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Sanitation dynamics: toilet acquisition and its economic and social implications.

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Abstract

Poor sanitation is an important policy issue facing India, which accounts for over half of the 1.1 billion people worldwide that defecate in the open [JMP, 2012]. Achieving global sanitation targets, and reducing the social and economic costs of open defecation, therefore requires effectively extending sanitation services to India's citizens. The Indian Government has shown strong commitment to improving sanitation. However, uptake and usage of safe sanitation remains low: almost 50% of Indian households do not have access to a private or public latrine (2011 Indian census). This highlights the need for novel approaches to foster the uptake and sustained usage of safe sanitation in this context. This study contributes to addressing this need in two ways: First, we use primary data collected in both rural and urban contexts in two states of India, to understand determinants of toilet ownership and acquisition. A theoretical model is presented accompanying our empirical findings. Second, while ours is not a randomized control trial, we are able to offer a rich picture on the main determinants and potential outcomes of sanitation uptake. Contrary to many studies on sanitation, our focus is not primarily on health outcomes but we emphasize economic and social status considerations. Further, toilet acquisition is analyzed in the context of an intervention that alleviated one of the major constraints to acquisition – financial resources - which allows us to highlight the importance of attending this constraint. These three contributions have important implications for the design of strategies to promote sanitation, a major focus of many governments of developing countries and international organizations at present.

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1 Introduction

More than 1 billion of the world's population lack access to improved sanitation [JMP, 2012]. Many antipoverty programs have aimed to increase uptake and usage by alleviating informational constraints and fostering demand and perceived need. Other programs have (partly) relaxed resource constraint by providing subsidies and more recently there are also attempts of improving access to formal financial services for individual sanitation needs of the poor.

The Government of India (GoI) for example established the Total Sanitation Campaign in 1999, which was later revamped as Nirmal Bharat Abhiyan (NBA) and most recently as the Swachh Bharat Abhiyan (SBH) scheme. This community led policy aims to increase demand for safe sanitation by providing information on the benefits of sanitation, subsidies for the poorest (Below Poverty Live, BPL) households and funds for construction of sanitation facilities in schools. These efforts are complemented by a (primarily financial) incentive, known as the Nirmal Gram Puraskar (clean village) (NGP) prize, awarded to communities (gram panchayats[1]) that have become open defecation free (ODF).

Evidence suggests that this program achieves its ultimate aim of contributing to improvements in the health of Indian's citizens. Spears [2012] and Spears and Lamba [2011] use survey data matched to census and program administrative data to exploit exogenous variation resulting from the temporal implementation of the program and from a discontinuity in the function mapping village population to prize sizes. They find that the TSC had a positive impact on reducing infant mortality and children's height [Spears, 2012], and cognitive achievement at age six [Spears and Lamba, 2011]. Kumar and Vollmer [2013] also find a positive impact on diarrhea reduction. However, results are not always clear as shown in Clasen et al. [2014], where despite huge sanitation investments in a large sample of households, health gains where not achieved.

However, despite having constructed several million toilets to date, the remaining task for the GoI is daunting. Estimates suggest that construction would need to happen at a rate of one toilet per second to meet set targets [WaterAid-India, 2011]. Apart from these sheer numbers, other challenges include sustainability and accessing the excluded and marginalized (ibid.). Current programs also tend to neglect slum-dweller populations for whom technically feasible and affordable solutions are far and beyond. The 2008-09 National Sample Survey Organisation [NSSO, 2010] survey estimates that 81 per cent of slum-dwellers in India have inadequate access to sanitation.

In this study, we use simple model to first investigates theoretically how sanitation investments interact with other household decisions and outcomes and then present the related empirically evidence. We use data collected as part of an evaluation effort of a sanitation intervention, to understand determinants of sanitation uptake and acquisition. The data set provides consistent information across an urban slum population of a major Indian city (Gwalior, situated in the state of Madhya Pradesh), peripheral villagers of the same city and a rural village population in Thiruvarur district in the Southern state of Tamil Nadu..

For the case of Gwalior, and possibly driven by the fact that the slums in our sample are all officially recognized by the state government (i.e. notified slums), we find a relatively high sanitation coverage of 53% at the time of our baseline survey in 2010. Peripheral and rural villages

[1] A Gram Panchayat is a local self government unit, comprising of a small number of villages.

exhibit much lower coverage, in line with all-Indian averages, with a 23% sanitation coverage in the peripheral villages of Gwalior and 28% coverages in rural villages in two blocks of Thiruvarur district. Of the sample households that did not own a toilet, 33% made the transition to own their private toilet by the time of the second round of data collection approximately 3.5 years later. These features of the data allow us to analyze determinants of toilet ownership in the two waves as well as determinants of acquisition between waves. We further analyze potential impacts of toilet ownership by exploring the panel structure of the data, controlling for a large set of covariates, household fixed effects and common-time shocks. We conduct a number of robustness checks on our findings by estimating different specifications, which generally show consistency of these results. However, we raise caution that the lack of clear exogenous variation in toilet ownership makes it difficult to attribute observed impacts undoubtedly to toilet ownership.

Most of our results on determinants of toilet ownership and acquisition are in line with expectations: We for example find that richer and more educated households as well as households from higher castes are more likely to own a toilet in both waves. An interesting finding from this first analysis is however is that we observe a shift towards greater inclusion over time along these margins. Our findings suggest that over time, households with less means gained access to sanitation. We find that at the time of the first round of data collection, households with savings were more likely to have toilets, but this relationship is not significant anymore at the time of the second round of data collection. We also find that households with a toilet have larger loans outstanding and this holds particularly true during the second wave. While most households claim to have used their savings for the construction of the toilet, our results provide evidence that access to credit played an important role to allow households to make investments in sanitation.

It is possible that we find this evidence due to the program the data collection activities were associated with. The initial purpose of the data was the evaluation of a sanitation intervention called FINISH, which stands for Financial Inclusion Improves Sanitation and Health. This program worked with a local NGO in Gwalior and a microfinance institution in Thiruvarur and the key features of the program are the provision of loans for sanitation and awareness creation activities. While it was not possible to make clear statement about the program's impact, we might expect that some of the increase in coverage would be at least partially driven by program activities. Findings like the ones on importance of loan access support this hypothesis.[2]

Since the rationale for improving the sanitation situation is typically improved health, we look at the relationship between toilet ownership/acquisition and a number of objective and subjective health outcomes. Interestingly, while we do not observe any changes in measures such as health expenditures and diarrhea incidences as well as more objective health measures (such as stool and water samples), we see a strong correlation of toilet ownership with perceived health. This indicates that, while it is often suggested hat health considerations play only a minor role in the decision to acquire sanitation, households that own a toilet do perceive themselves and their family to be healthier than their peers that do not.

Our results provide further interesting findings along dimensions less frequently considered in sanitation studies than health outcomes. We provide novel evidence that households with toilets

[2]Details on the evaluation study and problems encountered can be found in the FINISH Evaluation report.

experience gains primarily related to their status and living conditions. We find that the reported value of their dwelling increases significantly. Almost 30% of the dwelling's value at the time of the second wave can be attributed to the sanitation facility. In addition, households with sanitation - despite having similar incomes – also own more household and transportation assets, and have higher levels of consumption per capita. Our results further provide evidence that female labor supply was reduced both along the extensive and intensive margin for households that acquired sanitation assets.

One possible explanation that ties these findings together is that anticipated marriage and brides moving into the house of the groom and his family, are important motivating factors for the acquisition of toilets: Around 80% of toilet owners in sample report that their status in the community increased because of the toilet they constructed and women report that sanitation played an important role in their marriage decision. Data suggests that toilets are more likely to be built in households with a male household member of marriageable age and that toilet construction is related to the household composition changing with an additional female adult member entering the household. Despite having more adult females, average working hours for females in households with toilets are reduced. Such reduction in female labour supply ties in with the idea that households with a toilet care about status given that it is common in India to perceive working to be unnecessary for women if the household can afford it.

The rest of this paper is organized as follows. After this introduction, we describe the data and study population in Section 2. Thereafter, we presents a simple theoretical framework for understanding the main motivations behind household's investment on sanitation in section 3. Next, Section 4 describes the empirical strategy and discusses the main results. The final section concludes.

2 Data and study population

We use data collected as part of an evaluation effort of a sanitation intervention. Data was collected in two intervention sites, namely in urban and semi-urban areas of Gwalior city in the state of Madhya Pradesh and in rural villages in Tamil Nadu. Maps indicating the study locations are provided in Appendix 1.

We have two rounds of data in each study site between 2009 and 2014. These survey rounds covered 39 slums and 17 peripheral villages of Gwalior city and 46 gram panchayats in Thiruvarur. Henceforth, we will refer to these as 'study communities'. Table 1 provides details on the timing of the surveys as well as sample sizes for different instruments. The main survey instruments were a household survey as well as a individual survey with the main woman in the household and a community survey. As much as possible, these instruments were kept constant across study locations and survey rounds.

Apart from household general characteristics, the survey instruments include detailed information on living standards, assets, consumption expenditures, income, risk perceptions, credits, savings and insurance and demand for health care. A distinguishing feature of the data is an extensive module on sanitation and hygiene facilities, practices and perceptions. On top of that, it

Table 1: Survey dates and sample sizes

State		**Tamil Nadu**		**Madhya Pradesh**	
Study area		Thiruvarur district		Gwalior	
Unit of randomization		Gram panchayats		Slums, peripheral villages	
Sample size		46		56 (39 slums, 17 villages)	
Survey dates	Round 1	Nov 2009 to April 2010		Feb to April 2010	
	Round 2	April to Sept 2014		March to Dec 2013	
		Round 1	Round 2	Round 1	Round 2
Instruments	Household (HH)	1,239	1649	1,989	2016
	Main woman	1096	1325	1,967	1888
	Community	101	112	45	56
HH attrition		30%		8%	

also includes a report on observations by the interviewer which provides a second measure on toilet ownership and other hygiene-related facilities.

The interview with the main woman of the household covered information on time-utilization, hygiene practices and knowledge, and cultural background and measures of empowerment. The women are also asked about children in their household, particularly providing information on their health status, time utilization, and nutrition.

Moreover, in terms of objective health information, stool samples as well as water samples are available for the sample in Gwalior. The stool sample allows for the analysis of bacteria, worms and other signs of diseases that might be related to sanitation and quality of water. It includes information of 656 children aged 0 to 5 in 499 HHs at the second data collection round.

Finally, GPS data on HHs, water supplies and open defecation areas (OD) (the latter only in 37 communities of Gwalior) was collected as part of the second survey round. This allows for the calculation of distances to OD areas and water supplies. Moreover, there are water samples for most HHs of the FU which provide a more detailed picture of one of the potential mechanisms through which sanitation might impact families' lives.

2.1 Descriptive Information

Table 2 provides descriptive statistics of our sample households, which are a representative sample of our study area at the time of the first survey round in 2010.

Around 16% of the HHs reported to be Muslim and almost all the remaining Hindu (less than 10% were from other religious background - not shown). In terms of caste, 18% of HHs report to belong to forward castes (FC), 43% to backward castes (BC), 26% to scheduled castes (SC), 2% to scheduled tribes (ST), 11 % to most backward castes (MBC). In terms of household composition, our sample HHs comprise of on average 5 members, 3 of which are male. Around 36% of the HHs have at least one child under the age of 6 years. At the baseline, the main woman in the household is on average 37 years of age and the large majority (91%) is married. 46% have no formal education, and 29% completed more than grade 5.

Average HH income per capita was around 16,600 Rs per year at the time of the first survey

round, while it was 15,800 Rs at the second round approximately three years later. As India's inflation rates are 8.9%, 9.3% and 10.9% for 2011, 2012, 2013 (WDI, World Bank), the general increase on national consumer prices between the two survey rounds was around 32%. This fact, jointly with an increase in the average household size, implies that households experienced a real decrease in their average yearly income per capita of approximately 4% between the two survey rounds.[3] At these income levels, households are way below the commonly used international poverty line of 1.25 USD per person per day. Taking the 2010 first quarter exchange rate of about 1 USD to 46.5 INR, our households earned on average 0.97 USD per day at the time of the first survey round.

At the same time though, close to 90% of the HHs were owners of their dwelling, and they estimate their houses to be valued at 162,100 Rs at the first survey round (2013 prices) and 286,400 Rs at the second survey round. 21% of them had access to water through piped-water, a figure that increases to 28.8% by the second round. A bit more than one third of the sample has a toilet and almost half have a bathroom. For those HHs for which there is information on distance to Open Defecation (OD) areas (73% of Gwalior sample), the average distance is 120m. For the case of the distance to the nearest water source (available for 76% of Gwalior approximately), it is 760m. We will discuss our sample household's sanitation situation in more detail in the next section.

As describe before, we have information on a wide set of characteristics of the HHs. The average of such variables are available in Tables 7, 8, 9,10, and 11, which also include our results. We will discuss these tables in detail when describing the results from our empirical strategies.

[3]Such decrease are mainly driven by Thiruvarur data.

Table 2: Descriptive Statistics

	R1			R2		
	N Obs	Mean	SD	N Obs	Mean	SD
Social background and HH demographic composition						
Religion: Muslim	3401	16.6%	37.2	3808	14.7%	35.4
Forward caste	3374	17.9%	38.3	3766	16.2%	36.8
Backward caste	3374	42.7%	49.5	3766	41.4%	49.3
Scheduled caste	3374	26.3%	44.0	3766	27.9%	44.8
Scheduled tribe	3374	2.0%	14.2	3766	1.9%	13.5
Most backward caste	3374	11.1%	31.5	3766	12.7%	33.3
Nr of household (HH) members	3216	5.1	2.0	3527	5.3	3.4
Nr of male HH members	3216	2.7	1.3	3527	2.7	1.4
=1 if HH has at least one child under 6yrs	3421	36.2%	48.1	3701	35.3%	47.8
=1 if there is an unmarried boy 17-24	3146	33.2%	47.1	3505	32.6%	46.9
=1 if there is an unmarried girl 13-20	3146	32.3%	46.8	3505	30.9%	46.2
Main woman Age	2981	37.3	11.5	3099	38.1	11.6
=1 if main woman is married	2984	91.1%	28.5	3091	90.7%	29.0
=1 if main woman has no education	3002	46.8%	49.9	2874	43.6%	49.6
=1 if main woman has more than primary school	3002	29.2%	45.5	2874	37.1%	48.3
=1 if main woman lives with her in-laws	3002	11.3%	31.7	3831	21.1%	40.8
=1 if sanitation was taken into account for marriage	2851	36.2%	48.1	3025	18.0%	38.4
HH Income						
Self-Reported yearly income, 1000Rs of 2013	3196	76.8	87.9	3597	74.4	94.4
=1 if any bad shock during the last year	3421	13.4%	34.1	3790	19.5%	39.6
Dwelling Characteristics						
=1 if dwelling is owned, 0 otherwise	3217	89.5%	30.6	3802	87.9%	32.6
Pucca (Strong)	3203	30.6%	46.1	3646	56.4%	49.6
Semi-Pucca (Semi-strong)	3203	41.7%	49.3	3646	21.7%	41.2
Value of the Dwelling (1000 Rs of 2013)	2544	162.1	214.0	2937	286.4	371.4
Sanitation and Hygiene						
=1 if main source drinking water is hh service connection	3421	21.0%	40.7	3810	28.8%	45.3
=1 if HH has a toilet?	3217	36.6%	48.2	3637	53.5%	49.9
=1 if HH has a bathroom	3421	47.6%	49.9	3816	65.7%	47.5
Distance to the border of the closest OD area (100m)				1590	1.2	1.5
Distance from HH to nearest water source (100m)				1657	7.6	6.9
Community Level						
Proportion of HHs with connected water service	102	14.1	22.9	102	12.8	19.3
Total number of HHs surveyed	102	33.6	29.4	102	37.6	30.4
Proportion of HHs with toilet	101	23.3	30.2	97	26.6	29.8
In Gwalior area	102	54.9%	50.0	102	54.9%	50.0
Slum	102	37.3%	48.6	102	37.3%	48.6

† Rupees of 2013: R1 values where adjusted by a factor of 1.32. It was calculated based on national level figures for 2011, 2012 and 2013.

2.2 Sanitation data

The main component of the household survey is the module on sanitation. As shown in Table 2, we learn from this module that about 36% of the HHs at the time of round 1 data collection reported to have a toilet of their own. This figure varies considerably by the location of the community as we show in Table 3: in Gwalior peripheral villages about 24% of households had a toilet and in urban slums it was 54%; in rural Thiruvarur the figure is 28%. By the time of the second survey round, a bit than three years later, sanitation coverage was close to 53% in our study communities: 72% in urban slums and 44% in peripheral villages of Gwalior, and 46% in Thiruvarur.[4] Almost all the households in the study areas report to own a pour flush toilet, i.e. a toilet where water for flushing is poured in by the user. The water is typically (~63%) flushed into a pit or a septic tank. Only very few households have a toilet linked to a drainage system (on average 6-7%) and those that do are primarily situated in the notified slums of Gwalior. At the time of the first survey round, only about 4% of households had a simple pit latrine[5], the typically cheapest and most basic form of improved sanitation. These statistics are presented in Table 4. Over time, we see primarily an increase in this type of simple pit toilet. When zooming in on the 33% of households that did not have a toilet at baseline, but made the transition to become a toilet owner, we see that among these, the percentage of simple pit owners is higher than amongst previous toilet owners: About 20% of toilets constructed between the two survey rounds are simple pit models.

Table 3: Reported Toilet Ownership

Community	**Round 1 (%)**	**Round 2 (%)**
Thiruvarur	28.25	45.57
Gwallior Village	23.68	42.22
Gwallior Slum	53.98	71.89
Total	36.56	53.51

Table 4: Reported types of toilets owned

Grouped Type	**Round 1 (%)**	**Round 2 (%)**	**Restricted Round 2 (%)**
Pour/Flush to Pit, septic tank, etc.	63.38	64.40	63.83
Pour/Flush to Drainage	7.39	6.14	5.04
Pour/Flush to Other	18.44	14.07	10.43
Simple pit	4.25	14.99	20.00
Don't know/No answer	6.54	0.41	0.70

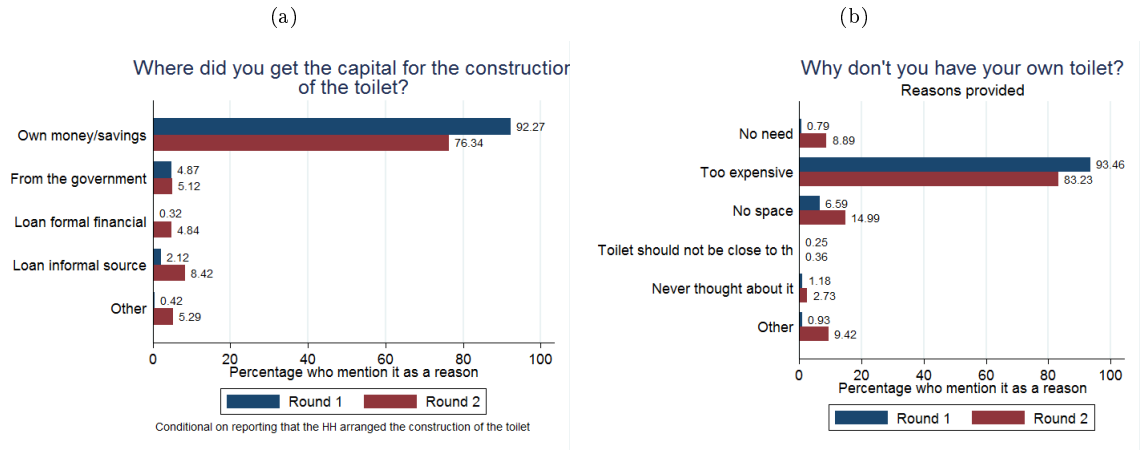
Restricted: HHs that did not report having a toilet at Round 1

Figure 1a provides information on financing of toilets. In both survey rounds the predominant financing source was own savings: 94% reported in 2010 to have financed their toilet with savings and 83% in 2013. Most of the remaining 6% of households in round 1 mentioned otherwise subsidies

[4] One might be concerned that household misreport their sanitation ownership status, possibly due to embarrassment, about not having sanitation facilities. In order to deal with that, the interviewer verified if there was or not a toilet in the house (such information is not available for 6% of the sample). In 95%-98% of the cases the interviewer agrees with the respondent on ownership status.

[5] A simple pit latrine typically consists of a pit dug into the ground, covered by slab or floor, with a hole through which excreta fall into the pit.

Figure 1



from the government and informal loans as sources for capital for the construction of their toilet. These two sources gained in importance between the two survey rounds with 13% of households reporting them.

Given the low average yearly income of our sample households which implies that a sanitation investment can be as large as 20% of the average yearly income[6], and the fact that funding for toilets are primarily savings, it then comes at no surprise that the cost of a toilet is the main constraint to toilet acquisition reported (as shown in Figure 1b). It is noteworthy though that the percentage of households citing high costs as the main constraint drops from 93% in 2010 to 83% in 2013. This comes with a dramatic increase in access to credit market between the two waves: loans as a proportion of income increase from around 10% to 20% of the HH income, and having taken a loan during the last year changed from 26% to 48%. Is this greater financial inclusion related to toilet acquisition? We will analyze that with more detail later.

3 Theoretical Framework

In order to understand how sanitation investment decisions are made and the consequences these decisions might have, we present next a simple theoretical model.

Toilet acquisition

In the theoretical framework we consider, households get utility from their consumption C, leisure L and health H. For simplicity of notation, we will assume that sanitation investment enter into the utility via health capital, via assets or directly into utility according to a function $h(T_t)$ which captures motives as comfort or other motivations that do not interact with economic activity.

[6]The implementing partner of the sanitation intervention this data was originally collected for, estimates that a usable and safe toilet could be constructed with Rs 10,000, including the pit, seat and platform, and a superstructure with roof and gate. Households themselves report to spend a much larger amount on a toilet, with on average over Rs 20,000.

There might be some heterogeneity in the parameters that govern this utility, for instance due to bargaining power between males and females [Stopnitzky, 2012]. Also, let's assume that U is quasi-concave, twice continuously differentiable and that $U_x > 0, U_{xx} \leq 0, x \in \{C, L, H\}$.

$$U_t = U(C_t, L_t, H_t) + h(T_t)$$

The household chooses non-durable consumption C_t, its total labour supply, $\bar{L} - L_t$ ($\bar{L}$ is the total number of hours available for leisure and labour), their borrow/savings level, B_t ($B_t < 0$ is equivalent to savings), and also whether to get a toilet, $T_t = 1$, or not, $T_t = 0$. Toilets are indivisible, so this is a discrete choice. If the decision to get a toilet is made in period t, it will only be available in period $t + 1$. A toilet investment costs k ($k \geq 0$).

The health production function $f(\cdot)$ translates H_t into H_{t+1}, but it also depends on toilet ownership, T, and the level of toilet density in the community household i lives in ($\overline{T}_t$).

$$H_{t+1} = f(H_t, T_t, \bar{T}_t)$$

For simplicity we might assume that $\overline{T}_t$ is exogenous. That is, individuals consider that their choice T_t is not relevant enough to modify $\overline{T}_t$.
Apart from labour, which is paid at a rate $w(H_t)$, the household has an income stream Y_t in each period which is unrelated to sanitation or health (which is assumed to be known with certainty). Access to capital markets is subject to a ceiling $\bar{B}$ ($B_t \leq \bar{B}$) and both savings and borrowing returns are subject to a fix and known interest rate $1 - r$.

$$C_t + w(H_t)L_t = A_t + w(H_t)\bar{L} + Y_t + B_t - kT_t$$

The sanitation investment increases the household's dwelling value, which is reflected in an increase in their assets, A_t (all of them considered to be liquid). The gross return on the sanitation investment is ρ_t, which is a function of the average level of sanitation $\overline{T}_t$ (an increase of the value of the dwelling). Then, the evolution of assets is governed by the returns of borrowing/savings and of the sanitation investment.

$$A_{t+1} = -rB_t + \rho_t T$$

Two period model

For ease of exposition, let's assume that there are only two periods. Also, $H_2 = f(H_1, T, \overline{T}_1)$ is assumed to be know with certainty and H_1, A and $\bar{T}_1$ are known. Hence, a household decides to construct a toilet if $V^{T=1} > V^{T=0}$, where $V^T(H_1, A_1, \bar{T}_1; \theta)$ (as defined in Equation 1) and θ is the set of parameters of the model.

$$V^T = max_{c_1,c_2,L_1,L_2,B} U(C_1, H_1, L_1) + \beta U(C_2, H_2(T), L_2) + \beta h(T) \tag{1}$$

$$st. \begin{cases} C_1 + w(H_1)L_1 = A_1 + w(H_1)\bar{L} + Y + B - kT \\ C_2 + w(H_2)L_2 = -rB + \rho T + w(H_2)\bar{L} + Y \\ B \leq \bar{B} \end{cases} \quad (2)$$

The first order conditions of the problem present the classic two elements of the inter-temporal consumer model. First, there is a normal trade-off between consumption and labour: $U_C(C_t, H_t, L_t) = U_L(C_t, H_t, L_t)\frac{1}{w(H_t)}$. Second, the Euler equation governs the relation between consumption (and labour) in both periods: $U_C(C_1, H_1, L_1) = \beta r U_C(C_2, H_2, L_2)$ as long as the credit constrain is not binding. Also, under such scenario, we can link both budget restrictions via borrowing:

$$C_1 + w(H_1)L_1 + \frac{1}{r}(C_2 + w(H_2(T))L_2) = [A_1 + Y + \frac{1}{r}Y] + [w(H_1)\bar{L} + \frac{1}{r}w(H_2(T))\bar{L}] + (\frac{\rho}{r} - k)T \quad (3)$$

Hence, the sanitation investment choice is determined by the following considerations.

First, when individuals are not restricted by a credit constraint, sanitation investment moves resources from period 1 into period 2. Hence the individual has to compare the gains from current forgone investment on the benchmark asset (borrowing and savings at rate r) with the returns from the sanitation investment: the direct utility from improved health outcomes, direct financial returns (dwelling valuation) and productivity. Notice that even if total life-cycle income reduces due to the investment (productivity and asset valuation gains do not compensate the price of the toilet k) and there is no direct utility from sanitation (so $h(T) = 0$), it might be still desirable for the household to invest on it if the direct utility from H_2 compensates for the reduction in life-time consumption and leisure.

Second, sanitation investment might change the balance between consumption and labour. This could be in two ways: first, if health affects productivity, wages might increase in the future. Second, it affects marginal utility of labour and consumption due to the direct impact on health (which might cancel out under specific utility functions). Hence the impact of sanitation on labour supply is then unclear and depends on the underlying assumptions of the utility function. If we consider female and male labour supply separately, the picture becomes even more complicated as the productivity gains, and hence time allocations to leisure, might be different.

Third, if individuals are limited by borrowing constraints, as in the classical setup, households might be unable to invest in sanitation even if they were willing to do so. The borrowing constraint is especially important as T is indivisible, which means that the investment would not be feasible unless the resources are sufficient to make the investment and compensate current consumption loss (due to the inability to smooth consumption completely).

A final remark is the dependence of the returns to the sanitation investment on other parameters in the model: First, the average level of sanitation $\bar{T}$ is central to the decision: if the adoption is too low the potential gains on health might be very small as public water sources might not improve at all (health production $f(\cdot)$ depend on both own and community sanitation). However, this is not necessary monotonic as a large $\bar{T}$ might mean that households can free-ride on the health benefits derived from investments done by others. A similar analysis can be done in the case of

financial returns, for instance, a low rate of adoption might increase the value of the dwelling notoriously as it becomes a luxury in the area (boosting ρ). Consequently, expectations on the rate of adoption of sanitation γ, which are unobserved and potentially heterogeneous across households can be considered an important determinant in the adoption decision. Notice that if the community is small enough, individuals might decide strategically their investment in order to shape $\bar{T}_2$ (see for instance Shakya et al. [2014], Dickinson and Pattanayak [2012]). Hence, any prediction requires further assumptions on these functions which go beyond the scope of this paper.

The next section describes the method we adopt to analyze sanitation adoption decisions and will present empirical findings alongside this theoretical model, shedding light on some of the ambiguous prediction.

4 Methods and results

Our analysis has two main objectives: (1) Assessing determinants of toilet ownership and acquisition and (2) understanding the benefits of toilet ownership on a number of outcomes. The latter analysis tries to tease out causality attached to observed correlates.

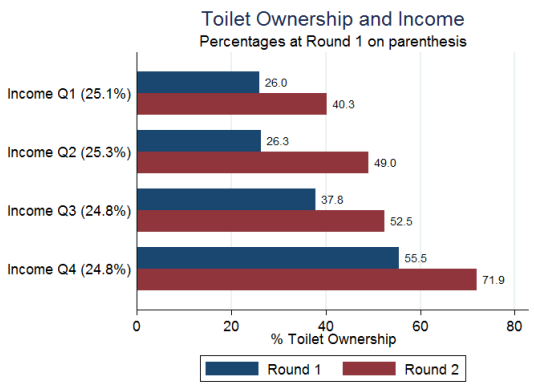
Take the example of household income. Our data confirms the common observation that income is a major driver of toilet-ownership: HHs with higher income are more likely to own a toilet. This is depicted in Figure 2a, where we plot the percentage of HHs owning a toilet against the income quartile they fall into. Such gradient is also present in social status: In both Round 1 and Round 2, there is a clear ranking by caste as shown in Figure 2b. We observe a strong gradient in the first survey round (darker bards), which declines in the second round (lighter bards) but still shows that richer households are more likely to have a toilet. In this example, our analysis on determinants of toilet ownership looks at whether such correlations remain even when accounting for other household characteristics. The second part of our analysis tries to understand whether it does not only hold that richer households are more likely to own a toilet but also whether owning a toilet makes households richer.

A well executed experimental evaluation design would allow to clearly attribute any role that toilet ownership plays in an observed change in household income. In our setting however, where no such clear exogenous variation is introduced, stronger assumptions need to be made. For some outcomes - such as income - the task becomes particularly difficult as the direction of causality is not easily defined: more income implies further access to sanitation but improved health can yield higher income. We will however, not consider income as an outcome in our attribution analysis and rather concentrate on consumption and other economic indicators as well as other outcomes related to health and productivity. We instead account for income alongside other characteristics of the household in our analysis. We describe in section 3.2 the approach we use and assumptions we need to make.

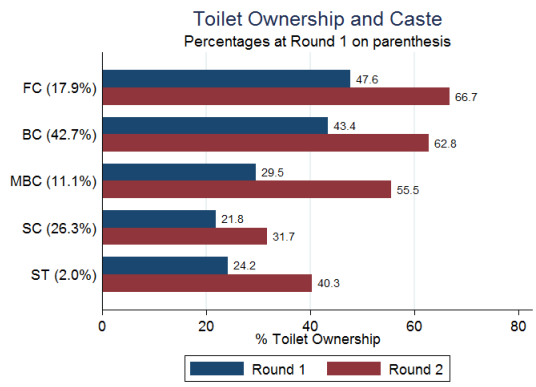
Before doing so, we however dive into the analysis of determinants of toilet ownership and acquisition, discussing in more detail the methodology used and presenting our findings.

Figure 2

(a)



(b)



NOTE: Percentage of households belonging to each category at Round 1 are presented in parenthesis.

4.1 Determinants of toilet ownership and acquisition

In this section we explore what household characteristics are associated with sanitation uptake. The features of our data allow us to analyze two types of variation: cross-sectional and longitudinal. Exploring the cross-sectional variation informs us about characteristics that are correlated with toilet ownership at a specific point in time, even if these characteristics vary little over time, such as religion or caste. We can compare findings for the two survey rounds and learn which covariates are important determinants consistently in both years. The longitudinal feature of our data enables the analysis of the role of variables that show variation over time. It further allows us to analyze determinants of toilet acquisition. By zooming in on households that had no toilet at the time the first round of data was collected, we can correlate household characteristics with toilet acquisition.

Methodology

For the cross-sectional analysis we use a linear probability model. It establishes the correlation between a set of covariates X and toilet ownership status T at data collection wave τ as shown in Equation 4. Variables vary at the level of the HH i, the community j and time t. The vector of estimated parameters $\hat{\beta}_1$ gives us an idea of the correlation between each variable on the right hand side and toilet ownership, assuming that it is linear relationship. We cluster the error term at the community level. This parameter $\hat{\beta}_1$ would provide the causal effect only if any omitted variable, that is unobserved but is related with T, is uncorrelated with the variable of interest x. Further, the direction of causality would have to be clearly determined - as discussed previously taking income as an example. An example of a variable where the direction would be more easily established is caste: a household's caste might influence toilet acquisition but the reverse is unlikely to hold: acquisition of a toilet would not change the caste of a household.

$$T_{i,j,t=\tau} = g(X'_{i,j,t=\tau}\beta_1 + u_{i,j,t=\tau}) \tag{4}$$

To analyze determinants of toilet acquisition we constrain our sample to households that had no toilet in 2010. We again estimate a linear probability model, but make now use of the longitudinal feature of our data: the left-hand side is the status of toilet-ownership in 2013, while the right-hand side are covariates measured at the time of the first survey round in 2010. This is shown in Equation 5. The same caveats on identification of causal effects apply. In terms of policy implications, this analysis provides an interesting framework though: we can learn whether some particular characteristics actually determine the decision of a HH to invest in sanitation.

$$T_{i,j,t=2} = g(X'_{i,j,t=1}\beta_2 + u_{i,j,t=2}) \quad | \quad T_{i,j,t=1} = 0 \tag{5}$$

Results

Table 5 presents the results of the analysis of determinants of toilet ownership and acquisition. We concentrate on the same set of covariates as used to describe our sample households in section 2.1. We repeat the sample averages for each covariate in columns 1 and 2 for easiness of comparison of the point estimates. Since sample sizes change slightly with each specification, the averages might differ somewhat in each column and in comparison to those presented in Table 2. Columns 3, 4, and 5 present the estimated coefficient β for the covariates under the different specifications discussed above (equations 4 and 5). We will start by discussing findings about which household characteristics are correlated with toilet ownership, presented in column 3 for 2010, and in column 4 for 2013. Thereafter, we will turn to the discussion of determinants of toilet ownership, estimates of which are presented in column 5.

Determinants of toilet ownership

The top panel of Table 5 focuses on household income. As income itself might be an outcome, due to the potential improvement of health and productivity, the variable is aggregated by quartiles for this cross-sectional analysis. In both survey rounds (estimates in columns 3 and 4) we find confirmed that households of higher income are significantly more likely to have a toilet. This is a finding our descriptive analysis already suggested. It is worth stressing though that reverse causality is likely to play an important role: part of that positive correlation might be because HHs with improved sanitation facilities and hygiene behaviour might be more productive. This issue is not solved in this analysis.

We find a very similar pattern to that of household income for the social background of the households. Even when we take into account household income (as done throughout in the analysis), forward caste households are more likely than backward caste ones to own a toilet whereas schedule castes and tribes are less likely to have one in comparison to backward caste households. There are slight differences over time, but the general picture is consistent in both years as shown in the descriptive analysis.

The data does not reveal any significant difference in toilet ownership patterns by the religion of the household (results not shown).

However, we further look at the correlation of demographic composition of the household with toilet ownership. While one might expect larger households to be more likely to own a toilet due

to higher demand, we do not see this reflected in the context of our data. Also other household composition information does not seem to correlate with toilet ownership in our two survey rounds.

Consistently over the years though is a positive and significant correlation between toilet ownership and the education level of the main woman in the household. Notice that sanitation might be relevant for the marriage market as ownership seems clearly related to have taken it into account on the matching.

The final set of variables we look at is the type and location of the household's dwelling. We find that owning, or living in a dwelling of strong or semi-strong structure is a significant correlate with toilet ownership. Further, at the time of the first survey round, living in a slum is associated with a significantly higher probability of having a toilet, but in general the expansion is slower in Gwalior as it started from a higher point. notice, however, that there seems to be a positive relationship between average sanitation and the likelihood to own a toilet, meaning that network effects might play an important role.

Distance to OD areas and community water sources are not reported in this table as it only includes data for Gwalior at Round 2. No significant relationship was found in that case.

Determinants of toilet acquisition

Results on our estimations on correlations with toilet acquisition are presented in column 5 of the same Table, Table 5. The estimates presented here help us gain a deeper understanding of which characteristics at the baseline might forecast sanitation adoption.

The results from estimating equation 5 show that the expansion was more likely to be at the third quartile, also it seems clear that once income is taken into account, schedule caste and tribe are less likely to improve their sanitation access in comparison with backward caste. This tell us that disparities on access to sanitation might be growing.

Of further importance seems to be changes in the household composition: The arrival of a new female HH member increases the likelihood of constructing a toilet significantly. We also find that this increase is *not* due to the birth of a household member. It might therefore be that this new adult member brings additional resources that allow making the investment in a toilet. Notice also that it is more likely that a household invest in sanitation if one male household member is close to the legal marriage age. This relationship on the other hand does not hold for female household members of marriage age. Two possible mechanisms come to mind to explain these findings: the first one is that households invest into sanitation in preparation for marriage, either to make their groom candidate a more desirable candidate or since potential brides may have made their commitment decision conditional on the construction of a toilet. This latter explanation is not unlikely considering campaigns of the Indian Government using slogans such as "no loo no bride". The second mechanism is that households with boys of marriageable age anticipate an income shock through bride dowry, which facilitates the investment into sanitation. While some households have reported income from dowry in the section on household income, and hence this would already be accounted for in our analysis, it is likely that dowry income is considerably under reported in our data. This is since dowries are illegal in India and we would therefore expect households to be hesitant to report them. We nevertheless do not think that the dowry mechanisms is the dominant

one but rather the investment into a toilet in preparation of a marriage. Findings we present in the next section where we analyze the link between toilet ownership and outcomes support this hypothesis.

Toilet acquisition can come from construction but it is also possible that households moved from a dwelling without a toilet to one with. Households that migrated within a community were tracked at the followup survey to the extent possible. Such a change in dwelling is however not found to be relevant. We again look also at the location of the household's dwelling in relation to OD areas and water sources. We do so only for our sample in Gwalior as this type of data is not available for Thiruvarur. Results are presented in Table 6. Note that distances for round 1 have to be inferred since GPS coordinates were only collected during the second survey round. An intuitive hypothesis would be that HHs that are located far from OD areas are more willing to invest in sanitation, which is precisely what we see in our findings: being further away from the OD area increases the likelihood of constructing a toilet between the two survey rounds. Estimates on distance to water sources provide a similar picture, showing that living further away from a water source increases the likelihood of constructing a toilet. This could be seen as less intuitive since the need for water increases with owning a toilet.

Table 5: Toilet ownership Determinants: cross-section logits

Eq4. Logit : $Y_{i,j,t=\tau} = g(X_{i,j,t=\tau}\beta_1 + u_{i,j,t=\tau}$
Eq5. Logit (R): $Y_{i,j,t=2} = g(X_{i,t,t=2}\beta_2 + u_{i,j,t=2}) | T_{i,j,t=1} = 0$

	Descriptive		Marginal Effects		
	R1	R2	R1	R2	R2 New
	(1)	(2)	(3)	(4)	(5)
Independent Variables X	$\bar{X}_{t=1}$	$\bar{X}_{t=2}$	Eq4	Eq4	Eq5
HH Income					
Income quartile 2 or above	*75.8%*	*75.3%*	−0.92	2.30	3.32
			(2.63)	(2.57)	(2.51)
Income quartile 3 or above	*50.7%*	*48.5%*	6.52***	2.60	7.12**
			(2.33)	(2.38)	(2.91)
Income quartile 4 or above	*25.0%*	*25.7%*	8.12***	11.57***	−1.96
			(2.06)	(2.16)	(3.76)
Social background					
Forward caste	*18.5%*	*18.2%*	−0.51	1.04	−0.60
			(3.37)	(2.57)	(5.55)
Most backward caste	*11.0%*	*11.0%*	−1.45	−0.13	5.93
			(2.86)	(2.75)	(4.04)
Scheduled caste	*26.6%*	*27.0%*	−13.47***	−20.08***	−15.76***
			(2.44)	(2.28)	(3.84)
HH Demographic Composition					
Nr of household (HH) members	*5.2*	*5.5*	0.37	0.51	1.21
			(0.68)	(0.73)	(1.23)
Nr of male HH members	*2.7*	*2.8*	−1.31	−0.82	−4.26**
			(0.98)	(0.98)	(1.67)
=1 if HH has at least one child under 6yrs	*33.4%*	*34.7%*	−1.13	−0.59	−1.59
			(1.91)	(2.43)	(2.81)
=1 if there is an unmarried boy 17-24	*33.4%*	*33.6%*	−0.43	−2.56	9.59***
			(1.88)	(1.65)	(2.59)
=1 if there is an unmarried girl 13-20	*32.2%*	*31.8%*	−0.21	−2.05	−4.65
			(1.72)	(2.04)	(3.55)
=1 if main woman completed grade IX or above	*12.8%*	*18.4%*	11.17***	12.28***	3.98
			(2.19)	(2.28)	(4.77)
=1 if sanitation was taken into account for marriage	*36.6%*	*17.5%*	5.54***	5.79***	4.25
			(2.13)	(2.03)	(2.70)
Dwelling and Community Characteristics					
Pucca (Strong)	*30.3%*	*59.4%*	26.54***	22.95***	5.57
			(2.37)	(2.31)	(3.54)
Semi-Pucca (Semi-strong)	*42.8%*	*21.8%*	14.85***	8.98***	7.26**
			(2.37)	(2.82)	(2.85)
Proportion of HHs with connected water service in the village/slum	*15.3*	*15.3*	0.01	−0.07	−0.22*
			(0.05)	(0.06)	(0.13)
Proportion of HHs with toilet in the village/slum	*26.6*	*34.0*	0.61***	0.75***	0.52***
			(0.05)	(0.07)	(0.12)
In Gwalior area	*66.0%*	*63.9%*	−24.42***	−34.37***	−15.92**
			(3.32)	(3.73)	(6.49)
Slum	*39.4%*	*38.0%*	6.85***	10.70***	18.21***
			(2.38)	(2.83)	(3.78)
Total N Observations			2726	2661	1509

† Rupees of 2013: R1 values where adjusted by a factor of 1.32. It was calculated based on national level figures for 2011, 2012 and 2013.
X_i includes socio-demographic controls of the main woman, HH head and the HH demographics and socio-economic status. Robust SE on parenthesis. Significance: * 10%, ** 5%, *** 1%.

Table 6: Sanitation uptake and distance to OD areas and water sources

Eq5. Logit: $Y_{i,j,t=2} = g(X_{i,t,t=2}\beta_2 + u_{i,j,t=2}) \vert T_{i,j,t=1} = 0$		
	(1)	(2)
Independent Variables X	$\bar{X}_{t=2}$	Eq5
Distance to the border of the closest OD area (100m)	*1.4%*	1.95*
		(1.13)
Distance from HH to nearest water source (100m)	*1.4%*	1.08***
		(0.21)
Total N Observations		761

X_i includes socio-demographic controls of the main woman, HH head and the HH demographics and socio-economic status. Robust SE on parenthesis. Significance: * 10%, ** 5%, *** 1%.

4.2 Toilet ownership and outcomes

We now turn to understanding links between toilet ownership and a number of outcomes. Ideally, we would like to answer the question of what the impact of owning a toilet is on variables capturing for example health and productivity of household members. However, as discussed before, the lack of a clear exogenous variation on toilet ownership makes it harder to address this question. We proceed in line with our analysis above to move away from correlations and get closer to causality. We further present robustness checks on our findings.

Methodology

We can gauge the direction and size of potential impacts by analyzing how outcomes Y_i are related to toilet ownership T_i, conditional on the determinants X_i. Here, the dependent variable is the relevant outcome and we add toilet ownership as the main covariate of interest. Equation 6 presents the cross-section analysis using ordinary least squares, and equation 7 an individual linear fix-effects model.

$$Y_{i,j,t=\tau} = \delta T_{i,j,t=\tau} + X'_{i,j,t=\tau}\omega_1 + u_{i,j,t=\tau} \tag{6}$$

$$Y_{i,j,t} = \delta T_{i,j,t} + X'_{i,j,t}\omega_2 + \alpha_i + \gamma_t + u_{i,j,t} \tag{7}$$

Robustness checks

We performed several alternative specifications in order to analyze the sensitivity of the findings presented. The first one is to test the sensitivity of estimates to the inclusion of different set of covariates, X. The second one is to use linear models instead of logits for the determinants of toilet ownership and for the dichotomous outcomes. These checks are supportive of our findings presented here.

The third robustness check we conduct is to estimate Equation 5 on a sample of households matched based on the probability that they will construct a toilet in the future (propensity score) in

order to get a closer approach to causal estimates[7]. While some of the variables remain unbalanced (this holds for the Thiruvarur data and partlicularly for income quartiles and caste), Figure 5 in the appendix provides the relevant evidence that through the matching procedure we ensure to run regressions on a comparable sample at Round 1. We furtehr include controls in our matching estimates to reduce potential bias. Doing so, our findings are for the large part confirmed. We will mention the relevant results in our discussion below and present a summary Table with key findings from the matching in Appendix Table 12. We note that the matching discards of observations that are unsuitable for matching, which reduces our sample size and hence power to detect impacts. However, this does not greatly affect the findings.

Results

We present our findings clustered around different areas: Health, productivity and time use, household's wealth and finances and a set of variables focusing on the main woman in the household. The result tables are all set-up similar to those presenting findings on determinants of toilet ownership and acquisition (Table 5). The main difference is that columns 3, 6, 9, and 11 now present the estimator for δ (associated with toilet ownership) for each dependent variable (outcome) Y. As before, we provide the average for each outcome (columns 2, 5, 8) for the relevant sample. We also show respective sample sizes in columns 1, 4, 7 and 10.

Results - Health & Environment

One of the main objectives of improving sanitation coverage is an improvement in the health situation. Sanitation in its broad sense is the maintenance of hygienic conditions. Toilets in this context act to prevent human contact with faeces. To gauge whether the construction of toilets improved the health of our study population, we distinguish between two sets of health outcomes: subjective and objective measures.

The upper panel of Table 7 presents findings on reported health outcomes: reported illnesses and health seeking behavior. We find little evidence for impacts of toilet ownership on any of these. There is a positive association between demand of health care and sanitation ownership (columns 3 and 6). However, this seems to be a fixed effect related to preferences for health-care as the panel estimator is not different from zero, showing that the construction of a toilet does not seem to increase or reduce demand for health care. Matching results confirm this. Also, notice that hospitalization is unrelated to sanitation ownership, which might be related to acute illnesses derived from poor sanitation.

We do not find any evidence of reduced incidence of diarrhea, which might be driven by the fact that only six to ten percent of children were affected at the time of the survey rounds. This is likely to limit our ability to detect any changes with the sample size at hand.

Our subjective health indicators are respondent's perceptions of his/her own health and that of his/her family. Respondents were asked to rate their own and their family's health on a scale from 1 to 10 (with one presenting very poor health). They were also asked to rate their health in

[7] See Rosenbaum and Rubin [1983], Heckman et al. [1997] for further discussion. The procedure was implemented using kernel matching on the propensity score, psmatch2 [Leuven and Sianesi, 2014] in Stata 13

comparison to other community members of similar age and gender. Regression estimates on these outcomes are reported in the second panel of Table 7. While the coefficients on toilet ownership are all estimated to be positive, none is significant at the conventional level of 5% in our cross-sectional analysis. However, in our panel specification (column 11) we find an interesting pattern: While having a toilet is not correlated with rating ones own and ones family's health higher, the main respondent is 9.44 percentage points more likely to perceive him/herself as healthier than peers in the community and 7.6% more likely to perceive his/her family as healthier than other families in the community, after a toilet is constructed.[8] This shows the household's own perception that their toilet makes them better off compared to others.

In terms of more objective health measures we have information on stool sample analysis for children under the age of 6 and also show estimates on water quality test results.

Stool sample examination results are only available for the second survey round, hence constraining us in the methods we can apply. Overall we do not find significant correlations and patterns. There is some indication that households that constructed a toilet might be more likely to experience a small degree of malabsorption (based on higher likelihood of mucus and fat in the stool), also it might be an increase on the likelihood to present bacteria. However, the correlation for indicators of parasite infections for households with and without a toilet (based on OVA and cysts in the stool as well as acid reaction) is negative. An important issue here is sample selection: the stool sample comes from more educated households, with higher income. This implies that estimated effects are likely to be biased downwards, given that one would expect higher incidences of illnesses in poorer and lower educated households. Another issue might be statistical power due to lack of variation. Although sanitation coverage is around 60% in this sample, a bigger sample might be required to find variation in this type of outcomes.

We finally present results on water samples that were taken at the household level and tested for colony counts and other water quality indicators. Again, we do not find any difference in the quality that could be related to toilet ownership. The coefficient on the colony count is positive but not significant, providing therefore no reason to believe that toilets were badly constructed and could therefore lead to the contamination of drinking water sources. This could also be due to a high chlorine coverage of about 50% in the water. For both household types (with and without toilets) the PH is with a level of 7.2 within the commonly accepted range of 6.5-8.5.

[8] Matching estimates also show positive coefficients but the significance decreases, particularly in the panel specification. Perceptions on better health of one's own family becomes however significant at the ten percent level in the cross-section specifications.

Table 7: Health Variables

Eq6. Cross-section τ **:** $Y_{i,j,t=\tau} = \delta Toilet_{i,j,t=\tau} + X_{i,j,t=\tau}\omega_1 + u_{i,j,t=\tau}$
Eq7. Panel: $Y_{i,j,t} = \delta Toilet_{i,j,t} + X_{i,j,t}\omega_2 + \alpha_i + \gamma_t + u_{i,j,t}$
Sample: All available data in each survey at HH level. **Restricted (R):** HHs that did not report having a toilet at the R1.

	Cross-section analysis									Panel	
	Round 1			Round 2			Restricted Round 2			Linear Panel	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Outcome Variables Y	N Ind	$\bar{Y}_{t=1}$	Eq6	N Ind	$\bar{Y}_{t=2}$	Eq6	N Ind	$\bar{Y}_{t=2}$	Eq6	N Ind	Eq7
Health Outcomes											
=1 if visited a doctor without hospitalization (last 4 weeks)	3023	*35.1%*	5.00**	3331	*49.8%*	4.23**	1586	*49.6%*	0.91	2488	2.50
			(2.07)			(1.88)			(2.98)		(2.87)
=1 if any hh member hospitalized in last 12 months	3071	*11.2%*	−0.68	3336	*18.0%*	2.41	1585	*15.9%*	1.29	2489	0.58
			(1.53)			(1.61)			(2.40)		(1.99)
=1 if any children had diarrhoea last 7 days	2350	*10.0%*	0.18	1991	*6.7%*	−0.01	1037	*6.9%*	0.76	1732	1.44
			(1.60)			(1.04)			(1.59)		(2.10)
Subjective Health (Gwalior)											
Rate your own health from 1-10, where 1 is very poor health	1906	*7.0*	0.10	1927	*8.6*	0.06	1039	*8.6*	0.11	1744	0.07
			(0.07)			(0.07)			(0.10)		(0.09)
Perceive himself as healthier than others	1897	*32.1%*	1.19	1889	*29.3%*	1.88	1016	*29.8%*	4.44	1709	9.18***
			(3.08)			(2.41)			(2.77)		(3.34)
Rate your family's health from 1-10, where 1 is very poor health	1899	*6.9*	0.05	1924	*8.8*	0.10	1037	*8.7*	0.14	1740	0.11
			(0.07)			(0.06)			(0.09)		(0.08)
Perceive family as healthier than others	1894	*29.6%*	0.20	1881	*28.6%*	2.89	1012	*27.9%*	4.87	1701	7.13**
			(2.65)			(2.59)			(3.45)		(3.34)
Stool Sample (Gwalior)											
At least 1 child presents mucus in the stool				466	*53.4%*	7.15	263	*53.6%*	10.35		
						(7.26)			(7.64)		
At least 1 child presents stool acid reaction				466	*65.2%*	−4.26	263	*70.0%*	2.56		
						(5.43)			(5.50)		
At least 1 child presents OVA in the stool				466	*24.9%*	−4.09	263	*23.2%*	−3.87		
						(3.96)			(5.05)		
At least 1 child presents Cyst in the stool				466	*5.8%*	−1.40	263	*5.7%*	−3.30		
						(1.75)			(2.95)		
At least 1 child presents fat in the stool				466	*53.2%*	0.56	263	*56.7%*	2.29		
						(5.00)			(7.15)		

Continued on next page

Table 7: (Continued)

	Cross-section analysis									Panel	
	Round 1			Round 2			R. Round 2			Linear Panel	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Outcome Variables Y	N Ind	$\bar{Y}_{t=1}$	Eq4	N Ind	$\bar{Y}_{t=2}$	Eq4	N Ind	$\bar{Y}_{t=2}$	Eq4	N Ind	Eq5
At least 1 child presents starch in the stool				466	*56.0%*	−2.82	263	*56.3%*	1.10		
						(4.45)			(7.62)		
At least 1 child presents bacteria in the stool				466	*9.4%*	−2.22	263	*7.2%*	4.49*		
						(2.19)			(2.58)		
Water Quality (Gwalior)											
=1 if water is clear				1701	*73.7%*	4.38	931	*72.1%*	2.66		
						(3.19)			(4.24)		
=1 if deposit present				1701	*73.7%*	4.33	931	*72.1%*	2.30		
						(3.19)			(4.22)		
=1 if chlorine present				1701	*46.5%*	−0.73	931	*54.8%*	−0.71		
						(2.73)			(3.41)		
PH				1701	*7.2*	−0.00	931	*7.2*	0.01		
						(0.02)			(0.02)		
Coloby count (1000s organisms)				597	*104.5*	1.60	330	*102.9*	−0.22		
						(2.61)			(2.91)		

† Rupees of 2013: R1 values where adjusted by a factor of 1.32. It was calculated based on national level figures for 2011, 2012 and 2013.
X_i includes socio-demographic controls of the main woman, HH head and the HH demographics and socio-economic status. Robust SE on parenthesis. Significance: * 10%, ** 5%, *** 1%.

Productivity and children's time allocation

One of the possible results of improved sanitation coverage is an increase in productivity due to improved health. That might be reflected in wages and in participation on the labor market, but - as we showed in our theoretical framework - it is not straightforward how. For instance, improved productivity might increase potential wages which may drive more people into the labor market; as a result, wages might not increase and even could decrease. Results just presented raise doubts of the importance of this channel. However, the picture found in the data is richer than this.

Cross-sectional analysis from both of the two survey rounds reveals that there is a positive correlation between the total number of hours supplied by the HH and sanitation ownership (results not shown). However, when we include controls, such links fade out. The interesting pattern that emerges is when we look at labor supply by gender (presented in Table 8, first two outcomes variables): We find that while male labor supply is the same for households with and without a toilet[9], female labor supply is reduced for households with sanitation. These findings are confirmed in our panel specification, column 11 as well as through the matching exercise.[10] One possible explanation for this finding is that male wages might increase faster than those of females, so that one would expect households to re-allocate labour hours to male household members in response. However, there is no significant evidence of differential wage growth by genders[11].

Are these results causal? As before, our identification strategy requires us to make strong assumptions for this claim. However there is a strong correlation between female labor participation conditional on HH income level and demographics. We have seen that HHs that construct toilets also have women who work less. One possible theory is that both sanitation and non-female labour participation are related to social status, and some HHs are willing to invest their resources to achieve it.

We do not have information on time allocation of the women beyond working hours, but results we present next might suggest that women take over tasks that were previously undertaken by children, including certain home chores and collection of water. The lower panel of Table 8 shows estimates of the relationship between toilet ownership and the time allocation of children age 3-15 years in the household (this information was available for our Gwalior sample only). We conduct the analysis using an indicator for a positive amount of time reported in a specific activity by at least one child within the considered age rage. As a robustness check (not reported in the table), we also estimated the relationship with reported average hours of all the children in the household, a variable we expect to suffer from a significant degree of truncation. The findings are in line. Consistently across all specifications we find evidence that children living in households with a toilet spend less time on domestic housework. We also find evidence in some of the specifications that these children spend significantly less time carrying water. These reductions ate all confirmed in the matching estimation. Our findings suggest that some of these hours are spent on education.

[9] An exception is the coefficient in the baseline cross-sectional specification, which is negative and significant.

[10] When breaking it down by age of the women (not shown) we find that it is mainly women above the age of 25 years that work less. Results are not shown but available from the authors on request. Note that while coefficients are consistent in the matching exercise, the findings loose their significance in this specification, likely due to the significantly reduced sample size.

[11] If anything, the panel coefficient of the matching exercise suggests a reduction in male wage.

Table 8: Time Allocation and Labour Market

Eq6. Cross-section τ **:** $Y_{i,j,t=\tau} = \delta Toilet_{i,j,t=\tau} + X_{i,j,t=\tau}\omega_1 + u_{i,j,t=\tau}$
Eq7. Panel: $Y_{i,j,t} = \delta Toilet_{i,j,t} + X_{i,j,t}\omega_2 + \alpha_i + \gamma_t + u_{i,j,t}$
Sample: All available data in each survey at HH level. **Restricted (R):** HHs that did not report having a toilet at the R1.

	Cross-section analysis									Panel	
	Round 1			Round 2			Restricted Round 2			Linear Panel	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Outcome Variables Y	N Ind	$\bar{Y}_{t=1}$	Eq6	N Ind	$\bar{Y}_{t=2}$	Eq6	N Ind	$\bar{Y}_{t=2}$	Eq6	N Ind	Eq7
Labour market											
Total male paid working hours of the HH	3071	*12.7*	-1.74^{***}	3355	*10.1*	0.46	1597	*10.2*	0.69	2505	0.69
			(0.44)			(0.38)			(0.52)		(0.48)
Total female paid working hours of the HH	3071	*3.1*	-1.19^{***}	3355	*3.0*	-1.01^{***}	1597	*3.1*	-1.05^{***}	2505	-0.98^{***}
			(0.36)			(0.21)			(0.30)		(0.34)
(LOG) Typical wage/hour males (Rs†) per hhm	2016	*21.6*	$7.22\%^{*}$	2238	*40.8*	1.06%	1058	*34.5*	5.06%	1681	1.96%
			(3.85)			(3.35)			(3.66)		(5.33)
(LOG) Typical wage/hour female (Rs†) per hhm	598	*12.5*	7.78%	875	*21.4*	$13.93\%^{*}$	454	*19.3*	15.07%	660	2.82%
			(8.47)			(7.28)			(9.21)		(20.06)
Children 3-5 Time Allocation (Gwalior)											
Children 3-15: =1 if doing domestic housework	1542	*44.8%*	-6.57^{**}	1409	*46.8%*	−3.50	781	*49.8%*	−1.62	1266	-11.84^{***}
			(2.71)			(2.40)			(2.99)		(3.75)
Children 3-15: =1 if carrying water	1542	*41.5%*	-8.23^{**}	1402	*37.9%*	-9.05^{***}	777	*45.6%*	-9.06^{**}	1259	-15.18^{***}
			(3.27)			(2.78)			(3.51)		(4.33)
Children 3-15: =1 if working HH business	1542	*2.3%*	-2.56^{**}	1401	*14.7%*	−1.45	776	*18.8%*	−1.49	1258	−1.28
			(1.10)			(1.66)			(2.10)		(2.38)
Children 3-15: =1 if playing	1542	*82.2%*	2.75	1403	*88.9%*	−1.67	778	*90.4%*	0.71	1260	2.04
			(2.39)			(2.04)			(2.40)		(2.99)
Children 3-15: =1 if taking care of elders or sick HH members	1542	*42.5%*	−0.20	1404	*30.8%*	2.93	779	*32.0%*	3.33	1261	−1.82
			(3.22)			(2.81)			(3.42)		(4.36)
Children 3-15: =1 if extra education	1542	*21.0%*	7.57^{***}	1409	*32.2%*	4.86^{*}	781	*28.4%*	3.95	1266	2.81
			(2.55)			(2.84)			(4.45)		(3.75)

† Rupees of 2013: R1 values where adjusted by a factor of 1.32. It was calculated based on national level figures for 2011, 2012 and 2013. Wages are for individuals aged 25 to 60.
X_i includes socio-demographic controls of the main woman, HH head and the HH demographics and socio-economic status. Robust SE on parenthesis. Significance: * 10%, ** 5%, *** 1%.

Consumption, Wealth and Finances

Sanitation can affect the wealth of households in a number of ways. We discussed in our theoretical framework that through improved health households might become more productive and hence work more or earn higher wages. Given that we are controlling for annual income per capita of the household, a downward bias might be introduced in all estimates that are directly related to it. However, we find large, positive and significant correlation between sanitation ownership and uptake and household consumption. Table 9 shows estimates for a number of consumption expenditure variables. Total expenditure is, consistently across specifications, positively correlated with sanitation ownership as well as acquisition. In line, estimates on non-durable consumption expenditures, which includes expenditures on items such as transport, utilities, fuel, salary, education, health, cosmetics, follow the same pattern. No clear relationship is found on expenditures on alcohol and tobacco, food consumption expenditures on the other hand also show positive and significant correlations with toilet ownership. However, for food consumption expenditures, this relationship only in the cross-sectional specifications. Once the panel estimator is considered, the point estimate is not different from zero.[12] Overall, the evidence suggests that, while there might be extra operational costs due to the toilet, there seems to be a general increase in consumption expenditures for household that decided to invest in a toilet.

A change one would expect due to investment in sanitation is an increase in the dwelling value. And we see this to be indeed the case. Table 10 shows that owning a toilet increases the value of the dwelling significantly - a finding that is consistent across all our specifications and in the robustness analysis. And the increase in value is much above the investment needed to construct the toilet. As mentioned before, the typical toilet owned in our sample (a single pit toilet) can be built with 10,000 Rs and households that provided estimates on construction costs of their toilet reported these to have been around Rs 20,000. The reported increase in value of the dwelling due to the toilet is on the other hand significantly higher at 50,000 Rs. This is for houses that are on average worth 170,000 Rs in 2013. It is worth stressing though that these values are self-reported and it is conceivable that respondents have a biased view on the value of an investment as large as 20% of average household annual income. However, having said that, typically toilets also provide households with private bathing space and we indeed find that households with a toilet are about 30% more likely to also own a bathroom.

Interestingly, we also find significant relationships between sanitation and other assets the households own. Specifically, the value of other *household* asset is significantly higher if household have a toilet and there is some indication that also transportation assets (bicycle, scooter, motorbike and fourwheeler) increases with sanitation ownership. These results tell us more about the idea of social status: despite having similar income, HHs with sanitation might also have better quality of life in general.

We finally consider savings and credit of our study households, shown in the lower panel of Table 10. Results on savings suggest that households with toilets are slightly more likely to have savings in 2010, but not in 2013 (matching panel results even suggest a decrease in savings). This supports

[12] Results of the matching are confirming these results on consumption expenditures, showing positive and highly significant increases in total consumption of around 16-17 percentage points, primarily driven by expenditures on non-durable consumption. The results on food consumption are again less clear and differ by specification.

once again that toilet-ownership is spreading towards household with less means. We already saw that households of lower income and lower castes caught up in terms of toilet ownership between the two waves.

Results on credit outcomes suggest that the investment in toilets was facilitated by greater credit access. We see that households which own a toilet have larger loans (as a proportion of their income), especially at the time of the second survey round in 2013. The result holds in the cross-sectional as well as longitudinal specification. Also matching estimates show this pattern. This is a very interesting result with respect to the descriptive analysis: most of the HHs claimed that they used their own resources to build a toilet, however it seems that access to credit is essential for allowing HHs to make such investments.

Table 9: Household Consumption

Eq6. Cross-section τ **:** $Y_{i,j,t=\tau} = \delta Toilet_{i,j,t=\tau} + X_{i,j,t=\tau}\omega_1 + u_{i,j,t=\tau}$
Eq7. Panel: $Y_{i,j,t} = \delta Toilet_{i,j,t} + X_{i,j,t}\omega_2 + \alpha_i + \gamma_t + u_{i,j,t}$
Sample: All available data in each survey at HH level. **Restricted (R):** HHs that did not report having a toilet at the R1.

	Cross-section analysis									Panel	
	Round 1			Round 2			Restricted Round 2			Linear Panel	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Outcome Variables Y	N Ind	$\bar{Y}_{t=1}$	Eq6	N Ind	$\bar{Y}_{t=2}$	Eq6	N Ind	$\bar{Y}_{t=2}$	Eq6	N Ind	Eq7
Consumption last year per hhm											
(LOG) Total consumption (1000 Rs†)	3065	*23.8*	13.65%***	3354	*23.0*	17.74%***	1597	*20.7*	13.85%***	2505	14.49%***
			(2.57)			(2.77)			(3.72)		(3.57)
(LOG) Total food consumption excl. tobacco and alcohol (1000 Rs†)	3033	*15.5*	8.25%***	2997	*9.7*	10.13%***	1457	*8.6*	8.23%**	2304	4.88%
			(2.77)			(2.47)			(3.80)		(3.79)
(LOG) Non-durable I consumption (1000 Rs†)	3043	*6.2*	28.45%***	3339	*10.6*	28.10%***	1591	*8.8*	17.44%***	2494	24.10%***
			(4.11)			(3.29)			(5.04)		(4.71)
(LOG) Expenditure on Alcohol and tobacco yearly (1000 Rs†)	617	*0.9*	12.56%	718	*1.8*	−2.48%	376	*2.0*	−1.23%	590	−7.03%*
			(14.43)			(13.18)			(17.59)		(4.11)

† Rupees of 2013: R1 values where adjusted by a factor of 1.32. It was calculated based on national level figures for 2011, 2012 and 2013.
X_i includes socio-demographic controls of the main woman, HH head and the HH demographics and socio-economic status. Robust SE on parenthesis. Significance:
* 10%, ** 5%, *** 1%.

Table 10: Assets and finances

Eq6. Cross-section τ : $Y_{i,j,t=\tau} = \delta Toilet_{i,j,t=\tau} + X_{i,j,t=\tau}\omega_1 + u_{i,j,t=\tau}$
Eq7. Panel: $Y_{i,j,t} = \delta Toilet_{i,j,t} + X_{i,j,t}\omega_2 + \alpha_i + \gamma_t + u_{i,j,t}$
Sample: All available data in each survey at HH level. **Restricted (R):** HHs that did not report having a toilet at the R1.

	Cross-section analysis									Panel	
	Round 1			Round 2			Restricted Round 2			Linear Panel	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Outcome Variables Y	N Ind	$\bar{Y}_{t=1}$	Eq6	N Ind	$\bar{Y}_{t=2}$	Eq6	N Ind	$\bar{Y}_{t=2}$	Eq6	N Ind	Eq7
Water and Dwelling Characteristics											
=1 if main source drinking water is HH service connection	3071	*22.2%*	15.82***	3352	*30.0%*	8.72***	1596	*23.7%*	6.65***	2504	12.58***
			(2.61)			(1.94)			(2.23)		(2.24)
=1 if HH has a bathroom	3071	*50.6%*	38.61***	3353	*68.2%*	27.14***	1596	*60.5%*	28.75***	2504	29.97***
			(2.44)			(1.89)			(2.61)		(2.56)
(LOG) Value of the dwelling (1000 Rs.†)?	2442	*160.9*	41.22%***	2700	*274.6*	46.97%***	1340	*201.5*	37.78%***	1980	38.09%***
			(5.56)			(5.92)			(8.94)		(8.65)
Other assets											
(LOG) Transport (1000 Rs†)	2237	*11.2*	29.78%***	2506	*26.2*	50.54%***	1153	*15.2*	40.36%***	1861	30.43%***
			(7.56)			(7.64)			(10.19)		(9.93)
(LOG) House elements (1000 Rs†)	2977	*68.0*	15.81%***	3220	*367.7*	30.38%***	1537	*272.9*	28.26%***	2434	31.73%***
			(4.94)			(5.97)			(8.47)		(7.98)
(LOG) Farm (1000 Rs†)	1163	*50.5*	−3.06%	1385	*97.9*	22.98%**	749	*97.2*	1.62%	1001	26.70%*
			(14.83)			(11.12)			(14.09)		(15.74)
Savings and loans											
=1 if hh has any type of savings	3071	*36.2%*	3.10	3343	*46.7%*	3.59**	1591	*44.1%*	1.50	2495	1.93
			(2.15)			(1.72)			(2.44)		(2.54)
(LOG) Amount of savings per hhm (1000 Rs†)	1073	*3.2*	9.14%	1483	*2.2*	43.85%***	673	*1.9*	29.42%**	1017	29.81%
			(10.82)			(8.68)			(12.46)		(19.36)
=1 if household has debt outstanding	2916	*38.5%*	−4.76**	2745	*56.4%*	−0.19	1288	*58.6%*	3.66	1972	−0.45
			(2.29)			(2.62)			(3.57)		(3.16)
(LOG) Amount of debt outstanding (calculated) per hhm (1000 Rs†)	1091	*10.0*	20.98%***	1741	*23.6*	38.64%***	802	*18.6*	61.65%***	1149	57.66%***
			(7.69)			(10.43)			(12.42)		(17.07)

† Rupees of 2013: R1 values where adjusted by a factor of 1.32. It was calculated based on national level figures for 2011, 2012 and 2013.
X_i includes socio-demographic controls of the main woman, HH head and the HH demographics and socio-economic status. Robust SE on parenthesis. Significance:
* 10%, ** 5%, *** 1%.

Main woman of the household

Our final set of outcomes focuses on the main woman in the household. We consider three types of variables: Financial information of the woman (savings), her knowledge about hygiene and sanitation practices and indicators of empowerment. The latter are often considered a determinant of uptake with more empowered women having higher bargaining power to push for the asset. We check here whether a relationship exists the other way round and the direction of this possible relationship. One could consider that a toilet provides the women of the household with less influence since they now have less reason to leave the dwelling and hence less possibilities for interaction with others in the community. On the other hand, one could think of situations where a toilet offers time savings which lead to more interaction and say within the household.

The upper panel of Table 11 shows results on empowerment indicators. We find little consistent correlation between sanitation and empowerment of the main woman in the household. The freedom of mobility indicator captures whether or not the women were allowed to go unaccompanied to a local market, to the health center or doctor, to visit neighbours, to visit friends/family within village, to visit relatives outside the village, to visit religious facilities, to collect water. The index runs from 0 to 7 as it is the sum of positive answers to those questions. Control over money index, from 0 to 6, follows a similar pattern. It takes into account if women control the money needed for buying fruits or vegetables, other food items, clothes for herself, medicine for herself, toiletries for herself, and clothes and medicine for her kids. Participation in household choices is a sum of dichotomous questions related to her participation on a set of decisions: to work, to buy a durable good, how to allocate the typical budget, and what to do with extra resources. The unconditional correlations are negative for control over money[13] and mobility indexes, while positive for the participation one. These results might suggest that both women empowerment and sanitation are outcomes of the marriage market (as discussed in the determinants section), and sanitation per se does not seem to be related to variations on such power once the couple is established. However, given that we do not have exogenous variation on women power in the household, we cannot test such hypothesis formally. Similarly, we do not find that savings of the main woman seem to change with toilet ownership or acquisition.

The last two variables presented in the Table capture hygiene knowledge of the main woman. The variables are derived from a set of 21 items that ask if water can cause diseases, for causes of diarrhea, and possibilities to prevent it. While the correlation is positive with the total correct answers, and negative with the incorrect ones (it was possible to omit questions), such relation is weak and seems unrelated to the decision to invest or not in sanitation. However, matching results show stronger evidence in the panel specification that knowledge increases over time with a positive and significant coefficient on number of correct answers and the opposite for number of incorrect answers.

[13] Matching results suggest a significant negative relationship between sanitation ownership and control over money.

Table 11: Main women hygiene-related outcomes

Eq6. Cross-section τ **:** $Y_{i,j,t=\tau} = \delta Toilet_{i,j,t=\tau} + X_{i,j,t=\tau}\omega_1 + u_{i,j,t=\tau}$
Eq7. Panel: $Y_{i,j,t} = \delta Toilet_{i,j,t} + X_{i,j,t}\omega_2 + \alpha_i + \gamma_t + u_{i,j,t}$
Sample: All available data in each survey at HH level. **Restricted (R):** HHs that did not report having a toilet at the R1.

	Cross-section analysis									Panel	
	Round 1			Round 2			Restricted Round 2			Linear Panel	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Outcome Variables Y	N Ind	$\bar{Y}_{t=1}$	Eq4	N Ind	$\bar{Y}_{t=2}$	Eq4	N Ind	$\bar{Y}_{t=2}$	Eq4	N Ind	Eq5
Main women hygiene-related outcomes											
Freedom of mobility index	3071	*5.1*	−0.33*	3355	*4.9*	−0.14	1597	*5.0*	−0.29	2505	0.01
			(0.20)			(0.13)			(0.20)		(0.17)
Participation in household choices index	3071	*3.2*	−0.30**	3355	*3.7*	0.05	1597	*3.7*	0.05	2505	0.03
			(0.15)			(0.09)			(0.12)		(0.12)
Control over money index	3071	*4.3*	−0.25	3355	*2.8*	−0.17	1597	*2.9*	−0.33*	2505	−0.08
			(0.18)			(0.12)			(0.17)		(0.16)
Report to have savings on her own				2842	*33.8%*	−0.17	1378	*32.2%*	0.89		
						(1.95)			(2.52)		
Savings amount (if any)				2843	*706.0*	−82.36	1379	*519.5*	−149.88		
						(147.33)			(126.02)		
Hygiene Knowledge test index: correct answers	2840	*16.3*	0.03	2847	*14.2*	0.12*	1382	*15.0*	0.07	2184	0.08
			(0.19)			(0.07)			(0.12)		(0.33)
Hygiene Knowledge test index: incorrect answers	2781	*4.4*	0.08	2847	*7.5*	−0.12*	1382	*6.7*	−0.09	2184	0.07
			(0.17)			(0.07)			(0.11)		(0.32)

† Rupees of 2013: R1 values where adjusted by a factor of 1.32. It was calculated based on national level figures for 2011, 2012 and 2013.
X_i includes socio-demographic controls of the main woman, HH head and the HH demographics and socio-economic status. Robust SE on parenthesis. Significance: * 10%, ** 5%, *** 1%.

5 Discussion and Conclusions

We make use of primary data collected as part of an evaluation exercise of a sanitation intervention called FINISH. While not experimental, this data provides us with the opportunity to study important determinants of toilet ownership and acquisition of slum-dwellers and households in peripheral as well as rural villages in two states of India.

Gaining a deeper understanding of characteristics that determine toilet ownership and acquisition is important given the current push and aim to improve the sanitation situation in India, as well as in other developing countries. Including in the analysis both urban and rural households adds important considerations: India's slum population is growing rapidly while at the same time having no or only inadequate access to safe sanitation. High population density coupled with improper means of disposing faeces provides a breeding ground for preventable disease epidemics. At the same time, it is important not to leave rural areas behind, highlighting a potential concern about the sanitation gap between urban and rural areas.

Our findings suggest that an important motivator for toilet construction is status and living standards. Households not only report their status to have increased due to acquisition of a private toilet, they also report the value of their dwelling to be significantly higher and we find other changes that could be related to improved status such as a reduction in labor of the main woman in the household. This reduced labor shows sign of increasing investment in education of the children in the household.

Contrary to studies that suggest that health considerations play only a minor role in the decision to acquire sanitation, we find that households perceive to be healthier than their neighbors because of the constructed toilet. While we cannot draw a clear conclusion from the data whether households are actually healthier, our evidence strongly suggests that they personally feel that the toilet made them better off compared to other households. These results - in line with other studies ([Sinroja, 2013]) suggest that - contrary to common perception - willingness to pay exists in these markets and households are aware of benefits they can reap from having access to safe sanitation

We however also provide evidence that financial constraints are particularly binding for households in the lower end of the income distribution and that access to finance facilitates uptake. This could be through finance for the specific purpose of building sanitation, but also by freeing other resources that can now be invested to construct a toilet.

These findings, which are robust to a number of specification tests, can provide important input in designing sanitation interventions, tailored to both rural areas as well as to slum-dweller populations. They suggest that messaging around status and moving up in society might resonate well with this type of population. Our findings also suggest that campaigns such as the 'no loo, no bride' campaign launched by the government of Haryana in 2005 might work particularly well in a slum-setting. A paper by [Stopnitzky, 2012] shows in line with this that increasing proportions of females with strong sanitation preferences drive male investment in toilets.

Overall, our findings suggest that despite being an investment of considerable size for poor households, they value the decision and perceive to have gained along a number of margins.

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Appendix 1: Study locations

Figure 3: Study site - Gwalior

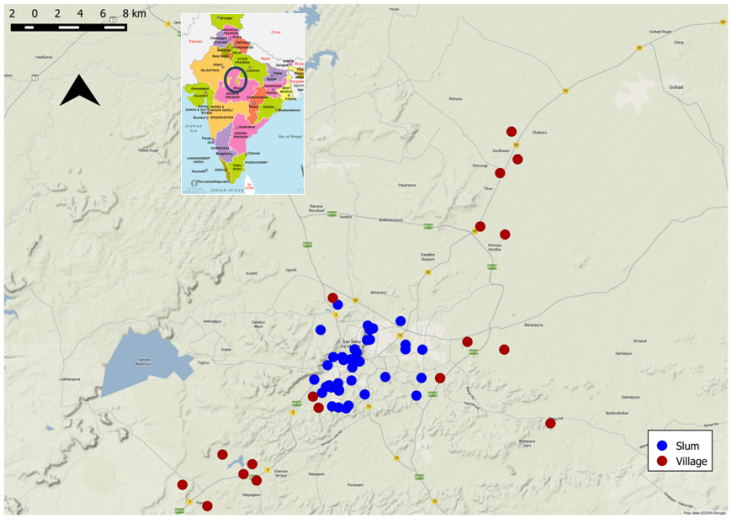
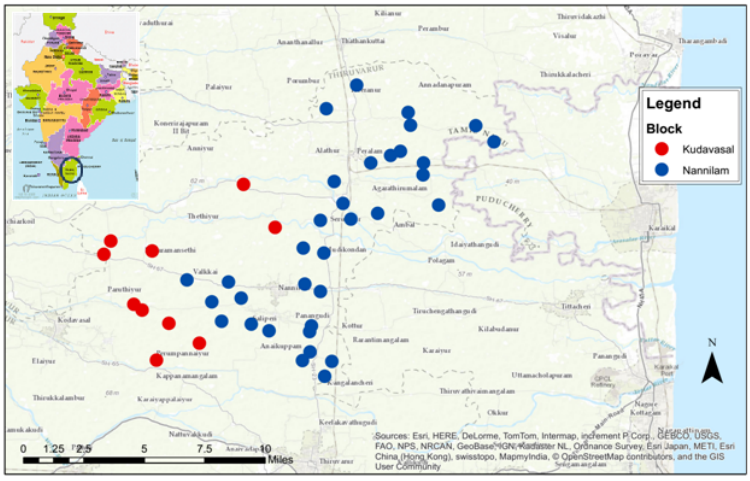


Figure 4: Study site - Tamil Nadu



Appendix 2: Robustness check - Propensity score matching

Figure 5: Propensity Score Matching

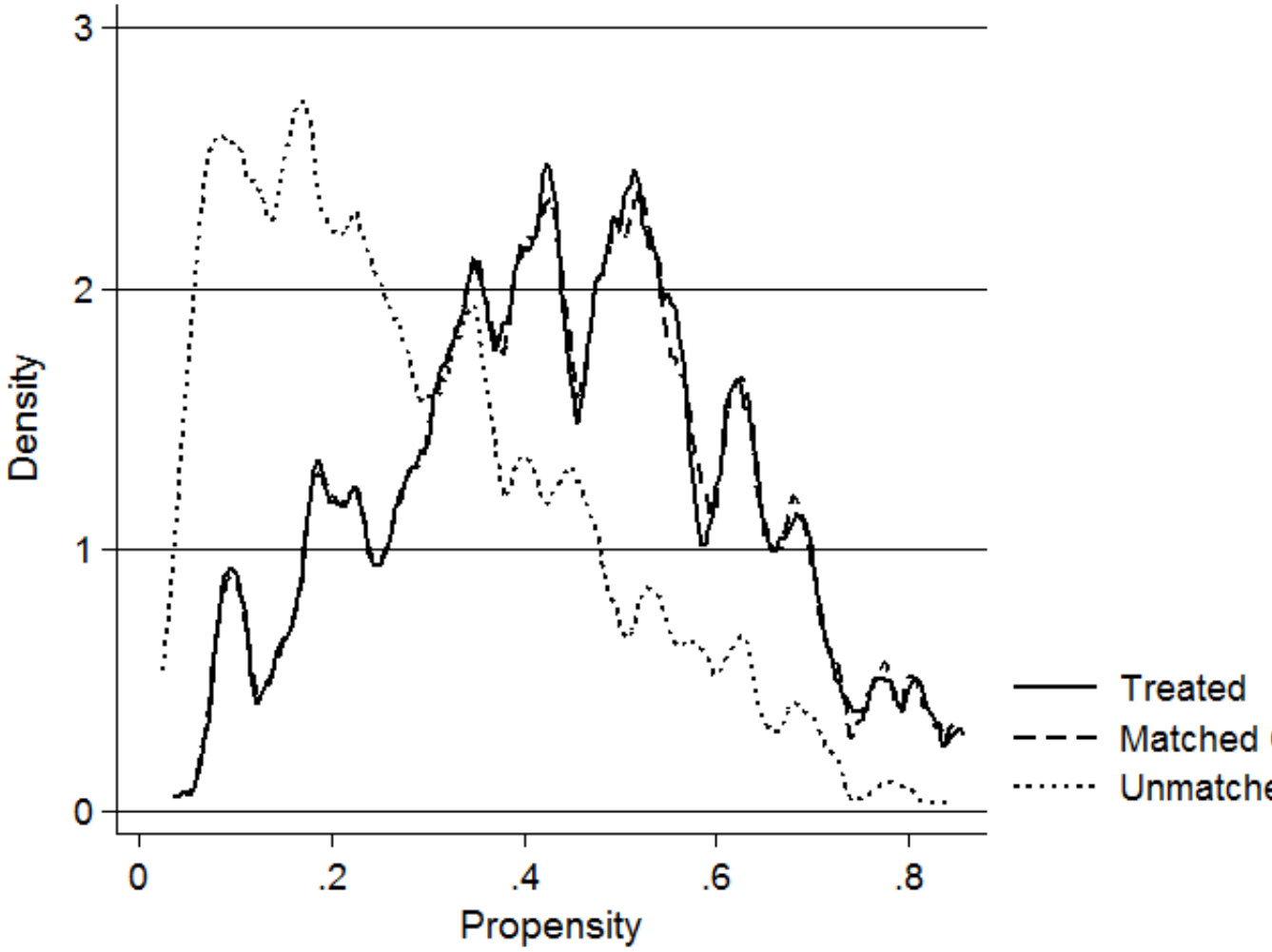


Table 12: Estimates under the matched sample on Round 1 covariates

Eq6. Cross-section τ : $Y_{i,j,t=\tau} = \delta Toilet_{i,j,t=\tau} + X_{i,j,t=\tau}\omega_1 + u_{i,j,t=\tau}$
Eq7. Panel: $Y_{i,j,t} = \delta Toilet_{i,j,t} + X_{i,j,t}\omega_2 + \alpha_i + \gamma_t + u_{i,j,t}$
Sample: All available data in each survey at HH level. **Restricted (R):** HHs that did not report having a toilet at the R1.

	Cross-section analysis			Panel	
	Restricted Round 2			DID on R.	
	(1)	(2)	(3)	(4)	(5)
Outcome Variables Y	N Ind	$\bar{Y}_{t=2}$	Eq6	N Ind	Eq7
Health Outcomes					
=1 if visited a doctor without hospitalization (last 4 weeks)	1497	*50.0%*	3.85	1692	−2.75
			(3.87)		(4.35)
Labour market					
Total male paid working hours of the HH	1508	*10.2*	0.33	1709	0.70
			(0.96)		(0.87)
Total female paid working hours of the HH	1508	*3.2*	−1.49***	1709	−1.11*
			(0.39)		(0.63)
Children 3-5 Time Allocation (Gwalior)					
Children 3-15: =1 if doing domestic housework	712	*49.6%*	−2.17	712	−9.35
			(3.19)		(6.13)
Children 3-15: =1 if carrying water	708	*44.2%*	−12.64***	708	−11.28
			(3.93)		(6.97)
Children 3-15: =1 if extra education	712	*28.9%*	2.69	712	0.70
			(4.84)		(5.27)
Consumption					
(LOG) Total consumption (1000 Rs†)	1220	*21.1*	12.44%***	1709	17.31%***
			(4.70)		(6.60)
(LOG) Total food consumption excl. tobacco and alcohol (1000 Rs†)	1213	*8.6*	7.83%*	1516	−11.45%*
			(4.18)		(6.64)
Water, Dwelling Characteristics, and Other Assets					
=1 if HH has a bathroom	1507	*59.7%*	28.13***	1708	27.08***
			(3.42)		(3.98)
(LOG) Value of the dwelling (1000 Rs.†)	1267	*201.8*	47.00%***	1449	48.36%***
			(9.25)		(9.71)
(LOG) Transport (1000 Rs†)	1081	*15.2*	48.58%***	1248	40.60%***
			(13.82)		(15.59)

† Rupees of 2013: R1 values where adjusted by a factor of 1.32. It was calculated based on national level figures for 2011, 2012 and 2013.
X_i includes socio-demographic controls of the main woman, HH head and the HH demographics and socio-economic status. Robust SE on parenthesis. Significance: * 10%, ** 5%, *** 1%.