Estimating Spillover effects in Smallholder Farmer Networks in Western Kenya

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Context

- Majority(83%) of farms in the world are smallholder farms.
- In Sub-Saharan Africa, most of them are subsistence farms
- PlantVillage in Africa
  - Increase climate change resiliency
  - Tackle trans-continental crop pests and diseases.
- Goal is to introduce and increase Disease Management Behaviors (DMBs)

Motivation

- Farmer organizations in Africa, specifically farmer groups in Kenya with LF and FFs.
- Most farmers are also accessible via SMS.
- Adoption of new technologies among farmers is generally slow and inhomogeneous but social channels help.
- Take advantage of these social networks to introduce and increase DMB adoption.

Preregistration

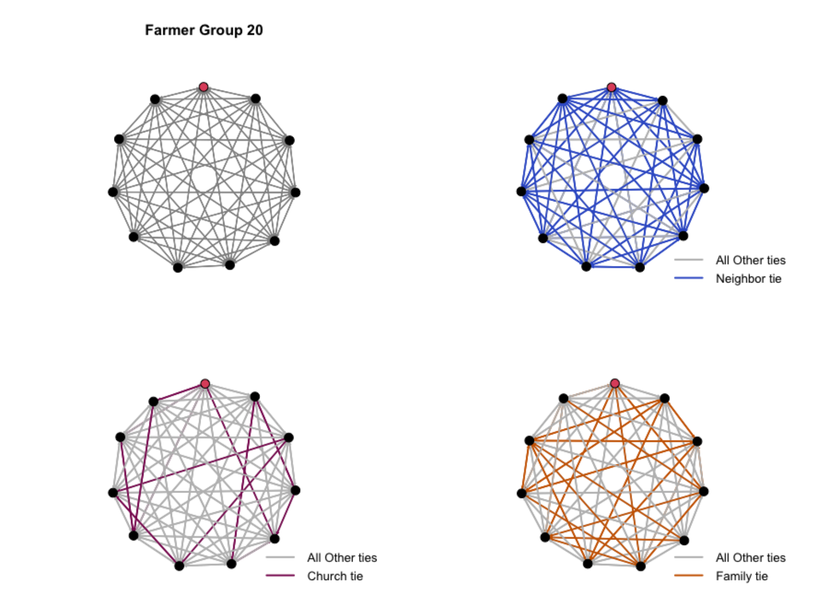
Preregistration at Open Science Framework
https://doi.org/10.17605/OSF.IO/TXDP7

Hypothesis

Does SMS messaging on DMBs have spillover effects and does it increase interest/adoption on farms?

- We hypothesize that there are spillover effects via social networks to SMS treatments.
- We hypothesise that larger the tie weight between farmers, the more likely they are to share and adopt methods.

Farmer Group's Network



Study Design

- 40 Farmer groups over 2 counties resulting in around 400 farmers
- First survey and network data collected from everyone
- Cluster Randomized Trial with rerandomization(Morgan & Rubin (2012))
  - Rerandomization allows the experimenter to improve covariate balance by pre-specifying a covariate balance criterion.
  - The balance criterion allows for blocking by county and takes into account individual and group level values.

Treatments

- Treatment: Only LF receives treatment (SMS messaging)
- Control: LF and all FFs in farmer group receive treatment (SMS messaging)
- Treatment Unit is a single farmer group
- Measurement Unit is a single farmer in a group
  - Use of mulching in farm
  - Scouting for Fall Army Worm (FAW) in farm
  - Knowledge of Parasitoids to combat FAW

Preregistered Methods

- Testing for interference at different tie thresholds: Bowers et al. (2013) testing framework
- Estimation via Exposure Mapping: Aronow and Sammi(2017)

Bowers et al.(2013)

- "Fisherian" Randomization Test
- Framework for testing rather than estimation
- Write any causal model to transform potential outcome of one treatment vector $\mathbf{z}$, $y_{i,\mathbf{z}}$ to potential outcome for another treatment vector $\mathbf{w}$, $y_{i,\mathbf{w}}$.

$$\mathcal{H}(y_{i,\mathbf{z}}, \mathbf{w}, \theta) = y_{i,\mathbf{w}} \tag{1}$$

- More specifically, potential outcome, $y_{\mathbf{z}}$ to uniformity trial, $y_{\mathbf{0}}$.
- Uniformity Trial (Rosenbaum2007): All units receive the control condition, as if the experiment had not been carried out.

Bowers et al.(2013) cont.

Testing Framework

- Causal model positing the form of interference. Could be theoretically motivated
- With hypothesized values of θ, use the model to map observed outcomes $(\mathbf{y}_z)$ to the uniformity trial.
- Select a test statistic T that is effect increasing, i.e. is small when the treated and control distributions are similar and large if they diverge.
- Generate empirical distribution of T by sampling from $\mathbf{Z} \in \Omega$.
- Estimate p-value.

Bowers et al.(2013) cont.

Examples from the paper

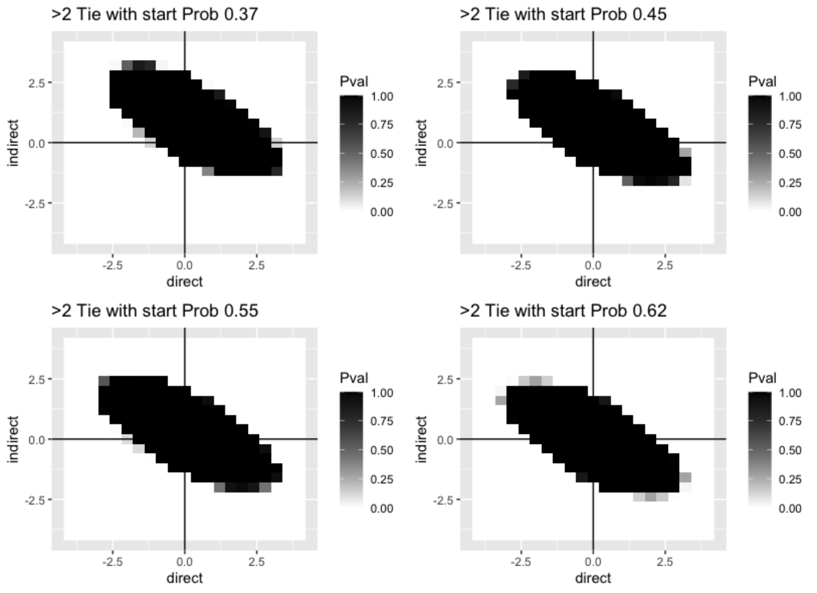
- No interference, additive model: $\mathcal{H}(y_{i,\mathbf{z}}, \mathbf{0}, \tau) = y_{i,0} + z_i \tau$
- Direct + spillover from treated neighbours (multiplicative): $\mathcal{H}(y_{i,\mathbf{z}}, \mathbf{0}, \beta, \tau) = [\beta_0 + (1 - z_i)(1 - \beta_0) exp(-\tau_0^2 \mathbf{z}^T \mathbf{S})]^{-1} \mathbf{y}_{\mathbf{z}}$

Our outcome data is binary.

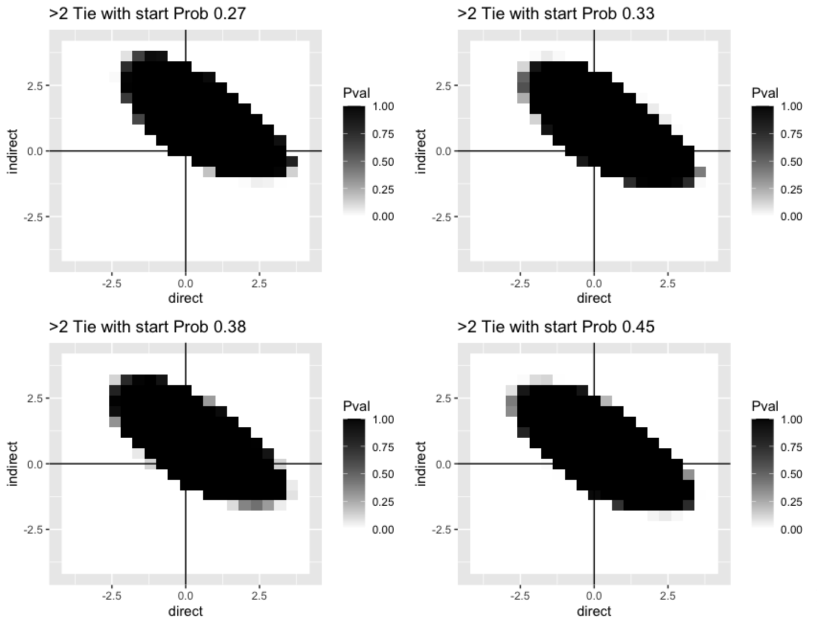
$$\text{logit } p(x) = \beta_0 + \beta_1 dir + \beta_2 ind$$

Sum of deviance residuals becomes our T and produce the empirical distribution of T by sampling from $\mathbf{Z} \in \Omega$.

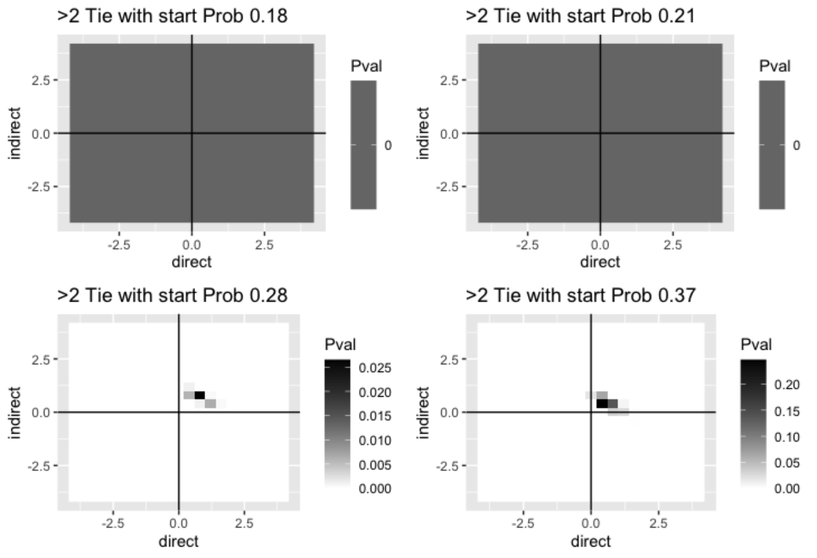
Use of Scouting



Use of Mulching



Interest in Parasitoids



Work in Progress

- Re-weight/prioritise family ties.
- Check assumptions on LF's experiencing both direct and indirect effects
- Rewrite uniformity trial model

Thank You

Exposure Mapping