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# Indira Awas Yojana and Housing Adequacy: An Evaluation using Propensity Score Matching

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## Abstract

Indira Awas Yojana (IAY) was a public housing assistance program of the Government of India with its primary purpose being the provision of housing to the homeless rural poor households. The efficacy of this program has not been rigorously evaluated in the literature and thus this paper is an attempt in that direction. This paper, by using IHDS-II, a nationally representative sample from India, and relying on the quasi-experimental technique of Propensity Score Matching, concludes that the IAY has been moderately successful in meeting its goals in term of housing characteristics such as pucca house, pit toilet, smokeless chulha, hand pump water; but, it fails to reach its stated goals in terms of external housing adequacy such as the presence of excrement/human waste and stagnant water in the vicinity of house and the access to village health facility and electrification.

JEL Classifications: H53, I38, O18, R2

Keywords: Indira Awas Yojana, Public Housing Program, Propensity Score Matching, Impact Evaluation, India.

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## 1.0 Introduction

The access to decent housing is included in the United Nation's Sustainable Development Goals (Goal 11). It sees housing as an essential human need which is needed for survival and basic human decency. Housing is also linked to ownership, sense of identity, community building, and promotion of self-esteem and confidence. Since housing supports livelihoods and promotes social integration, it is deemed critical for an individual's social and economic development. Moreover, home ownership is viewed as a form of cultural expression and a symbol of social standing.

The government of India acknowledged the role of housing in its strategy of poverty alleviation, and subsequently, launched several public housing assistance programs over the years beginning with Community Development Movement (CDM), a Village Housing Programme (VHP) in 1957, which provided loans to individuals and cooperatives of up to Rs. 5,000 per unit. The most ambitious public housing program called Indira Awas Yojana (IAY) was launched in June 1985 by the Government of India, as a sub-scheme of the National Rural Employment Program (NREP), with an objective of removing poverty through the provision of housing to the rural households. Indira Awas Yojana is a publicly funded program that aims to provide homes to homeless rural poor households; and, also to those who live in dilapidated and kutcha homes. This program also provides loans to the landless poor for the sole purpose of buying land to construct house. The program intends to provide access to housing to SC/STs, female headed households, households with disability, and marginalized households. The program stipulates that every house under IAY should include a toilet, soak pit and compost pit, smokeless chulhas (exempted if the households have an LPG /biogas connection). A provision for the roof water harvesting system is also allowed

if the local conditions are appropriate. The program also encourages households to construct a bathroom.[2]

This paper aims to evaluate the effectiveness of Indira Awas Yojana since there is no systematic and rigorous study that addresses this issue in the academic literature. This paper relies on a quasi-experimental statistical tool of propensity score matching to perform impact evaluation. The non-availability of data from a randomized control trial makes propensity score matching a suitable strategy for the available cross-sectional survey data. The data for this study is obtained from the India Human Development Survey-II (IHDS-II), which was collected by NCAER and University of Maryland. This data covers more than 42,000 households from across India and is representative of the whole country.

This paper aims to compare the households who availed the housing loans under the IAY with those who did not but were comparable in every other observable respect. The outcome variables aim to include those measures that reflect the objectives specified under the IAY such as housing quality, linkage with environment and infrastructure, which collectively can be termed as housing adequacy that we further classify into two categories, viz, internal and external.

**2.0 Related Literature**

Unfortunately, the literature is sparse in its coverage of IAY. There are a few studies that have tried to evaluate the IAY with regards to the number of homeless households who benefited under this plan (see, for example, Venkateswarlu, 2017; Shivanna & Kadam, 2017[a]; Shivanna & Kadam, 2017[b]). However, these studies, lack the rigors required of an impact evaluation of a public housing assistance program. There are two government level evaluations of IAY that we are aware of. The first one is a study carried out by the Department of Economic and Statistical Analysis,

[2] The above description is obtained from the IAY Guidelines (http://iay.nic.in/netiay/IAY%20revised%20guidelines%20july%202013.pdf).

Government of Haryana, which focuses on several aspects of IAY's impact on beneficiaries including whether the objectives of the scheme are being achieved, whether the beneficiaries are receiving the allocated funds, whether the funds are disbursed in a smooth and timely fashion, whether the funds are being utilized in the proper way by the beneficiaries, and whether the houses are built as per the guidelines and in a timely fashion (See, Bishnoi, 2012). The last aspect is relevant to this study since it evaluates whether the built houses under the IAY met the guidelines of the program. Bishnoi (2012) using a sample of 160 households, who participated in the program from Haryana, concludes that the program met its goal of providing pucca houses to all participants. It also concludes that the program was successful in terms of the provisioning of smokeless chulha, sanitation and ventilation facilities. However, it also found that the program was not successful in terms of the provision of drinking water. Even though, the effort on the part of the Government of Haryana to assess the efficacy of IAY is laudable, it is naïve and rudimentary in its approach since the analysis lacks the statistical rigor required of an evaluation study, as will be made clear subsequently in the next section.

The second government level evaluation is by the Comptroller and Auditor General (CAG) of India, which audited the IAY from 2008 to 2013 in 168 districts across 27 states and 4 union territories. The CAG report is critical of the program and found several irregularities in its implementation, notably in the identification and selection of the beneficiaries and the construction of house and the quality of house.[3]

Unfortunately, we could not find a single study that attempts to evaluate the impact of IAY on housing adequacy using a nationally representative sample and apposite methodology.

[3]https://cag.gov.in/sites/default/files/audit_report_files/Union_Performance_Indira_Awaas_Yojana%20_37_2014_chapter_3_exe-sum.pdf

This study assumes importance because merely providing financial and technical assistance for home construction and subsequently counting the number of homes constructed and then claiming that the program met its goal, could be misleading. Thus, it is imperative that the program should be evaluated on the basis of quality and adequacy of constructed homes, as per the objectives laid down in the IAY program.

## 3.0 Methodology

The chief econometric concern that we face in estimation is the issue of self-selection, which is likely to bias the estimates. It is plausible to think that there are some intrinsic differences between households that choose to participate and those that do not, and if we do not observe these characteristics, it is possible that the IAY specific housing adequacy outcomes are not only driven by the participation but also by the unobservable factors. In this scenario, the true casual impact of participation in IAY on housing adequacy outcomes is hard to estimate through standard OLS regression. In other words, the estimate is likely to be biased.

To assess the true causal impact of participation in IAY on housing adequacy outcomes, we will need to know what would have been the housing adequacy outcomes of a household that chose to participate in IAY had it not participated in IAY. Unfortunately, the same household cannot be at the same time in the program and not in the program. However, there are tools that allow us to create reasonable statistical counterfactuals to the treatment group.

The gold standard in impact evaluation is the Randomized Control Trial (RCT), whereby a randomly selected group of households are chosen to participate in the program and another group with similar characteristics serves as control without receiving participation. However, such an

experiment is impractical in many circumstances due to a set of complex issues related to participation, and IAY is no exception in that regard. That leaves us with quasi-experimental techniques, such as Propensity Score Matching (PSM), which allow us to mimic experiments, in the sense, that we can create statistical counterfactuals to the treatment group and derive meaningful results without conducting the experiment.

The PSM strategy has been documented to reduce selection bias (see, for example, Dehejia & Wahba, 1998; Hong & Raudenbush, 2005; Shadish_et al., 2002). Propensity score matching, if appropriately used, should yield relatively unbiased estimates of IAY's effects on housing adequacy measures. Results obtained from quasi-experiments using propensity score matching methods can closely approximate those obtained from randomized control trials (Becker & Ichino, 2002). For example, Luellen, Shadish, and Clark (2005) contrasted findings from two quasi-experiments using propensity score matching to those obtained from two true experiments. Use of propensity score matching reduced selection bias by 73–90%. The mean differences obtained from the propensity score analyses and those obtained using randomization differed by only .09 and .20 of a point on each study's particular outcome measure. Because of its ability to greatly reduce selection bias, propensity score matching is increasingly being utilized in the fields of policy evaluation and economics (see, for example, Harknett, 2006; Jones, D'Agostino, Gondolf, & Heckert, 2004; Czajka, Hirabayashi, Little, & Rubin, 1992; Lechner, 2002; Bryson at al., 2002; Levine & Painter, 2003; List et al., 2003; O'Keefe, 2004, Jalan & Ravallion 2003; Trujillo, Portillo, & Vernon, 2005; Lynch, Gray, & Geoghegan, 2007; Mendola, 2007; Pufahl & Weiss, 2009; Oh et al., 2009; Cox-Edwards & Rodríguez-Oreggia, 2009; Mensah, Oppong, & Schmidt, 2010; Becerril & Abdulai, 2010; Wamser, 2014; Chiputwa, Spielman, & Qaim, 2015).

Under the PSM strategy, the selection into treatment group is based on observable characteristics. Every household is assigned a propensity score based on observable characteristics that determine participation in IAY in the first stage. We use the following observable characteristics: an indicator of whether household lives in the rural area, an indicator of whether the household is below the official poverty level, an index of household assets, an indicator of whether the household owns/cultivates agricultural land, the educational attainments of male and female household heads, household size, an indicator of whether the household belongs to SC/ST social group, religious affiliation of the household, an indicator of whether the household has acquaintance with elected officials, measures of household exposure to media, household size, number of adult males and females in the household, the age of male and female household heads, an indicator of whether the household has acquaintances with local elected politicians, and the district and state of the household.

In the second stage, several matching algorithms could be employed to compare the mean outcomes between the treatment and control groups. We primarily rely on Radius Matching with a caliper of 0.01, which has been used in other impact evaluation studies as well (see for example Kumar & Volmer, 2013). However, for the sake of robustness of our result, we will also report the results from Nearest Neighbor Matching. The matching algorithms are briefly discussed below.[4]

**The Nearest-Neighbor Matching (NNM):** Under this algorithm each treatment unit is matched to the comparison unit with the closest propensity score. Matching can be done with or without replacement. Matching with replacement means that the same nonparticipant can be used as a match for different participants. We use the five nearest neighbors matching with replacement.

[4] The following discussion is borrowed from Khandker et al (2010).

**Radius Matching (RM):** One problem with NN matching is that the difference in propensity scores for a participant and its closest nonparticipant neighbor may still be very high. This situation results in poor matches and can be avoided by imposing a threshold or "tolerance" on the maximum propensity score distance (caliper). This procedure therefore involves matching with replacement, only among propensity scores within a certain range.

**Propensity Score-based weighted regression**

For robustness check, we rely on the estimation of a weighted multiple regression model, which uses the propensity scores as sampling weights. It has been suggested that this weighting procedure, which relies on the propensity score, balances the distribution of covariates, and yields fully efficient estimates (see, for example, Rosenbaum, 1987; Hirano and Imbens, 2001; Hirano et al., 2003). We weight the treatment and control groups by their respective propensity scores and obtain covariate distribution, which is similar for the two groups. The inverse of the propensity score, serves as the weight for the treatment group; while the inverse of one minus the propensity score, serves as the weight for the control group.

**4. Data and Descriptive Statistics**

This study relies on data from the second round of India Human Development Survey (IHDS-II), which was administered in 2011-12. According to the IHDS-II descriptions, it is a nationally representative, multi-topic survey of 42,152 households in 384 districts, 1420 villages and 1042 urban neighborhoods across India. The survey covers almost all states and union territories of India. The survey relied on a couple of one-hour interviews in each household to elicit information on topics such as covered health, education, employment, economic status, marriage, fertility,

gender relations, and social capital. IHDS was jointly executed by researchers from the University of Maryland and the National Council of Applied Economic Research (NCAER), New Delhi (Desai et al, 2015).

### 4.1 Outcome Variables

In this paper, our objective is to evaluate the effectiveness of IAY with regards to internal and external housing adequacy by considering the outcomes that the program aims to deliver. The program stipulates certain housing standards to be met to qualify for the loan. First, the house built under this program must be 'pucca ', implying that it should be able to endure normal wear and tear due to usage and natural forces including climatic conditions, with reasonable maintenance, for at least 30 years. It should have roof of permanent material and its walls should be capable of withstanding local climatic conditions and need to be plastered only when the outer surface of the walls is erodible. Hence, we consider three such housing adequacy outcome variables; namely, whether the house has pucca walls, pucca roof, and pucca floor. Approximately, 73% of the sampled households have pucca walls, 85% have pucca roof, and 66% have pucca floor. Approximately, 57% of the sampled households have houses with pucca walls, pucca roof, and pucca floor. Second, every house should include a toilet, soak pit and compost pit. To assess toilet specific outcome, we consider four variables that indicate whether the household has no access to toilet (open field defecation), pit toilet, septic toilet, and flush toilet. Approximately, 44.5% of the sampled households have no access to toilets, implying that they defecate in open fields. Approximately, 14.9% of the sampled households have access to pit toilets at home. Whereas, 30.4% of the sampled households have access to septic toilets and 9.75% to the flush toilets at home. Unfortunately, the IHDS-II did not contain any information on soak pit and compost pit, and therefore, we are unable to include these outcomes in this study. Third, the program

participation requires the household to construct smokeless chulha, which however can be exempted for households in possession of an LPG /biogas connection. We consider four chulha specific variables to assess this goal. These variables are: open fire chulha, traditional chulha, improved chulha, and non-biomass chulha. Approximately, 16.1% households cook food in open fire chulhas, 39.9% in traditional chulhas, 7% in improved chulhas, and 36.3% in non-biomass chulhas. Fourth, the IAY also provides loans for acquiring land sites for the sole purpose of constructing house. The program stipulates that while selecting land, it should be ensured that it is fit for construction of houses especially in terms of physical connectivity, power connectivity, availability of drinking water, access to public institutions, etc. We assess these goals by considering whether the house has access to clean water, tube well, hand pump, open well, covered well, piped water, electricity, absence of excrement/stagnant water surrounding the house, and closeness of health facility. Approximately, 92.8% of the sampled households have access to clean water. Approximately, 11% of the sampled households rely on tube wells for water; while, 26.4% rely on hand pumps. Approximately, 1.5% of the households rely on covered wells and 8.3% on open wells for water. Approximately, 48.2% of the sampled households rely on piped water. As far as the external housing adequacy is concerned; approximately, 87.3% of the sampled households have electricity at home. Approximately, 21.8% of the households have the presence of excrement/human waste surrounding their homes. Whereas, approximately, 15.3% of the sampled households have the presence of stagnant water near their homes. Approximately, 54.4% of the sampled households have a health facility in their villages.

### 4.2 Treatment Variable

For the treatment variable, we utilize the information from the following question that the IHDS-II asked survey participants: During the past five years did you or any other member of your

household participate in/ benefit from social insurance schemes (government or private)? One of the options to this question was Indira Awas Yojana. Out of 41,975 households who responded to this survey question, approximately 5.13% of the households had participated/benefited from IAY.

### 4.3 What Determines Selection into Program?

The design of IAY elicits participation from households with certain characteristics, as it is voluntary in nature, even though it seeks to target poor homeless families in rural areas. Thus, it is essential to understand what determines participation into public housing program. The stipulation of IAY suggests that households without homes or who live in kutcha/dilapidated homes and are below the official poverty level and belong to SC/ST, female headed households, and households with disability, and marginalized households are eligible for participation in the program. Since the program relies on households self-selecting themselves into participation, it is worth learning what determines their participation. The observed household characteristics that are likely to influence participation into IAY include whether the household belongs to SC/ST social group, is below poverty level, household assets, tills/own agricultural land, religion, size of the household, educational attainment of male and female household heads, an indicator for residing in the rural area, a measure of exposure to media, a measure of acquaintance with local elected politicians, and the age of the male and female household heads. We also control for household's district and state, as IAY participation rules are not uniformly implemented across all states.

Approximately, 34% of the surveyed households are in the possession of BPL-based ration cards. Almost 65.4% of the surveyed households live in the rural areas. The IHDS-II constructs an index to measure household assets based on the year 2005 assets possessed by the household. This index ranges from 0-30. The mean score of the household assets based on this index is 14.85. Approximately, 44.5 percent of the surveyed households owned or cultivated agricultural lands.

The average years of schooling for the male head of the household in this sample is 7.8 years with standard deviation of 5. The maximum years of schooling is 16 years, and the minimum is zero years. The average years of schooling for the female head of the household in this sample is 5.6 years with standard deviation of 5.2. The maximum years of schooling is 16 years, and the minimum is zero years. The average size of the household is 4.85 persons with standard deviation of 2.3. The largest household comprised of 33 people and the smallest consisting of only one person. The average number of adult males in a household is 1.42 with standard deviation of 0.87. The highest number of adult males observed in a household is 9 and the smallest being zero. The average number of adult females in a household is 1.49 with standard deviation of 0.78. The highest number of adult females observed in a household is 9 and the smallest being zero. Approximately, 30 percent of the surveyed households belonged to the SC/ST social group. The average age of the male household head is 49.15 years with standard deviation of 13.5 years. The highest age for this variable is 99 years and the lowest age is 15 years. The average age of the female household head is 44.61 years with standard deviation of 13.06 years. The highest age for this variable is 99 years and the lowest age is 7 years. Approximately, 3.8% of the surveyed households had membership in a political party and 29% of the households attended political meetings. On a scale of 1-3, to indicate a household's confidence in the local panchayat's ability to implement public projects, the average score is 1.91 with standard deviation of 0.68. Approximately, 13.2% of the surveyed households had acquaintances with elected politicians outside of their community/caste.

## 5.0 Results

### 5.1 Naive Result

Table-1 presents the estimation result of linear probability model (LPM) where we control for a host of influencers on the outcome variables.[5] The estimation results suggest that the IAY households are 6.4% more likely to live in houses with pucca walls than the non-participants. This result is statistically significant at the 1% level. Also, the homes of IAY households are 2.1% more likely to have pucca roofs relative to the non-participants. This result is statistically significant at the 5% level. Whereas, there is no statistically significant difference between IAY households and non-IAY households in terms of living in houses with pucca floors and pucca houses (pucca wall, pucca roof, and pucca floor).

With regards to the non-availability of toilet at home and the flush toilet at home, there are no statistically significant differences between the IAY participants and non-participants. The IAY participants are 1.6% more likely to have pit toilet at home compared to the non-participants. This result is statistically significant at the 10% level. However, the IAY participants are 1.7% less likely to have septic toilets at home relative to the non-participants, and this result is statistically significant at the 5% level.

The IAY participants are 2.1% more likely to use the open fire chulha relative to the non-participants, and the result is statistically significant at the 5% level. Whereas, the non-participants are 3.1% more likely to use traditional chulha than the participants. The result is statistically significant at the 1% level. We did not find any statistically significant difference between the two groups in terms of using either improved chulha or non-biomass chulha.

[5] An appropriate model to use would be a logit or probit. However, the impact evaluation literature typically reports the results from the LPM, in spite of its shortcomings in dealing with the binary dependent variables. The reason being that the estimates under LPM can be directly and conveniently compared with the results of quasi-experimental models, such as the PSM based models. It's worth noting that the primary conclusions of the paper are not based on this model.

When it comes to water, we did not find any statistically significant difference in terms of either the availability of drinking water or the access to piped water between the two groups of households. However, the IAY households are 2.1%, 1.9%, and 0.9% less likely to access water from tube well, covered well, and open well relative to the non-participants. These results are statistically significant at the 1% level. Whereas, the IAY participants are 6.7% more likely to rely on hand pump water compared to the non-participants, and this result is statistically significant at the 1% level.

The IAY participants are 3.1% less likely to have electricity in their homes relative to the non-participants. This result is statistically significant at the 1% level. Whereas, the IAY participants are 2.6% more likely to have the presence of stagnant water near their homes relative to the non-beneficiary homes. This result is statistically significant at the 1% level. Moreover, we did not find any statistically significant difference in either the presence of excrement/human waste surrounding homes or the access to village health facility between the two groups.

**5.2 Propensity Score Estimation**

Table 2 column 6 presents the result of logit model of program participation where the dependent variable is participation in IAY. It is evident that most of the observed covariates are statistically significant in explaining participation. Below poverty line, rural, SC/ST, size of the family, age of the male household head, attend public meeting, and confidence in local panchayat positively predict participation in IAY. Whereas, household assets, educational attainment of male and female household heads, acquaintance with elected politician, age of the female household head negatively predict participation in IAY.

**5.3 Post Matching Quality**

There are several tests available to assess how good the quality of a match is for the covariates in the post-matching scenario. A good matching is an indicator of a covariate being similar in both pre- and post-matching cases. One can look at the mean difference in pre- and post-matching scenarios for each covariate and the resulting t-values. If the t-statistic is not significant, then we can conclude that the matching is good. Our results suggest that excellent matching is achieved in all covariate cases. Additionally, there are other summary measures to assess the quality of matching such as Psuedo-$R^2$ statistic and Likelihood-Ratio test. A low value of Psuedo-$R^2$ and a high value of the Likelihood-Ratio test is a sign of good matching. The results presented in the table for radius matching overwhelmingly suggest that we have an excellent matching and were able to reduce the observed selection bias.

In order to assess, if we have sufficient overlap in the propensity scores between the treated and non-treated groups, since the matching process includes only those observations that are on common support; we also provide a graph of the density distribution of the propensity scores. The visual inspection of the density distribution of the propensity score suggests that we have sufficient overlap between the treated and the control groups, and thus satisfies the overlap condition of the matching process.

### 5.4 PSM Based Estimation Results

Table-4 presents the estimation results of PSM using radius matching with a caliper of 0.01. The estimation results suggest that the IAY households are 8.4% more likely to live in houses with pucca walls than the non-participants. This result is statistically significant at the 1% level. Also, the homes of IAY households are 3% more likely to have pucca roofs relative to the non-participants. This result is statistically significant at the 1% level. Whereas, IAY households are

2.9% more likely to live in houses with pucca floors than the non-participants, and the result is statistically significant at the 5% level.

With regards to the non-availability of toilet at home and the septic toilet at home, there are no statistically significant differences between the IAY participants and non-participants. The IAY participants are 2.8% more likely to have pit toilet at home compared to the non-participants. This result is statistically significant at the 1% level. However, the IAY participants are 1.4% less likely to have flush toilets at home relative to the non-participants, and this result is statistically significant at the 1% level.

The IAY participants are 2% more likely to use the open fire chulha relative to the non-participants, and the result is statistically significant at the 10% level. Whereas, the non-participants are 2.4% more likely to use traditional chulha than the participants. The result is statistically significant at the 10% level. The IAY participants are 1.4% more likely to use the improved chulha relative to the non-participants and the result is statistically significant at 10% level. We did not find any statistically significant difference between the two groups in terms of using the non-biomass chulha.

With regards to water, we did not find any statistically significant difference in terms of either the availability of drinking water or the access to piped water between the two groups of households. However, the IAY households are 2.2%, 0.7%, and 2.2% less likely to access water from tube well, covered well, and open well relative to the non-participants. These results are statistically significant at the 1% level. Whereas, the IAY participants are 6.3% more likely to rely on hand pump water compared to the non-participants, and this result is statistically significant at the 1% level.

The IAY participants are 2.4% less likely to have electricity in their homes relative to the non-participants. This result is statistically significant at the 5% level. Whereas, the IAY participants are 3.1% more likely to have the presence of stagnant water near their homes relative to the non-beneficiary homes. This result is statistically significant at the 1% level. Moreover, we did not find any statistically significant difference in either the presence of excrement/human waste surrounding homes or the access to village health facility between the two groups.

**5.5 Sensitivity Analysis**

Given that the PSM only accounts for the biases due to the unobserved characteristics, a reliance on it does not imply that the biases due to the unobserved variables will be eliminated. Thus, it is plausible to think that there exist some unseen biases that could potentially influence our estimates. One such example might be that the households who participated in IAY are more motivated, and therefore are more likely to take measures to improve the quality of their homes, even if they didn't participate in the program. This leads us to believe that our estimates could be biased since the extent of their motivations could not be observed. The estimation of treatment effects with matching methods crucially depends on the assumption of conditional independence, meaning that the treatment and control groups do not differ on unobservable attributes that influence the selection into treatment and outcome variables. Failing this assumption, one is likely to obtain non robust estimates from the matching methods (Rosenbaum, 2002). The selection bias is hard to quantify because we are using the non-experimental data. Thus, we employ the Rosenbaum's (2002) method to ascertain the extent of unobservable variables influence such that the estimated treatment effects become invalid. We present the results from the sensitivity analysis in table 5. First, we analyze the Q _mh and P_mh statistics. These statistics suggest that the PSM estimates are not sensitive to the selection bias due to the unobserved characteristics, and the estimated

treatment effects remain statistically significant even in the presence of large unobserved biases. Next, we examine Q_mh+ and P_mh+ statistics for the positive unobserved selection bias. This is likely to occur when IAY households may have higher rates of adequate housing, which results in upward bias and needs to be adjusted downwardly. On the other hand, the negative unobserved selection bias implies that those households who participate in IAY are also more likely to have lower rates of housing adequacy, thereby underestimating the treatment effects, which therefore needs to be adjusted upwardly. The results suggest that even after allowing for a significant amount of positive or negative selection on unobservable characteristics, the PSM estimates remain statistically significant.[6]

**6.0 Inverse Probability Weighted Regression**

Table-6 presents the estimation results of inverse probability weighted regression. These estimations fully support the conclusions obtained under the PSM model. The participants in IAY are 6.6% more likely to have pucca walls, 3% more likely to have pucca roof, and 1% more likely to have pucca floor relative to the non-participants. These estimates are statistically significant at the 1% level. The IAY participants are 1.3% less likely to defecate in open fields (no toilets), 4% more likely to have pit toilets, 0.6% more likely to have septic toilets, and 3.2% less likely to have flush toilets relative to the non-participants. These estimates are statistically significant at the 1% level. With regards to the provision of chulha, the IAY participants are 2.3% more likely to have open fire chulha, 1.5% less likely to have traditional chulha, 1.2% more likely to have improved chulha, and 1.9% less likely to have non-biomass chulha relative to the non-participants. These estimates are statistically significant at the 1% level. When we look at the availability of water, the

[6] The sensitivity analysis used in this paper is borrowed from Kumar & Vollmer (2013).

IAY participating households are 1.5% more likely to have adequate availability of water than the non-participating households, and the result is statistically significant at the 1% level. Moreover, the proportion of households that rely on tube well water is 2% less for the IAY participating households relative to the non-participants, and the result is statistically significant at the 1% level. Whereas, IAY households are 5.8% more likely to rely on handpump water relative to the non-participants, and the result is statistically significant at the 1% level. Additionally, IAY households are 1.4% and 1.2% less likely to rely on open and covered well water, respectively, relative to the non-participating households. These estimates are statistically significant at 1% level. We did not find any statistically significant difference in the reliance on piped water between the two groups. IAY households are 0.7 percent less likely to have access to electricity and 1.4% more likely to have the prevalence of excrement surrounding their homes relative to the non-participating households. These results are statistically significant at the 1% level. The IAY households are 6.3% more likely to have stagnant water near their homes and 2.9% more likely to have access to the village health facility relative to the non-participating households. These results are statistically significant at 1% level.

## 7.0 Alternative PSM Models

Table 7 presents the estimation results of PSM model using the Nearest-Neighbor matching algorithm. The results, more-or-less, confirm the conclusions drawn under radius matching.

## 8.0 Discussion and Limitations

First, we discuss the results concerning the internal housing adequacy outcomes. Our results, based on all model specifications, unequivocally suggest that a greater proportion of IAY beneficiaries (treated group) live in homes with pucca walls than the non-beneficiaries (control group). All

model specifications except one, also suggest that a greater proportion of the treated households live in homes with pucca roof than the control households. Although, greater proportion of the treated households live in homes with pucca floors relative to the control households, the result is not statistically significant in some model specifications. Overall, it can be concluded that the participation in IAY resulted in homes with pucca walls, pucca roof, and pucca floors, making the program a success on this outcome measure.

The results concerning the external aspects of housing adequacy as measured by electricity connection, presence of excrement/human waste matter surrounding the house, presence of stagnant water near the house, and presence of village health facility do not show any positive impact on the participants. One explanation for this could be found in the fact that many of the participants already owned the land and availed the loan facility to construct new house or improve the existing house. If these land sites lacked external housing adequacy, the participation in IAY is not likely to substantially improve these aspects, as it is not explicitly required to participate. A positive outcome could only be expected for those participants who took the loan to purchase land to construct house, since the participation is contingent on meeting the required guidelines pertaining to the external housing adequacy. Another possibility is that the funding for the external housing adequacy might have come from some other programs, such as Jawahar Rojgar Yojana or NREGA, which have their own goals and pace of implementation, and therefore external housing adequacy might not manifest in a prompt fashion with the objectives of IAY. The third possibility is poor implementation of the program and lack of oversight and accountability.

Since the paper relies on propensity score matching, which relies on matching between the treatment and control groups taking place solely on observed characteristics, it is possible that some unobserved characteristics might have systematically influenced the outcome variables.

Unfortunately, the PSM technique cannot address this possibility and maintains a strong assumption that the unobserved characteristics did not influence the outcome variables.

The results of this paper based on PSM and IPW regression do point towards the success of the IAY in terms of meeting some of the program objectives. However, in spite of, our carefully executed statistical exercises to establish causal links between participation in IAY and various housing adequacy measures considered in this paper, we refrain from claiming the causal links, due to the strong assumptions required for such a claim under the PSM approach. However, it should not go without notice that this study shows a very strong statistical association between the two measures.

**9.0 Conclusion**

Indira Awas Yojana, a public housing assistance program of the government of India, started in 1985 as a part of the mission to eradicate poverty, and subsequently becoming a full-fledged program in 1996 and now rechristened as the Pradhan Mantri Awas Yojana, aims to provide housing to the rural homeless poor households, SC/STs, other marginalized sections of the society, disabled and female-headed households.

This study aims to evaluate the effectiveness of IAY in terms of the outcome goals laid out in the program with regards to internal and external housing adequacy by using a nationally representative sample consisting of more than 42,000 households from across India, and employing the quasi-experimental technique of propensity score matching.

The results of this paper suggest that IAY has been a moderately successful program especially with regards to the internal housing adequacy measures such as the pucca structure of house, provision of toilet, provision of smokeless chulha, availability of drinking water. However, the

program cannot be characterized as success in terms of the external housing adequacy related measures, such as electrification, presence of excrement/human waste and stagnant water, and the availability of village health facility. Although, it should be noted that the shortcomings in terms of external housing adequacy measures cannot solely be attributed to IAY, since other government programs are also tasked with the improvement of rural infrastructure.

Based on the findings of this paper, we recommend that the government of India should continue with this program, but more emphasis should be given to a better implementation in terms of accomplishing the external housing adequacy outcomes in addition to making sure that the program is able to yield hundred-percent of the internal housing adequacy outcome measures.

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**Table 1: Naïve Result (LPM)**

| Outcome Variables | Coefficient of IAY | Standard Error | T-Statistic |
|---|---|---|---|
| Pucca Wall | .064 | .010 | 5.96*** |
| Pucca Roof | .021 | .009 | 2.16** |
| Pucca Floor | .009 | .009 | 1.02 |
| Pucca House | .009 | .010 | 0.93 |
| No Toilet | .002 | .010 | 0.22 |
| Pit Toilet | .016 | .008 | 1.86* |
| Septic Toilet | -.017 | .008 | -2.10** |
| Flush Toilet | -.0006 | .003 | -0.18 |
| Open Fire Chulha | .021 | .010 | 2.02** |
| Traditional Chulha | -.031 | .012 | -2.64*** |
| Improved Chulha | .010 | .007 | 1.42 |
| Non-biomass Chulha | .0007 | .007 | 0.10 |
| Adequate Availability of water | -.0007 | .006 | -0.11 |
| Tube Well Water | -.021 | .007 | -2.90*** |
| Handpump Water | .067 | .010 | 6.34*** |
| Open Well Water | -.019 | .007 | -2.62*** |
| Covered Well Water | -.009 | .001 | -6.49*** |
| Piped Water | -.012 | .010 | -1.12 |
| Electricity | -.037 | .008 | -4.20*** |
| Excrement | -.000 | .011 | -0.01 |
| Stagnant Water | .026 | .010 | 2.57*** |
| Village Health Facility | .017 | .012 | 1.42 |

**Table-2: Descriptive Statistics of Covariates (Pre- & Post-Matching) & Logit Result of Participation**

| Variable | Matching Status | Mean Treatment | Mean Control | % \|Bias\| Reduction | T-Stat | Logit |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI |
| BPL | U | .642 | .323 | | 30.69*** | .959*** |
| | M | .648 | .649 | 99.7 | -0.05 | (.055) |
| Lived in rural | U | .923 | .639 | | 27.19*** | 1.317*** |
| area in 2011=1 | M | .924 | .939 | 94.9 | -1.69 | (.102) |
| Assets in 2005 | U | 10.942 | 15.063 | | -30.42*** | -.029*** |
| (index) | M | 11.13 | 11.013 | 97.2 | 0.70 | (.006) |
| Agricultural Land | U | .534 | .441 | | 8.54*** | -.171*** |
| | M | .553 | .602 | 48.6 | -2.85*** | (.056) |
| Education-male | U | 5.435 | 8.023 | | -22.57*** | -.025*** |
| household head | M | 5.33 | 5.334 | 99.8 | -0.02 | (.007) |
| Education-Female | U | 2.940 | 5.79 | | -24.37*** | -.042*** |
| household head | M | 2.957 | 2.926 | 98.9 | 0.23 | (.007) |
| Household size | U | 4.960 | 4.847 | | 2.21** | .045*** |
| | M | 5.206 | 5.218 | 89.8 | -0.15 | (.016) |
| SC/ST=1 | U | .526 | .285 | | 23.98*** | .550*** |
| | M | .513 | .500 | 94.6 | 0.75 | (.053) |
| Religion | U | 1.250 | 1.322 | | -3.79*** | -.041 |
| | M | 1.247 | 1.262 | 80.4 | -0.48 | (.030) |
| Number of male | U | 1.375 | 1.430 | | -2.86*** | .047 (.048) |
| adults | M | 1.487 | 1.472 | 72.4 | 0.59 | |
| Number of female | U | 1.416 | 1.494 | | -4.50 | -.021 |
| adults | M | 1.440 | 1.437 | 95.8 | 0.14 | (.054) |
| Age of male | U | 49.019 | 49.168 | | -0.46 | .013* |
| household head | M | 48.65 | 48.465 | -24.5 | 0.43 | (.007) |
| Age of female | U | 44.172 | 44.652 | | -1.61 | -.011 |
| household head | M | 43.035 | 42.851 | 61.7 | 0.45 | (.007) |
| Member of | U | .027 | .038 | | -2.68*** | -.119 |
| political party =1 | M | .029 | .029 | 94.8 | 0.10 | (.151) |
| Knows elected | U | .082 | .134 | | -6.91*** | -.277*** |
| official=1 | M | .087 | .090 | 94.4 | -0.30 | (.091) |
| Attend public | U | .437 | .284 | | 15.20*** | .503*** |
| meeting =1 | M | .458 | .439 | 87.3 | 1.14 | (.053) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Confidence in | U | 1.900 | 1.915 | | -1.00 | .054*** |
| Panchayat =1 | M | 1.913 | 1.905 | 42.0 | 0.38 | (.037) |
| District | U | 17.11 | 14.711 | | 8.57 *** | .015*** |
| | M | 17.179 | 16.928 | 89.5 \| | 0.52 | (.001) |
| State | U | 19.616 | 18.3 | | 6.04*** | .011*** |
| | M | 19.737 | 19.674 | 95.2 | 0.21 | (.003) |
| N | | | | | | 33605 |
| Pseudo $R^2$ | | | | | | 0.136 |

**Table-3: Summary Measures of Matching Quality**

| Summary of Covariate | Pseudo-$R^2$ | LR $Chi^2$ | P> $Chi^2$ | Mean Bias | Median Bias |
|---|---|---|---|---|---|
| Balance before and after | 0.138 | 1868.63 | 0.000 | 27.5 | 16.7 |
| Matching | 0.003 | 15.48 | 0.692 | 1.9 | 1.4 |

**Figure-1: Graph of Common Support**

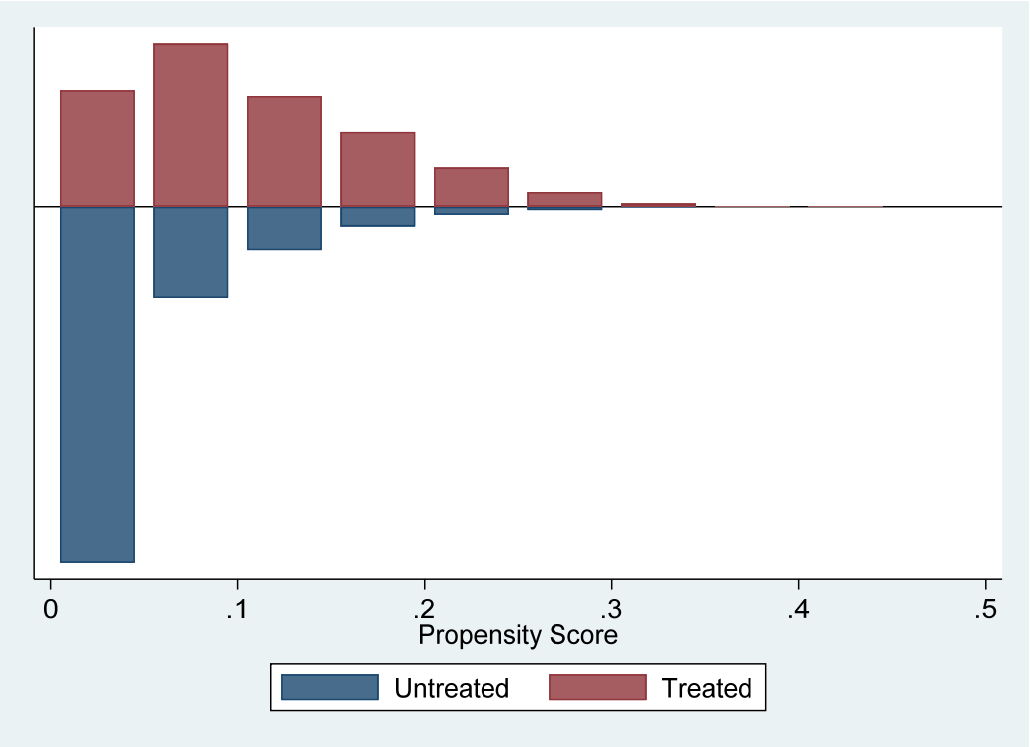


**Table-4 PSM Estimation Radius Matching (Caliper 0.01)**

| Radius Matching (0.01) ATT | Mean Treated | Mean Control | Mean Difference | S.E | T-stat |
|---|---|---|---|---|---|
| Pucca Wall | .627 | .545 | .082 | .012 | 6.73*** |
| Pucca Roof | .784 | .753 | .030 | .010 | 2.89*** |
| Pucca Floor | .471 | .443 | .028 | .012 | 2.22** |
| No Toilet | .683 | .690 | -.007 | .012 | -0.66 |
| Pit Toilet | .146 | .118 | .028 | .009 | 3.09*** |
| Septic Toilet | .151 | .156 | -.004 | .009 | -0.50 |
| Flush Toilet | .015 | .029 | -.014 | .003 | -3.70*** |
| Open Fire Chulha | .247 | .228 | .019 | .010 | 1.79* |
| Traditional Chulha | .521 | .544 | -.022 | .012 | -1.78* |
| Improved Chulha | .100 | .085 | .014 | .007 | 1.93* |
| Non-biomass Chulha | .125 | .134 | -.009 | .009 | -1.08 |
| Adequate Water Availability | .924 | .925 | -.001 | .006 | -0.23 |

| | | | | | |
|---|---|---|---|---|---|
| Tube Well Water | .092 | .114 | -.021 | .007 | -2.92*** |
| Handpump Water | .421 | .357 | .064 | .012 | 5.11*** |
| Open Well Water | .093 | .115 | -.021 | .007 | -2.95*** |
| Covered Well Water | .002 | .010 | -.008 | .001 | -5.06*** |
| Piped Water | .355 | .362 | -.007 | .012 | -0.57 |
| Electricity | .762 | .786 | -.024 | .010 | -2.25** |
| Excrement | .306 | .303 | .002 | .011 | 0.20 |
| Stagnant Water | .217 | .185 | .031 | .010 | 3.03*** |
| Village Health Facility | .466 | .449 | .017 | .012 | 1.37 |

**Table 5: Sensitivity Analysis: Mantel-Haenszel Bounds**

| Outcome | Gamma | Q_mh+ | Q_mh- | p_mh+ | p_mh- |
|---|---|---|---|---|---|
| Pucca Walls | 1 | 10.1395 | 10.1395 | 0 | 0 |
| Pucca Walls | 1.5 | 18.453 | 2.19917 | 0 | .013933 |
| Pucca Walls | 2 | 24.7574 | 3.31986 | 0 | .00045 |
| Pucca Walls | 2.5 | 29.9746 | 7.67564 | 0 | 8.2e-15 |
| Pucca Walls | 3 | 34.5002 | 11.2907 | 0 | 0 |
| Pucca Roof | 1 | 8.13088 | 8.13088 | 2.2e-16 | 2.2e-16 |
| Pucca Roof | 1.5 | 15.1681 | 1.40611 | 0 | .079846 |
| Pucca Roof | 2 | 20.5067 | 3.26061 | 0 | .000556 |

| | | | | | |
|---|---|---|---|---|---|
| Pucca Roof | 2.5 | 24.9263 | 6.96355 | 0 | 1.7e-12 |
| Pucca Roof | 3 | 28.7609 | 10.0399 | 0 | 0 |
| Pucca Floor | 1 | 17.1024 | 17.1024 | 0 | 0 |
| Pucca Floor | 1.5 | 26.1946 | 8.62694 | 0 | 0 |
| Pucca Floor | 2 | 33.2152 | 2.81373 | 0 | .002448 |
| Pucca Floor | 2.5 | 39.0924 | 1.60636 | 0 | .054098 |
| Pucca Floor | 3 | 44.232 | 5.26896 | 0 | 6.9e-08 |
| No Toilet | 1 | 20.4052 | 20.4052 | 0 | 0 |
| No Toilet | 1.5 | 12.1889 | 29.3451 | 0 | 0 |
| No Toilet | 2 | 6.63595 | 36.3102 | 1.6e-11 | 0 |
| No Toilet | 2.5 | 2.41548 | 42.1701 | .007857 | 0 |
| No Toilet | 3 | .9576 | 47.3112 | .169132 | 0 |

**Table 5 (contd.): Sensitivity Analysis: Mantel-Haenszel Bounds**

| Outcome | Gamma | Q_mh+ | Q_mh- | p_mh+ | p_mh- |
|---|---|---|---|---|---|
| Pit Toilet | 1 | .214269 | .214269 | .415169 | .415169 |
| Pit Toilet | 1.5 | 6.0406 | 5.52531 | 7.7e-10 | 1.6e-08 |
| Pit Toilet | 2 | 10.2948 | 9.76577 | 0 | 0 |
| Pit Toilet | 2.5 | 13.7149 | 13.1859 | 0 | 0 |
| Pit Toilet | 3 | 16.6113 | 16.098 | 0 | 0 |
| Septic Toilet | 1 | 14.1993 | 14.1993 | 0 | 0 |
| Septic Toilet | 1.5 | 21.0053 | 7.9058 | 0 | 1.3e-15 |
| Septic Toilet | 2 | 26.2649 | 3.63273 | 0 | .00014 |

| | | | | | |
|---|---|---|---|---|---|
| Septic Toilet | 2.5 | 30.6523 | .370712 | 0 | .355426 |
| Septic Toilet | 3 | 34.4703 | 2.21729 | 0 | .013302 |
| Flush Toilet | 1 | 11.7722 | 11.7722 | 0 | 0 |
| Flush Toilet | 1.5 | 15.1511 | 8.85306 | 0 | 0 |
| Flush Toilet | 2 | 17.8861 | 7.00259 | 0 | 1.3e-12 |
| Flush Toilet | 2.5 | 20.2285 | 5.66718 | 0 | 7.3e-09 |
| Flush Toilet | 3 | 22.2989 | 4.62857 | 0 | 1.8e-06 |
| Open Fire Chulha | 1 | 10.3737 | 10.3737 | 0 | 0 |
| Open Fire Chulha | 1.5 | 3.27032 | 17.8735 | .000537 | 0 |
| Open Fire Chulha | 2 | 1.62461 | 23.6023 | .052123 | 0 |
| Open Fire Chulha | 2.5 | 5.48331 | 28.3664 | 2.1e-08 | 0 |
| Open Fire Chulha | 3 | 8.67548 | 32.5129 | 0 | 0 |

**Table 5 (contd.): Sensitivity Analysis: Mantel-Haenszel Bounds**

| Outcome | Gamma | Q_mh+ | Q_mh- | p_mh+ | p_mh- |
|---|---|---|---|---|---|
| Traditional Chulha | 1 | 10.5582 | 10.5582 | 0 | 0 |
| Traditional Chulha | 1.5 | 2.31685 | 19.1763 | .010256 | 0 |
| Traditional Chulha | 2 | 3.41427 | 25.6967 | .00032 | 0 |
| Traditional Chulha | 2.5 | 7.93461 | 31.0811 | 1.1e-15 | 0 |
| Traditional Chulha | 3 | 11.689 | 35.744 | 0 | 0 |
| Improved Chulha | 1 | 4.91615 | 4.91615 | 4.4e-07 | 4.4e-07 |
| Improved Chulha | 1.5 | .039873 | 9.98825 | .484097 | 0 |
| Improved Chulha | 2 | 3.33126 | 13.819 | .000432 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| Improved Chulha | 2.5 | 6.05039 | 16.9809 | 7.2e-10 | 0 |
| Improved Chulha | 3 | 8.31934 | 19.7183 | 0 | 0 |
| Non-Biomass Chulha | 1 | 21.2575 | 21.2575 | 0 | 0 |
| Non-Biomass Chulha | 1.5 | 28.5059 | 14.7681 | 0 | 0 |
| Non-Biomass Chulha | 2 | 34.2371 | 10.5057 | 0 | 0 |
| Non-Biomass Chulha | 2.5 | 39.09 | 7.34102 | 0 | 1.1e-13 |
| Non-Biomass Chulha | 3 | 43.36 | 4.8203 | 0 | 7.2e-07 |
| Adequate Water Availability | 1 | .324078 | .324078 | .372939 | .372939 |
| Adequate Water Availability | 1.5 | 4.64545 | 3.9011 | 1.7e-06 | .000048 |
| Adequate Water Availability | 2 | 7.81482 | 7.0473 | 2.8e-15 | 9.1e-13 |
| Adequate Water Availability | 2.5 | 10.3798 | 9.57473 | 0 | 0 |
| Adequate Water Availability | 3 | 12.5693 | 11.7152 | 0 | 0 |

**Table 5 (contd.): Sensitivity Analysis: Mantel-Haenszel Bounds**

| Outcome | Gamma | Q_mh+ | Q_mh- | p_mh+ | p_mh- |
|---|---|---|---|---|---|
| Tube Well Water | 1 | 2.77664 | 2.77664 | .002746 | .002746 |
| Tube Well Water | 1.5 | 7.63572 | 1.88457 | 1.1e-14 | .029744 |
| Tube Well Water | 2 | 11.2444 | 5.28215 | 0 | 6.4e-08 |
| Tube Well Water | 2.5 | 14.179 | 7.98777 | 0 | 6.7e-16 |
| Tube Well Water | 3 | 16.6844 | 10.2697 | 10.2697 | 10.2697 |
| Handpump Water | 1 | 15.1068 | 15.1068 | 0 | 0 |
| Handpump Water | 1.5 | 6.83746 | 23.9315 | 4.0e-12 | 0 |
| Handpump Water | 2 | 1.13364 | 30.7236 | .128473 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| Handpump Water | 2.5 | 3.22166 | 36.3992 | .000637 | 0 |
| Handpump Water | 3 | 6.84412 | 41.3562 | 3.8e-12 | 0 |
| Open Well Water | 1 | 1.38642 | 1.38642 | .082809 | .082809 |
| Open Well Water | 1.5 | 3.28538 | 6.19122 | .000509 | 3.0e-10 |
| Open Well Water | 2 | 6.72805 | 9.7397 | 8.6e-12 | 0 |
| Open Well Water | 2.5 | 9.48012 | 12.6252 | 0 | 0 |
| Open Well Water | 3 | 11.8023 | 15.0967 | 0 | 0 |
| Covered Well Water | 1 | 4.36664 | 4.36664 | 6.3e-06 | 6.3e-06 |
| Covered Well Water | 1.5 | 5.69363 | 3.21818 | 6.2e-09 | .000645 |
| Covered Well Water | 2 | 6.77159 | 2.48593 | 6.4e-12 | .006461 |
| Covered Well Water | 2.5 | 7.70054 | 1.95407 | 6.8e-15 | .025346 |
| Covered Well Water | 3 | 8.52757 | 1.53785 | 0 | .062043 |

**Table 5 (contd.): Sensitivity Analysis: Mantel-Haenszel Bounds**

| Outcome | Gamma | Q_mh+ | Q_mh- | p_mh+ | p_mh- |
|---|---|---|---|---|---|
| Piped Water | 1 | 10.4801 | 10.4801 | 0 | 0 |
| Piped Water | 1.5 | 18.7862 | 2.54447 | 0 | .005472 |
| Piped Water | 2 | 25.0656 | 2.9619 | 0 | .001529 |
| Piped Water | 2.5 | 30.243 | 7.30489 | 0 | 1.4e-13 |
| Piped Water | 3 | 34.7193 | 10.9122 | 0 | 0 |
| Electricity | 1 | 14.9508 | 14.9508 | 0 | 0 |
| Electricity | 1.5 | 22.6736 | 7.80791 | 0 | 2.9e-15 |
| Electricity | 2 | 28.6801 | 2.9317 | 0 | .001686 |

| | | | | | |
|---|---|---|---|---|---|
| Electricity | 2.5 | 33.7326 | .750634 | 0 | .226437 |
| Electricity | 3 | 38.1651 | 3.81394 | 0 | .000068 |
| Excrement | 1 | 8.25239 | 8.25239 | 1.1e-16 | 1.1e-16 |
| Excrement | 1.5 | .758179 | 16.0548 | .224172 | 0 |
| Excrement | 2 | 4.47375 | 21.9471 | 3.8e-06 | 0 |
| Excrement | 2.5 | 8.62265 | 26.8104 | 0 | 0 |
| Excrement | 3 | 12.0753 | 31.0211 | 0 | 0 |
| Stagnant Water | 1 | 7.15475 | 7.15475 | 4.2e-13 | 4.2e-13 |
| Stagnant Water | 1.5 | .466921 | 14.1168 | .320278 | 0 |
| Stagnant Water | 2 | 4.19512 | 19.3764 | .000014 | 0 |
| Stagnant Water | 2.5 | 7.90498 | 23.7187 | 1.3e-15 | 0 |
| Stagnant Water | 3 | 10.9939 | 27.479 | 0 | 0 |

Gamma : odds of differential assignment due to unobserved factors

Q_mh+ : Mantel-Haenszel statistic (assumption: overestimation of treatment effect)

Q_mh- : Mantel-Haenszel statistic (assumption: underestimation of treatment effect)

p_mh+ : significance level (assumption: overestimation of treatment effect)

p_mh- : significance level (assumption: underestimation of treatment effect)

**Table 6: Inverse Probability Weighted Regression**

| Outcome Variables | Coefficient of IAY | Standard Error Robust | Z-Statistic |
|---|---|---|---|
| Pucca Wall | .071 | .010 | 6.56*** |
| Pucca Roof | .023 | .009 | 2.41** |

| | | | |
|---|---|---|---|
| Pucca Floor | .020 | .009 | 2.18** |
| No Toilet | -.012 | .010 | -1.22 |
| Pit Toilet | .034 | .008 | 3.92*** |
| Septic Toilet | .002 | .008 | 0.37 |
| Flush Toilet | -.011 | .003 | -3.6*** |
| Open Fire Chulha | .022 | .010 | 2.01** |
| Traditional Chulha | -.019 | .012 | -1.63 |
| Improved Chulha | .014 | .007 | 1.92* |
| Non-biomass Chulha | -.002 | .006 | -0.43 |
| Adequate Availability of water | -.002 | .006 | -0.32 |
| Tube Well Water | -.021 | .007 | -2.93*** |
| Handpump Water | .063 | .010 | 5.97*** |
| Open Well Water | -.020 | .007 | -2.76*** |
| Covered Well Water | -.012 | .000 | -16.17*** |
| Piped Water | -.009 | .010 | -0.86 |
| Electricity | -.030 | .008 | -3.74*** |
| Excrement | -.000 | .011 | -0.04 |
| Stagnant Water | .032 | .010 | 3.08*** |
| Village Health Facility | .019 | .012 | 1.54 |

**Table-7: Nearest Neighbor Matching**

| Nearest Neighbor Matching ATT | Mean Treated | Mean Control | Mean Difference | S.E | T-stat |
|---|---|---|---|---|---|
| Pucca Wall | .627 | .543 | .084 | .013 | 6.23*** |
| Pucca Roof | .783 | .754 | .028 | .011 | 2.49** |
| Pucca Floor | .471 | .430 | .041 | .013 | 2.96*** |
| No Toilet | .682 | .701 | -.018 | .013 | -1.44 |
| Pit Toilet | .147 | .117 | .029 | .009 | 3.04*** |
| Septic Toilet | .151 | .147 | .003 | .010 | 0.39 |
| Flush Toilet | .015 | .030 | -.015 | .003 | -3.90*** |
| Open Fire Chulha | .248 | .227 | .020 | .011 | 1.72* |
| Traditional Chulha | .521 | .546 | -.025 | .013 | -1.80* |
| Improved Chulha | .100 | .087 | .012 | .008 | 1.50 |

| | | | | | |
|---|---|---|---|---|---|
| Non-biomass Chulha | .124 | .132 | -.007 | .009 | -0.84 |
| Adequate Water Availability | .924 | .926 | -.002 | .007 | -0.30 |
| Tube Well Water | .092 | .114 | -.022 | .008 | -2.75*** |
| Handpump Water | .421 | .367 | .053 | .013 | 3.91*** |
| Open Well Water | .093 | .115 | -.021 | .008 | -2.57*** |
| Covered Well Water | .002 | .009 | -.006 | .001 | -3.90*** |
| Piped Water | .355 | .352 | .003 | .013 | 0.23 |
| Electricity | .763 | .798 | -.035 | .011 | -3.00*** |
| Excrement | .306 | .297 | .009 | .012 | 0.72 |
| Stagnant Water | .217 | .184 | .032 | .011 | 2.88*** |
| Village Health Facility | .467 | .435 | .032 | .013 | 2.30** |