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Investigating the Structure of Son Bias in Armenia With Novel Measures of Individual Preferences

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Abstract

Sex ratios at birth favoring boys are being documented in a growing number of countries, a pattern indicating that families selectively abort females. Son bias also explains why, in many countries, girls have more siblings and are born at relatively earlier parities compared with their brothers. In this study, we develop novel methods for measuring son bias using both questionnaire items and implicit association tests, and we collect data on fertility preferences and outcomes from 2,700 participants in Armenia. We document highly skewed sex ratios, suggesting that selective abortions of females are widespread among parents in our sample. We also provide evidence that sex-selective abortions are underreported, which highlights the problem of social desirability bias. We validate our methods and demonstrate that conducting implicit association tests can be a successful strategy for measuring the relative preference for sons and daughters when social desirability is a concern. We investigate the structure of son-biased fertility preferences within households, across families, and between regions in Armenia, using measures of son bias at the level of the individual decision-maker. We find that men are, on average, considerably more son-biased than women. We also show that regional differences in son bias exist and that they appear unrelated to the socioeconomic composition of the population. Finally, we estimate the degree of spousal correlation in son bias and discuss whether husbands are reliably more son-biased than their wives.

Keywords

Son preference; Sex-selective abortion; Fertility choice; Implicit association test; Armenia

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Introduction

The most recent population census in Armenia counts 387,501 children below age 9. Among them, 206,994 are boys, but only 180,507 are girls. These numbers imply a sex ratio of more than 114 boys for every 100 girls—a striking deviation from the natural sex ratio at birth of about 105 boys per 100 girls.[1] Skewed sex ratios have also been documented in Albania, Azerbaijan, China, Georgia, India, Korea, Montenegro, Pakistan, Tunisia, and Vietnam (Chao et al. 2019; United Nations 2019).

Little is known, however, about the preferences that give rise to elevated sex ratios at birth. Many studies have focused exclusively on fertility outcomes, which provide only limited information about the underlying fertility preferences. Although fertility outcomes can reveal son bias at the group level, they are a very imprecise measure of fertility preferences at the household level and cannot be used to distinguish between the relative preferences of mothers and fathers within households.[2] Studies that do attempt to measure son-biased fertility preferences at the level of the individual often rely exclusively on survey data, which are likely compromised by social desirability bias.

Social desirability bias refers to individuals' tendency to answer questions in ways that will be viewed favorably by others, and social desirability constitutes one of the most important sources of bias affecting responses in survey-based research studies. Strong social norms shape whether parents are willing to reveal son-biased fertility preferences openly, and responses to explicit questions about the preferred gender of children will therefore likely be biased. In the context of Armenia, various non-governmental organizations (NGOs) have recently launched information campaigns targeted toward reducing son bias in prospective parents, and the government has passed legislation to curb sex-selective abortions (International Center for Human Development 2016; Sexuality Policy Watch 2016). As a consequence, parents in Armenia may have become less willing to talk openly about abortions and son-biased fertility preferences (Fenton et al. 2001; Jilozian and Agadjanian 2016). This complicates the study of son bias because it is unclear whether differences in stated fertility preferences across individuals or groups of individuals should be interpreted as stemming from differences in the degree of son bias, or whether they simply reflect differences in the severity of social desirability bias.

For this study, we designed novel implicit association tests and administered them to a large sample of 2,700 participants in their homes between May 2017 and March 2019. Our implicit association tests avoid asking participants directly about fertility preferences. Instead, we infer son bias from reaction times in categorization tasks involving drawings

[1]The numbers reported here are based on the 2011 population census. A new population census is currently underway, but the data were not publicly available at the time of writing. More recent data from Armenia's Civil Status Register reported 124,343 live births of boys and 111,358 live births of girls over the period 2014–2019, suggesting that the sex ratio at birth currently stands at around 112 boys for every 100 girls—a moderate reduction from earlier levels but still much higher than the natural sex ratio at birth (Statistical Committee of the Republic of Armenia 2020).

[2]Similarly, birth records alone cannot distinguish between the role of parental demand for sex selection and the supply of medical ultrasound, a necessary precondition for sex-selective abortions. This problem has been recognized, for example, by researchers studying whether the surge in the sex ratio at birth that has been observed in the Caucasus following the dissolution of the Soviet Union is best understood in terms of parents' changing fertility preferences or the increased availability of ultrasonography (Duthé et al. 2012; Hohmann et al. 2014).

of families with sons only, drawings of families with daughters only, and value-laden words. We also build on recent work by Jayachandran (2017) to complement our implicit association tests with a measure of explicit son bias based on survey questions, which overcomes some important biases of similar measures that have been used in the literature. In this article, we evaluate the validity of these measures, and we use our data to generate important insights about the structure of son bias within and across households in Armenia.

Our paper contributes to the literature on measuring fertility preferences and to the literature on distorted sex ratios. We contribute to the literature on measuring fertility preferences by implementing and validating novel measures of son bias at the level of the individual decision-maker (Bongaarts 1990; Coombs 1974; Fuse 2010; McClelland 1979, 1983; Norling 2018). Because we measure both mothers' and fathers' fertility preferences, we can use our data to study spousal differences in son bias (Dahl and Moretti 2008; Hassan et al. 2019; Lundberg 2005; Robitaille 2013; Robitaille and Chatterjee 2018). Our methodology for measuring implicit son bias also relates to recent work that used implicit association tests in the field to elicit attitudes on sensitive topics (Beaman et al. 2009; Efferson et al. 2015; Lowes et al. 2015; Vogt et al. 2016). Furthermore, our study relates to research on the elevated sex ratio in the Caucasus region by directly measuring the fertility preferences of parents who selectively abort female fetuses (Duthé et al. 2012; Guilmoto 2013, 2015; Meslé et al. 2007; Michael et al. 2013). Finally, by providing measures of preferences, we hope that our study can also be informative for more theoretical approaches that study the interplay of preferences with technology diffusion and fertility decline (Kashyap and Villavicencio 2016).

Prevalence and Underreporting of Sex-Selective Abortions

A straightforward way to study son bias and sex selection in Armenia is to ask parents directly about sex-selective abortions or their relative preference for sons over daughters. In our questionnaire, we included a module that asked female participants about their reproductive histories, including miscarriages and abortions at different gestational ages and whether the sex of the fetus was known at the time of the abortion. Relying exclusively on self-reports, however, increases the risk of drawing wrong conclusions from data that suffer from social desirability bias. This problem is generally well recognized, but overcoming social desirability bias has remained a challenge. The standard approach to dealing with social desirability is to provide anonymity and privacy to the study participants so that their responses will be less affected by reputation concerns.

To test the feasibility of this approach, we adopted a research protocol that emphasized the high degree of privacy that we were able to provide for our participants.[3] We physically separated the household members for the purpose of data collection by interviewing them

[3]High degrees of privacy are standard in research studies that can be conducted in the lab. Data collection in the field typically involves compromises that result in lower degrees of privacy. For example, participants in the Demographic and Health Surveys and the Multiple Indicator Cluster Survey—the two most prominent surveys that collect data about parental gender preferences—are interviewed in a face-to-face setting, and responses to sensitive questionnaire items must be communicated to the facilitators who record them.

in different rooms of their home so that there was no opportunity for family members to influence each other's responses.[4]

To make the physical separation salient, we ensured that husbands and wives were interviewed at the same time by different facilitators. The most sensitive questions, including any question about abortions, were asked in a computerized self-administered questionnaire that allowed our participants to record their answers in a completely private setting. The facilitators were instructed to leave the room while the participants answered these questions, and the responses were not accessible to the facilitators after the participants had completed the self-administered questionnaire. Finally, the data collection was overseen by an independent monitoring team, the Women's Resource Center of Armenia, which ensured strict adherence to the privacy protocol.

We collected data in three regions of Armenia: the capital region of Yerevan, as well as Gegharkunik and Syunik, the regions with the highest and the lowest sex ratio (respectively) among children in the 2011 census.[5] Within each region, we randomly sampled married couples with at least one child under age 16 living at home, according to a two-stage sampling frame described in detail in section A.1 of the online appendix. Whenever possible, we collected data from the husband, the wife, and the husband's mother.[6] We now present evidence for sex selection in our data and show that, despite our extensive efforts to minimize the risk of social desirability bias, we have clear indications that sex-selective abortions are underreported. This result underscores the problem of social desirability and motivates the use of implicit association tests to complement the survey data.

Evidence for Sex Selection

The sex ratio among children in our sample is 112.7 boys for every 100 girls. This ratio is consistent with population-level sex ratios in Armenia computed from birth registry data (Guilmoto 2013).[7] Whereas preferentially choosing to stop having children after the birth of a son can affect the sex ratio within families, an elevated sex ratio *across families* can result only from parents actively engaging in sex selection. In the context of Armenia, this typically takes the form of sex-selective abortions.[8]

Figure 1 plots sex ratios among first-, second-, and third-born children in our sample.[9] These disaggregated results reveal a striking pattern. Whereas the sex ratios among first- and second-born children are statistically indistinguishable from the natural ratio of 105 boys

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[4]In households with not enough rooms to allow the assignment of each household member to a different room, our facilitators separated the participants with mobile room dividers.

[5]Specifically, we focus on the sex ratio among children below age 16. The ratio of boys to girls is 1.08 in Syunik, 1.22 in Gegharkunik, and 1.12 in Yerevan.

[6]Young couples in Armenia often share their household with the husband's parents. In conversations with our implementation partners, we learned that the husband's mother has a reputation for exerting influence on young couples' fertility decisions. This information prompted us to collect data not only from the focal couple but also from the husband's mother. The focus of this article, however, is not on the role of mothers-in-law in shaping fertility outcomes, and we leave this question for future research.

[7]See section A.1 of the online appendix for a more detailed discussion of the representativeness of our sample.

[8]The upcoming section Validating Our Measures of Implicit and Explicit Son Bias discusses evidence of son-biased fertility stopping behavior in our data.

[9]We restrict our attention to the sex ratios for first-, second-, and third-borns because only 6% of all sampled households have four or more children. See Figure A.1 in the online appendix for the sex ratios among children born fourth or later. Importantly, to compute the sex ratios in Figure 1, we use data from all households, including households with four or more children.

for every 100 girls, the sex ratio among third-born children is significantly higher, at about 177 boys per 100 girls. This finding is consistent with previous research documenting an elevated sex ratio among third-born children in Armenia and attests to a widespread practice of sex selection in favor of boys (Guilmoto 2013; Meslé et al. 2007).

We further disaggregate the sex ratio by focusing on children born to parents who still lacked a son or lacked a daughter.[10] Interestingly, we find that the spike in the sex ratio among third-born children is particularly pronounced for families in which the first two children are girls. In these families, the sex ratio among third-born children reaches a staggering 330 boys for every 100 girls. When we condition on families without daughters, the sex ratio of third-borns remains indistinguishable from the natural ratio, suggesting that it is indeed the absence of a son rather than the desire for a more balanced gender composition that induces parents in Armenia to engage in sex selection.[11]

Evidence for Underreporting of Sex-Selective Abortions

To test for underreporting, we compute the number of missing girls in our sample and compare it against the number of reported abortions. We followed a stepwise procedure when recording abortion histories. We began by asking the participants whether they ever had an abortion.[12] Then, if this question was answered affirmatively, we asked the participants about abortions after the eighth week of pregnancy.[13] If the participant reported having had abortions after the eighth week of pregnancy, we asked about the timing of these abortions. In particular, for each abortion, we asked whether it had taken place before the birth of the first child, after the birth of the first but before the birth of the second child, and so on. Finally, we asked whether the participant knew whether she was expecting a boy or a girl.

Abortion rates are high in Armenia, reflecting the country's history of reliance on induced abortions as a method of fertility regulation (David 1992; Remennick 1991). Consistently, about one-third of all mothers in our sample reported having had at least one abortion, and many reported having had multiple abortions. Among those who reported any abortions, about two-thirds reported at least one abortion after the eighth week of pregnancy, and about one-fourth reported multiple such abortions between two births. Although there may be little stigma associated with having had abortions to limit the number of children, it is unclear whether participants are willing to reveal their selective abortion of female fetuses.

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[10]See Guilmoto (2017) for a recent study that follows a similar strategy to study son-biased fertility outcomes in Georgia, Indonesia, and Vietnam.

[11]In section A.2 of the online appendix, we show that we obtain qualitatively similar results if we conduct this analysis for each region separately (Figure A.2), and we further disaggregate the sex ratio among third-born children by plotting it separately for all possible gender compositions among the first two children (Figure A.3).

[12]Answer categories are *yes*, *no*, and *prefer not to answer*. Only 3.57% of all respondents preferred not to answer.

[13]The sex of a fetus can be reliably ascertained via ultrasound starting from the 12th week of pregnancy (Mazza et al. 2001). .Analysis of fetal DNA found in the mother's blood allows for sex discernment at an earlier moment in the first trimester, but such analyses are not conducted routinely. We want to distinguish potentially sex-selective abortions from all other abortions that were carried out earlier. However, given that abortions beyond the 12th week of pregnancy are illegal in Armenia except for special medical circumstances, we feared that asking respondents about abortions after the 12th week would result in underreporting. Thus, we asked respondents about abortions after the eighth week of pregnancy.

Because the sex ratio is distorted at only higher parities (Figure 1), we separately compute the number of missing girls among first-, second-, and third-born children.[14] To compute the number of missing girls, we count the number of sons in our sample and then derive the expected number of daughters implied by a natural sex ratio of 105 boys for every 100 girls (Sen 1992). The difference between the expected and the actual number of daughters constitutes our estimate of how many girls are missing in our sample. This estimate of the number of missing girls is conservative because it abstracts from the possibility of selective abortions of male fetuses.

Given that our survey asked about the timing of the abortions, we can compare the number of missing girls among first-, second-, and third-born children with the number of reported abortions in the relevant interbirth interval. For example, the sex ratio among second-born children will be affected by sex-selective abortions after the birth of the first child but before the birth of a second child. Similarly, sex-selective abortions after the birth of the second child but before the birth of a third child influence the sex ratio among third-born children. Our focus is on whether there are enough reported abortions in the relevant interbirth interval to account for the missing girls in our sample. More specifically, a telltale sign of underreporting would be the number of reported abortions in our sample falling below the lower bound of the 95% confidence intervals associated with our estimates of missing girls.

Panel a of Figure 2 plots the number of missing girls in our full sample along with the number of self-reported abortions after the eighth week of pregnancy. We estimate that 102 girls are missing among third-born children in our sample. At the same time, our participants reported about 250 abortions that occurred after the birth of the second and before the birth of a third child. Hence, we observe more than enough self-reported abortions to account for the missing girls, and we cannot reject the null hypothesis that there is no underreporting of abortions. This conclusion follows from the fact that the number of reported abortions in general, without conditioning on the sex of the fetus, does not fall below the confidence intervals for missing girls. Following this logic, however, we find unambiguous evidence for underreporting of *sex-selective* abortions. In particular, the number of self-reported abortions for which the mother reported knowing that she was expecting a girl is strictly below the 95% confidence interval for missing girls among third-born children.

In panel b of Figure 2, we repeat this exercise on the restricted sample, excluding self-reported abortions and births that occurred after a family already had a son. Two findings stand out. First, almost all missing girls can be linked to parents who did not yet have a son. This finding is consistent with Figure 1 and follows from the fact that the total number of missing girls among third-born children is almost as high in the restricted sample (panel a, Figure 2) as it is in the full sample (panel b, Figure 2). Second, not only is the number of abortions for which the mother reported knowing that she was expecting a girl again too low to account for the number of missing girls among third-born children, but the overall number of self-reported abortions is itself only slightly higher than the number of missing girls. This finding implies that almost all self-reported abortions that occurred after the birth

[14]Although two children are the most common family size in our sample, about one-third of all sampled households have a third child.

of second children in this sample must have been sex-selective, even though in the majority of cases the respondents claimed that they did not know whether they were expecting a girl or a boy.[15]

To summarize, we find that many participants falsely reported that they did not know the sex of the fetus when deciding whether to end the pregnancy, presumably to conceal the sex-selective nature of the abortion. We take these findings as a stark reminder that even with a research design like ours that guarantees an unusual degree of privacy to the participants, untruthful reporting and social desirability bias remain a serious concern. Our primary objective in this article is to study the structure of son-biased fertility preferences. However, given the documented underreporting of sex-selective abortions, we must recognize the risk that social desirability may also induce participants to understate their degree of son bias when asked about it directly. An important advantage of our research design is that we complement measures of explicit son bias with implicit association tests to deal with the problem of social desirability.

Measuring Son Bias

We pursued two complementary strategies to measure an individual's degree of son bias. First, we developed and implemented implicit association tests that we specifically designed to measure son bias among Armenian participants. We call this our measure of *implicit son bias*. Implicit association tests present participants with visual and auditory stimuli and require the participants to quickly sort these stimuli according to changing categorization schemes, thereby measuring a person's association between mental representations. Implicit association tests have been successfully used to elicit attitudes on sensitive topics such as racism and gender norms, and such tests are credited with overcoming social desirability bias (Asendorpf et al. 2002; Egloff and Schmukle 2002; Greenwald et al. 1998; Greenwald et al. 2009; Kim 2003; Nosek et al. 2005; but see also Karpinski and Hilton 2001; Nosek et al. 2007).[16] Second, we built on Jayachandran's (2017) research to construct a survey-based measure of son bias at the level of the individual, which overcomes important biases characterizing past research. We call this our measure of *explicit son bias*.

Implicit Association Tests

We designed two versions of an implicit association test (IAT) to measure son bias: a Valence IAT and a Stereotype IAT. In both versions, our participants were presented with drawings of two Armenian families and audio recordings of value-laden words. The first family has two sons, and the second family has two daughters. Both families were shown

[15]Similarly, we can estimate the share of sex-selective abortions in the total number of reported abortions across all parities by comparing our estimate of the total number of missing girls to the total number of reported abortions in our sample. Ignoring the possibility of sex-selective abortions in favor of girls, we find that about 20% of all reported abortions that occurred after the eighth week of pregnancy must have been sex-selective in favor of boys. Hence, although sex selection appears to be the motive behind a significant share of abortions in Armenia, this statistic also shows that more abortions were carried out for reasons unrelated to son-biased fertility preferences.

[16]Randomized response represents another well-known strategy for dealing with social desirability in studies about controversial attitudes or behavior. The principal idea of randomized response measures is to allow any individual participant plausible deniability. Randomized response techniques are useful tools to induce truthful responses and to elicit typical preferences at the group level, but they cannot provide reliable measures of individual preferences.

in typical everyday scenes (see section A.3 of the online appendix for examples of the drawings).

In the Valence IAT, each drawing was followed by an audio recording of either a positive word (e.g., joyous, excellent, spectacular) or a negative word (e.g., sad, to fail, yucky). In the Stereotype IAT, we used the same drawings but selected words that pertain to stereotypes that associate sons with flourishing families. In particular, we used words belonging either to the semantic category *flourishing* (e.g., to multiply, to immortalize, descendant) or the semantic category *withering* (e.g., to fade, extinction, infertility).

In both implicit association tests, we asked the participants to quickly sort drawings and words according to changing categorization schemes that grouped the family with sons together with positive (flourishing) words and the family with girls together with negative (withering) words, or vice versa. Our measure of interest is the individual's D score, which is constructed from a participant's relative response time under the two sorting rules (Greenwald et al. 2003). D scores are distributed on the interval [−2, 2], where a positive score indicates an automatic mental association between positive (flourishing) words and sons and between negative (withering) words and daughters.

Figure 3 summarizes the distribution of D scores by subject type and region. As we show more formally later, it is evident that men are more son-biased on average than women. This pattern is found in all regions and holds for both versions of the implicit association test. Households were randomly assigned to take either the Valence IAT or the Stereotype IAT. Because the two versions of the implicit association test produce similar results, we combine the D scores from both versions in most of the analyses here. In the remainder of this article, we refer to the D scores as our measure of implicit son bias. For details about the design of the implicit association tests, the exact protocol for administering the tests, and the algorithm to compute D scores, see section A.3 of the online appendix.

Survey-Based Measures of Son Bias

The typical approach for elicitation of a participant's ideal family composition (as, for example, in the Demographic and Health Surveys) involves asking the participant the following question:

> If you could go back to the time you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?

This question is then followed by a second question:

> How many of these children would you like to be boys, how many would you like to be girls, and for how many would the sex not matter?

This methodology involves a number of risks. Most importantly, responses will suffer from rationalization bias given that parents feel the need to report an ideal family size and gender composition that resembles their actual family (Rosenzweig and Wolpin 1993; Westoff and Ryder 1977). Moreover, forcing respondents to condition their responses to the second question on their response to the first question can introduce additional bias. Consider a person who likes a balanced gender mix but would always choose a family composition with more sons than daughters over a family composition with more daughters than sons. We call such a person *weakly son-biased*. Given the aforementioned sequence of questions, however, weak son bias will be revealed only if the respondent's optimal family size corresponds to an odd number of children. This conditioning bias becomes particularly problematic for comparisons of individuals across regions or socioeconomic backgrounds who will differ in their preferred family sizes.[17]

To overcome these biases, we build on Jayachandran's (2017) research to construct an explicit measure of individual son bias based on three principles. First, we asked each participant to specify the ideal gender composition for the future families of the youngest child in the household. Although respondents should care about the fertility outcomes of the youngest child, these hypothetical families did not exist at the time of the study, and so rationalization cannot affect responses. Second, we explicitly controlled for conditioning on family size by asking respondents to report their ideal gender composition for families of various sizes, which allows us to separate preferences related to family composition from preferences related to family size. To avoid that anchoring confounds our results, we distributed these questions across different parts of the questionnaire, and we randomized the order in which they were presented across participants. Third, we did not simply elicit the ideal sex ratio conditional on families of various sizes; rather, we elicited the entire ideal ordering of sons and daughters.

To summarize the explicit fertility preferences of a given participant in a single statistic, we construct an index that captures the degree to which each participant's preferred family composition is biased toward sons.[18] The index is based on a scoring algorithm that considers whether the participant (1) prefers a first child to be a son, (2) prefers more sons than daughters, or (3) prefers families with exclusively male children. The resulting index can take integer values between 0 and 9. In the remainder of this article, we refer to this index as our measure of explicit son bias. A detailed description of our scoring algorithm and a histogram of the resulting index values are presented in section A.4 of the online appendix.

Validating Our Measures of Implicit and Explicit Son Bias

To validate our novel measures of son bias, we subject them to two tests. First, we ask whether our measures of implicit and explicit son bias are internally consistent at the individual level. Second, we ask whether both measures of son bias are consistent with realized fertility outcomes.[19]

Figure 4 shows the association between our measures of implicit and explicit son bias in a binned scatter plot. We find a positive and highly significant relationship between our

[17]A third weakness of the traditional approach for eliciting ideal family compositions is its inability to isolate preferences over the optimal number of children from preferences over the sex composition of children. For example, parents in many societies are concerned with having at least one male heir. When participants are asked about the ideal family size, it is then unclear whether they value large families per se or whether they see large families as a means to increase the likelihood of having at least one son.

[18]Although Jayachandran (2017) implemented a cross-subject design, we can construct such an index because we asked each participant to specify the ideal gender composition for families of different sizes. We preregistered this index in Efferson et al. (2018).

[19]In section A.5 of the online appendix, we conduct a third validation test in which we correlate our measures of son bias with a variable that approximates the question asked in the Demographic and Health Surveys.

two measures of son bias.[20] In section A.5 of the online appendix, we demonstrate that this association remains positive and significant after we account for the gender of the respondent, the gender composition of the children in the household, and the community in which the respondent resides.

Our measure of explicit son bias directly quantifies the degree of bias in a respondent's stated fertility preferences, and its key advantage is that its interpretation is straightforward. The weakness of any explicit approach to measuring son bias is that one cannot rule out social desirability bias in the responses. Implicit association tests are useful in that they solve the problem of social desirability bias by design. Their weakness is that an interpretation of D scores as measures of son bias hinges on the existence of a link between son-biased fertility preferences and relative response times across different categorization tasks. The positive association between the two measures of son bias documented in Figure 4 reassures us that social desirability bias does not render the index uninformative and that our implicit association tests indeed capture variation across participants that is closely related to their fertility preferences. We interpret the internal consistency of our two measures as evidence that both D scores and index values are useful proxies of latent son bias.

In a second validation exercise, we assess the behavioral relevance of our measures by asking whether higher levels of measured son bias are positively associated with son-biased fertility outcomes. Son-biased parents tend to keep having children until they reach their desired number of sons, and it is well understood that this fertility strategy results in girls having, on average, a greater number of siblings and boys having a higher chance of being the last-born child (Altindag 2016; Basu and De Jong 2010; Clark 2000; Filmer et al. 2009; Yamaguchi 1989). It also increases the expected share of boys in each household.[21] Our data offer clear evidence of son-biased fertility stopping behavior. In 61% of all households in our sample, the youngest child is a son. Moreover, consistent with son-biased fertility stopping behavior, we find that parents whose first child is a girl have, on average, 0.24 more children than parents whose first child is a boy.[22]

We can then ask whether parents who have more boys than girls or parents whose youngest child is a son are also likely to have high levels of measured son bias. Reassuringly, this is indeed the case. The binned scatter plots in Figure 5 show the individual-level association of measured son bias and observed fertility outcomes. We find that participants with high levels of implicit and explicit son bias also have comparatively more son-biased fertility

[20]The raw correlation between our measures of implicit and explicit son bias is .128.

[21]Although son-biased fertility stopping behavior cannot affect the aggregate sex ratio, it does increase the expected share of boys within any given household. Consider, for example, a household that continues to have children until a son is born and then stops. If the first child is a son, the share of boys in this household will be 1. This outcome occurs with probability .5 if we assume, for simplicity, that the natural sex ratio at birth is exactly 1. Similarly, for the share of boys in this household to be .5, the first child needs to be a girl, and the second child needs to be a boy, which occurs with probability $.5^2$, and so on. The expected share of boys in this household is therefore given by $\sum_{x=1}^{\infty} .5^x \frac{1}{x} = ln(2) \approx .693$.

[22]Some of these households may not yet have reached their desired family size. If we restrict our attention to households in which both parents agree that they do not want any more children, the share of households where the last child is a boy increases to 67%, and the difference in average family sizes increases to 0.36 children.

outcomes.[23] These results clearly show that both our measures of son bias are systematically related to fertility outcomes.

We also find a significant association between measured son bias and the gender of a participant's first child, which means that interpreting the individual-level correlations shown in Figure 5 requires some caution. Interestingly, a first-born daughter is associated with a reduction in implicit and explicit son bias by 0.12 and 0.28 standard deviations, respectively. Because sex-selective abortions at first parity are rare, we interpret this statistical association as a causal effect, suggesting that the experience of having daughters makes parents less son-biased (Blau et al. 2020; Dahl and Moretti 2008; Lundberg 2005).[24] Hence, the correlations in Figure 5 are probably at least partly driven by a causal effect of fertility outcomes on measured son bias.

The obvious way to conclusively demonstrate that our measures of son bias predict fertility outcomes would involve collecting data from prospective parents and then recording their fertility outcomes several years later. We collected data from parents who already had children and therefore cannot offer this empirical test. Instead, we address the problem of reverse causality by exploiting regional variation in son bias. The principal idea is that we can study the association of son bias and fertility outcomes at the community level while accounting for the effect of fertility outcomes on measured son bias at the household level.[25]

We perform our analysis in two steps. First, we compute measures of son bias at the community level by regressing D scores and index values on community fixed effects while accounting for a full set of subject-type and family-composition fixed effects. Second, we use census data provided by the Statistical Committee of the Republic of Armenia to correlate the estimated community fixed effects with aggregate sex ratios in the 45 communities included in our study. Controlling for subject type in the first step is important because male participants in our sample have significantly higher D scores than female participants, and we therefore need to account for the fact that the share of households in which we were able to interview husbands differs across communities.[26] We include family-composition fixed effects to absorb any effect of fertility outcomes on measured son bias at the household level.

[23]If we use D scores and index values in a horse-race regression, we find that both measures of son bias significantly predict fertility outcomes. The effect size is larger, however, for our index of explicit son bias. A possible explanation for the differential effect size is that fertility outcomes affect our measure of explicit son bias. If participants consider the gender of their youngest child when deciding on the optimal family composition of this child's future family, for example, the correlation between the index and the gender of the youngest child may be inflated.

[24]We estimate the difference in son bias between parents whose first child is a son and parents whose first child is a daughter by regressing our standardized measures of son bias on subject-type fixed effects and a dummy variable indicating whether the first child is a daughter. We also investigate whether the causal effect of having a first-born daughter differs for mothers and fathers, and we find no evidence for heterogeneous effects.

[25]Finding a correlation between son bias and sex ratios measured at the community level requires that at least some of the heterogeneity in son bias is across rather than within communities. As we will document in the section The Structure of Son Bias in Armenia, we find significant variation in son bias across regions. Moreover, geographic differences in sex ratios appear to be quite stable over time. Gegharkunik and Syunik were, respectively, the regions with the highest and the lowest sex ratio among children under 16 in the 2011 census, and the same two regions remain at the extreme ends of the regional variation in the sex ratio at birth today (Statistical Committee of the Republic of Armenia 2020).

[26]See section A.1 of the online appendix for a detailed description of the sampling protocol.

Sex ratios at the community level cannot be affected by son-biased fertility stopping behavior at the household level and therefore reflect the prevalence of sex-selective abortions. Table 1 shows that both our implicit as well as our explicit measures of son bias predict community-level sex ratios constructed from census data. The correlation coefficients are significant at standard significance levels and have the expected sign. Because the number of observations varies considerably across communities, we also report weighted correlation coefficients where the weights correspond to the number of observations in each community. The weighted and unweighted correlations are very similar. We interpret these correlations as evidence that our measures of explicit and our implicit son bias capture behaviorally relevant aspects of son bias, including a respondent's willingness to engage in sex selection in favor of boys.

The Structure of Son Bias in Armenia

Having established the internal and external validity of our measures of son bias, we can now use our data to investigate the structure of son bias in Armenia. We focus on important questions that require measures of son bias at the level of the individual decision-maker and cannot be answered using behavioral measures like sex ratios or parity progression ratios, which can be estimated only at the group level. We first explore the correlates of son bias, with a particular focus on how son bias differs between men and women and across different regions of Armenia. Given the documented gender gap in son bias, we then ask how common it is for husbands to be more son-biased than their wives. This second question is of importance for a policy-maker who considers aiming an intervention at men to target the more son-biased parent in any given household. Our measures of son bias, which are relatively resistant to rationalization and social desirability biases, are well suited to answer these questions.

Gender Differences, Regional Cultures, and Socioeconomic Correlates of Son Bias

Does average son bias differ between men and women? Does it differ across different regions of Armenia? Different socialization processes for boys and girls and entrenched gender norms can instill differences in average son bias between men and women. Similarly, son bias may be rooted in local cultures that differ across regions. In fact, our implementation partners in Armenia often described son bias as a highly regional phenomenon, and census data confirm that sex ratios at birth differ among the three regions in our study. However, differences in sex ratios can also stem from differential access to sex-selection technology, and it is not clear *ex ante* whether significant differences in the degree of son bias exist between participants who live in Gegharkunik, a region with an extremely distorted sex ratio at birth, and participants living in Syunik, where the distortion of the sex ratio is less severe.

Here, we show that regional differences in son bias exist and that they align with geographic variation in the sex ratio at birth. This finding, however, still leaves the question of whether differences in average son bias between Gegharkunik and Syunik really stem from differences in local cultures and norms. Alternatively, regional differences in son bias may simply reflect the socioeconomic composition of the population in these two regions, with residents of Gegharkunik being poorer and less educated, on average, than residents of Syunik. To sort out this question, we control for the independent effects of key socioeconomic variables and study whether son bias in Armenia varies regionally in ways that are not explained by differences in the composition of the population.[27]

Table 2 reports estimation results from ordinary least squares (OLS) regressions that regress measures of son bias on three sets of explanatory variables. The first set consists of a single dummy variable indicating whether the participant is male. The second set consists of two dummy variables indicating whether the participant lives in Gegharkunik or Syunik, the regions with, respectively, the highest and the lowest sex ratios at birth in our sample. The omitted category is the capital region, Yerevan. In the third set, we include variables describing a participant's socioeconomic status. This set includes measures of household income, education level, and age, as well as dummy variables for a participant's profession.[28] Besides reporting the coefficients for each of these regressors, we also report Owen values from a Shapley decomposition of the coefficient of determination into the respective components explained by each set of regressors (Huettner and Sunder 2012; Shorrocks 2013).[29]

Using the D scores from our implicit association test as the dependent variable, we find that male participants are much more son-biased than female participants. Being male increases the D scores by about one-half a standard deviation. Furthermore, participants living in Gegharkunik, the region with the highest sex ratio at birth in our sample, are significantly more son-biased than participants living in Syunik, the region with the lowest sex ratio at birth. This regional gap is not explained by differences in income, education, age, or profession and appears consistent with a local culture of strong son bias in Gegharkunik. However, the regional differences in son bias are small compared with the gender difference, which is about three times as large. Interestingly, none of the socioeconomic variables are significant at standard levels. Perhaps even more strikingly, the Shapley decomposition in column 2 of Table 2 reveals that the gender of the participant alone accounts for almost three-fourths of the explained variation in son bias, regions account for less than 10%, and our entire set of socioeconomic variables accounts for only 16%.

How do the results from our explicit measure of son bias compare with these results from our implicit measure? In columns 3 and 4, we show the same regression but replace the D scores with our index values. Consistent with our previous results, we again find that male participants are significantly more son-biased than female participants, and inhabitants of Gegharkunik are more son-biased than inhabitants of Syunik. The gender gaps in explicit and implicit son bias are of comparable magnitude, but regional differences are more pronounced for our measure of explicit son bias. Socioeconomic variables do play some role in explaining son-biased fertility preferences, with more educated participants and

[27]Because Armenia is very homogeneous ethnically, we ignore differences in fertility behavior across ethnic groups and focus on the composition of the population in terms of socioeconomic characteristics.

[28]See section A.6 of the online appendix for a description of how we construct the education and income variables.

[29]Differences in overall R^2 between the specifications likely reflect differences in the relative amount of noise in the dependent variable. Implicit association tests, for example, are designed to be immune to social desirability bias, but they likely constitute a relatively noisy measure of latent son bias. Differences in R^2 between specifications, however, do not affect the interpretation of the Shapley values, which are unaffected by classical measurement error in the dependent variable.

employees of the government or NGOs being less son-biased and participants with higher household income being more son-biased. However, we again find that socioeconomic variables do not explain much of the variation in son bias, whereas region and gender alone account for almost 80% of the explained variation.[30]

How should we interpret the fact that regional differences appear more pronounced when we study the distribution of our measure of explicit son bias compared with the results we obtain based on our implicit association tests? One interpretation is that explicit fertility preferences, on which we base our construction of the index, are subject to social expectation, whereas D scores are not. As explained in the section Survey-Based Measures of Son Bias, our measure of explicit son bias is constructed based on self-reported gender preferences for the future family of the youngest child in the household. If participants live in an environment where son bias is the norm, they may want to report more son-biased gender preferences either because social desirability induces them to do so or because they believe that having sons will allow their offspring to thrive in a son-biased environment. To understand whether this is a plausible interpretation, we study regional variation in son-biased norms.

Researchers often argue that preferences for male children in patrilineal societies like Armenia stem from the notion that sons ensure the continuation of the family lineage, whereas daughters leave upon marriage to live with the families of their spouses (see, e.g., Murphy et al. 2011). To understand whether the importance of patrilineal norms differs between the three regions in our sample, we asked participants to report the extent to which they agreed with the Armenian adage, "The son is ours, the daughter belongs to the others." We also asked our participants whether they thought that other parents in Armenia agree or disagree with this adage, which allows us to study the perception of norms (Bicchieri 2005). We randomized the order in which the two questions were presented across participants, and we scored the answers on a five-level Likert item ranging from strongly disagree (=1) to strongly agree (=5). More than one-half (57%) of respondents reported thinking either that other parents in Armenia agree with the adage or that other parents strongly agree. However, only 36% of respondents in our sample actually agreed or strongly agreed themselves.

In columns 5 and 6 of Table 2, we repeat the regression analysis using as the dependent variable the degree of personal agreement with the Armenian adage. We find that residents of Gegharkunik indeed agree more strongly with the adage compared with residents of Syunik. Socioeconomic variables also play a role with wealthier, more educated, and younger people agreeing less. How participants answer questions about their preferred family composition may also depend on the perceived importance of son-biased norms. In columns 7 and 8, we present results for the second question asking participants whether they thought that other parents in Armenia generally agree with the adage. It turns out that whether a participant thinks that other parents agree with the adage depends almost

[30]Finding little correlation between son bias and socioeconomic variables contrasts with studies in other countries that found significant associations between the sex ratio at birth and parental education, profession, or wealth (Bhat and Zavier 2007; Chun et al. 2009; Guilmoto and Ren 2011; Siddhanta et al. 2003). However, socioeconomic variables can predict the sex ratio at birth even in contexts where son bias does not vary across socioeconomic groups. Wealthier parents may be more likely to have sons, for example, if insufficient financial means make it harder to engage in sex selection.

entirely on the region that the participant lives in with participants in Syunik thinking much less frequently that other parents would agree with the adage relative to participants in Gegharkunik and in Yerevan. To the extent that responses to our survey questions are affected by social expectations, these differences in perceived norms suggest that our measure of explicit son bias likely overstates regional differences. To summarize, using D scores as our preferred measure of son bias, we find that the greatest differences in son bias occur between male and female participants. Regional differences in son bias do exist, but they are small compared with the gender difference. Socioeconomic variables, on the other hand, cannot explain differences in son bias.

Spousal Differences in Son Bias

In this last section, we discuss the policy relevance of the documented gender gap in son bias. We consider the case of a policy-maker who has access to an intervention that is believed to greatly reduce or eliminate son bias among individuals exposed to the intervention.[31] The policy-maker has limited resources, and knowing that son bias varies across individuals, must decide what segment of the population to target in an effort to maximize the impact of the intervention. Any targeting strategy that exposes individuals with little or no son bias to the intervention is inefficient. Unfortunately, direct measures of fertility preferences are typically not available, and the fact that son bias appears largely unrelated to socioeconomic variables limits the scope for identifying relatively more son-biased households. The significant gender gap in son bias documented in the previous section, however, raises the prospect that by targeting men, the intervention can be focused on the more son-biased parent in any given household. The strategy of targeting the more son-biased parent in any given household promises to be particularly effective if the intervention is expected to produce local spillovers inside the household (Efferson et al. 2020).[32]

To assess the extent to which a policy-maker can rely on gender as a proxy for relative son bias, we would like to know the probability that a randomly sampled husband is more son-biased than his wife. This probability depends on the difference in average son bias between men and women, the variation in son bias among men and women, and the degree to which the fertility preferences of husbands and wives are correlated. To compute this probability, we leverage the fact that whenever possible, we collected data from both spouses.[33] We begin our analysis with the rough-and-ready approach of simply counting how often the level of measured son bias for a male participant exceeds that of his wife. Interestingly, despite the large gender difference in average son bias documented in the

[31]For example, the intervention could be an information campaign, a focus group workshop, or a conditional cash transfer. Alternatively, the policy-maker may try to affect the sex ratio at birth through a supply-side intervention that limits access to sex-selection technology. Our study, however, focuses on the demand for sons, and we therefore consider the case of a policy-maker committed to reducing son bias.

[32]This conclusion rests on the assumption that the intervention is equally effective for all son-biased individuals. If, in contrast, the effects of the intervention are heterogeneous, the policy maker must manage this additional source of complexity, but a reliable measure of or proxy for individual preferences remains extremely useful. Whether the policy-maker can lower the sex ratio at birth by targeting men also depends on the question of whether fathers or mothers exert more control over decisions regarding family planning. In section A.7 of the online appendix, we show that fertility outcomes at the household level are correlated with measured son bias of both mothers and fathers, suggesting that the fertility preferences of both parents matter.

[33]For the analyses in this section, we drop the data from husbands' mothers. We also drop all data from households in which we were able to collect data from only one of the spouses.

previous section, *D* scores of husbands—our measure of implicit son bias—exceed those of their wives only 69 of 100 times. Our measure of explicit son bias finds husbands to be more son-biased than their wives only 54 of 100 times. One possible interpretation of this result is that heterogeneity in son bias among individuals of a given sex overshadows the documented difference in average son bias between men and women. Unless the degree of spousal correlation is very high, this would imply that husbands are, in many cases, actually less son-biased than their wives.

Another interpretation, however, is that unlike precise measures such as height or weight, most psychological traits such as tastes or attitudes are measured with some degree of noise. For example, despite the obvious virtues of implicit association tests, it is a challenge for implicit measures to achieve high levels of test-retest reliability (Cunningham et al. 2001; Nosek et al. 2007). Similarly, not all the variation in our index measure will reflect true variation in latent son bias. Random noise does not affect our estimates of the gender gap in son bias, but imperfect reliability biases the degree of spousal correlation in measured son bias toward 0 and thus implies that a simple comparison of measured son bias among husbands and wives understates the reliability of gender as a predictor of relative son bias.

A first step in dealing with noise is to combine *D* scores and index values in a composite measure of son bias that has higher reliability. We construct this composite measure of son bias by taking the average of an individual's *D* score and index value after having normalized both measures to have unit variance. This step increases the share of households in which measured son bias is larger for the husband compared with his wife to 72%. Using the composite measure of son bias, the degree of spousal correlation in son bias is .17 after we condition on the gender composition of children in the household. However, if there is noise in our *D* scores and index values, then this composite measure will nevertheless fall short of being a perfectly reliable measure of latent son bias. As a consequence, we still underestimate the degree to which latent son bias is correlated among spouses, and we will overestimate the share of households in which the wife is more son-biased than her husband. In a second step, we therefore deal with noise in our composite measure of son bias more formally.

Let us postulate that the relationship between measured son bias and latent son bias can be written as follows:

$$measuredBias_i = latentBias_i + \varepsilon_i,$$

where ε_i is an independent error term that captures noise. We assume that latent son bias of the husband and wife is jointly normally distributed with a mean of $\begin{pmatrix} \mu_{husband} \\ \mu_{wife} \end{pmatrix}$ and a covariance matrix of $\begin{pmatrix} \sigma^2_{husband} & \sigma \\ \sigma & \sigma^2_{wife} \end{pmatrix}$. The probability that a husband's degree of latent son bias exceeds that of his wife is then given by

$$F\left(\frac{\mu_{husband} - \mu_{wife}}{\sqrt{\sigma^2_{husband} + \sigma^2_{wife} - 2\rho\sigma_{husband}\sigma_{wife}}}\right),$$

where $F(\cdot)$ is the cumulative distribution function of a standard normal distribution, and ρ is the degree of spousal correlation in latent son bias. The expected levels of son bias among husbands and wives, which appear in the numerator, can be estimated directly from the data. Moreover, for a given assumption on the variance of ε, we can also use the data to derive estimates for $\sigma_{husband}$, σ_{wife}, and ρ.[34]

We consider three alternative scenarios for the relative amount of noise in our composite measure of son bias. In a low-noise scenario, we assume that noise accounts for one-quarter of the variation in measured son bias among men and women, respectively. In a medium-noise scenario, we assume that one-half of the variation in measured son bias is due to noise. Finally, in a high-noise scenario, we assume that noise accounts for three-quarters of the variation in measured son bias. These scenarios correspond to assuming that the reliability coefficient of our composite measure, defined as the ratio of variation in latent son bias to total variation in measured son bias, takes a value in (.75, .5, .25}.

Table 3 reports the degree of spousal correlation implied by a given assumption on the relative importance of noise, as well as the associated probability that a husband is more son-biased than his wife. Moving from the low-noise to the high-noise scenario, the implied degree of spousal correlation in latent son bias increases by a factor of 3. Similarly, the implied percentage of households in which husbands are more son-biased than their wives increases from 75% to 95%. Hence, gender is a fairly reliable proxy for relative son bias among parents, especially if one believes that latent son bias is measured with a significant degree of noise. For the policy-maker who tries to make efficient use of resources by always targeting the more son-biased parent in any given household, these results suggest that focusing on men can be a simple strategy to approximate this goal.

Discussion

In this study, we implement and validate novel measures of implicit and explicit son bias, and we demonstrate their usefulness in revealing the structure of son bias in Armenia. Our novel implicit association tests are designed to reveal son bias while avoiding the problems associated with directly interrogating individuals about their preferred fertility outcomes. We complement this measure of implicit son bias with a measure of explicit son bias based on questionnaire items, which builds on Jayachandran's (2017) work and overcomes important biases characterizing past research. We demonstrate that our measures of implicit and explicit son bias are internally consistent and that they correlate with son-biased fertility outcomes at both the household and the community level.

[34]The standard deviation of latent son bias among husbands and wives is given by $\sigma_k = \sqrt{Var(measuredBias^k) - Var(\varepsilon)}$, where $k \in \{husband, wife\}$. The spousal correlation in latent son bias is given by $\rho = (\sigma_{husband}\sigma_{wife})^{-1}\tilde{\sigma}$, where $\tilde{\sigma}$ denotes the spousal covariance in measured son bias conditional on the gender composition of children in the household.

Although deviations from the natural sex ratio at birth are being documented in a growing number of countries, less is known about the underlying fertility preferences. It is generally understood that heightened sex ratios at birth require that three distinct forces come together: (1) parents must have a preference for sons, (2) the technology for sex selection must be available, and (3) fertility must be low so that parents face a high risk of remaining without a son (Guilmoto 2009). Differences in desired fertility levels and unequal access to sex selection, however, make it difficult to infer the degree of parental son bias from realized fertility outcomes. We measure son bias directly, which allows us to isolate and study parental preferences for sons.

An important strength of our research design is that we measure fertility preferences at the level of individual decision-makers. By extension, this opens a path to analyzing how individual preferences vary within households, across regions, and by socioeconomic background. Because we measure both parents' fertility preferences, we can study gender differences in son bias. Our analyses reveal that men are, on average, significantly more son-biased than women. This finding could not have been obtained from analyses focusing exclusively on fertility outcomes because these outcomes are realized at the household level and do not allow the researcher to distinguish between fathers' and mothers' preferences. Our finding of an important gender gap in son bias echoes results from other studies showing that fathers tend to spend more time with their sons than daughters and that sons increase marital stability (Blau et al. 2020; Dahl and Moretti 2008; Lundberg 2005). These same studies, however, point out that interpreting gender differences in parents' behavior is difficult because fathers may have a comparative advantage in raising sons, or parents may believe that male role models are more important for boys than girls. In contrast to studies that infer son bias from behavior, our methodology allows us to measure spousal differences in son bias directly.

Our analyses also reveal regional differences in son bias that align with geographic variation in the sex ratio at birth. These regional differences persist after we account for the composition of the population in terms of age, income, and education. Investigating what explains regional differences in son bias promises to be an insightful avenue for future research. One possible explanation is migration. A significant fraction of men in Armenia spend part of the year abroad, most often in Russia, in search of better job opportunities. The resulting absence of men and the economic dependency on remittances may well affect son bias. Gegharkunik, the region with the most distorted sex ratio at birth in our sample, has seen particularly high levels of out-migration in the early 2000s, and migration still plays an important role today (Agadjanian and Sevoyan 2014; Guilmoto 2013; Sevoyan and Agadjanian 2010; Yeganyan and Shahnazaryan 2004). This regional variation in migration patterns is reflected in our data. Among sampled households in Yerevan and Syunik, only 6% have a father who regularly works abroad, compared with 32% among sampled households in Gegharkunik. These numbers are only correlational, of course, but they raise questions about the causal impact of migration on fertility preferences.

Interregional migration can also provide important insights into the nature of son bias. For example, the question of whether son bias is transmitted vertically within families or horizontally under the influence of social norms could be studied by comparing families that have lived in the same region for several generations with families that have only recently immigrated from another region with either lower or higher average levels of son bias. If vertical transmission is more important than horizontal transmission, then son bias among the descendants of migrants should remain close to average son bias in the region of origin.

Despite our extensive efforts to provide privacy for our participants and to minimize the risk of social desirability bias, we have clear indications that sex-selective abortions are underreported. This serves as an important reminder that social desirability bias is a serious concern for research on sex-biased fertility preferences. It also underscores the value of our implicit association tests in establishing the robustness of our main results. By showing that implicit association tests can be used to reveal son bias, our work contributes to the growing literature that uses implicit association tests in a field setting to measure attitudes about sensitive topics for which respondents may not be prepared to explicitly reveal their attitudes (Beaman et al. 2009; Efferson et al. 2015; Lowes et al. 2015; Vogt et al. 2016).

Our findings of a significant gender gap in son bias can inform the design of effective policy interventions. In most situations, the policy-maker will not have access to individual-level data on fertility preferences, and we discuss the reliability of gender as a proxy for son bias. We estimate the degree of spousal correlation in son bias and argue that most husbands in our sample are more son-biased than their wives. Hence, focusing on men may be a particularly effective strategy for the policy-maker who is committed to reducing son bias among prospective parents in Armenia.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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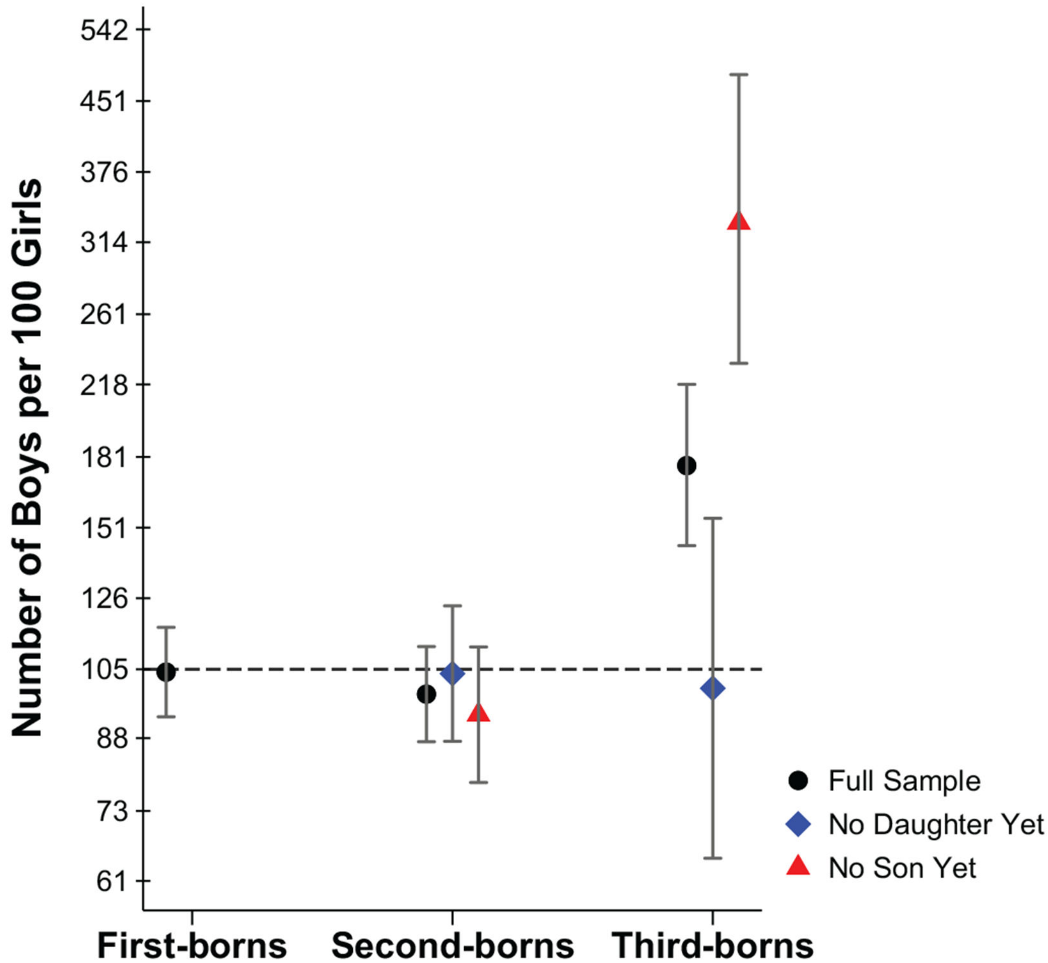

Fig. 1.

The ratio of boys to girls in our sample, computed separately by birth order. We compute 95% confidence intervals using the Clopper-Pearson method for calculating binomial proportion confidence intervals.

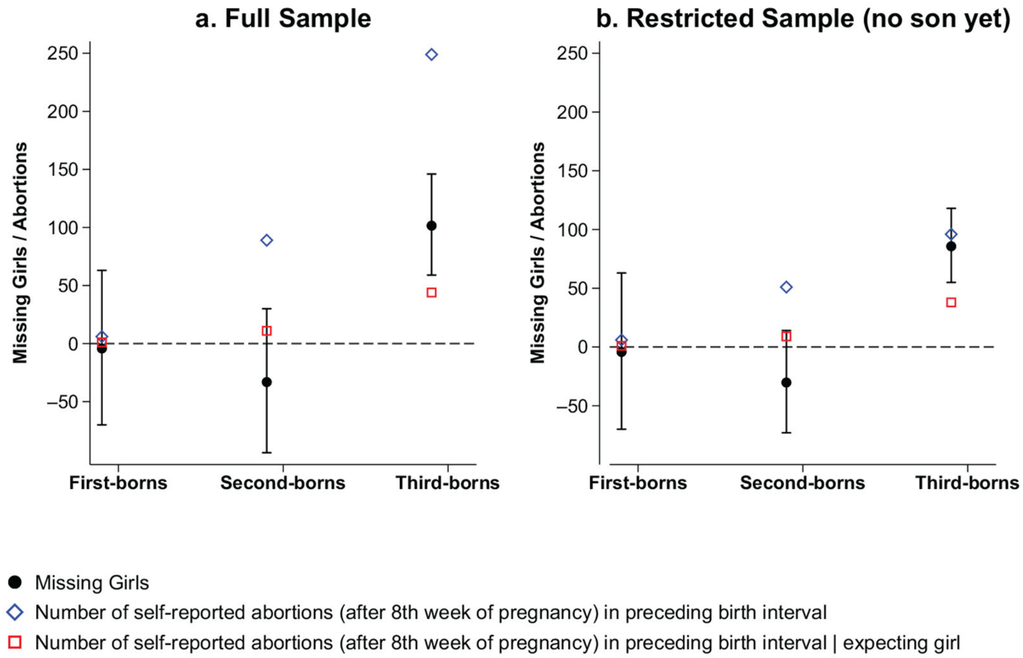

Fig. 2.

Evidence for underreporting of sex-selective abortions. We infer the *expected* number of girls from the observed number of boys in our sample by modeling the gender of a child as an i.i.d. draw from a Bernoulli distribution and assuming a natural sex ratio at birth of 105 boys for every 100 girls. Our estimate of missing girls is simply the difference between the actual and the expected number of girls in our sample. We separately count the number of self-reported abortions preceding the birth of first-, second-, and third-born children. Sex-selective abortions occurring after the birth of a second child but before the birth of a third child affect the sex ratio among third-born children, even if no third child is ever born to the mother who has the abortion. Hence, the preceding birth interval for third-born children begins after the birth of the second child and, in the event of a third birth, ends before that birth; the situation is similar for second-born and first-born children.

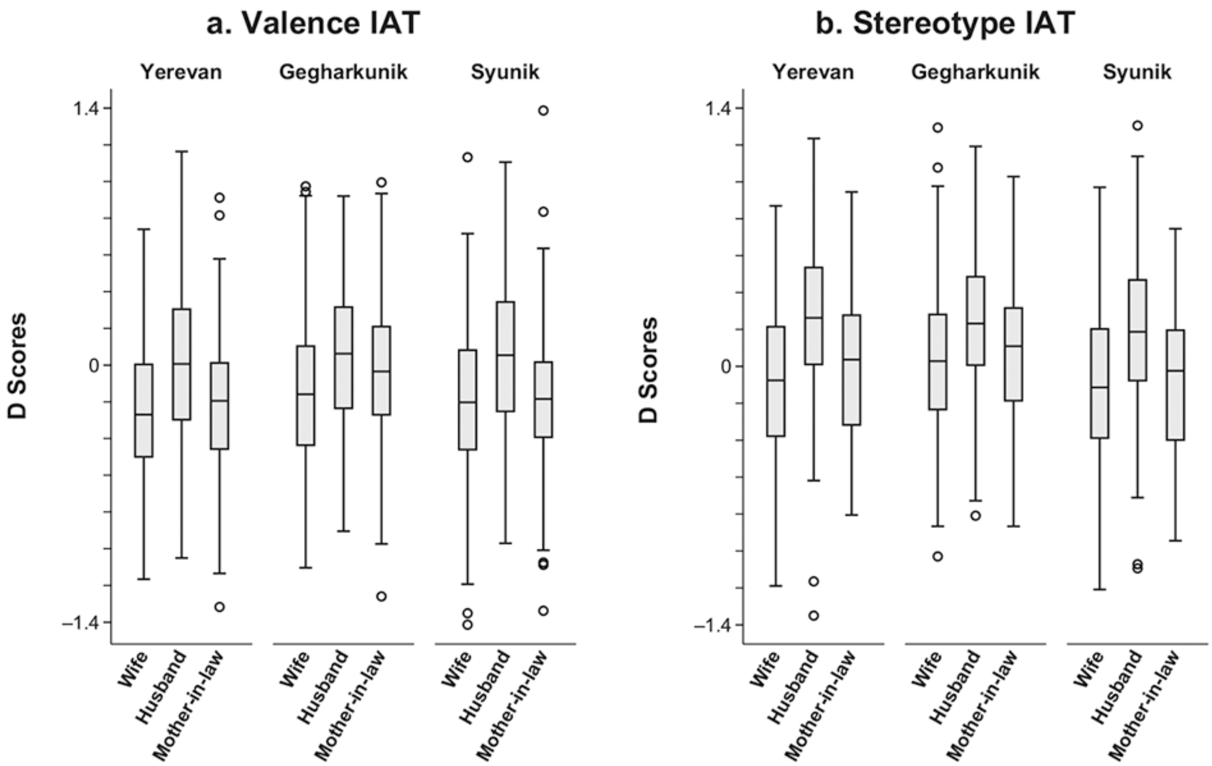

Fig. 3.

Distribution of *D* scores by region and subject type. The upper and lower ends of each box indicate the upper and lower quartiles, respectively, with the line inside the boxes indicating the median. The whiskers indicate the upper and lower adjacent values, and the circles indicate any observation that falls above or below the adjacent values.

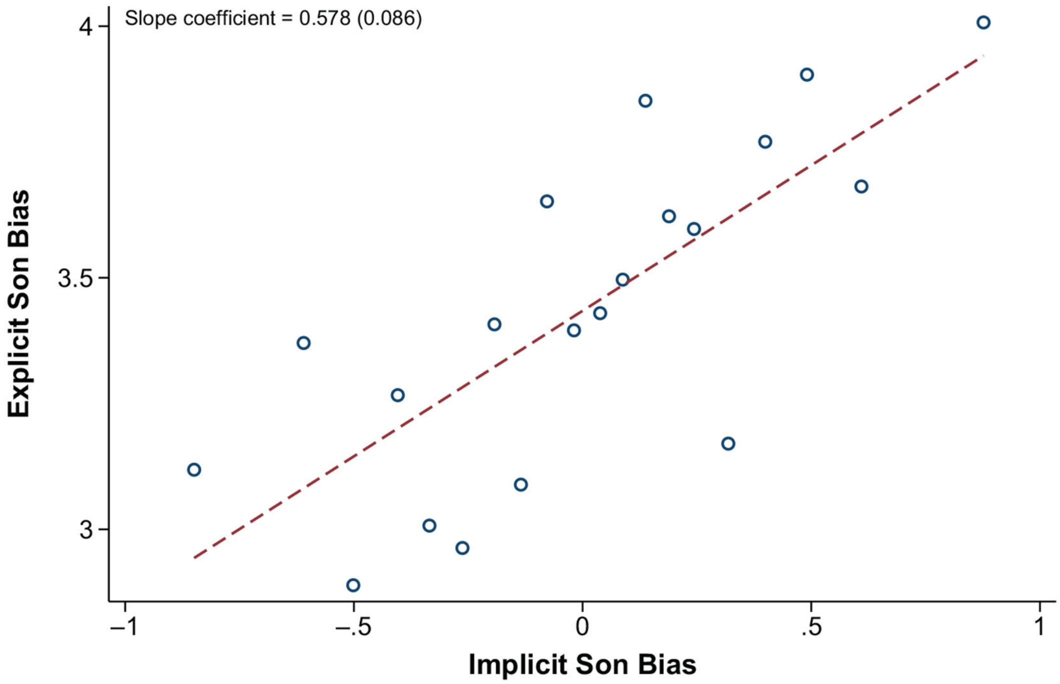

Fig. 4.

Binned scatter plot showing the individual-level association of our measures of implicit son bias (*D* scores) and explicit son bias (index). To decide on the optimal number of bins, we follow Cattaneo et al. (2019), who developed a data-driven decision procedure based on an integrated mean square error approximation.

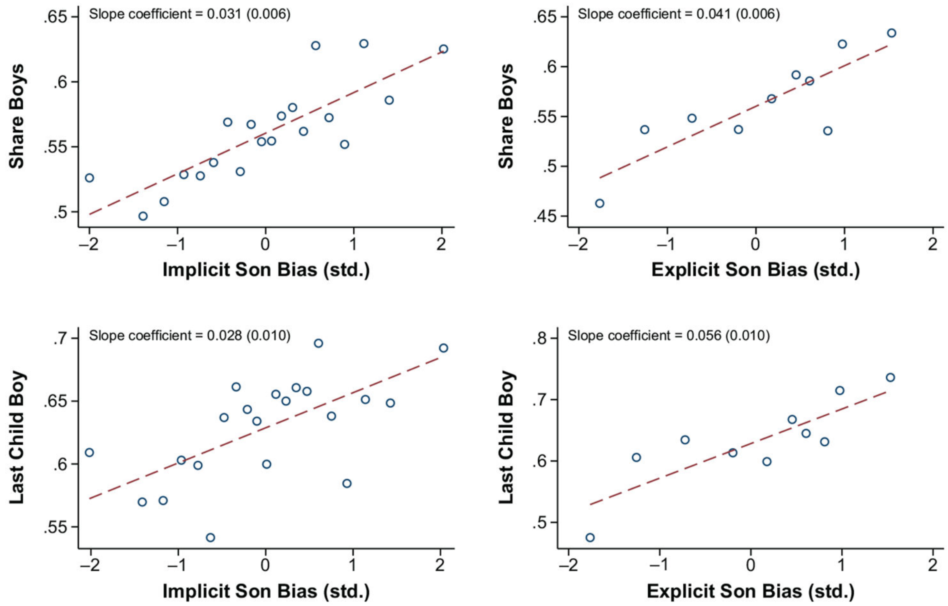

Fig. 5.

Binned scatter plot showing the individual-level association of measured son bias and fertility outcomes. Because only children are extremely rare in Armenia, we restrict our analysis to parents with two or more children. In all regression, we control for subject-type fixed effects. To facilitate comparisons of the effect sizes, we standardize our measures of implicit son bias (D scores) and explicit son bias (index values) to have 0 mean and unit variance.

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Table 1

Community-level correlation of measured son bias and sex ratios at birth

	Community-Level Sex Ratio	
	Unweighted Correlation	**Weighted Correlation**
Implicit Son Bias	.3091 (.0388)	.3370 (.0236)
Explicit Son Bias	.3931 (.0075)	.3916 (.0078)
Number of Observations	45	45

Note: Values in parentheses are *p* values.

Table 2

Regression results and Shapley decomposition

	D Scores (std.)		Index (std.)		Personal View		Perceived Norm	
Dep. Variable	**OLS (1)**	**Shapley (%) (2)**	**OLS (3)**	**Shapley (%) (4)**	**OLS (5)**	**Shapley (%) (6)**	**OLS (7)**	**Shapley (%) (8)**
Respondent Type		74.9		20.3		0.6		0.2
Male	0.527** (0.057)		0.439** (0.053)		−0.025 (0.064)		−0.010 (0.053)	
Region		9.2		57.8		46.4		92.9
Gegharkunik	0.176** (0.065)		0.492** (0.060)		0.386** (0.073)		0.086 (0.061)	
Syunik	−0.040 (0.059)		−0.236** (0.055)		−0.334** (0.067)		−0.558** (0.055)	
Socioeconomic Status		16.0		22.0		53.0		6.9
Income level	0.012 (0.021)		0.076** (0.020)		−0.075** (0.024)		0.006 (0.020)	
Education level	−0.031 (0.029)		−0.075** (0.027)		−0.149** (0.033)		−0.019 (0.027)	
Year of birth	−0.003 (0.002)		—0.004† (0.002)		−0.015** (0.002)		−0.002 (0.002)	
Agriculture	0.010 (0.095)		−0.127 (0.088)		0.040 (0.107)		−0.015 (0.088)	
Commerce and private business	−0.060 (0.084)		−0.110 (0.078)		0.176† (0.094)		0.072 (0.078)	
Construction	0.026 (0.132)		−0.049 (0.123)		0.364* (0.149)		0.109 (0.123)	
Government, intergovernmental organization, or NGO employee	0.034 (0.065)		−0.126* (0.061)		0.113 (0.074)		0.087 (0.061)	
Pay by the day	0.048 (0.131)		−0.226† (0.122)		−0.259† (0.148)		0.050 (0.122)	
Constant	5.037 (4.015)		7.187† (3.733)		29.981** (4.532)		4.174 (3.743)	
N	1,804		1,804		1,804		1,804	
Overall R^2	.065		.146		.130		.087	

	D Scores (std.)		Index (std.)		Personal View		Perceived Norm	
Dep. Variable	**OLS (1)**	**Shapley (%) (2)**	**OLS (3)**	**Shapley (%) (4)**	**OLS (5)**	**Shapley (%) (6)**	**OLS (7)**	**Shapley (%) (8)**
F Statistic Model	11.363		27.904		24.405		15.534	

Notes: The results in this table are based on our *representative sample*, which excludes households living in communities that we have specifically targeted because of their extreme sex ratios at birth. See section A.1 of the online appendix for details about our two-stage sampling approach. *D* scores and index values are standardized to have unit variance so that coefficients on correlates are comparable. The variables in columns 5 through 8 are constructed from responses to the questions about the Armenian adage discussed in the main text. We encode the responses by assigning values between 1 (strongly disagree) and 5 (strongly agree). For occupations, the excluded category is “Housework or other.” Standard errors are shown in parentheses.

† $p<.10$

* $p<.05$

** $p<.01$

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Table 3

Spousal correlation in latent son bias and the probability that a randomly sampled husband is more son-biased than his wife

	Reliability Coefficient		
	.75	**.50**	**.25**
Spousal Correlation, ρ	.20	.30	.60
Prob($latentBias^{husband} > latentBias^{wife}$)	.75	.81	.95