Gender Composition of Children and Sanitation Behavior in India†

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Abstract

Open defecation has been linked to various environmental and public health issues and has gained significant policy attention. Investing in better sanitation has also been advocated to provide women with privacy and protection from harassment. Nonetheless, previous research has shown that because of son-biased preferences, households in India underinvest in outcomes for their female children. Linking the gender composition of children to the sanitation behavior in Indian households, I find that households increase toilet ownership in the presence of female children by 5% in urban and 2.5% in rural areas, respectively. These results are robust to various empirical specifications, falsification tests, and bounding analysis to test for omitted-variable bias. Various heterogeneity analyses suggest that the decline in open defecation in response to having a female child is driven by households living in regions with a higher prevalence gender-based harassment and weaker law and order. These findings provide new evidence that differences in the gender composition of households create differential incentives to adopt toilets, a finding that can be harnessed to reduce open defecation in India.

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I. Introduction

Open defecation (OD; defecating in open places, behind bushes, near roads, near railway tracks, etc.) imposes a high cost on the local environment and public health. Historical improvements in sanitation have been linked to gains in public health and human capital in the developed world,[1] and poor sanitation in developing countries has been associated with significant negative health externalities.[2] Additionally, in developing countries, small improvements in sanitation have been linked to gains in health[3] and human capital[4] thereby highlighting the importance of reducing OD as a powerful solution to the public health problem. In this paper, I study the association between the presence of a female child and the adoption of better sanitation practices in India—a country that accounts for 60% of the world's OD.

Incentives to reduce OD in developing countries have been explored in the context of caste (Lamba and Spears (2013); O'Reilly et al. (2017b)), religion (Vyas and Spears (2018)), the role of government (Ban et al. (2010)), local communities (McGranahan and Mitlin (2016); Zuin et al. (2019); Guiteras et al. (2015)) and the role of infrastructure and financial and behavioral nudges (O'Reilly et al. (2017a); Yishay et al. (2017); Brown et al. (2017)). Because of the negative health externalities of OD, the economic literature has largely looked at this issue as a public good problem. Apart from the health externalities, there are other negative consequences connected to OD, such as lack of privacy for women and gender-based harassment[5] which, unlike a public good problem, directly affect the agents making choices (e.g., adopt a toilet, defecate in the open). With the exception of Stopnitzky (2017) which focuses on marriage market mechanisms, the association between the presence of female members in a household and sanitation behavior has received relatively little attention in the literature.

The presence of female children is likely to provide incentives for households to invest in toilets, thereby reducing OD. Defecating in the open imposes high costs on women and girls because, compared

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1 Bleakley (2007), Cutler and Miller (2005), and Watson (2006) provide evidence about the role of sanitation in achieving better health and human capital in the US.

2 Duflo et al. (2015), Geruso and Spears (2018), Garg et al. (2018), Spears and Lamba (2016) and Coffey et al. (2017), Usman et al. (2018), Ramani et al. (2017) provide evidence connecting OD to acute malnutrition, child mortality, poor child cognition, anemia, and diarrhea.

3 Cameron et al. (2021) and Ausburg and Rodriguez-Lesmes (2018) provide evidence in the context of maternal and child health in India and Indonesia.

4 Orgill-Meyer and Pattanayak (2020) provide evidence of improved sanitation and long-term cognitive scores of children in India.

5 Jadhav et al. (2016) and JAGORI and UN-Women (2010) find evidence related to sexual harassment faced by women who defecate in the open.

to men and boys, they need more privacy. These costs include loss of dignity, lack of privacy, and the possibility of harassment when women and girls defecate, urinate, or attend to menstrual hygiene in the open. These gender-specific costs may drive the need for investing in improved sanitation practices and reducing OD.

Using the National Family Health Survey (NFHS), a large representative household-level survey conducted in 2015–16 in India, I link the gender composition of children to households' sanitation behavior. A common challenge when comparing households with and without female children is to adequately account for unobserved heterogeneity in the preferences of decision-makers, which affects both the gender composition of children and other observable outcomes (e.g., sanitation behavior). It is especially crucial in India, where son-biased preference is widely prevalent. In the presence of son-biased preference, a correlation develops over time between fertility, the gender composition of children, and observed household characteristics. To overcome this problem, I compare households with a firstborn girl and those with a firstborn boy. The gender of the firstborn child impacts the gender composition of children (see figure 3).

While the gender of the firstborn child is regarded as plausibly exogenous,[6] it usually does not in itself form the basis of a credible identification strategy without considering the relation between the gender of the firstborn child and the characteristics of the household that they live in. Various economics studies that use the gender of the firstborn child as a part of their identification strategy either have identified factors conditioning on which the gender of the firstborn provides exogenous variation or have studied the relation of firstborn gender with household characteristics to predict and account for the direction of bias (e.g., see Kishore and Spears (2014); Rosenblaum (2013); Barcellos et al. (2014); Anukriti et al. (2020)).

In this paper, the gender of the firstborn child, while plausibly exogenous at birth, correlates with household characteristics over time and may impact sanitation behavior through channels other than just the presence of a female child. However, this correlation does not necessarily create a bias that confounds the observed relation between gender composition and sanitation. Son-biased preference entails a desire to have a certain number of boys, resulting in larger families for firstborn girls, in turn impacting

[6] There is evidence that first pregnancy in India has a biologically normal sex ratio and that sex-selective abortions are costly and prevalent at higher birth orders. Portner (2010), Bhalotra and Cochrane (2010), and Jha et al. (2011) show that first pregnancy in India exhibits a biologically normal sex ratio. Hesketh and Xing. (2006) report that sex-selective abortions are common at later birth orders.

household resources. With lower per capita resources in a larger family, sanitation practices and sources are likely to be inferior. Tests conducted in this paper for differences in household characteristics with the firstborn child being a girl versus boy provide evidence that per capita resources are lower in families with a firstborn girl. Therefore, when the firstborn is a female, it is likely to push toilet ownership toward zero. Nevertheless, I identify various channels that may confound this relationship and find that the observed results are robust to these channels. I also conduct a bounding exercise suggested by Oster (2019) and find that the results are robust to omitted-variable bias.

I find that urban households with firstborn girls are 5% more likely to own a toilet than those with firstborn boys. Their rural counterparts with firstborn girls are 2.5% more likely to own a toilet than those with firstborn boys. These estimates are economically meaningful. Geruso and Spears (2018) find that a 10 percentage point reduction in OD in a neighborhood is associated with a decline in infant mortality of 6 per 1,000, or about 8 percent of the population-mean infant mortality rate. I also combine the previous rounds of the NFHS survey in India (1992–93, 1998–99, and 2005–6) in a similar empirical framework that provide more rigorous controls for time trends and find that the results are perfectly in line with the cross-sectional results using the NFHS 2015–16. I also find that the reduction in OD is related to firstborn female children in the age range in which they have likely crossed pubescence, not younger firstborn children. Further heterogeneity analysis suggests that households in states where crime against women is higher show a larger reduction in OD when the firstborn child is female. Similarly, states with slower economic progress and lower trust in police show a higher reduction in OD. Recent studies such as Borker (2018) demonstrate that women are willing to suffer a cost in the form of lower human capital attainment to reduce the perceived risk of street harassment. Also, toilet construction has been associated with a reduction in crime against women (Hossain et al. (2022)). Therefore, it is likely that the reduction in OD is higher in areas where women are more likely to live in unpleasant social environments, and the heterogeneity analysis in this paper provides evidence of this.

As in recent studies like Stopnitzky (2017) and Coffey et al. (2017), the OD indicator is constructed using the NFHS variable, which does not capture the sanitation behavior of each household member. Therefore, the reduction in OD in a household here, as in these studies, should not necessarily be interpreted to mean all individuals within a household are switching from OD to toilet use. Using a survey that captures individual sanitation behavior in a smaller sample of rural India, I find suggestive evidence that adopting a toilet is associated with a reduction in OD by some but not all household members.

This paper contributes to the literature looking at investment in female children in the presence of strong gender biases. In India, where there is a preference for sons, the private benefits for daughters are often ignored. Sen (2003), Jeffery et al. (1989) show that India has a widespread preference for male children. Barcellos et al. (2014), Jayachandran and Kuziemko (2011), and Deaton (2003) show that households in India selectively underinvest in private benefits such as nutrition, education, postnatal time, and attending to female children (e.g., breastfeeding). Because of the economic cost of investing in a toilet, toilet ownership is a constraint in poorer areas. It is, therefore, less likely that poorer households in India will invest in toilets, which yields disproportionately higher benefits for female children. However, an unpleasant social environment (i.e., one with a higher probability for harassment) is more likely to bring costs to the household as a whole, and investing in a toilet might be a channel to reduce these costs. Furthermore, religious doctrines in India have long established that in a patriarchal society, women are the responsibility of men. They are to be dependent on men and are subject to ostracism for not following the doctrines.[7] This suggests that households may provide a sanitation facility if the cost of harassment of a female child accrues to everyone in the household. The empirical findings in this paper align with a household decision-making model in which the household internalizes the potential costs of female harassment and invests in a good that has higher private benefits for female children.

With the exception of Stopnitzky (2017), which looks at the role of gender-based social campaigns for newly married women, the association between gender and sanitation has received little attention in the literature. This paper contributes by exploring a different household structure in which the incentives to reduce OD come organically from differences in the gender composition of children across households, even in the absence of an external intervention such as a campaign. This paper also contributes to the literature looking at the impact of gender shocks on household decision-making (see Anukriti et al. (2020)) and an extensive literature attempting to understand sanitation behavior, the causes of OD, and the benefits from reducing OD (see Adukia (2017); Geruso and Spears (2018); Spears and Lamba (2016); Coffey et al. (2017); Hammer and Spears (2016); Clasen et al. (2015); Gertler et al. (2015); Hossain et al. (2022); Yishay et al. (2017); Brown et al. (2017)). Finally, by finding that households with female children have a higher demand for toilets, this paper suggests an avenue to generate robust first-stage take-up of

[7] *Manusmriti* is one of the oldest religious doctrines of Hindus, dictating the duties of Hindus. According to Manusmriti, a Hindu woman must not be independent. She should be under the custody of her father, brother, husband, or son depending on stage of life and age (Manusmriti 5/151 and 9/3). The Quran lays out the duties of followers of Islam and states that men are the protectors and maintainers of women and should support women (Quran 4:34).

toilets in studies that aim to link sanitation and developmental outcomes.[8]

While the government of India, in its flagship Swachh Bharat Abhiyaan (Clean India Campaign), has made large budget outlays to free India from OD,[9] take-up of toilets as a means of improving sanitation is slow,[10] leaving improvement in sanitation in India an open question for researchers. Understanding who has stronger incentives for reducing OD is vital for efficient and effective targeting of resources.

II. Background - *Costs related to OD*

Sanitation practices depend on numerous factors, such as the region a household lives in (for example, urban vs. rural), socioeconomic status, and behavioral factors in the area in which it lives. There are costs associated with both practicing and reducing OD. Considering the gender composition of children and its relation with OD, there are the following different types of costs.

1. Shame while practicing OD

OD makes a neighborhood unpleasant and therefore has a shame factor attached to it. A higher rate of OD in an area indicates OD is a common practice, and therefore it is likely that less shame is associated with an individual decision to defecate in the open. Conversely, in areas where the average rate of OD is lower, an individual decision to defecate in the open will attract more shame. The mean level of OD in NFHS 2015–16 is 49% in rural areas compared to 12% in urban areas (see Table 1). Households living in rural areas have access to large fields and open space, contributing significantly to high OD rates in these areas. Defecating in the open in fields far from one's home does not pose any direct cost of pollution and impurity near houses and hence does not result in more shame. Analyzing OD behavior in rural areas, Coffey and Spears (2017) document that women in rural areas prefer to defecate in the open since it gives them a chance to get out of the house and meet friends. They also usually go out to defecate in groups. Both of these findings suggest that less shame is associated with practicing OD in rural areas. In contrast, in urban areas, households live in constrained spaces that provide less access and privacy

8 Generating a large-enough first-stage adoption of toilets and identifying the subsequent impacts on outcomes (e.g., health) have been a challenge in recent studies (see Hammer and Spears (2016), Clasen et al. (2015), Gertler et al. (2015), Guiteras et al. (2015) and Patil et al. (2014) for recent examples).

9 Per the Ministry of Information and Broadcasting, the government of India has spent about 83 percent of their advertising expenditure on this flagship program (see http://164.100.47.190/loksabhaquestions/annex/8/AU2287.pdf).

10 See Spears and Coffey (2018) for a detailed analysis using NFHS-4 in India.

when defecating in the open. Therefore, the costs due to shame from OD are likely to be higher in urban areas.

2. Being exposed while practicing OD

Lack of privacy while defecating or urinating in the open creates the added cost of being exposed to gender-based violence and harassment. This cost is likely to be higher for women than men. A related literature (e.g., Jadhav et al. (2016), Saleem et al. (2019), Kayser et al. (2021) and JAGORI and UN-Women (2010)) provides evidence linking OD to gender-based harassment in India. Looking at urban areas, households in poorer pockets likely face significant space constraints, lack of privacy, and therefore higher probability of harassment. It is, however, not straightforward to identify whether these costs are higher or lower in rural areas. While it is likely easier in rural areas for women to ensure adequate privacy because of the availability of large spaces, it might also be easier for perpetrators to commit crimes against women. The distribution of the exposure cost in rural eras is, therefore, a priori ambiguous.

3. Financial costs of reduce OD

Switching away from OD involves direct costs in terms of the financial resources required to adopt a toilet. Areas with higher average income (such as urban areas) are likely to have a higher toilet adoption rate than regions with lower average income (such as rural areas). Within areas, wealthier households can better afford to switch away from OD than poorer households.

III. Conceptual Framework - *The Role of Female Children*

The interaction of the costs discussed in the previous section may generate differential incentives for households to reduce OD. These incentives are also likely to vary with the presence or absence of female children. Exposure costs are higher for households with female children because of gender-based harassment and the need to protect them from that. They are also likely higher in space-constrained and high-diversity urban areas. Switching away from OD also has a financial cost, which puts a relatively higher burden on poor households. These interactions and possible changes in sanitation behavior are summarized in the following testable predictions:

1. Because households in richer communities tend to have better sanitation coverage (or lower OD),

households living in richer areas face a higher cost of shame from OD. Richer households also have lower financial costs of switching away from OD. Therefore, they are likely to have toilets (and low OD rates) irrespective of the presence of female children.

2. Households living in poorer urban regions bear a high financial burden of switching away from OD. However, for such households with female children, the exposure costs of OD may outweigh the financial costs of switching away from it. In this case, they are more likely to reduce OD when they have female children.

3. Households living in rural areas likely face lower shame costs, but their level of exposure costs is a priori ambiguous. While the availability of a large space might make it easier for women to reduce exposure, it arguably also makes it more convenient for perpetrators to commit crimes against women. OD for households with female children is then likely a function of the interaction of financial and exposure costs. Even if the probability of gender-based harassment is lower under certain conditions, it will not be zero. Therefore, it is conceivable that richer households in rural areas may adopt a toilet to reduce any nonzero level of exposure cost.

The underlying mechanism linking the presence of female children in a household to the OD behavior of household members and, therefore, to the average OD rate in a neighborhood is complex. What happens after the toilet is adopted, given the presence of a female child? Is the toilet only used by the child, or do other members also use it? One extreme scenario is that the households adopt a toilet because they have female children, and everyone in the household uses that toilet, resulting in large improvements in neighborhood sanitation. Another extreme is that the household adopts a toilet, but no one except the female child uses the toilet, therefore not adequately moving the needle in terms of neighborhood sanitation. The reality, however, likely lies somewhere in the middle. The empirical work in this paper touches upon the mechanism, but the setup in this paper is limited to drawing suggestive inferences at best. In order to uncover this complex mechanism, researchers need access to data and a quasi-experimental setup that documents sanitation behavior for individual household members across a large set of regions along with a credible source to construct an experimental variation in the gender composition of children. Future research in this area would benefit immensely from access to the data infrastructure described here.

IV. Data

The main data set used in the analysis is NFHS of India, conducted in 2015–16. NFHS (India's version of the Demographic and Health Survey) is a large, nationally representative survey. The respondents are women aged 15–49 and report birth histories and other information about their children. This survey also includes information on household and household-member characteristics, assets, infrastructure, and other self-reported health outcomes. The main variables I use in the analysis come from the birth records of NFHS. These include birth order, gender, and date of birth for each of the children ever born to the surveyed women. Apart from these, I use characteristics of the women surveyed, the head of the household, the residence (rural or urban), and proxies for wealth (data on categories of assets).

The main explanatory variable is the gender of the firstborn child who is alive and lives with the parents. Following recent studies such as Geruso and Spears (2018); Stopnitzky (2017) and Coffey et al. (2017), to construct the primary outcome of interest, I use the following survey question from the NFHS: "What kind of toilet facility do members of your household usually use?" I create an indicator OD equal to 1 if a household reports "Having no toilet facility, going to field/bush to relieve themselves" and 0 otherwise. The OD variable is constructed at the household level, as the NFHS does not collect information on within-household use of toilets or on individual OD behavior. Regarding sanitation practices, the Sanitation Quality, Use, Access, and Trends (SQUAT) survey (see Coffey et al. (2014)) conducted in 2013–14 in India is the only survey that elicits individual sanitation behavior within a household. However, this survey does not include complete birth records like NFHS and is only conducted in rural areas of northern India. Hence, NFHS 2015–16 remains the largest nationally representative survey, and it allows the use of the gender of the first-ever-born child as the main explanatory variable and allows me to study OD in this paper's empirical setup. Therefore, similar to recent studies like Stopnitzky (2017) and Coffey et al. (2017)), reduction in OD in a household should not necessarily be interpreted to mean all individuals within the household switch away from OD to toilet use.[11] The analysis later in the paper finds suggestive evidence using the SQUAT survey that the sanitation behavior of both the firstborn child and other members of the household changes in response to the presence of female children.

Household wealth is a crucial variable related to the adoption of better sanitation facilities. Although

[11] Geruso and Spears (2018) using the SQUAT survey, show that in about 40% of households owning a toilet in rural northern India, least one individual chooses to defecate in the open.

NFHS does not record the income or consumption of surveyed households, it records households' assets. Recent empirical studies use asset ownership as a proxy for household wealth (Geruso and Spears (2018)). I do not use the asset index provided by NFHS since it includes sanitation facilities and other variables that are related to the construction of the house and correlate directly with the sanitation facilities. Instead, I create an asset index as a measure of a household's wealth by creating a standard-normal index of the sum of various assets in the household. Table 1 provides summary statistics related to a few key variables.

V. Empirical Strategy

V.A Identification

The identification in this paper relies on linking the presence of female children in a household to the gender of the firstborn child. There is evidence in the literature that firstborn gender is quasi-exogenous[12], and various studies in India use this identification strategy.[13] Bhalotra and Cochrane (2010) provide evidence in favor of this assumption. Figure 1 (from Bhalotra and Cochrane (2010)) shows that the proportion of females in first births stayed normal between 1985 and 2005. More importantly, no changes were observed in this trend even after the introduction of ultrasound technology and associated structural changes in its availability in 1985 and 1995. My paper relies on the cross section provided by NFHS 2015–16, and it is important to observe the fraction of girls in first births across geographic locations. Figure 2 plots the ratio of female to male first births in the districts in NFHS 2015–16. The distribution reveals substantial regional variation in the gender ratio at first birth and, therefore, likely variation in the use of sex-selective abortions. Consequently, the empirical setup in this paper calls for using the gender of the firstborn child as an identification strategy only when looking within geographic locations—i.e., conditional on district fixed effects.

There are multiple drivers of sex-selective abortions (and, in turn, the gender of the firstborn) that are also likely correlated with the sanitation behavior of a household. Bhalotra and Cochrane (2010) identify wealth, mother's education, and religion as major drivers of sex-selective abortions. Specifically, they

[12] Portner (2010) and Jha et al. (2011) showed that first pregnancy in India exhibited a biologically normal male-female sex ratio and Hesketh and Xing. (2006) showed that sex-selective abortions were common at later birth orders, but not the first birth.

[13] For example, see Barcellos et al. (2014), Kishore and Spears (2014), and Rosenblaum (2013).

find that the use of sex-selective abortion is more common in wealthier households, households with relatively educated women, and, conditional on wealth and education, among Hindus as compared to Muslims. These characteristics are likely correlated with the sanitation behavior of a household as well. The simultaneous relation that these factors might have with the dependent variable (sanitation behavior) and the independent variable (gender of the firstborn) threaten the validity of the identification strategy's. An ideal test of the validity would involve showing orthogonality between these factors and the gender of the firstborn child, and factors that passed the test would be ideal control variables in the empirical setup. However, since NFHS is a repeated cross section, I do not observe factors like wealth, parents' education, or household infrastructure around or before the birth of the firstborn children (the children who are now older in the 2014–15 round of NFHS), thereby not allowing me to perform the ideal test. Nevertheless, I conduct a few tests related to the following ideas that speak to the ideal test:

1. Unlike the older firstborn children, the newer cohort of firstborn children in NFHS 2015–16 (e.g., children less than or equal to two years old) live in a household in which not much time has passed since birth. Therefore, the test of orthogonality between the gender of the firstborn and the household characteristics provides a closer proxy for the ideal test mentioned above. This is similar to the test for the identifying assumption in Barcellos et al. (2014).

2. For the older cohorts of firstborn children in NFHS 2015–16, while current household characteristics are not an ideal proxy for characteristics around the time of the birth of these children, an analysis like (1) but using the young firstborn cohorts from the rounds of NFHS in 1992, 1999, and 2005 can serve as a reasonable proxy for retrospectively looking at the current older cohorts.

3. For the current older cohorts of firstborn children in NFHS 2015–16, one may ask whether current household characteristics have evolved over time (since the first child's birth) in a direction that weakens the identification strategy. Specifically, compared to the households with firstborn boys, do the households with firstborn girls become positively selected on characteristics like wealth, education, and infrastructure? If so, OD behavior is more attributable to these characteristics than to female children's presence in the households. This is similar to the discussion in Barcellos et al. (2014), in which a key consideration is whether the presence of sex-selective abortions biases the estimates toward zero or in a direction that contaminates the main effect to be studied, the former being much more acceptable than the latter.

For test (1), I analyze the difference in household characteristics by the gender of the firstborn child for the sample with a young firstborn child (two years of age or less) in NFHS 2015–16. I use a regression of various household characteristics on a dummy variable with equal to 1 when the firstborn child is a girl and 0 otherwise. This specification is run with district fixed effects to account for regional variation in the independent variable.[14] Table 2 reports the results separately for urban and rural areas. As observed above, households with a young firstborn girl are statistically similar to their counterparts with a firstborn boy.[15] This result supports the identifying assumption by showing that conditional on regional fixed effects, for very young children, the gender of the firstborn child does not predict the household characteristics that might also influence sanitation behavior. It can also be interpreted as evidence that the gender of the firstborn child is not predicted by the household characteristics (around the time of the birth) that also predict the use of sex-selective abortions.

Motivated by test (1), I conduct a test to inform idea (2) . This test is the same as (1) except that it is conducted using the 1992, 1999, and 2005 rounds of NFHS in India. The sample is restricted to firstborn children who are ≤ 2 years of age during the survey round, which means that the cohorts included in the sample for this test represent the cohorts that are 24–25, 17–18, and 11–12 years old, respectively, in NFHS 2015–16. Table A1 shows the results, for the variables that are consistently available across all the three previous rounds of NFHS, of estimating the same equation as in (1) but with the changed sample and using primary-sampling-unit fixed effects.[16] As in the previous test, the results here show that the gender of the firstborn children for the older cohorts in NFHS 2015–16 does not predict any household characteristics (around the time of birth) that might predict sanitation behavior or the use of sex-selective abortions.

Finally, I conduct a test to answer the question in (3). Because of son-biased preferences, households in India practice fertility-stopping rules. As a result, a correlation develops over time between household-level outcomes and the gender of the first child. Households in which the firstborn child is a girl are more likely to have a higher fertility rate to achieve the desired number of sons and, hence,

[14] Standard errors are also clustered at the district level.

[15] A few variables show marginally significant differences, but they do not survive a multiple-hypothesis correction, which is relevant for drawing inferences from multiple comparisons.

[16] District identifiers are not available in the 1992, 1999, and 2005 rounds of NFHS in India. Primary sampling units are sampling clusters used in NFHS and typically represent a city block in urban areas and a village in rural areas. Primary sampling units, in that sense, are usually much more granular than large administrative blocks like districts.

more likely to have larger families. Larger families have lower per capita resources, making them poorer on average and, therefore, more likely to practice OD (or not invest in a toilet). These differences in the household characteristics will likely bias the estimates of comparing OD practice in households with firstborn girls with boys toward zero. They can therefore be taken to be lower bounds.

To investigate this, I compare household characteristics across households with firstborn girls versus boys. This analysis is similar to (1) and (2) except that the sample is the entire universe of households in NFHS 2015–16 and therefore includes households with firstborn children of all ages. District fixed effects are used in all estimates. Table 3 reports the results separately by rural and urban regions. The asset index in the first row shows that households with a firstborn girl are poorer than households with a firstborn boy. Households with better infrastructure, such as piped water, a cement/concrete floor, and walls, may find it easier to adopt a toilet. As observed, households whose first child is a girl have less piped water in their dwelling and depend more on the public source of water. In rural and urban areas, households with firstborn children use inferior cooking fuel and inferior construction material for their dwellings. Overall, Table 3 demonstrates that households with firstborn girls are poorer on average on various dimensions, and these dimensions are likely not positively correlated with toilet adoption.

Households show evidence of gender-biased fertility-stopping rules, as the mothers of firstborn girls are more likely to be pregnant at the time of the survey than mothers of firstborn boys. As expected, firstborn girls are more likely to survive[17], and they live in larger households with more siblings. While the families with firstborn children are larger and therefore have lower per capita resources, the per capita costs of new investments (such as a toilet) are also lower, making toilet adoption more likely. Looking at the mothers' characteristics, such mothers are not likely to be more or less educated than mothers of firstborn boys. However, they are observed to be younger (by a quarter to a third of a year) than mothers of firstborn boys. However, it is not clear whether this results in any bias. Some of these observations could be construed as potential threats to identification, and I explore them carefully later in the paper. In Section 7, I conduct various robustness checks and find that it is unlikely that potentially confounding factors such as mothers' characteristics, pregnancy, and family size play a role in explaining the findings and are therefore unlikely to create a bias.

There are two main findings from the analysis so far. First, the analysis informing points (1) and (2)

[17] This is biologically consistent, as girls are more likely to survive after birth compared to boys.

above reveal that the gender of the firstborn child is not correlated with the household characteristics (around the time of the birth) that drive the use of sex-selective abortions nor likely correlated with the sanitation practices followed by a household. This analysis supports the identification framework that relies on the gender of the firstborn child conditional on regional fixed effects. Second, the analysis informing point (3) reveals that the same household characteristics do not evolve in a direction that might positively correlate with toilet adoption in a household.

Finally, it remains to be seen whether the gender of the firstborn child affects the presence of female children in my data. Figure 3 shows the average number of female children in households in NFHS data, separated by the gender of the firstborn child. As observed, households whose firstborn child is a girl have, on average, more female children than households whose firstborn child is a boy.

V.B Estimation

For the main results, I run a reduced-form linear probability model as follows:

$$OD_{id} = \beta FB_{id}^{Girl} + Y_{id} + X_{id} + \delta_d + \epsilon_{id} \tag{1}$$

Here i indicates the household living in district d. The outcome is the indicator variable OD. FB^{Girl} indicates the first-born gender being female. δ_d denotes district fixed effects. Y is the asset index. X is the vector of household-level controls. The full list of controls is: higher-order polynomials of asset index; total fertility (linear and quadratic polynomial); indicators for the age of the firstborn child (linear and quadratic polynomial); indicators for sources of water; indicators for construction material of the floor, roof, and wall; altitude of sampling cluster; an indicator for households reporting Islam as their religion; indicators of caste; indicators of the current age of the mother; indicators for years of education of mother; indicator for whether mother is pregnant; and finally an indicator for nuclear households. The child's age and household's caste are important determinants of family structure and size and socioeconomic status and therefore correlated with families' sanitation behavior. They may have a differential impact on sanitation behavior by region a household lives in. In the richest specification, I also control for a set of interacted fixed effects: district*caste, caste*age, age*district. Standard errors are clustered at the level of the district. β is the coefficient of interest.

VI. Main Results

VI.A Do Households Reduce OD When They Have Female Children??

Using equation (1), I analyze the main hypothesis: that households reduce OD if they have a female child, where the gender of the firstborn child identifies the presence of a female child. Columns 1–5 of Table 4 report the results for urban areas. Column 1 represents the core identification strategy—i.e., the gender of the firstborn child is the main explanatory variable conditional on the district fixed effects. It shows that having a firstborn girl is associated with a reduction in OD. This association between firstborn gender and OD retains its strength and statistical relevance with the full set of household-level controls (column 2) and a variety of fixed effects interacting the district with caste and age cohorts (column 3). Additionally, column 4 includes granular fixed effects at the level of primary sampling unit in NFHS[18], and the results are robust.

The preferred specification in column 5 shows a statistically significant (at the 1% level) increase in toilet ownership of about 5% of the mean. Columns 6–10 show similar results for rural areas. Column 10 shows an increase in toilet ownership of about 2.5%. This association retains its strength and significance with all controls and fixed effects.[19] This analysis provides support for the testable predictions in Section 3. While both urban and rural regions show a reduction in OD associated with the gender of the firstborn child, the reduction is stronger for urban areas. This indicates that households in urban areas respond more to the presence of female children by reducing OD.

1. Bounding Analysis

In this section, I test the robustness of results from Table 4 to the presence of potentially unobserved variables. Using the strategy developed by Altonji et al. (2005) and Oster (2019), I assess the potential role of the exclusion of these variables in the empirical model. The methodology focuses on the idea that the selection on observables can provide insights into the selection on unobservable. To illustrate the

[18] NFHS is a two-stage random sample, first sampling primary sampling unit and then households within sampled primary sampling units. A primary sampling unit, in that sense, is a sampling cluster. It is usually a city block in an urban area or a village in a rural area.

[19] There are a few controls in the main specification, such as wealth index and fertility, which may be considered endogenous (see Angrist and Pischke (2009)). As shown in Table 3, both the asset index and fertility are associated with the gender of the firstborn child. They, however, remain essential controls when trying to control for household characteristics that may impact sanitation behavior. In Table A2, I remove the wealth and fertility controls from the household controls for both rural and urban areas and find that the reduction in OD remains, and in the case of urban areas, it is very close to the impact sizes shown in the main results in Table 4.

basic idea, consider the following empirical model:

$$Y = \beta X + \beta_z Z + W \tag{2}$$

Here X is the outcome of interest, Z is the set of observed, and W is the set of unobserved variables. The aim is to estimate the bias in β due to the unobserved set of variables W. Altonji et al. (2005) demonstrate that the bias can be quantified as:

$$\frac{Cov(X, W)}{Var(W)} = \delta \frac{Cov(X, \beta_z Z)}{Var(\beta_z Z)} \tag{3}$$

Here δ represents the degree of proportionality of the relation between X and unobservables and the relation between X and the observed set of variables Z. Oster (2019) uses the idea to extend the methodology for deducing the bias by observing the movements in the coefficient of interest β when the observed set of covariates is added to the model. I follow Oster (2019) and an application in Jain et al. (2021) to evaluate the presence of bias in the model used to report the main results. The estimated β is a function of two key parameters: δ and R_{max} i.e., $\beta(\delta, R_{max})$. R_{max} is the R-squared from a hypothetical model that includes a full set of observed and unobserved covariates and hence is unbiased. Following Oster (2019) and Jain et al. (2021), I set R_{max} as 1.3 times the R-square from the regression that includes a full set of observed covariates Z, and conduct two robustness tests. First, the interval $[\beta^c, \beta(1, min(1.3^* R_c^2, 1))]$ should not contain 0. The β^c represents the coefficient from a model with a full set of observed covariates, and R_c^2 is the corresponding R-square. And second, I calculate the value of δ, which would render the coefficient β to be 0, i.e., a null effect, and compare it vis-a-via a case where the bias is 1:1 with the selection on observables, i.e., $\delta = 1$.

Table 5 shows the results of this bounding exercise for both urban and rural areas.[20] The R_{max}^2 is set at 1.3 times the estimated R_c^2 from the model with a full set of observed covariates for both urban and rural areas. For urban areas, the calculated interval is $[-0.006, -0.007]$, which does not contain 0. Similarly,

[20] I use the Stata command psacalc, designed for computing the relevant statistics in Oster (2019). The controlled regression model is the one used to generate columns 4 and 9 of Table 4. It includes the most granular fixed effects at the level of primary sampling unit, all household-level controls, and standard errors clustered at the district level. The model with the richest set of controls is used to generate columns 5 and 10, but that adds a range of fixed effects interacted with each other, which makes it imperative to use a computation supporting high-dimensional fixed effects (Stata command reghdfe). The High Dimensional Fixed Effects (HDFE) method, however, is incompatible with psacalc. The coefficients in Table 4 do not change much when using these interacted fixed effects, and the R-squared rises from 0.55 to 0.62, thereby making the model choice for the bounding exercise very similar to the model with the richest set of controls.

for rural areas, the estimated interval is $[-0.01, -0.02]$, which does not contain 0. Furthermore, the estimated coefficients in table 4 are very close to the interval of coefficients calculated in the bounding exercise. In addition to that, the absolute value of the estimated δ, which would render the estimated β to be 0 for both urban and rural areas, is 9.65 and 2.02, respectively. These values are very high[21], and given that the mean difference tests do not show any signs of upward bias, they suggest that unobserved covariates do not lead to an overestimation of the impacts shown in table 4. Overall, this bounding exercise suggests that the estimated results are robust to potential omitted-variable bias.

2. Falsification using a young firstborn child

As discussed in Section 3, a central notion is that households will invest in better sanitation when the expected costs of female children's practicing OD are higher. Households are more likely to be sensitive to the need for a toilet for a girl when she hits puberty or is close to that. Suppose the reduction in OD also shows up when the female children are below puberty. In that case, it may indicate that the results are driven by other factors that confound with the gender of the firstborn. To test this, I run a falsification test using the preferred specification of equation (1) while restricting the firstborn child to eight years or lower.[22] Table 6 reports the results. The association between firstborn gender and OD is not the same as the main results for urban and rural areas. Columns 4 and 8 with preferred specifications show a small, positive, and statistically insignificant association between the gender of the firstborn and sanitation behavior. This exercise suggests that the association between firstborn female child and reduction in OD is valid only for households with a female child close to puberty and provides support for testable predictions from the conceptual framework.

3. Using previous rounds of the NFHS survey in India

India launched a massive sanitation campaign in 2014 called Swachh Bharat Abhiyaan (Clean India Campaign) to make India OD free in five years. The program rollout included media and social campaigns for reducing OD and adopting/building toilets. While the rollout was across India and the specification used in this paper should account for between-area differences in access and rollout (through district and primary-sampling-unit fixed effects), I test whether the incentives for reducing OD in the

[21] Oster (2019) demonstrates that the average estimated value of δ is 0.545 and that 86% of the estimated values of δ fall within $[0, 1]$.

[22] The broad age range of attaining puberty in girls is about 10–14 years in India. Some studies also document early puberty starting as early as 8 years of age (Khadgawat et al. (2016)).

presence of female children existed before the campaign. I pool the pre-2015–16 rounds of the NFHS survey (rounds from 1992, 1999, and 2005) and put the sample through the main specification.[23] Table A3 shows the results, and as observed, the impact sizes are very similar to the ones observed in Table 4. This exercise points to the presence of incentives to switch away from OD in the presence of a female child, even in the absence of large social campaigns.

4. Pooling NFHS 2015-16 with previous NFHS rounds

In this paper, the 2015–16 round of the NFHS is used as the primary data, as it outperforms the previous rounds in sample size, inclusion of district IDs, and an extensive range of reported assets. More importantly, the heterogeneity analyses conducted in the next subsection require additional data sources (such as the Indian Human Development Survey) that document crime against women, people's trust in local institutions, and so on but are not available close to the 1992 and 1999 rounds. However, I pool all previous rounds of NFHS data with the 2015–16 round with available variables and controls common across all rounds. I run the main analysis equation on the pooled data (with survey-round fixed effects) and find that households with a firstborn girl reduce OD (see Table A4) and that the coefficients are similar to the main analysis in Table 4.

VI.B Who Drives the Reduction in OD among Households with Female Children?

The results observed in the previous section can be explored in light of the interaction of both social and economic costs of reducing OD. As discussed in Section 3, households in urban areas are likely to face higher social costs of OD than their rural counterparts. While social costs are hard to observe, indicators such as crime against women, people's trust in local institutions (e.g., police), and state performance correlate with the degree of safety of women in an area, and therefore, with the social costs.

1. Heterogeneity by high- versus low- crime regions

Households living in areas where there is higher crime against women likely have stronger incentives to reduce OD than their counterparts in lower-crime regions. I look at this possibility using the Indian Human Development Survey (IHDS) conducted in 2011-12, which asks a question about the frequency of events related to the harassment of girls in a neighborhood. Since this variable is self-reported, it is less

[23] The pre-2015 rounds of the NFHS in India do not report district IDs, so primary-sampling-unit fixed effects are used. Standard errors are also clustered at the primary-sampling-unit level.

likely to be affected by reporting bias than other data sources like crimes reported to police (as recorded by the National Crime Record Bureau). Although this variable likely only captures a perceived level of gender-based harassment, perceptions are likely highly correlated with the real level of harassment. In addition, unlike the National Crime Record Bureau and official reports at the police station level, where it is challenging to separate rural from urban areas, the IHDS provides a clear rural-versus-urban distinction. I code the response to this question as 1 if reported "sometimes" or "often" and as 0 if reported "rarely/never." Using this variable, I rank states and union territories (UTs) in India from the highest to the lowest rate of harassment against girls, separately for urban and rural areas. Households in both regions are then divided into High Crime (top 10 states) and Low Crime (all other states).[24]

Table 7 reports the results. The OD rate is similar in the two groups (high and low crime) for both regions, indicating that both groups have similar room to improve. As observed in urban regions, the entire reduction in OD is driven by states with high rates of harassment. While the remaining states show a small reduction in OD, it is statistically insignificant. In rural areas, both high- and low-crime groups show a reduction in OD. To test whether the coefficients are different across high- and low-crime regions, I estimate a regression in which I interact firstborn gender (= 1 for girls) with a dummy for high-crime region while controlling for the firstborn-gender dummy and the high-crime dummy separately. Table 7 reports the interaction coefficients, and it is observed that the coefficients in urban areas are statistically different from each other, while those for rural areas are not.

2. Heterogeneity by confidence in law enforcement

Similarly, IHDS 2011-12 asks respondents about their confidence level in local police to enforce the law. I rank states by level of confidence in the police, generating a list of 10 states where people reported the lowest confidence and a list of all others with higher confidence.[25] Table 8 reports the results. Similar to the results for heterogeneity by crime against women, urban households living in states with the lowest confidence in the police seem to be driving the result. In contrast, households living in other states show a smaller and statistically insignificant reduction in OD. On the other hand, households in

[24] IHDS 2011–12 and NFHS 2015–16 also report district identifiers, and hence it is possible to generate low- versus high-crime categories at the district level. However, IHDS includes only 375 districts, compared to 640 districts in NFHS. Therefore, state-level categorization is undertaken to keep the original sample from Table 4 intact.

[25] I code the response to this question as 1 if respondent reported "A great deal of confidence in police" and 0 if they reported "only some confidence" or "hardly any confidence at all". The ranking of states is based on the average of this variable, from lowest to highest.

rural areas show a similar reduction in both high- and low-confidence groups. The test for difference in coefficients shows that urban areas with low trust in the police demonstrate a higher reduction in OD, although it is marginally statistically insignificant.

3. Heterogeneity by state performance

Regions that lag in socioeconomic indicators are poorer and less developed and usually have a more patriarchal societal structure. Given the male-dominant household structure, the incidence and costs of harassment of a female child are likely to be higher,[26] resulting in higher potential costs from harassment. Also, these regions usually have weaker state machinery and institutions. Their citizens have fewer avenues to seek protection against violations of the law and are largely self-reliant. It is conceivable that these regions have stronger incentives to reduce OD in the presence of a female child. I use one indicator to classify states as weaker versus stronger in socioeconomic indicators. The states of Bihar, Madhya Pradesh, Rajasthan, Odisha, and Uttar Pradesh are typically tagged as economically low-performing states. They are termed BIMAROU states.[27] Table 9 shows the result of estimating equation (1) on the sample divided by BIMAROU and non-BIMAROU states. A large reduction in OD is observed for urban households living in BIMAROU states as compared to Non-BIMAROU states. However, the association between sanitation and the gender of the firstborn child remains similar for rural households in both BIMAROU and non-BIMAROU states. The test for difference in coefficients shows that although the result is statistically insignificant, urban regions in BIMAROU states show a higher reduction in OD.

Heterogeneity analysis by crime, trust in law enforcement, and state performance suggests that households in urban areas demonstrate higher sensitivity to social costs by reducing OD in the presence of female children. As discussed in Section 3, this is likely because of space constraints in urban areas, making it harder for girls to defecate in the open and thereby protect them from harassment. Also, urban areas have a higher rate of crime against women as compared to rural areas[28], which corroborates their higher sensitivity to the costs arising from such crimes. In rural areas, where the community is more tight-knit and the space constraint is weaker, the sensitivity to social costs is lower.

[26] Reporting and booking the male perpetrators is likely to be hard.

[27] See https://www.financialexpress.com/india-news/bimaru-redux-niti-aayog-ceo-says-bihar-madhya-pradesh-uttar-pradesh-rajasthan-keeping-india-backward/1143709/

[28] My own calculation from IHDS 2011-12 shows that rate of reported crime against women is 27% in urban areas as opposed to 19% in rural areas.

4. Heterogeneity by Economic Status

Another important factor related to switching away from OD is economic cost. Richer households in urban areas face heavy shame of defecating in the open and hence are likely to have toilets irrespective of the gender composition of their children. Among poorer urban households, the resource constraint to adopt a toilet is tighter. But as shown before, the sanitation behavior of urban households is sensitive to indicators correlating with the social costs of OD. Therefore, a fraction of poor urban households may have incentives to switch away from OD if they have female children. On the other hand, rural households are less sensitive to indicators that correlate with the social costs of OD. In the presence of female children, it might be the economic costs of switching away from OD that drive the results for the rural regions in 4.

To explore the change in sanitation behavior in the presence of female children by economic status,I divide households into deciles of the asset index, separately for rural and urban areas. The sample composition in each asset decile may change given a correlation between asset index and firstborn gender. Assets can be construed as an outcome in the base form of this analysis, and this analysis needs the stronger assumption that assets are exogenous. I compile the asset index separately for the families with firstborn boys or girls and pool the resulting categories by gender into each asset decile. This does away with the assumption that assets are exogenous and makes the more reasonable assumption that within the groups of households defined by the sex of the firstborn child, the relative ranking of the asset index is exogenous to the outcome of interest.

Using the preferred specification of equation (1) on the main analysis sample, Figure 4 & 5 report the coefficient of interest for urban and rural regions, respectively. The x-axis in both figures divides the sample into asset deciles, ranging from the poorest group (1st decile) to the richest group (10th decile).

Looking first at the results for urban areas in Figure 4, the OD rate is falling rapidly as households get richer. The OD rate is high and ranges from 48% to 24% for the two poorest groups of the asset index. It starts to fall as households get richer and falls to zero for the wealthiest households. Households in the poorest decile do not show a reduction even if their firstborn child is a girl. This provides evidence that a very tight budget constraint outweighs the cost of a female child's defecating in the open. Households in the 2nd decile show a reduction of OD by approximately 20% of the mean. After that, the mean OD rate falls for wealthier households, and the room for improvement shrinks. Moving to rural areas, Figure 5 shows that OD rates are not only higher on average than in urban areas but stay higher for even the wealthier groups of households. For example, while a set of median households (ranked by asset index) in urban areas has an OD rate of lower than 9%, its counterpart in rural areas has almost a 61% OD rate. In contrast to the case in urban areas, this provides empirical evidence for lower social costs of OD in rural households where space is not constrained. As observed, the reduction in OD in rural areas starts to show up only in the richer deciles (6th–10th), where the economic constraint is not as tight as with their poorer counterparts.

These results show that with a slight relaxation in the economic constraint, poorer urban areas respond to the presence of female children by reducing OD (possibly due to the presence of high social costs). However, in rural areas, this economic constraint must be relaxed much further, and the reduction in OD only shows up for the richer households.

5. Changes in the sanitation behavior within the household

Who reduces OD when a toilet is adopted in response to the presence of female children? Is it just the female children or also the other members of the household? The answer to this question provides more insights into the broader theme of neighborhood sanitation improvements. NFHS does not record the sanitation behavior of each individual household, and therefore, a direct investigation is not possible. The SQUAT survey in 2013–14 (Coffey et al. (2014)) is a potential data source in that it records the individual sanitation behavior of the household members. However, there are two main limitations of using these data. First, unlike NFHS, this survey does not record a full birth history, and therefore, identifying the firstborn child of the household head is a challenge.[29] Second, the SQUAT survey was only conducted in a sample of rural villages in the states of Bihar, Haryana, Madhya Pradesh, Rajasthan, and Uttar Pradesh, thereby ruling out urban areas from any analysis.

In the analysis using the SQUAT survey, I use the oldest reported child (in the household roster) of the household head as a proxy for the firstborn child. However, the older children are likely to leave the household after marriage or migration (e.g., for a job or study) and therefore will not be recorded in the household roster. The probability that the firstborn is excluded from the roster is not random, and specifically not random with respect to the gender of the child.[30] To reduce the likelihood of migration,

[29] SQUAT survey records in the household roster only the members staying in the household for at least two months in the previous year.

[30] Female children in India usually marry earlier than their male siblings and are likely to be missing from the roster. Similarly, a male child is more likely to migrate to a city for further study or a job.

I restrict the age of the oldest reported child to ≤ 18 years, which is the legal age of marriage and voting and is likely strongly correlated with children's independence. While this step does not remove the likelihood of migration entirely, it certainly is a step in the direction of mitigating it.

Another important empirical feature of the SQUAT survey is the sample size. The sample size satisfying the conditions laid out in the previous paragraph is only about 1% of the sample used in the rural NFHS analysis. With the inflated standard errors due to the small sample size, the quantitative lessons from the analysis rely largely on the coefficient's size and sign and not on its statistical significance. Table 10 shows the results with and without restricting the age of the oldest reported child. Column 1 corroborates the main result: that households reduce OD in the presence of female children. Columns 2 and 3 provide evidence of a reduction in OD by not only the proxied firstborn child but also other members of the household. The reduction in OD for the firstborn child is slightly higher than the reduction by other members of the household. While it is unlikely that the toilet adoption in response to female children would lead to *all* household members switching away from OD[31], this analysis provides suggestive evidence that *some* of the other members also reduce OD.

6. In what types of toilet use is reduction in OD reflected?

By definition, a reduction in OD means an increase in toilet use. But what types of toilet use substitute for OD? Understanding toilet use also provides insights into the shame-costs discussion. Is the shame about not having a toilet or a specific type of toilet? Using the categories provided in NFHS, I classify toilet types into toilets with a flush system, toilets with a pit system, improved toilets, and other types of toilets. Table 11 uses the presence of a specific toilet type as an outcome with a dummy variable with a value equal to 1 if a specific type is present and 0 otherwise. This outcome variable also includes households with no toilet and the value of the dummy variable is 0 for these households. In urban areas, OD is mostly substituted for a flush toilet and, to a smaller extent, for a pit toilet. In rural areas, the shift is mainly driven by a flush toilet. There are different types of flush toilet that are included in this aggregate category of "flush toilets", e.g., flush to sewer, septic tank etc.[32] Dis-aggregating the flush category further reveals the drivers of shift in toilet ownership within the "flush" category. In urban

[31] Using the SQUAT survey, Geruso and Spears (2018) show that at least one individual in about 40% of the households owning a toilet still practices OD.

[32] NFHS 2015 captures the following categories under flush toilets - flushed to piped sewer system, flush to septic tank, flush to pit laterine, flush to somewhere else, and flush to an unknown outlet.

areas, the shift is mainly driven by the toilets that use a "flush to piped sewer" system. However, in rural areas, the shift is driven by toilets that use a "flush to septic tank" and "flush to a pit". These trends are consistent with the presence of sewer lines as a main source of waste containment system in the urban areas, and a lack of sewer systems in the rural areas. In both regions, there is no shift to using improved toilets, providing evidence that shame costs largely are about not having a toilet and not about not having an upgraded toilet.

VII. Robustness to confounding channels

1. Role of other female members

If, because of the firstborn gender, there is a systematic presence of additional female members in the household other than daughters, it cannot be ruled out that the results shown in the previous section are driven by the additional female member and not by the female child. Table 3 shows that in households with a firstborn girl, a significantly higher number of women are 15–49 years of age. Possible explanations are the presence of the firstborn girl herself, presence of additional female children the household had after the first child (to achieve the desired number of sons), or systematic entry of different female members into these households. The last possibility is a deep concern for the validity of the results. For example, the entry of a new daughter-in-law could be a significant confounder, regarding which Stopnitzky (2017) provides causal empirical evidence of a reduction in OD.

I analyze the gender composition of households with the firstborn child as male versus female. Table A5 reports the result of estimating equation (1) on gender composition of households. firstborn girls have about one additional female member (column 1) in rural and urban areas. Column 2 shows that the number of additional female members in column 1 can be entirely explained by the presence of additional daughters only. Column 3 indicates a lower presence of other female members in households with firstborn daughters. Looking specifically at the presence of a daughter-in-law (column 4), households with a firstborn girl have fewer daughters-in-law (potentially because of the delay in the marriage of a son as the son is younger than the firstborn female sibling). This exercise indicates that the results discussed in the previous section are not driven by any female member of the household apart from additional daughter(s).

Finally, table 3 shows that the pregnancy rate among mothers of firstborn girls is higher than that among mothers of firstborn boys. This is likely because of the desire to have a son. In Table A6, I exclude the households with pregnant mothers. The results are similar to the main results in Table 4, providing evidence that households do not drive a reduction in OD exclusively in the presence of pregnant mothers.

2. Role of other household characteristics

Households with firstborn girls end up having more children, thereby pushing per capita resources in the household down. Therefore, households with firstborn girls are likely to be poorer, making them unlikely to invest in a toilet (and reduce OD). Table A7 demonstrates the difference in various assets in households with a firstborn girl versus a boy. As observed, in rural and urban areas, households with a firstborn girl report lower assets than households with a firstborn boy. This difference in asset ownership suggests that households with a firstborn girl have lower asset ownership. It is unlikely that a reduction in OD is driven by any omitted variables correlated with the economic status and gender of the firstborn child.

A toilet is likely to be a one-time investment. Since this investment benefits all household members, the per capita costs are lower for larger families, making them more likely to make this investment. Since firstborn girls live in larger households, these households are potential candidates to invest in a toilet because per capita costs are lower. If true, this is a confounding factor for the main results. To explore this, I use a difference-in-differences framework in which I interact the firstborn gender with the household size while controlling separately for both firstborn gender and size. Table A8 shows the coefficient on interaction of the firstborn gender with the total household members. The coefficient is negative but very small and statistically insignificant. This provides evidence that lower per capita resources in households with firstborn girls are likely to outweigh the lower per capita costs of investing in reducing OD and, therefore, unlikely to confound the main results.

Table 3 shows that mothers of firstborn girls are slightly younger than mothers of firstborn boys. In general, households are more likely to invest in a toilet for an older female member who is incapable of going out to defecate/urinate, which is less likely to bias the results in a problematic direction. However, I explore this using a similar difference-in-differences framework by interacting the firstborn gender with the mother's age (and separately controlling for both). Table A9 shows the coefficient on the interaction term. In urban areas, this coefficient is zero. In rural areas, this coefficient is negative and significant, signifying that households with firstborn girls who have an older mother are more likely to reduce OD. However, as shown in Table 3, mothers of firstborn girls are not systematically older than mothers of firstborn boys, thereby providing evidence against this confounding channel.

VIII. Discussion and Conclusion

Using the gender of the firstborn child conditional on geographic controls as a plausibly exogenous shock, this paper finds that poor urban households and richer rural households reduce OD when they have female children. This behavior is potentially explained by an interaction between costs associated with female children's OD (thereby being exposed to harassment) and budget constraints. After exploring various subsamples and heterogeneities, I find considerable support for the hypothesis related to the interaction of costs and budget constraints.

This paper contributes to our understanding of sanitation behavior and its drivers in India. First, by highlighting the presence of costs that are not exclusively private to the female children and the impact of these costs on investment for the welfare of female children, it contributes to the literature analyzing decision-making in households with gender biases (e.g., Barcellos et al. (2014), Jayachandran and Kuziemko (2011), Deaton (2003)).

Second, recent studies linking sanitation and health outcomes (e.g., Geruso and Spears (2018)) analyze the problem of poor sanitation from the perspective of a public good problem and conclude that the private demand for improved sanitation is suboptimal. By identifying a difference in the demand for sanitation within households with male versus female children, this paper documents a previously unknown heterogeneity within the population that generates lower aggregate private demand. In doing so, this paper highlights the existence of incentives (such as protecting female children from harassment) that potentially lead to this heterogeneity. Understanding these incentives can improve the targeting of campaigns and subsidy programs, thereby boosting private demand. Adding to the strand of literature analyzing the association between sanitation practices and the gender of household members (e.g., Stopnitzky (2017) in the context of marriage markets), this paper identifies a new possible mechanism in which the presence of female children leads to improvement in household sanitation practices. Social campaigns for improved sanitation aim to change the incentives to adopt a toilet, but they rely on existing channels for success, such as bargaining in marriage markets (the focus of Stopnitzky (2017)). This paper uncovers an additional channel that has the potential to be tapped to generate changes in the incentives for adopting a toilet, thereby impacting neighborhood sanitation. Years after the start of a large sanitation campaign called Swachh Bharat Mission (Clean India Campaign), there is still room to improve neighborhood sanitation in India (see Gupta et al. (2020)). This paper identifies a potential target population for whom the incentives to adopt improved sanitation practices are stronger than others and, therefore, could increase the effectiveness of social campaigns and subsidy-based sanitation programs such as Swachh Bharat Mission.

Finally, scientific studies are an important avenue to understand the broader impacts of poor neighborhood sanitation, such as the impacts on health and welfare outcomes. These studies can also inform policy decisions by quantifying the impact of improving sanitation on these outcomes. However, generating a large-enough first-stage adoption of toilets and identifying the subsequent health impacts has been a challenge in recent studies (see Hammer and Spears (2016), Clasen et al. (2015), Gertler et al. (2015), Guiteras et al. (2015) and Patil et al. (2014) for examples). This paper identifies households with female children as potentially larger adopters of toilets, a finding that future research can use to generate larger first-stage effects and improve our understanding of how sanitation affects various developmental outcomes.

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Tables

Table 1: SUMMARY STATISTICS: NFHS 2015-16

Outcome	(1) Rural	(2) Urban
Total population	74.66%	25.34%
Number of HH members	6.09	5.85
Number of Children	2.9	2.4
Mother's Age	36	35
Father's Age	47	46
First-born Gender: *Female*	47.56%	47.14%
First-born Age	6.8	4.3
Religion: *Hindu*	76.7%	73.4%
Religion:*Muslim*	10.03%	14.7%
Open Defecation	49%	12%

Notes: This table provides summary statistics of key demographic variables in 2015-16 round of NFHS in India.

Table 2: DIFFERENCES ACROSS HOUSEHOLDS WITH MALE OR FEMALE FIRST-BORNS - *Age* $\leq$ *2 yrs.*

Variable	Urban			Rural		
	Mean	Difference	Standard Error	Mean	Difference	Standard Error
Asset Index	-0.241	0.026	[.05]	-0.065	-0.016	[.023]
Water Source						
Piped into Dwelling	0.29	-0.033	[.024]	0.088	0.007	[.007]
Piped to yard/plot	0.183	-0.037	[.02]*	0.093	-0.012	[.009]
Public tab/standpipe	0.162	0.03	[.021]	0.131	0.001	[.01]
Tubewell or borehole	0.216	0.004	[.014]	0.491	0	[.013]
Cooking Fuel						
LPG, Natural Gas	0.729	-0.007	[.023]	0.187	-0.01	[.012]
Wood	0.148	0.017	[.012]	0.634	0.003	[.014]
Floor Material						
Mud/Clay/Earth	0.104	0.003	[.009]	0.443	0.01	[.011]
Animal Dung	0.022	0.006	[.003]*	0.113	0.003	[.006]
Cement	0.558	0.005	[.024]	0.306	-0.011	[.013]
Roof Material						
Metal/GI	0.176	0.004	[.01]	0.238	0.006	[.007]
RCC/RBC/Cement/Concrete	0.495	-0.015	[.026]	0.22	0.02	[.013]
Thatch/Palm Leaf	0.013	-0.005	[.004]	0.075	0.008	[.007]
Burnt Brick	0.029	0.002	[.005]	0.065	-0.004	[.005]
Wall Material						
Mud	0.052	-0.013	[.008]*	0.216	0.008	[.01]
Cement/Concrete	0.464	0.022	[.026]	0.203	0.013	[.011]
Burnt Brick	0.231	-0.003	[.018]	0.233	-0.018	[.01]*
Household and Mother Characteristics						
Religion: Muslim	0.176	-0.001	[.02]	0.132	0.005	[.008]
Mother's current age	25.006	0.068	[.213]	23.552	0.044	[.098]
Mother's highest year of education	4.274	0.054	[.159]	4.057	-0.02	[.05]
Is the mother currently pregnant?	0.096	0.018	[.019]	0.127	0.008	[.009]
Number of household members	3.791	0.049	[.063]	3.971	0.001	[.05]
Number of children under 5 years	1.086	0.001	[.02]	1.109	0.012	[.012]

Notes: This table reports the mean differences across various household characteristics for the households with the first-born child being girl (=1) versus boy (=0). The age of first-born child is restricted to $\leq$ 2 years. Coefficient β from equation (1) is reported (estimated without any controls) along with the p-value. Standard errors are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01, **** p<0.001.

Table 3: Differences Across Households with Male or Female First-Borns - *Full sample*

Variable	Urban Mean	Urban Difference	Urban Standard Error	Rural Mean	Rural Difference	Rural Standard Error
Asset Index	0	-0.05	[.012]***	0	-0.065	[.005]***
Water Source						
Piped into Dwelling	0.316	-0.015	[.005]***	0.091	0	[.001]
Piped to yard/plot	0.176	0.003	[.004]	0.107	-0.002	[.002]
Public tab/standpipe	0.159	0.007	[.004]*	0.142	0.002	[.002]
Tubewell or borehole	0.211	-0.001	[.003]	0.474	-0.002	[.002]
Cooking Fuel						
LPG, Natural Gas	0.737	-0.009	[.004]**	0.197	-0.005	[.002]**
Wood	0.16	0.008	[.003]***	0.618	0.005	[.003]**
Floor Material						
Mud/Clay/Earth	0.087	-0.002	[.002]	0.4	0.003	[.002]
Animal Dung	0.021	0.001	[.001]*	0.11	0.001	[.001]
Cement	0.529	0	[.005]	0.328	-0.004	[.002]*
Roof Material						
Metal/GI	0.155	0.004	[.002]*	0.21	-0.001	[.001]
RCC/RBC/Cement/Concrete	0.524	-0.011	[.005]**	0.252	-0.003	[.002]
Thatch/Palm Leaf	0.012	0	[.001]	0.064	0.003	[.001]**
Burnt Brick	0.028	-0.002	[.001]*	0.065	0	[.001]
Wall Material						
Mud	0.046	0.002	[.001]	0.199	0.006	[.002]***
Cement/Concrete	0.47	-0.003	[.004]	0.229	-0.004	[.002]*
Burnt Brick	0.24	0.004	[.004]	0.247	0	[.002]
Household and Mother Characteristics						
Religion: Muslim	0.173	-0.003	[.003]	0.111	0	[.002]
Is the first born child alive?	0.943	0.012	[.002]***	0.913	0.014	[.002]***
Mother's Current Age	36.707	-0.37	[.084]***	35.899	-0.25	[.044]***
Mother's highest year of Education	6.984	-0.025	[.02]	3.828	0.017	[.012]
Is the mother currently pregnant?	0.024	0.006	[.002]***	0.034	0.012	[.001]***
Number of household members	4.716	0.082	[.015]***	4.998	0.083	[.01]***
Number of children under 5 years	0.477	0.061	[.008]***	0.62	0.062	[.005]***
Number of women (15-49 years)	1.481	0.257	[.008]***	1.443	0.159	[.004]***

Notes: This table reports the mean differences across various household characteristics for the households with the first-born child being girl (=1) versus boy (=0). Coefficient β from equation (1) is reported (estimated without any controls) along with the p-value. Standard errors are clustered at district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01, **** p<0.001.

Table 4: GENDER OF FIRST-BORN CHILD AND REDUCTION IN OD

Dependent Variable:	Open Defecation Rate									
	Urban					Rural				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
First-born (Girl)	-0.006***	-0.008***	-0.009***	-0.007***	-0.006***	-0.004***	-0.012***	-0.010***	-0.008***	-0.013***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations	71,478	71,478	71,478	71,478	71,478	159,334	159,334	159,334	159,334	159,334
Mean OD	.12	.12	.12	.12	.12	.52	.52	.52	.52	.52
Household Controls	No	Yes	No	No	Yes	No	Yes	No	No	Yes
District FE	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Other Interacted FE	No	No	Yes	No	Yes	No	No	Yes	No	Yes
PSU FE	No	No	No	Yes	No	No	No	No	Yes	No

Notes: This Table reports the estimates from equation (1). Outcome variable in all columns is the indicator variable OD = 1 if household defecates in open and OD = 0 if not. Results are reported separately by Urban and Rural areas. Column 5 and 10 are *preferred* specifications that include the full set of household controls, district fixed effects and interacted fixed effects (district, caste and age of first-born). Column 4 and 8 replace the district FE with primary sampling unit FE. Standard errors (in parenthesis) are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table 5: BOUNDING EXERCISE

	Panel A: Urban Areas			
	Coefficient		Bounding (R^2_{max} = 0.72)	
	Uncontrolled	Controlled	β_s for δ =1	$\lvert\delta\rvert$ for β_s = 0
β_s	-0.003	-0.006	-0.007	9.65
R^2	0.07	0.55		
	Panel B: Rural Areas			
	Coefficient		Bounding (R^2_{max} = 0.81)	
	Uncontrolled	Controlled	β_s for δ =1	$\lvert\delta\rvert$ for β_s = 0
β_s	0.005	-0.01	-0.02	2.02
R^2	0	0.622		

Notes: This table shows the bounding exercise suggested by (Oster 2019) for robustness to omitted variables bias by observing the coefficient movements after the inclusion of controls.

Table 6: GENDER OF FIRST-BORN CHILD AND REDUCTION IN OD - *Young First-Born*

Dependent Variable:	Open Defecation Rate									
	Urban					Rural				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
First-born (Girl)	0.002	-0.001	-0.002	0.003	-0.001	0.007	-0.001	0.003	-0.002	0.004
	(0.005)	(0.005)	(0.004)	(0.005)	(0.006)	(0.005)	(0.004)	(0.004)	(0.004)	(0.005)
Observations	15,539	15,539	15,539	15,539	15,539	38,910	38,910	38,910	38,910	38,910
Mean OD	.13	.13	.13	.13	.13	.55	.55	.55	.55	.55
Household Controls	No	Yes	No	No	Yes	No	Yes	No	No	Yes
District FE	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Other Interacted FE	No	No	Yes	No	Yes	No	No	Yes	No	Yes
PSU FE	No	No	No	Yes	No	No	No	No	Yes	No

Notes: This Table reports the estimates from equation (1) on the sample where the age of first-born is restricted to be below 8 years. Outcome variable in all columns is the indicator variable OD = 1 if household defecates in open and OD = 0 if not. Results are reported separately by Urban and Rural areas. Column 5 and 10 are *preferred* specifications that include the full set of household controls, district fixed effects and interacted fixed effects (district, caste and age of first-born). Column 4 and 8 replace the district FE with primary sampling unit FE. Standard errors (in parenthesis) are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table 7: CRIME AGAINST WOMEN AND CHANGE IN SANITATION BEHAVIOR

Dependent Variable:	Open Defecation Rate			
	Urban		Rural	
	(1)	(2)	(3)	(4)
First-born (Girl)	-0.014***	-0.005*	-0.014***	-0.012***
	(0.003)	(0.003)	(0.004)	(0.002)
Observations	30,032	41,446	42,405	116,929
Region	High Crime	Low Crime	High Crime	Low Crime
Mean OD	.12	.11	0.57	.5
Household Controls	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Other Interacted FE	Yes	Yes	Yes	Yes
FB Girl × High Crime	-0.008**		-0.002	
	(0.004)		(0.004)	

Notes: This table reports the estimates of equation (1) for urban and rural regions divided by prevalence of crime against women. Columns are divided by crime reports across 10 states/UTs with highest incidences and remaining other states/UTs (using crime reports from Indian Human Development Survey). Column 1 & 3 report the results for 10 states/UTs with highest crime against women and column 2 & 4 report the results for all other states/UTs. Last row reports the coefficient on interaction of FB gender with high crime areas (from a version of equation 1 where FB gender and high crime dummy are included separately). Preferred specification of equation (1) with full set of household controls and fixed effects is used. Standard errors (in parenthesis) are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table 8: TRUST IN POLICE AND CHANGE IN SANITATION BEHAVIOR

Dependent Variable:	Open Defecation Rate			
	Urban		Rural	
	(1)	(2)	(3)	(4)
First-born (Girl)	-0.011***	-0.006**	-0.014***	-0.012***
	(0.003)	(0.003)	(0.003)	(0.002)
Observations	34,467	37,011	62,122	97,212
Region	Low Trust	Higher Trust	Low Trust	Higher Trust
Mean OD	.11	.12	0.56	.49
Household Controls	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Other Interacted FE	Yes	Yes	Yes	Yes
FB Girl × Low Trust	-0.006		-0.002	
	(0.004)		(0.004)	

Notes: This table reports the estimates of equation (1) on urban and rural regions divided by the level of trust in police (using self-reported information from Indian Human Development Survey). Column 1 & 3 report the results using 10 states reporting the lowest trust in police. Column 2 & 4 report the results using all other states reporting a higher level of trust in police. Last row reports the coefficient on interaction of FB gender with low trust areas (from a version of equation 1 where FB gender and low trust dummy are included separately). Preferred specification of equation (1) with full set of household controls and fixed effects is used. Standard errors (in parenthesis) are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table 9: STATE PERFORMANCE AND CHANGE IN SANITATION BEHAVIOR

Dependent Variable:	Open Defecation Rate			
	Urban		Rural	
	(1)	(2)	(3)	(4)
First-born (Girl)	-0.013***	-0.005**	-0.012***	-0.012***
	(0.004)	(0.002)	(0.003)	(0.002)
Observations	22,837	48,641	65,543	93,791
Region	BIMAROU	Non-BIMAROU	BIMAROU	Non-BIMAROU
Mean OD	.16	.12	.72	.37
Household Controls	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Other Interacted FE	Yes	Yes	Yes	Yes
FB Girl × BIMAROU	-0.005		0.001	
	(0.004)		(0.004)	

Notes: This table reports the estimates of equation (1) on urban and rural regions divided by low and high performing states. Columns are divided by indicators of low versus high performing states. Column 1 & 3 report the results using *BIMAROU* states (Bihar, Madhya Pradesh, Rajasthan, Odisha and Uttar Pradesh). Column 2 & 4 report the results for *Non-BIMAROU* states (all others). Last row reports the coefficient on interaction of FB gender with BIMAROU areas (from a version of equation 1 where FB gender and BIMAROU dummy are included separately). Preferred specification of equation (1) with full set of household controls and fixed effects is used. Standard errors (in parenthesis) are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table 10: INDIVIDUAL SANITATION BEHAVIOR USING THE SQUAT SURVEY 2013-14

	Open defecation behavior in SQUAT 2014		
	(1)	(2)	(3)
OD practiced by:	Anyone in the household	Only the FB child	Anyone except FB child
	Panel A: Unrestricted by age		
First reported child (Girl)	-0.020	-0.035	-0.017
	(0.015)	(0.018)	(0.015)
Observations	3,073	2,897	3.073
	Panel A: Restricted by age (age $\leq$ 18)		
First reported child (Girl)	-0.015	-0.034	-0.011
	(0.017)	(0.020)	(0.017)
Observations	1,766	1,592	1,766

Notes: This table reports the estimates from equation (1) on the sample of households in the SQUAT survey 2013-14 where the oldest reported child of the household head is used as a proxy for the first born child. Results are shown in two panels - panel A is the full sample as described before, while panel B restricts the age of the oldest reported child to $\leq$ 18 years. Column 1 to 3 record the OD practice for a specific set of individuals within the household. Similar to the main analysis using NFHS 2015-16, the empirical specifications here control for a set of household and geographic controls. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table 11: CHANGE IN TYPES OF TOILET USE IN RESPONSE TO THE FEMALE FIRST BORN CHILD

	Types of toilets in use			
	(1)	(2)	(3)	(4)
Toilet type:	Flush toilet	Pit toilet	Improved toilet	Other type
	Panel A: Urban areas			
First-born (Girl)	0.0052**	0.0020	0.0005	0.0003
	(0.0026)	(0.0017)	(0.0007)	(0.0008)
Observations	71,478	71,478	71,478	71,478
	Panel B: Rural areas			
First-born (Girl)	0.0143***	0.0009	-0.0002	0.0004
	(0.0021)	(0.0014)	(0.0005)	(0.0005)
Observations	159,334	159,334	159,334	159,334

Notes: This table reports the estimates of equation (1) on the sample of households used in the main analysis using NFHS 2015-16. The dependent variable is a dummy (=1) if the household reports using a specific type of toilet (in column 1 to 4), and (=0) otherwise. Standard errors are clustered at the district level, and the significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

IX. Figures

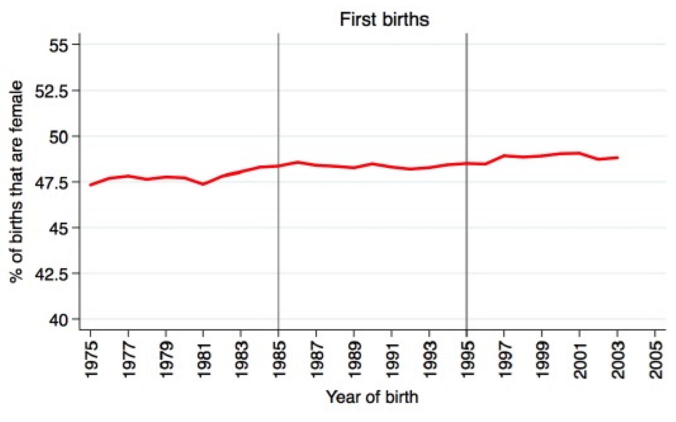

Figure 1: FRACTION OF FEMALE IN FIRST-BORN CHILDREN (1975-2005)

Notes: Source: Bhalotra and Cochrane 2010. This figure shows the evolution of percent female among first births over 1975-2005 in India. Additionally, it shows that despite ultrasound availability (in 1985 and 1995), the sex ratio of first births has remained normal.

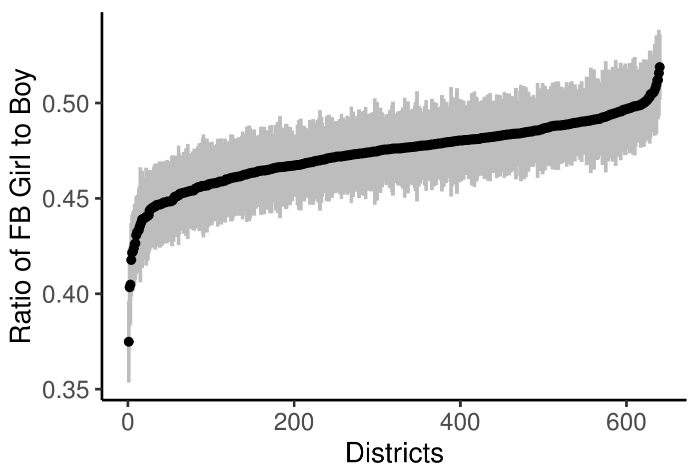

Figure 2: FRACTION OF FEMALE IN FIRST-BORN CHILDREN IN DISTRICTS IN NFHS 2015-16

Notes: This figure shows the percent female among first births in 640 districts of India in NFHS 2015-16. The black dots represent the weighted mean and the grey bars represent a 90% confidence interval around the weighted mean.

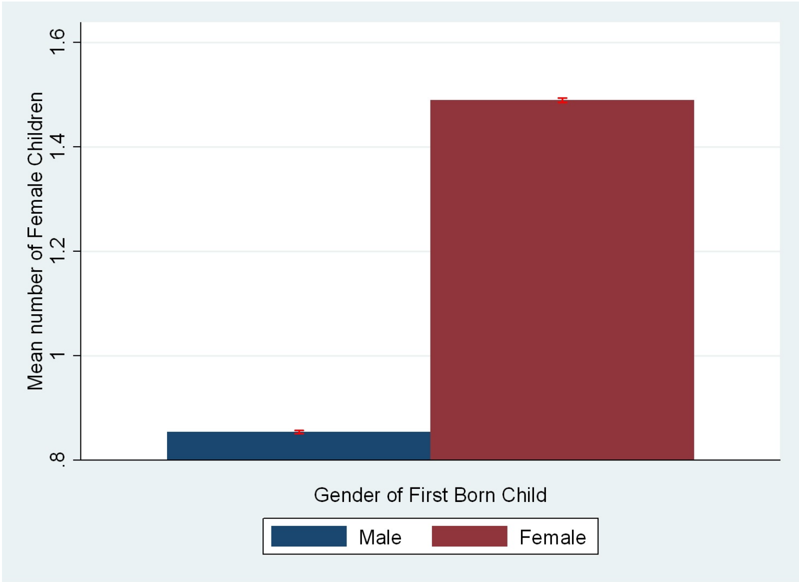

Figure 3: AVERAGE NUMBER OF FEMALE CHILDREN BY GENDER OF FIRST-BORN CHILD

Notes: This figure shows the average number of female children born to all households in NFHS 2015-16, separated by the gender of the first-born child.

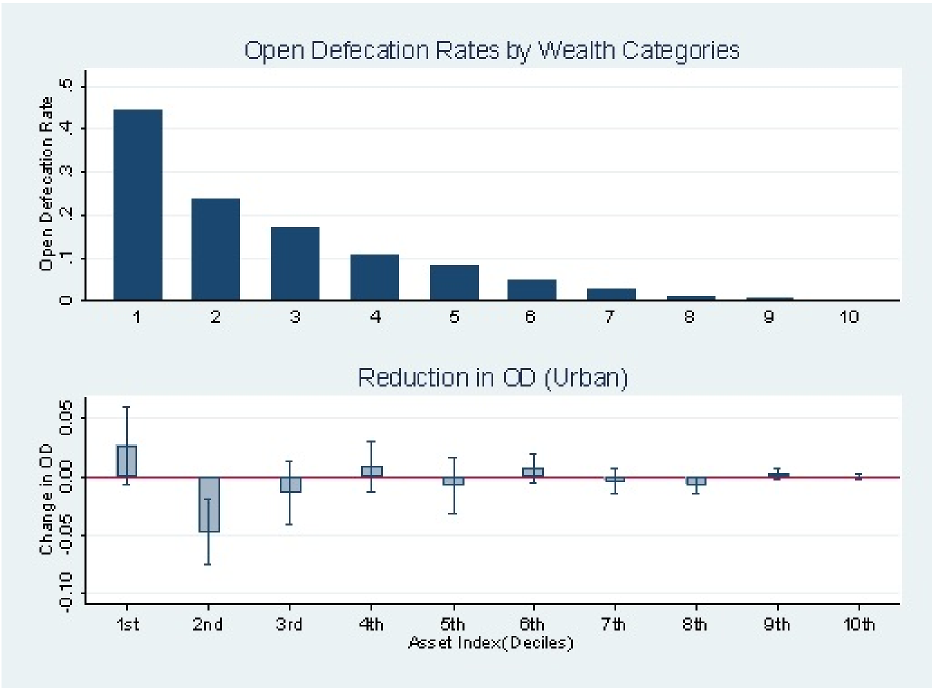

Figure 4: GENDER OF FIRST BORN AND REDUCTION IN OD - *By Deciles of Asset Index in Urban Areas*

Notes: The panel on top shows the OD rate by decile of asset index in urban areas (from poorest 1st decile to richest 10th decile). The panel below that shows the estimates of (1) on the urban sample divided by the deciles of asset index. Confidence intervals are at 90% level.

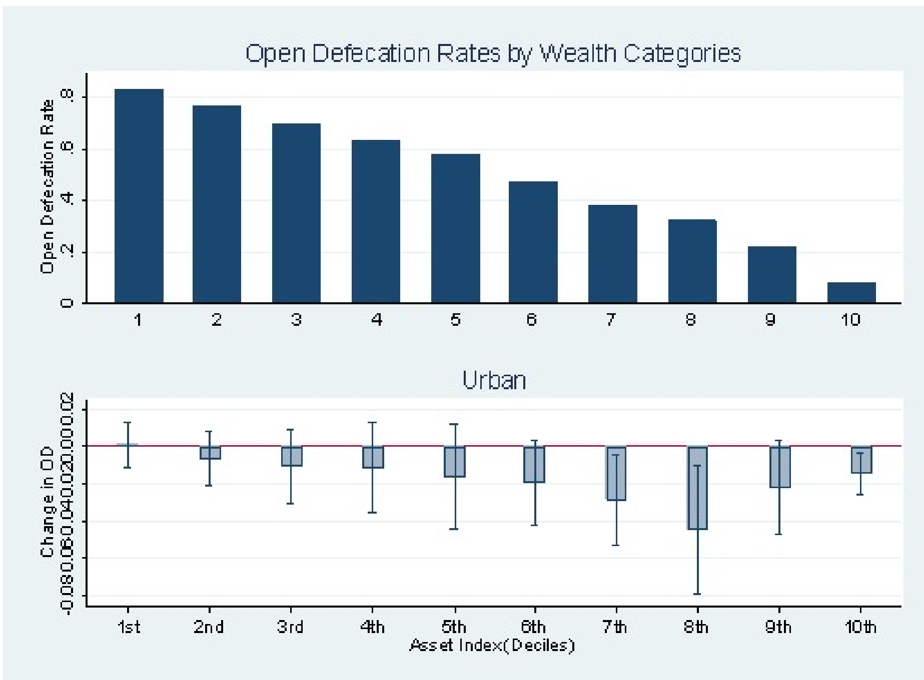

Figure 5: Gender of First Born and Reduction in OD - *By Deciles of Asset Index in Rural Areas*

Notes: The panel on top shows the OD rate by decile of asset index in rural areas (from poorest 1st decile to richest 10th decile). The panel below that shows the estimates of (1) on the rural sample divided by the deciles of asset index. Confidence intervals are at 90% level.

X. Appendix

Table A1: RETROSPECTIVE DIFFERENCE IN HOUSEHOLD CHARACTERISTICS FOR THE FIRST BORN CHILDREN IN 2015-16 - *Using previous rounds of NFHS*

	Urban		Rural	
Household Characteristic	Difference	Standard Error	Difference	Standard Error
Asset Index	-0.009	[0.043]	-0.005	[0.031]
Religion: *Muslim*	0.012	[0.012]	-0.009	[0.011]
Mother's age	0.063	[0.189]	0.008	[0.141]
Mother's highest year of education	-0.039	[0.087]	0.129	[0.084]
Is the mother currently pregnant?	0.005	[0.017]	-0.004	[0.013]
Number of household members	0.147	[0.079]*	-0.003	[0.068]

Notes: This table reports the mean differences across various household characteristics for the households with the first-born child being girl (=1) versus boy (=0) in the combined sample of the 1992, 1999 and 2005 rounds of NFHS in India. The age of first-born child is restricted to 2 years. Coefficient β from equation (1) is reported (estimated with the primary sampling fixed effects and the NFHS round fixed effects) along with the standard errors. Standard errors are clustered at the level of the primary sampling unit (PSU). Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01, **** p<0.001.

Table A2: ROBUSTNESS TO REMOVING WEALTH AND FERTILITY CONTROLS

Dependent Variable:	Open Defecation Rate			
	Urban		Rural	
	(1)	(2)	(3)	(4)
First-born (Girl)	-0.007***	-0.005**	-0.013***	-0.008***
	(0.002)	(0.002)	(0.002)	(0.002)
Observations	71,478	71,478	159,334	159,334
Household Controls	Yes	Yes	Yes	Yes
District FE	Yes	Yes	Yes	Yes
Other Interacted FE	Yes	Yes	Yes	Yes
Excluded Wealth	Yes	Yes	Yes	Yes
Excluded Fertility	No	Yes	No	Yes

Notes: This Table reports the estimates from equation (1) on urban and rural samples where controls for wealth (asset index) and fertility are removed sequentially. Outcome variable in all columns is the indicator variable OD = 1 if household defecates in open and OD = 0 if not. Preferred specification of equation (1) with full set of household controls and fixed effects is used (after removing indicated controls). Standard errors (in parenthesis) are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table A3: MAIN RESULTS - 1992, 1999 AND 2005 ROUNDS OF DHS

Dependent Variable:	Open Defecation Rate					
	Urban			Rural		
	(1)	(2)	(3)	(4)	(5)	(6)
First-born (Girl)	-0.008***	-0.010***	-0.007***	-0.013***	-0.013***	-0.011***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
Constant	0.210***	0.450*	0.216	0.806***	0.580	0.806***
	(0.008)	(0.243)	(0.210)	(0.007)	(0.374)	(0.202)
Observations	54,878	54,878	54,873	87,939	87,939	87,933
Mean OD	.16	.16	.16	.73	.73	.73
Survey Round FE	Yes	Yes	Yes	Yes	Yes	Yes
Household Controls	No	Yes	Yes	No	Yes	Yes
PSU FE	No	No	Yes	No	No	Yes

Notes: This Table reports the estimates from equation (1) on the pooled sample from 1992, 1999 and 2005 DHS surveys in India. Outcome variable in all columns is the indicator variable OD = 1 if household defecates in open and OD = 0 if not. Results are reported separately by Urban and Rural areas. Column (3) and (6) are the richest specification. Survey rounds fixed effects are used in all specifications. PSU fixed effects are used instead of district fixed effects. Standard errors (in parenthesis) are clustered at the PSU level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table A4: MAIN RESULTS - ALL ROUNDS OF DHS COMBINED

Dependent Variable:	Open Defecation Rate					
	Urban			Rural		
	(1)	(2)	(3)	(4)	(5)	(6)
First-born (Girl)	-0.009***	-0.011***	-0.007***	-0.014***	-0.018***	-0.013***
	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)
Constant	0.214***	0.450*	0.251	0.804***	0.580	0.805***
	(0.008)	(0.242)	(0.196)	(0.006)	(0.379)	(0.204)
Observations	129,388	129,388	129,352	255,776	255,776	255,660
Mean OD	.13	.13	.13	.58	.58	.58
Survey Round FE	Yes	Yes	Yes	Yes	Yes	Yes
Household Controls	No	Yes	Yes	No	Yes	Yes
PSU FE	No	No	Yes	No	No	Yes

Notes: This Table reports the estimates from equation (1) on the pooled sample from 1992, 1999, 2005 and 2015 DHS surveys in India. Outcome variable in all columns is the indicator variable OD = 1 if household defecates in open and OD = 0 if not. Results are reported separately by Urban and Rural areas. Column (3) and (6) are the richest specification. Survey rounds fixed effects are used in all specifications. Household controls which are common across all rounds are used along with PSU fixed effects in place of district fixed effects. Standard errors (in parenthesis) are clustered at the PSU level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table A5: GENDER OF FIRST-BORN CHILD AND GENDER COMPOSITION OF HOUSEHOLD

	Gender Composition (Female Members)			
	(1)	(2)	(3)	(4)
Dependent Variable:	All Female Members	Only Daughters	Other than Daughters	Daughter in Law
	Panel A: Urban Areas			
First-born (Girl)	0.952***	1.033***	-0.081***	-0.081***
	(0.008)	(0.007)	(0.006)	(0.003)
Observations	71,478	71,478	71,478	71,478
	Panel B: Rural Areas			
First-born (Girl)	0.971***	1.097***	-0.125***	-0.107***
	(0.007)	(0.006)	(0.005)	(0.003)
Observations	159,334	159,334	159,334	159,334

Notes: This table reports the estimates of equation (1) on Urban and Rural areas (in Panel A and B, respectively). The outcome variable here are total number of female members of household (Column 1), number of daughters of household head (Column 2), number of female members other than daughters of household head (Column 3) and, number of daughters in law of household head (Column 4). Standard errors (in parenthesis) are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table A6: MAIN RESULTS - EXCLUDING PREGNANT MOTHERS

Dependent Variable:	Open Defecation Rate	
	Urban	Rural
	(1)	(2)
First-born (Girl)	-0.007***	-0.013***
	(0.002)	(0.002)
Observations	69,515	152,790
Mean OD	.12	.52
Household Controls	Yes	Yes
District FE	Yes	Yes
Other Interacted FE	Yes	Yes

Notes: This Table reports the estimates from equation (1) on urban and rural sample after dropping the households where the mother of first-born was pregnant during the survey. Outcome variable in all columns is the indicator variable OD = 1 if household defecates in open and OD = 0 if not. Results are reported separately by Urban and Rural areas. Column (2) and (4) are the richest specification. Preferred specification of equation (1) with full set of household controls and fixed effects is used. Standard errors (in parenthesis) are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table A7: ASSET COMPOSITION BY GENDER OF FIRST-BORN CHILD

	Urban			Rural		
Asset	Mean	Difference	Standard Error	Mean	Difference	Standard Error
Electricity	0.978	-0.001	[.001]	0.844	-0.012	[.002]***
Radio	0.097	0.003	[.002]	0.081	-0.001	[.001]
Television	0.879	-0.011	[.002]***	0.543	-0.028	[.002]***
Refrigerator	0.518	-0.008	[.004]**	0.17	-0.011	[.002]***
Bicycle	0.485	-0.029	[.004]***	0.528	-0.03	[.003]***
Motorcycle/Scooter	0.502	-0.044	[.004]***	0.29	-0.039	[.002]***
Car/Truck	0.108	-0.006	[.002]***	0.037	-0.004	[.001]***
Mattress	0.841	-0.001	[.003]	0.621	-0.013	[.002]***
Pressure Cooker	0.857	-0.001	[.003]	0.476	-0.007	[.002]***
Chair	0.868	-0.007	[.003]***	0.701	-0.015	[.002]***
Cot or Bed	0.908	-0.003	[.002]	0.885	-0.005	[.002]***
Table	0.735	-0.004	[.003]	0.504	-0.013	[.003]***
Electric Fan	0.904	-0.01	[.002]***	0.639	-0.023	[.002]***
Internet	0.21	-0.024	[.003]***	0.068	-0.022	[.001]***
Computer	0.174	-0.015	[.003]***	0.037	-0.008	[.001]***
Air Conditioner/Electric Cooler	0.344	-0.02	[.004]***	0.105	-0.014	[.002]***
Washing Machine	0.282	-0.012	[.003]***	0.064	-0.008	[.001]***
Water Pump	0.188	-0.004	[.003]	0.118	-0.01	[.002]***
Agricultural Thresher	0.005	0	[.001]	0.013	-0.002	[.001]***

Notes: This table reports the mean differences by the gender of first-born child across various assets owned by the household. Differences are reported separately by urban and rural areas. Standard errors are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table A8: INTERACTION OF HOUSEHOLD SIZE WITH GENDER OF FIRST-BORN

Dependent Variable:	Open Defecation Rate	
	Urban (1)	Rural (2)
First-born (Girl) x HH Size	-0.0006	-0.0014
	(0.643)	(0.209)
Observations	71,478	159,334
Household Controls	Yes	Yes
District FE	Yes	Yes
Other Interacted FE	Yes	Yes

Notes: This table reports the estimates from interaction of gender of the first-born child and household size (number of members in household), by urban and rural regions. It reports the interaction coefficient of gender and size variable. This model is a version of equation 1 where the interaction term is included along with separate control for first-born gender and size variable. Standard errors (in parenthesis) are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.

Table A9: INTERACTION OF MOTHER'S CURRENT AGE WITH GENDER OF FIRST-BORN

Dependent Variable:	Open Defecation Rate	
	Urban (1)	Rural (2)
First-born (Girl) x Mother's Current Age	0.000 (0.000)	-0.001*** (0.000)
Observations	71,478	159,334
Household Controls	Yes	Yes
District FE	Yes	Yes
Other Interacted FE	Yes	Yes

Notes: This table reports the estimates from interaction of gender of the first-born child and mother's age at the time of interview, by urban and rural regions. It reports the interaction coefficient of Gender and Age variable. This model is a version of equation 1 where the interaction term is included along with separate control for first-born gender and mother's age at the time of survey. Standard errors (in parenthesis) are clustered at the district level. Significance level is denoted by: * p<0.1, ** p<0.05, *** p<0.01.