

# Women Inheritance Rights and Household Sanitation

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## Abstract

*Given that women benefit from toilets in households more than men, this paper seeks to estimate the impact of increased inheritance rights of women on the presence of a toilet in the household. We exploit the amendment to the Hindu Succession Act (HSA) as a source of exogenous variation to the female inheritance rights and their bargaining power. Daughters being usually married away to the households of the groom,- available data do not have all original household characteristics, which leads to eligibility of treatment not being perfectly observed to the researcher. Under very generic assumptions, we show that in presence of treatment being partially observed, one can derive lower bounds on the average treatment effect in a difference in differences framework. Our results suggest that the HSA increased the probability of the presence of a toilet in the household a woman is married into, by atleast 3.5% points. We derive the asymptotic distribution of the true average treatment effect, and show that with data on the unobservable eligibility condition from another dataset, how the true average treatment effect can be estimated. We also uncover heterogeneous treatment effects by the sex of the first born child, which is an important determinant of bargaining power of women in the household.*

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# 1 Introduction

Open defecation is a menacing problem in the developing countries, and it is mostly pronounced in India. Out of the 950 million people world-wide who practice open-defecation around 569 million of them live in India.<sup>1</sup> The result of open-defecation are diseases like diarrhea and stunting among many others. Each year 117,000 children under the age of 5 succumb to diarrhea. In 2016, 39% of children in India under the age of 5 were stunted. The use of toilets in India has not been prevalent primarily because of notions of religious purity and casteism, along with lack of knowledge. Over-crowding and poor usage of public latrines has not helped the cause either. Given these harmful consequences of open-defecation, an interesting observation is that a presence of a toilet in a household, disproportionately benefit women more than men. Women are often victims of sexual harassment when they go out in the open to defecate, urinate or attend to their menstrual hygiene. Women avoid eating and drinking during the day in order to avoid the need to urinate or defecate as this often requires travelling to faraway places in the company of someone. This is likely to affect their health and well being while also affecting their overall productivity. Thus, it is not hard to imagine that women derive greater benefits relative to men from the presence of a toilet. Coffey et al. (2014) argue that women and young girls, who appear to have the highest demand for toilet use are typically not the primary decision makers within their households and this is likely to be an important constraint on the demand for toilets in rural India as the people who are most likely to benefit from the presence of a toilet are the least likely to have the intra-household resources to build one.

A growing literature offers evidence that household outcomes are a result of the distribution of bargaining power within a household. While various outcomes for women like education and dowries as a result of the property rights amendments in India have been analysed, studying its impact on the presence of a toilet in the household, given the above motivation

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<sup>1</sup>See

<https://www.nationalgeographic.com/magazine/2017/08/toilet-defecate-outdoors-stunting-sanitation/>

is a particularly intriguing question. Our paper contributes to this literature and seeks to analyse the impact of increased inheritance rights for women on the presence of a toilet in the household. We use the amendment to the Hindu Succession Act as a source of exogenous variation in female inheritance rights which equalized property inheritance rights of daughters' to that of sons' and subsequently increased their bargaining power to estimate the causal impact of this policy on presence of a toilet in the household.

There is substantive evidence which suggests that household outcomes, to a large extent, depend on who in the household owns the assets and resources generating income. In India, majority of the household property is in the form of land. Land not only serves as a source of livelihood but also as a source of old age support and status (Agarwal, 1994). With the amendment to the property inheritance law, any resulting increase in women's access to land and other assets must have increased their intra-household status and bargaining power. This in turn might have resulted in positive socioeconomic outcomes specific to women. An important point to note here is that while daughters are legally entitled to inherit an equal share of household property as sons, a common concern is whether the law is being abided by or not. A law may not be abided by perfectly because of many reasons like lack of awareness or lack of punitive deterrence. Roy (2015) finds that parents circumvented the law by "gifting" their shares of land to sons (this was made possible due to the intestate nature of inheritance) but at the same time compensated the daughters by giving them alternative transfers in the form of either higher dowries or higher education. For the purpose of our question, even if the amendment failed to bequest the daughters with their rightful shares in the household property, even an increment in their dowries or years of education would have increased their bargaining power.

A challenge in estimating the causal impact of the Hindu Succession Act amendment on the presence of a toilet is to surpass the potential endogeneity problem. Any unobserved heterogeneity at the household level, correlated with property rights, could also be correlated with the outcome of interest, i.e. presence of a toilet in the household and this may

generate spurious results. To address this problem, we use the amendment to the Hindu Succession Act as a source of exogenous variation in female inheritance rights.

Roy (2015) also exploits the amendment to the Hindu Succession Act as a source of exogenous variation in female inheritance rights to study the impact on dowry payments and educational outcomes for women. She finds that there was a significant increase in the years of schooling for young girls of school going age and dowry payments increased for girls nearing marriageable age. She uses data obtained from Rural Economic Demographic Survey (REDS) which has retrospective information on all the members of a household, including daughters who have married and left the household. An advantage of using this dataset is that it has information on the timing of the death of the grandfather of daughters which is then used as a proxy for the timing of the division of the household's joint ancestral property <sup>2</sup>. For the purpose of our question, this dataset would not be of use as we require information on the outcome for women in their marital families rather than their birth families.

We find that the amendment to the Hindu Succession Act significantly increased the likelihood of the households to have a toilet. In particular, we find that following the amendment, the women who were eligible under the amendment were 4.5% more likely to have a toilet in their marital families relative to comparable women who were not eligible. The results indicate that following their access to equal property inheritance rights as sons, daughters are more likely, in their marital household, to invest resources in acquiring goods that they directly benefit from (such as the presence of a toilet). However, results of heterogeneous treatment effects by the sex of the first born child of women reveal that, households with a boy as the first born child are more likely to have a toilet relative to households with a first born girl child. This, on the other hand, suggests that it is not merely their access to property inheritance rights that is instrumental in shaping their decision making power. Indian households, especially in rural areas, tend

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<sup>2</sup>One of the eligibility condition for a woman to be eligible under the amended HSA was that her household's joint ancestral property should have been undivided at the time of the amendment in her state

to have a strong preference for sons over daughters. This in turn has a direct bearing on the status and bargaining power of the mother. Our results suggest that the impact of the amendment had a more pronounced effect on those households where women gave birth to a boy relative to those households where women had given birth to a girl.

The rest of the paper is organized as follows: Section 2 provides an overview of the related literature. Section 3 describes the institutional background of the Hindu inheritance law in India and the various sanitation campaigns that have been implemented so far. Section 4 outlines the data followed by Section 5 which outlines the empirical strategy and model. Section 6 presents results and robustness checks and Section 7 concludes.

## 2 Literature Review

This paper relates to several strands of literature: research on intra-household allocation of resources and bargaining power, work on inheritance rights and the Hindu Succession Act amendments, research on parental preference for sons and studies on sanitation and open defecation in India.

There are two broad approaches to study intra-household allocation of resources and bargaining power. The traditional approach models households behaving in accordance with the *unitary* model which assumes that all members of a household have similar preferences and the household acts as a single decision unit to maximize a common household utility function which in turn yields household outcomes. Household resources are pooled and then reallocated according to some common rule. However, there is mounting empirical evidence that unitary models do not hold in practice. For example, many studies have rejected the “income pooling” property of the unitary model. Thomas (1990), through a survey data on family health and nutrition in Brazil, finds that income in the hands of the mother has greater effects on the health of the family than income under the hands of the father. He further finds that mothers prefer to invest resources

in the health and well-being of daughters whereas fathers prefer to invest in sons. Both his findings are in direct contrast with the unitary model under which the effect on these outcomes should be the same regardless of who controls the household resources. As a result, following Chiappori (1988), Chiappori (1992) and Browning and Chiappori (1998), some alternative models have been proposed under the *collective* approach which explicitly models intra-household allocation within a bargaining framework, as a Pareto efficient outcome. The household is assumed to have a welfare function which is a weighted sum of the individuals' private utility functions. Thus, household behaviour is analysed taking into account the heterogeneity in preferences of members of a household. According to the collective models, the distribution of household resources is an outcome of cooperative or non-cooperative Nash bargained equilibrium and the welfare of household members depends on the distribution of bargaining power. Unlike the traditional unitary models, household members have an incentive not to pool income and allocate resources towards goods that they care about.

There is a huge body of work that talks about how socioeconomic outcomes vary when ownership of assets shifts from men to women. Studies have shown that systematic differences in socioeconomic outcomes can result due to systematic differences between the preferences of males and females. Duflo (2003) evaluates the impact of the South African old-age pension program on child nutrition. She compares the impact of the pension program by the gender of the recipient and finds that girls' anthropometric status improves when pensions were given to women whereas no such effects were seen for pensions received by men. Thomas (1990) finds that children do better if their mothers control a larger fraction of household resources. Women devote higher proportions of their income to family needs than do men (Strauss et al., 2000). In China, higher female incomes following the agricultural reforms increased the survival rates for girls (Qian, 2008). Rosenzweig and Schultz (1982) show that survival probabilities of female infants in India are higher in areas where opportunities for female employment are greater.

However, women's contribution into the household budget may not be the only factor

in influencing her decision making power within the household. A woman's right to inherit land and other property is often claimed to be a significant determinant of her economic security and position in the family (Bank, 2014). Property inheritance rights for women can substantially elevate their intra-household status and positively affect their decision-making power. Moreover, in rural societies, a large fraction of households' endowment of physical capital is in the form of land, a key asset that serves not only as a source of livelihood but also a source of old-age support and status (Agarwal, 1994). Agarwal and Panda (2007) find evidence of lower domestic violence against women who have access to immovable property like land than comparable women with no such assets. They show that women who own property have a stronger fall-back position outside marriage and command greater bargaining power within their household than comparable women who do not own any property. Using HSA as a natural experiment, Roy (2008) finds evidence that endowing women with inheritance rights equal with men increased their autonomy/say within their marital families. Tisdell and Roy (2002) argue that granting property rights to women increases their investment incentive and boosts productivity of the land, leading to a positive effect on their earnings and say in the family. Heath and Tan (2014) using HSA as a source of exogenous variation in women's unearned income found that the exposure to HSA raised women's autonomy and labor supply into high paying jobs. Calvi (2016), using amendments to HSA as a natural experiment, finds that improvements in women's bargaining power within the household lead to better health outcomes. She further demonstrates that policies aimed at promoting intra-household equality, such as improving women's rights to inherit property can have a large impact on reducing female poverty and mortality.

There exists substantive research on the issues and concerns surrounding the practice of open defecation. In rural India, a majority of people defecate in the open as they lack access to household sanitation. While everyone deserves the privacy, health benefits, and dignity of a safe toilet, this is especially true of women who are most vulnerable to the effects of poor sanitation. Aid Water (2013) describe how poor sanitation is largely a

women’s issue partly as a result of women’s biology, given that women menstruate for a large part of their lives and partly as a result of their frequently subordinate position in society which can mean that they are at a higher risk of violence. Recent empirical evidence from India supports these facts. Jadhav (2016), using data from National Family Health Survey-III, find that women who practice open defecation are twice as likely to fall victim to acts of sexual violence than women with a household toilet. This effect is twice the effect of open defecation on child diarrhea. For women, private toilets provide a sense of dignity and personal security. However, a recent survey has pointed out contrasting evidence with regards to sanitation preferences of people. Coffey et al. (2014) point out that people display a “revealed preference” for open defecation. They present evidence from a survey conducted in Bihar, Haryana, Madhya Pradesh, Rajasthan and Uttar Pradesh which suggests that over 40 percent of households with a working toilet have at least one member who defecates in the open. In such households, however, across all age groups men are more likely to defecate in the open than women. The respondents in the survey are asked their preferences regarding toilet use and for most of them defecating in the open gives them an opportunity to take a morning walk, see their fields and take fresh air. Additionally, the respondents do not cite open defecation as a threat to health. The authors conclude by saying that toilet construction is not enough to substantially reduce open defecation and that there is a need of large-scale campaigns to change sanitation preferences of people and promote toilet use. While this may be true, the argument that women derive greater benefits from the presence of private toilets stands undisputed.

### **3 Institutional Details**

#### **3.1 The Hindu Succession Act of 1956 (HSA)**

Inheritance rights in India vary by religion. There are two major legal doctrines regarding Hindu inheritance namely the *Mitakshara* and *Dayabhaga* schools. The Hindu Succession



law of 1956 governs the property rights of Hindus, Sikhs, Buddhists and Jains following the *Mitakshara* system. The *Mitakshara* system distinguishes individual property from joint ancestral property which includes land (Agarwal, 1994). Joint household property was any property that was accumulated by the patriarch of the family and jointly held by the members of the house. Separate property was accumulated separately by the father. Following the act, daughters of a Hindu male dying intestate were equal inheritors, along with sons, only of their father's separate property but had no share in the joint property. Rights to the joint property were limited to the *coparceners* that only constituted male members of a family. Thus, under the original HSA, women were only entitled to inherit their share in the property of their father whereas men in addition to the father's property were *coparceners* or joint heirs in the joint household property by birth. Since joint property takes the form of land that is typically family owned, women were at a disadvantage under the inheritance rules and HSA was by no means a gender neutral law.

### 3.2 State Amendments to Hindu Succession Act (HSAA)

Over time, some south Indian states have enacted legislation to amend the law at state level. Kerala in 1976, Andhra Pradesh in 1986, Tamil Nadu in 1989 followed by Karnataka and Maharashtra in 1994 were the five states that took measures to redress the gender-inequality inherent in HSA. Daughters were granted equal inheritance rights as sons in the family property but conditional on daughters satisfying some eligibility criteria<sup>3</sup>. In 2005, all the eligibility criteria were removed and the amendment was implemented at the national level granting equal claims to daughters by birth as sons, to the joint household property.

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<sup>3</sup>The following conditions needed to be satisfied by a woman to be eligible under the HSAA-

1. One had to belong to one of the five reform states
2. One had to be unmarried at the time when the amendment was passed in her state
3. One had to be a Hindu, Jain, Sikh or Buddhist
4. The household property of the woman's house must have been undivided at the time of the passing of the amendment in her state

### 3.3 Total Sanitation Campaign(*Swachh Bharat Abhiyan*)

The Government of India launched the Total Sanitation Campaign in India in the year 1999 with the objective of accelerating sanitation coverage in the country. The campaign was renamed Nirmal Bharat Abhiyan in 2012 and is presently called Swachh Bharat Abhiyan. Many states have since been declared open defecation free. While advances have been witnessed in the construction of sanitation infrastructure with operations being scaled and higher funds going into the program, more efforts need to be put to alter the sanitation preferences of people. The religious and cultural beliefs surrounding sanitation preferences have largely occluded India's attempts to be open defecation free.

## 4 Data

We use the 2005 wave of Indian Human Development Survey (IHDS) conducted by National Council for Applied Economic Research. The IHDS is a nationally representative survey of 41,554 households and 215,753 individuals. we use household level data along with data from the section on Eligible Women. our total sample consists of 27,792 households. For the purpose of our analysis, we consider the wife of the household head for every household. we estimate the effect of her intra-household bargaining power on the presence of a toilet in her marital household.

Descriptive statistics of key variables are given in Table 1. The mean age of women in our sample is 38 years. The year of marriage for women in our sample varies from 1933 to 2005. The Hindu Succession Act was amended at national level in 2005 hence we drop all the women who got married in 2005. Among the women belonging to the reform states, 48 percent of the women got married after the reform was passed in their state. The average years of education of the women in the reform states is 4.4 years while it is 3.3 years for women in the non-reform states.

## 5 Empirical Strategy

### 5.1 Empirical Strategy

We use a triple difference framework in order to estimate the causal effect of HSA on the presence of a toilet in a household. As discussed earlier, one of the eligibility criterion under the amendment was that the woman's maternal household property should have been undivided at the time when the amendment was passed in her state. However, our dataset does not have information on this condition. Roy (2015) studies the impact of the HSAA on education and dowries for daughters, but these are pre-marriage outcomes and her dataset (REDS) has retrospective information on all the members of the household including daughters who have married and left the household (REDS does not have post-marriage data for daughters who have left the household and hence it is not useful for the purpose of our analysis). She uses data on the timing of a daughter's grandfather's death as indicative of whether the household property was undivided at the time of amendment in her state. This is because in Indian households, property typically gets divided when the patriarch of the family dies. I, however, do not observe this as surveys do not ask this question for the married women of the household. If one could observe this in data, the causal effect of HSA on the outcome of interest could have been estimated using standard triple difference framework. However, in our model, the treatment group is mis-measured following which some individuals from the control group fall in the treatment group. This mis-measurement would lead to a bias in the estimated average treatment effect. In spite of this, we can find a way of estimating the direction and magnitude of the bias. In the following proposition we derive bounds on the true parameter, when the treatment group is mis-measured.

$Toilet_i$  is an indicator variable which takes the value 1 if household  $i$  has access to a private toilet and 0 otherwise.  $State_i$  is an indicator variable taking the value 1 if

woman  $i$  of a reform state  $s$  was unmarried in year  $t$  when state  $s$  amended HSA.  $Prop_i$  is an indicator variable which takes the value 1 if for woman  $i$ , if household property was divided at the time the reform was implemented in her state.  $Rel_i$  is an indicator variable taking value 1 if woman  $i$  belongs to one of the following religions- Hinduism, Sikhism, Jainism, Buddhism and takes the value 0 otherwise. Thus,  $State_i$ ,  $Prop_i$  and  $Rel_i$  together determine whether a woman was eligible under amendment to HSA.

**Proposition 1.** *Suppose the true model is given by,*

$$\begin{aligned} Toilet_{is} = & \beta_0 + \alpha State_i Marr_{is} Rel_i Prop_i + \delta_1 State_i + \delta_2 Rel_i + \delta_3 Marr_{is} + \delta_4 Prop_i \\ & + \beta_1 State_i Marr_{is} Prop_i + \beta_2 State_i Rel_i Prop_i + \beta_3 Marr_{is} Rel_i Prop_i \\ & + \gamma_1 State_i . Rel_i + \gamma_2 Marr_{is} . Rel_i + \gamma_3 Prop_i . Marr_{is} + \gamma_4 Prop_i . State_i \\ & + \gamma_5 Prop_i . Rel + \gamma_6 State_i . Marr_{is} + X'_{is} \gamma + \mathbb{F} + \varepsilon_{is} \end{aligned}$$

where,  $\alpha$  captures the true average treatment effect.

Suppose the econometrician does not observe the event  $Prop_i \in \{0, 1\}$  and estimates the following model-

$$\begin{aligned} Toilet_{is} = & \tilde{\beta}_0 + \tilde{\alpha} State_i . Marr_{is} . Rel_i + \tilde{\delta}_1 State_i + \tilde{\delta}_2 Rel_i + \tilde{\delta}_3 Marr_{is} + \\ & \tilde{\beta}_1 State_i . Marr_{is} + \tilde{\beta}_2 Marr_{is} . Rel_i + \tilde{\beta}_3 State_i . Rel_i + X'_{is} \gamma + \mathbb{F} + \varepsilon_{is} \end{aligned}$$

Then  $\tilde{\alpha} = \mathbb{E}(Prop_i) \alpha$ .

Also  $[\tilde{\beta}_1 \sim \mathcal{N}(\mu, \sigma^2)] \Rightarrow [\sqrt{n}(\hat{\beta}_1 - \frac{\mu}{\mathbb{E}(Prop_i)}) \xrightarrow{d} \mathcal{N}(0, \frac{\sigma^2}{\mathbb{E}(Prop_i)^2})]$

*Proof.* See Appendix □

## 5.2 Empirical Model

Given the above proposition, we estimate the following model-

$$\begin{aligned} Toilet_{is} = & \tilde{\beta}_0 + \tilde{\alpha} State_i.Marr_{is}.Rel_i + \tilde{\delta}_1 State_i + \tilde{\delta}_2 Rel_i + \tilde{\delta}_3 Marr_{is} + \\ & \tilde{\beta}_1 State_i.Marr_{is} + \tilde{\beta}_2 Marr_{is}.Rel_i + \tilde{\beta}_3 State_i.Rel_i + X'_{is}\gamma + \mathbb{F} + \varepsilon_{is} \end{aligned}$$

$X_{is}$  is the vector of control variables for woman  $i$  belonging to state  $s$ .  $\mathbb{F}$  is the vector of state and religion-caste fixed effects.

Since  $\mathbb{E}(Prop_i) \equiv Pr(Prop_i = 1)$ , this implies  $\tilde{\alpha} \leq \alpha$ , as long as  $Pr(Prop_i = 1)$  is non-zero. Thus,  $\tilde{\alpha}$  is a lower bound of  $\alpha$ , the true parameter and is of the same sign as  $\tilde{\beta}_1$ . To estimate the true model parameter, one needs to estimate  $\mathbb{E}(Prop_i)$ . Given that,  $\alpha = \frac{\tilde{\alpha}}{\mathbb{E}(Prop_i)}$  can be estimated. Observe that the second part of the proposition speaks of inference on the true parameter of interest. This is derived using the Delta method.

## 5.3 Additional Concerns

We do not have data on women who have changed their religion, post-marriage. Failing to take this into account could result in biased estimates as religion is one of the criteria determining whether a woman benefitted under the amendment. However, this is not much of a concern as inter-religious marriages are a rare occurrence in India.<sup>4 5</sup> Furthermore, the occurrence of inter-caste marriages within a religion is rare.<sup>6</sup> Thus, not being able to observe the above events is unlikely to change the results statistically.

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<sup>4</sup>Roy (2015) in her analyses of the effect of HSA on education of women, finds only 3% of marriages to be inter-religious.

<sup>5</sup>Das et al. (2011) provides evidence that only about 2.1% marriages in India are inter-religious. Social stigma is one of the biggest hindrances.

<sup>6</sup>Banerjee et al. (2013) shows evidence of strong preference of marrying within the caste, to the extent that individuals are willing to trade off qualities like having a masters degree and no education.

## 6 Results

In all our estimations, we have included state, religion and caste fixed effects. These fixed effects are important to consider because preferences towards sanitation and health vary across religions and caste, not only because they are correlated with income, but also because of cultural norms (Borooah, 2010). Table 2 shows the estimates for different sets of control variables. The first column shows the estimates corresponding to the model with only fixed effects and no explanatory variables. we find that there is a statistically significant effect of HSA on the presence of a toilet and that treated women are 8.3% points more likely to have a toilet in the household relative to comparable women who did not receive the treatment. Adding demographic characteristics (log of income, education of the woman, highest level of education in the household, dummy for urban residence, number of teenaged girls, number of adult women, number of senior citizens) as controls, the coefficient of interest changes to 3.7% points. Next, along with this when we add controls for exposure to media (listening to radio, watching television, reading the newspaper)<sup>7</sup>, we find that the results are robust, yielding a statistically significant estimate of an increase in the probability of there being a toilet by 3.4% points.

### 6.1 Heterogeneous Effects

We show heterogeneous treatment effects, by the sex of the first born child in Table ??.

It has been widely documented (Kishore and Spears (2012), Sen (2003), Arnold et al. (1998)) that the sex of the first born child plays an important role in the social and household status of a woman. In other words, it affects the intra-household bargaining power of women. we estimate the triple difference model incorporating a dummy variable for the sex of the first born child of the woman. we drop those households where the

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<sup>7</sup>Media over many years has been effective in increasing the awareness towards health in India. Stopnitzky (2017) evaluate the impact of a sanitation campaign “No Toilet, No Bride” (initiated in Haryana in 2005) on latrine adoption. This campaign was widely promoted through various social media platforms and the results indicate that private sanitation coverage in Haryana increased by 21%. Also see Goolsbee and Petrin (2004)

woman had twins of different genders as her first borns. However, from our results, there is no indication of sex of the first born child affecting the intra-household status of the mother. This goes on to say that although parental preference for sons in rural India is quite pervasive, this does not reflect in our results. The first column shows that households with a first born boy are 11.6% points more likely to have a toilet relative to comparable households however, the estimate is insignificant. As can be seen in the table, the estimate remains insignificant even as religion, caste fixed effects and social media controls are added to the model. Hence, we can not conclude any link between the sex of the first born child determining the intra-household status of the mother.

## 6.2 Placebo Tests

Since we do not have a standard difference-in-difference-in-differences framework, with many years of data before and after the policy, standard ways in which placebo tests are conducted will not be useful for this analysis. However observe that, the time dimension can be brought in from the year of marriage of the woman in question.

We drop all those women married after 1976, so no treated women are in this sub-sample. we randomly select a year of marriage before 1976 as a pseudo year of placebo policy implementation. In Table 4, we show the results where we take year 1956 as a psuedo policy implementation year. The results show no statistically significant effect of the policy, after adding demographic, media exposure and fixed effects as controls. This is also robust to using other years as the pseudo implementation year.

## 7 Work Ahead

We plan to incorporate Athey and Imbens (2006) in our framework. Athey and Imbens (2006), with both continuous and discrete outcomes, generalize the standard difference in

differences framework to estimate the entire counterfactual distribution of the outcomes of the treatment group in absence of treatment and that of the control group in presence of treatment and shows the model to be identified non-parametrically. Our next goal is to incorporate Athey and Imbens (2006) in our framework where treatment group is not perfectly observed and see if non-parametric identification can be achieved. Apart from doing some robustness checks of clustering the standard errors at the district level , we are primarily interested in documenting heterogeneity of impact of increased inheritance rights within women in households over observable characteristics of women (education, labor force participation, wages etc.) [DDDD-estimation]. These provide mechanisms of how having inheritance rights for women increase their bargaining power, which in turn affect in households having more toilets. We will also extend the model, to include proportions of women exposed to HSA in the household and not just wife of the household head.

## 8 Conclusion

Kofi Annan, on the sixtieth anniversary of the Commission on the Status of Women at United Nations Headquarters remarked <sup>8</sup>

*“...there is no tool for development more effective  
than the empowerment of women and girls” .*

Our paper, estimates a positive and significant impact of inheritance rights on the presence of a toilet in the household. This is a key result, which in the context of women having very little say in household decisions, goes to show how policies aimed at improving the status of women can in turn positively impact their socioeconomic outcomes. The link between sanitation and women’s status is particularly interesting to examine as women disproportionately benefit from having access to private toilets relative to men and also on the other hand have very little bargaining power in the

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<sup>8</sup>See <https://www.un.org/press/en/2006/wom1586.doc.htm>



household. We use the amendment to Hindu Succession Act as an exogenous variation to the female inheritance rights. We use a triple differences framework to estimate the impact of the reform, where the treatment group constitutes the women who satisfied the eligibility criteria under the reform. However, one of the eligibility conditions is not observed in the data which causes the treatment group to be not perfectly observable. With minimal assumptions, we derive lower bounds on the true parameter estimate in a difference in differences framework. This can be generalized to a  $n$ -difference framework, with one eligibility criterion being unobserved. We find that following the amendment, women who were eligible under the amendment were more likely to have a toilet in their marital families relative to comparable women who were not eligible. This can also be interpreted as the reform being successful in increasing the intra-household bargaining power of women in their marital household and this further enabled women to take decisions from which they directly benefited (such as access to a private toilet in the house).

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## 9 Appendix

### 9.1 Proof of Proposition 1

*Proof.* For the sake of brevity, we write  $Toilet_i$ ,  $State_i$ ,  $Rel_i$ ,  $Marr_i$  and  $Prop_i$  as  $T_i$ ,  $s_i$ ,  $r_i$ ,  $m_i$  and  $p_i$  respectively.

The true model is:

$$T_i = \beta_0 + \alpha smrp + \delta_1 s + \delta_2 r + \delta_3 m + \delta_4 p + \beta_1 smp + \beta_2 srp + \beta_3 mrp + \gamma_1 sr + \gamma_2 mr + \gamma_3 pm + \gamma_4 ps + \gamma_5 pr + \gamma_6 sm + X'_{is}\gamma + \mathbb{F} + \varepsilon_{is}$$

The estimated model is:

$$T_i = \tilde{\beta}_0 + \tilde{\alpha} smr + \tilde{\delta}_1 s + \tilde{\delta}_2 r + \tilde{\delta}_3 m + \tilde{\beta}_1 sm + \tilde{\beta}_2 mr + \tilde{\beta}_3 sr + X'_{is}\gamma + \mathbb{F} + \varepsilon_{is} \quad (1)$$

From the estimated model we can write,

$$\begin{aligned} \tilde{\alpha} = & [\mathbb{E}(T_i|s=1, r=1, m=1) - \mathbb{E}(T_i|s=1, r=0, m=1)] - \\ & [\mathbb{E}(T_i|s=0, r=1, m=1) - \mathbb{E}(T_i|s=0, r=0, m=1)] - \\ & [\mathbb{E}(T_i|s=1, r=1, m=0) - \mathbb{E}(T_i|s=1, r=0, m=0)] - \\ & [\mathbb{E}(T_i|s=0, r=0, m=0) - \mathbb{E}(T_i|s=0, r=1, m=0)] \end{aligned}$$

Using Law of Iterated Expectations and assuming that  $p$  is independent of other terms,

we can write:

$$\begin{aligned}
\tilde{\alpha} = & [\mathbb{E}(T_i|s = 1, r = 1, m = 1, p = 0).Prob(p = 0) + \mathbb{E}(T_i|s = 1, r = 1, m = 1, p = 1).Prob(p = 1)] - \\
& [\mathbb{E}(T_i|s = 1, r = 0, m = 1, p = 0).Prob(p = 0) + \mathbb{E}(T_i|s = 1, r = 0, m = 1, p = 1).Prob(p = 1)] - \\
& [\mathbb{E}(T_i|s = 0, r = 1, m = 1, p = 0).Prob(p = 0) + \mathbb{E}(T_i|s = 0, r = 1, m = 1, p = 1).Prob(p = 1)] + \\
& [\mathbb{E}(T_i|s = 0, r = 0, m = 1, p = 0).Prob(p = 0) + \mathbb{E}(T_i|s = 0, r = 0, m = 1, p = 1).Prob(p = 1)] - \\
& [\mathbb{E}(T_i|s = 1, r = 1, m = 0, p = 0).Prob(p = 0) + \mathbb{E}(T_i|s = 1, r = 1, m = 0, p = 1).Prob(p = 1)] + \\
& [\mathbb{E}(T_i|s = 1, r = 0, m = 0, p = 0).Prob(p = 0) + \mathbb{E}(T_i|s = 1, r = 0, m = 0, p = 1).Prob(p = 1)] - \\
& [\mathbb{E}(T_i|s = 0, r = 0, m = 0, p = 0).Prob(p = 0) + \mathbb{E}(T_i|s = 0, r = 0, m = 0, p = 1).Prob(p = 1)] + \\
& [\mathbb{E}(T_i|s = 0, r = 1, m = 0, p = 0).Prob(p = 0) + \mathbb{E}(T_i|s = 0, r = 1, m = 0, p = 1).Prob(p = 1)]
\end{aligned}$$

Now, using the expression of  $T_i$  from the true model to compute the above expectations and simplifying, we get:

$$\tilde{\alpha} = \alpha.Prob(p = 1) \quad (2)$$

□

Now let us derive the asymptotic distribution of the true average treatment effect .

*Proof.*  $\tilde{\alpha} \sim \mathcal{N}(\mu, \sigma^2)$

$$\Rightarrow \sqrt{n}(\hat{\alpha} - \mu) \xrightarrow{d} \mathcal{N}(0, \sigma^2)$$

Using the delta method, we have

$$\sqrt{n}\left(\frac{\hat{\alpha}}{Pr(p=1)} - \frac{\mu}{Pr(p=1)}\right) \xrightarrow{d} \mathcal{N}\left(0, \frac{\sigma^2}{Pr(p=1)}\right)$$

Observe that the function  $g(x) = \frac{x}{Pr(p=1)}$  is continuous and differentiable  $\forall x \in \mathcal{R}$

□

Table 1: Descriptive statistics

Variable	All states	Non-reforming states	Reform states
Age	38.305 (10.954)	38.705 (11.121)	37.472 (10.55)
Log(Income)	10.466 (0.968)	10.474 (0.976)	10.449 (0.949)
Education of Wife (yrs)	3.715 (4.522)	3.341 (4.451)	4.492 (4.569)
Education of Head(yrs)	7.224 (4.985)	7.186 (5.038)	7.301 (4.873)
Urban household	0.358 (0.479)	0.346 (0.476)	0.383 (0.486)
#Teen-aged girls (15-20yrs)	0.715 (0.937)	0.755 (0.966)	0.631 (0.868)
#Adult women (> 21yrs)	1.427 (0.744)	1.437 (0.755)	1.406 (0.718)
#Senior citizens(> 60yrs)	0.342 (0.638)	0.338 (0.643)	0.349 (0.626)
Do men listen to radio	0.495 (0.5)	0.498 (0.5)	0.488 (0.5)
Do men read newspaper	0.525 (0.499)	0.488 (0.5)	0.602 (0.49)
Do men watch TV	0.744 (0.437)	0.708 (0.455)	0.819 (0.385)
Do women listen to radio	0.402 (0.49)	0.39 (0.488)	0.428 (0.495)
Do women read newspaper	0.301 (0.459)	0.262 (0.44)	0.382 (0.486)
Do women watch TV	0.714 (0.452)	0.662 (0.473)	0.819 (0.385)
Observations	27792	18780	9012

Note: Standard errors are in parenthesis

Table 2: Impact of HSA on presence of toilet

VARIABLES	(1) Toilet	(2) Toilet	(3) Toilet
State*Marr*Rel	0.0832*** (0.0293)	0.0372** (0.0154)	0.0344** (0.0144)
Marr*Rel = o,	-	-	-
State*Marr	-0.0517* (0.0296)	-0.0766*** (0.0105)	-0.0638*** (0.0127)
State*Rel	-0.122 (0.0761)	0.0262 (0.0541)	0.0291 (0.0540)
Marr = o,	-	-	-
Rel	-0.0652 (0.0712)	-0.126** (0.0477)	-0.132** (0.0489)
State	-0.151*** (0.0373)	-0.224*** (0.0289)	-0.253*** (0.0283)
Log(Income)		0.0765*** (0.00629)	0.0654*** (0.00579)
Education of Wife (yrs)		0.0179*** (0.00204)	0.0147*** (0.00200)
Education of Head(yrs)		0.0145*** (0.00128)	0.00974*** (0.000860)
Urban household = 1, Urban		0.298*** (0.0255)	0.274*** (0.0213)
#Teen-aged girls (15-20yrs)		0.00733*** (0.00219)	0.00346 (0.00227)
#Adult women (>21yrs)		0.00734* (0.00419)	0.00384 (0.00413)
#Senior citizens(>60yrs)		0.0178*** (0.00513)	0.0177*** (0.00502)
Do men listen to radio = 1			-0.0288** (0.0135)
Do men read newspaper = 1			0.0538*** (0.0177)
Do men watch TV = 1			-0.00800 (0.0118)
Do women listen to radio = 1			0.0219 (0.0152)
Do women read newspaper = 1			0.0609*** (0.0172)
Do women watch TV = 1			0.0894*** (0.0171)
State FE	Yes	Yes	Yes
Religion & Caste FE	No	No	No
Observations	27,639	27,186	26,504
R-squared	0.163	0.436	0.446

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1



Table 3: Heterogeneous Effects: Impact of HSA on presence of toilet

VARIABLES	(1) Toilet	(2) Toilet	(3) Toilet	(4) Toilet
(State*Rel*Marr)*(Boy dummy)	0.116 (0.0762)	0.108 (0.0784)	0.122 (0.0771)	0.111 (0.0781)
State*Rel*Marr	-0.0384 (0.0592)	-0.0345 (0.0591)	-0.0477 (0.0600)	-0.0451 (0.0587)
Rel*Marr*Boy dummy = o,	-	-	-	-
Rel*State*Boy	-0.0624 (0.0416)	-0.0486 (0.0438)	-0.0704 (0.0423)	-0.0560 (0.0432)
State*Marr*Boy	-0.0582 (0.0641)	-0.0540 (0.0657)	-0.0674 (0.0643)	-0.0607 (0.0648)
State*Marr	-0.0296 (0.0397)	-0.0221 (0.0400)	-0.0157 (0.0411)	-0.00807 (0.0401)
Marr*Rel = o,	-	-	-	-
State*Rel	0.0720 (0.0682)	0.0644 (0.0673)	0.0803 (0.0734)	0.0753 (0.0708)
State*Boy	0.0102 (0.0299)	-0.00166 (0.0323)	0.0203 (0.0295)	0.00728 (0.0307)
Rel*Boy	-0.0269** (0.0122)	-0.0293** (0.0136)	-0.0253** (0.0119)	-0.0278** (0.0133)
Marr*Boy = o,	-	-	-	-
State	-0.236*** (0.0409)	-0.256*** (0.0394)	-0.200*** (0.0440)	-0.222*** (0.0411)
Marr = o,	-	-	-	-
Rel	-0.111** (0.0491)	-0.115** (0.0503)	-0.0667 (0.199)	-0.00976 (0.208)
Boy	0.0187 (0.0119)	0.0235* (0.0133)	0.0167 (0.0115)	0.0218* (0.0128)
Log(Income)	0.0774*** (0.00616)	0.0659*** (0.00573)	0.0731*** (0.00631)	0.0625*** (0.00583)
Education of Wife (yrs)	0.0177*** (0.00201)	0.0146*** (0.00198)	0.0162*** (0.00198)	0.0134*** (0.00198)
Education of Head(yrs)	0.0148*** (0.00130)	0.0100*** (0.000925)	0.0138*** (0.00126)	0.00937*** (0.000878)
Urban household = 1, Urban	0.300*** (0.0259)	0.277*** (0.0215)	0.294*** (0.0255)	0.273*** (0.0216)
#Teen-aged girls (15-20yrs)	0.00922*** (0.00209)	0.00510** (0.00222)	0.00949*** (0.00208)	0.00551** (0.00224)
#Adult women (>21yrs)	0.00642 (0.00408)	0.00342 (0.00402)	0.00649 (0.00404)	0.00351 (0.00400)
#Senior citizens(>60yrs)	0.0180*** (0.00520)	0.0177*** (0.00502)	0.0142*** (0.00516)	0.0144*** (0.00496)
Constant	-0.428*** (0.0725)	-0.327*** (0.0662)	-0.370* (0.204)	-0.344 (0.208)
State FE	Yes	Yes	Yes	Yes
Exposure to media variables	No	Yes	No	Yes
Religion & Caste FE	No	No	Yes	Yes
Observations	26,102	25,444	26,102	25,444
R-squared	0.438	0.448	0.445	0.453

Robust standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Table 4: Impact of Placebo Treatment (1) on presence of toilet

VARIABLES	(1) Toilet	(2) Toilet	(3) Toilet
Placebo Reform 1 x Rel	-0.122*** (0.0425)	-0.0198 (0.0378)	-0.00139 (0.0377)
Placebo Reform 1 = 1	-0.173** (0.0678)	-0.259*** (0.0598)	-0.308*** (0.0605)
Rel = 1	0.0173 (0.0547)	0.0117 (0.0414)	0.00855 (0.0419)
Log_Income		0.0599*** (0.00650)	0.0465*** (0.00656)
Education of woman(years)		0.0194*** (0.00200)	0.0143*** (0.00207)
Highest Adult Male Education(years)		0.0174*** (0.00133)	0.0107*** (0.00149)
Urban=1		0.303*** (0.0147)	0.269*** (0.0152)
Teen-aged girls(15-20years)		-0.0119** (0.00567)	-0.0122** (0.00568)
Adult Women(>=20years)		0.00407 (0.00726)	0.00310 (0.00732)
Senior Citizens(>=60 years)		0.0229*** (0.00657)	0.0218*** (0.00655)
Do men listen to radio = 1			-0.0394** (0.0171)
Do men read the newspaper = 1			0.0676*** (0.0156)
Do men watch TV = 1			-0.00403 (0.0209)
Do women listen to radio = 1			0.0228 (0.0170)
Do women read the newspaper = 1			0.111*** (0.0166)
Do women watch TV = 1			0.0849*** (0.0206)
Constant	0.938*** (0.0744)	-0.275*** (0.0903)	-0.157* (0.0916)
STATE, RELIGION & CASTE FE	YES	YES	YES
Observations	5,532	5,428	5,306
R-squared	0.231	0.432	0.450

Robust standard errors in parentheses

Standard errors are clustered at household level

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1