ARTNeT

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific

Demand for household sanitation: The case of India

Anurag Banerjee

Nilanjan Banik

Ashvika Dalmia

ASIA-PACIFIC RESEARCH AND TRAINING NETWORK ON TRADE

Working Paper

NO. 154 | 2016

The Asia-Pacific Research and Training Network on Trade (ARTNeT) is an open regional network of research and academic institutions specializing in international trade policy and facilitation issues. IDRC, UNCTAD, UNDP, ESCAP and WTO, as core network partners, provide substantive and/or financial support to the network. The Trade and Investment Division of ESCAP, the regional branch of the United Nations for Asia and the Pacific, provides the Secretariat of the network and a direct regional link to trade policymakers and other international organizations.

The ARTNeT Working Paper Series disseminates the findings of work in progress to encourage the exchange of ideas about trade issues. An objective of the series is to publish the findings quickly, even if the presentations are less than fully polished. ARTNeT Working Papers are available online at www.artnetontrade.org. All material in the Working Papers may be freely quoted or reprinted, but acknowledgment is requested, together with a copy of the publication containing the quotation or reprint. The use of the working papers for any commercial purpose, including resale, is prohibited.

Disclaimer:

The designations employed and the presentation of the material in this Working Paper do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. Where the designation “country or area” appears, it covers countries, territories, cities or areas. Bibliographical and other references have, wherever possible, been verified. The United Nations bears no responsibility for the availability or functioning of URLs. The views expressed in this publication are those of the author(s) and do not necessarily reflect the views of the United Nations. The opinions, figures and estimates set forth in this publication are the responsibility of the author(s), and should not necessarily be considered as reflecting the views or carrying the endorsement of the United Nations. Any errors are the responsibility of the author(s). The mention of firm names and commercial products does not imply the endorsement of the United Nations.

ASIA-PACIFIC RESEARCH AND TRAINING NETWORK ON TRADE

WORKING PAPER

NO. 154 |2016

Demand for household sanitation: The case of India

Anurag Banerjee,[*] Nilanjan Banik,[**] and Ashvika Dalmia[***]

Please cite this paper as: Anurag Banerjee, Nilanjan Banik, and Ashvika Dalmia (2016), Demand for household sanitation: The case of India.

ARTNeT Working Paper Series No. 154, 2016, Bangkok, ESCAP.

Available at http://artnet.unescap.org

[*] Anurag Banerjee, Durham Business School, United Kingdom [**] Nilanjan Banik, Mahindra Ecole Centrale, India [***] Ashvika Dalmia, Durham Business School, United Kingdom. The authors are grateful to Mia Mikic for helpful comments on an earlier draft of this paper. Thanks also to the ARTNeT Secretariat for technical support in disseminating this paper. Any errors that remain are the sole responsibility of the authors. The corresponding author's email: nilbanik@gmail.com.

Abstract

Worldwide, India has the highest number of people defecating in the open. In an attempt to reduce number of open defecation, a supply side initiative is underway. In 2014-2015, Government of India, constructed 8 million toilets. However, an important aspect for this supply-side initiative to become successful is to create demand for toilets. In this paper we look at household demand for toilets, and study the factors leading to open defecation. Using Demographic and Health Survey data we create a wealth index, and use it to rank household preference for toilets vis-à-vis 20 other different consumer durables. Our results suggest, among lists of household items that any individual want to have, toilets get a lower preference – ranked 12, out of 21. Additionally, we examine preference structure for using toilets among residents from various federal states in India. We find residents of North-Eastern states are more likely to use toilets. We further investigate factors leading to toilet usage among households. Results indicate a strong case for imparting education and public awareness, especially, among the female cohort.

Keywords: India, Sanitation, Toilets, Preference Structure, Logit, NFHS-3

JEL classification: C01, I18, O11

Contents

Figures

Tables

1. Introduction

On October 2, 2014 Indian Prime Minister Mr. Narendra Modi launched the *Swachh Bharat* (Clean India) mission, aimed at creating a 'Clean India' over the next five years. The launch of the mission comes in answer to the rising perception about Indian cities not being clean. This, unfortunately, is also true to a certain extent. A number of people in rural areas still do not have access to toilets. Each day, about 100,000 tons of human faeces are found in the open (UNICEF, 2015). Certain schools in rural areas do not have access to toilets. Over 40 per cent of government schools in India do not have a functioning toilet (UNICEF, 2015). According to Census 2011, only 32.70 per cent of rural households have access to toilets. Worldwide, India has the highest number of people defecating in the open, at 597 million (WHO, 2014). In 2012, average concentration of open defecator per square kilometre area was highest in India, more than double than the world average (Coffey et al., 2014).

The *Swatch Bharat* mission is a supply-side initiative that plans to build 110 million toilets across India between 2014 and 2019. The underlying presumption is India has a large number of poor populations who cannot afford to construct a toilet, and therefore the need for government intervention. However, the social returns in terms of better health outcome will be higher provided people start using these toilets, and stop defecating in the open.

The success of government initiative would then depend upon influencing demand for toilets. This paper addresses this important aspect. As far as the authors are aware this is the first quantifiable attempt to look into household characteristics influencing his/her decision to use toilets. In fact, we rank in terms of household preference, the demand for toilets vis-à-vis 20 other consumer durables such as cot, watch, mattress, chair, bicycle, table, electric fan, television, pressure cooker, radio, motorcycle, water pump, mobile telephone, sewing machine, refrigerator, tractor, animal drawn cart, thresher, and computer.

Moreover, India is culturally diverse, and provides a natural setting to observe variation in terms of preference for toilet usage against the aforementioned 20 other consumer durables. Ergo, we examine preference structure for using toilets among residents from various states in India. We estimate the likelihood of having a toilet in a household conditional on wealth index, standard of living, household demographic characteristics, and broader cultural and religious factors.

This study takes advantage of the first large dataset – Demographic and Health Survey (DHS) data collected in 2005-2006. The Indian version of the DHS data, that is, the third round of the National Family and Health Survey (NFHS-3) data contains information about

use of toilets by various household characteristics, namely, gender, religion, area, and geography.

Our results suggest among lists of household items that any individual want to have toilets get a lower preference – ranked 12, out of 21. Results also suggest a strong case for imparting education and public awareness, especially, among the female cohort. A household in which a woman has attained *higher* education (18 years of schooling) is 3.1 times more likely to use a toilet. Area-wise, households living in urban areas are 19 times more likely to use toilet in comparison to their rural counterparts. Person with a particular religious background and culturally ingrained to certain religion are less likely to use toilet. *Hindu* (religion) households are less likely to use toilets.

The rest of the article is organized as follows. Section 2 discusses the literature survey. In Section 3 we describe the data. In Section 4 we state our empirical model. Section 5 discusses results from our analysis. Section 6 concludes with relevant policy implications.

2. Related literature

Throughout the world, poor sanitation is one of the leading risk factors for infant mortality. World Health Organization defines basic sanitation as the 'lowest-cost technology ensuring hygienic excreta and sullage disposal and a clean and healthful living environment both at home and in the neighbourhood of users' (UNICEF, 2015). Faeces contain germs that, when released into the environment, make their way onto children's fingers and feet, into their food and water, and wherever flies take them. Exposure to these germs may cause diarrhoea, and in the long term, also can cause changes in the tissues of their intestines that prevent the absorption and use of nutrients in food (Checkley et al., 2008). Every 15 seconds a child dies of a preventable disease relating to contaminated water, sanitation and hygiene (UNICEF, 2015). Recent evidence from Bangladesh and India suggest children exposed to worse sanitation environment are likely to have a stunted growth and are likely to develop enteropathy (Lin et al., 2013; Spears, 2012). George (2008) estimate for each dollar spent on sanitation itis likely to yield a return of $7 to an individual, ashe is less likely to remain absent from work (that is, remain productive) or visit a doctor. Working with district-level income data from India, Banerjee and Banik (2014), show closed drainage system has the maximum impact on income – for 1 per cent increase in a closed drainage system, the income increases between 0.96 per cent and 2.58 per cent. Given its importance in affecting income and development outcomes, 'Clean India' campaign is certainly commendable.

However, this is not the first time that the government started sanitation and hygiene interventions. In 1986, government launched Central Rural Sanitation Programme (CRSP), giving incentives in the form of full or partial funding to households for building toilets. However, this supply-driven programme met with a limited success. Banerjee and Mandal (2011) show between 1981 and 2001, average yearly expansion of toilet was a meagre 1 per cent. The cost of the setting up toilet was often unaffordable for a number of households, especially in rural areas. As economic agents such as firms and non-profit organizations (NPOs) were not involved, there was lack of awareness and generation of demand for sanitary facilities.

Keeping in view these shortcomings, the CRSP was improved. In 1999, CRSP inculcate a demand driven approach. Launched in 1999, and titled 'Total Sanitation Campaign (TSC),' the programme emphasized more on information, education and communication (IEC), human resource development, and capacity development activities, to increase awareness about better sanitation among rural people. Subsequently, in 2003, the government also launched *Nirmal Gram Yojana* (Clean Village Campaign), providing monetary incentives to *Gram Panchayats* (political subdivisions comprising multiple small villages), NPOs, and economic agents, assisting toilet coverage in villages. Unfortunately, this effort also met with limited success. Reports indicate over 40 per cent of the funds under TSC, especially those allocated under IEC remained unused, and government subsidies were often unavailable to households which required it the most (Shah et al., 2013).

Studies have examined the reasons behind limited success of TSC. Ramani (2008) attribute it to market failure. To a poor person, especially, individuals who are at the Bottom of the Pyramid (BOP), the opportunity cost of constructing a toilet is high. The term BOP is coined by Prahalad (2005) as individuals who survive on less than $2 a day. There are no short-term benefits, as the poor care less about long-term health impact of sanitation. From the supply-side, construction of toilets are undertaken by NPOs which are particularly driven by their organisational aims rather than driven by market incentives. Lack of demand also explains why there is a lack of innovation from industry in producing low-cost toilets. In addition to these demand and supply-side factors, a study undertaken by J-PAL (2012) attributes institutional constraint as a factor. For instance, constructing closed drainage system requires coordination between centre, states, and municipalities/gram panchayats at the local-level – which sometime may not be forthcoming.

Finally, there are cultural issues. Coffey et al. (2014) find in rural northern India there is a revealed preference for defecating in the open. In a survey covering 3235 households spreading across five north Indian states – Bihar, Rajasthan, Uttar Pradesh, Madhya Pradesh

and Haryana – results indicate in spite of having toilets, over 40 per cent of the households practiced open defecation. In fact, their model indicates nearly 50 per cent of all rural households will continue to practice open defecation even if government build toilets.

However, O'Rielly and Louis (2014) have a better story to tell. In a survey covering households from rural Himachal Pradesh and West Bengal, this study finds successful adoption of toilet is conditional upon three factors. First is the political will to govern so that the toilets are delivered, and also to mobilize an awareness programme to educate the citizens about the beneficial impact of using toilets. Second is the peer pressure, arising from social stigma of defecating in the open, when everyone else in the neighbourhood is using a toilet. And, third is the political ecology arising from the government bodies guaranteeing supply of water, and ecological factors such as soil quality – making some areas better suited for building toilets than others.

Although the aforementioned studies find out the sets of demand, supply-side, and cultural factors contributing to use of toilets, none of these map preference structure for using toilets vis-à-vis other consumer durables. We believe mapping preference structure is essential to understand effective demand for toilets. We use various household characteristics to map this preference structure. Additionally, the earlier studies use case based approach, something that we are complementing with statistical analysis.

3. Description of data

We use NFHS-3 data collected in 2005-2006. NFHS-3 survey interviewed 109,041 households spreading across 28 states in India. Information about 108,933 are found and are reported in Table 1. Administered under Ministry of Health and Family Welfare, Government of India, NFHS-3 collected information on women and children about health, family welfare, and nutritional intake. Related to toilet, the survey asked the following question: 'What kind of toilet facility do members of your households usually use?'(IIPS and Macro International, 2007, p.48). Respondents are asked to choose among the following options: (a) Flush or pour flush toilet – piped sewer, septic tank, pit latrine, flush to somewhere else; (b) Pit latrine – ventilated improved pit/biogas; pit latrine with slab; without slab, open pit; (c) Twin pit/composting toilet; (d) Dry toilet; and (e) No facility. Additional information about whether households are first time user of toilet, and what kind of existing toilet facility they have, are also asked. Throughout the analysis household is the unit of measurement. [1]In accordance with the DHS methodology, missing values for categorical items (for example, source of

[1] Preliminary findings from the NFHS-3 survey are reported in the Appendix A.

drinking water) are not reassigned, and are treated as 'non available (NA)' observations. Missing values for dichotomous variables (for example, electricity and durable goods) are assigned to the category of failure, that is, the household does not possess these goods. Table 2 reports the variables that we use for our empirical analysis.

Table 1: Summary statistics of the variables

			Latrine users		**Non-latrine users**	
		Sample Total	Number	% of group	Number	% of group
Total sample		108939	67483	61.95%	41456	38.05%
Type of residence	Rural	58753	22713	38.66%	36040	61.34%
	Urban	50186	44770	89.21%	5416	10.79%
Household's highest education level	No education/Preschool	9088	2586	28.46%	6502	71.54%
	Primary	15859	5856	36.93%	10003	63.07%
	Secondary	59940	37180	62.03%	22760	37.97%
	Higher	24038	21853	90.91%	2185	9.09%
Household head's gender	Male	93246	57933	62.13%	35313	37.87%
	Female	15693	9550	60.86%	6143	39.14%
Household head's religion	Hindu	79941	44681	55.89%	35260	44.11%
	Muslim	13341	10033	75.20%	3308	24.80%
	Christian	10037	8552	85.20%	1485	14.80%
	Other	5592	4200	75.11%	1392	24.89%
Household has electricity	Yes	85766	61931	72.21%	23835	27.79%
	No	23173	5552	23.96%	17621	76.04%
Household's wealth	Owns house	91445	53684	58.71%	37761	41.29%
	Owns agricultural land	43850	20803	47.44%	23047	52.56%
	Owns a bank or post office account	49253	38324	77.81%	10929	22.19%
House type	*Kachcha* (Mud/Bamboo house)	11355	3102	27.32%	8253	72.68%
	Semi-pucca	39590	16568	41.85%	23022	58.15%
	Pucca (Brick house)	57215	47300	82.67%	9915	17.33%

Source: Authors' calculation

Table 2: Use of toilets by household characteristics

Characteristics	Variables	Description of variables at a household-level	Description, for household *i*
Use of a toilet facility	Toilet	Household has a toilet facility	=1, if yes 0, if no
Women's education	Preschool	Dummy for highest education level of eligible women in the household	=1, if no/ preschool education 0, otherwise
	Primary	Dummy for highest education level of eligible women in the household	=1, if primary education 0, otherwise
	Secondary	Dummy for highest education level of eligible women in the household	=1, if secondary education 0, if otherwise
	Higher	Dummy for highest education level of eligible women in the household	=1, if higher education 0, if otherwise
Number of women	Women	Number of eligible women in household	=0-20
Type of residence	Megacity	Dummy for type of residence	=1, if a city with population exceeding 10 million 0, otherwise
	Large city	Dummy for type of residence	=1, if a large city 0, otherwise
	Small city	Dummy for type of residence	=1, if a small city 0, otherwise
	Large town	Dummy for type of residence	=1, if a large town 0, otherwise
	Small town	Dummy for type of residence	=1, if a small town 0, otherwise
	Rural	Dummy for type of residence	=1, if countryside 0, otherwise
Sex	Gender	Dummy for gender, household-head	=1, if female 0, if male
Age	Age	Age, household-head	3<Age<95 (Discrete)
Wealth	House	Household owns this or other house	=1, if yes 0, if no

	Land	Household owns land usable for agriculture	=1, if yes 0, if no
	Hectare	Hectares of agricultural land	0<Hectare<95 (Discrete)
	Bank	Household has a bank or post office account	=1, if yes 0, if no
Standard of Living Index	Durable Dwelling	Index of durable goods, and dwelling characteristics	-1.75<Durable Dwelling<2.48
Religion	Hindu	Dummy for household-head, religion	=1, if Hindu 0, otherwise
	Muslim		=1, if Muslim 0, if otherwise
	Christian		=1, if Christian 0, otherwise
	Other religion		=1, if other religion (Sikh, Buddhist, Jain, Jewish, Parsi, no religion, Donyi polo) 0, otherwise
Caste	Caste	Dummy for household-head, caste or tribe	=1, if scheduled caste, scheduled tribe or other backward caste 0, otherwise
State variables	State dummies	State dummy, Delhi is the reference category	
	Water	% of households that have water available within their premises	24.7%<Water<91.2%
	Wealth	Expected wealth of households (restricted to those who own agricultural land)	0<Wealth<1.55

4. Empirical method

The empirical analysis has two parts. In the first part of the analysis we examine the preference for having a toilet vis-à-vis other consumer durables. In the second part of the analysis we look at various household characteristics, including, preference structure for having toilets across residents from various federal states in India.

For the first part of the analysis we create a wealth index. The motivation is to examine importance of toilet vis-à-vis other major components of wealth. We define wealth in the

conventional sense, as net stock of financial and real assets that are appreciating over time. OECD (2013) considers immovable property such as house, savings in banks, equities and bonds, and land ownership as components of wealth.[2]

We follow OECD (2013), and create a wealth index. Wealth is treated as a random variable. It is created from durables (variables) $x_1,\ x_2,\ \ldots, x_n$ that any household is likely to have, with probabilities $p_1,\ p_2,\ \ldots, p_n$, respectively. The expected wealth for any household *i* is given as $E\ (Wealth_i) = \sum_{i=1}^{n} x_i p_i$. Following OECD (2013), we consider house, bank accounts, and agriculture land, as components of wealth. Therefore, in this paper, expected wealth of any representative household, say, *Household i* is given as: $E(Wealth_i) = House_i \times p_{house} + Bank_i \times p_{bank} + Land_i \times p_{land}$. Given this base-level of expected wealth, we compute the probabilities with which any household is likely to get any particular consumer durable. Alongside, toilet, we consider 20 other different consumer durables. Once we compute these 21 different probabilities, we rank them to determine demand for toilets in comparison to other 20 consumer durables.

We use logistic regression, and the parameters are estimated using maximum likelihood method of estimation. Although a probit model produces similar results (Verbeek, 2012), we use logit, as it has advantage over probit for computing the odd ratios (Hosmer and Lemeshow, 2000). Odd ratio gives the likelihood that a consumer will prefer any particular consumer durable. The odd ratio of success, that is, a consumer *i* with a given wealth base (that is, $Wealth_i$) will prefer to have a particular durable, say *j* is given as:

$$\frac{\Pi_j}{1-\Pi_j} = e^{\alpha+\beta(Wealth_i)} \tag{1}$$

A log-transformation of equation (1) yields:

$$\log(\frac{\Pi_j}{1-\Pi_j}) = \alpha + \beta(Wealth_i) \tag{2}$$

The exponentiation of the coefficient (β)is the odd-ratio. Higher β indicates a higher odd-ratio. The odd-ratio is calculated as a ratio of the event that a good, say for instance mobile phone is adopted, when a particular attribute $Wealth_i$is given, against the event that the mobile phone is adopted in absence of $Wealth_i$. Importantly, for the computation of the odds ratio to be suitable, the individual variable must be statistically significant. Thus, for a dichotomous significant independent variable x (for example, mobile phone) that takes the values 0 and 1, the odds ratio is defined 'as the ratio of the odds for *x* = 1 to the odds for *x* = 0' (Hosmer and

[2] We restrict landownership for agricultural land only. Considering urban land does not change the expected wealth outcome, and hence is not included.

Lemeshow, 2000, p. 49). By comparing to a cut-off value, like 0.5, we can predict choice of adopting a particular durable good using the rule as given in Brooks (2008):

$$\hat{x} = \begin{cases} 1, \hat{\pi} \geq 0.5 \\ 0, \hat{\pi} < 0.5 \end{cases}$$

Hence, the probability 0.5 represents the margin at which the good is assumed. At this probability, the odds of a success is 1 and the level of wealth at which the durable good is adopted by individual *i* can be found by rearranging equation (2) as:

$$E(Wealth_i) = -\frac{\alpha}{\beta} \tag{3}$$

For the second part of the analysis we run a multivariate analysis incorporating various household characteristics, namely, gender, religion, area, standard of living, institution, and geography. To select on the appropriate variables we take note of related literature about use of toilets. For instance, Jenkins and Curtis (2005), and Santos et al. (2011) argue as there is an element of safety and dignity associated with it, women are more likely to use toilets in comparison to their male counterparts. Therefore, gender is an explanatory variable. Similarly, we consider female literacy rates. Using Census-2011 data (survey conducted by Government of India) Ghosh and Cairncross (2014) find an inverse relation between female literacy rates and open defecation. Wei et al. (2004) reports a similar finding - female literacy rates explain 24.3 per cent of the variance in the distribution of toilet usage.

These findings are important. The implication is that the problem of sanitation in India is not solely determined by the supply side factors such as construction of toilets, but requires behavioural alterations resulting from higher education. This will help to develop market for toilets (O'Reilly, 2010).

Following Santos et al. (2011) we consider age. They find younger respondents in Salvador and Brazil prefer to use toilets in comparison to their older cohorts. Bonu and Kim (2009) find regional factors such as state-level toilets intake, and urban-rural residence as factors, affecting uptake in toilet usage. To control for the region specific effect, we differentiate respondents from urban and rural areas. And, within urban areas, we differentiate between mega city, large city, small city, large town, and small town. For capturing state-specific effect we introduce state dummies.

We consider percentage of household in any particular state with water connection as a proxy for institution. The reason for including the institutional factors is the study by J-PAL

(2012). Also, important are castes and religions (Bonu and Kim, 2009; Ghurye, 1992). Religion and cast dummies capture effect of these components on use of toilets.

Finally, as wealth is an important indicator for standard of living, we create a standard of living index. DHS has created a wealth index where one of the constituent components is toilet. Bonu and Kim (2009) use this wealth index as an independent variable. Although they use a large data-set obtained from the 60th round of National Sample Survey (January-June 2004), a limitation in their methodology arise from toilet featuring in both as dependent and independent variables. This may lead to problems associated with endogeneity.

We create a separate standard of living index using consumer durables other than toilets.[3]We use Principal Component Analysis (PCA) to create this standard of living index. Filmer and Pritchett (2001) recommend using PCA as it is comparatively easy to perform and interpret, and results in more accurate weighting values for the indicator variables, than mere aggregation. While creating this standard of living index we also include our previously calculated $Wealth_i$ variable, alongside other variables (See, Appendix B). Given these independent variables, we run a logistic regression to estimate the predicted probability for a household to use toilets.

$$\log(\Pi_i) = \beta_0 \boldsymbol{X} + \varepsilon_i \qquad (4)$$

Π_i is the dependent variable, and captures the probability of household *i* using a toilet. $\boldsymbol{X}$ is a matrix of all independent variables, namely, female literacy, gender, types of residence (cities and rural areas), age, wealth, standard of living index, religion, institutional factors, and state dummies. Each one of these independent variables may affect use of toilets. The following variables are used as the reference categories: *Preschool* for female literacy, *Hindu* for religion, *Rural* for area of residence, and *Delhi* for the state variable. The reference variables are to avoid problem associated with multicollinearity (dummy variable trap).

In order to test joint significance of the variables, we use Neyman-Pearson Likelihood Ratio (LR) test. This test analyses whether there is a significant difference between the estimated model, and a constant null. Under the null hypothesis, the LR statistic has a χ^2 distribution with degrees of freedom equal to the number of independent variables (Carter Hill et al., 2008). Additionally, we use Wald test to examine whether any individual parameter is significantly different from zero (Cameron and Trivedi, 2005; Griffiths et al., 2012). A limitation for using Wald test is it can be biased by large standard errors (Fears et al.,1996). In our case, the standard errors are small (all less than one) and hence Wald test can be used. As a

[3] See, Appendix B, for the variables that we include for creating the standard of living index.

measure for goodness of fit we use Adjusted McFadden R-square. The adjusted McFadden R^2 computes the level of improvement the model of interest offers over a null model, while penalising it for containing too many predictors (Smith and McKenna, 2013). Additionally, to check power of the hypothesis we run a restricted model (discussed later). All statistical analyses are generated using EViews 7.2. As our analysis is based on publicly available data, ethical approval was not sought.

5. Results

Table 3 report the conditional probability of a household practicing open defecation, given various characteristics.

Table 3: Computing conditional probabilities[4]

Attributes	**Conditional probabilities**
Probability (Open defecation| has computer)	**0.018**
Probability (Open defecation| has car)	**0.024**
Probability (Open defecation| has refrigerator)	**0.064**
Probability (Open defecation| has mobile telephone)	**0.065**
Probability (Open defecation| urban residence)	**0.108**
Probability (Open defecation| has motorcycle/scooter)	**0.123**
Probability (Open defecation| house is *pucca*)	**0.173**
Probability (Open defecation| has television)	**0.188**
Probability (Open defecation| has a bank or post office account)	**0.222**
Probability (Open defecation| has radio)	**0.241**
Probability (Open defecation| head of household is Muslim)	**0.248**
Probability (Open defecation| has electricity)	**0.278**
Probability (Open defecation| has bicycle)	**0.393**
Probability (Open defecation| owns this or other house)	**0.413**
Probability (Open defecation| head of household is Hindu)	**0.441**
Probability (Open defecation| owns land usable for agriculture)	**0.526**
Probability (Open defecation| house is *semi-pucca*)	**0.582**
Probability (Open defecation| rural residence)	**0.613**
Probability (Open defecation| house is *kaccha*)	**0.727**

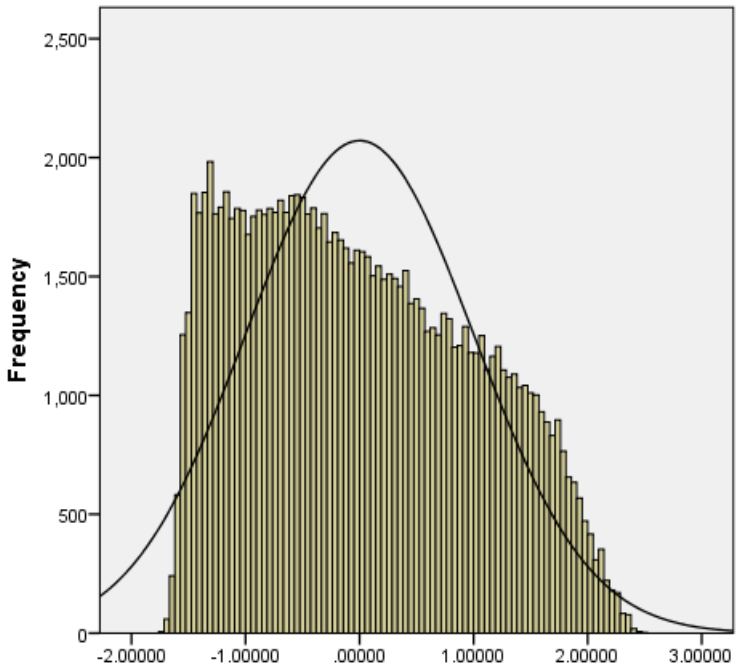
Source: Authors' calculation

The result suggests that use of toilets is considerably low among households residing in rural areas (0.613), who are economically poor (0.727 for kaccha house), and are from Hindu religion background (0.441).[5]On the contrary, households who are economically better-off

[4] Computed using NFHS-3 data.
[5] Probabilities are in the parenthesis.

(having computers, television, and motorcycles) and have access to a bank account, have a larger proportion of toilet users among them. To understand why India house majority of the world population defecating in the open we create a Standard of Living Index, incorporating various consumer durables and dwelling characteristics (See, Appendix B).

Figure 1: Distribution of households by Standard of Living Index



Source: Authors' calculation

Figure 1 suggests an unequal living standard (positive Chi-Square density function), with a majority population having a lower standard of living. Our conditional probability estimates suggest that the poor are more likely to defecate in the open. Therefore, it is no surprising that a lower living standard may explain why more number of people defecates in the open.

To compute preference, we rank households demand for toilets vis-à-vis other consumer durables such as cot, watch, mattress, chair, bicycle, table, electric fan, television, pressure cooker, radio, motorcycle, water pump, mobile telephone, sewing machine, refrigerator, tractor, animal drawn cart, thresher, and computer.

Table 4: Ranking the preference

Rank	Durable goods
1	Cot/bed
2	Watch
3	Mattress
4	Chair
5	Bicycle
6	Table
7	Electric fan
8	Television
9	Pressure cooker
10	Radio
11	Motorcycle/scooter
12	**Toilet**
13	Water pump
14	Mobile telephone
15	Telephone (non-mobile)
16	Sewing machine
17	Refrigerator
18	Tractor
19	Animal-drawn cart
20	Thresher
21	Computer

Source: Authors' calculation

Table 4 indicates among lists of household items that any individual want to use/consume toilets get a lower preference, ranked 12 out of 21. Television and motorcycle both ranks higher than toilets. It means these two items will be adopted at a lower level of wealth before a toilet. A limitation of this data is that it is relatively old (NFHS-3 was implemented in 2005-2006). A newer data set is most likely to reveal mobile phones getting a better rank than toilets.[6]

For the second part of the analysis we report results from equation (4). To increase power of the hypothesis, we ran two versions of equation (4) – the unrestricted (model 1 in Table 5),

[6] NFHS-4 survey is expected to be out by 2017 (Development Tracker, 2015).

and restricted version (model 2 in Table 5). For the restricted version we dropped the gender and house variables. The predictive power of model 2 increased when we drop these two variables. For selecting models, we use Akaike information criteria (AIC). Given a number of potential models, the model with the lowest AIC value is chosen. Hosmer and Lemeshow (2000) propose a test to measure whether the model fits the data, which is computed by dividing the observations into approximately equal groups in sequence of their predicted probability. They contend that an appropriate goodness of fit measure is the one which is centred largely on a comparison between observed values and those values predicted by the model (Hosmer and Lemeshow, 2000). A test statistic is calculated, which under the null hypothesis follows a $\chi 2$ distribution asymptotically with degrees of freedom equal to G – 2, where G is the number of groups the observations are split (See Appendix C).

Table 5: Regression results

Type of Variable	**Variable**	**Model 1**	**Model 2**
	Intercept	-1.363***	-1.464***
Women's Education	Primary	0.159***	0.160***
	Secondary	0.535***	0.535***
	Higher	1.130***	1.130***
Number of Women in the Household	Women	-0.167***	-0.168***
Type of Residence	Megacity	3.534***	3.547***
	Large city	2.954***	2.966***
	Small city	1.785***	1.792***
	Largetown	1.888***	1.891***
	Small town	1.025***	1.029***
Household head's gender	Gender	-0.029	-
Household head's age	Age	0.004***	0.004***
Wealth Variables	House	-0.102	-
	Hectare	0.011**	0.011
	Bank	0.192***	0.190***
Standard of Living Index	DurableDwelling	2.029***	2.031***
Household head's religion	Muslim	1.695***	1.695***
	Christian	0.229**	0.227**
	Otherreligion	0.537***	0.540***
Household head's caste	Caste	-0.255***	-0.253***

State Dummies	JammuandKashmir	-0.746***	-0.746***
	HimachalPradesh	-0.197	-0.183
	Punjab	0.470**	0.480**
	Uttaranchal	0.827***	0.833***
	Haryana	0.097	0.098
	Rajasthan	-0.453**	-0.455**
	UttarPradesh	0.389**	0.386**
	Bihar	0.831***	0.837***
	Sikkim	3.689***	3.690***
	ArunchalPradesh	4.121***	4.140***
	Nagaland	3.885***	3.903***
	Manipur	4.721***	4.723***
	Mizoram	5.647***	5.654***
	Tripura	6.626***	6.635***
	Meghalaya	3.321***	3.323***
	Assam	3.703***	3.705***
	WestBengal	2.564***	2.565***
	Jharkhand	-0.061	-0.063
	Orissa	0.309	0.312
	Chhattisgarh	-0.008	-0.010
	MadhyaPradesh	0.536***	0.538***
	Gujarat	0.316	0.319
	Maharashtra	0.062	0.066
	AndhraPradesh	0.649***	0.655***
	Karnataka	0.357*	0.361*
	Goa	0.889***	0.900***
	Kerala	3.844***	3.847***
	TamilNadu	-0.249	-0.250
Overall Significance	LR test Statistics	χ^2 (47) = 64.00***	χ^2 (45) = 61.66***

,* Indicates the coefficient is significant at a 2.5% level and 1% level, respectively.

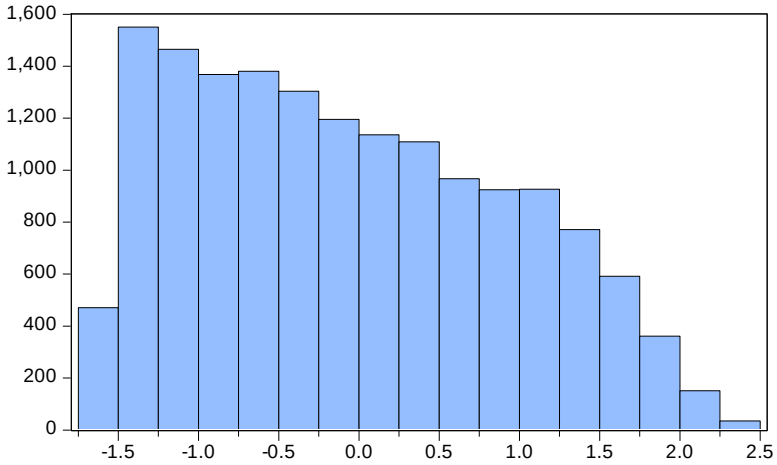
We get some interesting results. Table 5 indicates the importance of female literacy rates. The coefficient on female literacy rates suggest as level of education increase, women are more likely to use a toilet. A household in which a woman has attained a higher education is 3.1 times more likely to use a toilet in comparison to a household where a woman has attained education till the preschool level. Educated women are better able to relate to health

and hygienic behaviours that come with use of toilets. Our result is consistent with Wei et al. (2004) and Ghosh and Carincross (2014) stressing the need for female literacy rates.

Interestingly we find, as number of woman in any household increases, that household is less likely to use toilets. The gender variable is also not statistically significant. Results from Jenkins and Curtis (2005) and Santos et al., (2011) indicate otherwise. Women are more likely to use toilets than men due to perceived benefits of greater dignity and safety.

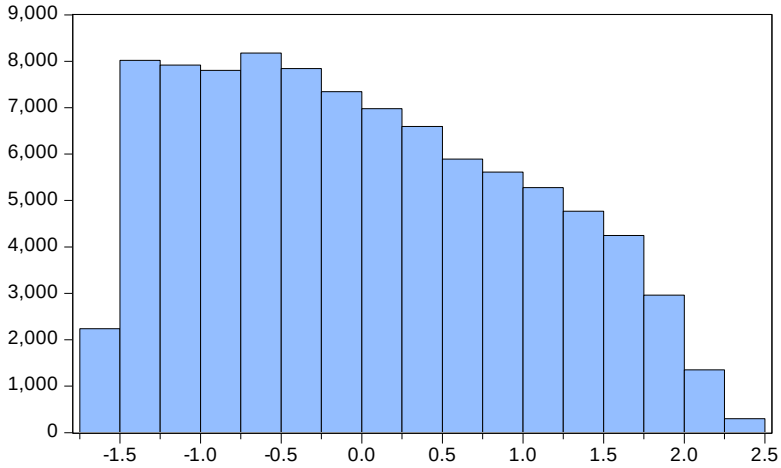
However, there is an explanation for our results. Jenkins and Sugden (2006) found women have been known to face more barriers for using toilets than men. In our case, a more pertinent reason is standard of living. The positive impact of more women in the household, or the household head being a woman, may be negated by the fact that such households have a lower mean standard of living index score in comparison to household headed by men, -0.071 (for female) compared to 0.012 (for male) [See, Figure 2 and 3]. Additionally, the age of the household head has a negligible impact on the likelihood of using a toilet. According to UNESCO's Education for All (EFA) Global Monitoring Report (2014), India has the highest population of illiterate adults, 287 million, 37 per cent of total population of such people across the world. Lack of education about health and hygiene may be another reason for low toilet usage by the young Indians.

Figure 2: Histogram of Standard of Living scores where the household head is a female



Source: Authors' calculation

Figure 3: Histogram of Standard of Living scores where the household head is a male



Source: Authors' calculation

Region-wise, urban households are more likely to use toilets in comparison to their rural counterparts. In comparison to rural areas, use of toilet in mega cities such as Mumbai and Kolkata are nearly 35 times higher. The odds ratios for the region variables demonstrate, as the level of urbanisation increases, the probability of a household using toilet also increases. The odd ratios for households from large cities using a toilet are much higher than the ones residing in small cities, which in turn is higher than ones residing in small towns. And all these urban-odd ratios are higher than the odd ratios computed for the rural areas. A household in a small town is 2.8 times more likely to use a toilet than his counterpart from rural areas. Our findings is similar to that of Bonu and Kim (2009) who demonstrate that the rural-urban differential in household possession of latrines has remained large over the past decade - diminishing slightly from 62 per cent in 1992-1993 to 57.8 per cent in 2004-2005.

As to why urbanization may lead to more use of toilets, Planning Commission (2002), Government of India cited two reasons. First is higher concentration and construction of toilet facilities in urban areas are facilitated by government-private initiatives, which is not so much prevalent in rural areas. Second is because of other factors such as low awareness about possible health benefits, higher levels of poverty, beliefs that owning a household toilet has high costs, and a simple lack of modernisation could be a barrier to improved sanitation in rural areas. Expansion of city limit may also infringe upon the privacy of common people to defecate in the open (O'Rielly and Louis, 2014).

The positive sign on the coefficient Hectare variable indicates that as number of units of agricultural land holding increases, it indicates that the household is becoming wealthier and

is more likely to use toilet. This finding is similar to Salter (2008) and O'Connell (2014). Additionally, a household that owns a bank or post office account is 1.2 times more likely to use a toilet than the ones who do not have access to these amenities. Financial inclusion is a key component for toilet usage.

Also important is wealth. Household with a better standard of living are likely to use toilets more than the ones who are poor. Our model predicts the odds of using a toilet becomes 7.6 times higher if Standard of Living Index variable increases by 1 unit. A richer household with a pucca house is more likely to use toilets. Research by Dickinson and Pattanayak (2007) yields similar findings, with correlation between housing characteristics such as type of walls and toilet usage. Halder and Kabir (2008) demonstrated that the absence of a toilet facility is linked to a lower socioeconomic status (based on household assets, housing conditions, etc.) in Bangladesh.

Then there are religion and cultural factors affecting use of toilets. India is distinctive in terms of having a diverse culture, religion, and caste. And, all of these vary across states in India. The religion variables demonstrate that the odd ratio for a Muslim household using a toilet is 5.4 times higher than a Hindu household. Even a Christian household is 1.3 times more likely to adopt toilet in comparison to their Hindu counterparts. Using DHS data, Bonu and Kim (2009) obtained a similar result, with the Hindu households having lowest coverage of sanitation facilities in comparison to other religions.

This result is surprising, as Indian Muslims are on average both poorer and less educated than the Hindus (Bhalotra et al., 2010). There could be two plausible reasons. First, there may be a historical path-dependency related to religion that encourages open defecation among Hindus. Ramaswamy (2005) and Bathran (2011) argue that open defecation among Hindu households is due to caste system, where the customary circumvention of excreta is sustained by keeping defecation away from the house and entrusting the clean-up job to the so-called 'untouchables' or 'lower' castes. Second, this gap may not be related to religious differences at all but to the fact that Muslims are more likely to live in urban areas relative to the Hindus (Bhalotra et al., 2010). The observation is indeed confirmed by the data that we use. The conditional probability of the household residing in the urban areas is 0.45 for Hindu and 0.55 for Muslims.

The coefficient of the Caste variable predicted by Model 3 is -0.253, implying that Scheduled Caste (SC), Scheduled Tribe (ST) and Other Backward Class (OBC) households have a lower probability of using a toilet when compared with households from general caste Hindu, Muslims and Christians. When it comes to accessing different types of public goods in India,

Banerjee and Somanathan (2007) find there is a pronounced caste-based differential, with ST households continuing to be significantly deprived. They contend that this is a result of these tribal castes living in relatively inaccessible areas of the nation, and thus having lower access to public goods in comparison to others. This line of argument is supported by our results. For the households living in rural areas and countryside, the conditional probability that these household belongs to SC, ST or OBC is over 0.60, in comparison to 0.41 for people from other communities. Additionally, Srinivasan and Mohanty (2004) found that the level of abject poverty is higher among these castes, which could be another potential reason for poorer sanitation coverage among SC, ST, and OBCs.

Finally is the state-level variance in the use of toilets. The odd ratios for households in the North-Eastern Indian States of Manipur, Mizoram, Tripura, Meghalaya etc. and the southern state of Kerala using a toilet facility are much higher than a household in Delhi (the reference state). For example, a household in Tripura is 761.5 times more likely to use a toilet than a household in Delhi. Ghosh and Cairncross (2014) and Bonu and Kim (2009) also find similar results, with access to toilets is highest among the north-eastern states. The state dummies for Rajasthan, Jammu & Kashmir, Himachal Pradesh, Jharkhand, Chhattisgarh and Tamil Nadu have negative coefficients implying that the probability of households using a toilet in these states is lower than in Delhi. Such findings have been observed in previous academic literature as well, with the backward States of Rajasthan, Jharkhand and Chhattisgarh having lower levels of toilet usage in comparison to other states (Coffey et al., 2014).

We also map how a toilet will be adopted out of 21 different durable goods across various states in India. The better the rank of a toilet on a household's wealth preference ordering, the lower the level of wealth it will be adopted. Kerala and North Eastern States have a higher preference for having a toilet. This result may be the consequence of some inherent state culture, such as the North-East Indian states and Kerala having higher literacy rates, and hence better awareness about hygiene, or due to state-level differentials in sanitation infrastructure, namely availability of water and closed drainage systems. In fact, in Kerala communities like the Nairs and Ezhavas, and in Meghalaya the Khasi, Jaintias, and the Garo tribes (comprising majority of the population) practice matriarchy, where women have power in activities relating to allocation, exchange, and production. This can also explain the prevalence of more toilet users in these states (See Table 6).

Table 6: Mapping the preference structure across states

State	Ranking
India	**12**
Arunachal Pradesh	1
Manipur	2
Assam	2
Kerala	2
Nagaland	3
Tripura	3
Sikkim	4
Mizoram	5
West Bengal	5
Meghalaya	6
Goa	7
Bihar	8
Andhra Pradesh	8
Uttaranchal	9
Gujarat	10
Delhi	11
Jammu & Kashmir	11
Orissa	11
Madhya Pradesh	11
Karnataka	11
Himachal Pradesh	12
Punjab	12
Haryana	12
Chhattisgarh	14
Maharashtra	14
Tamil Nadu	14
Uttar Pradesh	15
Jharkhand	15
Rajasthan	18

The results indicate, households are more likely to use toilets if the educational level among women member is high, they are wealthy in terms of access to banks and own hectares of agricultural land, have a high standard of living, and if the family lives in urban areas. Households are less likely to use toilets if the household head is Hindu, belongs to the SC, ST or OBC caste, and if they reside in certain states such as Rajasthan, Jammu & Kashmir, Jharkhand, and Chhattisgarh. These findings are generally in line with existing literature. However, earlier studies have used case-study base approach. We complement these earlier studies with rigorous statistical analysis.

6. Conclusions and policy implications

There are a number of policy implications. First, governments from developing countries, and India in particular, should concentrate on demand creation for using toilets. They must ensure that a larger proportion of funds are directed towards IEC component of the policy. The lesson from the *Nirmal Gram Yojana* experience suggests cash incentives will not necessarily increase awareness to use toilets. Not only monitoring is required but increased CLTS that stresses on educating about hygiene, and social marketing, along with encouraging small-scale entrepreneurial actions that use the state as a promoter, is expected to be fruitful.

Second, empirical analysis analyses indicate female literacy rate is an important factor. Use of toilets can be improved by policies that aim to emancipate and increase education levels among women. For increasing sanitation coverage it will be wise to target women, and actively involve them in policymaking.

Third, as there is rural-urban divide, with sanitation problem concentrated in rural parts of India. There is a need for government policies specifically focusing on improving sanitation in rural areas. Such policies can be combined with rural education initiatives, along with measures to improve financial inclusion for the households.

Fourth, the religion and caste-based differentials in adoption of toilets are more difficult to eradicate. Religion and caste-based differentials are rooted in some ingrained beliefs and attitudes. As Hindu households are less likely to use toilets, they can be motivated to adopt latrine use by strictly eradicating the dehumanising practice of manual scavenging, often performed by the ‘lower’ castes. Empowering the ‘lower’ castes, by encouraging them to pursue alternative jobs, and possibly providing them with subsidies to construct latrine facilities will help.

A limitation of this study is that we have not considered the market demand for toilet. It will be interesting to consider factors, such as the price for providing a toilet. Additionally, a more encompassing income and wealth variables will be useful to evaluate if sanitation subsidies that target the poor have actually reached the intended groups. These variables will enable construction of a precise demand function for toilet.

Finally, it will be advantageous to conduct a cross-country analysis to examine the factors which present greater hindrance towards adoption of toilets. Such a study will enable governments to shape relevant sanitation policies, allowing them to focus on factors leading to open defecations.

References

Banerjee A. and R. Somanathan, 2007. “The political economy of public goods: Some evidence from India”, *Journal of Development Economics*, vol. 82, pp. 287-314.

Banerjee A. and N. Banik, 2014. “Is India Shining?”, *Review of Development Economics,* vol. 18, No. 1, pp. 59-72.

Banerjee T. and K. Mandal, 2011. “Revisiting the Midnapore Model after Ten Years of Total Sanitation Campaign (TSC) in India”, *SSRN Working Paper*. Available from http://ssrn.com/abstract=1768687. [Accessed 8 May 2015]

Bathran R., 2011. “Indian Sanitation”, *Economic and Political Weekly*, vol. XLVI, pp. 34-37.

Bhalotra S., C. Valente and A. Van Soest, 2010. “The puzzle of Muslim advantage in child survival in India”, *Journal of Health Economics*, vol. 29, pp. 191-204.

Bonu S. and H. Kim, 2009. “Sanitation in India: Progress, Differentials, Correlates and Challenges”, *Asian Development Bank*, South Asia Occasional Paper Series No. 2.

Brooks, C., 2008. “Introductory Econometrics for Finance”, 2nd edition, Cambridge: Cambridge University Press.

Cameron A.C. and P.K. Trivedi, 2005. “Microeconometrics: Methods and Applications”, Cambridge: Cambridge University Press.

Carter Hill R., W.E., Griffiths and G.C. Lim, 2008. “Principles of Econometrics,’ 3rd edition, New Jersey: John Wiley & Sons, Inc.

Census Data 2011. “House listing and Housing”. Available from http://www.censusindia.gov.in/2011census/hlo/HLO_Tables.html [Accessed 8 March 2015].

Checkley, W., Buckley, G., Gilman, R., Assis, A., Guerrant, R., Morris, S., Molbak, K., Branth, P., Lanata, C. and R. Black, 2008. “Multi-country analysis of the effects of diarrhoea on childhood stunting”, *International Journal of Epidemiology,* vol.37, No. 4, pp. 816-830.

Coffey D., Gupta A., Hathi P., Khurana N., Spears D., Srivastav N. and S. Vyas, 2014. “Revealed Preference for Open Defecation: Evidence from a New Survey in Rural North India”, *Economic and Political Weekly*, vol. XLIX, No. 38, pp. 43-55.

Development Tracker, 2015. Available from http://devtracker.dfid.gov.uk/projects/GB-1-204169/ [Accessed 8 March 2015]. [Accessed 18 January 2015]

Fears T.R., Benichou J. and M.H. Gail, 1996. "A Reminder of the Fallibility of the Wald Statistic", *The American Statistician*, vol. 50, No. 3, pp. 226-227.

Filmer D. and L.H. Pritchett, 2001. "Estimating Wealth Effects Without Expenditure Data – Or Tears: An Application to Educational Enrollments in States of India", *Demography, v*ol. 38, No. 1, pp. 115-132.

George, R., 2008. "The Big Necessity: The Unmentionable World of Human Waste and Why It Matters", New York City: Holt Paperbacks.

Ghosh, A. and S. Cairncross, 2014. "The uneven progress of sanitation in India", *Journal of Water, Sanitation and Hygiene for Development*, vol. 4, No. 1, pp. 15-22.

Halder A.K. and M. Kabir, 2008. "Child Mortality Inequalities and Linkage with Sanitation Facilities in Bangladesh", *Journal of Health, Population and Nutrition*, vol. 26, No. 1, pp. 64-73.

Hosmer D.W. and S. Lemeshow, 2000. "Applied Logistic Regression", New York: Wiley.

International Institute for Population Sciences (IIPS) and Macro International, 2007. "National Family Health Survey (NFHS-3), 2005-06", *India: Key Findings,* Mumbai: IIPS.

Jenkins M.W. and V. Curtis, 2005. "Achieving the 'good life': why some people want latrines in rural Benin", *Social Science and Medicine*, vol. 61, No. 11, pp. 2446–2459.

Jenkins M.W. and S. Sugden, 2006. "Rethinking Sanitation: Lessons and Innovations for Sustainability in the New Millennium"*, Human Development Report Office Occasional Paper*, UNDP.

J-PAL, 2012. "J-PAL Urban Services Review Paper", Cambridge, MA: Abdul Latif Jameel Poverty Action Lab.

Lin, A., Arnold, B., Afreen, S., Goto, R., Huda, T., Haque, R., Raqib, R., Unicomb, L., Ahmed, T., Colford, J. and S. Luby, 2013. "Household environmental conditions are associated with enteropathy and impaired growth in rural Bangladesh", *The American Journal of Tropical Medicine and Hygiene",* vol. 89, No. 1, pp. 130-137.

O'Connell K., 2014. "What Influences Open Defecation and Latrine Ownership in Rural Households? : Findings from a Global Review", *Water and Sanitation Program: Working Paper,* Washington: World Bank.

O'Reilly., 2010. "Combining sanitation and women's participation in water supply: an example from Rajasthan", *Development in Practice*, vol. 20, No. 1, pp. 45-56.

O'Reilly and E. Louis, 2014. "The toilet tripod: Understanding successful sanitation in rural India", *Health and Place*, vol. 29, pp. 43-51.

OECD, 2013. "OECD Guidelines for Micro Statistics on Household Wealth," OECD Publishing. Available from http://www.oecd.org/statistics/OECD-Guidelines-for-Micro-Statistics-on-Household-Wealth.pdf [Accessed 8 March 2014].

Planning Commission, 2002. "India Assessment 2002: Water Supply and Sanitation", Delhi: Government of India. Available from http://planningcommission.gov.in/reports/genrep/wtrsani.pdf [Accessed 19 March 2015].

Prahalad, C.K., 2005. "Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits", New Jersey: Prentice Hall.

Ramani, S.V., 2008. "Playing in Invisible Markets: Toilet Innovations and Empowerment", The Charles Cooper Annual Memorial Lecture, *UNU-MERIT Working Paper Series.*

Ramaswamy, G., 2005. "India Stinking: Manual Scavengers in Andhra Pradesh and their Work", Chennai: Navayana Publishing.

Salter, D., 2008. "Identifying Constraints to Increasing Sanitation Coverage: Sanitation Demand and Supply in Cambodia", *Water and Sanitation Program*. Available from http://www.wsp.org/sites/wsp.org/files/publications/Sanitation_demand_and_supply_fieldnote_final__1.pdf [Accessed 8 March 2015].

Santos A.C., Roberts J.A., Barreto M.L. and S. Cairncross, 2011. "Demand for sanitation in Salvador, Brazil: a hybrid choice approach", *Social Science and Medicine*, vol. 72, No. 8, pp. 1325–1332.

Shah A., Thathachari J., Agarwal R. and A. Karamchandani, 2013. "A market led, evidence based, approach to rural sanitation", *Monitor Inclusive Markets*, on behalf of The Bill & Melinda Gates Foundation.

Smith, T.J. and C.M. McKenna, 2013. “A Comparison of Logistic Regression Pseudo R^2 Indices”, *Multiple Linear Regression Viewpoints*, vol. 39, No. 2.

Spears, D., 2012. “Health and Cognitive Achievement among Indian Children”, *Economics and Human Biology, v*ol. 10, No. 2, pp. 210-19.

Srinivasan K. and S.K., Mohanty, 2004. “Deprivation of Basic Amenities by Caste and Religion: Empirical Study using NFHS Data”, *Economic and Political Weekly*, vol. 39, No. 7, pp. 728-735.

The DHS Program STAT compiler, 2015. Available from http://www.statcompiler.com/ [Accessed 18 February 2015].

UNICEF, 2000. “Learning from Experience: Evaluation of UNICEF’s Water and Environmental Sanitation Programme in India, 1966-1998”, New York: Evaluation Publications.

Verbeek, M., 2012. “A Guide to Modern Econometrics”, 4th edition, West Sussex: John Wiley & Sons Ltd.

Wei F., Pillai V. and A., Maleku, 2004. “Sanitation in India: Role of Women’s Education”, *Health Science Journal*, vol. 8, Issue 1, pp. 90-101.

WHO, 2014. *Progress on Drinking Water and Sanitation: 2014 Update,* Geneva: World Health Organisation. Available from http://www.wssinfo.org/fileadmin/user_upload/resources/JMP_report_2014_webEng.pdf [Accessed 8 March 2015].

UNESCO, 2015. Education for All. Available from http://www.unesco.org/new/en/education/themes/leading-the-international-agenda/education-for-all/. [Accessed 18 June 2015].

UNICEF, 2015. Joint Monitoring Programme (JMP) for Water Supply and Sanitation. Available from http://www.wssinfo.org/ [Accessed 17 April 2015].

Appendix

Appendix A: Key findings from National Family Health Survey (NFHS)

	1992-1993 NFHS	1998-1999 NFHS	2005-2006 NFHS
Total households interviewed	88,562	92,486	1,09,041
% living in rural areas	73.9	73.0	66.7
% households with female head	9.2	10.3	14.4
% of men with no education	29.2	21.6	21.9
% of women with no education	54.7	44.4	41.5
% of households with piped drinking water	33.1	38.6	42.0
% of households with no toilet facility	69.7	63.7	55.3
% of households with electricity	50.9	60.1	67.9
% of women unexposed to mass media	N/A	41.4	35.3

Source: The DHS STAT compiler (2015).

Appendix B: Data used for Standard of Living Index

Household Attributes	Label	Description
Drinking water	Source of drinking water	=11, if piped into dwelling 12, if piped to yard/plot 13, if public tap/standpipe 21, if tube well or borehole 31, if protected well 32, if unprotected well 41, if protected spring 42, if unprotected spring 43, if river/dam/lake/ponds/stream 51, if rainwater 61, if tanker truck 62, if cart with small tank 71, if bottled water
Non-drinking water	Source of non-drinking water	=11, if piped into dwelling 12, if piped to yard/plot 13, if public tap/standpipe 21, if tube well or borehole 31, if protected well 32, if unprotected well 41, if protected spring 42, if unprotected spring 43, if river/dam/lake/ponds/stream 51, if rainwater 61, if tanker truck

		62, if cart with small tank
Electricity	Household has electricity	=1, if yes 0, if no
Radio	Household has radio	=1, if yes 0, if no
Fridge	Household has refrigerator	=1, if yes 0, if no
Bicycle	Household has bicycle	=1, if yes 0, if no
Scooter	Household has motorcycle/scooter	=1, if yes
Car	Household has car	0, if no =1, if yes
Phone	Household has non-mobile telephone	0, if no =1, if yes
Mobile	Household has a mobile telephone	0, if no
Watch	Household has a watch	=1, if yes 0, if no
Cart	Household has an animal-drawn cart	=1, if yes 0, if no
Mattress	Household has a mattress	=1, if yes 0, if no
Cooker	Household has a pressure cooker	=1, if yes
Chair	Household has a chair	0, if no =1, if yes
Bed	Household has a cot/bed	0, if no =1, if yes
Table	Household has a table	0, if no =1, if yes
Electric Fan	Household has an electric fan	0, if no =1, if yes
TV Black &White	Household has a black & white television	0, if no =1, if yes
TV Colour	Household has a colour television	0, if no
Sewing	Household has a sewing machine	=1, if yes
Computer	Household has a computer	0, if no =1, if yes
Pump	Household has a water pump	0, if no =1, if yes
Thresher	Household has a thresher	0, if no =1, if yes
Tractor	Household has a tractor	0, if no =1, if yes 0, if no =1, if yes 0, if no =1, if yes 0, if no

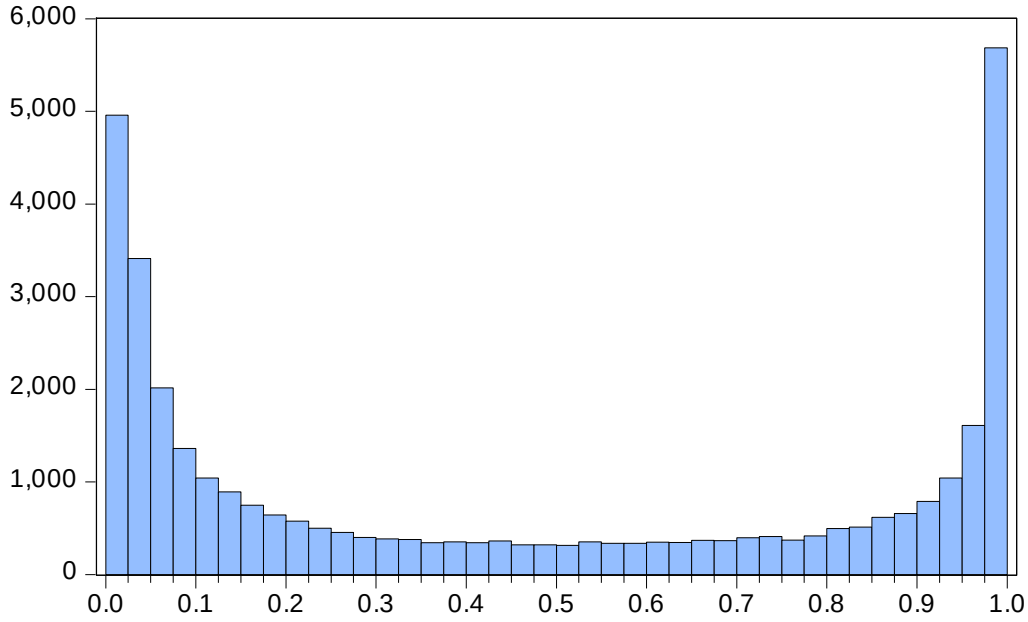
Fuel	Type of cooking fuel	=1, if electricity 2, if LPG, natural gas 4, if biogas 5, if kerosene 6, if coal, lignite 7, if charcoal 8, if wood 9, if straw/shrubs/grass 10, if agricultural crop 11, if animal dung
Floor	Main floor material	=11, if mud/clay/earth 12, if sand 13, if dung 21, if raw wood planks 22, if palm, bamboo 23, if brick 24, if stone 31, if parquet, polished wood 32, if vinyl, asphalt strips 33, if ceramic tiles 34, if cement 35, if carpet 36, if polished stone/marble/granite
Wall	Main wall (exterior) material	=11, if no walls 12, if cane/palm/trunks 13, if mud 14, if grass/reeds/thatch 21, if bamboo with mud 22, if stone with mud 23, if plywood 24, if cardboard 25, if unburnt brink 26, if raw/reused wood 31, if cement/concrete 32, if stone with lime/cement 33, if burnt bricks 34, if cement blocks 35, if wood planks/shingles 36, if GI/metal/asbestos sheets
Roof	Main roof material	=11, if no roof 12, if thatch/palm leaf 13, if mud 14, if sod/mud and grass mixture 15, if plastic/polythene sheeting 21, if rustic mat

		22, if palm/bamboo 23, if raw wood planks/timber 24, if unburnt bricks 25, if loosely packed stone 31, if metal/GI 32, if wood 33, if calamine/cement fiber 34, if asbestos sheets 35, if RCC/RBC/cement/concrete 36, if roofing shingles 37, if tiles 38, if slate 39, if burnt brick
Window	House has any windows	=1, if yes 0, if no
Glass	House has windows with glass	=1, if yes 0, if no
Screen	House has windows with screens	=1, if yes 0, if no
Shutter	House has windows with curtains or shutters	=1, if yes 0, if no
Dejure	Number of dejure members per sleeping room	=0:24
Domestic servant	Household has a domestic servant	=1, if yes 0, if no

Appendix C: Predictive power of the model 2

Group	Estimated equation			Constant probability		
	$Toilet_i$=0	$Toilet_i$=1	Total	$Toilet_i$=0	$Toilet_i$=1	Total
P($Toilet_i$=1) ≤ c	17890	3492	21382	19342	16195	35537
P($Toilet_i$=1) > c	1452	12703	14155	0	0	0
Total	19342	16195	35537	19342	16195	35537
Correct	17890	12703	30593	19342	0	19342
% Correct	**92.49**	**78.44**	**86.09**	**100.00**	**0.00**	**54.43**
% Incorrect	7.51	21.56	13.91	0.00	100.00	45.57
Total Gain	-7.51	78.44	31.66			
% Gain	NA	78.44	69.47			

Addendum Appendix C: Histogram of predicted probabilities of latrine use in model 2



The Asia-Pacific Research and Training Network on Trade- ARTNeT– is an open network of research and academic institutions and think-tanks in the Asia-Pacific region, established by core partners IDRC, ESCAP, UNCTAD, UNDP and WTO. ARTNeT aims to increase the amount of high quality, topical and applied research in the region by harnessing existent research capacity and developing new capacities. ARTNeT also focuses on communicating these research outputs for policymaking in the region including through the ARTNeT Working Paper Series which provide new and policy–relevant research on topics related to trade, investment and development. The views expressed in this publication are those of the authors and do not necessarily reflect the views of the United Nations and ARTNeT secretariat or ARTNeT members.

This and other ARTNeT publications are available from

artnet.unescap.org

ARTNeTontrade

@ARTNeTontrade

ARTNeT Group

artnetontrade@un.org

ARTNeT Secretariat, United Nations ESCAP

Rajadamnern Nok Avenue

Bangkok 10200, Thailand

Tel: +66(0) 22881410

Fax: +66(0) 22881027