Sustaining Sanitation

Long-term effects of a sanitation campaign

Jennifer Orgill (jennifer.orgill@duke.edu)
August 9, 2016

Camp Resources
10 year evaluation of a sanitation campaign RCT in Odisha, India

- Information dispersion,
- Social shaming
- Latrine subsidy for poor households

Follow-ups after:
- 1 year
- 5 years
- 10 years

Adoption of latrines increased significantly for 5 years in treatment villages.
Abandonment of latrines significantly higher in treatment villages 6-10 years after intervention.
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Externalities: Water contamination
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Poor sanitation affects human capital development
**Externalities:** Water contamination

Poor sanitation affects human capital development

- **Child stunting** (Dickinson et al., 2015; Spears et al., 2013; Rah et al., 2015; Schmidt 2014)
- **Diarrheal incidence** (Duflo et al., 2015; Guiteras et al., 2015; Kumar and Vollmer 2012)
- **Time costs** (Dickinson et al., 2015; Pattanayak et al., 2010)
Why Should We Care About Sanitation?

Technology adoption (latrines) has been difficult despite cost-effective solutions
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Important factors in technology adoption (Jaffe et al. 2002):

- Peer effects / imitative adoption behavior (Rode and Weber, 2016; Dickinson et al., forthcoming)
- Information (Pattanayak and Pfaff, 2009)
- Uncertainty (Isik, 2004)
As of 2009, only one study measured effects of sanitation beyond 2 years (Waddington et al., 2009)
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  - Elementary econometrics

Since 2009, only one working paper exploring impacts longer than 2 years (Duflo et al. (2016 WP))
Sustained behavior change is difficult...
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- Individuals forget "cues" (Aragwal et al., 2013; Gallagher 2013)

But possible?

- Persistent effect if messages given consistently for two years (Allcott and Rogers, 2014)

- Reduced water consumption persisted two years after social comparison treatment (Ferraro and Price, 2011)
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Community Led Total Sanitation RCT

Elements of the RCT:

- Conducted in 2005
- Bhadrak district in Odisha, India
- 40 villages: 20 treatment, 20 control
- Village wide intervention
- 1086 households; all had children under 5 years old
- Objective: to increase latrine coverage
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Revisiting 2005 Intervention

Photo Credit: Katherine Anderson (WSSCC) 2015
Revisiting 2005 Intervention

Photo Credit: Jesse Coffie Danku (WASH SNV Netherlands) 2014
Revisiting 2005 Intervention
Fig. 2. Latrine ownership in households below and above the poverty line and in the overall sample before and after an IEC sanitation campaign in Bhadrak, Orissa, India, 2005–2006

Improved child health outcomes:
2006 Follow-Up

Improved child health outcomes:

- Mid Upper Arm Circumference
- Height for Age
- Weight for Age
2006 Follow-Up

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Time savings
2006 Follow-Up

Improved child health outcomes:

- Mid Upper Arm Circumference
- Height for Age
- Weight for Age

Time savings

Increased reported satisfaction with village sanitation

## Descriptive Statistics

<table>
<thead>
<tr>
<th>Description</th>
<th>Mean</th>
<th>Std Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary water source is public well or surface water</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>Household primarily uses open defecation</td>
<td>0.92</td>
<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
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<td></td>
</tr>
<tr>
<td>Household owns bicycle</td>
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<td></td>
</tr>
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<td>Monthly household savings (Rupees)</td>
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N=1086 households
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Two-period model \((t = 1, 2)\)

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Theoretical Model of Sustained Sanitation Behavior

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Assume:

- No switching between types of household between periods
- \(W^\theta_1 = W^\theta_2\)
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- \(\delta^P = \delta^R\)
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In \(t = 1\), household decides whether to adopt latrine or not \((F_1 = 0, 1)\)

- Cost of adoption for type \(P = l - s\)
- Cost of adoption for type \(R = l\)
Theoretical Model of Sustained Sanitation Behavior

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- $\delta^P = \delta^R$

In $t = 1$, household decides whether to adopt latrine or not ($F_1 = 0, 1$)

- Cost of adoption for type $P = l - s$
- Cost of adoption for type $R = l$

In $t = 2$, household decides whether to continue using latrine ($M_2 = 0, 1$)

- Cost of maintenance for both types = $m$
Theoretical Model of Sustained Sanitation Behavior

Let $U_t(W_t(C_t, .); \theta)$

where:

$C =$Household Human Capital Accumulation

<table>
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<tr>
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<td>$U^P_W = U^R_W$</td>
</tr>
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<td>$W^P_C &gt; 0$</td>
<td>$W^R_C &gt; 0$</td>
<td>$W^P_C &lt; W^R_C$</td>
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In period 1, households will purchase a latrine if:

\[ W_1^P - (1 - s) + \frac{\partial W_1^P}{\partial C} + \delta W_2^P - \delta m > W_1^P + \delta W_2^P \]

\[ W_1^R - I + \frac{\partial W_1^R}{\partial C} + \delta W_2^R - \delta m > W_1^R + \delta W_2^R \]
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\[ W_1^R - l + \frac{\partial W_1^R}{\partial C} + \delta W_2^R - \delta m > \underbrace{W_1^R + \delta W_2^R}_{\text{Payoff to R for purchasing latrine}} \]

\[ \underbrace{W_1^R + \delta W_2^R}_{\text{Payoff to R for not purchasing latrine}} \]
Reordering Terms:

\[
\frac{\partial W_1^P}{\partial C} - l + s - \delta m > 0
\]

\[
\frac{\partial W_1^R}{\partial C} - l - \delta m > 0
\]
Reordering Terms:

\[
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\frac{\partial W_1^R}{\partial C} - l - \delta m > 0
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Recall that:

\[
\frac{\partial W_1^P}{\partial C} < \frac{\partial W_1^R}{\partial C}
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Reordering Terms:

\[ \frac{\partial W_1^P}{\partial C} - l + s - \delta m > 0 \]
\[ \frac{\partial W_1^R}{\partial C} - l - \delta m > 0 \]

Recall that:

\[ \frac{\partial W_1^P}{\partial C} < \frac{\partial W_1^R}{\partial C} \]

Implications:

- For sufficiently large $s$, we expect $\theta = P$ households to be more likely to adopt latrines than $\theta = R$ households.
- For small $s$, $\theta = R$ households are more likely to adopt.
Theoretical Model of Sustained Sanitation Behavior: Period 2

In period 2, households that previously adopted latrines will continue using latrine if:

\[ W_2^P - m + \frac{\partial W_2^P}{\partial C} > W_2^P \]

\[ W_2^R - m + \frac{\partial W_2^R}{\partial C} > W_2^R \]

Payoff of maintaining latrine  Payoff of abandoning latrine

Reordering Terms:

\[ W_2^P - m + \frac{\partial W_2^P}{\partial C} > 0 \]

\[ W_2^R - m + \frac{\partial W_2^R}{\partial C} > 0 \]

Implications:

• ✓ = P households are more likely to abandon latrines than ✓ = R households
In period 2, households that previously adopted latrines will continue using latrine if:

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Reordering Terms:

\[ \frac{\partial W_2^P}{\partial C} - m > 0 \]

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Implications:

- \( \theta = P \) households are more likely to abandon latrines than \( \theta = R \) households
Empirical Specification

Outcomes of interest:

- Ever owning a latrine
- Abandoning a latrine
  - Filling latrine
  - Latrine destroyed
  - Stopped using latrine
\[ Y_{it} = \beta_0 + \beta_1 \text{TREATMENT}_i \\
+ \beta_2 \text{POST}2006_t \\
+ \beta_3 \text{POST}2010_t \\
+ \beta_4 \text{POST}2016_t \\
+ \beta_5 (TREATMENT_i \times \text{POST}2006_t) \\
+ \beta_6 (TREATMENT_i \times \text{POST}2010_t) \\
+ \beta_7 (TREATMENT_i \times \text{POST}2016_t) + \epsilon_{it} \]  (1)
Difference-in-Difference Specification

\[ Y_{it} = \beta_0 + \beta_1 \text{TREATMENT}_i + \beta_2 \text{POST}2006_t + \beta_3 \text{POST}2010_t + \beta_4 \text{POST}2016_t + \beta_5 (\text{TREATMENT}_i \times \text{POST}2006_t) + \beta_6 (\text{TREATMENT}_i \times \text{POST}2010_t) + \beta_7 (\text{TREATMENT}_i \times \text{POST}2016_t) + \epsilon_{it} \] (1)
Y_{it} = \beta_0 + \beta_1 TREATMENT_i + \beta_2 BPL_i + \beta_3 BPL_i \times Treatment_i \\
+ \beta_4 POST_{2006t} + \beta_5 POST_{2010t} + \beta_6 POST_{2016t} \\
+ \beta_7 BPL_{2006it} + \beta_8 BPL_{2010it} + \beta_9 BPL_{2016it} \\
+ \beta_{10} (TREATMENT_i \times POST_{2006t}) \\
+ \beta_{11} (TREATMENT_i \times POST_{2010t}) \\
+ \beta_{12} (TREATMENT_i \times POST_{2016t}) \\
+ \beta_{13} (TREATMENT_i \times POST_{2006t} \times BPL_{2006it}) \\
+ \beta_{14} (TREATMENT_i \times POST_{2010t} \times BPL_{2010it}) \\
+ \beta_{15} (TREATMENT_i \times POST_{2016t} \times BPL_{2016it}) + \epsilon_{it} \quad (2)
Triple Difference Specification

\[ Y_{it} = \beta_0 + \beta_1 TREATMENT_i + \beta_2 BPL_i + \beta_3 BPL_i \times TREATMENT_i \]
\[ + \beta_4 POST2006_t + \beta_5 POST2010_t + \beta_6 POST2016_t \]
\[ + \beta_7 BPL2006_{it} + \beta_8 BPL2010_{it} + \beta_9 BPL2016_{it} \]
\[ + \beta_{10} (TREATMENT_i \times POST2006_t) \]
\[ + \beta_{11} (TREATMENT_i \times POST2010_t) \]
\[ + \beta_{12} (TREATMENT_i \times POST2016_t) \]
\[ + \beta_{13} (TREATMENT_i \times POST2006_t \times BPL2006_{it}) \]
\[ + \beta_{14} (TREATMENT_i \times POST2010_t \times BPL2010_{it}) \]
\[ + \beta_{15} (TREATMENT_i \times POST2016_t \times BPL2016_{it}) + \epsilon_{it} \quad (2) \]
DID Results: Ever Owned A Latrine

![Graph showing the difference in latrine ownership between control and treatment groups over years. The y-axis represents the proportion of ever owned latrines, ranging from 0.0 to 0.6. The x-axis represents the years from 2005 to 2016. The graph shows a steady increase in latrine ownership from 2005 to 2016 for both control and treatment groups. The treatment group shows a higher proportion of latrine ownership compared to the control group post-treatment.]

Legend:
- **Control**: Blue line
- **Treatment**: Orange line
DID Results: Ever Owned A Latrine
DID Results: Abandoned Latrine (since 2005)
DID Results: Ownership/Abandonment of Latrines
DID Results: Ever Owned a Latrine (Poor)
DID Results: Ever Owned a Latrine (Rich)
DDD Results: Ever Owned a Latrine (Poor/Rich)
DID Results: Abandoned a Latrine (Poor)

![Graph showing the percentage of ever abandoned poor households over years, with a vertical line indicating the year of treatment occurrence. The graph compares the control group (blue) and the treatment group (orange). The data points show a significant increase in the treatment group starting from 2010, with a peak at 0.20*** (0.05) in 2016.]
DID Results: Abandoned a Latrine (Rich)
DDD Results: Abandoned a Latrine (Poor/Rich)
Conclusions

The treatment effect persisted in latrine adoptions over time

- The initial adoption treatment effect was larger for poor households receiving subsides than rich households
- No significant difference in treatment effect between medium (5 years) and long-term (10 years)
Conclusions

The treatment effect persisted in latrine adoptions over time

- The initial adoption treatment effect was larger for poor households receiving subsides than rich households
- No significant difference in treatment effect between medium (5 years) and long-term (10 years)

Treatment assignment positively predicted latrine abandonment in the 10 year follow-up, but not before

- This rate of abandonment was higher among poor households (not statistically significant)
Implications

Subsidies important to targeting low-income households to adopt improved sanitation technologies

How long can we expect these technologies to endure before abandonment? 5-6 years

To have enduring impacts, programs should:

- Consider costs of providing maintenance subsidies, incentives, etc. 5-6 years after initial adoption
- Promote technologies on an ongoing basis
- Focus on simultaneous policies that increase human capital to make maintenance costs more affordable

Focus on sustaining behaviors is critical as Modi makes initial latrine adoption nationwide priority
Implications

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Thank You!

Comments welcome at
jennifer.orgill@duke.edu
## DID Results

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<td>-0.02**</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.01)</td>
</tr>
<tr>
<td><strong>Treatment*Post2010</strong></td>
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<td>0.01</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.03)</td>
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<tr>
<td><strong>Treatment*Post2016</strong></td>
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<td>0.16***</td>
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<tr>
<td></td>
<td>(0.08)</td>
<td>(0.05)</td>
</tr>
<tr>
<td><strong>Observations</strong></td>
<td>4,155</td>
<td>4,174</td>
</tr>
<tr>
<td><strong>Number of households</strong></td>
<td>1,086</td>
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</tr>
<tr>
<td><strong>Number of villages</strong></td>
<td>40</td>
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</tr>
<tr>
<td><strong>R-squared</strong></td>
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Robust clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
## Triple Difference Results

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<tr>
<th></th>
<th>(1) Ever Owned a Latrine</th>
<th>(2) Ever Abandoned a Latrine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment<em>Post2006</em>BPL</td>
<td>0.04</td>
<td>0.03*</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.02)</td>
</tr>
<tr>
<td>Treatment<em>Post2010</em>BPL</td>
<td>0.22***</td>
<td>-0.00</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Treatment<em>Post2016</em>BPL</td>
<td>0.17***</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.05)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statistics</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observations</td>
<td>4,152</td>
<td>4,109</td>
</tr>
<tr>
<td>Number of households</td>
<td>1,085</td>
<td>1,042</td>
</tr>
<tr>
<td>Number of villages</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.15</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Robust clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1