Gender Composition of Children and Sanitation Behavior In India*

Deepak Saraswat†

January 19, 2019

Abstract

Open Defecation has been linked to various public health issues and has gained significant policy attention. Investing in adoption of better sanitation has also been advocated on the grounds of providing women with privacy and protection from potential harassment. Nonetheless, previous research has shown that due to son-biased preferences, households in India under-invest in outcomes for their female children. Linking the gender composition of children in an Indian household to their sanitation behavior I find that, in certain cases, households reduce open defecation in presence of female children. Reduction in Open Defecation ranges from 4 to 7.6 percentage points (18-30%). Various heterogeneity analysis suggest that the reduction in OD is driven by households facing a potentially high cost of harassment related to the female children. The findings in this paper provide a new first stage association between gender composition of children and sanitation behavior and also contribute to the economic literature on decision making in households belonging to developing countries.

JEL Codes: O10, O18, J16, J18
Keywords: Sanitation, Open Defecation, Gender Composition of Children, Child Investment, India

*I thank Dean Spears, Michael Geruso, Nishith Prakash, Richard Murphy, Shrijata Chattopadhyay, Gaurav Chiplunkar and seminar participants at the University of Connecticut (Department of Agricultural and Resource Economics) and Southern Economic Association's 88th Annual Meeting for their helpful comments and suggestions. I am responsible for any errors that remain.

†Department of Economics, University of Connecticut. deepak.saraswat@uconn.edu.

1 Introduction

India accounts for 60% of world's open defecation[1]. Open defecation (henceforth OD) i.e. defecating in open places, behind bushes, near roads, near railway tracks etc is considered to be a huge burden on public health and has been a focus of policy attention for more than a decade in India. Understanding and reducing OD (thereby improving sanitation) has been a central question in economics and public health literature. While improvements in sanitation has been linked to public health and human capital gains in developed world[2], poor sanitation in developing countries like India has been associated with significant negative health externalities[3]. Due to negative health externalities of OD, the economic literature has largely looked at this issue from a lens of *public good problem*. Apart from the health externalities there are other negative consequences connected to OD such as gender based harassment which, unlike a public good problem, would have direct implications on the agent making a choice (e.g. adopt a toilet or defecate in open). This potential association between gender and sanitation behavior has received relatively less attention in the literature.

This paper focuses on other negative consequences of defecating in the open due to which households might be incentivised to switch away from it. Defecating in the open may have significant costs to women and girls because, as compared to men and boys, they need more privacy. These costs include loss of dignity, lack of privacy, and the possibility of harassment when they defecate, urinate or attend to menstrual hygiene in the open. This paper attempts to answer a specific question - Do households adopt better sanitation (or stop defecating in the open) due to the presence of adult female children? Using the gender composition of children in household, I link the sanitation behavior (whether the household practices OD or not) to presence of female children. In addition to that, I analyze the timing of change in sanitation behavior (reduction in OD) and attempt to understand the mechanisms underlying the change in behavior using various socio-economic heterogeneities.

A common challenge while comparing the households with and without the presence of female children is to adequately account for unobserved heterogeneities in preferences of decision makers, which likely affect both the gender composition of children and other observed outcomes (e.g. sanitation behavior). This is particularly important in context of India where son preference is widely prevalent. In presence of son biased preferences, a correlation develops overtime between the observed household characteristics and number and gender composition of children. This paper follows the current economics literature by using the gender of first born child as plausibly exogenous indicator of the presence of girl child in the household (see Bhalotra & Cochrane.C (2010), Rosenblaum (2013), Portner

[1] In comparison, its economically weaker counterparts such as Ethiopia, Pakistan, Nigeria and Sudan account for 4.5%, 4.4%, 3% and 1.5%, respectively.

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

[3] Recent studies in Indian context provide evidence of association between sanitation practices and health and well-being. Duflo *et al.* (2015) suggest clear pathways by which exposure to fecal pathogens introduced by neighbors could lead to acute malnutrition and ultimately death. Geruso & Spears (2018) explore the effect of open defecation on childhood mortality which answers a long-standing puzzle of higher mortality among Hindu kids in India. Spears & Lamba (2016) find that exposure to open defecation negatively impacts child cognitive function. On the flip side, there is evidence that reduction in open defection is associated with gains in health. Coffey *et al.* (2017) links reduction in open defecation to reduction in anemia in Nepal.

(2010), Barcellos *et al.* (2014) and Jayachandran & Kuziemko (2011)). In support of this identification, related literature shows that first pregnancy in India has a biologically normal sex ratio and that sex selective abortions are costly and prevalent at higher birth orders.[4] Nevertheless, unlike previous literature using this identification, the direction of potential bias is less of a concern in this paper. Son biased preferences begets a desire to have certain number of boys which results in girls living in larger families. With less per capita resources in a larger family, any bias if at all (in observed reduction in OD), is likely to be *downwards*. Tests conducted in this paper for differences in household characteristics with first born child as a girl versus boy provide support for this.

Using the National Family Health Survey (NFHS) conducted in 2015-16 in India, I use gender of first-born child to highlight and understand a potential association between presence of female children and sanitation behavior of a household. Results suggest that poor households living in urban areas, where the costs of open defecation are likely to be higher, reduce open defecation by 14.4 - 34.8% (3.2-7.6 percentage points from the base level of 21.9%) if the first born child is a girl. Putting the magnitude of results in perspective; Geruso & Spears (2018) find that a 10 percent point reduction in open defecation around the 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. Stopnitzky (2017) finds a increase of 21% in toilet ownership (from a base level of 29%) in response to the "no toilet - no bride" campaign in Haryana.

To understand the potential mechanisms underlying this reduction in OD, I conduct further analysis to gauge the timing of reduction in OD and examine the heterogeneities in this behavior across various socio-economic dimensions. Related to timing, the reduction in OD is found to be associated with first born female children who are in age range where they are of/ have crossed *pubescence*, and not with younger first born children. In addition to that, similar analysis amongst first born age-groups suggests that reduction in OD picks up higher magnitude and becomes statistically significant when the first born child is reaching an age where girls are observed to be getting married. Overall, I find suggestive evidence that reduction in OD comes around the age of first born female child when the *costs* from a potential harassment are higher.

There are factors other than age of female child which can result in higher costs due to harassment or higher chances of harassment. These include regions with crime against women, weaker socio-economic indicators, higher preference for son and/or prevalence of patriarchy, higher prevalence of dowry etc. Heterogeneity analysis suggests that households in states where crime against women is higher[5] show larger reduction in OD when first born child is female while other states do not. States with higher prevalence of son preference[6]

[4] Portner (2010), Bhalotra & Cochrane.C (2010) and Jha *et al.* (2011) show that first pregnancy in India exhibit a biologically normal male:female sex ratio of 1.04-1.07. Hesketh & Xing. (2006) report that sex-selective abortions are common at later birth orders. Working in the research theme similar to this paper, Kishore & Spears (2014) and Anukriti *et al.* (2018) use gender of first born child as an indicator of presence of male and female children in a household.

[5] These crime rankings exclude specific crimes like domestic violence, dowry death, suicides etc, which are domestic in nature. To account for reporting bias, I look at both the crimes reported to the police station and self-reports of such crimes using a representative household survey.

[6] Using sex-ratio as a proxy

and higher dowry prevalence[7] show higher reduction in OD in presence of first bron female child while other states show weaker and insignificant association. States with slow economic progress and lower literacy rates, as a proxy of weak socio-economic indicators, show similar results.

In Indian context where there is a general preference for son, the private benefits for daughters are ignored. Sen (2003), Jeffery *et al.* (1989) show that India has a widespread preference for male child. Barcellos *et al.* (2014), Jayachandran & Kuziemko (2011) and Deaton (2003) show that households in India selectively under-invest in private benefits such as nutrition, education, postnatal time and attention for a girl child (e.g. breastfeeding). Just like these private benefits, access to toilet also acts as a private good for girls, as presence/absence of that is related to private benefits/costs to them. Recent economic literature has linked access to toilet to benefits like girl's education[8] and absence of that to unpleasant social environment[9]. While education and health are private benefits, unpleasant social environment (i.e. potential of harassment) is more likely to bring the costs to household as a whole. 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 ostracization in various events of not following the doctrines[10]. It suggests that households may provide a sanitation facility if the costs of a female child being harassed accrues to everyone in the household.

The empirical findings in this paper align with a model of household decision making where the household *internalizes* the potential cost of female harassment and given the other factors driving these costs (economic condition, social costs etc.), invests in a *private* good (sanitation facility) for female children. In this framework, the *non-private* nature of potential *costs* acts as the motivation for household to internalize these costs. The absence of these *non-private* costs on the other hand, would result in the underinvestment in female children as observed in the literature. The *first* contribution of this paper is to the literature analyzing decision making at a household level with differential outcomes for male and female children in presence of strong gender biases.

Closest to this paper is the work of Stopnitzky (2017), which finds an increase in toilet adoption due to a social campaign "no toilet-no bride" in Indian state of *Haryana*[11], thereby

[7] Measured as the ratio of prevalent marriage expenses and household income in the region

[8] Adukia (2017) shows that school latrine construction program in India increases school enrollment of pubescent-age girls and much more when there is access to sex-specific toilets.

[9] Linking sanitation practices and sexual harassment, (Jadhav *et al.* (2016)) provide evidence from Indian context that women who openly defecate are twice as likely to suffer from non-partner sexual violence compared to those who do not. (JAGORI & UN-Women (2010)) provide evidence from Urban slums in New Delhi that 66% women living in these slums report a verbal abuse, 46% report a visual abuse and 10% report a sexual assault.

[10] *Manusmriti* is one of the oldest religious doctrines for *Hindus*, dictating the duties of a hindu. According to *Manusmriti* a hindu woman must not be independent and should be under the custody of their father, brother, husband or son depending on stages of life and age (*Manusmriti 5/151 and 9/3*). It also states that in case a woman tears the membrane [hymen] of her Vagina, she shall instantly have her head shaved or two fingers cut off and made to ride on Donkey (Manusmriti 8/369). *Quran* lays out the duties for followers of *Islam* and states that men are the protectors and maintainers of women and should spend for and support women in their means (Quran 4:34)

[11] This campaign urged the families looking for the marital match for their female children to demand toilet adoption from potential suiters.

highlighting the importance of bargaining in marriage market in adoption of *private* good for female members. This paper makes a contribution which is distinct from Stopnitzky (2017) as I analyze a different household structure; but can also be viewed as complementary since the incentives for reduction in OD in both these studies are coming from the potential costs to female members which, owing to their *non-private* nature, have to be internalized by the household as a whole.

Second, this paper provides a unique new first stage result related to the gender of the first born child and its association with sanitation behavior of a household. This first stage result has a potential to contribute to further economic research like understanding peer-effects of sanitation behavior on neighbors or in social network of a household. Guiteras *et al.* (2015) show that rural households in Bangladesh adopt sanitation when they are in proximity to a household who received subsidy for building toilets, thereby highlighting the importance of social connections in sanitation behavior. The new first stage result from this paper may help invite future research in spillovers of sanitation behavior through kinship and social networks. Identifying the reasons for lack of research in better understanding the externalities of open defecation, Geruso & Spears (2018) highlight the lack of a strong first-stage in take-up of better sanitation in experimental studies as one of the key reasons. Difficulty in generating a large enough first-stage effect has been demonstrated by three recent field experiments in rural India (Hammer & Spears (2016); Clasen *et al.* (2014), Pl *et al.* (2015)). The result from this paper provides evidence of previously not known natural incentives for taking up better sanitation, and when coupled with potential spillovers in sanitation practices, it can help future experimental studies in generating larger first-stage effects.

A branch of literature analyzing weak institutions and governance has linked mafia and gang presence to weaker institutions and law enforcement[12]. It is argued that inhabitants would be willing to pay a cost such as protection money to mafia and gangs as they provide them a protection umbrella in absence of weaker institutions[13]. As discussed before, heterogeneity analysis in this paper suggests that reduction in OD is driven by regions where the costs of harassment are likely to be higher (owing to weaker governance and socio-economic indicators). *Third* contribution of this paper is to the literature analyzing alternatives in absence of institutions and law enforcement.

Government of India, in its flagship *"Swachh Bharat Abhiyaan"* (Clean India Campaign) launched in 2014 has planned and executed large budget outlays with an aim to make India open defecation free by 2019. It is estimated that Government of India spent about 83 percent[14] of their total advertising expenditure on this flagship program but the progress is slow (Spears & Coffey (2018)). Consequently, eradicating OD still remains a significant policy challenge for India. Empirical findings in this paper are also relevant for policy makers. It contributes to the understanding of who adopts toilet and who does not, which is likely

[12]See Jankowski (1991), Carven (1992) and Lieven (1998) for discussion in context of various geographies.

[13]Kumar & Skaperdas (2009) analyze organized crime and propose that they emerge where economic institutions are weak. They argue that its only in absence of costless enforcement of law and property rights a mafia can ask for protection money, thereby providing a safety umbrella which was absent for inhabitants before.

[14]Ministry of Information and Broadcasting, Government of India (See http://164.100.47.190/loksabhaquestions/annex/8/AU2287.pdf)

to improve the targeting of resources towards improving sanitation.

2 Background

A billion people worldwide defecate in the open and Indian alone accounts for 60% of them (UNICEF & WHO (2014)). These stark numbers along with well-known health consequences of open defecation makes it a high-priority policy concern. Apart from the effects on public health, defecating in open has negative externalities like the potential for harassment of girls and women who go out to defecate in the open. Women value toilets to a greater extent than men because they suffer disproportionately from male harassment when they defecate, urinate, or attend to menstrual hygiene in open (Stopnitzky (2017)).

Whether or not households practice open defecation also depends on critical factors like the region a household lives in (for example urban vs. rural) and how rich or poor they are. Households living in rural areas have access to large fields, open space, and more privacy while defecating in open which contributes significantly to high open defecation rates in these areas[15]. Defecating in the open in fields far from their home does not pose any immediate cost of pollution and impurity near houses and hence does not result in a higher social cost. These factors may induce low enough social costs that the monetary cost of adopting a toilet is higher, and we can expect even richer households in rural areas to be practicing open defecation. In rural areas, where the community is more integrated and privacy concerns are lower for women, harassments while defecating in the open may also be a lower probability event. On the contrary, in urban areas, households live in constrained spaces which provide less access to open space and less privacy while defecating in the open. Since urban areas have better and modern infrastructure, the social costs (shame) of polluting it and spreading impurity (as perceived by residents) is also higher. These costs are higher in high-income areas and we can expect richer households to be adopting a toilet, irrespective of gender composition of their children. Households in poorer pockets of urban areas, have higher costs of defecating in the open due to significant space constraints, lack of privacy and a higher probability of harassment. In spite of being poor, we may expect the households living in the slum with adult female children to be incentivised to invest in a toilet and not defecate in the open.

3 Conceptual Framework

3.1 Setup

In this sub-section, I look back at Section I and set up a framework in which a household decided whether or not to adopt a toilet (or stop defecating in the open). This decision

[15]Qualitative work (Coffey & Spears (2017)) to understand open defecation practices has documented some interesting features of sanitation practices in rural areas, like - a) Households in rural areas may also prefer to defecate in open since they like open environment and not being constrained by walls of a toilet, b) They have been doing so for generations and a behavioral change is harder for them, c) Women in rural areas also prefer to defecate in open since it gives them a chance to go out of house and meet friends.

depends on the presence of a female child, the income of a household and the region they live in (rural, urban, etc.).

In a one-period framework, a household i is maximizing their utility over a bundle of consumption good X and adopting a toilet t (or a decision to not Openly Defecate), as follows:

$$\max_{\{X_i,t_i\}} \; V_i = U_i(X_i, \varphi_i, t_i) - \omega C_i(F_i, t_i) \quad s.t. \quad X_i + Pt_i \leq I_i \tag{1}$$

Where, X_i is a bundle of all consumption goods, the price for which is normalized to 1. $t_i \in \{0, 1\}$ is a decision to adopt a toilet, the price for which is P. I_i is the aggregate set of resources a household has.

The first term $U_i(.)$ represents the utility from consuming X, disutility from φ_i which represents the social cost of open defecation (as seen in Section I), and the utility from having a toilet t. The factor $\varphi_i \in [\varphi^L, \varphi^H]$ is the social cost factor related to the region a household i lives in (such as the cost of shame, lack of privacy etc., when defecating in the open). It is positive and is bounded[16]. The second term relates to the cost of open defecation, specific to the presence of female children in household. It is explained below in more detail.

The factor ω represents the probability of harassment an adult female child might face while defecating in open[17]. $C_i(F_i, t_i)$ is the cost factor representing a number of female children a household has and if or not they have a toilet. The factor $F_i = \sum_j \alpha_{ij} f_{ij}$ represents the total number of female children above a certain age cutoff, where, f_{ij} is the jth female child of household i and $\alpha_{ij} = 1$ if $f_{ij} \geq \bar{f}$[18] and 0 otherwise. The interaction of ω & $C(.)$ determines the cost a household faces when their adult female child defecates in the open.

Some key assumptions related to the setup are as follows:

1. $C_F(F_i, t_i) > 0$ and $C(F_i, 1) = C(0, t_i) = 0$ i.e. the cost factor is increasing in number of female kids above a certain age cutoff[19] and is 0 if there are no female kids above a certain age cutoff or the household has a toilet.

2. The utility term $U(.)$ is increasing and concave in the level of consumption X and decreasing in social cost factor φ.

I assign the term $U_i(.)$ in equation (1) a specific form: $U_i(X_i, \varphi_i, t_i) = u(X_i) - \varphi_i(1 - t_i)$, and accordingly, the value function becomes, $V_i = u(X_i) - \varphi_i(1 - t_i) - \omega C_i(F_i, t_i)$.

[16] φ_i can range from very small values in sparsely populated remote rural areas to slightly higher values in somewhat dense areas to the high value in poor space constrained urban region to very high value in a posh urban residential society. It can also be negative for some households living in poor regions who have been defecating in the open for generations and have strong preferences for it. For simplicity in mathematical proofs, I assume it to be continuous between the defined bounds and non-negative.

[17] The probability of harassment links more closely to the crime rate in the region a household lives in. For mathematical simplicity, I assume it is constant. Even if we let it vary by region (low for rural areas, higher for urban areas), the direction of results would not change but the mathematical arguments become cumbersome

[18] $\bar{f}$ is a specific age cutoff, such as puberty, beyond which a female child needs privacy and other harassment related risks kick in.

[19] This will be tested in empirical analysis in Section VI.

Given the binary nature of decision to adopt a toilet and the assumptions mentioned above, a household chooses an optimal V_i^* amongst following two options:

$$V_i^* = \begin{cases} V_i(0) = & u(I_i) - \varphi_i - \omega C_i(F_i, 0) \quad if \quad t_i = 0, \\ V_i(1) = & u(I_i - P) \qquad\qquad\qquad\quad if \quad t_i = 1 \end{cases} \tag{2}$$

Given the optimal choice of value based on toilet adoption decision, I have following proposition and subsequent cases (Appendix A provides relevant proofs):

Proposition: $\exists$ a level of social cost $\bar{\varphi}$, such that,

1. **Case 1**: $\forall \;\; \varphi_i < \bar{\varphi}$,

$$u(I_i) - \varphi_i - \omega C_i(F_i, 0) > u(I_i - P) \implies V_i^*(0) > V_i^*(1),$$

2. **Case 2**: and, $\forall \;\; \varphi_i \geq \bar{\varphi}$, $\exists$ an $\bar{I}$, such that, $\forall \; I_i \geq \bar{I}$,

$$u(I_i - P) \geq u(I_i) - \varphi_i - \omega C_i(F_i, 0) \implies V_i^*(1) \geq V_i^*(0)$$

3. **Case 3**: and, $\forall \;\; \varphi_i \geq \bar{\varphi}, \;\; \& \;\; \forall \; I_i < \bar{I}$,

$$\begin{aligned} u(I_i) - \varphi_i - \omega C_i(F_i, 0) > u(I_i - P) &\implies V_i^*(0) > V_i^*(1) \quad \text{if } F_i = 0, \text{ i.e. } C_i(.) = 0 \\ u(I_i - P) \geq u(I_i) - \varphi_i - \omega C_i(F_i, 0) &\implies V_i^*(1) \geq V_i^*(0) \quad \text{if } F_i > 0, \text{ i.e. } C_i(.) > 0 \end{aligned}$$

Where, $V_i^*(1) \geq V_i^*(0)$ means that, not openly defecating (adopting better sanitation) gives a household higher utility. Conversely, $V_i^*(0) > V_i^*(1)$ means that continuing to defecate openly gives a household higher utility.

3.2 Testable Predictions

The proposition and the cases put forth in the previous section provides us cases where a representative household may or may not adopt a toilet depending on aggregate resources, the region they live in and the presence of elder female children they have. These theoretical cases give us empirically testable hypothesis, that, given the *treatment* (presence of or some female children) status of a household, under what conditions they are likely to be incentivised to adopt better.

Taking into account the Indian context (as discussed in Section I), we can relate the social costs to sanitation choices of households. A large proportion of households in rural areas are likely to be living in areas where there are low regional costs to open defecation (low φ) and going by Case 1 in the previous sub-section, irrespective of income and gender composition of kids; they are likely to not adopt a toilet, i.e., *Never Takers*. Going by Case 2, richer households in urban areas face high enough social costs of open defecation (high φ) that, irrespective of the gender composition of children, they are likely to adopt a toilet, i.e., *Always Takers*. Households living in poor urban regions have a higher cost of defecating

in the open but, at the same time, they are poorer. Their marginal utility gain from not spending in adopting a toilet is high enough, such that, a) In the absence of an adult female child, the utility gain outweighs the social cost, but b) In the presence of an adult female child, the total costs (social + potential cost of female harassment) outweighs the utility gain. Going by Case 3, these households will only adopt a toilet if they have adult female children in a household, i.e., *Compliers*. However, some of these poor households will be soo poor that the budget constraint remains tight for them even when they have female children; they will remain *never takers*. Table 1 summarizes the cases in an experimental framework.

4 Data and Empirical Strategy

4.1 Data

The main dataset used in the analysis is National Family Health Survey (NFHS) of India, conducted in 2015-16. The NFHS (India's version of Demographic and Health Survey) is a large, nationally representative survey and is regarded as a very high-quality demographic survey. The respondents are women aged 15-49 and report birth histories and other information for their children. This survey also includes information on household assets, infrastructure and other health related reports. The main variables I use in the analysis are the birth records from NFHS. These include birth order, gender, date of birth, whether the child is alive, and whether or not s/he continues to live in the household, for each of the child ever born to the surveyed women. Apart from these, I use characteristics of the women surveyed, of the head of the household, the residence (rural or urban) and indicators of wealth in a household (data on categories of assets). As the main outcome of interest, I use the survey question where a household reports: *"What kind of toilet facility do members of your household usually use?"*. I create an indicator OD equals to 1 if a household reports: "*Having no toilet facility, going to field/bush to relieve themselves*" and 0 otherwise. Table 16 provides summary statistics related to few key variables.

As discussed in previous sections, household wealth could be a key factor related to adoption of better sanitation facilities. Although, NFHS does not record income or consumption of surveyed households, it records the assets a household owns. Recent empirical studies use these asset ownerships as a proxy of household wealth (Geruso & Spears (2018)). I create an 'Asset Index' as a measure of the wealth of a household by summing over the dummy variables recording presence of various assets in household and creating a standard normal index of it[20].

Another key factor which could relate to the adoption of sanitation facilities is the age of oldest girl child. As discussed before, households might be incentivized to adopt a toilet when the eldest girl child is entering (or near) puberty. A general age range of attaining Puberty in Girls is about 10-14 years in India (Khadgawat *et al.* (2016)). Other similar studies also document early puberty starting as early as eight years of age. I take the minimum age cutoff for my sample to be eight years for a first born child. It includes the usual starting

[20]This Index is created at the level of Residence x Survey Round; total six levels. Standardizing the Index: $Index = [(Sum\ of\ Indicators)_i - (Mean\ within\ a\ level)]/[Standard\ Deviation\ within\ the\ level]$

range of 10 years for the onset of puberty and also two years before that to account for the earlier onset of puberty and/or an earlier recognition of a need for privacy by parents.

For main analysis, I use households where, 1) Either the mother or father of the first born child are household head, and 2) first born child is alive and is living in parents house. This is refereed to as *main analysis sample* in rest of the paper.

4.2 Empirical Strategy

For all results reported in section 6 to 9, I run a reduced form linear probability model as follows:

$$OD_{ir} = \beta FB_{ir}^{Girl} + \chi_{ir} + \delta_i + \delta_i^{Inter} + \epsilon_{ir} \tag{3}$$

where, i indicates the household and r is the region they lives in. Outcome is the indicator variable OD_i. FB_i^{Girl} is indicator for first born gender being female. χ is the set of household level controls[21]. I also include district, caste and year of birth fixed effects and their interactions with each other to exclude confounding factors related to those. δ and δ_i^{Inter} represent the set of fixed effects and interactions respectively. The coefficient of interest if β. I refer to this specification (including all controls, FEs and interactions), the *preferred specification*. Standard errors are clustered at the level of primary sampling unit (PSU) [22].

5 Identification

The main independent variable in my research question is the presence of and/or a number of female children in the household. An ideal (but hypothetical) comparison would be between households with and without an elder female child in which the presence of that child is randomly assigned. To get close to this ideal comparison, various studies in Indian context use gender of first child as a plausible random assignment [(Barcellos *et al.* (2014)), (Kishore & Spears (2014))]. I use the same identification strategy in the main analysis of this paper. Gender of first born child is considered random in many economic studies [(Rosenblaum (2013)), (Bhalotra & Cochrane.C (2010))]. A problem central to these studies is that, due to 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. To get around this problem, these studies restrict the samples to households with a very young first born child.

[21] Full list of control are - Standardized value of asset index, number of household members, number of women and girls in the household, age of household head and the mother of first botn, education of household head and the mother, frequency of watching TV and reading newspaper in the household, main floor material, main roof material, main wall material, religion followed by the household and if the responding mother currently pregnant

[22] The NFHS is a two-stage random sample, first sampling Primary Sampling Unit (PSU) and then households within sampled PSUs. PSU is that sense is a sampling cluster. It is usually city blocks in urban areas and villages in rural areas.

In this paper, the sample of interest are the households in which the first born child are grown up, hence the solution to restrict sample does not apply here. Households in which the first-born child is a girl are more likely to have a higher fertility rate to achieve the desired number of sons, and hence larger family on an average. Larger families have lower per capita resources which make them poorer on average, and hence more likely to practice open defecation (or not invest in a toilet). The bias induced due to the gender of the first child if at all, will only induce a downward push on any association I find between gender of the first child and the sanitation practices. In the empirical analysis below, using mean difference tests, I first check if household characteristics and other relevant outcomes are statistically similar across households with young first born children. Next, to check if relevant outcomes change in a direction which could potentially induce upward bias on the results, I run similar mean difference tests while restricting the maximum age of first born to be 16 years in urban areas and 15 years in rural areas[23]

Finally, it remains to see if the gender of the first born child affects the presence of female children in my data. Figure 1 uses the Main Analysis Sample and plots the average number of female kids vs. the average total number of kids for all the households in the sample. The association shown in the plot is separated by the gender of the first born child. As observed, households with the first born child as a girl have, on average, a higher number of female kids compared to households with the first born child as a boy.

6 Results

6.1 How do households with first born girl child compare to first born boy child

Before the main analysis I run mean difference checks on various household characteristics and relevant outcomes. I use equation (3) with sanitation behavior of a household and other household characteristics as outcome variable and estimating it without any controls.

The first set of mean difference check looks at the difference in relevant outcomes of households in main analysis sample with first born child of age 5 years or less. Table 2 reports the results, separately by Rural and Urban regions. Reassuringly, the main outcome of interest, Open Defecation is not statistically different in both regions across the comparison groups. Households with the first born girl are not significantly richer or poorer than households with the first born boy. Households with better infrastructure such as piped water, cement/concrete floor, walls, etc. may find it easier to adopt a toilet. As observed, households with first child as girl do not differ significantly from those with first child a boy in any of these categories. Households with the first born girl are also not observed to be different in parent's education and level of social awareness (reading newspapers and watching TV). It appears that fewer mothers in rural areas have primary education but it cannot be ruled out that this difference is significant just by chance[24].

[23]as shown in Figure 5 and 7, first born female children are starting to marry and leave parent's house when they turn 17 years in Urban areas and 16 years in Rural areas. Age restriction is done to avoid confounding outcomes when the structure of household changes as girls marry and leave.

[24]Nevertheless, I control for all these factors while estimating the regressions for main results.

The second set of mean difference checks uses the main analysis sample with the age restriction for first born child (16 years for urban and 15 years for rural). Table 3 reports these results. Households show evidence of gender-biased fertility stopping rules, as the mothers of the first-born girl are more likely to be pregnant at the time of survey as compared to mothers of first-born boys. Looking at asset index, households with first born girl child are significantly poorer than households with the first born boy. Households with the first born girl go for a larger fertility and hence are poorer on average due to lower per capita resources. This, however, does not induce any upward bias on my results. As expected, first born girls live in larger households and with more siblings but again they do not put any upward bias on my results. Households with the first born girl are also not observed to be having better construction (material for floor, walls, etc.) or more educated and/or aware parents (education, reading newspaper, watching TV, etc.). Household head in urban households with the first born girl are slightly older. I include parents age as one of the controls in main analysis.

Overall, these mean difference checks help support the identification strategy that there are no significant differences in the variables related to Open Defecation which may put an upward bias on main outcome of interest.

6.2 Do households reduce open defecation due to presence of female children?

Using equation (3), I analyze the main hypothesis that households might reduce open defecation (adopt a better sanitation facility) if they have a girl child; the presence of whom is identified by a the gender of first born child. Results are reported in two sets; one using full main analysis sample and second using main analysis sample with maximum age cutoff of 16 years for urban areas and 15 years for rural areas). Results are reported starting from a version of equation (3) with no controls and adding subsequent controls to arrive at the preferred specification with all controls.

Table 4 reports the results for urban areas. Starting with full sample in Column 1, households with first born child as female seem to be reducing open defecation but the coefficient is statistically insignificant. This association becomes stronger and statistically significant with each subsequent set of controls. The preferred specification in Column 4 shows a statistically significant (at the level of 5 %) reduction in open defecation of about 4.7% of the mean. Moving to the second set with age restriction, the association between first born gender and reduction in open defecation using preferred specification in Column 8 becomes slightly stronger and stays significant. Appendix figure 8 and 9 show that coefficients demonstrate stability as each set of fixed effects in included to arrive at the final preferred specification.

Table 5 reports the results for rural areas. Households with first born girl child are found to be practicing more OD (Column 1) but the association fades away as controls are included. Both full sample and age restricted sample show weak and statistically insignificant association between first born gender and reduction on open defecation.

Analysis in Table 4 and 5 provides support for testable predictions in section 3.2. Gender of first born is associated with reduction in OD in urban areas but not in rural areas.

6.3 Who is driving the reduction in OD in presence of female children?

As observed in previous section, the gender of first born child relates to the sanitation behavior of a household in urban areas. It gives empirical support to the research question and testable predictions from Section 3, but it is not yet clear if this association is supported by all households or it varies by economic status. It is conceivable that households belonging to different economic and social groups may not change sanitation practices due to presence of a girl child. As suggested by the conceptual framework (See Table 1) the households living in poor urban regions are more likely to respond to the need of toilet for female children in household.

To investigate the validity of conceptual framework, I start by restricting the age range of first born child to 8-16 years in the age restricted pool (from Table 4 and 5)[25]. Then the households are divided into *deciles* of asset index.

Using the preferred specification of equation (3), Panel A and B of Table 6 report the coefficient of interest for urban and rural regions, respectively. Column 1-10 include households in *deciles* of asset index, going from poorest to richest households in both regions.

Looking first at the results for Urban areas in Panel A, mean OD rate suggests that open defecation rate is falling rapidly as households get richer. Open defecation rate is high and ranges from 45% to 22% for the two poorest groups of asset index (Column 1 & 2). It starts to fall as households get richer and reduces to almost zero. Poorer households also have higher OD rates are most likely to be the ones to reduce OD if they have female children at home[26]. As expected in Panel A, households falling in 2nd decile of asset index show a reduction in OD if the first born child is girl. However, this reduction does not show up for the poorest decile, which is consistent with the conceptual framework that there might be some households who are poor enough for the budget constraint to be very tight for them. This amount to a 34.7% reduction in OD in urban households belonging to the 2nd poorest decile of asset index. Moving along the richer groups, this association becomes weaker and statistically insignificant. Appendix figure 10 show that the observed coefficient demonstrate stability as each set of fixed effects in included to arrive at the final preferred specification[27].

Moving to results in rural areas in Panel B, it shows that open defecation rates are not only higher on average than urban areas, but they stay higher for even the richer groups of households. For example, while a set of *median* households (ranked by by asset index) in urban areas had OD rate of lower than 8%, its counterpart in rural areas has almost a 50% OD rate. In contrast to the case in urban areas, this provides empirical evidence for lower costs of open defecation in rural households where space is not constrained. As discussed

[25]Usual age of reaching menarche in Indian girls is 10-14 years [Khadgawat *et al.* (2016), but it has sometimes been recorded as 8 years as well. I restrict the minimum age to observe only the subgroup of first born girls who have likely reached menarche and also include 2 years before starting age of 10 to account for early onset of menarche and households forward looking behavior.

[26]Poorer households with higher OD rates signifies they are living in worser conditions of the urban area, might be facing the higher crime rate and anti-social elements. Also given a higher OD rate, they have much larger room for improvement

[27]Inclusion of District*Year of Birth widens the error band and increases the magnitude of the coefficient. However, its almost perfect overlap with other specification's confidence intervals suggests that it is not statistically distinguished from other specifications.

in the conceptual framework, rural households may have low costs of defecating in the open and may not have incentives to switch from OD even if they have elder female kids in the household. Results in Panel B show that point estimates of the difference in open defecation between households with first born girl versus boy are very low for all decile groups of asset index. Given large confidence intervals, a conclusion of 'no statistically significant differences' cannot be ruled out.

7 Robustness

Previous sections have established the causal link between reduction in open defecation and gender of the first born child, and also the section of population which is most likely to support this link. This section attempt to test the relevance and validity of results with respect to hypothesis in Section 3 and robustness to potentially conflicting channels.

7.1 Falsification

As discussed in Section 3 and demonstrated in the conceptual framework, a central notion is that households will be incentivised to invest in better sanitation when the expected costs of female children practicing OD is higher. If the reduction in open defecation also shows up when the female kids in the household are below the age of puberty, it may indicate that the results are potentially driven by causal factors other than what I have considered so far. To test this, I run a falsification test using preferred specification of equation (3). While the data used for falsification analysis is same as the main analysis Sample, it differs in the age cutoff. Only the households with the first born child less than 8 years of age are included. Same as the analysis in Section 6 this falsification test is run on two sets - one, using full sample (with age restriction as above) and second, with households divided into *deciles of asset index*.

Table 7 reports the first set of results. The association between OD and first born gender is in the expected direction in urban areas but weak and statistically insignificant. Column (4) using the preferred specification reports a positive, small and statistically insignificant coefficient. Table 8 reports the second set of results with households divided into *deciles* of asset index and using the preferred specification. As observed, both rural and urban areas do not an association between reduction in OD and first born gender.

The falsification exercise suggests that association between first born female child and reduction in open defecation is valid only for elder female children and provides support for testable predictions from conceptual framework.

7.2 When is the toilet *needed* and what drives the need?

As suggested by Table 6 (Column 2 in Panel A) and falsification analysis in Table 8, it is only after the first born girls crosses 8 years or age that the reduction in OD starts to show up. It is however unclear if the incentive to reduce OD comes with the increased demand of menstrual hygiene and privacy (as first born girls reach menarche) or when protecting them from potential harassment becomes important (when they are about to be married).

If households start adopting toilets when their first born child reaches menarche, it would suggest that households are responding to the private demands of their girl child, which however is contradictory to literature about girl's status in India. On the other hand, if households start adopting a toilet when the eldest girl is about to be married, it would support my hypothesis that households are reducing the costs (like delay in marriage) due to potential harassment.

Figure 5 & 6 using the NFHS data helps in understanding the timing of toilet adoption. Figure 5 shows the proportion of first born children in urban areas being married by age groups ranging from 8-23 years. Proportion of married children are separated by the gender of the first born child. Figure 6 plots the coefficients from the preferred specification on the households belonging to 2nd decile of asset index in Panel A of Table 6. Each coefficient represents a different age group (on x-axis).

As observed in the Figure 6, gender of first born is not associated with reduction in OD until they are 16 years of age and only starts to show significant difference when they are 16 years or more. In Figure 5, age 17 is associated with first born girls being married and leaving their parent's house. The reduction in OD showing up a year before potential marital match suggests that households are responding more in line of the hypothesis of "reducing harassment costs" and not so much to the private demand of the girl child.

7.3 Are results driven by female members other than female children?

If there are additional female members in the household who are not the daughters of the household head, it cannot be ruled out that the results shown in Table 4 and 6 are driven by the additional female member and not by the female child. Table 3 shows that in households with first born girl, there are significantly higher number of women who are 15-49 years of age. Possible explanation of this could be the presence of first born girl herself, additional female kids the household had after first child (in order to achieve desired number of sons) or systematic presence/entry of additional female members in these households. The latter one, if present is of a deep concern for validity of the results. For e.g. entry of new daughter in law could be a major confounder, in regard to which Stopnitzky (2017) provides causal empirical evidence of reduction in OD.

I analyze the difference in gender composition of households with first born child as male versus a female for households in urban areas in 2nd decile of asset index (restricting the maximum age to 16 years). Table 11 reports the result of estimating equation (3), without any controls, FEs or interactions, with four different outcomes (Column 1-4). Households with first born girl have about 1.06 additional female member (Column 1), and if looked at only the number of female children as outcome (Column 2), the coefficient seems to explain the additional female member in Column 1. Column 3 estimates the regression with all female members other than daughter of household head as outcome and there are no differences (both statistically and by magnitude). Looking specifically at the presence of daughter in law (Column 3), households with first born girl has lower number of daughters in law (potentially due to delay in marriage of son or son being young). These results strengthen the association of results in Section 6 with the testable predictions in Section 3.

7.4 Are results driven by difference in household characteristics?

As observed before, the age at which first born girls are leaving the household is associated closely with household's sanitation behavior. A question arises if household characteristics change around the time of first born girl's marriage in the direction which can explain the reduction in OD. Marriage being a big event in a household in India, it is conceivable that people would renovate their houses, purchase new assets etc and as a part of those, they may construct toilets as well. However, a large portion of marriage expenses are financed by girl's family and in addition to that, they pay dowry. Given such high expenses, it is less likely that family will engage in own house renovations or asset accumulations. Nevertheless, I estimate the regression as in equation (3),without any controls, FE and interactions, on the sample of households belonging to urban areas and in 2nd decile of asset index. This regression is run on households level outcomes as mean difference checks and on the assets owned by household.

Table 9 shows the mean difference checks for household level outcomes (same as Table 2 and Table 3) while Table 10 shows the mean difference checks for various household assets reported in NFHS survey. As seen in Table 9, none of the household characteristics change in the direction which could suggest household level improvements[28]. Table 10 shows the mean differences in various assets. Just a few households with first born girl report having no electricity and bicycle (the differences which are significant), and that does not suggest any potential biases. Households with first born girl have higher number of mattresses, which may be due to larger family size or for giving their female children separate beds to sleep.

8 Inference Checks

All results reported in the previous section are generated by using comparisons amongst multiple groups of asset index. Thus, it cannot be ruled out that the reduction in OD, where it shows up is appearing 'by chance'. To mollify this concern, I put the analysis through additional stress tests using three different inference checks.

8.1 Bonferroni Correction

Under multiple hypothesis testing, the chances of rejecting the null (making a Type-I error) increases by the factor of number of hypothesis being tested. The analysis then requires correction for multiple hypothesis. In Section 6.3, within each region (rural and urban), the regression is estimated for 10 groups of asset index and thus, p-value of 2nd decile in urban analysis being less than 0.05 alone is not enough for claiming its statistical significance. A Bonferroni multiple comparison correction for n independent comparisons requires a significance threshold of $\alpha = \frac{0.05}{n}$ for each comparison to recover a desired $\alpha = 0.05$.

Table 17 replicates the results of Column 2 (Panel A) of Table 6 with each column 1-4 adding a successive list of controls. Using the bonferroni criterion, the p-value reported

[28]Households with first born girl report having more roofs made of 'Asbestos Sheet'. Asbestos sheet roofs are usually an inferior quality roofing material (as opposed to Cement, stone or Concrete) and are less likely to be an improvement. In addition, this is the only category showing difference and its appearance *'by chance'* cannot be ruled out.

Column 3 is just enough to recover an $\alpha = 0.05$ and Column 4 is close to recovering an $\alpha = 0.1$.

8.2 Power of sample

This test deals with a statistical question - Is the sample size in 2nd decile of urban analysis enough to detect the observed effect size? Focusing on reduced form results for 2nd decile in urban areas, I conduct a retrospective power calculation. This exercise takes households in main analysis sample where the first born child was boy as a control group, and the ones in which the first born child was girl as treatment group. Given the distribution of data and the outcome (Open Defecation), I generate the minimum detectable effect sizes and the sample size required to be powered to detect those effect sizes. The effect size is measured here as a percentage change in open defecation with respect to the mean open defecation rate of households with born child as boy. Standard deviations of OD in both comparison groups are taken into account. Calculations were made with a preset power level = 0.8 and an $\alpha = 0.05$.

Figure 2 reports the result of this exercise for the specification of equation (3) with no interactions and Figure 3 shows the one using preferred specification, including all controls and interactions. These figures suggest that available sample size of 3771 households in Column 2 of Panel A in Table 6 is enough to detect the observed effect sizes.

8.3 Placebo Test

Another potential concern related to the results in Table 6 is that the associated confidence intervals may be large enough to allow for the result to just appear 'by chance'. I put an additional stress test on the data to alleviate this concern. I do a placebo test where I reassign the treatment status (first being child being girl) randomly across all the sample households in urban areas belonging to 2nd decile of asset index and run the preferred specification of equation (3) on it. I do this random assignment 3000 times, resulting in 3000 counterparts of β from equation (3). I then plot a distribution of these randomly generated coefficients and put the original effect size along with it. Figure 4 shows the distribution and the original coefficient (a vertical line in red) from Column 2 in Panel A of Table 6 . As observed, the set of randomly generated coefficients are centered around a mean of 0 and the original coefficients lie far left on the tail. This test strengthens the statistical relevance of the result in Table 6.

9 Heterogeneity

9.1 Crime Against Women and Sanitation Behavior

Hypothesis in section 3 and results in section 6 and 7 establish that households respond to private demand of sanitation when the costs of female children defecating in open are likely to be higher. It is conceivable that households living in areas where there are higher crime against women would have higher incentives to reduce OD as their girl child reaches

marriageable age. I look at this possibility using the state level crime data reports by National Crime Record Bureau (NCRB) for the year 2015 in India.

National Crime Records Bureau (NCRB) records varies crimes being reported in all police stations of each state in India. I use the records to construct state-wise ranking of *crime against women*, and specifically, the crimes which are likely to be committed outside the household. These rankings are calculated after excluding certain crime categories which are unlikely to be crime against women committed outside the household[29]. NCRB crime statistics are likely to be the lower bound of rate of crime against women as these are crimes which were reported to the police station. In India, it is not uncommon for many of these crimes to go unreported (due to concerns surrounding shame, harassment by police or perpetrators etc.). To supplement the NCRB data, I use data from Indian Human Development Survey (IHDS, 2011-12), where households are asked about the frequency of crime against girls in their neighborhood. I rank states using the response from households in urban areas[30].

I estimate the preferred specification using equation (3) on the urban households in 2nd decile of asset index (Table 6), in two categories, one each for rankings using NCRB and IHDS. Table 12 reports the results. Each category reports the results divided into highest ranking 10 states/UTs with highest crime against women (Column 1 & 3) and all remaining states/UTs (Column 2 & 4). Results show that households belonging to 10 states with highest crime against women reduce open defecation if their first born child is girl while households belonging to other states do not. Results using rankings from self-reported crime show a much stronger reduction in OD.

9.2 Sanitation behavior in High vs Low performing states

Regions which lag behind on economic indicators will have less per capita resources at a household level. Given son biased preferences, the resources allocated to the female members of household are likely to be very low resulting in prevalence of more *patriarchal* household structures. Given male dominant household structure, the incidences and costs of girl child being harassed are likely to be higher[31], resulting in higher *costs* from potential harassment. These regions being poorer will also have higher OD rates and hence, more room for improvement from baseline levels. It is expected that these regions will exhibit stronger response to presence of female children and reduce OD as compared to other regions. Another indicator of low performing states with likely high *patriarchal* prevalence is literacy rate. Regions with lower literacy are likely to be have higher probability and costs of harassment ad hence more room for improvement.

[29]NCRB classifies certain crimes as crime against women. These crime categories are - Rape, Attempt to commit Rape, Kidnapping & Abduction of women, Dowry Deaths, Assault on women with intend to Outrage her Modesty, Insult to modestly of women, cruelty by husband or his relatives, importation fo girls from foreign country, abetment of suicides of women in cases related to dowry, sati etc. I exclude dowry deaths, cruelty inside household, abetment of suicide while calculating the rankings. Rankings are then calculated using rate of crime against women (after excluding certain crimes as before) as incidence of crime against women per 100,000 women in a State/UT.

[30]IDHS records the response to questions of crime against girls as being *rare*, *somewhat regular* and *very frequent*. I calculate the crime rate by coding *somewhat regular* and *very frequent* as 1 and *rare* as 0. States are then ranked by highest to lowest percentage based on this binary variable.

[31]Higher crime rates along with the reporting and booking the male perpetrators is likely to be hard

Indian states of Bihar, Madhya Pradesh, Rajasthan, Uttar Pradesh and Odisha are typically tagged as economically low performing states and are termed *BIMARU* states[32]. Population Census of India (2011) is used to rank states/UTs on literacy rate. Table 13 shows the results using preferred specification on urban households in 2nd decile of asset index. As expected, BIMARU states show stronger (and statistically significant) reduction in OD while this association is weaker (and insignificant) in other states. 10 states with lowest literacy rates show high (and statistically significant) reduction while other states do not.

9.3 Social norms and sanitation behavior

Social norms such as son preference and practice of dowry can be linked to the prevalence of *patriarchy* in a society. Regions with higher son preference would have male dominant social structure in which case, the shame from harassment of a girl is more likely to be accrued to her family rather than a perpetrator. It would also be reasonable to expect families in regions with higher dowry practices to internalize the potential harassment cost, thereby preventing the costs of marrying their girl child from going up. Households are in these regions are more likely to adopt toilet in presence of female child.

Using Population census of India (2011) I rank the states/UTs from lowest to highest sex ratio ,which is an indicator of son preference. For dowry prevalence, I use Indian Human Development Survey (IHDS) which asks respondents about prevailing marriage expenses in their community/neighborhood and also about their incomes in past year. I rank states/UTs by the ratio of prevailing expenses and income in past year. Table 14 reports the results using preferred specification on urban households in 2nd decile of asset index. As expected, states with high son preference and states with high dowry prevalence show stronger (and statistically significant) reduction in OD while the comparison groups do not.

9.4 Sanitation behavior by Religion and Caste

Religion and caste are shown to be one of the determinants of sanitation behavior in India. Households belonging to lower castes have higher room for improvement as they are exposed to higher poverty (and higher crime rates). Hindus on the other hand practice more OD than muslims and have higher room for improvement there.

Results in Table 15 use preferred specification across caste and religious divisions. As expected, the households belonging to *other backward castes* and hindus are found to be reducing OD in presence of female child.

10 Conclusion

This paper focuses on negative externalities of open defecation on female children/adult girls and its potential association with sanitation behavior of a household. Findings suggest that incentivised by the presence of female child, poor households living in urban areas (where cost of open defecation is higher) reduce open defecation. This association does not exist for

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

richer households in urban areas and households in rural areas. This association seems to be driven by "shame" costs on the household if the female child gets harassed while defecating in the open. In addition, this relation seems to be stronger in Indian states which have higher rate of crime against women. These results provide a new first stage association between gender composition of children and household sanitation behavior and also inform policy about who adopts toilets for girls and who does not.

References

Adukia, A. 2017. Sanitation and Education. *American Economic Journal: Applied Economics*, **9(2)**, 23–59.

Anukriti, S., Kwon, S., & Prakash, N. 2018. Household Savings and Marriage Payments: Evidence from Dowry in India. *Working papers 2018-09, University of Connecticut, Department of Economics*.

Barcellos, Silvia H., Carvalho, L., & Lleras-Muney, A. 2014. Child Gender and Parental Investments in India: Are Boys and Girls Treated Differently? *American Economic Journal: Applied Economics*, **6**, 157–189.

Bhalotra, S., & Cochrane.C, T. 2010. Where Have All the Young Girls Gone? Identification of Sex Selection in India. *IZA Discussion Paper no. 5381, Institute for the Study of Labor, Bonn*.

Bleakley, H. 2007. Disease and Development: Evidence from Hookworm Eradication in the American South. *Quarterly Journal of Economics*, **122 (1)**, 73–117.

Carven, T. 1992. South Africa: The Other Frontline. *The New Statesman and Society*, **5**, 22–23.

Clasen, T, Boisson, Sophie, Routray, Parimita, Torondel, Belen, Bell, Melissa, Cumming, Oliver, Ensink, Jeroen, & et al. 2014. Effectiveness of a rural sanitation programme on diarrhoea, soil-transmitted helminth infection, and child malnutrition in Odisha, India: A cluster-randomised trial. *Lancet Global Health*, **2(11)**, e645–53.

Coffey, D., & Spears, D. 2017. *Where India Goes: Abandoned Toilets, Stunted Development and Costs of Caste*. Harper Collins.

Coffey, D., Geruso, M., & Spears, D. 2017. Sanitation, Disease Externalities, and Anemia: Evidence From Nepal. *The Economic Journal*, **Accepted**.

Cutler, D., & Miller, G. 2005. The role of public health improvements in health advances: The twentieth-century United States. *Demography*, **42 (1)**, 1–22.

Deaton, A. 2003. Health, Inequality, and Economic Development. *Journal of Economic Literature*, **41, No.1**, 113–58.

Duflo, E., Greenstonea, M., Guiteras, R., & Clasen, T. 2015. Toilets Can Work: Short and Medium Run Health Impacts of Addressing Complementarities and Externalities in Water and Sanitation. *NBER WP 21521*.

Geruso, M., & Spears, D. 2018. Neighborhood Sanitation and Infant Mortality. *American Economic Journal: Applied Economics*, **10**, 125–62.

Guiteras, R., Levinsohn, J., & Mobarak, AM. 2015. Sanitation subsidies. Encouraging sanitation investment in the developing world: a cluster-randomized trial. *Science*, **348(6237):903-6**.

Hammer, J., & Spears, D. 2016. Village sanitation and child health: Effects and external validity in a randomized field experiment in rural India. *Journal of Health Economics*, **48**, 135–48.

Hesketh, Therese, & Xing., Zhu Wei. 2006. Abnormal Sex Ratios in Human Populations: Causes and Consequences. *Proceedings of the National Academy of Sciences of the USA 103*, **36**, 13271–75.

Jadhav, A., Weitzman, A., & Smith-Greenway, E. 2016. Household sanitation facilities and women's risk of non-partner sexual violence in India. *BMC Public Health*.

JAGORI, & UN-Women. 2010. *Safe Cities Free of Violence Against Women and Girls Initiative: Baseline Survey in Delhi*. Report. Jagori and UN Women.

Jankowski, M.S. 1991. *Islands in the Street: Gangs and American Urban Society*. University of California Press, Berkeley.

Jayachandran, S., & Kuziemko, I. 2011. Why Do Mothers Breastfeed Girls Less than Boys? Evidence and Implications for Child Health in India. *Quarterly Journal of Economics*, **126**, 1485–1538.

Jeffery, P., Jeffery, R., & Lyon, A. 1989. Labor Pains and Labour Power. *London:Zed*.

Jha, P., Kesler, M., Kumar, R., Ram, U., Aleksandowicz, L., Bassani, D., Chandra, S., & Banthia., J. 2011. Trends in Selective Abortions in India: Analysis of Nationally Representative Birth Histories from 1990 to 2005 and Census Data from 1991 to 2011. *Lancet*, **377**, 1921–28.

Khadgawat, R., Marwaha, RK., Mehan, N., Surana, V., Dabas, A., Sreenivas, V., Gaine, MA., & Gupta, N. 2016. Age of Onset of Puberty in Apparently Healthy School Girls from Northern India. *Indian Pediatrics*, **53 Issue 5**, 383–387.

Kishore, A., & Spears, D. 2014. Having a son promotes clean cooking fuel use in urban India: Women's status and son preference. *Economic Development and Cultural Change*, **62 Issue 4**, 673–699.

Kumar, V., & Skaperdas, S. 2009. On the economics of organized crime. *Chap. 10 of:* Garoupa, N (ed), *Criminal law and economics*. Cheltenham: Edward Elgar.

Lieven, A. 1998. *Chechnya: The Tombstone of Russian Power*. New Haven: Yale University Press.

Pl, Gertler., Shah, Manisha, Alzua, Maria Laura, Cameron, Lisa, Martinez, Sebastian, & Patil., Sumeet. 2015. How Does Health Promotion Work? Evidence from the Dirty Business of Eliminating Open Defecation. *NBER WP 20997*.

Portner, C. C. 2010. Sex Selective Abortions, Fertility and Birth Spacing. *Working Paper no. 4, University of Washington.*

Rosenblaum, D. 2013. The Effect of Fertility Decisions on Excess Female Mortality in India. *Journal of Population Economics*, **26 No. 1**, 147–80.

Sen, A. 2003. Missing Women Revisited: Reduction in Female Mortality Has Been Counter balanced by Sex Selective Abortions. *British Medical Journal*, **327**, 1297–98.

Spears, D., & Coffey, D. 2018. Open defecation in rural India, 2015-2016: Levels and trends in the NFHS-4. *Working Paper*.

Spears, D., & Lamba, S. 2016. "Effects of Early-Life Exposure to Rural Sanitation on Childhood Cognitive Skills: Evidence from India's Total Sanitation Campaign. *Journal of Human Resources*, **51 (2)**, 298–327.

Stopnitzky, Y. 2017. No Toilet No Bride? Intrahousehold Bargaining in Male-Skewed Marriage Markets in India. *Journal of Development Economics*, **127**, 269–282.

UNICEF, & WHO. 2014. *Progress on Drinking Water and Sanitation 2014 Update*. Report. UNICEF.

Watson, T. 2006. Public health investments and the infant mortality gap: Evidence from federal sanitation interventions on U.S. Indian reservations. *Journal of Public Economics*, **90 (8–9)**, 1537–60.

A: Mathematical Appendix

In addition to assumptions in Section III-A, I assume, $C(1,0)$ is given; the aggregate resources an household i, $I \in [I_L, I_H]$ where $I_L > 0$ and $I_H < \infty$; household can only have a finite number of girl children above the cut-off age, $F_i = 0, 1, 2, ..., N$; the minimum φ, $\varphi_L < u(I_H) - u(I_H - P) - \omega C(N, 0)$.

Proposition: ***Case 1***: $\forall\ I_i\ \exists\ \bar{\varphi}$, such that, for $\varphi_i < \bar{\varphi}$,

$$V_i(0) > V_i(1) \qquad \forall i \tag{4}$$

Proof: Consider equation (4),

$$\begin{aligned} & V_i(0) > V_i(1) \\ \implies & U(I_i, \varphi_i, 0) - \omega C(F_i, 0) > U(I_i - P, \varphi_i, 1) \\ \implies & u(I_i) - \varphi_i - \omega C(F_i, 0) > u(I_i - P) \\ \implies & \hat{\varphi}(I_i, F_i) \equiv u(I_i) - u(I_i - P) - \omega C(F_i, 0) > \varphi_i \end{aligned} \tag{5}$$

In equation (5), we obtain the cutoff as a function of income and the number of children. In order to make the cutoff independent of them, we observe that, $\hat{\varphi}(I_i, F_i)$ is decreasing in both, I_i[33] and F_i[34]. Hence, the lowest value of $\hat{\varphi}(I_i, F_i)$ is the cutoff level below which all households do not adopt a toilet. Now, we obtain,

$$\bar{\varphi} \equiv \hat{\varphi}(I_H, N) = u(I_H) - u(I_H - P) - \omega C(N, 0) \tag{6}$$

■

Case 2: For all $\varphi_i > \bar{\varphi}$, $\exists\ \bar{I}$ such that for $I_i > \bar{I}$,

$$V_i(1) > V_i(0) \quad \forall i, \forall F_i \geq 0, \tag{7}$$

Proof: Equation (7) suggests that the household has a higher net utility from adopting a toilet:

$$U(I_i - P, \varphi_i, 1) > U(I_i, \varphi_i, 0) - \omega C(F_i, 0) \tag{8}$$

In this case, equation (8) should hold for all possible values of F_i. Since, the RHS is decreasing in F_i, if the inequality holds for $F_i = 0$, it also holds for $F_i > 0$. Therefore, the condition in equation (8) reduces to:

$$U(I_i - P, \varphi_i, 1) > U(I_i, \varphi_i, 0) \tag{9}$$

[33]The derivative of $\hat{\varphi}(I_i, F_i)$ wrt I_i is $u'(I_i) - u'(I_i - P)$. Since $u(.)$ is concave in X, $I_i > I_i - P$ implies that $u'(I_i) < u'(I_i - P)$.

[34]The derivative of $\hat{\varphi}(I_i, F_i)$ wrt F_i is $-\omega C_F(F_i, 0)$. Here, $C_F(F_i, 0) > 0$ implies that $-\omega C_F(F_i, 0) < 0$.

Note, that equation (9) does not depend on ω. From equation (9), we get,

$$u(I_i - P) > u(I_i) - \varphi_i \tag{10}$$
$$\implies \varphi_i > u(I_i) - u(I_i - P) \tag{11}$$

Note, that the LHS is constant for all I_i[35] and the RHS is decreasing in I_i[36]. Hence, corresponding to each level of $\varphi_i > \bar{\varphi}$, there exists an $\bar{I}(\varphi_i)$ such that for $I_i > \bar{I}(\varphi_i)$ households will always adopt a toilet. $\bar{I}(\varphi_i)$ is given by:

$$\varphi_i = u(\bar{I}(\varphi_i)) - u(\bar{I}(\varphi_i) - P) \tag{12}$$

■

Case 3: For given cost $C(1,0) = C_1$, $\varphi_i > \bar{\varphi}$, and $I_i < \bar{I}(\varphi_i)$ $\exists \tilde{I} < \bar{I}(\varphi_i)$ such that $\forall i$ with $I_i \in [\tilde{I}, \bar{I}(\varphi_i)]$,

$$U(I_i, \varphi_i, 0) > U(I_i - P, \varphi_i, 1), \qquad \text{if } F_i = 0 \tag{13}$$
$$U(I_i - P, \varphi_i, 1) > U(I_i, \varphi_i, 0) - \omega C(F_i, 0) \qquad \text{if } F_i > 0 \tag{14}$$

Conceptual Explanation: I will provide a conceptual explanation supporting the validity of Case 3 above. Consider equation (13),

$$U(I_i, \varphi_i, 0) > U(I_i - P, \varphi_i, 1) \tag{15}$$
$$\implies u(I_i) - \varphi_i(1-0) - \omega C(F_i, 0) > u(I_i - P) \tag{16}$$
$$\implies u(I_i) - u(I_i - P) > \varphi_i \tag{17}$$

In this case, there are no adult girl child in household, $I_i \in [\tilde{I}, \bar{I}(\varphi_i)]$ and I_i is sufficiently low, such that marginal utility out of income is higher and a gain in utility because of not adopting a toilet is higher than the social cost of open defecation. Hence, in this case a household will not adopt a toilet.

Similarily, consider equation (14),

$$U(I_i - P, \varphi_i, 1) > U(I_i, \varphi_i, 0) - \beta C(F_i, 0) \tag{18}$$
$$\implies u(I_i) - u(I_i - P) < \varphi_i + \omega C(F_i, 0) \tag{19}$$

In this case, there are adult girl child in household (hence, $C(.) > 0$), all other factors are same as equation (13). The gain in utility by not adopting a toilet in this case is outweighed by the social cost + cost associated with an adult female child in the household. Hence, in this case a household will adopt toilet only if $C(.) > 0$

■

[35]

[36]Derivative of the RHS wrt I_i is $u'(I_i) - u'(I_i - P)$. Since $u(.)$ is concave in X, $I_i > I_i - P$ implies that $u'(I_i) < u'(I_i - P)$

Tables

Table 1: Testable Predictions

		No Female Children (T = 0)	
		0	1
Female Children (T = 1)	0	Never a Toilet **(Case 1)**	Defiers
	1	Compliers **(Case 3)**	Always a Toilet **(Case 2)**

Notes: This Table represents the Testable Predictions from Section III. Decision to adopt a toilet or not is represented in Second Row and Second Column by 0 and 1. It is 1 if households adopts a toilet and 0 otherwise. Treatment is the presence of female children in a household and is represented by $T = 1$ for treated and $T = 0$ for control.

Table 2: Mean Differences Check - *First born ≤ 5 years*

	Rural			Urban		
Outcome	Mean	Difference Girl - Boy	P-Value	Mean	Difference Girl - Boy	P-Value
Wealth: Asset Index	0	-0.012	0.622	0	-0.018	0.272
Open Defecation Rate	0.106	0.004	0.645	0.485	0.005	0.582
Source of Water						
Piped in Dwelling	0.303	-0.021	0.072	0.092	-0.004	0.357
Piped to Yard/Plot	0.185	-0.001	0.885	0.096	0.001	0.868
Public Tap/Standpipe	0.156	0.011	0.23	0.137	0.001	0.828
Cooking Fuel						
LPG/Natural Gas	0.766	-0.002	0.822	0.215	-0.001	0.918
Kerosene	0.028	-0.007	0.09	0.008	0.001	0.586
Coal/Lignite	0.018	0.001	0.825	0.009	0.001	0.691
Wood	0.13	0.007	0.41	0.622	-0.005	0.502
Animal Dung	0.014	0.002	0.588	0.064	0.003	0.428
Construction						
Floor Type: Mud/Clay/Earth	0.094	-0.01	0.166	0.437	-0.001	0.939
Floor Type: Brick	0.007	0.002	0.338	0.006	-0.001	0.479
Floor Type: Stone	0.041	-0.004	0.377	0.025	-0.003	0.205
Floor Type: Cement	0.558	0.003	0.795	0.323	0.008	0.294
Roof Type: Metal/GI	0.19	-0.006	0.577	0.265	0.006	0.377
Roof Type: Calamine/Cement Fibre	0.036	0.007	0.151	0.022	0.001	0.705
Roof Type: Asbestos Sheet	0.067	0.005	0.389	0.07	-0.002	0.557
Roof Type: RCC/RBC/Cement/Concrete	0.507	-0.005	0.668	0.216	0	0.956
Wall Type: Mud	0.045	-0.008	0.133	0.213	0.009	0.201
Wall Type: Bamboo with Mud	0.027	0.003	0.458	0.096	0	0.933
Wall Type: Cement/Concrete	0.478	-0.004	0.764	0.214	0.005	0.465
Wall Type: Burnt Bricks	0.222	-0.009	0.406	0.214	-0.002	0.821
Household/Child Characteristics						
Religion: Hindu	0.712	-0.007	0.56	0.729	-0.01	0.177
Religion: Muslim	0.153	-0.003	0.765	0.124	0.005	0.357
Mother's Age	26.145	-0.096	0.423	24.469	0.037	0.614
Father's Age	30.959	-0.158	0.278	29.167	0.018	0.86
Is mother currently pregnant?	0.13	0.031	0	0.166	0.027	0
Number of HH members	3.616	0.007	0.831	3.799	0.01	0.694
Number of Children (under 5 years)	0.997	0.005	0.393	0.999	0.007	0.17
Number of Women (15-49 years)	1.14	0.012	0.299	1.164	-0.002	0.801
First Born received prenatal care?	0.768	-0.002	0.872	0.582	0.002	0.772
First born alive?	0.98	0.001	0.734	0.967	0.006	0.049
Education/Awareness						
Mother's Education: No Education	0.096	-0.001	0.867	0.238	0.01	0.165
Mother's Education: Primary	0.086	-0.01	0.173	0.141	-0.011	0.057
Mother's Education: Secondary	0.544	0	0.978	0.536	-0.001	0.925
Mother's Education: Higher	0.274	0.011	0.333	0.086	0.002	0.679
Father's Education: No Education	0.072	0.004	0.511	0.152	0	0.981
Father's Education: Primary	0.103	-0.004	0.571	0.169	0	0.987
Father's Education: Secondary	0.535	0.003	0.823	0.566	0.001	0.898
Father's Education: Higher	0.29	-0.003	0.801	0.113	-0.001	0.846
Reading newspaper atleast once a week?	0.382	0.003	0.775	0.144	0.01	0.083
Watching TV atleast once a week?	0.864	-0.008	0.332	0.579	0	0.985

Notes: This table reports the mean differences across various household characteristics for the households with the first born being young (≤ 5 years of age). Coefficient β from equation (3) is reported (estimated without without any controls) along with the p-value. Standard errors are clustered at PSU level.

Table 3: Mean Differences Check - *First born* $\leq$ *marriage age*

	Rural			Urban		
Outcome	Mean	Difference Girl - Boy	P-Value	Mean	Difference Girl - Boy	P-Value
Wealth: Asset Index	-0.15	-0.034	0	-0.182	-0.023	0
Source of Water						
Piped in Dwelling	0.325	-0.015	0.001	0.098	-0.006	0
Piped to Yard/Plot	0.178	0.005	0.163	0.112	0.003	0.113
Public Tap/Standpipe	0.158	0.006	0.096	0.145	-0.001	0.796
Cooking Fuel						
LPG/Natural Gas	0.753	-0.014	0.001	0.21	-0.007	0.004
Kerosene	0.017	-0.001	0.601	0.006	0	0.47
Coal/Lignite	0.02	0.001	0.431	0.009	0	0.916
Wood	0.149	0.009	0.009	0.614	0.002	0.439
Animal Dung	0.02	0	0.871	0.086	0.003	0.115
Construction						
Floor Type: Mud/Clay/Earth	0.081	0.001	0.702	0.391	0.002	0.4
Floor Type: Brick	0.007	0.002	0.07	0.008	0	0.811
Floor Type: Stone	0.054	0.001	0.761	0.031	-0.003	0.004
Floor Type: Cement	0.53	0	0.989	0.338	-0.001	0.668
Roof Type: Metal/GI	0.153	0.003	0.419	0.217	0.001	0.801
Roof Type: Calamine/Cement Fibre	0.033	0.002	0.174	0.022	0	0.764
Roof Type: Asbestos Sheet	0.064	0.005	0.034	0.059	-0.001	0.363
Roof Type: RCC/RBC/Cement/Concrete	0.534	-0.006	0.217	0.253	0.002	0.405
Wall Type: Mud	0.043	0.002	0.346	0.193	0.004	0.096
Wall Type: Bamboo with Mud	0.021	0	0.747	0.068	0.001	0.743
Wall Type: Cement/Concrete	0.476	-0.006	0.229	0.235	-0.004	0.079
Wall Type: Burnt Bricks	0.236	0.001	0.895	0.241	0.005	0.04
Household/Child Characteristics						
Religion: Hindu	0.714	-0.005	0.212	0.75	0.002	0.353
Religion: Muslim	0.171	0.003	0.434	0.116	0.001	0.611
Mother's Age	35.402	0.011	0.833	33.927	0.03	0.374
Father's Age	40.323	0.062	0.305	38.521	0.021	0.598
Is mother currently pregnant?	0.027	0.01	0	0.041	0.021	0
Number of HH members	4.798	0.213	0	5.13	0.284	0
Number of Children (under 5 years)	0.537	0.123	0	0.726	0.18	0
Number of Women (15-49 years)	1.447	0.111	0	1.398	0.099	0
First Born received prenatal care?	0.771	-0.004	0.675	0.586	0	0.983
Education/Awareness						
Mother's Education: No Education	0.223	0.004	0.319	0.442	0.005	0.114
Mother's Education: Primary	0.132	0.003	0.375	0.173	-0.002	0.493
Mother's Education: Secondary	0.499	-0.005	0.286	0.354	-0.004	0.155
Mother's Education: Higher	0.146	-0.001	0.719	0.031	0.001	0.334
Father's Education: No Education	0.13	0.001	0.669	0.258	0.001	0.765
Father's Education: Primary	0.133	0.001	0.804	0.192	0	0.873
Father's Education: Secondary	0.535	0.002	0.634	0.484	-0.004	0.179
Father's Education: Higher	0.202	-0.004	0.284	0.066	0.003	0.069
Reading newspaper atleast once a week?	0.357	-0.015	0.001	0.114	0.001	0.665
Watching TV atleast once a week?	0.87	-0.008	0.019	0.563	-0.003	0.257

Notes: This table reports the mean differences across various household characteristics for the households with the first born $\leq$ 15 an 16 years old (in rural and urban regions, respectively). Coefficient β from equation (3) is reported (estimated without without any controls) along with the p-value. Standard errors are clustered at PSU level.

Table 4: Gender of first born child and reduction in OD (Urban Areas)

	Full Sample				First Born $\leq$ 16 years age			
Outcome: OD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
First Born Gender	-0.0031	-0.0055***	-0.0069***	-0.0056**	-0.0001	-0.0058**	-0.0066***	-0.0063**
(Female = 1)	(0.0024)	(0.0021)	(0.0012)	(0.0023)	(0.0032)	(0.0027)	(0.0025)	(0.0029)
Mean OD Rate	0.117	0.117	0.117	0.117	0.124	0.124	0.124	0.124
Household Controls		X	X	X		X	X	X
District FE			X	X			X	X
Caste FE			X	X			X	X
YOB FE			X	X			X	X
District*Caste FE				X				X
YOB*Caste FE				X				X
District*YOB FE				X				X
Observations	71478	71478	71478	71478	43877	43877	43877	43877

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This Table reports the estimates from equation (3) on the Urban areas of the *main analysis sample*. Outcome variable in all columns is the indicator variable OD = 1 if household defecates in open and OD = 0 if not. Results are reported in two categories, 1). Full Sample (all urban households in main analysis sample), and 2). Age restricted sample, where the age of first born child is restricted to 16 years (17 years mark a point in data where the girls are getting married and leaving their parents house in urban areas). Results are reported in four columns, each adding a new set of controls, with column (4) and (8) being the richest specification. Household controls include - Standardized value of asset index, number of household members, number of women and girls in the household, age of household head and the mother of first born, education of household head and the mother, frequency of watching TV and reading newspaper in the household, main floor material, main roof material, main wall material, religion followed by the household and if the responding mother currently pregnant. Standard errors clustered at Primary Sampling Unit.

Table 5: Gender of first born child and reduction in OD (Rural Areas)

	Full Sample				First Born $\leq$ 15 years age			
Outcome: OD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
First Born Gender	0.00793***	-0.00283	-0.00206	-0.00271	0.00230	-0.00245	-0.00157	-0.00188
(Female = 1)	(0.00224)	(0.00177)	(0.00159)	(0.00168)	(0.00311)	(0.00245)	(0.00220)	(0.00232)
Mean OD Rate	0.518	0.518	0.518	0.518	0.54	0.54	0.54	0.54
Household Controls		X	X	X		X	X	X
District FE			X	X			X	X
Caste FE			X	X			X	X
YOB FE			X	X			X	X
District*Caste FE				X				X
YOB*Caste FE				X				X
District*YOB FE				X				X
Observations	206739	206739	206739	206739	102354	102354	102354	102354

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This Table reports the estimates from equation (3) on the Rural areas of the *main analysis sample*. Outcome variable in all columns is the indicator variable OD = 1 if household defecates in open and OD = 0 if not. Results are reported in two categories, 1). Full Sample (all urban households in main analysis sample), and 2). Age restricted sample, where the age of first born child is restricted to 15 years (16 years mark a point in data where the girls are getting married and leaving their parents house in urban areas). Results are reported in four columns, each adding a new set of controls, with column (4) and (8) being the richest specification. Household controls include - Standardized value of asset index, number of household members, number of women and girls in the household, age of household head and the mother of first born, education of household head and the mother, frequency of watching TV and reading newspaper in the household, main floor material, main roof material, main wall material, religion followed by the household and if the responding mother currently pregnant. Standard errors clustered at Primary Sampling Unit.

Table 6: Results by Wealth Categories - *Deciles of Asset Index*

				Panel A: Urban Areas						
Outcome: OD	(1st)	(2nd)	(3rd)	(4th)	(5th)	(6th)	(7th)	(8th)	(9th)	(10th)
First Born (Female = 1)	0.065	-0.076**	-0.011	-0.047	-0.021	-0.007	0.011	-0.003	0.001	0.002
	(0.087)	(0.032)	(0.044)	(0.037)	(0.031)	(0.026)	(0.023)	(0.007)	(0.008)	(0.002)
Mean OD Rate	0.450	0.219	0.144	0.11	0.083	0.046	0.026	0.013	0.004	0.004
Observations	2353	3771	2601	2806	2900	2686	2477	3806	1380	2364
				Panel B: Rural Areas						
Outcome: OD	(1st)	(2nd)	(3rd)	(4th)	(5th)	(6th)	(7th)	(8th)	(9th)	(10th)
First Born (Female = 1)	0.001	0.003	-0.003	-0.006	-0.023	-0.021	0.002	-0.002	-0.032	-0.008
	(0.011)	(0.025)	(0.010)	(0.025)	(0.024)	(0.030)	(0.032)	(0.039)	(0.022)	(0.016)
Mean OD Rate	0.811	0.73	0.651	0.565	0.495	0.422	0.362	0.30	0.23	0.122
Observations	6703	4622	10633	5551	5278	4983	4387	3778	4971	4461

Standard errors in parentheses

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This Table reports the estimates from equation (3) on the Main Analysis Sample in Urban Areas. Outcome variable in all columns of both Panel A and B is the indicator variable OD = 1 if household defecates in open and OD = 0 if not. Analysis is for households belonging to deciles of asset index(from poorest to richest decile). Results are reported in two panels of Urban and Rural areas. In both Panel A & B, the sample as described in the text, is the set of households, a) where the husband of respondent (surveyed woman) is head of the household, b) with the first child at least 8 years old and at most 16 years old in urban areas/at most 15 years old in rural areas, and c). where the first born child is alive. These results report the coefficient from the richest specification of equation (3) which included household controls, district FE, caste FE, YOB FE and their respective interactions. Standard errors clustered at Primary Sampling Unit.

Table 7: Gender of first born child and reduction in OD - *Falsification*

	Urban Areas				Rural Areas			
Outcome: OD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
First Born Gender	-0.000154	-0.00124	-0.00273	0.00116	0.00938*	0.00445	0.00659*	0.00720*
(Female = 1)	(0.00541)	(0.00455)	(0.00430)	(0.00525)	(0.00497)	(0.00394)	(0.00354)	(0.00385)
Mean OD Rate	0.117	0.117	0.117	0.117	0.124	0.124	0.124	0.124
Household Controls		X	X	X		X	X	X
District FE			X	X			X	X
Caste FE			X	X			X	X
YOB FE			X	X			X	X
District*Caste FE				X				X
YOB*Caste FE				X				X
District*YOB FE				X				X
Observations	15539	15539	15539	15539	39582	39582	39582	39582

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This Table reports the estimates from equation (3) on the *falsification sample* in Rural and Urban areas of the *main analysis sample*. *Falsification sample* is same as the sample used in Table 4 and 5, except that the age of first born child is restricted to ≤ 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 in two sets, one each for Urban and Rural areas. Results are reported in four columns, each adding a new set of controls, with column (4) and (8) being the richest specification. Household controls include - Standardized value of asset index, number of household members, number of women and girls in the household, age of household head and the mother of first born, education of household head and the mother, frequency of watching TV and reading newspaper in the household, main floor material, main roof material, main wall material, religion followed by the household and if the responding mother currently pregnant. Standard errors in parentheses. Standard errors clustered at Primary Sampling Unit.

Table 8: Falsification by Wealth Categories - *Deciles of Asset Index*

				Panel A: Urban Areas						
Outcome: OD	(1st)	(2nd)	(3rd)	(4th)	(5th)	(6th)	(7th)	(8th)	(9th)	(10th)
First Born (Female = 1)	0.0751	0.00257	0.0481	0.0405	-0.0496	-0.00430	0.0729	0.000693	3.91e-18	3.25e-18
	(0.146)	(0.0410)	(0.0904)	(0.0626)	(0.0673)	(0.0410)	(0.104)	(0.0114)	(.)	(3.74e-10)
[1em] Mean OD Rate	0.393	0.194	0.144	0.096	0.077	0.045	0.036	0.013	0.006	0.002
Observations	1706	2371	1532	1601	1522	1409	1126	1572	516	839
				Panel B: Rural Areas						
Outcome: OD	(1st)	(2nd)	(3rd)	(4th)	(5th)	(6th)	(7th)	(8th)	(9th)	(10th)
First Born (Female = 1)	0.009	-0.015	0.004	0.036	0.029	-0.013	-0.018	0.006	0.025	0.006
	(0.017)	(0.043)	(0.017)	(0.048)	(0.050)	(0.049)	(0.069)	(0.082)	(0.048)	(0.036)
Mean OD Rate	0.810	0.714	0.642	0.564	0.499	0.433	0.379	0.329	0.281	0.160
Observations	4487	2808	6310	3403	3211	3136	2602	2210	2942	2454

Standard errors in parentheses

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This Table reports the estimates from equation (3) on the *falsification sample* in Urban and Rural Areas. *Falsification sample* is same as the sample used in Table 6, except that the age of first born child is restricted to ≤ 8 years. Outcome variable in all columns of both Panel A and B is the indicator variable OD = 1 if household defecates in open and OD = 0 if not. Analysis is for households belonging to deciles of asset index(from poorest to richest decile). Results are reported in two panels of Urban and Rural areas. These results report the coefficient from the richest specification of equation (3) which included household controls, district FE, caste FE, YOB FE and their respective interactions. Standard errors clustered at Primary Sampling Unit.

Table 9: Mean Differences Check - *Urban households in 2nd decile of Asset Index*

Outcome	Mean	Difference Girl - Boy	P-Value
Wealth: Asset Index	-0.928	0	0.95
Source of Water			
Piped in Dwelling	0.215	-0.004	0.748
Piped to Yard/Plot	0.184	0.013	0.299
Public Tap/Standpipe	0.228	0	0.98
Cooking Fuel			
LPG/Natural Gas	0.577	-0.01	0.511
Kerosene	0.033	-0.001	0.876
Coal/Lignite	0.037	-0.001	0.92
Wood	0.264	0.01	0.495
Animal Dung	0.033	-0.001	0.813
Construction			
Floor Type: Mud/Clay/Earth	0.147	-0.008	0.477
Floor Type: Brick	0.01	0.004	0.174
Floor Type: Stone	0.055	-0.002	0.783
Floor Type: Cement	0.599	0.001	0.942
Roof Type: Metal/GI			
Roof Type: Calamine/Cement Fibre	0.219	-0.003	0.823
Roof Type: Asbestos Sheet	0.043	-0.001	0.907
Roof Type: RCC/RBC/Cement/Concrete	0.098	0.019	0.048
Wall Type: Mud	0.336	-0.023	0.124
Wall Type: Bamboo with Mud			
Wall Type: Cement/Concrete	0.079	0.005	0.589
Wall Type: Burnt Bricks	0.033	-0.002	0.736
Household/Child Characteristics	0.378	-0.014	0.357
Religion: Hindu	0.253	0.013	0.348
Religion: Muslim			
Mother's Age	0.683	0.005	0.725
Father's Age	0.194	0.008	0.517
Is mother currently pregnant?	32.54	0.092	0.532
Number of HH members	37.356	-0.002	0.991
Number of Children (under 5 years)	0.022	0.013	0.004
Number of Women (15-49 years)	4.862	0.304	0
First Born received prenatal care?	0.505	0.147	0
First born alive?	1.126	0.175	0
Education/Awareness			
Mother's Education: No Education	0.323	-0.001	0.961
Mother's Education: Primary	0.185	0.008	0.538
Mother's Education: Secondary	0.466	-0.01	0.538
Mother's Education: Higher	0.027	0.003	0.594
Father's Education: No Education	0.212	-0.008	0.545
Father's Education: Primary	0.186	0.017	0.164
Father's Education: Secondary	0.547	-0.013	0.424
Father's Education: Higher	0.056	0.004	0.629
Reading newspaper atleast once a week?	0.164	-0.003	0.765
Watching TV atleast once a week?	0.789	0.003	0.819

Notes: This table reports the estimates of equation (3), without any controls, on sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6). Outcome of interest are mean differences in household characteristics, similar to Table 2 and 3. Standard errors are clustered at PSU.

Table 10: Mean Differences Check - *Urban households in 2nd decile of Asset Index*

Assets	Mean	Difference Girl - Boy	P-Value
Mattress	0.677	0.031	0.044
Pressure Cooker	0.721	0.007	0.659
Chair	0.725	0.014	0.362
Cot or Bed	0.846	-0.009	0.439
Table	0.479	0.009	0.581
Electric Fan	0.82	-0.009	0.482
Color Television	0.763	-0.014	0.34
Sewing Machine	0.152	0.011	0.373
Internet	0.013	-0.005	0.176
Computer	0.002	0.001	0.663
Air Conditioner/Cooler	0.085	0.006	0.495
Washing Machine	0.022	0.002	0.761
Water Pump	0.038	0.004	0.556
Thresher	0.002	-0.002	0.29
Electricity	0.976	-0.01	0.06
Radio	0.044	0	0.968
Refrigerator	0.095	0.005	0.613
Bicycle	0.409	-0.039	0.017
Motorcycle/Scooter	0.139	-0.007	0.539
Car/Truck	0.007	-0.003	0.214

Notes: This table reports the estimates of equation (3), without any controls, on sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6). Outcome of interest are mean differences in various assets owned by a household. Standard errors are clustered at PSU.

Table 11: Gender composition (number of females) of the households

	(1) All Female	(2) Daughters Only	(3) Other than Daughters	(4) Daughters in Law only
First Born (Female = 1)	1.061****	1.066****	-0.00523	-0.00305***
	(0.0249)	(0.0204)	(0.0138)	(0.0011)
Observations	6142	6142	6142	6142

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This table reports the estimates of equation (3), without any controls, on sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6 *plus* Column 2 in Panel A of Table 8). 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 erros in parenthesis. Standard errors are clustered at PSU.

Table 12: Crime Against Women and Reduction in Open Defecation

Outcome: OD	(1)	(2)	(3)	(4)
	Using Crime Reports (NCRB)		*Using Self Reports (IHDS)*	
	Top 10 states	Other states	Top 10 states	Other states
First Born Gender	-0.130***	-0.003	-0.207***	-0.0153
(Female = 1)	(0.049)	(0.041)	(0.069)	(0.039)
OD Rate	0.27	0.17	0.25	0.20
Observations	1852	1919	1443	2328
HH Controls	X	X	X	X
District FE	X	X	X	X
Caste FE	X	X	X	X
YOB FE	X	X	X	X
District*Caste FE	X	X	X	X
YOB*Caste FE	X	X	X	X
District*YOB FE	X	X	X	X

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This table reports the estimates of equation (3) on sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6). The preferred specification with the richest set of controls is used. Outcome of interest is Open Defecation (OD). Columns are divided by crime reports across 10 states/UTs with highest incidences and remaining other states/UTs. Column 1 & 3 report the results using crime records of crime against women by National Crime Record Bureau (NCRB) in 2015. Column 3 & 4 report the results using the self-reports incidences of crime against women in the Indian Human Development Survey in 2012. Standard errors in parentheses. Standard errors are clustered at PSU.

Table 13: Socio-Economic Status and reduction in Open Defecation

Outcome: OD	(1)	(2)	(3)	(4)
	BIMARU vs Non-BIMARU		*Literacy Rate*	
	BIMARU	Non-BIMARU	Bottom 10 States	Other States
First Born Gender	-0.136*	-0.035	-0.182***	0.003
(Female = 1)	(0.074)	(0.036)	(0.058)	(0.036)
OD Rate	0.25	0.21	0.27	0.19
Observations	1073	2698	1651	2120
HH Controls	X	X	X	X
District FE	X	X	X	X
Caste FE	X	X	X	X
YOB FE	X	X	X	X
District*Caste FE	X	X	X	X
YOB*Caste FE	X	X	X	X
District*YOB FE	X	X	X	X

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This table reports the estimates of equation (3) on sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6). The preferred specification with the richest set of controls is used. Outcome of interest is Open Defecation (OD). Columns are divided by indicators of low versus high performing states. Column 1 & 3 report the results using *BIMARU* states (Bihar, Madhya Pradesh, Rajasthan and Uttar Pradesh) and *Non-BIMARU* states (all others). Column 3 & 4 report the results using the 10 states/UTs ranking the lowest on literacy rates, and all other states/UTs . Standard errors in parentheses. Standard errors are clustered at PSU.

Table 14: Social norms and reduction in Open Defecation

Outcome: OD	(1)	(2)	(3)	(4)
	Son Preference		*Dowry Amount*	
	Top 10 States	Other States	Top 10 States	Other States
First Born Gender	-0.132*	-0.034	-0.125**	0.004
(Female = 1)	(0.069)	(0.038)	(0.050)	(0.043)
OD Rate	0.22	0.22	0.27	0.17
Observations	1597	2164	1949	1822
HH Controls	X	X	X	X
District FE	X	X	X	X
Caste FE	X	X	X	X
YOB FE	X	X	X	X
District*Caste FE	X	X	X	X
YOB*Caste FE	X	X	X	X
District*YOB FE	X	X	X	X

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This table reports the estimates of equation (3) on sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6). The preferred specification with the richest set of controls is used. Outcome of interest is Open Defecation (OD). Columns are divided by indicators of social norms in sample households. Column 1 & 3 report the results using states ranking among top 10 by *son preference* (having lowest 10 sex ratios) and all other states/UTs; using the Population Census of India 2011. Column 3 & 4 report the results using states ranking in top 10 by *dowry prevalence* (measured as: reported dowry amount in community/reported household income in past year using Indian Human Development Survey 2012) and all other states/UTs . Standard errors in parentheses. Standard errors are clustered at PSU

Table 15: Caste, religion and reduction in Open Defecation

Outcome: OD	(1)	(2)	(3)	(4)	(5)	(6)
	By Caste				*By Religion*	
	Scheduled Caste	Scheduled Tribe	OBC	General Caste	Hindu	Muslim
First Born Gender	-0.0505	-0.0128	-0.0715***	-0.0108	-0.123**	-0.0109
(Female = 1)	(0.0543)	(0.0269)	(0.0226)	(0.0340)	(0.0590)	(0.103)
OD Rate	0.33	0.17	0.24	0.11	0.27	0.14
Observations	785	567	1679	701	2629	765
HH Controls	X	X	X	X	X	X
District FE	X	X	X	X	X	X
Caste FE					X	X
YOB FE	X	X	X	X	X	X
District*Caste FE					X	X
YOB*Caste FE					X	X
District*YOB FE	X	X	X	X	X	X

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This table reports the estimates of equation (3) on sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6). The preferred specification with the richest set of controls is used. Outcome of interest is Open Defecation (OD). Columns are divided by indicators of social norms in sample households. Column 1-4 report the results divided in four different caste categories. Column 5 & 6 report the results divided by two religious categories- *hindu* and *muslim*. Standard errors in parentheses. Standard errors are clustered at PSU

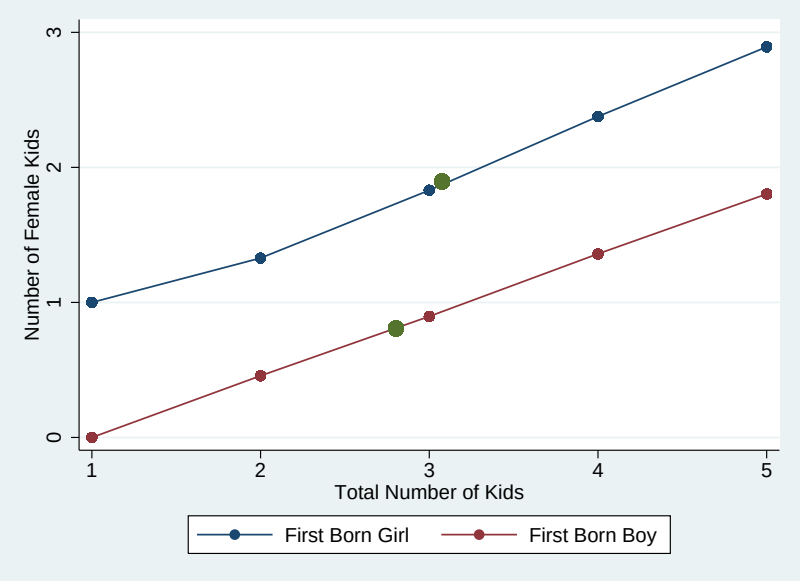

Figure 1: Sibling size and Gender composition by Gender of first born child

Notes: This Figure plots the association between Total Number of Kids and Number of Female Kids in a household, separated by the gender of first born child. The sample here is the Main Analysis Sample for Urban areas. The Green dots represent the interaction point of means from both axis.

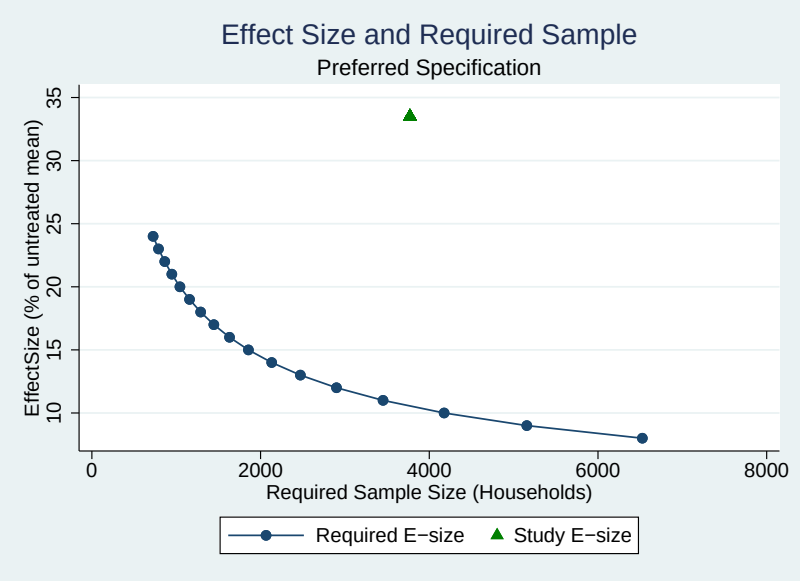

Figure 2: Retrospective Power Calculation - I

Notes: This Figure shows the result of retrospective power calculations on the sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6). The preferred specification of equation (3) is used for estimation. The combination of study effect size and estimation sample (green triangle) being above and/or in region right of blue curve (representing various other possible combinations) represents sufficient power to detect the observed effect size.

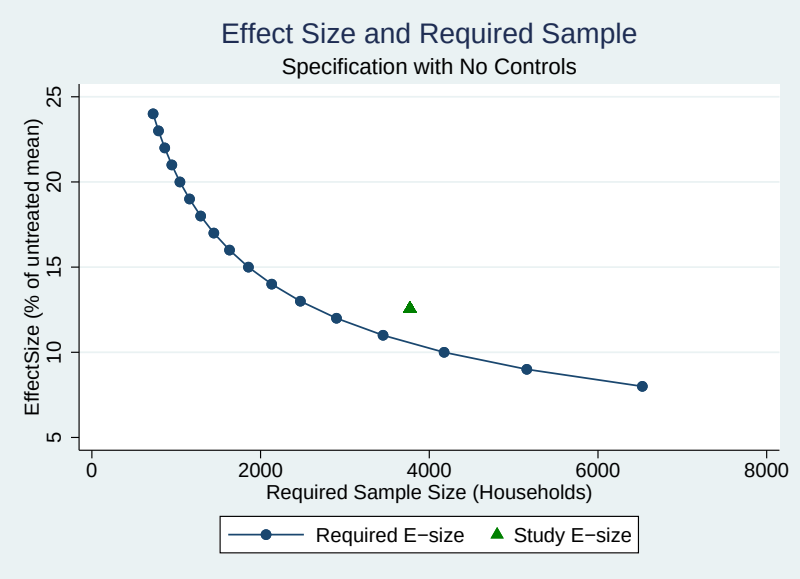

Figure 3: Retrospective Power Calculation - II

This Figure shows the result of retrospective power calculations on the sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6). The specification of equation (3) with no controls is used for estimation. The combination of study effect size and estimation sample (green triangle) being above and/or in region right of blue curve (representing various other possible combinations) represents sufficient power to detect the observed effect size.

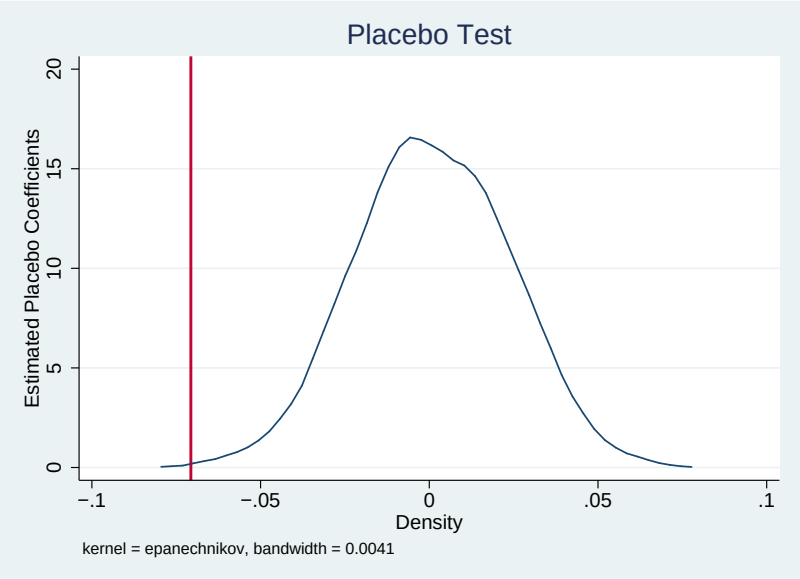

Figure 4: Placebo Test

This Figure plots the results of placebo exercise. The coefficients resulting from 3000 regressions similar to equation (4) with random treatment assignment are plotted along with the original coefficient (in red). Sample here is the Main Analysis Sample for urban households in 2nd decile of asset index.

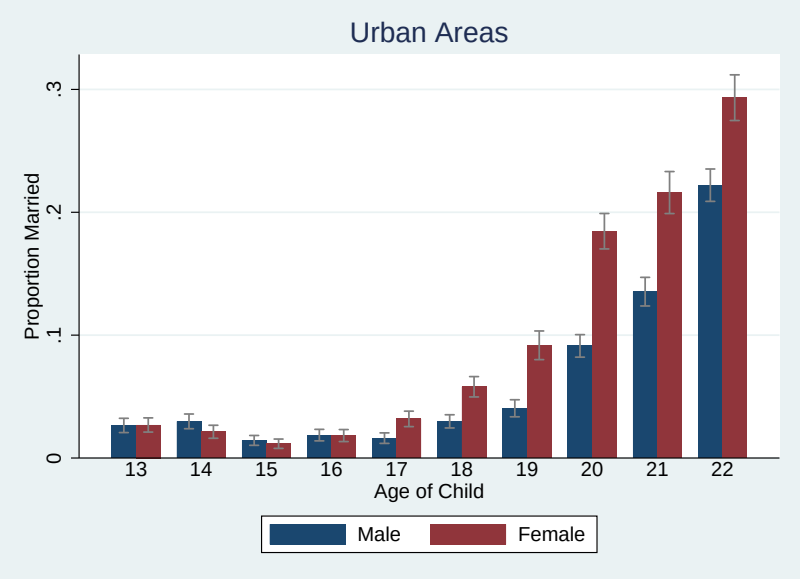

Figure 5: Marriage Age of first born children (Urban Areas)

Notes: This figure shows the age of first born child on x-axis and the proportion of them who are married on y-axis, using the *main analysis sample* for urban areas. The plots are separated by gender of the first born child and bars representing means include the associated confidence intervals.

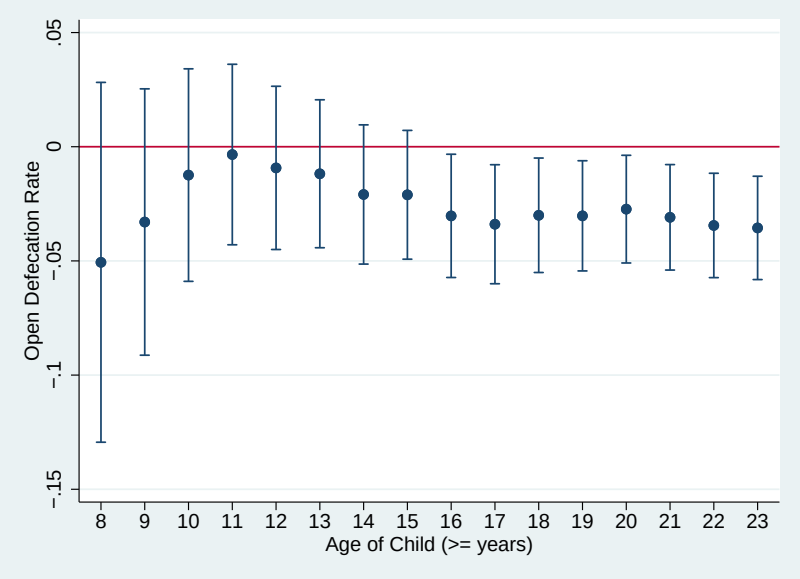

Figure 6: Reduction in OD and gender of first born - *by age*

This figure shows the coefficient from estimating the equation (3) on urban households in 2nd decile of asset index of main analysis sample on groups of age of first born child (ranging from 8-23 year old). Preferred specification with richest set of controls is used. Standard errors are clustered at level of PSU.

Appendix B: Tables and Figures

Table 16: Summary Stats: NFHS 2014-15

Outcome	Rural	Urban
Total population	72%	28%
Number of HH members	5.8	5.6
Number of Children	2.9	2.4
Mother's Age	36	35
Father's Age	47	46
First Born Gender: *Female*	43.4%	43.1%
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 variables related to the entire NFHS 2014-15 data.

Table 17: Robustness to Controls: *Urban HH's in 2nd Wealth Decile*

Outcome: OD	(1)	(2)	(3)	(4)
First Born Gender	-0.0302**	-0.0319**	-0.0391***	-0.073**
(Female = 1)	(0.0142)	(0.0131)	(0.013)	(0.0311)
Mean OD Rate	0.219	0.219	0.219	0.219
HH Controls		X	X	X
District FE			X	X
Caste FE			X	X
YOB FE			X	X
District*Caste FE				X
YOB*Caste FE				X
District*YOB FE				X
P-Value	0.035	0.015	0.004	0.012
Observations	3371	3371	3371	3371

* $p < 0.01$ ** $p < 0.05$, *** $p < 0.01$ **** $p < 0.001$

Notes: This table reports the estimates of equation (3) on sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6). Starting from Column 1 with no controls, it ends with Column 4 which is the preferred specification with the richest set of controls. Outcome of interest is Open Defecation (OD). Standard errors in parenthesis. Standard errors are clustered at PSU.

Table 18: Revisiting Testable Predictions

		No Female Children (T = 0)	
		0	1
Female Children (T = 1)	0	Never a Toilet **(Rural HHs &) Poorest urban HHs)**	Defiers
	1	Compliers **(Poorer Urban HHs)**	Always a Toilet **(Richer Urban HHs)**

Notes: This Table represents the version of Table **??** above with tested empirical evidence. Decision to adopt a toilet or not is represented in Second Row and Second Column by 0 and 1. It is 1 if households adopts a toilet and 0 otherwise. Treatment is the presence of female children in a household and is represented by $T = 1$ for treated and $T = 0$ for control....

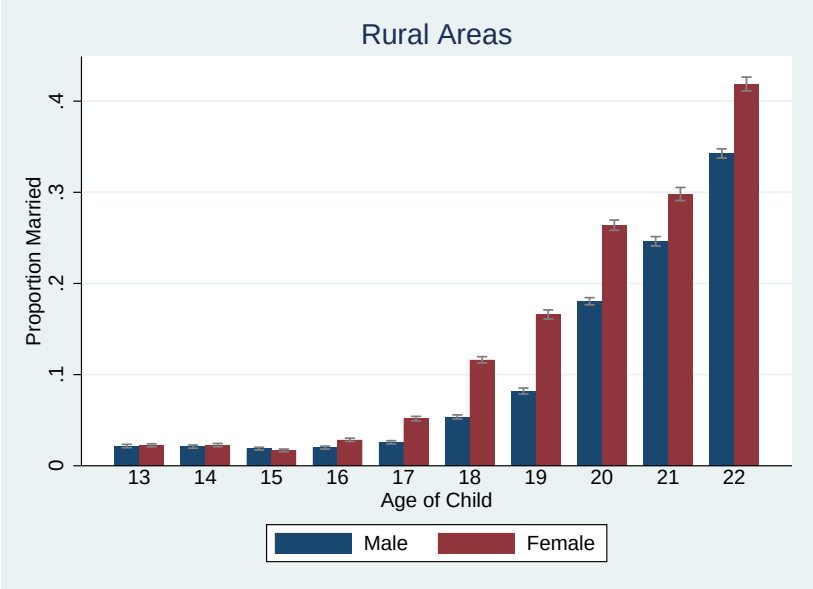

Figure 7: Marriage Age of first born children (Rural Areas)

Notes: This figure shows the age of first born child on x-axis and the proportion of them who are married on y-axis, using the *main analysis sample* for rural areas. The plots are separated by gender of the first born child and bars representing means include the associated confidence intervals.

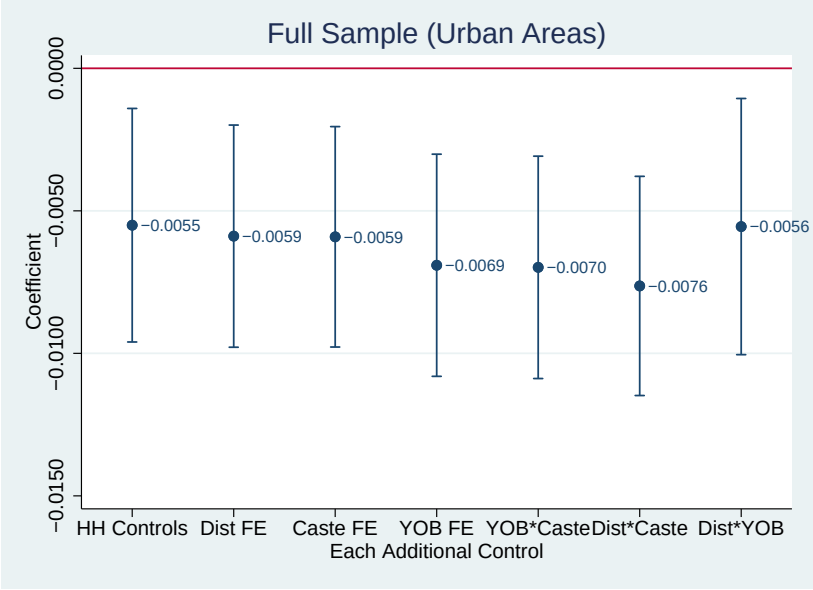

Figure 8: Coefficient Stability - *Full Sample (Urban)*

Notes: This figure shows the movements in coefficients as each additional fixed effect and their interactions are included (starting from including household controls) in estimating the equation (3) on the full *main analysis sample* for urban areas (sample in Column 1-4 of Table 3).

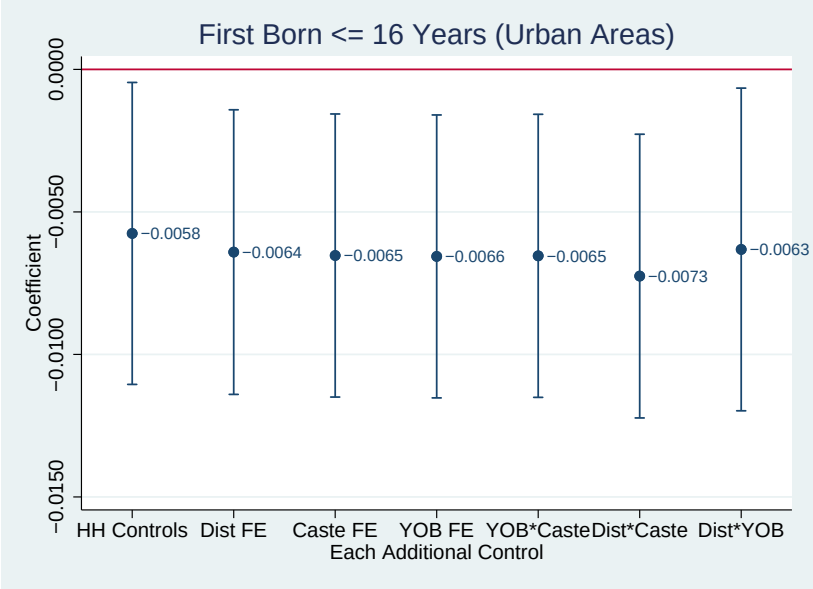

Figure 9: Coefficient Stability - *Age Restricted Sample (Urban)*

Notes: This figure shows the movements in coefficients as each additional fixed effect and their interactions are included (starting from including household controls) in estimating the equation (3) on the age restricted *main analysis sample* for urban areas (sample in Column 4-8 of Table 3).

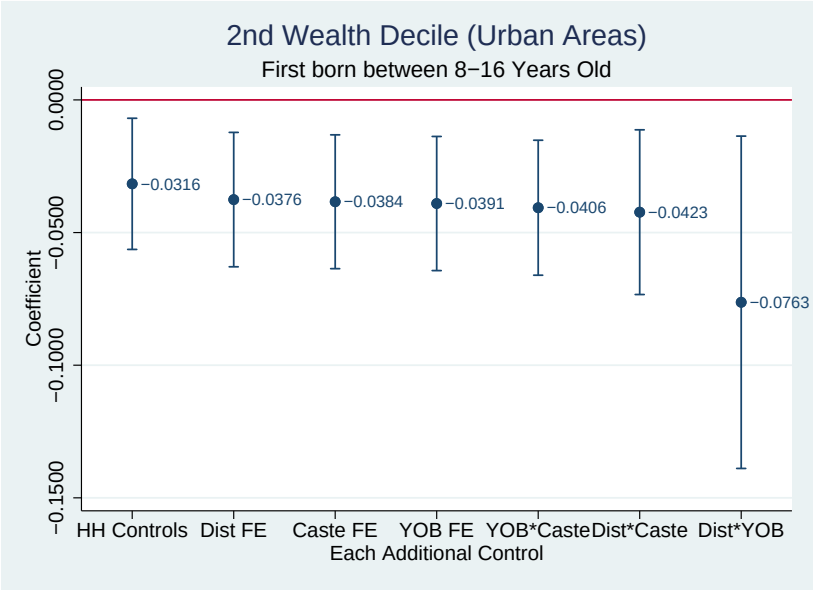

Figure 10: Coefficient Stability - *2nd Decile of Asset Index (Urban)*

Notes: This figure shows the movements in coefficients as each additional fixed effect and their interactions are included (starting from including household controls) in estimating the equation (3) on sample of urban households in 2nd decile of the asset index (Column 2 in Panel A of Table 6).