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The Effect of Sex of Firstborn Children on Fertility Preferences

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Abstract: Fertility rates around the world are falling at the same time that male-skewed sex ratios at birth are on the rise. The individual fertility choices people make contribute to this inverse relationship, exacerbating the problem of "missing women" as well as a number of other adverse social and economic effects. The decision to have a child is extremely complex. Distilling the interaction between fertility and sex compositional preferences, fertility levels, and gender norms is an important step toward understanding both the reproductive choices people make as well as the formation of fertility preferences. I use individual-level data from the Demographic and Health Survey (DHS) over the period from 1984 through 2018 to perform empirical analysis on the fertility preferences of women and men from over 75 countries. I exploit the exogenous sex of firstborn children and the timing of the DHS survey to explore the marginal effect of having a recently firstborn son or daughter on preferences for total fertility, as well as preferred numbers of sons and daughters. I then test two existing theories how on the sex of existing children influences parity progression: that the sex of existing children matters more in low fertility regimes in explaining subsequent births, and that the sex of children will matter more in places with less egalitarian gender norms. Analysis suggests that the sex of firstborn children plays a role in how fertility preferences update. The strongest preference changes are for ideal number of daughters, although total fertility also change dependent on the sex of one's firstborn. Finally, I find evidence to support the theory that fertility regimes and gender norms play a role in determining preference updates.

1. Introduction

Over the course of the past half-century, demographic transitions around the world have caused the average of number of children born per woman to fall from over five to less than two and a half. The dwindling global fertility rate is driven largely by developing countries, indicating a rise in individual- and family-level reproductive agency in these countries. Prior to this demographic shift, fertility decisions were largely made at a group level (Reher et al. 2017). Before the technological advancements that allowed infant and child mortality to fall and human life spans to increase, high rates of fertility were necessary to ensure society's survival. These technological advancements have allowed individual families to gain increased agency over reproductive choices and circumstances. European birth records from the late 1800s and early 1900s suggest that couples made, and reevaluated, fertility goals based off of their changing reproductive circumstances (Hank 2007; Reher et al. 2017). During a time when infant and child mortality was in decline, the somewhat unlikely event of a child's death often triggered a replacement birth. Additional evidence of reproductive goals includes the findings that many families with all female sibship sets continued having children until the birth of a son (Gray & Evans 2004; Reher et al. 2017).

This phenomenon, known as *son-based stopping*, can be observed in the reproductive outcomes of societies and individuals around the world (Gray & Evans 2004; Reher et al. 2017; Basu & De Jong, 2010; Reher et al. 2017; Yamaguchi 1989). Son-based stopping is an effect of the preference for male children that is pervasive, to some extent, in most societies. Many social, psychosocial, economic, and religious mechanism lie behind son-preference: sons inherit land, carry on family names and bloodlines, elevate the social status of mothers, care for aging parents, take on significant roles in certain religious practices, and more (Das Gupta et al. 2003; Giuliano 2017; Hank 2007; Jayachandran 2015). Daughters also carry their own set of parental utilities, often in their ability to care for younger siblings and help with household tasks. However, parents of daughters also have to worry about the potential costs of dowries and weddings, as well as the additional anxiety of sexual violence being more prevalent against daughters. (Hank 2007; Puri et al. 2011).

Individuals weigh these and other considerations and constraints, including their personal fertility preferences, when developing their reproductive goals and preferences in terms of the number of children they want and the sex composition of those children. Thanks to modern technology, couples who possess the means and the inclination can exercise complete control over the sex of their children with sex-selective technologies such as ultrasounds, selective abortions, sperm sorting, and pre-implantation sex technologies (Jayachandran 2017; Puri et al. 2011). Parents, on average, also want fewer children than ever before. When it comes to ensuring the birth of a son, many parents are not willing to leave it up to chance. Lower levels of total fertility mean that families with a strong desire for at least one son are more likely to sex-select by way of abortion, infanticide, or neglect. The relationship between the falling fertility rate and the availability of sex-selective technologies has led to a rising inequality in the observed sex-ratio at birth (SRB) since the 1980s (Basu 1999; Das Gupta & Bhat 1997; Jayachandran 2017; Park & Cho 1995).

According to the WHO, the "natural" SRB falls between 103 to 107 males born for every 100 females. Many countries, notably China, India, Vietnam, and Pakistan, have SRBs exceeding 110 (Roser & Richie 2020). When breaking down SRB by birth order, research shows that even in countries with a strong son-bias, the SRB of firstborn children falls into this "natural" range. It begins to diverge sharply with second children in these regions, especially if a couple's first child was a daughter (Anukriti et al. 2015; Zeng et al. 1993). Empirical research shows that parents most commonly want at least one child of either sex and suggests that sex selection is unlikely to be utilized for lower parity children where the main decision seems to be whether or not have a child (Bhalotra & Cochrane 2010; Hank 2007).

Taken together, the individual reproductive choices of people around the world have greatly contributed to the phenomena of "missing women" (Sen 1990). Overwhelmingly these missing women are from a subset of developing countries where sex ratios at birth (SRBs) are heavily skewed toward male children through means such as son-based stopping, sex-selective abortions, daughter-discriminatory prenatal health decisions, and female infanticide. Due to its striking humanitarian and societal implications, the issue of missing women has received a great deal of attention over the past three decades from researchers, policy makers, and governments alike. Despite making strides in numerous areas of social and economic development, countries with strong son-preference have SRBs that continue to rise sex-selective technologies become more widely available and as total fertility rates fall. As of 2010, 126 million women were missing due to sex-selection and excess mortality at birth. This number is expected to rise to 150 million by 2035 (Bongaarts & Guilmoto 2015). As sex-selection technologies become more prevalent, it becomes imperative to understand the individual preferences behind sex-imbalances and what can potentially alter these preferences.

There are two existing theories as to how the sex of children influence parity progression. The first is that the sex of existing children will matter more in low fertility regimes in explaining subsequent births. The second is that the sex of children will matter more in places with more unequal gender norms (Gray & Evans 2004; Hank 2007; Pollard & Morgan 2002). The strength of my research lies in the opportunity to observe how fertility preferences update in response to the sex of firstborn children, and how differential fertility regimes and cultural gender norms play a role in the ways that these preferences change. Becoming a parent marks a distinct change to anyone's life no matter their cultural context or motivations. For a number of intrinsic and extrinsic reasons, it is a reasonable assumption that the realities of birthing and caring for a child may cause individuals to reevaluate their reproductive goals and fertility preferences. Additionally, the exogenous sex of one's firstborn child is likely to factor into how these preferences are updated as substitutability of daughters and sons is highly dependent upon cultural gender norms.

My study is unique in using the plausibly exogenous variation in the sex of recently firstborn children to understand how the sex outcome of a birth changes preferences for total fertility and family composition. To my knowledge, this is the first study to analyze the effects of sex outcome of first birth on fertility preferences. I investigate changes in stated preferences for total number of children, and number of preferred sons and daughters, based upon the sex of an individual's recently firstborn child. I also test the two existing hypotheses about sex of children influencing parity progression by examining the ways in which country-level socio-cultural effects such as fertility and gender norms cause these preferences to differ. The rest of my paper is laid out as follows: Section 2 offers a review of relevant literature and the theoretical framework of paper, Section 3 includes information on my data sources and methodology, Section 4 discusses findings and robustness checks, and Section 5 concludes.

2. Literature Review

A robust body of literature shows that fertility preferences, and subsequently reproductive choices, are closely tied to cultural gender norms, which are themselves a subset of social norms.

In this section I discuss the threads of economic literature that form the theoretical framework and empirical backbone of my research.

2.1 The Evolution & Perpetuation of Social Norms

Because social norms are central to economic relationships, there is a robust body of economic literature on the subject. Many economic theorists have turned to evolutionary game theory to explore how social norms evolve and shift over time (Bowles 2004; Boyd & Richerson 2002, Young 1993, 2015). Several important aspects influence the ways in which norms develop. Firstly, they can positively self-reinforce at the group level. Secondly, they can mutate organically via experimentation. Finally, they can diverge across time and space. Meanwhile, a number of mechanisms enforce normative behavior including social pressure, coordination, signaling, and reference points (Boyd & Richerson 2002; Montgomery & Casterline 1996; Young 1993, 2015).

Two concepts, *persistence* and *tipping*, are crucial to the evolution of norms over time. Persistence refers to the fact that norms respond slowly to external conditions that may alter the costs and benefits of adherence. However, once a competitive new norm gains a foothold within a group the shift usually happens very suddenly, not slowly over time. Once this tipping point is reached, positive reinforcement and increased payoffs hasten the transition (Young 2015). Young (1993) calls the interaction of these two concepts as the *punctuated equilibrium effect.* He writes that these two effects "create a characteristic signature in the historical evolution of norms: there are long periods of no change punctuated by occasional bursts of activity in which an old norm is rapidly displaced by a new one" (Young 2015).

In a study on innovation diffusion, Young (2009) presents three norm diffusion models: contagion, social influence, and social learning. Contagion models show people adopting when they come into contact with others who have adopted, much like a virus. Social influence models see people adopting once enough other people in their group have adopted in a show of conformity. In social learning models, people adopt only after they have been convinced that the norm is worth adopting; after they have seen the beneficial outcomes of prior adopters. Social learning is the most prominent model of norm diffusion within the economic discipline as it is based upon utility maximization. Using an empirical study on the adoption of corn farming, Young concludes that it provides evidence that social learning is the most realistic of the three models (Young 2009).

Prior to the formal institutional enforcement of rules by the likes of a state, society used norms to regulate social order. Norms could spread easily across neighboring groups and were likely to be adopted and reinforced if they were beneficial to the group as a whole. Using a standard replicator model of evolutionary game theory, Boyd and Richerson (2002) show that group beneficial norms spread quickly in a spatially structured population as a result of the ready adoption of strategies with high average payoffs. Using the social learning model defined by Young, their simulation shows individuals interacting repeatedly within their own society and sometimes with neighboring groups. Individuals have a higher probability of adopting a strategy from a neighboring group if that strategy yields a high payoff. Likewise, individuals within one's own society will similarly adopt that trait if it yields higher payoffs than their current strategy. Individuals interact more often with others from their own society than from neighboring societies, hence a norm will be adapted faster within-society than across societies (Boyd and Richerson 2002).

Preferences, like social norms, emerge from individuals interacting with their environment and change in response to social learning and adaptation (Druckman & Lupia 2000; Young 2015; Wildavsky 1987). Druckman and Lupia (2000) discuss preferences as ranked sets of substitutable choices, with preferences serving as cognitive markers that people store in their memory and draw upon when making decisions. Preferences are ranked using comparative evaluations that draw on information at hand, belief systems, social norms, and reference groups.

Of course, not all groups are heterogeneous. Modern societies are increasingly made up of individuals with diverse cultural histories. Bisin and Verdier (2001) present a model explaining the persistence of culturally specific norms. In order to explore the dynamics of preferences and cultural transmission, the authors construct a model in which parents judge their children's actions and behaviors in accordance with their own preferences, therefore children are socialized in accordance with the preferences preferred by the parents. Because children are socialized primarily within the family unit and secondarily within their surrounding culture, parents will spend more resources directly socializing children in a culture where they are minority members. In a society where the family is a member of the majority, the family trusts the culture as a whole to socialize the child in their way of thinking and the parents will take on a more passive role. However, in a culture where the family is a minority the parents do not trust the majority culture and will expend effort to directly influence their children's preferences (Bisin and Verdier 2002).

2.2 The Formation of Gender Norms

Boserup (1970) theorized that cultural differences in economic development stem from male and female farming systems and the division of labor within agriculture. Boserup compared areas in Africa that historically practiced shifting cultivation with regions in Asia that predominantly used plough cultivation. She proposed a theory that normative divisions of labor resulted from a culture's agricultural practices. Shifting cultivation requires working a smaller tract of land with hand tools where families grow crops on a tract for a few years before clearing a new plot of land and beginning again with fresh soil. The use of small hand tools was suited for female labor, whereas men in these societies specialized in activities that required physical strength, such as felling trees and hunting game. In contrast to shifting cultivation, plough cultivation requires large draft animals and substantial physical strength to control both the animal and the plough itself. In plough regions, families cultivated larger tracts of land year after year. More overall food per family was required due to both fewer families engaging in agriculture, as well as the feed required for large draft animals. In these areas, men specialized in agriculture as a result of their greater relative upper body strength, making women's labor unessential to field work. This led to women focusing on tasks based within the confines of the home. Boserup believed that the historical roles of men and women within the household and agricultural spheres, respectively, inform attitudes toward work and gender roles today (Boserup 1970).

In a 2013 empirical study, Alesina et al. put Boserup's plough hypothesis to the test. They find evidence showing the descendants of ethnic groups that practiced plough-based agriculture have lower rates of female labor force participation and more unequal beliefs about gender norms than the descendants of their shifting-based agricultural counterparts (Alesina et al., 2013). Their findings are consistent with Boserup's hypothesis that agricultural traditions and the gendered divisions of labor they inspired informed cultural norms regarding the role of women and men in society.

Subsequent work by other economists has added to the body of empirical evidence supporting Boserup's hypothesis linking historical divisions of labor with current gendered social norms. Hansen et al. (2015) show that cultures with a longer history of agriculture have more patriarchal views towards gender roles. The authors believe that one mechanism behind their findings is a result of Malthusian dynamics: societies that have practiced agriculture for longer are more technologically advanced, which translated to higher overall fertility during the preindustrial era, and women therefore spending more time and effort childrearing. A second mechanism is that societies that have practiced agriculture for longer are more likely to farm cereals. Cereals require processing, a task that women have comparative advantage in as it interferes less with childcare (Hansen et al. 2015).

Researchers have connected more egalitarian gender norms to regions where women contributed directly to the subsistence of the home through activities such as farming or fishing. In these regions, the shadow value placed on women's labor can be gleaned by looking at the direction bridal wealth flows: bride prices (money or gifts given to a bride's family) tend to be practiced in areas with shifting agriculture, whereas dowries (money or gifts given to the groom's family) are more commonly seen in regions with plough-based agriculture (Boserup 1970; Guiliano 2017). Research shows that modern SRBs are more uneven in countries with a history of plough-based agriculture, indicating a preference for sons. Historical birthing records also show evidence of son-preference in these regions in the common occurrence of son-based stopping (Alesina, et al. 2018; Jayachandran 2017; Krause et al. 2019).

2.3 *Fertility Preferences, Reproductive Choices & Sex Ratios at Birth*

Fertility behavior and demographics have been studied by economists since the discipline's early days. Thomas Malthus (1798) observed dynamics known as a *Malthusian Trap*, in which population levels were kept in check by scarce resources. Population levels could grow if resources became more abundant, but the growing population would return per capita resource levels to the same steady state and thus remain trapped (Malthus 1798). Soon after, the beginning of the industrial revolution created a whole new set of population dynamics – forever changing the way humans make reproductive choices.

The industrial revolution ushered in exponential rates of capital accumulation, and with it the beginning of the first of many demographic transitions to take place around the world. It was during this era that reproductive agency shifted from group-level to family-level. As per capita income grew and medical advances caused a steep decline in rates of child mortality, people were able to make and keep reproductive goals with a new level of certainty. In these newly industrializing countries, the death of a child went from being something every couple expected to endure at least once to a relative rarity over the course of the late 1800s and early 1900s (Reher et al. 2017). Throughout the 1900s this transition continued to take place in countries around the world, with many less developed regions still in the midst their demographic transitions.

As countries' economies developed over the course of the 20th and 21st century, couples went from having over five children on average to less than two and a half (UN 2019). Many economists and demographers have studied the lower fertility levels that characterize the latter half of demographic transitions. Multiple mechanisms are theorized to be the driving force behind these changes, including declining rates of child mortality, higher rates of contraceptive access and use, increases in women's education and workforce participation, and couples waiting longer to have children or deciding to forego having children completely (Becker 1960; Guinnane 2011; Shultz 1973; Vogl 2013).

Gary Becker (1960) looked at the choices individual sets of parents must make when having children, reasoning that children are a type of consumer durable from which parents derive satisfaction. Individual families must determine not only how many children to have but how much to spend on each child. Demand for most consumer durables rises in both quality and quantity with income. Certain aspects of modernity, such as declining infant mortality and the availability of reliable birth control, mean that parents can control the number of children they have while being reasonably sure of the survival of those children. As incomes rise, parents often choose to have fewer children of increasingly high quality in terms of child health and education (Becker 1960; Becker & Lewis 1973).

Meanwhile, Galor and Weil (2005) present a macro-focused theory known as the *unified growth model* in which parents invest more resources in fewer children as technological growth progresses. They theorized that technology increases the returns to children's education, inducing parents to choose to educate their children and creating a feedback loop which increases technological progress, human capital, and income per capita (Galor & Weil, 2005).

Shultz (1973) likewise examines the fertility choices available to an individual household and considers the price of children with respect to both the human capital required to raise them, as well as the formation of children into human capital. Shultz uses a household production function where the bearing and raising of children is a decision made in accordance with other consumption and production decisions. In his view, children first take away from and then add to human capital in a household. Young children are labor-intensive, the cost of which is largely absorbed by women. As children grow, they become less costly in terms of labor and more costly in terms of consumption, including educational and leisure costs. However, older children also have the possibility of adding to family capital if they assist in production (Shultz, 1973).

In addition to economic utility, some combination of personal and social motivations lies behind people's decision to have a child. Personal motivations include a sense of identity, morality, creativity, or accomplishment. Meanwhile, social motivations include strengthening group ties, social status, or a sense of social comparison and/or competition (Gray & Evans 2004; Hoffman 1975). Hoffman (1975) theorizes that parenthood establishes an individual as a stable, mature, and acceptable member of a community in a way that little else does. She argues that this is particularly true for mothers of lower socio-economic status who have a harder time attaining status through means more available to men such as education and employment. Additionally, many cultures view motherhood as women's major role in life (Hoffman 1975).

Both Shultz and Becker developed models in which households make fertility decisions as a unit. In these unitary household models, decisions are made either by a dictator-like head of the household or through a consensus on the part of household members (Samuelson 1956; Becker 1973). However, more recent empirical studies on household decision-making show that the unitary model of the household is unrealistic, as households are made up of individuals who sometimes have conflicting preferences (Ashraf et al 2014; Duflo 2001; Thomas 1990; Qian 2008).

In empirical studies of household consumption decisions, economists found diverging preferences of husbands and wives on a number of different matters. A Zambia-based RCT gave either couples or individual women vouchers for free injectable birth control. Couples given access to the voucher were 19% less likely to ultimately use the birth control and 27% more likely to give birth than when women were privately offered vouchers individually (Ashraf et al. 2014). Duflo (2001) found that old-age pensions received by grandmothers as opposed to grandfathers resulted in granddaughters with 1.19 standard deviations improved weight-given-height and 1.16 standard deviations improved height-given-age than girls born before the pensions policies took effect. No significant changes were found for grandsons from either grandparent receiving the pension (Duflo 2001). A study in China found female children have higher survival rates and receive more education when women's incomes rise relative to men's (Qian 2008). Similarly, a study in Brazil found that when women's unearned incomes rise, women spend more on their daughters and when men's unearned incomes rise, they spend more money on their sons (Thomas, 1990). These findings reinforce the non-unitary model of household decision-making and suggest that men and women have different priorities when making consumption decisions. The results also show that women prioritize spending on their daughters (and granddaughters) more than men, implying some degree of daughter-preference on the part of women.

According to the WHO, in the absence of explicit discrimination against daughters – including sex-selective abortions, daughter-discriminatory prenatal health decisions, and female infanticide, the "natural" SRB falls between 103 to 107 males born for every 100 females. However, many countries exhibit SRBs well over the "natural" range – most of which are countries whose decedents practiced plough-based agriculture (Krause et al. 2019). China, India, and South Korea are three such countries with extreme male skewed SRBs. In a cross-cultural analysis, Das Gupta et al. (2003) argue that son-preference in these countries stems from rigidly patrilineal kinship systems that marginalize women, guaranteeing that parents have few economic incentives to raise daughters. This results in strong pressure, both socially and economically, to bear sons (Das Gupta et al. 2003).

Inheritance practices in these areas see the main productive assets of a household passed down to male heirs. Additionally, sons are inherently fixed within the social order of a household whereas daughters are expected to join their husband's household after marriage. Daughters spend less of their life contributing to the household of their parents than sons and can become a drain on household finances if their dowry or wedding expenses are significant. Sons, however, are expected to care for parents as they age. In South Korea, the eldest son is expected to care not only for his parents but for his ancestors in the afterlife as well. These factors contribute to households valuing sons over daughters (Das Gupta et al. 2003; Jayachandran 2017).

In the son preferring regions of the world, many fertility decisions made by couples are predicated on the ability to produce at least one male heir. Global trends in both implicit and explicit fertility preferences are falling in response to increased economic development. Due to these trends, as well as the fact that fertility preferences are lower in regions with historical plough agriculture, couples with strong son-preference have fewer overall chances to produce their desired number of male children. Unlike more fluid preferences for total fertility, son-bias as a social norm has proven to be remarkably inflexible over time, suggesting that economic development in and of itself is insufficient to ending pre-and post-natal discrimination against daughters (Jayachandran 2014; 2017). Jayachandran (2017) studies sex-composition preferences in India, showing that families that desire fewer children prefer a more male-skewed sex composition ratio than couples prefer to have more children.

A number of studies show that preferences for sons affect family composition outcomes. Families in historically plough-based societies, with their less egalitarian gender norms, are more likely to employ son-based stopping decisions in which they decide to quit having children only after the desired number of sons is attained (Jayachandran 2017; Krause et al. 2019; Yamaguchi 1989). Families with daughters are likely to have more overall children, meaning fewer resources to go around – and fewer still for the girl children, as studies show that parental investment in boys tends to be higher than in girls (Basu & De Jong 2010; Rosenzweig & Shultz 1982; Yamaguchi 1989). This is perhaps most evident in India where female child mortality is 43% higher than that of boys and is the highest among daughters with at least one older sister (Jayachandran 2015).

Numerous studies have outlined adverse consequences of make-skewed sex ratios. The impact on marriage markets is one of the most explicit consequences. In a highly skewed marriage market, many men will have to wait longer to marry or not marry at all, with the poorest men likely to be the most impacted (Guilmoto 2007). While it may seem that the consequences of fewer total women compared to men is likely to raise the fortunes of women, it often results in more pressure on women to marry and to become mothers early, denying women the choice to wait longer to marry, remain single, further their education, join the labor force, and more (Guilmoto 2007; Hesketh 2001). Women are also at increased risk of violence and trafficking in societies with highly imbalanced sex ratios (Hudson & den Boer 2005). Studies have found a correlation between imbalanced sex ratios and more violence and crime in societies; however, it has not been shown to be causal. Researchers hypothesize that mechanisms behind this correlation are due to the fact that men who aren't given the choice to marry are more at risk of marginalization, loneliness, and possible psychological problems (Diamond-Smith & Rudolph 2018).

2.4 Conceptual Model & Contribution to the Literature

The goal of this study is to use the plausibly exogenous variation in the sex of recently firstborn children to understand how the sex outcome of a birth changes preferences for total fertility and family composition. The natural experiment at the heart of this paper relies on the exogeneity of the sex of firstborn children. Sociologists have argued in favor of incorporating the sex of offspring when studying parental attitudes, and past social science studies have reliably shown that the sex of children can affect parental actions and preferences (Downey et al. 1994). Somville (2019) shows that men with firstborn daughters are less likely to beat and strangle their partners than men with firstborn sons. Greenlee et al. (2018) demonstrate that fathers with daughters voted for Hillary Clinton at a higher rate in the 2016 US presidential election. Likewise, Glynn & Sen (2016), Washington (2008), and Oswald and Powdthavee (2010) find that sex of offspring effects their parents' voting behavior.

The rest of this paper's conceptual framework is tied together by economic literature on preference formation, fertility preferences, and determinants of the sex ratio. As discussed in Sections 2.2 and 2.3, gender norms play an important role in the formation of fertility preferences and the bias for sons. Son-preference, like many cultural gender norms, has proven to be pervasive thanks to cultural transmission pathways that are robust even in the face of cultural mobility and generational changes (Alesina et al. 2013; Bisin & Verdier 2001; Kraus et al. 2019). As fertility preferences update following the birth of a first child, the surrounding cultural gender norms likely play a role in determining how preferences respond to the sex of firstborn children. Among cultures with less egalitarian gender norms and strong son preference, children of either sex are seen as much less substitutable than in more egalitarian societies.

There are two existing theories as to how the sex of children influence parity progression. The first is that the sex of existing children will matter more in low fertility regimes in explaining subsequent births. The second is that the sex of children will matter more in places with more unequal gender norms (Gray & Evans 2004; Hank 2007; Pollard & Morgan 2002). The strength of this study lies in the opportunity to observe how fertility preferences update in response to the sex of firstborn children, and how differential fertility regimes and cultural gender norms play a role in the ways that these preferences change.

Distilling the interaction between fertility, sex compositional preferences, and gender norms is important toward understanding both the reproductive choices people make as well as the formation of fertility preferences. To my knowledge, this is the first study to analyze the effects of sex outcome of first birth on fertility and sex composition preferences. My study contributes to the literature studying the ways in which the sex of offspring influences their parents' behavior and preferences, as well as the bodies of literature on preference formation and norm transmission, specifically on the subject of fertility preference formation. Additionally, my study contributes to understanding determinants of total fertility and the sex ratio.

3. Data & Methodology

3.1 Data Sources

I perform my empirical analysis using individual-level data from the Demographic and Health Survey (DHS), which has been administered by USAID in over 90 developing countries since 1984. To date, the DHS `has performed seven phases of the survey, with many countries being represented in multiple phases. Surveys are collected from households at a country-representative level. Detailed demographic and health information is recorded on all men, women, and children of a household. In addition to the household questionnaire, women and men of reproductive age (generally 15 – 49) are interviewed for individual-level women's and men's questionnaires.

The DHS women's questionnaire includes a detailed birth history for each woman. Using this information, I was able to create sets of indicator variables for children born within the twelve months preceding the DHS survey, firstborn children born in this timeframe, as well as the firstborn children of either sex born within this timeframe. In my analysis, I specifically use the indicator for female children born in the year prior to the DHS survey. Because of the women's dataset's detailed birth history, I am able to run stratified regressions on women who have firstborn daughters not born within the twelve months preceding the DHS survey in order to see if the results hold over time. The women's dataset includes responses from over 2.8 million women, about 100,000 of whom became mothers to a firstborn in the twelve months prior to being surveyed by DHS.

The DHS also includes data available from the individual men's questionnaire available for download. Unlike the DHS women's questionnaire, the survey completed by men at the individual level includes far less information on their children. Men respond to questions regarding the total number of children they have had, the number of each sex, the number of children of each sex that have died, and the age of their most recent child given in single year increments. Using this information, I was able to construct a sample of men who have a single living child aged one or under, including indicator variables for firstborn daughters and firstborn sons. The men's dataset includes observations from over 900,000 men, about 30,000 had a firstborn aged one or under at the time of the DHS survey.

Data on country-level total fertility and sex ratios at birth are provided by the Department of Economic and Social Affairs at the UN. Using this data, I constructed samples of countries in order to test hypotheses regarding the impact of fertility levels and cultural gender norms on fertility preferences. The countries included in each sample can be referenced in Appendix Table **XX.** Data on historical plough use was taken from a dataset constructed by Krause et al. (2019) and slightly adapt an equation from Alesina et al. (2013) to give a plough-intensity at the country-level rather than the district-level. Their equation is as follows:

$$Plough_c = \sum_e \sum_i \frac{N_{eic}}{N_c} \times I_e^{plough}$$

The dummy variable I_e^{plough} is equal to 0 if an ethnic group did not use the plough and 1 if the ethnic group did use the plough. N_{eic} represents the number of individuals of an ethnicity (e) living in each grid cell (i) in country (c). This number is divided by N_c, the total population of a country. The values of plough are continuous between {0, 1}. I have merged this data with my original DHS datasets at the country-level in order to test hypothesis (2) discussed above.

3.2 *Research Design*

My study is a natural experiment exploiting the sex of firstborn children as a source of exogenous variation. Taken together with the timing of the DHS survey in relation to first births, I am able to identify the marginal effect of having a son or having a daughter on how new parents update their fertility preferences. Thanks to the detailed birth history available in the women's data, I am able to test whether or not these preferences hold over time. The DHS questionnaires for both women and men include the three following questions on fertility preferences:

Question 1: *How many total children would you prefer, irrespective of the number of children you already have?*

Question 2: *How many boy children would you prefer, irrespective of the number of sons you already have?*

Question 3: *How many girl children would you prefer, irrespective of the number of daughters you already have?*

Looking to the samples of women and men who have recently had their first child, I run empirical analysis to see if the answers given to the three fertility preference questions differ based upon the sex of the firstborn.

Additionally, I am able to test two current theories surrounding parental sex preferences to see if they hold. These theories include that 1) the sex of existing children matter more in low fertility societies in explaining subsequent births, and 2) that the sex of children is more important in less egalitarian cultures (Gray & Evans 2004; Hank 2007; Pollard & Morgan 2002). To test the first theory, I run various sub-analysis, including on countries with below and above-average fertility levels, based upon the year 2000 world average of 2.7 children (UN 2019). To test the second theory, I run two separate analyses. Firstly, I use sex ratio at birth as a proxy for existing son-bias. I run analysis on countries with low, natural, and high sex ratios at birth, based upon the country-level averages over the years 2000-2005 (UN 2019). Secondly, I use historical plough use as a proxy for cultural gender norms and run samples on countries with historically high and low use of plough-based agriculture. The results provide insights into norm transmission and the formation of fertility preferences.

3.3 Model Specifications

I perform empirical analysis using an ordinary least squares (OLS) model with fixed effects at the administrative district level interacted with month, and interview year level. Standard errors are clustered at the administrative district level. I chose an OLS model after ensuring my data stood up to various tests of normality, including ensuring that the regression residuals are normally distributed and conducting a Kolmogorov–Smirnov test. My model specifications are as follows:

$$P_{idy} = \alpha + \beta_{idy} + \rho_{idy} + \delta_d + \gamma_y + u_{idy}$$

The dependent variable P_{idy} represents the fertility preferences of person *i* in administrative district *d* in year *y* in terms of their ideal number of total children, ideal number of boys, and ideal number of girls. The variable β_{idy} indicates if person *i* has a recently firstborn daughter by taking on the value 1 if an individual had a firstborn daughter and 0 if the individual had a firstborn son. Next, ρ_{idy} includes a vector of demographic controls including age, age at first birth, education measured in single years, a dummy for rural households, and a dummy for poor households constructed from the DHS wealth quintiles, with households in the bottom two quintiles 1 for poor and coded 0 otherwise. The model's fixed effects are represented by δ and γ. Additionally, because the DHS surveys at a country-representative level, and because some countries have been surveyed more than others, the respondents from certain countries make up a larger portion of my sample than those from less populous countries. In order to account for this, weighting was performed using the DHS provided sample weights in conjunction with year 2000 population levels.

3.3 Limitations

Possible limitations that I cannot account for in my identification strategy include sex selection, possible lack of reporting on miscarriages or stillbirths, and possible health effects that may vary by region and cause differential effects to female and male fetuses (Orzack et al. 2015). Sex selection is unlikely to be of concern in this study due to the fact that SRBs for first children generally fall into the "natural" range of 103 to 107 even in countries with strong son-preference (Anukriti et al. 2015; Bhalotra & Cochrane 2010; Zeng, et al., 1993). To ensure that sex selection was unlikely to introduce endogeneity, I tested the SRB of firstborn children using the women's data for its detailed birth history. In my sample, the overall SRB for firstborn children is 106.4. Additional robustness checks explained further in my results section attempt to account for any possible sex-selection.

4. Results

4.1 Descriptive Statistics

Tables 1 and 2 contain descriptive statistics on my variables of interest, as well as the control variables used in my regressions. In the women's DHS sample as a whole (Table 1a), women on average want 3.77 children. Women's preferred sex ratio for children is fairly even, with an average of 1.56 girls and 1.62 boys. Over 2.5 million women have answered the question regarding their preferred number of children, and slightly more than 2 million specified their preferred sex compositional preferences. This may explain the disparity between the total number of children desired and the number of specified boys and girls. Additionally, respondents could have preferences for a total number of sons and daughters and additional children of an unspecified sex. On average, the women in the DHS sample are close to 30 and were roughly 20 years old when they had their first child. They have a mean education duration of 5.58 years, 57% are members of rural households, and 33% are members of households in the bottom two quintiles of the DHS wealth index.

Descriptive statistics for women who are part of the recent first births sample, each having given birth to their first child within a year of being interviewed for the DHS survey, are visible in Table 1b. These women are demographically similar to the women's DHS sample as a whole. Women with a recent birth were on average 20 years old at the time of birth. They have a mean education duration of 6.39 year, 60% are members of rural households, and 34% are members of poor households. Two meaningful differences stand out: the women who have recently had their first child are 21 on average, which is substantially lower than the mean age of 30 in the general women's sample. Additionally, women in the recent first births sample want on average 3.32 children instead of the 3.77 for the overall sample. The mean difference in desired children of 0.45 amounts to a relative difference of 13.5% fewer children.

Men in the DHS sample want on average 4.44 children, 1.78 girls and 2.13 boys (Table 2a). Compared to women who want only 0.06 more sons than daughters, men seem to have a stronger preference toward boy children and on average want 0.35, or 19.6%, more sons than daughters. Men in the sample are on average 31 years old and were 25 at the time of their first child's birth. They have an average of 7.17 years of education. About 59% are members of rural households and 38% are members of poor households.

Meanwhile, the sample of men who have recently had their firstborn child are described in Table 2b. These men are also demographically similar to the men's sample as a whole. Men with recent first births have 7.97 years of education on average, were close to 26 at the time of their first child's birth and 27 at the time of the DHS survey. Men belonging to rural households make up 61% of the sample, and men belonging to poor households make up 38% of the sample. Similar to the women's first births sample, the ideal number of total children falls from 4.44 to 3.89 – a decrease of 0.55, or 14%, fewer children.

4.2 Main Results

Tables 3a and 3b show the regression results for the women's and men's recent first births samples. The coefficient represents the marginal effect of having a daughter, and due to the binary nature of the variable, the marginal effect of having a son would be the inverse of the coefficient. Columns (1) and (2) on each table show the marginal effect of having a daughter on total fertility preferences. Both before and after the vector of demographic controls are added in, women want 0.03 more children conditional on having a daughter. This is statistically significant at the 5% level. For men, the marginal effect of having a daughter is desiring about 0.058 more children. This is not statistically significant; though it is directionally positive. It appears that both men and women want more overall children after having a firstborn daughter and fewer children after having a firstborn son.

Columns (3) and (4) show the women's and men's results for ideal number of girls. Conditional on having a firstborn daughter, women prefer 0.09 more daughters both before and after the vector of demographic controls, statistically significant at a 1% level. Men prefer 0.094 more girl children before demographic controls are added to the regression and 0.087 more daughters following the addition of demographic controls, likewise significant at a 1% level. For both men and for women, the marginal effect of having a daughter appears to be a bias for more girl children. Likewise, having a son appears to decrease the number of girl children individuals prefer.

Columns (5) and (6) report the regression results for ideal number of preferred boys. Both before and after the addition of demographic controls, women prefer 0.04 fewer boy children conditional on having a firstborn daughter. This is highly statistically significant at the 1% level. Meanwhile, men show almost no change in the number of boy children they want following the recent birth of a daughter. A possible explanation for this difference is that son preference among men is stronger and more inelastic than that of women, and therefore the sex of their first child does not alter their preferences. Both sexes show a similar response toward having a girl as a first child, which results in a preference for about 0.09 more girl children. It is possible that for both sexes, preferences for daughters are more elastic. Women also show a significant change in the number of boys they prefer based upon the sex of their firstborn, suggesting that women's sex compositional preferences are more prone to update based upon the sex of her first child.

Looking to Figures 1a and 1b, which show the results for ideal number of children at a country level, it is evident that the sex of firstborn children results heterogeneous preference responses. The figures show the mean percentage difference in number of children preferred conditional on the sex of recently firstborn children for both the women's and the men's samples. Pink indicates countries in which first-time parents on average prefer more children conditional on having a firstborn daughter, while the countries shaded green indicate parents prefer more children conditional on having a firstborn son. The darker the color, the stronger the effect. Consistent with the regression results, both the women's and the men's maps have more pink countries than green, indicating it is more common overall for individuals to want more overall children if they have a firstborn daughter rather than a firstborn son.

The heterogeneous results suggest that socio-cultural factors influence both the formation of fertility preferences as well as how people's preferences update conditional on the sex of their first child. Notably, countries in Africa's matrilineal belt (Zambia, Malawi, and Mozambique) are shaded green in Figure 1a showing the women's results. Due to the practice of female land inheritance, perhaps having a daughter as a first child means women then feel less of a need to have additional children in order to produce an heir.

Additionally, while the majority of countries appear to see women and men with directionally similar preference updates, a number of countries do not. In Brazil, for example, women want up to 5% more children if their child is male and men want 5-10% more children if their first child is female. Similar patterns can be witnessed Bangladesh, Pakistan, Ukraine, Cambodia, Madagascar, Gabon, Côte d'Ivoire and Burkina Faso. Meanwhile, the opposite pattern can also be seen in which women appear to desire more children if their first child is female, while men desire more children if their first child is male. The strongest example of this is Kazakhstan, in which women want up to 5% more overall children if they have a firstborn daughter, yet men want 10-15% more children if their firstborn is male. This pattern is also evident to a lesser degree in Bangladesh, Albania, Azerbaijan, Nicaragua, Bolivia, Ghana, Mali and Togo.

4.3 Differential Fertility Countries

The differential effects visible in Figures 1a and 1b suggest that socio-cultural elements effect how the sex of firstborn children impacts parents' fertility preferences. According to theories on parental sex preferences, the sex of existing children should matter more in low fertility societies in explaining successive births (Gray & Evans 2004; Hank 2007; Pollard & Morgan 2002). In high fertility countries, couples have a higher probability of naturally attaining their desired sex composition of children than couples in low fertility countries, making the impact of the sex of existing children among couples who desire fewer overall children of higher import.

In order to understand more about how average fertility levels impact and are influenced by the sex of first children, I created subsamples of countries with below average and above average fertility based on year 2000 total fertility averages. Countries with total fertility rates at or below the global average of 2.7 children were included in the "low fertility" subsample and countries with total fertility rates above 2.7 were included in the "high fertility" subsample. Like the regressions explained in Section 4.1, only those parents with recent firstborns were included in my regressions in order to best identify the marginal effect of having a firstborn daughter versus having a firstborn son.

The women's results can be seen in Table 4a for low fertility countries and Table 4b for high fertility countries. In high fertility countries the marginal effect of having a female first child is a desire for 0.035 more children, significant at the 10% level. Among low fertility countries, however, the desired number of total children for women with a firstborn daughter appears to change very slightly, if at all. However, when it comes to ideal number of girl children, women in both the low and high fertility subsamples appear to have their preferences change based upon the sex of their firstborn child. Women in high fertility countries desire a highly significant 0.085 more girl children, while women in low fertility countries want 0.109 more girls. Both are significant at the 1% level. Lastly, conditional on having a female first child, women in high fertility countries want 0.034 fewer boys and women in low fertility countries want 0.067 fewer boys, both significant at the 5% level. While the sex compositional preference changes among women in low fertility countries are already stronger than for women in high fertility countries, these changes are also of a larger magnitude considering the average number of preferred children is smaller in low fertility countries.

The men's results for low fertility countries can be seen in Table 5a and the results for high fertility countries can be seen in Table 5b. Though the change is not statistically significant, men in high fertility countries appear to prefer more overall children conditional having a recently firstborn daughter. The regression coefficient is 0.13 with a standard error of 0.1, suggesting a directionally positive change with wide variation. Similar to women in low fertility countries, men in this subsample also see an insignificant and miniscule change in the total number of preferred children. When it comes to the sex composition of children, men in high fertility countries want 0.096 more daughters, conditional on having a firstborn daughter, though the coefficient is not a statistically significant. Meanwhile, men in low fertility countries want a highly statistically significant 0.078 more daughters. Neither sample of men show a statistically significant change in the number of boys preferred; however, men in high fertility countries show a directionally positive change conditional on having a recent firstborn daughter while men in low fertility countries show a directionally negative change.

The results from both the women's and the men's subsample suggest that preferences for total number of children are more elastic among those in high fertility countries where we see women's preferences changes by 0.035 depending on the sex of a firstborn and men's preferences change by somewhere in the range of 0.03 to 0.23. Meanwhile, the sex compositional preferences of women and men shift more in low-fertility countries. This is especially true among preferences for girls, which goes up by a highly significant 0.078 for men and 0.109 for women when their firstborn is female. This finding is consistent with the theory that sex of children should matter more in low fertility societies.

4.4 Differential Gender Norm Countries

As discussed in Section 2, gender norms play a substantial role in how fertility preferences are formed. They likely also play a role in how fertility preferences update depending on the sex of one's first child. In countries with less egalitarian gender norms, sons and daughters are seen as less substitutable than in countries with more egalitarian norms. I test the effect of differential gender norms on fertility preferences in two ways: using country-level SRBs as a proxy for existing son-preference and using historical plough use as a proxy for egalitarian gender norms.

According to the WHO, the "natural" sex ratio at birth is between roughly 103-107 boys born for every 100 females, due to varying the mortality levels of fetuses of each sex during pregnancy. Using data from the UN, I created subsamples of countries that over the years 2000-2005 had average sex ratios at birth below the natural level (low SRB), in the natural range (natural SRB) and above the natural range (high SRB). A breakdown of each sample can be found in Table **XX**.

The regression results for the women's regressions on regressions on the low, natural, and highly skewed SRB subsamples can be found in Tables 6a, 6b, and 6c. None of the samples return statistically significant results for a shift in the ideal number of total children based on the sex of firstborn children. However, the low SRB sample does have a directionally negative coefficient of -0.015, while the natural and high SRB samples have directionally positive coefficients of 0.045 and 0.33, respectively. Each sample has a highly statistically significant coefficient between 0.09 and 0.107 for ideal number of girls following the birth of a firstborn daughter. Meanwhile, the low SRB sample has a coefficient of -0.044, significant at the 10% level, for ideal number of boys following the recent birth of a firstborn daughter. The natural SRB sample sees a directionally similar coefficient of -0.073, significant at the 1% level. The high SRB sample, however, has a positive coefficient of 0.007 that is not statistically significant.

The regression results for the men's regressions on the low, natural, and highly skewed SRB subsamples can be found in Tables 7a, 7b, and 7c. Among the men's samples for ideal number of children, men in both the low and the natural SRB samples have directionally negative following the birth of a firstborn daughter. This coefficient is -0.135 for the low SRB sample and -0.054 for the natural SRB sample. Meanwhile, the high SRB sample has a coefficient of 0.083. None of these coefficients are statistically significant, though they are directionally interesting given what the sex ratio tells us about the existing son-bias within these countries. For the ideal number of girls, all three samples have directionally positive coefficients; however, the high SRB sample has the largest coefficient at 0.1 and is the only statistically significant coefficient. As for ideal number of boys, both the low and the natural samples have large and statistically significant preference changes based upon the sex of firstborn children. Men with a firstborn daughter prefer 0.216 fewer boys in the low SRB sample, and 0.123 fewer boys in the natural SRB sample. However, men with firstborn daughters in the high SRB sample appear to prefer more sons. The coefficient on this result is 0.044, though it is not statistically significant.

The second method I used to test the influence of gender norms on fertility preference changes is historical use of plough-based agriculture. Studies show that historical use of the plough resulted in less egalitarian gender norms, and that these norms are persistent in the present day compared with regions that practiced other agricultural methods (Alesina et al. 2011, 2013; Krause et al. 2019). The measure I used for historical plough use is a continuous variable along the interval [0, 1], based on the percentage of a country's population with ancestors who practiced plough-based agriculture. Similarly to previous papers that have relied on this variable, I've added countries with 0.85 and above to a "high plough use" subsample, and countries with 0.15 and below to a "low plough use" subsample. The regression results for the high and low plough use samples can be found in Tables 8 for the women's subsamples and Table 9 for the men's subsamples.

For women with firstborn daughters, both the low plough and high plough use subsamples have similar, non-statistically significant effects for their ideal number of children. The low plough use subsample has a coefficient of 0.022 and the high plough use subsample has a coefficient of 0.025. Likewise, for ideal number of girls, both women's subsamples have parallel results: conditional on having a firstborn female, women in low plough use countries prefer 0.098 more girl children, and women in high plough use countries prefer 0.083 more daughters, both significant at the 1% level. However, when it comes to the preferred ideal number of boys after having a firstborn daughter, the two samples differ. Women in the low plough use subsample desire a highly statistically significant 0.083 fewer boys, whereas women in the high plough use subsample desire 0.023 fewer boys, though this coefficient is not statistically significant. While it appears that preferences for ideal number of girls is affected based on the sex of firstborn children, and therefore more elastic, a similar elasticity in preferences for boys is only evident in the low plough use sample. It is possible that the high plough use sample has a stronger and less elastic preference for boys overall, given that less egalitarian gender norms in these countries mean that girl children and boy children are seen as less substitutable.

Among the men's samples, neither the high plough use nor low plough use subsample see a statistically significant change in ideal number of children after having a recent firstborn daughter. However, the coefficient of -0.027 is negative in the low plough use subsample and the coefficient of 0.09 is positive in the high plough use subsample. When it comes to ideal number of daughters, men with firstborn daughters in the low plough use subsample see almost no change in the desired number of daughters, whereas men in the high plough use subsample desire a highly significant 0.108 more daughters. These results nearly swap when it comes to ideal number of boys. In low plough use countries, men want 0.119 fewer boys, significant at the 5% level, if they've had a firstborn daughter, while the number of boys does not change a statistically significant amount based on the sex of the firstborn child. Among men in the low plough use sample, it seems that preferences for girl children are more elastic than preferences for boy children. Notably, many of the countries in the low plough use sample overlap with countries with below natural SRB which perhaps signals some degree of daughter-preference. Meanwhile, similarly to the women's high plough sample, we see an elastic preference for daughters and a static preference for sons.

Based upon the results for both the various SRB samples and the differential plough use samples, it does appear that gender norms play a large role in how fertility preferences are updated following the birth of a firstborn and based upon the sex of that firstborn. In countries where sons are preferred, we see more a more elastic preference for daughters and a less elastic preference for sons. In these countries, individuals are also likely to want more overall children conditional on having a daughter, perhaps signaling that they feel as if they must have more children in order to have a son. This is consistent with the theory that sex of children matters more in less egalitarian societies where children of either sex are seen as less substitutable by their parents and the wider culture.

4.5 Further Robustness Checks

I ran a series of checks in order to ensure the robustness of my findings and to account as much as possible for any limitations to my identification strategy. Firstly, I ran regressions on a women's and a men's subsample excluding India. While the majority of empirical evidence suggests that individuals do not use sex selection on their first children, anecdotal accounts suggests that some couples in India engage in first child sex selection if they only want one child. Additionally, India represents the largest number of respondents in the DHS data, making up a good portion of both the men's and the women's samples; by excluding India I am also able to check to see if data from India has an outsized effect on my findings. The results for the women's and men's subsamples excluding India can be found in Appendix Table A.1.

For the women's sample, the results are similar in magnitude to the main women's results in Table 3a. In the subsample excluding India, women's preferences for ideal number of children change by 0.028 dependent on the sex of her firstborn, while women's preferences for girl children go up by 0.078 and preferences for boys go down by 0.066. The sex composition preferences are significant at the 1% level, while the preferences for ideal number of children are not statistically significant, though they are similar in magnitude to the sample as a whole. Notably, respondents from India account for the largest portion of DHS responses, and therefore the largest single country included in my sample of women who had their first birth within twelve months of the DHS survey. It is conceivably that the smaller sample size accounts for the loss of significance on that coefficient.

For the men's subsample excluding India, the results are also directionally similar to the main results in Table 3b. The marginal effect of having a firstborn female child results in men desiring more overall children, and similarly main results this number is not statistically significant. The coefficient in the subsample excluding India is slightly higher at 0.117. The subsample also has a similar preference for more girls, conditional on the birth of a firstborn daughter, with a coefficient of 0.105 significant at the 5% level. Mirroring the main men's results, men's preferences for their ideal number of boys does not change a significant amount based on the sex of their firstborn child. It appears that neither the large representation of respondents from India nor the possible sex selection used among first time parents of that country appear to have an effect on my overall findings for women or for men.

Due to more detailed birth histories collected by the DHS in their women's questionnaire, I am also able to run two additional checks of robustness on the women's sample. The DHS women's survey includes a question inquiring as to whether a woman has had a pregnancy that did not result in a live birth. They do not inquire further into whether this is due to miscarriage, stillbirth, or abortion. In order to comprehensively account for any possible sex selective abortions, I ran a regression on a subsample of women excluding those who answered yes to this question, which can be found in Appendix Table A.2. The results are very similar in magnitude to the main women's results in Table 3a. For ideal number of children, women in this subsample prefer 0.027 more if they've had a firstborn daughter, significant at the 10% level. When it comes to their ideal number of girls, women prefer 0.091 more conditional on having a firstborn daughter. Lastly, women with a recent firstborn daughter prefer 0.038 fewer boys. Both the coefficients on ideal number of girls and ideal number of boys are significant at the 1% level. Ultimately, it does not appear that having any number of previous pregnancies not result in a live birth significantly change my findings.

Finally, due to the more detailed birth history from women, I was able to see if the results of the sex of a recent firstborn are similar or different from the longer-term effects of the sex of firstborn children. In order to check the longer-term effects of having a firstborn daughter, I ran a regression on a sample of women who are parents to one or more children, but who have not had a birth in the past twelve months. The results can be found in Appendix Table A.3. The results are similar in both magnitude and significance. Women who have a firstborn daughter prefer 0.031 more overall children, 0.111 more girl children, and 0.075 fewer boy children, all significant at the 1% level. While the marginal effect of having a daughter on total number of children is identical to the recent first births sample, the sample exploring the longer-term effects appear to have slightly stronger effects when it comes to sex composition. These results provide evidence of the long-term effect that the sex of one's firstborn child has on future fertility preferences.

5. Conclusion

My findings suggest that the sex of first children plays a role in determining preferences for total fertility, as well as preferred numbers of sons and daughters. Not only do the results show new parents updating their fertility preferences ex post facto, these updated preferences seem to hold over time. The strongest effect seen in my study is on both women's and men's preferences for ideal number of girls, which between 0.09 to 0.1 conditional on having a firstborn daughter. Overwhelmingly, both men and women also want more children on average after having a firstborn daughter and fewer children on average after having a firstborn son. However, it is unclear if the result of preferring more children is an effect of wanting more girl children after having a daughter or an effect of desiring more children overall in order to have a son. More research is ultimately necessary in order to fully understand this effect.

Moreover, I am able to test the two existing hypotheses concerning the interaction of parity progression with fertility regimes or gender norms. I find evidence to support both existing theories. I show that sex compositional preferences change more dependent on the sex of firstborn children in low fertility contexts. It also seems that cultural gender norms play a role in the ways that individuals respond to the sex of their firstborn child.

Multiple competing or interdependent mechanisms may be at play behind these results. I find evidence of less elastic son preference among both women and men, with men's preferences for sons appearing to be the most inelastic. Meanwhile, changes of higher magnitude and greater statistical significance are found for daughter preferences among both women and men. These findings indicate a relative flexibility in preferences for girls and inflexibility in preferences for boys. This result hardly comes as a surprise given the prevalence of son-preference around the world, as well as supporting what we know about intergenerational preference transmission. Additionally, some sort of retrospective or confirmation biases could be behind these updated preferences: parents who felt indifferent, or even negative, toward the idea of having a girl might feel otherwise following the birth of a daughter. Future research could attempt to disambiguate these potential mechanisms.

Ultimately, my findings suggest that both total fertility as well as sex compositional preferences update over the course of one's life. The sex of an individual's first child, in conjunction with becoming a parent, plays a role in determining how these preferences update, and these changes do appear to hold over time. Cultural norms regarding total fertility levels and gender roles likewise govern preference responses to the sex of first children. It is my hope that understanding more about fertility preference formation can guide future research and policies aiming to reduce the prevalence of skewed sex ratios, especially with regards to daughter discrimination.

Works Cited

Ashraf, Nava; Field, Erica & Lee, Jean. (2014). "Household Bargaining and Excess Fertility: An Experimental Study in Zambia." *American Economic Review, 104*(7), 2210-2237.

Alesina, Alberto; Giuliano, Paola & Nunn, Nathan. (2011). "Fertility and the Plough." *American Economic Review*, 101(3): 499-503.

Alesina, Alberto; Giuliano, Paola & Nunn, Nathan. (2013). "On the Origins of Gender Roles: Women and the Plough." *The Quarterly Journal of Economics*, 128(2): 469-530.

Anukriti, S., Bhalotra, S., & Tam, H. (2016). "Missing Girls: Prenatal versus Postnatal Discrimination." Working paper.

Barro, Robert J. & Becker, Gary S. (1988) "A Reformation of the Economic Theory of Fertility." *Quarterly Journal of Economics*, 103(1): 1-25.

Basu, Deepankur & De Jong, Robert. (2010). "Son Targeting Fertility Behavior: Some Consequences and Determinants." *Demography*, 47(2): 521-536.

Becker, Gary S. (1960). "An Economic Analysis on Fertility." *Demographic and Economic Change in Developed Countries*. National Bureau of Economic Research, Inc.

Becker, Gary S. (1973). "A Theory of Marriage." *Journal of Political Economy*, 81(4): 813-846.

Becker, Gary S. & Lewis, Gregg S. (1973). "Interaction Between Quantity and Quality of Children." *Economics of the Family: Marriage, Children, and Human Capital.* University of Chicago Press.

Bhalotra, Sonia R. & Cochrane, Tom. (2010). "Where Have All the Young Girls Gone? Identification of Sex Selection in India." IZA Discussion Paper No. 5381.

Bisin, Alberto & Verdier, Thierry. (2001). "The Economics of Cultural Transmission and the Dynamics of Preference." *Journal of Economic Theory*, 97:298-319.

Bongaarts, John & Guilmoto, Christophe Z. (2015). "How Many More Missing Women? Excess Female Mortality and Prenatal Sex Selection, 1970–2050." *Population and Development*, 41(2): 241-269.

Bowles, Samuel. (2004). *Microeconomics: Behavior, Institutions, and Evolution.* Princeton University Press, Princeton, NJ.

Boyd, Robert; Richerson, Peter J. (2002). "Group Beneficial Norms Can Spread Rapidly in a Structured Population." *Journal of Theoretical Biology*, 215(3): 287-296.

Dasgupta, Ari; Ha, Lan; Jonnalagadda, Spurthi; Schmeiser, Steven & Youngerman, Hannah. (2018). "The Daughter Effect: Do CEOs with Daughters Hire More Women to their Board?" *Applied Economics Letters*, 25(1): 891-894.

Das Gupta, Monica; Zhenghua, Jiang; Bohua, Li; Zhenming, Xie; Chung, Woojin; Hwa-Ok, Bae. (2003). "Why is Son Preference so Persistent in East and South Asia? A Cross Country Study of China, India, and the Republic of Korea." *The Journal of Development Studies*, 40(2): 153-187.

Diamond-Smith, Nadia & Rudolph, Kara. (2018). "The Association Between Uneven Sex Ratios and Violence: Evidence from 6 Asian countries." *PLoS One*, 13(6), e0197516.

Downey, Douglas B.; Jackson, Pamala B. &Powell, Brian. (1994). "Sons Versus Daughters: Sex Composition of Children and Maternal Views on Socialization." *The Sociological Quarterly*, 35(1): 33-50.

Druckman, James N. & Lupia, Arthur. (2000). "Preference Formation." *Annual Review of Political Science*, 3: 1-24.

Duflo, Esther. (2001). "Grandmothers and Granddaughters: Old Age Pension and Intrahousehold Allocation in South Africa." *World Bank Economic Review*, World Bank Group, 17(1): 1-25.

Duflo, Esther. (2012). "Women Empowerment and Economic Development." *Journal of Economic Literature*, 50(4): 1051-1079.

Galor, Oded & Weil, David N. (2005). "Population, Technology, and Growth: From Malthusian Stagnation to the Demographic Transition and Beyond." *American Economic Review*, 90(4): 806-828.

Giuliano, Paola. (2017). "Gender: An Historical Perspective." In Averett, S. L., Argys L. M., & Hoffman, S. D. (Ed.), *The Oxford Handbook of Women and the Economy* (Online version). Oxford: Oxford University Press.

Guilmoto, Christophe Z. (2007). "Sex-Ratio Imbalance in Asia: Trends, Consequences and Policy Responses." Paris: LPED/IRD.

Glynn, Adam N. & Sen, Maya. (2015). "Identifying Judicial Empathy: Does Having Daughters Cause Judges to Rule for Women's Issues?" *American Journal of Political Science*, 59(1): 37-54.

Gray, Edith & Evans, Ann. (2004). "Sex Composition of Children as A Determinant of Parity Progression." *Negotiating the Life Course Discussion Paper Series.* Discussion Paper DP- 018.

Greenlee, Jill S.; Nteta, Tatishe M.; Rhodes, Jesse H.; Sharrow, Elizabeth A. (2018). "Helping to Break the Glass Ceiling? Fathers, First Daughters, and Presidential Vote Choice in 2016." *Political Behavior.*

Guinnane, Timothy W. (2011). "The Historical Fertility Transition: A Guide for Economists." *Journal of Economic Literature*, 49(3): 589-614.

Hank, Karsten. (2007). "Parental Gender Preferences and Reproductive Behaviour: A Review of the Recent Literature." *Journal of Biosocial Science*, 39(5): 759-767.

Hansen, Casper W., Jensen, Peter S. & Skovsgaard, Christian V. (2015). "Modern Gender Roles and Agricultural History: the Neolithic Inheritance." *Journal of Economic Growth*, 20(1): 365-404.

Hesketh, Therese. (2011). "Selecting Sex: The Effect of Preferring Sons." *Early Human Development*, 87(11), 759-761.

Hoffman, Lois Wladis. (1975). "The Value of Children to Parents and the Decrease in Family Size." *Proceedings of the American Philosophical Society*, 119(6): 430-438.

Hudson, Valerie & den Boer, Andrea. (2005). "Missing Women and Bare Branches: Gender Balance and Conflict." *Environmental Change and Security Program Report*, (11), 20-24.

Jayachandran, Seema. (2015). "The Roots of Gender Inequality in Developing Countries." *Annual Review of Economics*, 7: 63-88.

Jayachandran, Seema. (2017). "Fertility Decline and Missing Women." *American Economic Journal: Applied Economics*, 9(1): 118-139.

Krause, Patrick; Anttila-Hughes, Jesse & Stopnitzky, Yaniv. (2019). "The Roots of Modern Sex Ratios." Working paper.

Malthus, Thomas Robert, (1798). *An Essay on the Principle of Population*, Project Gutenberg.

Montgomery, Mark R. & Casterline, John B. (1996). "Social Learning, Social Influence, and New Models of Fertility." *Population and Development Review*, 22: 151-175.

Orzack, Steven Hecht; Stubblefield, William J.; Akmaev, Viatcheslav R.; Colls, Pere, Munné, Santiago; Scholl, Thomas; Steinsaltz, David & Zuckerman, James E. (2015). "The Human Sex Ratio from Conception to Birth." *PNAS*, 112(16): E2102-E2111.

Oswald, Andrew J. & Powdthavee, Nattavudh. (2010) "Daughters and Left-Wing Voting." *The Review of Economics and Statistics* 92(2): 213-227.

Pollard, Michael S. & Morgan, Phillip. (2002). "Emerging Parental Gender Indifference? Sex Composition of Children and the Third Birth." *American Sociological Review*, 67(4): 600-613.

Puri, Sunita; Adams, Vincanne & Nachtigall, Robert D. (2011). "'There is Such a Thing as Too Many Daughters, but not Too Many Sons.': A Qualitative Study of Son Preference and Fetal Sex Selection Among Indian Immigrants in the United States." *Social Science & Medicine*, 72(7): 1169-76.

Reher, David Sven; Sandström, Glenn; Sanz-Gimeno, Alberto & van Poppel, Frans W. A. (2017). "Agency in Fertility Decisions in Western Europe During the Demographic Transition: A Comparative Perspective." *Demography*, 54(1): 3-22.

Ritchie, Hannah & Roser, Max. (2020). "Gender Ratio." OurWorldInData.org.

Ritchie, Hannah & Roser, Max. (2020). "World Fertility." OurWorldInData.org.

Rosenzweig, Mark R. & Schultz, T. Paul. (1982). "Market Opportunity, Genetic Endowments, and Intrafamily Resource Distribution: Child Survival in Rural India." *The American Economic Review*, 72(4): 803-815.

Samuelson, Paul. (1956). "Social Indifference Curves." *Quarterly Journal of Economics*, 70(1): 1-22.

Sen, Amartya. (1990). "More Than 100 Million Women Are Missing." *The New York Review of Books*, 37(20).

Shultz, Theodore W. (1973). "The Value of Children: An Economic Perspective." *Journal of Political Economy*, 81(2): 2-13.

Somville, Vincent. (2019) "Having a Daughter Reduces Male Violence Against a Partner." NHH Dept. of Economics Discussion Paper No. 24/2019.

Thomas, Duncan. (1990). "Intra-Household Resource Allocation: An Inferential Approach." *The Journal of Human Resources*, 25(4), 635.

Qian, Nancy. (2008). "Missing Women and the Price of Tea in China: The Effect of Sex-Specific Earnings on Sex Imbalance." *Quarterly Journal of Economics*, 123(3), 1251-1285.

United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects: The 2019 Revision.

Vogl, Tom. (2015). "Differential Fertility, Human Capital, and Development." *The Review of Economic Studies*, 83(1): 365-401.

Wildavsky, Aaron. (1987). "Choosing Preferences by Constructing Institutions: A Cultural Theory of Preference Formation." *The American Political Science Review*, 81(1): 3-22.

Yamaguchi, Kazuo. (1989). "A Formal Theory for Male-Preferring Stopping Rules of Childbearing: Sex Differences in Birth Order and in the Number of Siblings." *Demography*, 26(3): 451-465.

Young, Peyton H. (1993). "The Evolution of Conventions." *Econometrica*, 61(1): 57-84.

Young, Peyton H. (2009). "Innovation Diffusion in Heterogeneous Populations: Contagion, Social Influence, and Social Learning." *American Economic Review*, 99(5): 1899-1924.

Young, Peyton H. (2015). "The Evolution of Social Norms." *Annual Review of Economics*, 7: 359-387.

Table 1: Women's Descriptive Statistics

Table 1a: Women's DHS Sample

Variable	Obs.	Mean	Std. Dev.	Min	Max
Ideal number of children	2,530,000	3.77	2.24	0	12
Ideal number of girls	2,090,000	1.56	1.25	0	6
Ideal number of boys	2,090,000	1.62	1.31	0	6
Age	2,820,000	29.96	9.6	10	65
Age at first birth	2,090,000	19.67	3.99	12	48
Education (single years)	2,790,000	5.58	4.8	0	25
Rural household	2,820,000	0.57	0.49	0	1
Poor household	2,820,000	0.33	0.47	0	1

Table 1b: Women's Recent First Births Sample

Variable	Obs.	Mean	Std. Dev.	Min.	Max
Ideal number of children	96,097	3.32	1.96	0	12
Ideal number of girls	78,507	1.38	1.10	0	6
Ideal number of boys	78,507	1.45	1.18	0	6
Age	105,109	21.72	4.23	13	50
Age at first birth	103,363	20.72	4.12	12	48
Education (single years)	104,221	6.39	4.77	0	23
Rural household	105,109	0.6	0.49	0	1
Poor household	105,109	0.34	0.47	0	1

Table 2: Men's Descriptive Statistics

Table 2a: Men's DHS Sample

Variable	Obs.	Mean	Std. Dev.	Min.	Max
Ideal number of children	854,287	4.44	3.1	0	12
Ideal number of girls	849,227	1.78	1.61	0	6
Ideal number of boys	849,227	2.13	1.76	0	6
Age	926,678	31.54	11.72	13	64
Age at first birth	926,710	25.1	5.38	15	64
Education (single years)	926,031	7.17	4.74	0	25
Rural	926,678	0.59	0.49	0	1
Poor	926,678	0.38	0.49	0	1

Table 2b: Men's Recent First Births Sample

Variable	Obs.	Mean	Std. Dev.	Min.	Max
Ideal number of children	31,164	3.89	2.66	0	12
Ideal number of girls	31,164	1.51	1.39	0	6
Ideal number of boys	31,164	1.87	1.58	0	6
Age	31,539	27.06	5.33	15	59
Age at first birth	31,539	25.89	5.43	15	59
Education (single years)	31,519	7.97	4.81	0	21
Rural	31,539	0.61	0.49	0	1
Poor	31,539	0.38	0.49	0	1

Table 3: Main Results

Table 3a: Women's Total Fertility & Sex Composition Preferences

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.031**	0.030**	0.090***	0.090***	-0.041***	-0.042***
	(0.015)	(0.015)	(0.011)	(0.011)	(0.012)	(0.012)
Constant	2.831***	3.053***	1.099***	1.244***	1.325***	1.470***
	(0.007)	(0.059)	(0.005)	(0.039)	(0.006)	(0.046)
Observations	95,879	94,860	78,320	77,519	78,320	77,519
R-squared	0.512	0.531	0.384	0.395	0.378	0.396
Demographic controls		✓		✓		✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3b: Men's Total Fertility & Sex Composition Preferences

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.072	0.058	0.094***	0.087***	0.010	0.001
	(0.064)	(0.062)	(0.031)	(0.029)	(0.041)	(0.039)
Constant	3.253***	3.699***	1.211***	1.490***	1.534***	1.886***
	(0.031)	(0.361)	(0.015)	(0.192)	(0.020)	(0.177)
Observations	29,968	29,948	29,968	29,948	29,968	29,948
R-squared	0.477	0.490	0.323	0.332	0.398	0.413
Demographic controls		✓		✓		✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 1: Country-Level Total Fertility Preferences

Figure 1a: Women's Country-Level Total Fertility Preferences

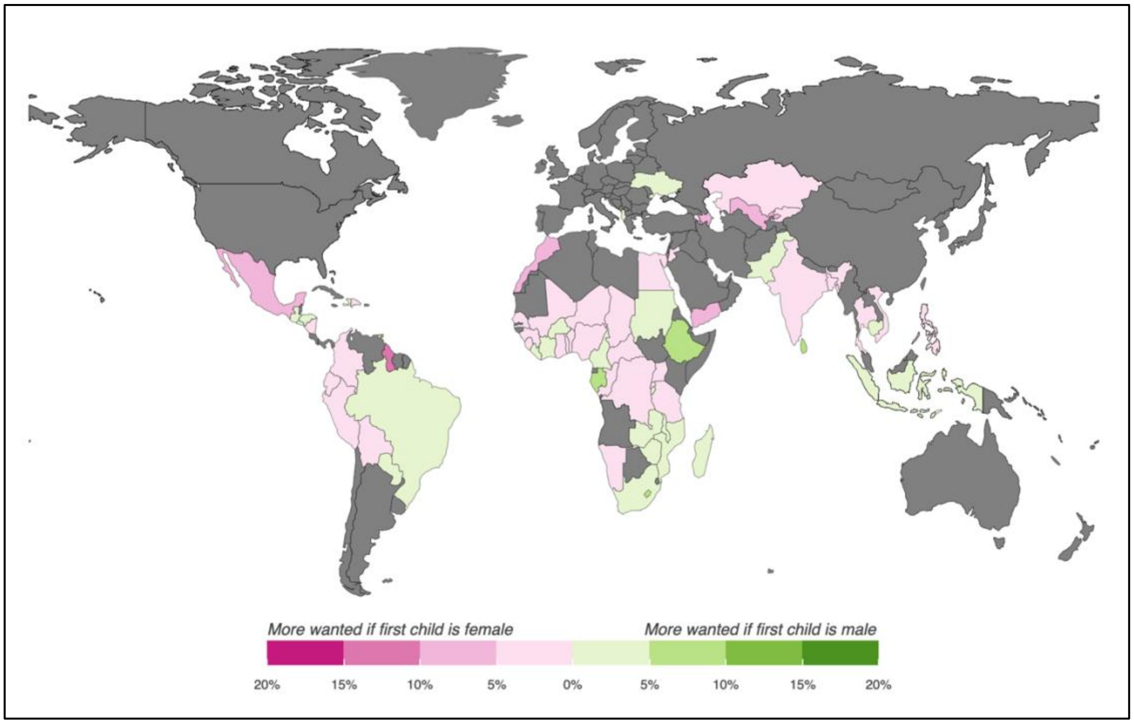

Figure 1b: Men's Country-Level Total Fertility Preferences

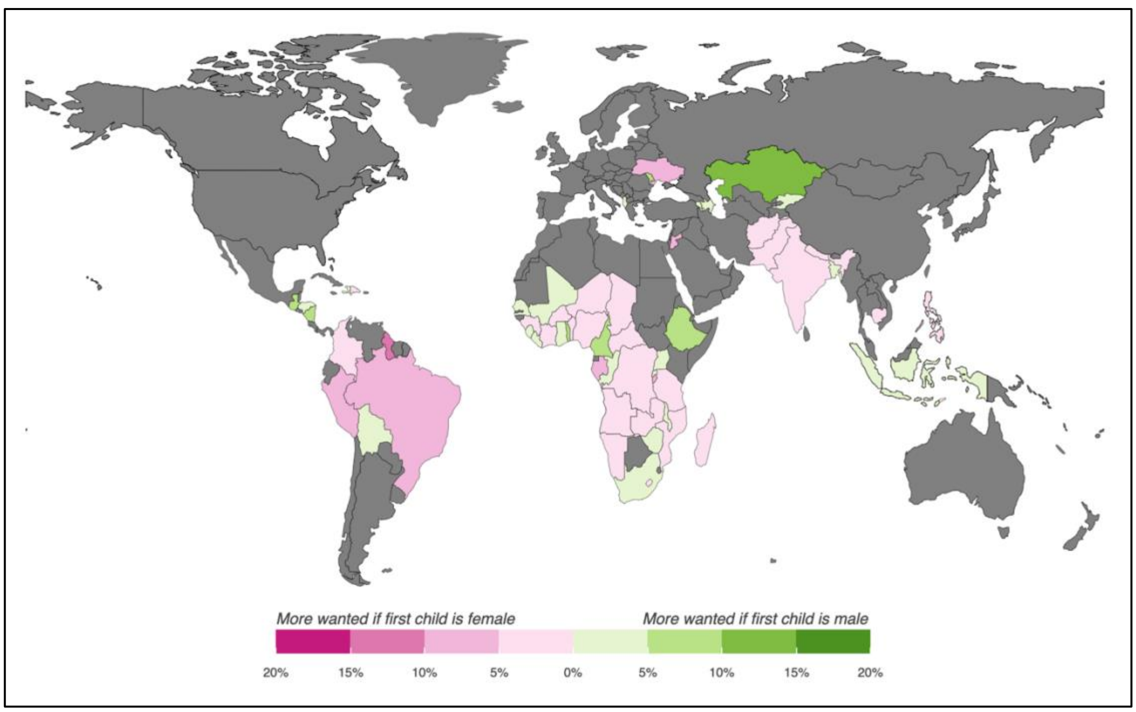

Table 4: Women's Differential Fertility Level Subsamples

Table 4a: Low-Fertility Countries Women's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.005	0.006	0.111***	0.109***	-0.067**	-0.067**
	(0.028)	(0.028)	(0.026)	(0.025)	(0.031)	(0.031)
Constant	2.301***	2.239***	0.898***	1.029***	1.012***	1.056***
	(0.013)	(0.079)	(0.012)	(0.059)	(0.015)	(0.068)
Observations	15,437	15,433	12,072	12,069	12,072	12,069
R-squared	0.192	0.196	0.201	0.205	0.205	0.207
Demographic controls		✓		✓		✓

Low fertility countries have an average total fertility rate below 2.7
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4b: High-Fertility Countries Women's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.035**	0.035*	0.085***	0.085***	-0.035***	-0.034**
	(0.018)	(0.018)	(0.012)	(0.013)	(0.013)	(0.013)
Constant	2.975***	3.254***	1.130***	1.265***	1.389***	1.543***
	(0.009)	(0.067)	(0.006)	(0.048)	(0.006)	(0.051)
Observations	75,195	74,185	61,781	60,987	61,781	60,987
R-squared	0.539	0.562	0.403	0.415	0.387	0.408
Demographic controls		✓		✓		✓

High fertility countries have an average total fertility rate above 2.7
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Men's Differential Fertility Level Subsamples

Table 5a: Low-Fertility Countries Men's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.022	0.013	0.085***	0.078***	-0.019	-0.028
	(0.060)	(0.065)	(0.025)	(0.029)	(0.025)	(0.026)
Constant	2.308***	2.730***	0.831***	1.209***	1.038***	1.427***
	(0.030)	(0.214)	(0.013)	(0.135)	(0.012)	(0.107)
Observations	10,963	10,956	10,963	10,956	10,963	10,956
R-squared	0.152	0.171	0.123	0.137	0.143	0.168
Demographic controls		✓		✓		✓

Low fertility countries have an average total fertility rate below 2.7
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5b: High-Fertility Countries Men's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.154	0.130	0.105	0.096	0.060	0.049
	(0.113)	(0.100)	(0.066)	(0.061)	(0.092)	(0.085)
Constant	4.805***	5.325***	1.834***	1.991***	2.345***	2.667***
	(0.053)	(0.840)	(0.031)	(0.439)	(0.044)	(0.409)
Observations	17,306	17,294	17,306	17,294	17,306	17,294
R-squared	0.356	0.379	0.247	0.259	0.296	0.313
Demographic controls		✓		✓		✓

High fertility countries have an average total fertility rate above 2.7
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6: Women's Differential Sex Ratio at Birth Subsamples

Table 6a: Low SRB Countries Women's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	-0.004	-0.015	0.105***	0.100***	-0.040	-0.044*
	(0.039)	(0.044)	(0.027)	(0.027)	(0.026)	(0.026)
Constant	3.727***	3.405***	1.683***	1.708***	1.774***	1.681***
	(0.019)	(0.152)	(0.013)	(0.115)	(0.012)	(0.117)
Observations	13,095	13,090	10,929	10,925	10,929	10,925
R-squared	0.400	0.433	0.241	0.262	0.242	0.257
Demographic controls		✓		✓		✓

Low SRB countries have fewer than 103 males born for every 100 females
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6b: Natural SRB Countries Women's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.050*	0.045	0.093***	0.090***	-0.069***	-0.073***
	(0.029)	(0.028)	(0.018)	(0.018)	(0.017)	(0.017)
Constant	2.892***	3.041***	1.200***	1.336***	1.376***	1.465***
	(0.014)	(0.075)	(0.009)	(0.043)	(0.008)	(0.054)
Observations	39,909	39,126	32,410	31,636	32,410	31,636
R-squared	0.537	0.545	0.385	0.390	0.422	0.427
Demographic controls		✓		✓		✓

Natural SRB countries have between 103-107 males born for every 100 females
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6c: High SRB Countries Women's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.026	0.033	0.104***	0.107***	0.001	0.007
	(0.021)	(0.023)	(0.016)	(0.017)	(0.018)	(0.019)
Constant	2.493***	2.864***	0.849***	0.991***	1.171***	1.356***
	(0.010)	(0.097)	(0.008)	(0.089)	(0.008)	(0.080)
Observations	17,217	17,209	12,814	12,810	12,814	12,810
R-squared	0.353	0.413	0.260	0.286	0.295	0.349
Demographic controls		✓		✓		✓

High SRB countries have in excess of 107 males born for every 100 females
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Men's Differential Sex Ratio at Birth Subsamples

Table 7a: Low SRB Countries Men's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	-0.004	-0.015	0.105***	0.100***	-0.040	-0.044*
	(0.039)	(0.044)	(0.027)	(0.027)	(0.026)	(0.026)
Constant	3.727***	3.405***	1.683***	1.708***	1.774***	1.681***
	(0.019)	(0.152)	(0.013)	(0.115)	(0.012)	(0.117)
Observations	13,095	13,090	10,929	10,925	10,929	10,925
R-squared	0.400	0.433	0.241	0.262	0.242	0.257
Demographic controls		✓		✓		✓

Low SRB countries have fewer than 103 males born for every 100 females
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7b: Natural SRB Countries Men's Subsample
OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.050*	0.045	0.093***	0.090***	-0.069***	-0.073***
	(0.029)	(0.028)	(0.018)	(0.018)	(0.017)	(0.017)
Constant	2.892***	3.041***	1.200***	1.336***	1.376***	1.465***
	(0.014)	(0.075)	(0.009)	(0.043)	(0.008)	(0.054)
Observations	39,909	39,126	32,410	31,636	32,410	31,636
R-squared	0.537	0.545	0.385	0.390	0.422	0.427
Demographic controls		✓		✓		✓

Natural SRB countries have between 103-107 males born for every 100 females
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7c: High SRB Countries Men's Subsample
OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.026	0.033	0.104***	0.107***	0.001	0.007
	(0.021)	(0.023)	(0.016)	(0.017)	(0.018)	(0.019)
Constant	2.493***	2.864***	0.849***	0.991***	1.171***	1.356***
	(0.010)	(0.097)	(0.008)	(0.089)	(0.008)	(0.080)
Observations	17,217	17,209	12,814	12,810	12,814	12,810
R-squared	0.353	0.413	0.260	0.286	0.295	0.349
Demographic controls		✓		✓		✓

High SRB countries have in excess of 107 males born for every 100 females
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Women's Differential Historical Plough Use Subsamples

Table 8a: Low Historical Plough Use Women's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.032	0.022	0.104***	0.098***	-0.078***	-0.083***
	(0.035)	(0.036)	(0.021)	(0.021)	(0.022)	(0.021)
Constant	3.739***	3.753***	1.715***	1.874***	1.901***	1.928***
	(0.017)	(0.100)	(0.010)	(0.061)	(0.011)	(0.064)
Observations	50,583	50,347	42,065	42,035	42,065	42,035
R-squared	0.543	0.556	0.311	0.322	0.363	0.371
Demographic controls		✓		✓		✓

Low historical plough use countries have between 0 and 0.15 on the variable $Plough_c$ described in Section 3.1

Robust standard errors in parentheses

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

Table 8b: High Historical Plough Use Women's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.023	0.025	0.082***	0.083***	-0.025*	-0.023
	(0.015)	(0.016)	(0.012)	(0.013)	(0.015)	(0.015)
Constant	2.416***	2.713***	0.840***	0.994***	1.085***	1.253***
	(0.007)	(0.072)	(0.006)	(0.059)	(0.007)	(0.058)
Observations	39,161	38,383	31,201	30,431	31,201	30,431
R-squared	0.276	0.315	0.207	0.220	0.253	0.287
Demographic controls		✓		✓		✓

High historical plough use countries have between 0.85 and 1 on the variable $Plough_c$ described in Section 3.1

Robust standard errors in parentheses

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

Table 9: Men's Differential Historical Plough Use Subsamples

Table 9a: Low Historical Plough Use Men's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	-0.027	-0.027	-0.003	-0.005	-0.118**	-0.119**
	(0.064)	(0.062)	(0.052)	(0.052)	(0.050)	(0.049)
Constant	5.073***	5.696***	1.923***	2.230***	2.472***	2.892***
	(0.030)	(0.199)	(0.024)	(0.129)	(0.023)	(0.121)
Observations	16,008	16,003	16,008	16,003	16,008	16,003
R-squared	0.506	0.532	0.342	0.354	0.405	0.420
Demographic controls		✓		✓		✓

Low historical plough use countries have between 0 and 0.15 on the variable $Plough_c$ described in Section 3.1
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9b: High Historical Plough Use Men's Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.110	0.090	0.121***	0.108***	0.053	0.038
	(0.081)	(0.081)	(0.036)	(0.034)	(0.049)	(0.047)
Constant	2.682***	3.087***	0.989***	1.292***	1.228***	1.555***
	(0.040)	(0.494)	(0.018)	(0.257)	(0.024)	(0.240)
Observations	12,838	12,821	12,838	12,821	12,838	12,821
R-squared	0.320	0.333	0.225	0.236	0.283	0.302
Demographic controls		✓		✓		✓

High historical plough use countries have between 0.85 and 1 on the variable $Plough_c$ described in Section 3.1
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix

Table A.1: Subsamples Excluding India

Table A.1a: Women's Subsample Excluding India

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.031	0.028	0.081***	0.079***	-0.065***	-0.066***
	(0.019)	(0.020)	(0.013)	(0.013)	(0.013)	(0.013)
Constant	3.119***	3.187***	1.293***	1.397***	1.482***	1.525***
	(0.009)	(0.065)	(0.006)	(0.055)	(0.006)	(0.046)
Observations	85,169	84,157	71,264	70,466	71,264	70,466
R-squared	0.518	0.530	0.368	0.376	0.395	0.403
Demographic controls		✓		✓		✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.1b: Men's Subsample Excluding India

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.127	0.117	0.109**	0.105**	0.028	0.024
	(0.094)	(0.086)	(0.053)	(0.050)	(0.076)	(0.072)
Constant	4.391***	4.826***	1.685***	1.862***	2.140***	2.448***
	(0.044)	(0.641)	(0.025)	(0.330)	(0.036)	(0.309)
Observations	22,094	22,075	22,094	22,075	22,094	22,075
R-squared	0.391	0.407	0.268	0.277	0.332	0.345
Demographic controls		✓		✓		✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.2: Women's First Pregnancies Only Subsample

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Recent firstborn daughter	0.031*	0.027*	0.093***	0.091***	-0.035**	-0.038***
	(0.016)	(0.016)	(0.012)	(0.012)	(0.014)	(0.014)
Constant	2.769***	2.989***	1.079***	1.205***	1.304***	1.457***
	(0.008)	(0.068)	(0.006)	(0.051)	(0.007)	(0.052)
Observations	76,426	75,719	68,068	67,371	68,068	67,371
R-squared	0.524	0.543	0.382	0.393	0.376	0.393
Demographic controls		✓		✓		✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.3: Women's Long-term Fertility & Sex Composition Preferences

OLS Regression with Fixed Effects

VARIABLES	(1) Ideal number of children	(2) Ideal number of children	(3) Ideal number of girls	(4) Ideal number of girls	(5) Ideal number of boys	(6) Ideal number of boys
Firstborn daughter	0.025***	0.031***	0.110***	0.111***	-0.077***	-0.075***
	(0.005)	(0.005)	(0.006)	(0.006)	(0.008)	(0.008)
Constant	3.318***	3.135***	1.261***	1.251***	1.554***	1.543***
	(0.003)	(0.058)	(0.003)	(0.027)	(0.004)	(0.031)
Observations	1,789,884	1,773,142	1,476,809	1,463,862	1,476,804	1,463,857
R-squared	0.421	0.468	0.306	0.326	0.290	0.322
Demographic controls		✓		✓		✓

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.4: List of Countries and their Subsample Inclusions

Country	Fertility Level Subsample	Sex Ratio at Birth Subsample	Historical Plough Use Subsample
Afghanistan	High fertility	103-107	High plough use
Albania	Low fertility	>107	High plough use
Angola	High fertility	<103	Low plough use
Armenia	Low fertility	>107	High plough use
Azerbaijan	Low fertility	>107	Low plough use
Bangladesh	High fertility	103-107	High plough use
Benin	High fertility	103-107	Low plough use
Bolivia	High fertility	103-107	N/A
Brazil	Low fertility	103-107	Low plough use
Burkina Faso	High fertility	<103	Low plough use
Burundi	High fertility	<103	Low plough use
Central African Republic	High fertility	<103	Low plough use
Cambodia	High fertility	103-107	High plough use
Cameroon	High fertility	103-107	Low plough use
Chad	High fertility	103-107	Low plough use
Colombia	Low fertility	103-107	Low plough use
Comoros	High fertility	103-107	Low plough use
Republic of Congo	High fertility	103-107	Low plough use
Democratic Republic of Congo	High fertility	103-107	Low plough use
Côte d'Ivoire	High fertility	103-107	Low plough use
Dominican Republic	High fertility	103-107	High plough use
Ecuador	High fertility	103-107	Low plough use
Egypt	High fertility	103-107	High plough use
El Salvador	High fertility	103-107	Low plough use
Eswatini	High fertility	<103	High plough use
Ethiopia	High fertility	103-107	N/A
Gabon	High fertility	<103	Low plough use
Ghana	High fertility	103-107	Low plough use
Guatemala	High fertility	103-107	Low plough use
Guinea	High fertility	<103	Low plough use
Guyana	High fertility	103-107	Low plough use
Haiti	High fertility	103-107	Low plough use
Honduras	High fertility	103-107	Low plough use

India	High fertility	>107	High plough use
Indonesia	Low fertility	103-107	High plough use
Jordan	High fertility	103-107	High plough use
Kazakhstan	Low fertility	103-107	N/A
Kenya	High fertility	<103	N/A
Kyrgyzstan	Low fertility	103-107	Low plough use
Lesotho	High fertility	>107	High plough use
Liberia	High fertility	103-107	Low plough use
Madagascar	High fertility	>107	Low plough use
Malawi	High fertility	>107	Low plough use
Maldives	High fertility	103-107	High plough use
Mali	High fertility	103-107	Low plough use
Mexico	Low fertility	103-107	Low plough use
Moldova	Low fertility	103-107	High plough use
Morocco	High fertility	103-107	High plough use
Mozambique	High fertility	<103	Low plough use
Namibia	High fertility	<103	Low plough use
Nepal	High fertility	>107	High plough use
Nicaragua	High fertility	103-107	Low plough use
Niger	High fertility	103-107	Low plough use
Nigeria	High fertility	103-107	Low plough use
Pakistan	High fertility	>107	High plough use
Paraguay	High fertility	103-107	Low plough use
Peru	High fertility	103-107	Low plough use
Philippines	High fertility	103-107	N/A
Rwanda	High fertility	<103	Low plough use
Sao Tome Principe	High fertility	<103	Low plough use
Senegal	High fertility	103-107	Low plough use
Sierra Leone	High fertility	<103	Low plough use
South Africa	High fertility	103-107	N/A
Sri Lanka	Low fertility	103-107	High plough use
Sudan	High fertility	103-107	Low plough use
Tanzania	High fertility	<103	Low plough use
Thailand	Low fertility	103-107	High plough use
Timor-Leste	High fertility	103-107	N/A
Togo	High fertility	<103	Low plough use

Trinidad and Tobago	Low fertility	103-107	Low plough use
Tunisia	Low fertility	>107	High plough use
Turkey	Low fertility	103-107	High plough use
Uganda	High fertility	<103	Low plough use
Ukraine	Low fertility	103-107	High plough use
Uzbekistan	Low fertility	103-107	N/A
Vietnam	Low fertility	>107	High plough use
Yemen	High fertility	103-107	High plough use
Zambia	High fertility	103-107	Low plough use
Zimbabwe	High fertility	<103	Low plough use