Optimal Incentives in the Presence of Social Norms: Experimental Evidence from Kenya

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Motivation

- Markets often fail to achieve socially optimal outcomes.
    - Governments shape economic incentives - cost and benefits of actions - to realign individual choices.
- Yet, these very individual choices are frequently also governed by social norms: they carry reputational costs and benefits.
    - Individuals take visible actions to signal their type. [DellaVigna et al. 2017; Perez-Truglia et al. 2017; Bursztyn et al. 2017, 2018; Karing 2021]
- Reputational incentives can interact with economic incentives, mitigating or amplifying their effects. [Bénabou and Tirole, 2012]
    - Governments can leverage these interactions for optimal policy design.

Research question

- How do changes in economic incentives interact with reputational incentives? What does it mean for optimal policy at scale?

- **Emerging theoretical literature**

- **Lack of empirical evidence:** so far, challenging to randomize *both* economic incentives and social norm concerns.

This paper.

This paper: what we do not do

- We do not study crowding out of intrinsic motivation in response to material rewards or punishments.

This paper: what we do - field experiment

Setting: deworming treatment in Kenya, increase take-up among adults.

- Vary social norm concerns.

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- Create experimental variation in the cost of deworming. Vary the distance people have to travel to receive treatment.
- Implement experiment at scale. Create common knowledge and shift equilibrium level of take-up. At large-scale: randomize 144 points of treatment and their communities, 200,000 adults targeted.

This paper: what we do - structural model

- Take theory to data. Estimate counterfactuals that account for endogenous social norm responses.

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- Take theory to data. Estimate counterfactuals that account for endogenous social norm responses. Build a structural model to identify social multiplier effects.
- Solve for optimal allocation of points of treatment. Combine parameter estimates with geographic location data.

This paper: what we ask specifically

1. How does the opportunity to signal take-up affect individuals' decision to deworm?
2. How does changing distance affect take-up and the reputational returns from deworming?
    - Do these changes mitigate or amplify the impact of cost on take-up?
3. What is the optimal allocation of deworming treatment locations in the presence of social multiplier effects?

This paper: what we find

- Increasing the visibility of actions through bracelets, take-up of deworming treatment $\Uparrow$ from 34 to 42 percent.
- Increasing the travel distance by 1km leads to a decline in take-up by 15 percentage points in the absence of signals.
- Bracelets as signals ATE twice as large at far distances.

  $\Rightarrow$ increases in reputational returns mitigate the negative impact of distance on take-up by 4 pp per km (social multiplier > -1).
- Optimal policy leverages endogenous social norm responses: with the same number of treatment locations serve a larger population.

Overview of talk

1. **Empirical context**
2. Theoretical framework
3. Experimental design
4. Reduced form results
5. Structural model $\longrightarrow$ social multiplier
6. Optimal policy choice

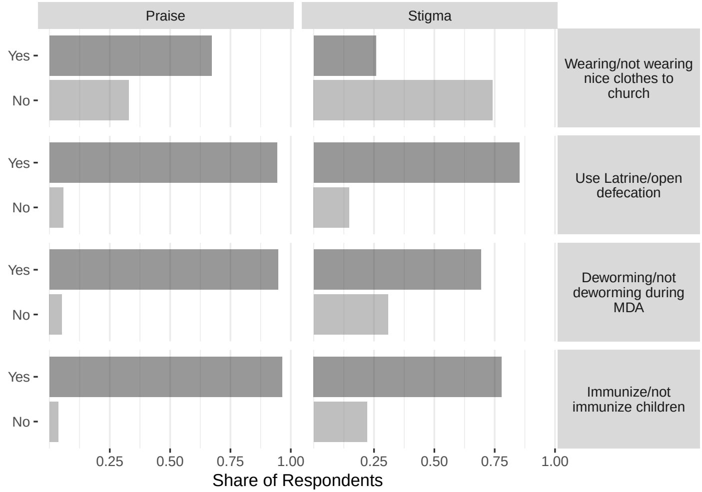
Empirical context

- Soil-transmitted helminths (STH) refer to intestinal worms infecting humans that are transmitted through contaminated soil. 2 billion people are infected.
- Development burden for children and adults in many LICs. Mild infections often are asymptomatic. More severe infections lead to abdominal pain, iron-deficiency, anemia, malnutrition, and stunting.
- Deworming is a public good:
  - Low private returns for many individuals.
  - Most of social benefits come through reduced disease transmission.
  - Children are dewormed in schools but remaining reservoir among adult population fosters reinfection ⇒ To stop transmission, need adults to deworm.
- Cost of screening is 4 to 10 times that of treatment. Deworming drugs are safe, no side effects for uninfected. Recommended every 6-12 months.

Western Kenya

- Worms are endemic, infection prevalence is over 20%.
- Kenyan Government deworms children for free in schools. School-based deworming is a well-known program.
- Adults can purchase deworming treatment at pharmacies and clinics for 150 KSh $\sim$ USD 1.5.
- Baseline survey
  - 78% of adults knew about deworming treatment.
  - 68% had taken deworming treatment before.
  - 37% reported to have dewormed in the past 12 months.
  - 31% of adults had knowledge of externalities.

Social norm concerns



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Social signaling (Bénabou and Tirole 2012)

$$U_i(y;v,\mu) = B_i(y;v) + \overbrace{\mu \mathrm{E}_{-i}[V \mid y]}^{\text{reputational returns}}$$

Individuals have different *prosocial* types that are unobservable to others. Others can use i's action to draw inferences about her type.

- Prosocial activity, $y \in \{0,1\}$, dewormed or not.
- Net private benefit of deworming, $B_i(y;v)$.
- Intrinsic motivation to look after one's health and that of others, $V \sim F_V$.
- $\mathrm{E}_{-i}[V \mid y]$ is the inference that others make about own type v based on your action y.
- Visibility of y and desirability to signal, $\mu = x \cdot \lambda$.

Equilibrium with signaling

Equilibrium v^*:

$$B(y=1;v^*)+\overbrace{\mu\Delta[v^*]}^{\text{net reputational incentive}}=0$$

where

$$\Delta[v^*]=\mathrm{E}[V|y=1]-\mathrm{E}[V|y=0]=\overbrace{\mathrm{E}[V|V>v^*]}^{\text{honor}}-\overbrace{\mathrm{E}[V|V\leq v^*]}^{\text{stigma}}$$

is the difference in the average type based on observed actions. Without signaling the equilibrium would be

$$B(y=1;\tilde{v})=0$$

and thus, with $v^*<\tilde{v}$, signaling induces greater take-up of deworming.

Interaction of cost and norms

Let c be the cost (disutility) of deworming, and define the average take-up to be

$$\bar{y}(c) = 1 - F_V(v^*(c)),$$

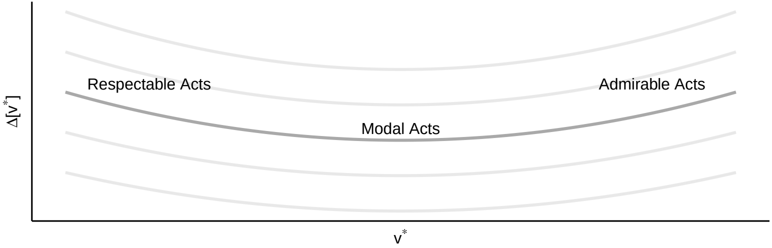
the slope of which is

$$\bar{y}'(c) = f_V(v^*(c)) \cdot \overbrace{\frac{-1}{1 + \mu\Delta'[v^*(c)]}}^{\text{social multiplier}}$$

Social multiplier

$$-\frac{\mathrm{d}v^*(c)}{\mathrm{d}c} = \frac{-1}{1+\mu\Delta'[v^*(c)]}$$

- $\Delta'[v^*] < 0 \implies$ More sensitive to changes in cost/benefits (respectable or normal acts) - amplification.
- $\Delta'[v^*] > 0 \implies$ Less sensitive to changes in cost/benefits (admirable or heroic acts) - mitigation.



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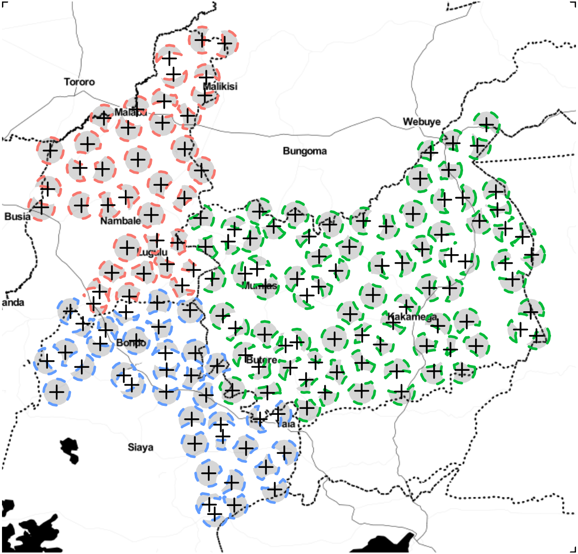
Community-based deworming program

- We worked with the government of Kenya and its county governments, providing free deworming treatment to approximately 200,000 adults in Busia, Siaya and Kakamega.
- Community Health Volunteers (CHVs) provided deworming at 144 central locations over 12 days, Monday-Sunday 8am-5pm.
- CHVs informed communities prior to deworming about the social benefits of deworming, the dates and location.

Site selection



School Locations

Experimental treatments

1. *Reputational concerns*: visibility of deworming take-up using:
   a) *Bracelets*: a social signal with some potential private valuation.
   b) *Indelible Ink*: a social signal with no private valuation.
   c) *Control*: no incentives.
   d) *Calendars*: a private incentive with low visibility.

   $Z \in \{\text{control, bracelet, calendar, ink}\}$
2. *Cost of deworming*: manipulating cost by randomly varying the distance to deworming location. $D \in \{\text{close, far}\}$

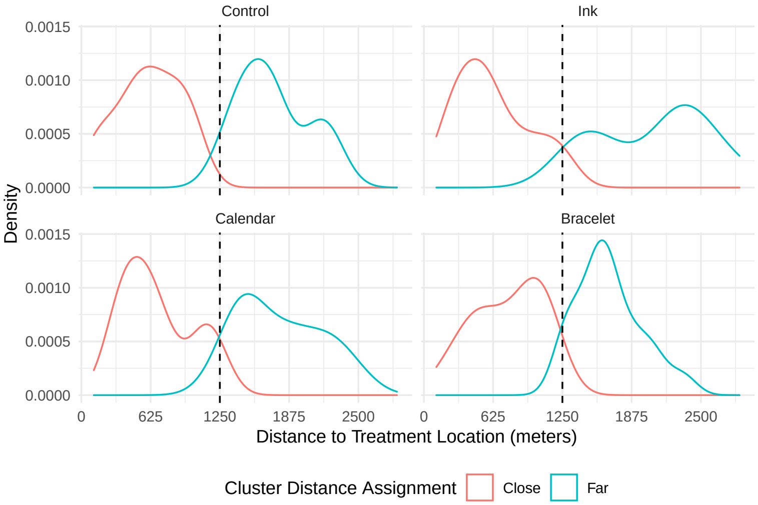
Information Campaign

Social signals

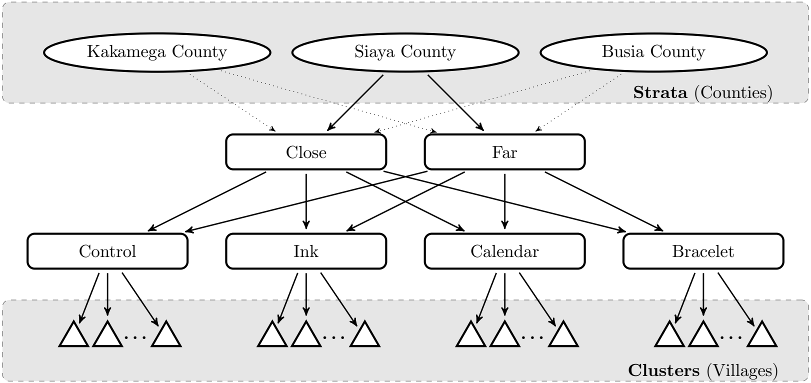
Bracelet saying "Treat worms: improve the health of your community"

Private incentive

Random distance to treatment location



Experiment design



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Reduced form model

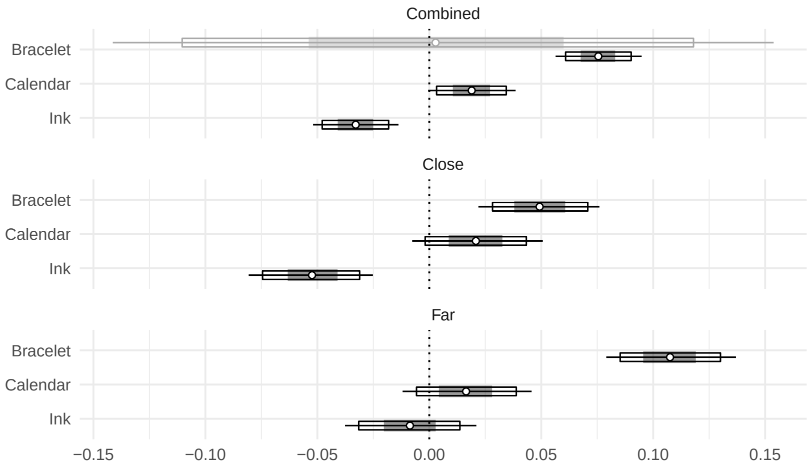
Probit model:

$$
\begin{aligned}
E[Y_i(z,g)] &= E[Y_i \mid Z = z, G = g] \\
&= \Phi\big(\alpha + z\beta_z + g\delta + (z \times g)\gamma_z\big)
\end{aligned}
$$

where

$$
\begin{aligned}
Z &\in \{\textit{bracelet, calendar, ink}\} \\
G &\in \{\textit{close, far}\}
\end{aligned}
$$

Reduced form results: Incentive ATEs



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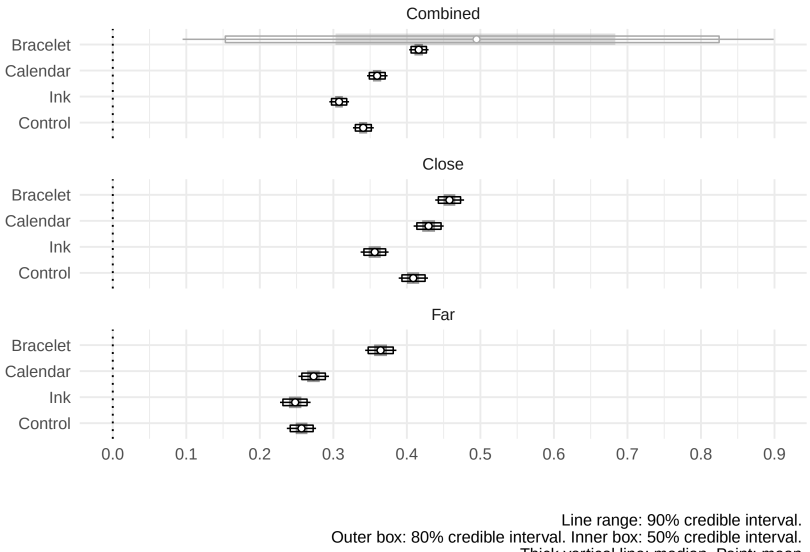
Thick vertical line: median. Point: mean.

Reduced form results: Incentive take-up levels



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Deworming take-up model

$$Y(z,d) = \mathbb{1}\{B(z,d) + \mu(z,d)\Delta[w^*(z,d)] + \overbrace{V + U}^{W} > 0\}$$

where we solve for the fixed point:

$$w^*(z,d) = -B(z,d) - \mu(z,d)\Delta[w^*(z,d)]$$

Augment the theoretical model:

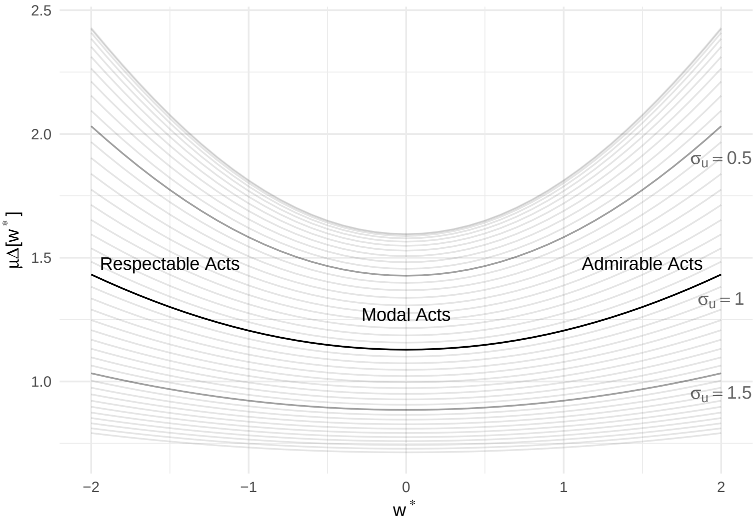
- $\mu(z,d) = x(z,d) \cdot \lambda$ visibility as a function of distance.
- U second source of unobservable heterogeneity, cost or taste shocks.

Bring information to bear from multiple sources:

- Use willingness-to-pay exercise to learn about $B(z,d)$
- Use beliefs data to estimate $\mu(z,d)$

Model Assumptions

Net reputational returns with non-structural shocks



Net private benefit B

$$B(z,d) = z\beta - \delta \cdot d, \; z \in \{\text{control, ink, calendar, bracelet}\}, d \in \mathbb{R}^+$$

We model individual's private utility to be

$$\beta_{\text{calendar}} = \beta_{\text{bracelet}} + \gamma^{\text{wtp}} \mu^{\text{wtp}}$$

$$\gamma^{\text{wtp}} \sim \texttt{Normal}^+(0, \tau^{\gamma,\text{wtp}}).$$

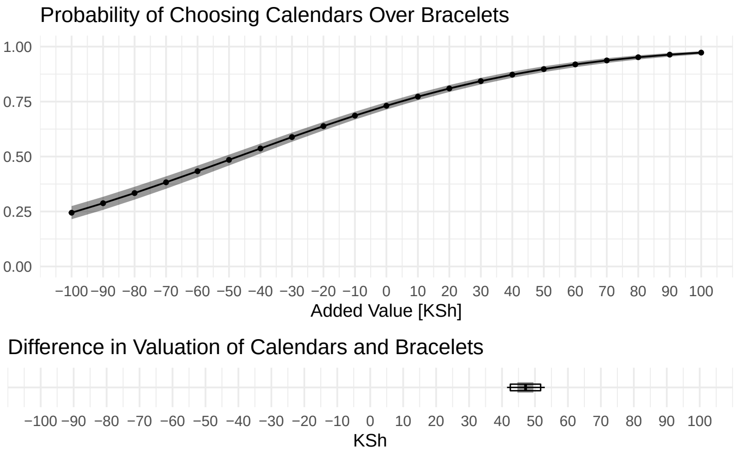
Willingness-to-pay experiment

We conducted an experiment to elicit the private valuation of calendars and bracelets:

1. Subjects (from the control arm) were asked to choose one of two gifts, a calendar or a bracelet (2% wanted neither).
2. Subjects were offered payment in order to switch to the gift not selected. Offer was randomly chosen from $0, 10, \ldots, 100$ KSh.

$\Longrightarrow$ Estimate a discrete choice model. Model Details

Willingness-to-pay experiment results



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Signaling benefit R

$$R(z,d) = \mu(z,d)\Delta[w^*(z,d)]$$

$$\mu(z,d) = \lambda \cdot \underbrace{\mathsf{logit}^{-1}(\alpha^{\text{lord}} + z\beta^{\text{lord}} + \delta^{\text{lord}} \cdot d + d \cdot z\rho^{\text{lord}})}_{p^{\text{lord}}}$$

$$\lambda \sim \mathtt{Normal}^+(0, \tau^\lambda)$$

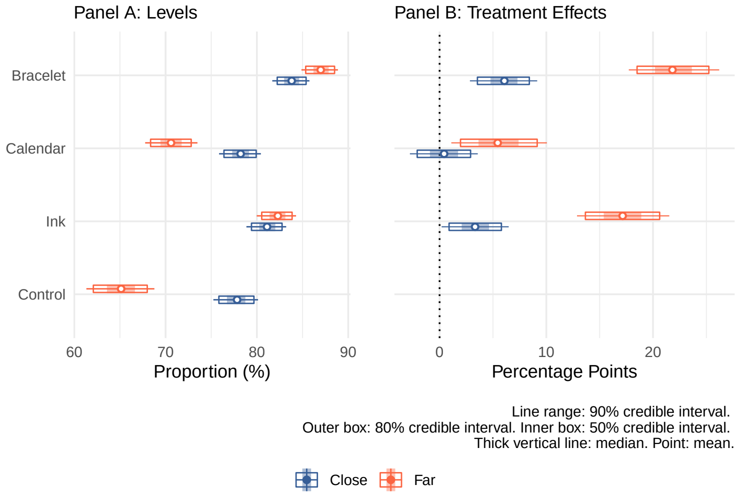
Model Details

Observability of actions μ

- In the endline survey, respondents were asked a set of questions about 10 random members of their community.
- Among these questions, we asked:
  - Whether they knew the person.
  - Whether they know if the other person got dewormed.
  - Whether the other person knew if the respondent got dewormed.
- We want to identify how the signaling treatments affect:
  a) Perception of the observability of others' actions (first-order)
  b) Perception of the observability of their own actions (second-order)

$\Longrightarrow$ Estimate a binomial model with belief elicitation data. Model Details

First-order beliefs results



Second Order Beliefs
Disaggregated First Order Beliefs

Treatment effects

Hold fixed each counterfactual component.

For $z \in$ {ink, calendar, bracelet}, $g \in$ {close, far}:

- Overall Effect,

$$E[\underbrace{\mathbb{1}\{B(z,d)+R(z,d)\}}_{Y(z,d)}]-E[\underbrace{\mathbb{1}\{B(\text{control},d)+R(\text{control},d)\}}_{Y(\text{control},d)}].$$

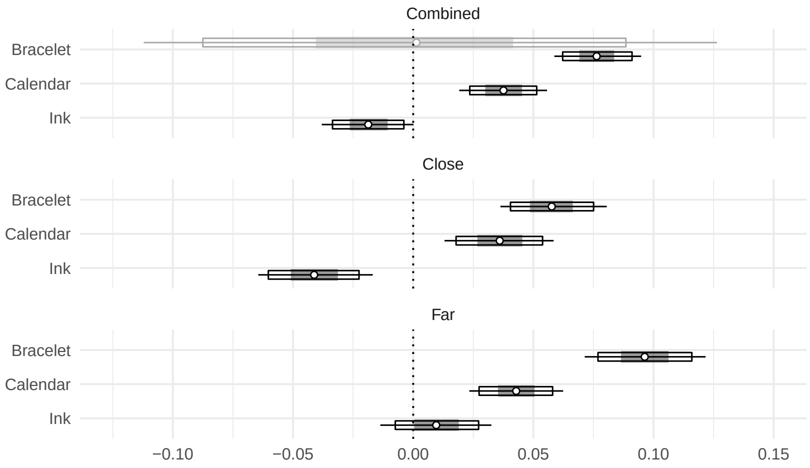
- Social Signaling Effect,

$$E[\mathbb{1}\{B(\text{control},d)+R(z,d)\}]-E[\mathbb{1}\{B(\text{control},d)+R(\text{control},d)\}].$$

- Private Incentive Effect,

$$E[\mathbb{1}\{B(z,d)+R(\text{control},d)\}]-E[\mathbb{1}\{B(\text{control},d)+R(\text{control},d)\}].$$

Incentive average treatment effects (revisited)



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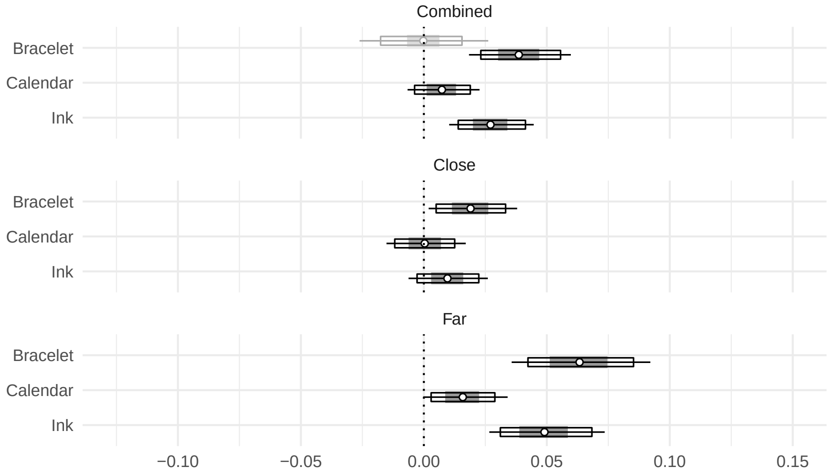
Signaling average treatment effects



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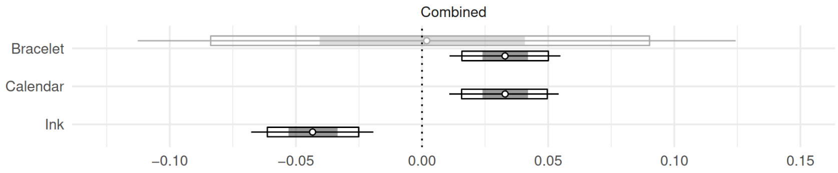
Private incentive average treatment effect



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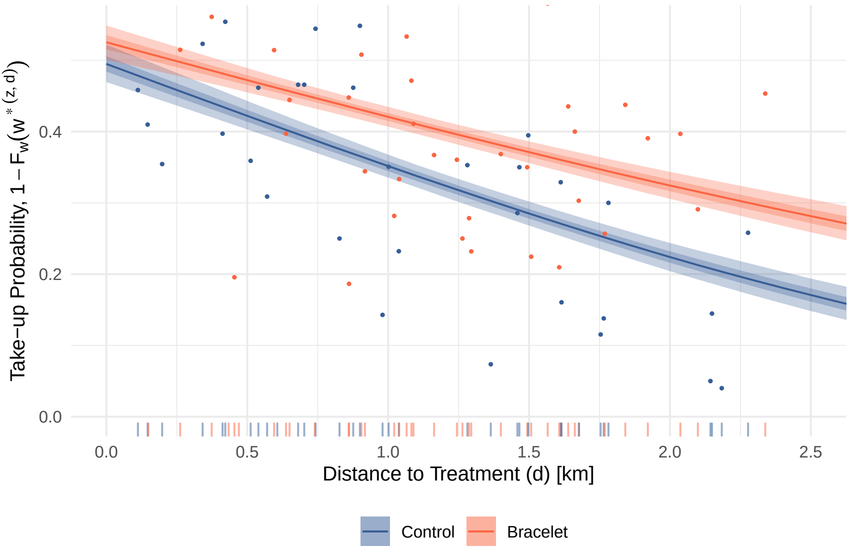
Take-up probability and distance



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Social multiplier

Recall our object of interest:

$$\bar{y}'(c) = f_V(v^*(c)) \cdot \underbrace{\frac{-1}{1+\mu\Delta'[v*(c)]}}_{\text{social multiplier}}$$

Which in our model corresponds to:

$$\frac{\partial\, \mathrm{E}[Y(z,d)]}{\partial d} = f_w(w^*) \cdot \frac{\left\{-\delta + \frac{\partial \mu(z,d)}{\partial d}\Delta[w^*]\right\}}{1+\mu(z,d)\Delta'[w*]}$$

- $SM^* > -1 \implies$ mitigation of distance increase on takeup.
- $SM^* < -1 \implies$ amplification of distance increase on takeup.

Takeup rate of change

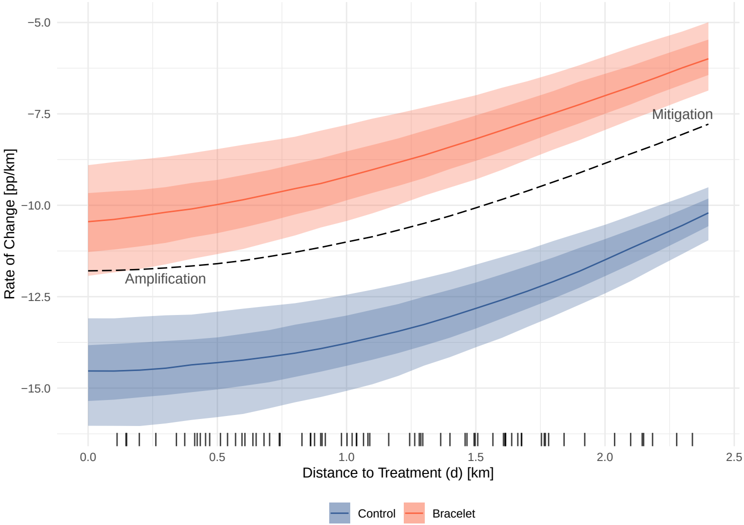
We want to estimate the causal impact of signals on the *take-up rate-of-change with respect to distance*, holding d and w^* fixed.

$$\left.\frac{\partial \operatorname{E}[Y(z,d,w)]}{\partial d}\right|_{\substack{z=\text{bracelet}\\ d=\tilde{d}\\ w=w^*(\text{control},\tilde{d})}} - \left.\frac{\partial \operatorname{E}[Y(z,d,w)]}{\partial d}\right|_{\substack{z=\text{control}\\ d=\tilde{d}\\ w=w^*(\text{control},\tilde{d})}}$$

where $\tilde{d} \in \mathbb{R}^+$.

$$\frac{\partial \operatorname{E}[Y(z,d,w)]}{\partial d} = \frac{-f_w(w)\left\{\delta - \frac{\partial \mu(z,d)}{\partial d}\Delta[w]\right\}}{1+\mu(z,d)\Delta'[w]}$$

Takeup rate of change



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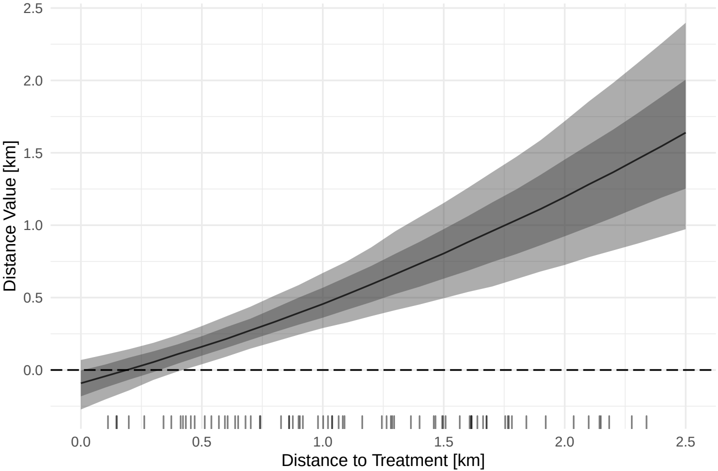
Multiplier

Value of reputational return



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$$V_R = \frac{\mu(z,d)\Delta[w^*]}{\delta}$$

Ink Calendar

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Optimal allocation choice

- Social planner goal minimize number of PoTs, achieving the expected social welfare of the control group $\overline{W}^C = E\left[\sum_{i=1}^{n} U(takeup_i^C)\right]$:

$$\min_{y_j, x_{i,j}} \sum_{j=1}^{m} y_j$$

$$s.t. \quad \sum_{i=1}^{n} U\left(\widehat{takeup}_{ij} x_{ij}\right) \geq \overline{W}^C$$

$$\sum_{j=1}^{m} x_{ij} = 1, \forall i$$

$$x_{ij} \leq y_j, \forall i, j$$

- y_j indicator whether PoT j is funded.
- x_{ij} indicator that village i uses PoT j.
- $U(\cdot) = \log(\cdot)$.

Optimal allocation choice

Structural model decomposes $takeup_{ij}$ into private utility and reputational return from signaling deworming status.

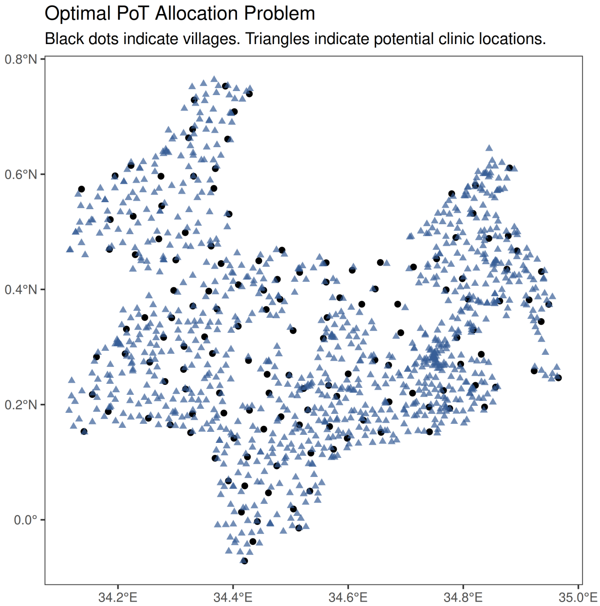
$$takeup_{ij} = \underbrace{B(z, d_{ij})}_{\text{private benefit}} + \underbrace{\mu(z, d_{ij})\Delta\left[w^*(z, d_{i,j})\right]}_{\text{reputational return, } R(z,d)}$$

Counterfactuals

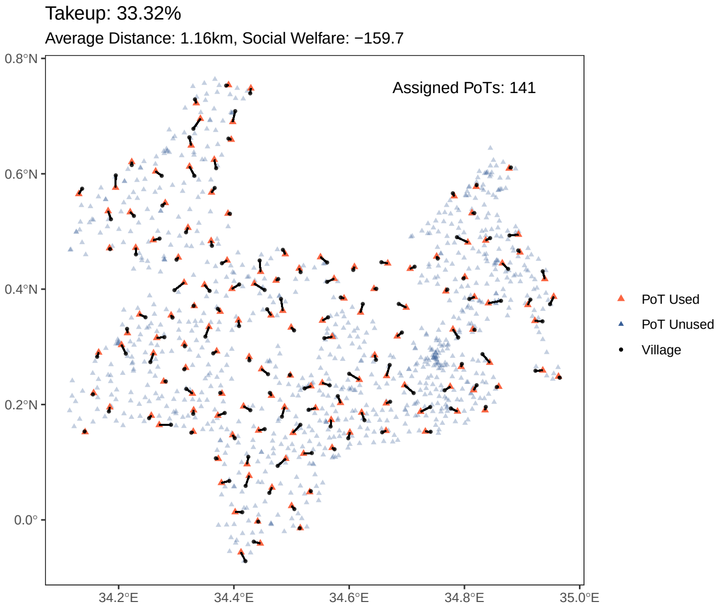
Relevant counterfactuals and their effect on # of required PoTs:

1. Fix private utility at control level, only vary the visibility μ_z from different incentives z.
2. Policy maker who is aware of reputational returns but unaware of how those change as distance increases.
3. Policy maker who is completely unaware vs. aware of reputational returns.
   - Mimicking knowledge from individual experimentation vs. at scale.

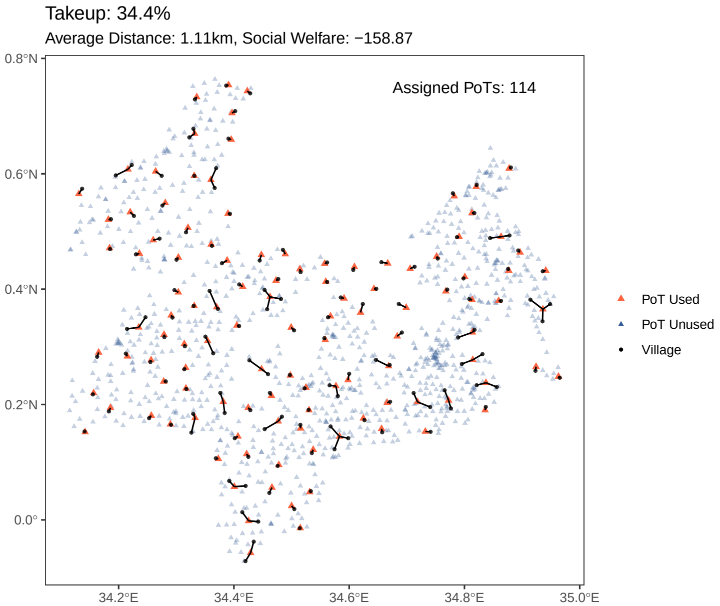
Optimal allocation - problem setup



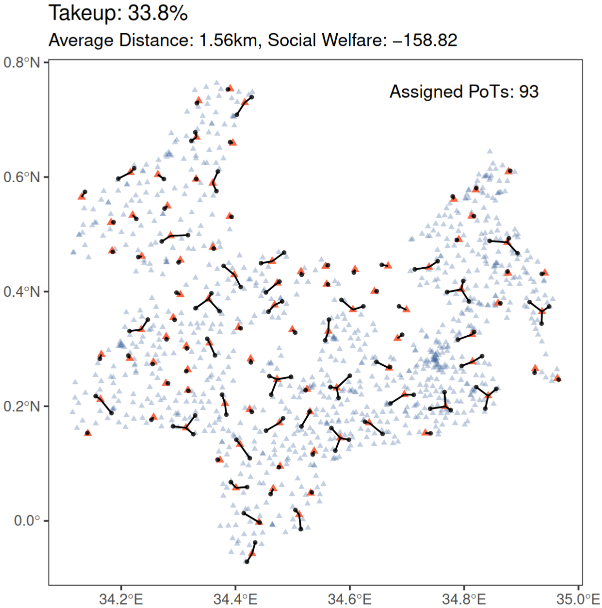
Control experimental allocation



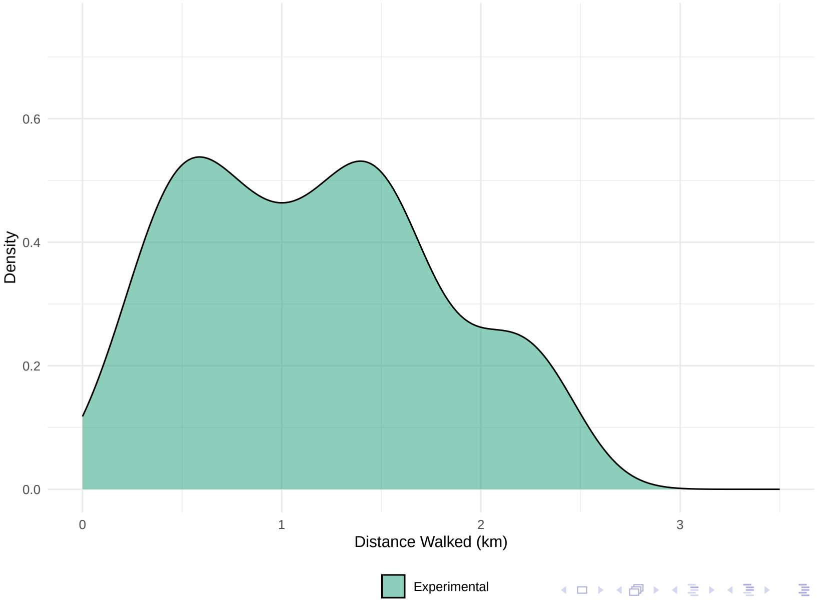
Optimal allocation - B_{control}, μ_{control}



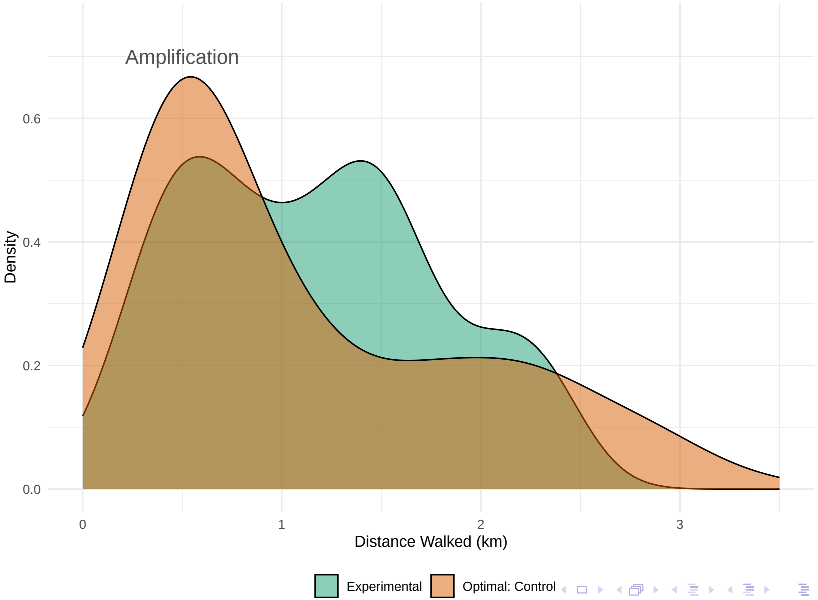
Optimal allocation - B_{control}, μ_{bracelet}



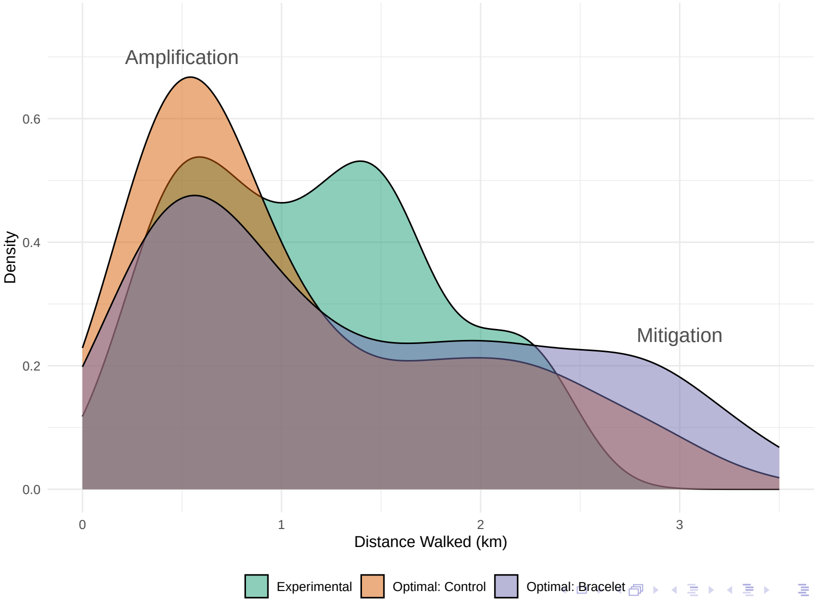
Distance to PoT - experimental allocation



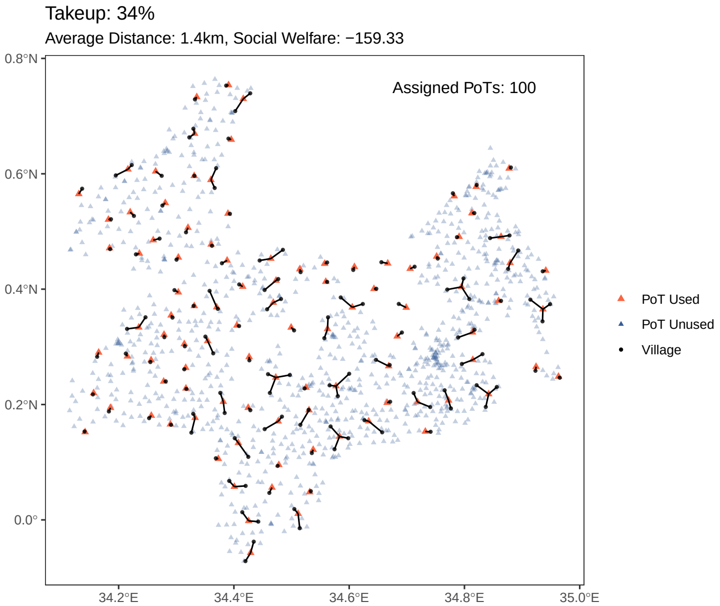
Distance to PoT - optimal allocation



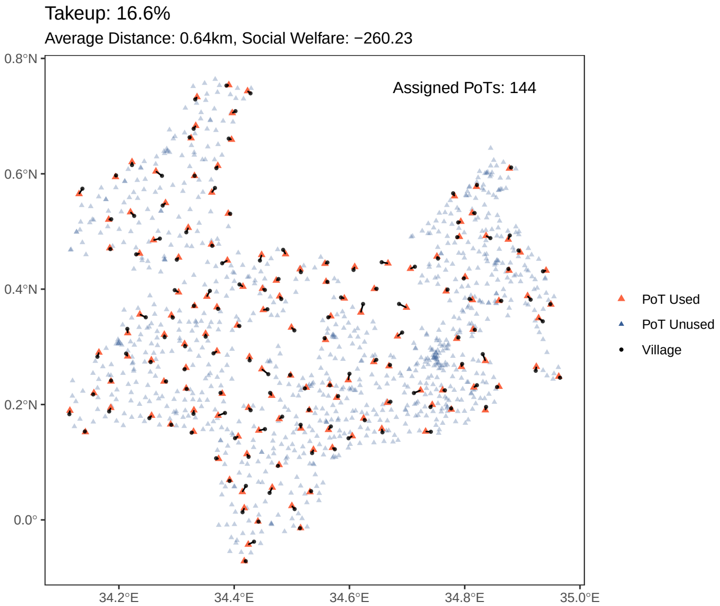
Distance to PoT - optimal allocation



Optimal allocation - B_{control}, $\overline{R}_{\text{bracelet},d=0.5\text{km}}$



Optimal allocation - B_{control}, $\mu = 0$



Conclusion

- Significant interactions between economic and reputational incentives. Learning about these requires experimentation at scale.
- Consistent with the theory, reputational returns increase as at lower equilibrium take-up levels when actions remain highly visible. Greater uncertainty about others' action increases, can reverse these effects.
- Increases in reputational returns mitigate the negative impact of higher cost. Decreases in returns can amplify the negative imapct of increases in cost.
- Deworming treatment locations can be set up further apart, with the same number of locations a larger geographic areas can be covered.

Thank you

Information campaign

1. Deworming is not only for children because everyone is at risk of being infected by worms or is infected but does not know.
2. Taking deworming tablets is like using a mosquito net to prevent Malaria or washing hands before eating to avoid diarrhea. You do not have to be sick or experience symptoms in order for you to get dewormed.
3. It is important to take deworming tablets every six 6 months to ensure that your body is always free of worms.
4. The government is providing free deworming tablets and all adults are encouraged to deworm themselves.
5. Deworming all adults will keep our community free from worms and those who do not deworm themselves shall put the entire community at risk, especially towards our children.
6. Remind your family members and neighbors to turn up for the free deworming medication on ____________ at ____________.
7. You will receive _________ for deworming yourself as a symbol of your passion towards improving the health of the members in your family and the community.

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Flyer control

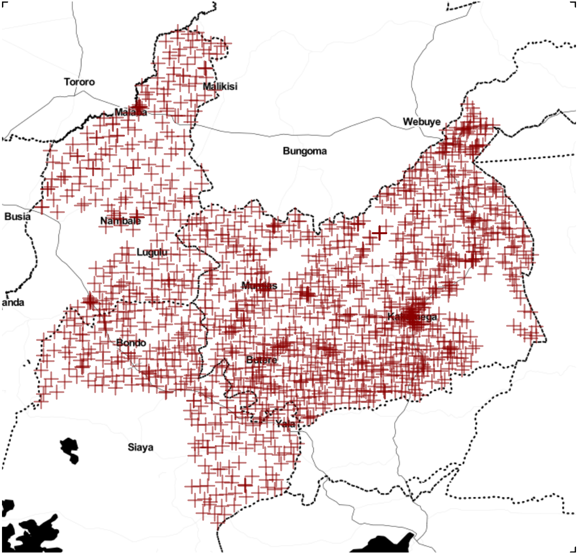
Flyer bracelet

Flyer ink


Jitibu minyoo: boresha afya ya jamii yako!
Saidia kuangamiza minyoo katika jamii yako
Wapi:
Lini:
Onyesha mchango wako kwa kutia wino kidole cha gumba
Madawa zitatolewa bure bila malipo yoyote
Serekali ya Kenya inatoa matibabu dhidi ya minyoo kwa watu wa umri wa 18 zaidi

Flyer calendar

Site selection



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First and second-order beliefs

- $Z \in \{\text{control, ink, calendar, bracelet}\}$, assigned incentive treatment.
- $D \in \mathbb{R}^+$, assigned distance to deworming location.
- $Y^{\text{rec}} \in \{0, \ldots, 10\}$, number of recognized peers.
- $Y^{\text{1ord}}(z, d)$, number of recognized peers respondent has knowledge of whether they got dewormed or not,

$$
\begin{aligned}
Y^{\text{1ord}}(z, d) &\sim \texttt{Binomial}(Y^{\text{rec}}, p^{\text{1ord}}) \\
p^{\text{1ord}}(z, d) &= \mathsf{logit}^{-1}(\alpha^{\text{1ord}} + z\beta^{\text{1ord}} + \delta^{\text{1ord}} \cdot d + d \cdot z\rho^{\text{1ord}}).
\end{aligned}
$$

- $Y^{\text{2ord}}(z, d)$, number of recognized peers who have knowledge of the respondent's deworming choice,

$$
\begin{aligned}
Y^{\text{2ord}}(z, d) &\sim \texttt{Binomial}(Y^{\text{rec}}, p^{\text{2ord}}) \\
p^{\text{2ord}}(z, d) &= \mathsf{logit}^{-1}(\alpha^{\text{2ord}} + z\beta^{\text{2ord}} + \delta^{\text{2ord}} \cdot d + d \cdot z\rho^{\text{2ord}}).
\end{aligned}
$$

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Willingness-to-pay experiment

- $G \in \{-1, 1\}$ indicates initial gift choice.
- $M \in \{0, 10, 20, \ldots, 100\}$ is the randomly assigned offer (in KSh).
- $W(m) \in \{0, 1\}$ indicates acceptance of m KSh offer.

$$\text{Difference in valuation, } V^{\text{wtp}} \sim \mathtt{Normal}(\mu^{\text{wtp}}, \sigma^{\text{wtp}})$$
$$\mu^{\text{wtp}} \sim \mathtt{Normal}(0, \tau^{\mu,\text{wtp}})$$
$$\sigma^{\text{wtp}} \sim \mathtt{Normal}^{+}(0, \tau^{\sigma,\text{wtp}})$$

$$\mathcal{L} = \begin{cases} \mathrm{P}[V^{\text{wtp}} < -m] & w = 0 \wedge g = -1 \\ \mathrm{P}[V^{\text{wtp}} > m] & w = 0 \wedge g = 1 \\ g \cdot \left(\mathrm{P}[V^{\text{wtp}} < g \cdot m] - \mathrm{P}[V^{\text{wtp}} < 0]\right) & w = 1 \end{cases}$$

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Net reputational returns with non-structural shocks

$$\Delta[w] = E[V \mid W > w] - E[V \mid W \leq w] = \frac{-\int_{-\infty}^{\infty} v F_u(w-v) f_v(v)\,\mathrm{d}v}{F_w(w)[1 - F_w(w)]}$$

- Individual shocks are driven by both a structural prosocial shock, V, and a non-structural shock, U.
- In assessing the net reputational returns of deworming, individuals need to account for both shocks.

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Important model assumptions

1. Linear distance cost d.
2. V and U have a unimodal and symmetric distributon.
   - $V \sim \texttt{Normal}(0, 1)$
   - $U \sim \texttt{Normal}(0, \sigma_u)$
3. Common knowledge about
   - Distribution of prosocial types.
   - Desirability of good reputation.
   - The average private benefit/cost of deworming and incentives.

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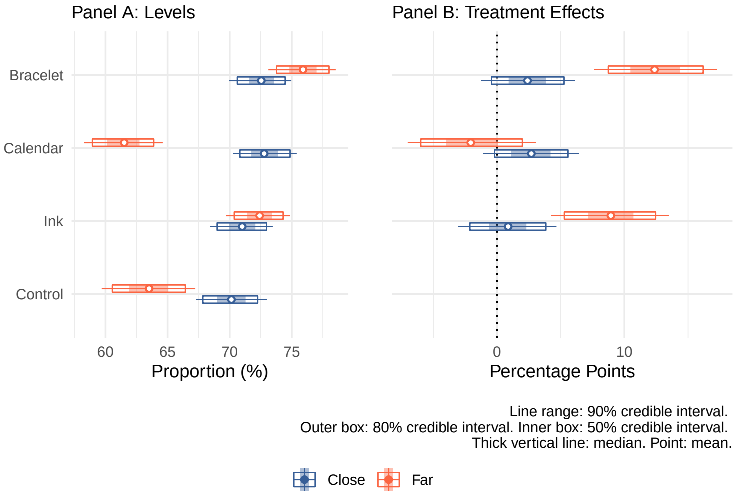
Second-order beliefs results



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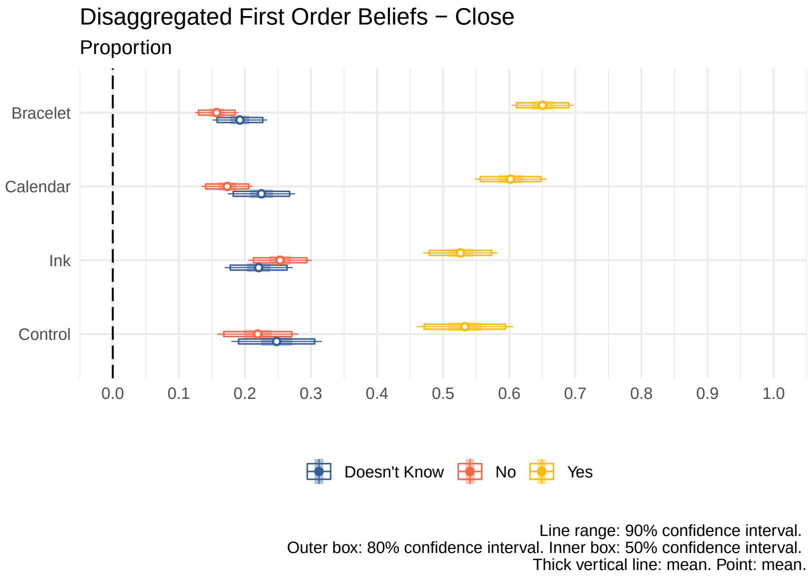
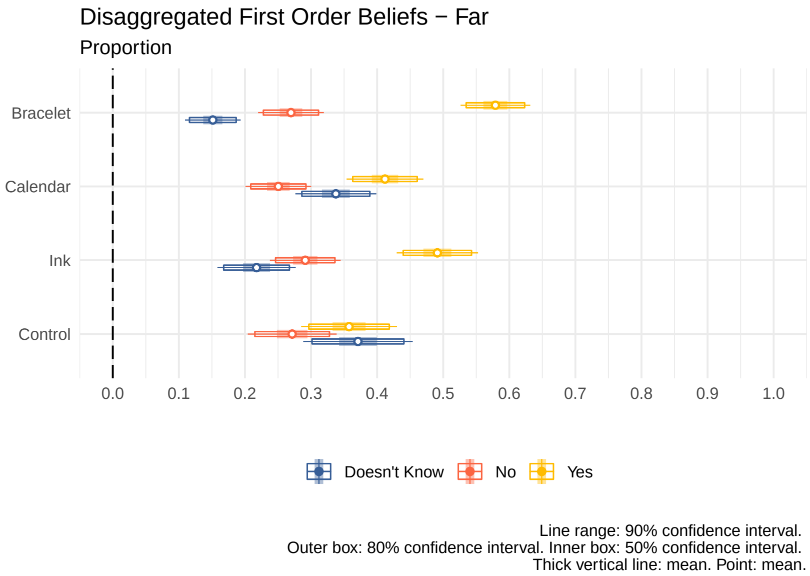
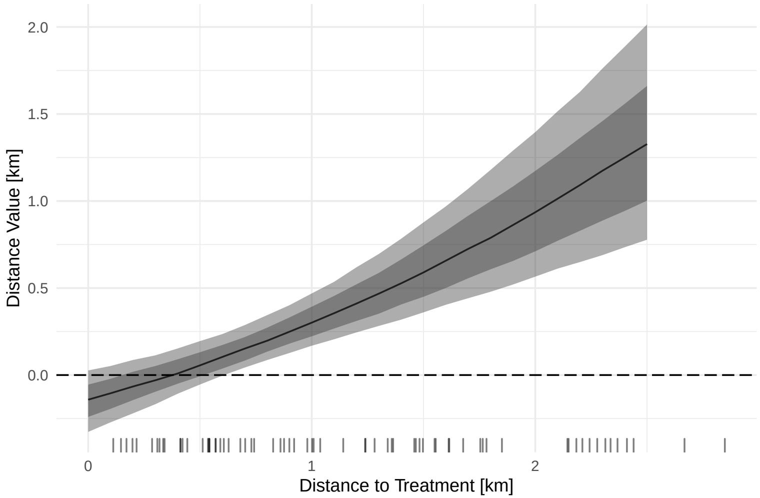
Disaggregated first-order beliefs



Disaggregated first-order beliefs



Value of reputational return - Ink



Line: Median. Outer ribbon: 80% credible interval. Inner ribbon: 50% credible interval.

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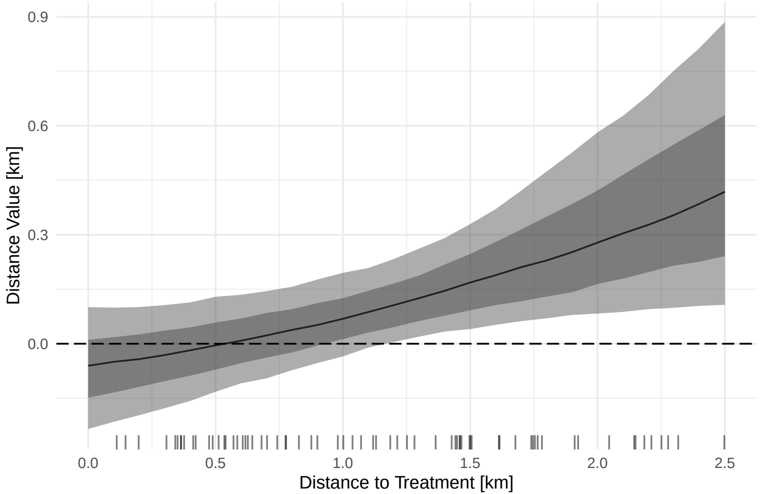
Value of reputational return - Calendar



Line: Median. Outer ribbon: 80% credible interval. Inner ribbon: 50% credible interval.

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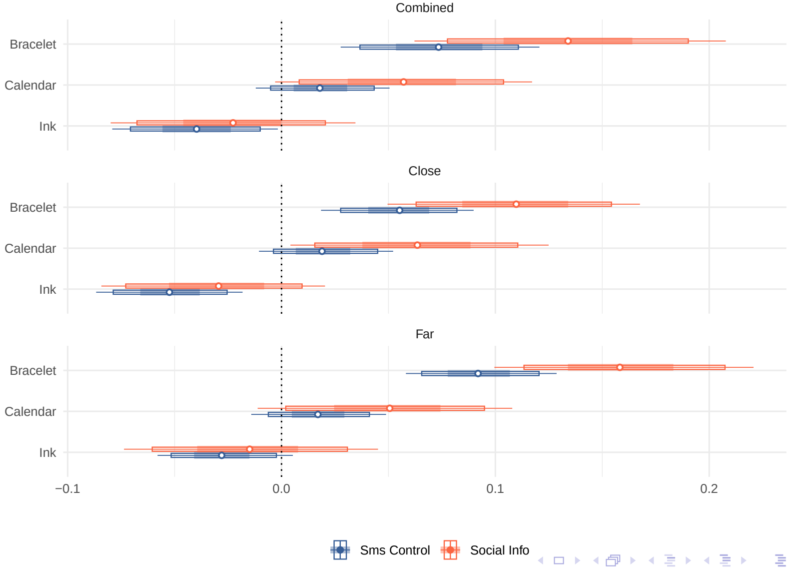
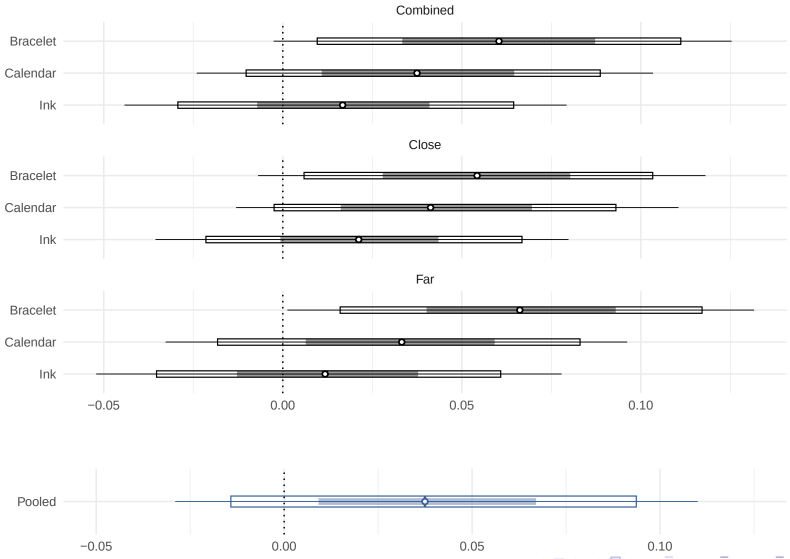
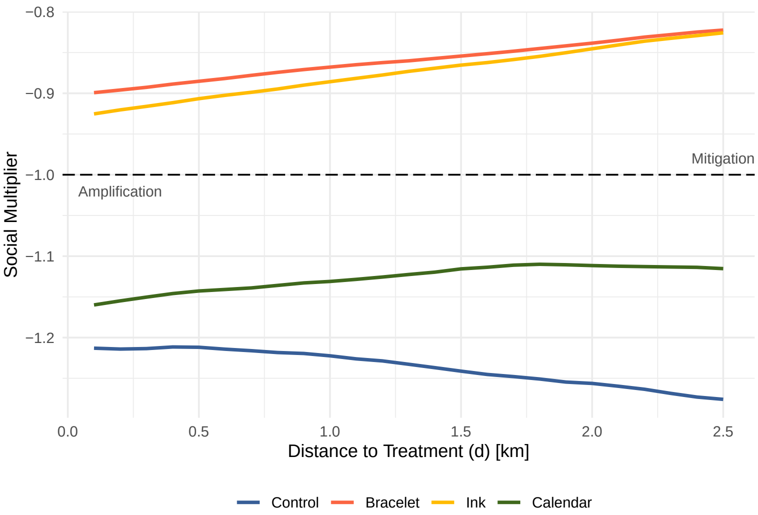
Reduced form results: SMS levels



Reduced form results: SMS ATEs



Social multiplier



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