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How Does Children's Sex Affect Parental Sex Preference: Preference Adaptation and Learning

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Abstract

This study examines the effects of children's sex on women's sex preference and investigates the underlying mechanisms. Women's sex preference is measured by the proportion of sons and daughters they would like to have. Based on data of a national representative sample of Peruvian women in the Demographic and Health Survey, we find that if the first child is a daughter, the ideal proportion of sons will be lower by 6.2 percentage points (pp), and the ideal proportion of daughters will be higher by 5.3 pp. Moreover, if the first two children are daughters, the ideal proportion of sons will be lower by 8.9 pp, and the ideal proportion of daughters will be higher by 6.2 pp. Further analysis shows that the effects of the sex of the first child are stronger for women with only one child than for women with multiple children and that the effects of having a daughter depend on her birth order, suggesting that both preference adaptation and learning play important roles in generating the effects of children's sex on parental sex preference.

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1 Introduction

Parents care about the sex of their children. In China, India, and some other developing countries, most parents want to have at least one son (Hesketh and Zhu 2006; Dyson 2012). Globally, many parents would like to have at least one child of each sex (Arnold 1992; Dahl et al. 2006; Mills and Begall 2010). The sex preference of parents significantly influences the sex composition of their children. They may continue childbearing until reaching their desired number of sons and/or daughters (Clark 2000; Altindag 2016). In countries with a strong preference for sons, parents may use abortions to select the sex of their children (Bhalotra and Cochrane 2010; Hesketh et al. 2011; Chen et al. 2013).

Despite the established link from parental sex preference to children's sex, little is known about whether and how the sex of children affects the sex preference of parents. This study proposes preference adaptation and learning as two channels through which children's sex reshapes parental sex preference. First, as documented in the literature of behavior economics, people's preferences are not immutable over time (Sugden 2004; Kőszegi and Rabin 2008; Witt and Schubert 2010). Instead, people often favor what they got rather than what they did not get (Elster 1982; Sen 1999; Sugden 2006;). This implies that parents tend to favor the actual sex composition of their children and realign their sex preference, which can be measured by their ideal sex composition, to the actual one if the two differ (*preference adaptation*). Second, the fundamental reason for sex preference is the different values of sons and daughters accrued to parents (Das Gupta et al. 2003; Ebenstein and Leung 2010; Bhalotra et al. 2020). However,

before becoming parents, people are likely to lack complete information on the costs and benefits of children of each of the two sexes. After transitioning to parenthood, people can acquire first-hand information on the values of sons and daughters, based on which they will update their preference (*learning*). Overall, both theories suggest that children's sex can affect parental sex preference.

However, the two theories suggest different ways in which children's sex affects parental sex preference, thereby leading to different testable hypotheses, H1 and H2. First, the preference adaptation theory suggests that the effects of the first child's sex are larger for parents with relatively few children (H1). According to this theory, what parents care about is the overall sex composition of their children. For parents with relatively few children, the first child can change the sex composition to a larger extent. As a result, the extent to which parents need to change their preferences is expected to be larger. Second, the preference adaptation theory predicts that children's birth order does not affect parental sex preference conditional on the sex composition of children. However, according to the learning theory, birth order does matter for the effects of children's sex on parental sex preference (H2). Parents may give different amounts of attention to different children depending on their birth order. Since parents learn the values of children while raising them, different amounts of attention imply different amounts of information and therefore different influences of children's sex on parental sex preference.

To examine the effects of children's sex on parental sex preference and test the two theories, we exploit the ideal context of Peru. Although a preference for daughters

is present in Peru, it is very weak (Fuse 2010). As a result, sex-selective abortions are very rare and children's sex is fully determined by the random hand of nature (Chao et al. 2019). Therefore, the first child's sex is exogenous and we can estimate its causal effects on parental sex preference. This is the first advantage offered by the Peruvian context. However, the exogeneity of children's sex is not guaranteed if we consider the sex of children born later in the birth order, which is critical for testing the learning theory. Suppose that people have heterogeneous preferences and that parents preferring sons are more likely to have another birth if the current children are all girls, while parents preferring daughters do the opposite, then considering children born later in the birth order may lead to a sample selection bias, and a correlation can be observed between children's sex and parental preference even if the former does not affect the latter.[1] Fortunately, the Peruvian context offers another advantage to overcome this problem. Since the preference for daughters is very weak, the parental decision on a second birth does not depend on the first child's sex. Therefore, we can include the second child's sex in our analysis without suffering a sample selection bias. Finally, to test the preference adaptation theory, we need to compare the effects of the first child's sex between parents with different numbers of children. However, if the measure of family size depends on the first child's sex, the results will be spurious.[2]

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[1]For simplicity, suppose that people's sex preferences are dichotomous. They can either prefer sons or daughters, which does not depend on children's sex. Further suppose that son-preferring parents will have another birth if the first child is a girl and stop childbearing if it is a boy, while daughter-preferring parents do the opposite. If we look at the sex of the first two children, which means that we restrict the sample to parents with at least two children, we can observe that parental sex preference can be fully predicted by the first child's sex.

[2]For simplicity, consider the previous example again. Parental sex preference can be fully predicted by the first child's sex and the family size together.

Since whether to have a second birth is unrelated to the first child's sex in Peru, we can test the preference adaptation theory by comparing the effects of the first child's sex between parents with only one child and parents with multiple children. This is the third advantage offered by the Peruvian context.

The empirical analysis is conducted using data from the Peruvian Demographic and Health Survey (DHS). In this survey, women were asked about the number of children they would like to have if they could go back to the time without any child and the number of boys and girls they would like to have among the children. Based on the answers, we measure sex preference by the ideal proportion of sons, the ideal proportion of daughters, and the proportion of children whose sex does not matter. The analysis reveals that compared with women who have a first-born son, the ideal proportion of sons reported by women with a first-born daughter is lower by 6.2 percentage points (pp), the ideal proportion of daughters is higher by 5.3 pp, and the proportion of children whose sex does not matter is higher by 0.9 pp. If the first two children are both daughters rather than sons, the ideal proportion of sons will be lower by 8.9 pp, the ideal proportion of daughters will be higher by 6.2 pp, and the proportion of children whose sex does not matter will be higher by 2.7 pp. The effects are sizable considering that on average Peruvian women want 37.1% of their children to be sons and 38.5% to be daughters.

To test the preference adaptation theory (i.e., H1), we compare the effects of having a first-born daughter between women who have only one child and those who have multiple children. The results show that the effects are much larger for women with

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only one child, verifying the role of preference adaptation. To test the learning theory (i.e., H2), we focus on the first two children and examine whether the effects of having a daughter depend on her birth order. The results reveal that the effects of having a first-born daughter and a second-born son are significantly different from those of having a first-born son and a second-born daughter. This implies that, in addition to preference adaptation, learning also plays a role in generating the effects of children's sex on parental sex preference.

This study contributes to the literature on the causes of sex preference. Most studies attribute sex preference to structural factors determining the value of sons relative to daughters accrued to parents, such as old-age support provided by sons (e.g., Das Gupta et al. 2003; Ebenstein and Leung 2010) and dowries associated with daughters (e.g., Diamond-Smith et al. 2008; Bhalotra et al. 2020). Other studies suggest that individual factors, such as education and exposure to mass media, are also important determinants (Lin 2009; Chen et al. 2020; Pande and Astone 2007). To the best of our knowledge, our study is the first to document causal evidence that people's sex preference depends on the sex of their children.[3]

The second contribution of our study is to propose and test two theories on the mechanisms through which children's sex affects parental sex preference. The evidence on the learning theory may have important policy implications. The preference for sons,

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[3]Some studies have mentioned that children's sex may affect parental sex preference (e.g., Aly and Shields 1991; Bhat and Zavier 2003; Robitaille 2013), but no study has seriously examined this relationship. For example, Aly and Shields (1991) state that "childbearing is an important event in changing the preference of parents". However, they restrict themselves from discussing how childbearing can change the sex preference of parents. Instead, they treat it as constant over time and explore how it can affect sequential fertility decisions.

which is very common in developing countries, has caused a demographic imbalance due to sex-selective abortions (Sen 1990; Klasen and Wink 2003; Hesketh and Zhu 2006; Dyson 2012; Chen et al. 2013; Robitaille and Chatterjee 2018). Other social problems have emerged, such as the shortage of women on the marriage market (Guilmoto 2012; Jiang et al. 2014) and male violence, since young unmarried men are the most prone to crime (Edlund et al. 2013). The preference for sons also disadvantages the health and education of girls, not only because parents shift resources from girls to boys but also because girls are more likely to be born to large families due to a son-biased fertility stopping rule (Pande 2003; Song and Burgard 2008; Jayachandran and Kuziemko 2011; Barcellos et al. 2014; Choi and Hwang 2015; Jayachandran and Pande 2017). Given these problems, it is imperative to combat the persistence of son preference through policy interventions (Kumar and Sinha 2020). Our finding that parenting is a learning process suggests that policies informing parents of the good aspects of daughters may have the potential to alleviate the problems of son preference.

Finally, our study can help to understand a puzzling finding that children's sex has little impact on parental subjective well-being. Margolis and Myrskylä (2016) find that the sex composition of the first two children has little impact on the happiness of parents in Germany and the UK, despite the prevalent preference for having a family with both boys and girls. Since parents tend to realign their sex preference to the sex composition of their children, our study suggests that the effects of children's sex on parental happiness are smaller than expected.

2 Theoretical Framework

This section builds a theoretical framework to guide our empirical analysis. First, we discuss the causes of sex preference. Next, we elaborate on the preference adaptation and learning theories to explain how children's sex can affect parental sex preference. Finally, we compare the predictions of the two theories.

2.1 Sex Preference

Sex preference often manifests itself as the parental desire for a child of a particular sex or children with a particular sex composition. There are different reasons for parents to have a specific sex preference. We present some of these below.

First, economic returns from raising sons and daughters can differ because of cultural, economic, and institutional arrangements. In many developing countries without a modern pension system, parents mainly rely on sons for financial support in their old age (Das Gupta et al. 2003; Chung and Das Gupta 2007; Ebenstein and Leung 2010; Ebenstein 2021). Parents may also need to pay a bride price or dowries at the marriage of their children, which can be a heavy economic burden (Diamond-Smith et al. 2008; Bhalotra et al. 2020; Dong et al. 2021). In addition, the earnings of female and male children can be different, imposing different limitations on their abilities to financially support parents (Koolwal 2007; Qian 2008; Mahajan and Ramaswami 2017). Since children serve as an instrument of investment in some sense, parents prefer the sex associated with more economic returns.

Second, noneconomic returns may also be different between the sexes. In particular,

inherent traits and behavioral characteristics of children are important to parents but may be different for boys and girls. For instance, girls are often presumed to be associated with neatness, cuteness, and helpfulness (Williamson 1976; Arnold and Kuo 1984), while boys are thought to be more fun and easier to raise (Goldberg 2009; Nugent 2013), although the differences can be blurring. Differences or perceived differences in noneconomic returns can help to explain the fact that, in Nordic countries, which have a high level of sex equality, parents still want to have at least one child of each sex (Andersson et al. 2006).

Finally, sex preference may continue even though the differences in the economic and noneconomic returns on which the preference was based no longer exist. Many studies show that migrants to Western countries from societies with a preference for sons still prefer sons over daughters although their socioeconomic situation has changed (e.g., Dubuc and Coleman 2007; Almond et al. 2013; Carol and Hank 2020). In this case, sons and daughters are simply treated as different children without any cost-benefit consideration.

To sum up, for various reasons, sons and daughters are not perfect substitutes from the perspective of parents. Parents may want some of their children to be boys and some to be girls.

2.2 Preference Adaptation and Sex Preference

Behavioral economics has documented ample evidence that human preference is not immutable as assumed by the orthodox rational choice theory (Sugden 2004; Kőszegi

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and Rabin 2008; Witt and Schubert 2010). A specific way preferences change is that people adjust their aspirations to the feasible options and prefer what they have already got and what they are likely to get rather than what did not get and what they are unlikely to get (Sugden 2006; Dorsey 2010). A canonical example is the fabled fox (Elster 1982). Upon realizing that he cannot get the grapes, he decides that he does not desire the grapes anyway because they are sour.[4] Such a preference was conceptualized as an adaptive preference by Elster (1982) in his groundbreaking work and was further applied to welfare economics by Sen (1982, 1999)) and Nussbaum (2001) to show that "the poor and deprived may accept and even find justification of their lot in life" (Sen 1982).

Adaptation is also relevant for parental sex preference. Imagine that two unlucky parents prefer sons but have only daughters, and unfortunately, their financial situation restricts them from having an additional child. Given the fact that they have no sons, what will they do? They may adhere to the preference for sons but live unhappily with their daughters; however, they may alternatively realign their preference to reality and live happily with their daughters. The latter will happen if people's preferences are sufficiently malleable. This example illustrates that parents will have disutility if the sex (composition) of their children differs from what they want, but parents may adapt their preference to reality to reduce the disutility.

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[4]The fable is titled *The Fox and the Grapes* in *Aesop's Fables.*

2.3   Learning and Sex Preference

Another way that children's sex can affect parental sex preference is learning. As discussed above, the fundamental reason for parents to prefer a male/female child to a female/male child is the difference in the economic and noneconomic values associated with each sex (e.g., Das Gupta et al. 2003; Qian 2008; Bhalotra et al. 2020). Before having a child, parents may hold beliefs about the benefits and costs of having a son versus having a daughter, which are mainly acquired from their parents and society. However, their beliefs may be misguided. For example, it is often believed that in China sons provide more old-age support to parents than daughters, although recent empirical evidence suggests no significant difference (Oliveira 2016). After becoming parents, people will learn first-hand information on the value of a daughter or a son and adjust their sex preference if they receive some new information. For example, if parents find that girls possess traits that they did not anticipate but they value, they will like daughters more. Overall, as long as a child brings something new to the parents' lives specific to his or her sex, a parent's sex preference will be updated.

In theory, the experience of having a son or a daughter can be good or bad (Luppi 2016); therefore, parents may increase or decrease their favor for a specific sex. However, in reality, the positives likely outweigh the negatives. Although no direct evidence exists about the dynamic changes of people's beliefs before and after having a child, much evidence has shown that people enjoy better subjective well-being after becoming parents (Myrskylä and Margolis 2014; Baetschmann et al. 2016; Shreffler et al. 2020), which suggests that parenting might be more rewarding than they expected. In

addition, no evidence has shown that gains in subjective well-being depend on the sex of children, which indicates that parents may underestimate the gains for both boys and girls. As a result, parents with a son like sons more, while parents with a daughter like daughters more.

2.4 Preference Adaptation vs. Learning

Both the preference adaptation and learning theories imply that a child's sex can influence parental sex preference. However, they suggest different ways in which children's sex plays a role, thereby leading to different testable hypotheses. First, a unique prediction of the preference adaptation theory is that the effects of the first child's sex are stronger for parents with relatively few children but weaker for parents with relatively many children (H1). In other words, the effects of the sex of the first child decrease with the birth of every subsequent child. According to this theory, what parents care about is the overall sex composition of their children. Their sex preference, which can be measured by their ideal sex composition of children, will be realigned to the actual sex composition if there is a dissonance between the two. For parents with relatively few children, a child can change the overall sex composition to a larger extent and on average cause a larger disparity between the ideal sex composition and the realized one. As a result, parents need to change their preferences to a larger extent. To clarify, consider a hypothetical example of two parents from different families, A and B. Suppose that before they had children, both of them preferred sons and hoped all their children would be boys. That is, their ideal proportion of sons was 100%.

Further, suppose that each of them has a daughter as the first child, and as a result, they have to adjust their sex preference. However, the extent of the adjustment can differ, depending on the total number of children they have. Suppose that A has four children, while B has only two. A simple computation suggests that the first child changes the proportion of sons by 25% for A but 50% for B. As a result, B has to adjust her preference to a larger extent to reconcile her preference and the reality.[5]

Second, the preference adaptation theory predicts that only the number of sons and daughters has an impact on parental sex preference but their birth order does not matter. For simplicity, consider a parent who has a son and a daughter. No matter whether the girl is the first or the second child, the family has both a son and a daughter. As a result, the effects of having a daughter on parental sex preference should be the same regardless of the birth order of the son and the daughter. In contrast, according to the learning theory, the effects of children's sex on parental sex preference are likely to depend on the birth order of the children (H2). Parents may pay different attentions to children depending on their birth order and hence acquire different information about children's economic and noneconomic values. In particular, parents may learn more from the first child, when they are parenting for the first time (Luppi 2016; Luppi and Mencarini 2018).[6] Finally, this different information will translate to different effects on parental sex preference. To sum up, the preference adaptation theory predicts that only the number of boys and girls in the family matters, whereas the learning theory

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[5]Parents also care about the sex of other children, which can be either male or female. Here we focus on the part of adjustment caused by the first child.

[6]Previous studies in various research areas suggest that parental attitudes are more affected by having a first-born daughter than having a second-born or a third-born daughter (e.g., Cronqvist and Yu 2017; Sharrow et al. 2018; Greenlee et al. 2020).

predicts that birth order also plays a role.

3   Background of Peru

While many societies show a preference for sons (Williamson 1976), a slight preference for daughters is present in Peru, as well as in the other countries of Latin America due to their cultural similarity. Most women in Peru either do not show a sex preference or want the same number of sons as daughters, some women want more daughters than sons, but relatively few women want the opposite (Fuse 2010).[7] Moreover, Peruvian women with two sons are marginally more likely to want another birth than those with two daughters, suggesting a slight preference for daughters (Arnold 1997).

The slight daughter preference in Peru is rooted in its family system. In places where son preference is strong, such as China and India, the family system is usually patrilineal and patrilocal. Parents mainly rely on sons but not daughters for support in old age (Das Gupta et al. 2003; Chung and Das Gupta 2007). In contrast, in Peru and other Latin American countries, the prevailing family system and social norms place little constraints on women's economic and social autonomy (Basu and Das Gupta 2001). Married daughters can maintain a mutually supportive relationship with their natal parents, and continue to contribute to their physical, financial, and emotional well-being. As a result, parents can expect the same amount of old-age support from daughters as from sons, and whether parents receive support from daughters or sons

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[7]According to Fuse (2010), a woman shows no sex preference if she states that her ideal sex composition is up to god or that her ideal number of both sons and daughters is zero and the number of children whose sex does not matter is a positive integer.

is only a matter of choice and circumstance (Basu and Das Gupta 2001). This is typically reflected in the intergenerational living arrangement, whereby coresidence between elderly parents and adult children facilitates resource flows from children to parents (Kochar 2000; Ebenstein 2021). While coresidence is more often with sons than with daughters in Asia and Africa, old people in Peru and other Latin American countries are as likely to coreside with daughters as with sons (Bongaarts and Zimmer 2002).

Unlike the case of China and India, where son preference is so strong that parents may use abortions to select their children's sex, daughter preference in Peru did not lead to a biased sex ratio at birth. Chao et al. (2019) show that the ratio of male to female births was always around the "natural" level in the period 1950-2017.[8] However, this is not surprising, because the preference for daughters is so weak that parents are not motivated to select the sex of their children. In addition, abortion has been illegal in Peru since 1924, making prenatal sex selection difficult. As will be clear below, the randomness of children's sex in the Peruvian context offers big advantages for identifying the causal effects of children's sex on parental sex preference and the underlying mechanisms.

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[8]Human beings tend to give more male births than female births due to some biological reasons. It is commonly believed that the natural ratio of male to female births is 1.05. Using a Bayesian model, Chao et al. (2019) estimate the natural ratio for multiple countries. For Peru, the estimated ratio is 1.041. The actual sex ratio at birth is close to both 1.05 and 1.041.

4   Data and Variables

The data for this study are from the Demographic and Health Survey (DHS) in Peru in 1996, 2000, and 2004-2011. The data are repeated cross-sectional. Since 1984, the DHS program has been collecting high-quality and nationally representative data on population and health in developing countries. Since 1990, DHS has included questions to elicit information on fertility ideals and sex preference. In Peru, information on fertility ideals and sex preference began with the 1996 survey and provides the key data for our study.

The sex of children is recovered from the complete history of a woman's birth record, which includes the sex, date, and survival status for each birth. We exclude women with a twin birth from the study. As will be clear in the next section, birth order is critical for testing the role of learning, but it makes little sense to differentiate the birth order of twins. In addition, we exclude women with over 10 births (top 1%). Finally, we are left with 108,036 women aged 15-49.[9]

In the empirical analysis, we focus on the sex of the first two children. Table 1 shows that Peruvian women in the sample have 2.9 children on average. The probability that the first child is a daughter is 0.490, and it is 0.487 for the second child. In addition, the women have received 8.1 years of schooling on average with a standard deviation of 4.5. They are 15-49 years old with an average age of 34, and 61.2% of them are living in urban areas.

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[9]Our main analysis focuses on women since the questions about sex preference were mainly administrated to women. These questions were also administrated to a small sample of men in the 1996 survey. The analysis based on the data of 683 men suggests that having daughters leads men to prefer a smaller proportion of sons and a larger proportion of daughters.

Table 1 Summary statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Panel A. Individual characteristics					
Children ever born	108036	2.931	1.953	1	10
First-born daughter	108036	0.490	0.500	0	1
Second-born daughter	80720	0.487	0.500	0	1
Years of schooling	108036	8.064	4.502	0	17
Age	108036	33.974	8.385	15	49
Urban residence	108036	0.612	0.487	0	1
Panel B. Sex preference					
Ideal proportion of sons	108036	0.371	0.278	0	1
Ideal proportion of daughters	108036	0.385	0.284	0	1
Proportion of children whose sex does not matter	108036	0.244	0.429	0	1
Want at least one son	108036	0.691	0.462	0	1
Want at least one daughter	108036	0.708	0.455	0	1
Want at least one child of each sex	108036	0.642	0.479	0	1

Following the literature (e.g., Clark 2000; Bhat and Zavier 2003; Fuse 2010), our measures of sex preference are constructed from the answers to the following two questions:

Q1. 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?

Q2. How many of these children would you like to be boys, how many would you like to be girls, and for how many would it not matter if it's a boy or a girl?

Although the questions ask people to think of the time with no children, people do take their later life experiences into account. Therefore, the answers convey fertility preference at the time of survey instead of at the time with no children. Based on the

answers, we compute the ideal proportion of sons, the ideal proportion of daughters, and the proportion of children whose sex does not matter. The first two variables capture parental preference for sons and preference for daughters, and the third variable reflects the extent to which parents treat sons and daughters equally.

Table 1 shows that Peruvian women on average want 37.1% of their children to be boys and 38.5% to be girls, suggesting a slight daughter preference (difference = 1.4 pp, p-value = 0.000), which follows the findings of Fuse (2010). In addition, for 24.4% of their children, they do not care about the sex. The data also show that 69.1% of Peruvian women want to have at least one son, 70.8% want to have at least one daughter, and 64.2% want to have at least one child of each sex.

5   Identification Strategies

5.1   Identifying the Effects of Children's Sex

To estimate the effects of children's sex on parental sex preference, the following regression model is employed,

$$Preference_i = \beta_0 + \beta_1 Sex_i + \beta_2 X_i + \epsilon_i, \tag{1}$$

where $Preference_i$ is the outcome variable, which can be the ideal proportion of sons, the ideal proportion of daughters, and the proportion of children whose sex does not matter reported by Woman i. The variable Sex is a measure of children's sex, which will be discussed in more detail below. X is a vector of control variables, i.e., a set of dummy variables indicating the age, education, number of children ever born, region

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and type of residence (urban or rural) of the respondent, and year of interview. ϵ is the disturbance term. If Sex is exogenous, β_1 will capture the causal effect of children's sex on parental sex preference.

As noted in Section 3, the sex of each child can be considered as a random variable. But, the sex of children would still be endogenous if we consider children born later in the birth order, since parents may make sequential fertility decisions based on their sex preference and the sex of previous children. For instance, parents who prefer sons are more likely to have another child if the current children are all girls, while parents who prefer daughters are more likely to have another child if the current children are all boys. As a result, considering children in all birth orders may lead to a sample selection bias, whereby a correlation can be observed between the sex of children and the sex preference of parents even if the former does not affect the latter.[10]

This problem can be avoided by focusing on the sex of the first child, as suggested by Dahl and Moretti (2008) and Choi and Hwang (2015), who identify the causal effects of children's sex on family structure and parental investment in children, respectively. The Peruvian context also allows us to look at the sex of the second child, as the data show that the probability of a second birth does not depend on the sex of the first child (difference = -0.000, p-value = 0.779), suggesting that including the second child's sex will not cause a sample selection bias. However, we cannot extend the analysis to higher birth orders, since parents are more likely to have a third child if the first two children are of the same sex (difference = 0.028, p-value = 0.000).[11] Therefore, we use

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[10]See Footnote 1 for a simple example illustrating this problem. See Choi and Hwang (2015) for more discussions.

[11]In fact, this pattern of parity progression ratios (i.e., the probability of transitioning to second

two measures of children's sex: (a) whether the first child is a daughter, and (b) the proportion of daughters among the first two children.

5.2 Identifying the Roles of Preference Adaptation and Learning

The preference adaptation theory predicts that the effects of the sex of the first child are stronger for parents with relatively few children. To test this hypothesis, we compare the effects of the first child's sex for parents with only one child and parents with at least two children.[12] To do this, we run the following regression model,

$$Preference_i = \alpha_0 + \alpha_1 Daughter_{1,i} + \alpha_2 Daughter_{1,i} \times Children_{2,i} + \alpha_3 X_i + u_i, \quad (2)$$

where $Children_2$ is an indicator which takes value 1 if parents have at least two children and 0 otherwise. The effect of a first-born daughter on parental sex preference is α_1 for parents with only one child and $\alpha_1 + \alpha_2$ for parents with more than one child.

The learning theory predicts that the effects of children's sex on parental sex preference depend on the birth order of the children. In particular, the effects of a first-born daughter differ from the effects of a second-born daughter. To test this hypothesis, we

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birth does not depend on the sex of the first child, while the probability of transitioning to third birth depends on the sex of the first two children) is not unique to Peru. Andersson et al. (2006) document the same pattern for Denmark, Finland, Norway, and Sweden.

[12]Here we divide parents into two groups based on the number of children. It is not valid to directly consider the number of children. The fact that parental decision on having a third child depends on the sex of the first two children suggests that the number of children depends on parental sex preference and therefore is an endogenous variable. In contrast, the parental decision on having a second child does not depend on the sex of the first child, so the dummy variable indicating more than one child does not suffer the endogeneity problem.

run the following regression model,

$$Preference_i = \gamma_0 + \gamma_1 DS_i + \gamma_2 SD_i + \gamma_3 DD_i + \gamma_4 X_i + v_i, \tag{3}$$

where, DS is a dummy variable that takes value 1 if the first child is a daughter and the second one is a son, SD is another dummy variable that takes value 1 in the opposite case, and DD indicates that the first two children are both daughters. The reference group consists of women with two sons. According to H2, $\gamma_1 \neq \gamma_2$.

6 Results

This section presents the results. First, we show how parental sex preference is affected by their children's sex. Next, we test the role of preference adaptation and learning in generating these effects. Finally, we discuss the robustness of the findings.

6.1 Effects of Children's Sex on Parental Sex Preference

In Table 2, we report the effects of children's sex on the ideal proportion of sons, the ideal proportion of daughters, and the proportion of children whose sex does not matter. In Panel A, the focus is on the sex of the first child, while Panel B focuses on the sex of the first two children.

The results reveal that children's sex has significant effects on parental sex prefer-ence. Panel A shows that if the first child is a daughter, the ideal proportion of sons will be lower by 6.2 pp while the ideal proportion of daughters will be higher by 5.3 pp. In addition, the proportion of children whose sex does not matter will be higher by

Table 2 Effects of children's sex on parental sex preference

	(1)	(2)	(3)
	Ideal proportion of sons	Ideal proportion of daughters	Proportion of children whose sex does not matter
Panel A. First child			
First-born daughter	-0.062***	0.053***	0.009*
	(0.002)	(0.002)	(0.004)
Controls	Yes	Yes	Yes
N	108036	108036	108036
R^2	0.037	0.022	0.028
Panel B. First two children			
Proportion of daughters	-0.089***	0.062***	0.027***
	(0.004)	(0.004)	(0.006)
Controls	Yes	Yes	Yes
N	80720	80720	80720
R^2	0.040	0.020	0.029

Notes: Numbers in parentheses are standard errors. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

0.9 pp. Panel B shows that if the first two children are daughters, the ideal proportion of sons will be 8.9 pp lower while the ideal proportion of daughters will be 6.2 pp higher. The proportion of children whose sex does not matter will be 2.7 pp higher. Overall, the results suggest that having daughters leads women to prefer fewer sons, more daughters, and more children whose sex does not matter. These effects are sizable considering that, on average, the ideal proportion of sons, the ideal proportion of daughters, and the proportion of children whose sex does not matter is 37.1%, 38.5%, and 24.4%, respectively.

6.2   Role of Preference Adaptation

This subsection investigates the role of preference adaptation in reshaping parental sex preference. To do this, we examine how the effects of a first-born daughter differ for mothers with only one child and mothers with multiple children.

The results in Table 3 reveal that the effects of a first-born daughter are much smaller for women with multiple children. Column (1) shows that a first-born daughter decreases the ideal proportion of sons by 9.2 pp for women with only one child. However, the effect will be reduced by 4.1 pp if women have more than one child. Column (2) shows that a first-born daughter leads women to want 8.5 pp more daughters if they have only one child. However, the effect is smaller by 4.4 pp if they have at least two children. Finally, no clear pattern can be observed for the proportion of children whose sex does not matter in Column (3). Overall, the results point to the importance of preference adaptation in generating the effects of children's sex on parental sex preference.

6.3   Role of Learning

This subsection investigates the role of learning in reshaping parental sex preference. We focus on women with at least two children and examine whether the effects of a first-born daughter differ from the effects of a second-born daughter.

The results are reported in Table 4. The main finding is that the effects of having a daughter are much larger if the daughter is the first child. Column (1) shows that the ideal proportion of sons is 5.4 pp lower for women with a first-born daughter and a

Table 3 Effects of children's sex on parental sex preference for women with different numbers of children

	(1) Ideal proportion of sons	(2) Ideal proportion of daughters	(3) Proportion of children whose sex does not matter
First-born daughter	-0.092***	0.085***	0.007
	(0.005)	(0.005)	(0.007)
First-born daughter × At least two children	0.041***	-0.044***	0.003
	(0.005)	(0.006)	(0.008)
Controls	Yes	Yes	Yes
N	108036	108036	108036
R^2	0.038	0.023	0.028

Notes: Numbers in parentheses are standard errors. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

second-born son, compared with women who have two sons as their first two children. However, the effect is only 4.2 pp if the daughter is the second child and the son is the first (difference = 1.3 pp, p-value = 0.000). Similarly, Column (2) shows that the ideal proportion of daughters is increased by 3.1 pp if the daughter is the first child and the son is the second, but the effect is only 1.2 pp if the daughter is the second (difference = 2.0 pp, p-value = 0.000). Finally, no significant difference is observed for the proportion of children whose sex does not matter (difference = -0.7 pp, p-value = 0.234), as shown in Column (3). Thus, the results reveal that the effects of children's sex on parental sex preference depend on children's birth order, suggesting that learning also plays a role in generating these effects.

6.4 Robustness Checks

Two robustness checks are conducted for the baseline results. We first check whether the results are driven by women at certain ages. Next, we check whether the effects

Table 4 Effects of children's sex and birth order on parental sex preference

	(1)	(2)	(3)
	Ideal proportion of sons	Ideal proportion of daughters	Proportion of children whose sex does not matter
Daughter-son	-0.054***	0.031***	0.023***
	(0.004)	(0.004)	(0.006)
Son-daughter	-0.042***	0.012**	0.030***
	(0.004)	(0.004)	(0.006)
Daughter-daughter	-0.089***	0.063***	0.026***
	(0.004)	(0.004)	(0.006)
Controls	Yes	Yes	Yes
N	80720	80720	80720
R^2	0.040	0.021	0.029

Notes: Numbers in parentheses are standard errors. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

of children's sex on parental sex preference still exist for alternative measures of sex preference. From them, we deduce that the results are robust to different subsamples and alternative measures of sex preference.

Women's Age

The effects of children's sex on parental sex preference may be driven by women at certain ages. Young women who are disappointed about the sex of their children still have much time to give birth to more children to "dilute" the effects of current children, and hence, they face less pressure to adapt their preference than old women. Moreover, the information about children's values may be revealed gradually as they grow up. Since the ages of children and parents are positively associated, old women are likely to have more information than young women. Therefore, the observed effects of children's sex on parental sex preference may only exist among women who have completed fertility. To address this concern, we replicate the baseline analysis for two

subsamples with different ages of women. In the first subsample, women are aged below 40 years and still have much time to bear babies; in the second subsample, women are aged 40 years and above and have almost completed their fertility. The results in Table 5 suggest that the effects of children's sex on parental sex preference exist for both subsamples of women, although the sizes of the effects may be somewhat different.

Alternative Measures of Sex Preference

In the previous analysis, parental sex preference is measured by the ideal proportion of sons, the ideal proportion of daughters, and the proportion of children whose sex does not matter. The rationale for these measures is that parents who prefer a specific sex want a larger proportion of children of that sex. However, sex preference may manifest itself in different ways. In particular, parents who prefer sons may want to have at least one son but do not care much about the proportion of sons as long as they have one son. In this subsection, we measure parental sex preference with three dummy variables that indicate the following: that women want at least one son, that women want at least one daughter, and that women want at least one child of each sex. The first two variables capture parental preference for a son and preference for a daughter, and the third one reflects whether parents differentiate between sons and daughters. The results in Table 6 suggest that compared with women with a first-born son, women with a first-born daughter are less likely to want at least one son, more likely to want at least one daughter, and less likely to want at least one child of each sex. A similar pattern can be observed for women whose first two children

Table 5 Effects of children's sex on parental sex preference (by women's age)

	(1) Ideal proportion of sons	(2) Ideal proportion of daughters	(3) Proportion of children whose sex does not matter
Panel A. Women aged below 40, first child			
First-born daughter	-0.067***	0.060***	0.007
	(0.003)	(0.003)	(0.004)
Controls	Yes	Yes	Yes
N	77289	77289	77289
R^2	0.041	0.024	0.030
Panel B. Women aged 40 and above, first child			
First-born daughter	-0.050***	0.036***	0.014*
	(0.004)	(0.004)	(0.007)
Controls	Yes	Yes	Yes
N	30747	30747	30747
R^2	0.032	0.019	0.026
Panel C. Women aged below 40, first two children			
Proportion of daughters	-0.090***	0.075***	0.015*
	(0.005)	(0.005)	(0.007)
Controls	Yes	Yes	Yes
N	52392	52392	52392
R^2	0.044	0.024	0.032
Panel D. Women aged 40 and above, first two children			
Proportion of daughters	-0.088***	0.040***	0.048***
	(0.006)	(0.007)	(0.010)
Controls	Yes	Yes	Yes
N	28328	28328	28328
R^2	0.036	0.018	0.028

Notes: Numbers in parentheses are standard errors. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

are both daughters, compared with women who have at least one son among the first two children. Overall, the results verify that children's sex has significant effects on parental sex preference.

Table 6 Effects of children's sex on parental sex preference (alternative measures)

	(1) Want at least one son	(2) Want at least one daughter	(3) Want at least one child of each sex
Panel A. First child			
First-born daughter	-0.051***	0.030***	-0.012**
	(0.004)	(0.004)	(0.004)
Controls	Yes	Yes	Yes
N	108036	108036	108036
R^2	0.028	0.021	0.021
Panel B. First two children			
Proportion of daughters	-0.067***	0.009	-0.031***
	(0.006)	(0.006)	(0.007)
Controls	Yes	Yes	Yes
N	80720	80720	80720
R^2	0.030	0.022	0.024

Notes: Numbers in parentheses are standard errors. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

7   Conclusions and Discussions

This study proposes preference adaptation and learning as two channels through which children's sex affects parental sex preference. First, parents may adapt their preference to their children's sex composition if there is any inconsistency between the desired and realized sex composition. Second, parents may learn the values of sons and daughters through parenting, and update their information based on which

sex preference is formed. The two theories lead to different hypotheses. First, the preference adaptation theory predicts that the effects of the first child's sex are stronger for parents with relatively few children. Second, the learning theory predicts that the effects of children's sex on parental sex preference depend on the birth order of the children. We test the effects of children's sex on parental sex preference and the two hypotheses based on the Peruvian DHS data. The results reveal statistically significant and economically sizable effects of children's sex on parental sex preference. That is, having daughters leads women to prefer a smaller proportion of sons, a larger proportion of daughters, and a slightly larger proportion of children whose sex does not matter. Further analysis shows that the effects of the sex of the first child are stronger for women with only one child compared with women with multiple children and that the effects of having a daughter depend on her birth order, suggesting that both preference adaptation and learning play important roles in generating the effects of children's sex on parental sex preference.

The evidence for the role of learning may have important policy implications. Given various and serious problems caused by a preference for sons and an imbalanced sex ratio in some developing countries, researchers and policymakers have been working to address this issue (Kumar and Sinha 2020). Two widely used policies, namely, bans of prenatal sex selection and cash transfers to parents with daughters, however, have proven not very effective in normalizing sex ratios or decreasing son preference. First, bans of prenatal sex selection are difficult to implement but only have limited effects on normalizing an imbalanced sex ratio (Guo et al. 2016; Kumar and Sinha

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2020). Second, cash transfers to families with daughters have some positive effects on the education of girls in the beneficiary households by subsidizing the cost of girls, but there is no evidence that such programs can change the underlying sex preference of parents (Sinha and Yoong 2009; Sekher and Ram 2015). Our results suggest that providing parents with information about the benefits of raising daughters may have the potential to reduce the preference for sons and thus alleviate related problems. However, note that our data come from a country with no strong preference for sons or daughters. Sex preference may be malleable in such countries but rigid in countries where the preference for sons is embedded in the culture. Therefore, more research is necessary before establishing any practical policy interventions.

Finally, our findings that parents realign their sex preference to the sex of their children is consistent with the negligible effects of children's sex on parental subjective well-being documented in the literature. Although parents generally want to have at least one child of each sex (Arnold 1992; Dahl et al. 2006; Mills and Begall 2010), in Germany and the UK, mixed sexes of the first two children have only small positive effects on parental happiness, which appear only a few years after the birth of the second child (Margolis and Myrskylä 2016). One explanation for the limited effects is that there are some positive factors associated with having same-sex children, such as the ability to recycle clothes and other items from the older siblings to the younger ones (Margolis and Myrskylä 2016). However, it is also possible that parents can adapt their sex preference toward the sex composition of their children, and therefore, the effects of children's sex on parental happiness are smaller and more short-lived than

expected.

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