, accept}}\\
&\quad\quad+\underbrace{\pi(t,Ed)p_M(t,Ed,q=1)\left[u(t,Ed,q=1)+E(\varepsilon_t^M|d_t^*=M,t,Ed,out,q=1)\right]}_{\text{high offer, accept}}\\
&\quad\quad+\underbrace{(1-\pi(t,Ed))(1-p_M(t,Ed,q=0))\left[EV(t+1,Ed,out)+E(\varepsilon_t^H|d_t^*=H,t,Ed,out,q=0)\right]}_{\text{low offer, reject}}\\
&\quad\quad+\underbrace{\pi(t,Ed)(1-p_M(t,Ed,q=1))\left[EV(t+1,Ed,out)+E(\varepsilon_t^H|d_t^*=H,t,Ed,out,q=1)\right]}_{\text{high offer, reject}}
\end{aligned}
$$

Since, $\pi(t, Ed)$ is the only unknown in this relation, we can rearrange to identify $\pi(t, Ed)$ at every state where a daughter is out of school. .

Likewise, in states where the daughter is still in school and a three-way choice exists, we have:

$$
\begin{aligned}
&EV(t,Ed,in)\\
&\quad=\underbrace{(1-\pi(t,Ed))p_M(t,Ed,q=0)\left[u(t,Ed,q=0)+E(\varepsilon_t^M|d^*=M,t,Ed,in,q=0)\right]}_{\text{low offer, accept}}\\
&\quad\quad+\underbrace{\pi(t,Ed)p_M(t,Ed,q=1)\left[u(t,Ed,q=1)+E(\varepsilon_t^M|d^*=M,t,Ed,in,q=1)\right]}_{\text{high offer, accept}}\\
&\quad\quad+\underbrace{(1-\pi(t,Ed))p_S(t,Ed,q=0)\left[EV(t+1,Ed+1,in)+E(\varepsilon_t^H|d^*=S,t,Ed,in,q=0)\right]}_{\text{low offer, school}}\\
&\quad\quad+\underbrace{\pi(t,Ed)p_S(t,Ed,q=1)\left[EV(t+1,Ed+1,in)+E(\varepsilon_t^H|d^*=S,t,Ed,in,q=1)\right]}_{\text{high offer, school}}\\
&\quad\quad+\underbrace{(1-\pi(t,Ed))p_H(t,Ed,q=0)\left[EV(t+1,Ed,out)+E(\varepsilon_t^H|d^*=H,t,Ed,in,q=0)\right]}_{\text{low offer, home}}\\
&\quad\quad+\underbrace{\pi(t,Ed)p_H(t,Ed,q=0)\left[EV(t+1,Ed,out)+E(\varepsilon_t^H|d^*=H,t,Ed,in,q=1)\right]}_{\text{low offer, home}} \qquad (36)
\end{aligned}
$$

where $p_H(t, Ed, q = 0) = 1 - p_M(t, Ed, q = 0) - p_S(t, Ed, q = 0)$. We can rearrange to find the remaining $\pi(t, Ed)$ in states when daughters are still in school.

C.2 Case 2: $\pi(\bar{\omega}_t, N) > 0$, $K = 2$

We next show how the inclusion of instruments which affect preferences but not beliefs can identify beliefs in models where marriage offers may not be received every period.

Let z be the instrument vector which affects the utility associated with different paths taken through the model: $u(t, Ed, q, z') \neq u(t, Ed, q, z''), \quad \forall z' \neq z''$. We require that these instruments are included in both the ex-post and ex-ante experiments. In this case, the ex-post experiment can identify $u(t, Ed, q, z), \forall z \in Z$ while in the ex-ante experiment we will observe: $p_d(t, Ed, q, z), \forall z \in Z$. Following the same process as in Step 1 above, we can thus combine these objects to identify expected value functions conditional on each level of the instrument, $EV(t, Ed, ., z)$, and the expected value of the preference shocks conditional on optimal actions, $E(\varepsilon_t^d | d^*, t, Ed, z, q, z)$.

Take the model with two groom types but where an offer is not guaranteed, i.e. where $\pi_t^0(.)+\pi_t^1(.) \leq 1$. Dropping dependence on schooling for ease of notation, we have:

$$\begin{aligned} EV(t, z) = &\underbrace{\pi_t^0 p_M(t, q=0, z) \left[u(t, q=0, z) + E(\varepsilon_t^M | d_t^* = M, t, q=0, z)\right]}_{\text{low offer, accept}} \\ &+ \underbrace{\pi_t^1 p_M(t, q=1, z) \left[u(t, q=1, z) + E(\varepsilon_t^M | d_t^* = M, t, q=1, z)\right]}_{\text{high offer, accept}} \\ &+ \underbrace{\pi_t^0 (1 - p_M(t, q=0, z)) \left[EV(t+1, z) + E(\varepsilon_t^H | d_t^* = H, t, q=0, z)\right]}_{\text{low offer, reject}} \\ &+ \underbrace{\pi_t^1 (1 - p_M(t, q=1, z)) \left[EV(t+1, z) + E(\varepsilon_t^H | d_t^* = H, t, q=1, z)\right]}_{\text{high offer, reject}} \\ &+ \underbrace{\left(1 - \pi_t^0 - \pi_t^1\right) \left[EV(t+1, z)\right]}_{\text{no offer}} \end{aligned} \tag{37}$$

Stacking over two distinct $z' \neq z''$, we get:

$$\begin{bmatrix} EV(t, z') - EV(t+1, z') \\ EV(t, z'') - EV(t+1, z'') \end{bmatrix} = \begin{bmatrix} a(z') & b(z') \\ a(z'') & b(z'') \end{bmatrix} \begin{bmatrix} \pi_t^0 \\ \pi_t^1 \end{bmatrix}$$

where:

$$
\begin{aligned}
a(z) \equiv \; & p_M(t, q=0, z)\left[u(t, q=0, z) + E(\varepsilon_t^M | d_t^* = M, t, q=0, z)\right] \\
& + (1 - p_M(t, q=0, z))\left[EV(t+1, z) + E(\varepsilon_t^H | d_t^* = H, t, q=0, z)\right] \\
& - EV(t+1, z) \\
b(z) \equiv \; & p_M(t, q=1, z)\left[u(t, q=1, z) + E(\varepsilon_t^M | d_t^* = M, t, q=1, z)\right] \\
& + (1 - p_M(t, q=1, z))\left[EV(t+1, z) + E(\varepsilon_t^H | d_t^* = H, t, q=1, z)\right] \\
& - EV(t+1, z)
\end{aligned}
$$

Thus, we can invert and recover π_t^q whenever the instrument shifts utility profiles.

C.3 Case 3: $K > 2$

Very similarly to in case 2, when there are more than two groom types the inclusion of preference-shifting instruments is needed to identify the model. As in case 2, we can identify utility functions and expected value functions conditional on each value of the instrument z. Taking the example as three groom types as an illustration, then, the recursive relationship between expected value functions becomes:

$$\begin{aligned}
EV(t,z) = &\underbrace{(1-\pi_t^1-\pi_t^2)p_M(t,q=0,z)\left[u(t,q=0,z)+E(\varepsilon_t^M|d_t^*=M,t,q=0,z)\right]}_{\text{low offer, accept}} \\
&+\underbrace{\pi_t^1 p_M(t,q=1,z)\left[u(t,q=1,z)+E(\varepsilon_t^M|d_t^*=M,t,q=1,z)\right]}_{\text{medium offer, accept}} \\
&+\underbrace{\pi_t^2 p_M(t,q=2,z)\left[u(t,q=2,z)+E(\varepsilon_t^M|d_t^*=M,t,q=2,z)\right]}_{\text{high offer, accept}} \\
&+\underbrace{(1-\pi_t^1-\pi_t^2)(1-p_M(t,q=0,z))\left[EV(t+1,z)+E(\varepsilon_t^H|d_t^*=H,t,q=0,z)\right]}_{\text{low offer, reject}} \\
&+\underbrace{\pi_t^1(1-p_M(t,q=1,z))\left[EV(t+1,z)+E(\varepsilon_t^H|d_t^*=H,t,q=1,z)\right]}_{\text{medium offer, reject}} \\
&+\underbrace{\pi_t^2(1-p_M(t,q=2,z))\left[EV(t+1,z)+E(\varepsilon_t^H|d_t^*=H,t,q=2,z)\right]}_{\text{high offer, reject}}
\end{aligned} \tag{38}$$

Stacking over two distinct $z' \neq z''$, we get:

$$\begin{bmatrix} EV(t,z')-c(z') \\ EV(t,z'')-c(z'') \end{bmatrix} = \begin{bmatrix} d(z') & e(z') \\ d(z'') & e(z'') \end{bmatrix} \begin{bmatrix} \pi_t^1 \\ \pi_t^2 \end{bmatrix}$$

where:

$$
\begin{aligned}
c(z) \equiv \;& p_M(t,q=0,z)\left[u(t,q=0,z)+E(\varepsilon_t^M|d_t^*=M,t,q=0,z)\right] \\
&+(1-p_M(t,q=0,z))\left[EV(t+1,z)+E(\varepsilon_t^H|d_t^*=H,t,q=0,z)\right] \\
d(z) \equiv \;& -p_M(t,q=0,z)\left[u(t,q=0,z)+E(\varepsilon_t^M|d_t^*=M,t,q=0,z)\right] \\
&+\pi_t^1 p_M(t,q=1,z)\left[u(t,q=1,z)+E(\varepsilon_t^M|d_t^*=M,t,q=1,z)\right] \\
&-(1-p_M(t,q=0,z))\left[EV(t+1,z)+E(\varepsilon_t^H|d_t^*=H,t,q=0,z)\right] \\
&+(1-p_M(t,q=1,z))\left[EV(t+1,z)+E(\varepsilon_t^H|d_t^*=H,t,q=1,z)\right] \\
e(z) \equiv \;& -p_M(t,q=0,z)\left[u(t,q=0,z)+E(\varepsilon_t^M|d_t^*=M,t,q=0,z)\right] \\
&+\pi_t^1 p_M(t,q=2,z)\left[u(t,q=2,z)+E(\varepsilon_t^M|d_t^*=M,t,q=2,z)\right] \\
&-(1-p_M(t,q=0,z))\left[EV(t+1,z)+E(\varepsilon_t^H|d_t^*=H,t,q=0,z)\right] \\
&+(1-p_M(t,q=2,z))\left[EV(t+1,z)+E(\varepsilon_t^H|d_t^*=H,t,q=2,z)\right]
\end{aligned}
$$

Again, so long as z is relevant for utility, we can invert to recover the vector of πs. The proof extends analogously for $K > 3$, requiring an increased support of the instruments.

D Heterogeneity by Observed Characteristics

We look at heterogeneity in the reduced form patterns of responses to the choice experiments to guide our structural specification for two reasons. First, our structural results are identified from patterns that are evident in the reduced form; Testing a null hypothesis of no heterogeneity in the reduced form is therefore equivalent to testing a null of no heterogeneity in the full structural model. Second, machine-learning methods exist that are effective at finding the most relevant predictors of heterogeneity in reduced form models when heterogeneity potentially exists along many dimensions. We thus make use of these methods to guide our search for important dimensions of heterogeneity, which we can then incorporate into the structural estimation.

To motivate what dimensions of observable respondent heterogeneity to include in our structural results, we interact a set of eighteen demographic characteristics with vignette characteristics given in Table 1. This is a high-dimensional problem as these demographic variables must be interacted with all of the characteristics described in the vignettes. To prevent over-fitting, we employ a Lasso model to assess the most important predictors of heterogeneity. To this end, we first start by specifying linear probability models of respondent choice in the ex-post and the ex-ante experiments. We use a linear probability model and introduce interactions between the scenario characteristics and the vector of observed characteristics of respondent i, Z_i.:

$$Y_{ir} = \delta H_{ir} + \alpha H_{ir} Z_i + \zeta_{ir} \tag{39}$$

In the ex-post experiment, $Y_{ir} = 1$ if a respondent chooses the first option and $H_{ir} = H_{ir1} - H_{ir2}$ with H_{irj} giving the characteristics of option $j = \{1, 2\}$ for respondent i in round r. In the ex-ante experiment, $Y_{ir} = 1$ if a respondent chooses marriage and H_{ir} gives the characteristics described in the vignette.

Lasso minimizes the mean-squared error of the prediction subject to a penalty on the absolute size of the estimated coefficients. We impose the inclusion of the scenario characteristics themselves, H_{ir} and only reduce model complexity in the interactions with observed demographic heterogeneity. Thus, we only penalize coefficients associated with the interaction terms $H_{ir}Z_i$. Following the notation of Ahrens (2019), the estimator is:[36]

$$\left[\hat{\delta}_{Lasso}(\lambda), \hat{\alpha}_{Lasso}(\lambda)\right] = \arg\min_{\delta,\alpha} \frac{1}{NR} \sum (Y_{ir} - \delta H_{ir} - \alpha H_{ir} * Z_i)^2 + \frac{\lambda}{NR} \sum_k \psi_k |\alpha_k| \tag{40}$$

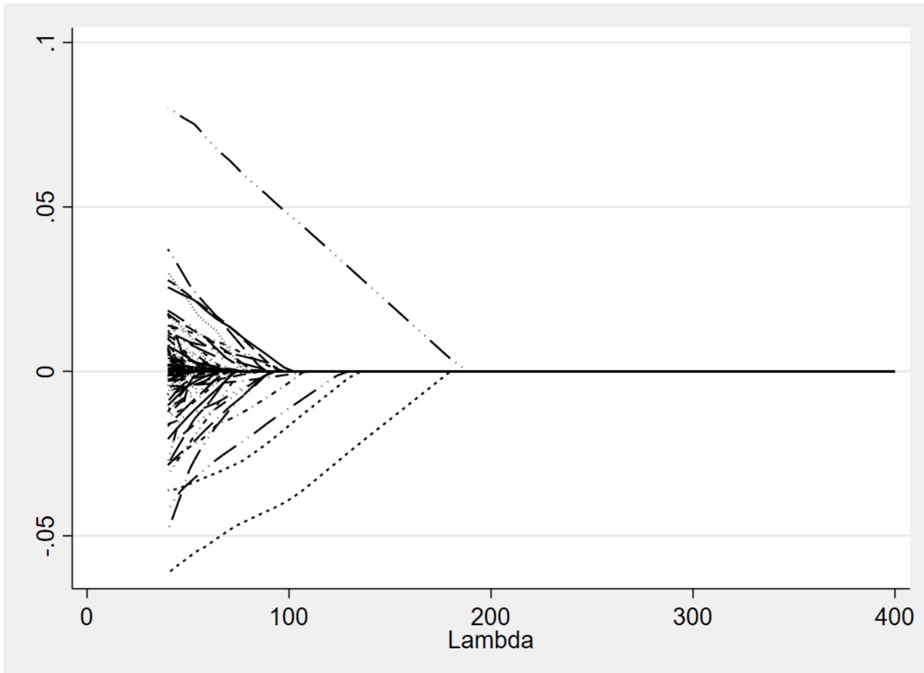
where NR are the number of observations and ψ_k standardize the magnitude of the coefficients.[37] λ is a tuning parameter that controls the degree of penalisation. We estimate coefficients under a range of values for λ and consider the "optimal" lambda as dictated by the Extended Bayesian Information Criterion (EBIC) and Rigorous Lasso methods to determine which dimensions of heterogeneity should be included.

Figure D.1 plots $\hat{\alpha}_{Lasso}(\lambda)$ with the the penalty parameter λ. As we increase the severity of the penalization, more coefficients are estimated to be zero. In both the ex-post and ex-ante experiments, the

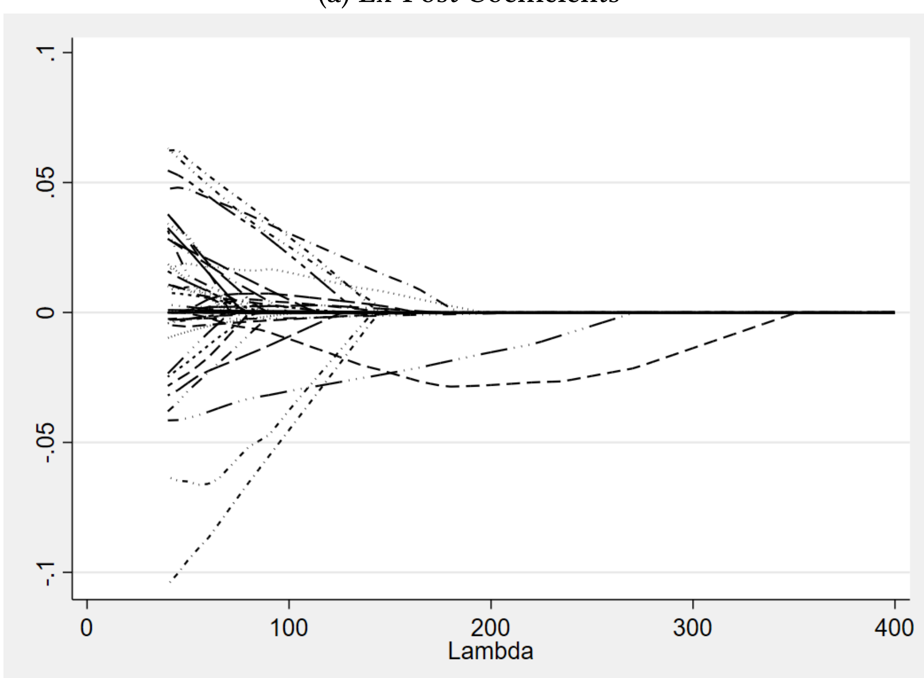
[36] Ahrens, A., C. B. Hansen, and M. Schaffer (2019). LASSOPACK: Stata module for lasso, square-root lasso, elastic net, ridge, adaptive lasso estimation and cross-validation.

[37] In particular, $\psi_k = [\sum_{ir}(\{H_{ir} * Z_i\}_k)^2]^{1/2}$ where $\{H_{ir} * Z_i\}_k$ is the kth component of $H_{ir} * Z_i$

Figure D.1: $\hat{\alpha}_{lasso}(\lambda)$ with Variation in λ



(a) Ex-Post Coefficients



(b) Ex-Ante Coefficients

EBIC and Rigorous Lasso approaches agree that no interaction terms should be included and thus that there is no heterogeneity in response patterns by observed characteristics. In the ex-post experiment, both the EBIC and Rigorous Lasso approaches agree that the optimal λ is greater than 189. Specifically, the EBIC is maximized for any $\lambda > 189$ while the rigorous method suggests the optimal λ is 315. In the ex-ante experiment, the EBIC is maximized for models where $\lambda > 351$, i.e. models where observed characteristics play no role.

E Summaries of Focus Group Discussions

Click here to view the translated summaries of the three focus groups carried out with caregivers of adolescent girls as part of formative research.