Information Provision and Agricultural Productivity

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Context and Motivation

Many governments have agricultural extension services, but they are costly, and research on whether/how/why they work to improve agricultural output remains somewhat cloudy.

- General result of low effectiveness of extension programs (Anderson and Feder 2007) – very costly, low accountability/monitoring.
- Cole and Fernando 2016, 2021 find no effect on cotton yield in India, with IVR/forums.
- SMS messages with sugar cane-specific tasks increased yield by 11.5% (Casaburi et al. 2019).
- Mobile messaging via digital technologies improve input decisions (Fabregas et al. 2024), which improves yield (Fabregas et al. 2019)

Kisan Call Centers

We study **Kisan Call Centers (KCC)** in India, launched January 2004. Distinguishing characteristics:

- Pull rather than push intervention – farmers only get information if they truly demand it.
- Answers from real people. Staffed with Farm Tele Advisors (FTAs) who must hold at least a bachelor's degree in agriculture or a related field.
- Attempt to answer any kind of question (weather, crop management, government schemes, etc)
- Inherent monitoring: FTAs required to log information about each call, including their answer.

Distribution of KCCs

- At *most* one KCC per state.
- Now available between 6am - 10pm every day (except government holidays).
- **Single phone number since 2009.**
  - Regular hours: Call gets forwarded to local KCC and FTA answers.
  - Off-hours: Call gets forwarded to IVR system, FTA might follow up later.
- Multiple offices have opened/closed, staffing levels have also changed.
- Aim to have comprehensive language coverage.

This Project

- **RQ:** How does information impact agricultural yield?
  - Total output vs. output per hectare of sown land
  - What type of calls matter most?

- **Current Data:**
  - $\sim$38 million Kisan call logs from 2006-2023.
  - Agricultural yield estimates from 2004-2017 for winter and monsoon seasons. (Gangopadhyay et al. 2022)
  - Percentage of land sown for 2005-2013 (India National Remote Sensing Centre)
  - Cell coverage data from 2008-2019 from OpenCellID. Created Counts
  - The SHRUG (Asher et al.2020)

KCC Query Data

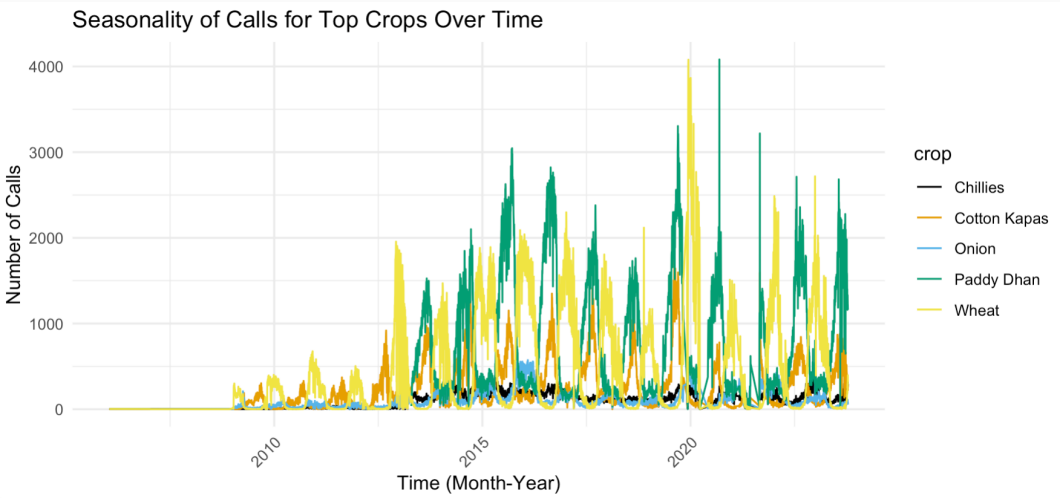
We have, for each call:

- State, district, block, date, query text, and FTA's answer for each call.
  - Block is typically a cluster of villages. In the data, the village name is usually concatenated in this column as well.
- Hand classified into "category," "crop," other descriptors.

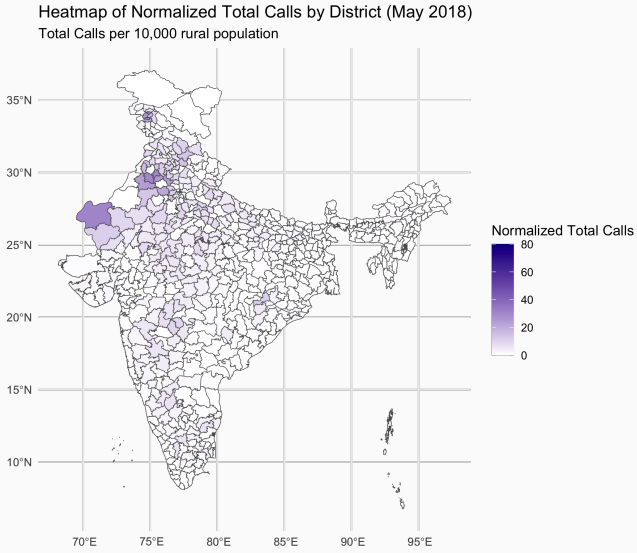
query_type	query_text	kcc_ans
Weather	Farmer asked query on Weather	15 21 08C 16C 04 11
Weather	Farmers want to know about the Government Agricult...	
Seeds	Asking about azola seeds availability	Recommended for contact to vellore Krishi Vigy
Plant Protection	ATTACK OF BLIGHT ON TOMATO	SPRAY AMISTAR 15 ML 15 litter of water for cc
Tank Pond and Reservoir Management	CALL RELATED TO FISHERY	REGISTERED CALL TRANSFERED TO FISHERY EXPI
Government Schemes	Farmer want to know information about govt scheme...	Recommended for to know about govt schemes
Tank Pond and Reservoir Management	SUBSIDY FOR NEW POND MANAGEMENT	RECOMMEMDED TO CONTACT BLOCK ASST FISH
10	Asking about mealy bug in cotton	Advice to use Quianlphous 20ml DDVP 8gmpun
Plant Protection	nformation regarding how to control mixed weeds in ...	IInformation regarding how to control mixed we
Weather	Information about weather forecast of Block - Kamasi...	
5	INFORMATION REGARDING IMPROVED VARIETIES OF R...	VARIETIES:PR-118PR-116PR-114PR-120PR-111

Calls follow the seasonality of crops

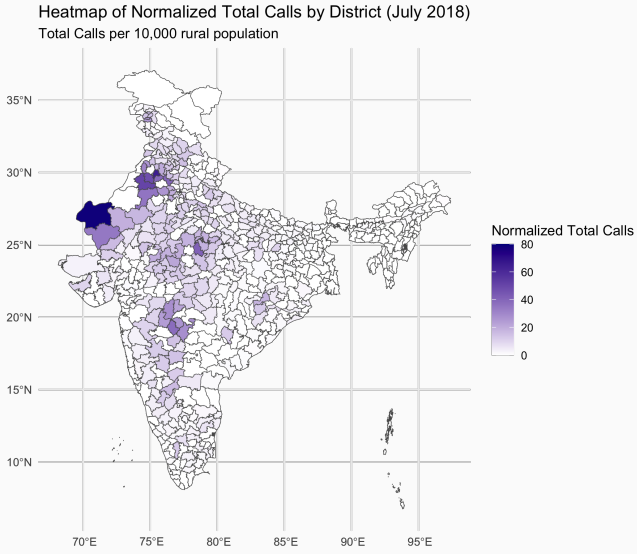
Rice



District Variation in Call Volume: Early Monsoon

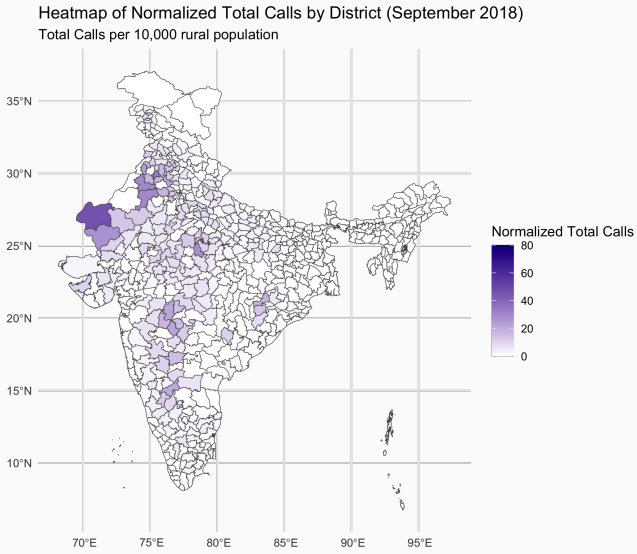


District Variation in Call Volume: Mid Monsoon



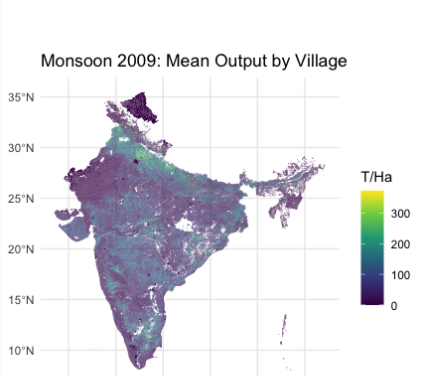
District Variation in Call Volume: Late Monsoon

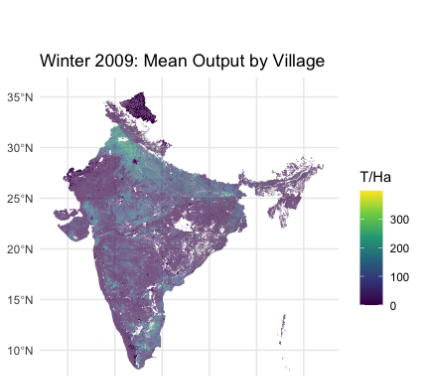
Full Timeframe



Outcome Data: Agricultural Yield from Gangopadhyay et al. (2022)

- Yield estimates from 2001-2017 (Gangopadhyay et al. 2022): Output (T/Ha) for each 500m $\times$ 500m pixel.
- Relatively new, used so far in climate-agriculture studies (Mei 2023; Merfeld 2023).
- Twice yearly observations: Monsoon and Winter seasons



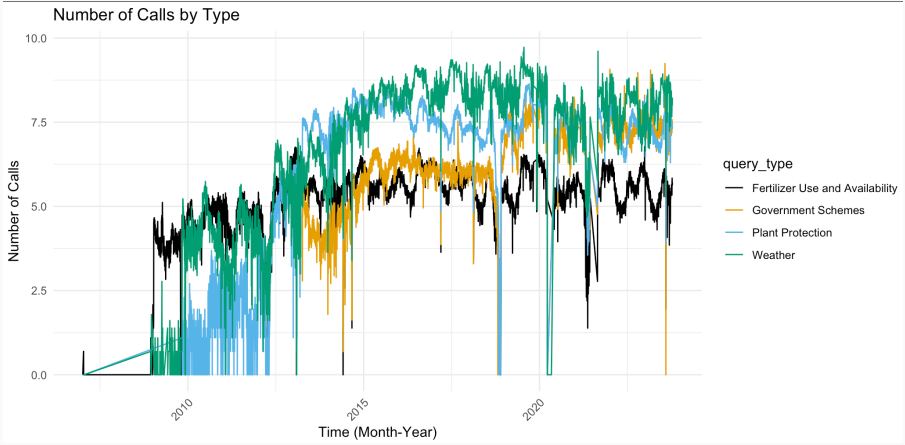


Identification Strategy

Identification Strategy

2009 Consolidation to Single Number

On February 13, 2009, KCC consolidated to a single number (1551), an easier number for farmers to remember/discover.



Approach to Identification

Challenge: The convergence to a single number on February 13, 2009 led to a large and sustained increase in call volume. How can we leverage this as a shock to KCC access?

Methodology:

- Convergence to one number should have been effective only in villages that had cell phone coverage.
- Use pre-2009 cell coverage to determine treatment status.
  - Exclude villages that first got mobile coverage $\geq$ 2009
  - Exclude villages from which KCC never received calls.
  - **Treatment:** Villages with cell coverage prior to 2009.
  - **Control:** Villages with no cell coverage from 2004-2017.
- We use a combination of the cell tower data and Population Census (2011) data to do identify which villages did or did not have cell coverage. Created Counts

Summary Stats: Treatment vs. Control

	Treated (n=1,476)		Control (n=466)	
	Mean	SD	Mean	SD
Total Yearly Calls	165.879	537.950	97.722	306.994
Total Output (Tonnes)	270.956	74.243	245.344	59.392
Terrain Ruggedness Index	4.884	4.0352	4.741	4.262
Elevation	222.833	248.316	191.317	209.527
Population Density (People/Ha)	9.717	11.972	10.522	18.632
Total Area (Ha)	1361.361	1227.753	295.791	381.331
Percentage Area Sown	0.515	0.268	0.569	0.258
Sown Area per Farmer (Ha)	2.568	24.604	1.926	7.395
Has Landline	0.888	0.314	0.122	0.327
Has Public Call Office	0.804	0.396	0.0946	0.292
Has Daily Newspaper Supply	0.921	0.268	0.488	0.499

Specification: DiD-IV

- **Challenge:** Variation in call volume is endogenous.
- **Approach:** Instrumental variables regression in which the instrument itself is a difference-in-differences to extract just the variation predicted by the consolidation to one number in 2009.

First stage:

$$\widehat{log(Calls)}_{it} = \gamma_{it} + \tau_1(Post \times Treated) + \tau_2 Post + \tau_3 Treated + \epsilon_{it}$$

Second stage:

$$Y_{it} = \alpha_{it} + \beta \widehat{log(Calls)}_{it} + \varepsilon_{it}$$

- $Y_{it}, log(Calls)_{it}$: Outcome of interest, log total calls in village i in year t.
- Both stages include village FE, year FE.

Identifying Assumptions

In order for our specification to be valid we need to satisfy three assumptions:

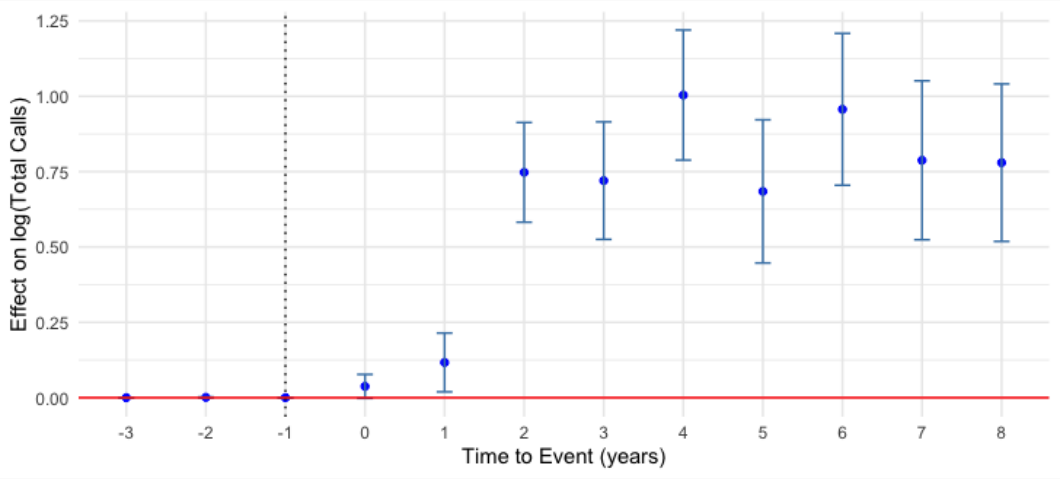
1. **Exclusion Restriction:** The diff-in-diff only impacts our outcomes through call volume.
   - **Post:** 1 if *year* $\geq$ 2009
   - **Treated**: 1 if had cell coverage *prior to* 2009, 0 if no cell coverage for *entire* sample period
   - Cell coverage not changing pre- or post-2009 for villages in sample. Only call center access is changing.
2. **Parallel Trends – First Stage:** Call volume would have followed similar trends between treatment/control in absence of number consolidation.
3. **Parallel Trends – Reduced Form:** All outcomes would have followed similar trends between treatment/control in absence of number consolidation.

Main Outcome Definitions

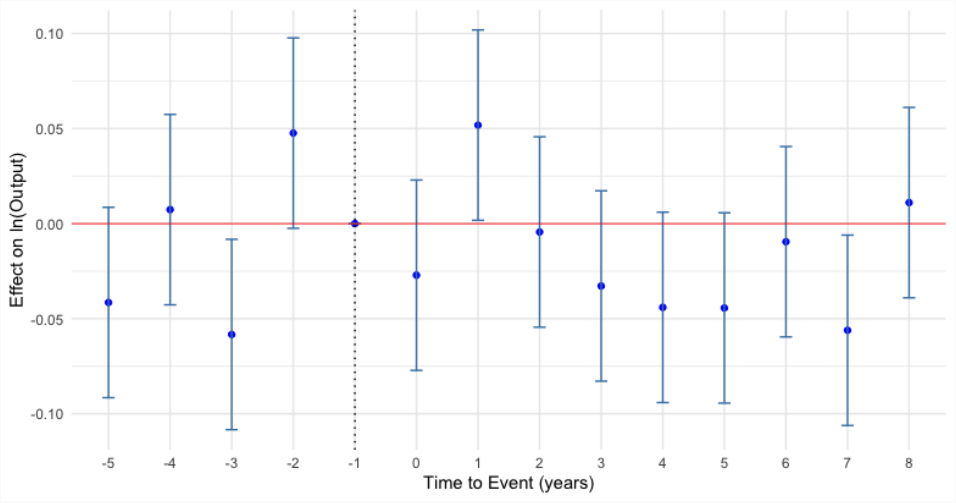
Our main results focus on the following output-related outcomes:

1. **Log Output:** The log of the total agricultural yield of a given village, measured in tonnes (t).
2. **Percentage Land Sown:** Percentage of total area in the village that is sown for agricultural use.
3. **Log Productivity:** The log of the total output in the village divided by the total area of land sown. Measured in tonnes per hectare of sown land (T/Ha).

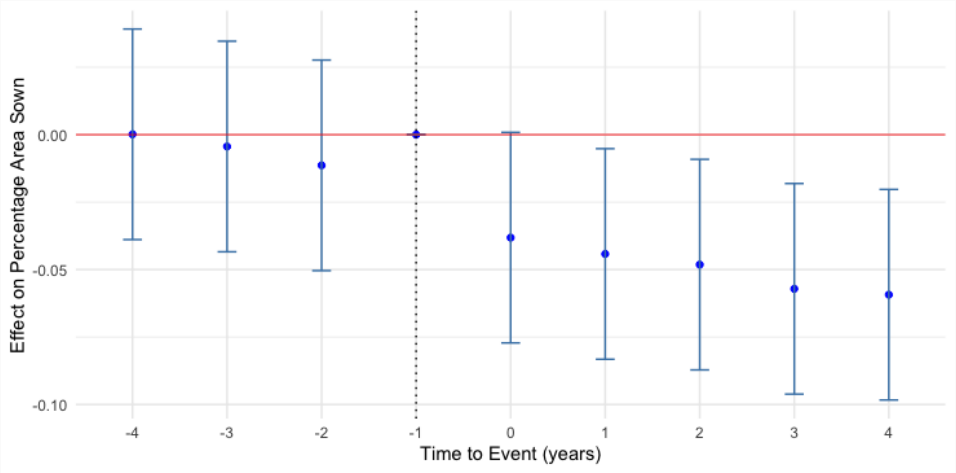
First stage: DiD on Total Call Volume



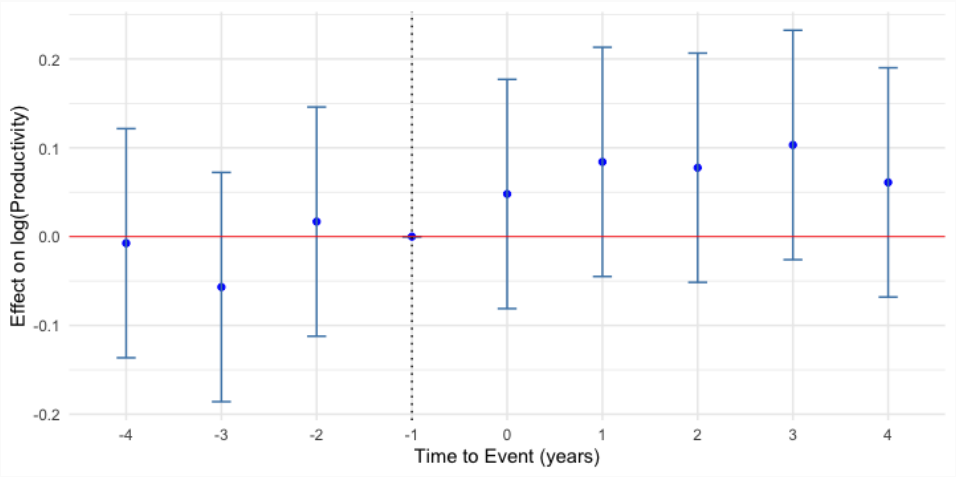
Reduced Form: DiD on Output



Reduced Form: DiD on Percentage of Land Sown



Reduced Form: DiD on Productivity



Results

Results

DiD-IV: Output

	Log Output (Total Tonnes)	Percentage Land Sown (%)	Log Productivity (Tonnes/Sown Hectare)
Log Total Calls	-0.0147*	-0.0841***	0.163***
	(0.00787)	(0.0119)	(0.0252)
Dep. Var Control Mean (levels)	245.344	0.569	8.766
Total Calls Control Mean (levels)	97.722	97.722	97.722
Village FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs	15,536	15,536	15,536
Villages	1,942	1,942	1,942

Interpreting the Main Results

Small fall in total output in treatment areas, but explained by sowing less land more efficiently. But we may be concerned about a couple things

1. Which farmers benefit?
   - Not very common to have cell phones back then, possible that benefits are only to those already at the right tail of the productivity distribution
2. We may be picking up extensive margin crop selection.
   - Monsoon crops tend to be denser than winter crops. If farmers switch to monsoon crops, that may show up as less sown land but higher productivity.

Interpreting the Main Results

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As a first pass, we examine:

- The variance of within-village productivity.
  - Will not be able to distinguish exact distributional effects, but if variance increases, may be sign that right tail of the productivity distribution is stretching further right.
- Monsoon/Winter output ratio

How is variance defined?

For each village, we have:

- The polygons that express the shape and the boundaries of the village
- 500m $\times$ 500m pixels of output (T/Ha) for each season.

We calculate the variance in output (in tonnes) between these pixels within each village, for all pixels that have > 0 output. Some caveats:

- Slightly different definition of productivity: output per pixel, each of which is the same size, and quite small.
- These are not (necessarily) farms.

DiD-IV: Variance, MW/Ratio

Reduced Form

	Prod. Variance	Monsoon/Winter Output Ratio
Log Total Calls	0.0573	0.00295
	(0.0419)	(0.0238)
Dep. Var. Control Mean	0.871	1.448
Total Calls Control Mean	97.722	97.722
Village FE	Yes	Yes
Year FE	Yes	Yes
Obs	15,240	14,185
Villages	1,905	1,775

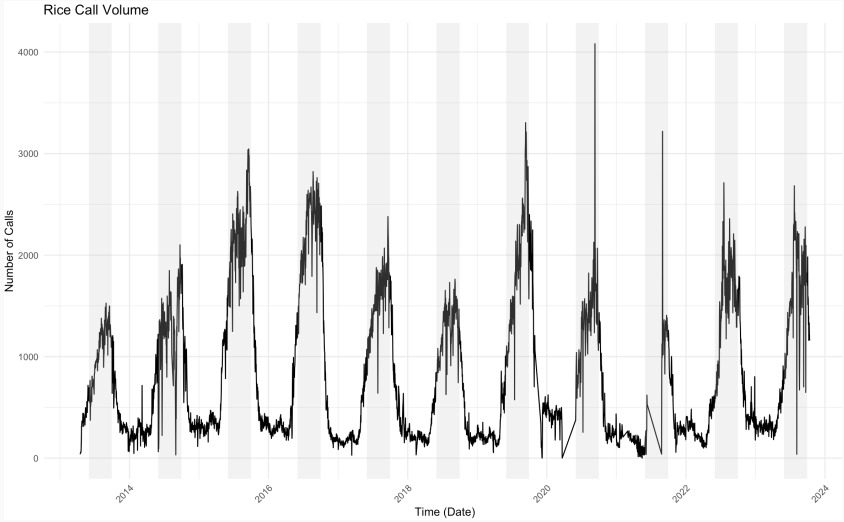
DiD-IV: Heterogeneity by Call Type First Stage

	Weather	Threats	Crop Mgmt.	Gov. Schemes
Effect on Log Prod.	0.515***	-13.855	0.415***	1.047***
	(0.0931)	(24.365)	(0.0905)	(0.136)
Indep. Var. Control Mean (calls)	35.939	2.257	36.269	3.797
Village FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Obs	15,536	15,498	15,498	15,498
Villages	1,942	1,938	1,938	1,938

Thank you!

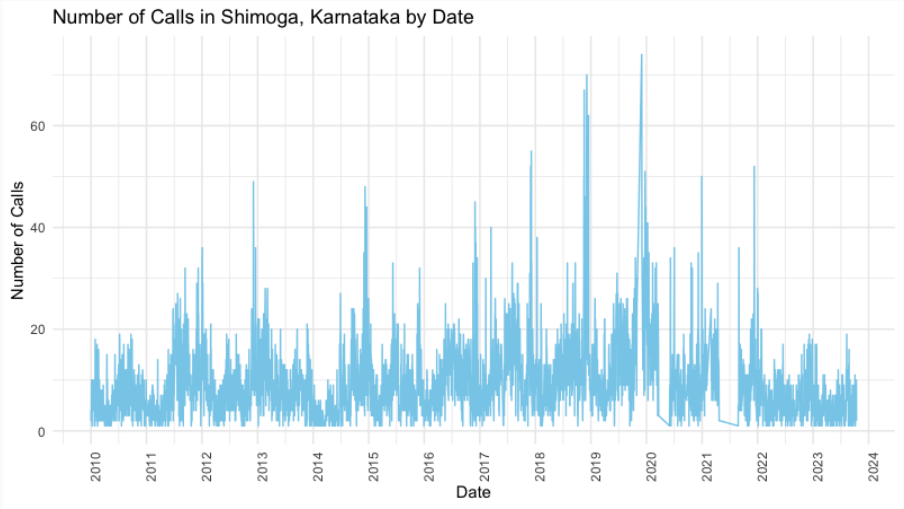
Rice Seasonality

Back



Intra-district Temporal Variation in Calls over Full Timeframe

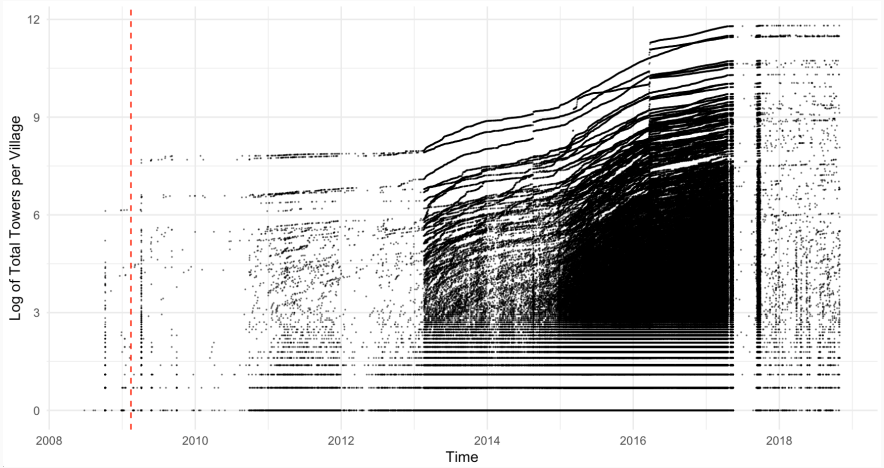
back



Cell Coverage Data

Back to Data Back to Strategy

- OpenCellID: Crowd-sourced cell coverage, gives a "first-seen" date for each cell with coverage.

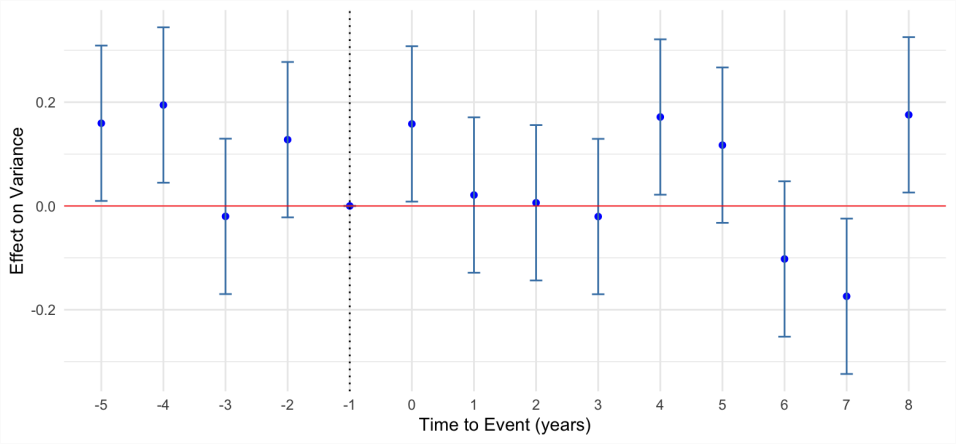


Variation in Weather Answers: Precision vs. Accuracy

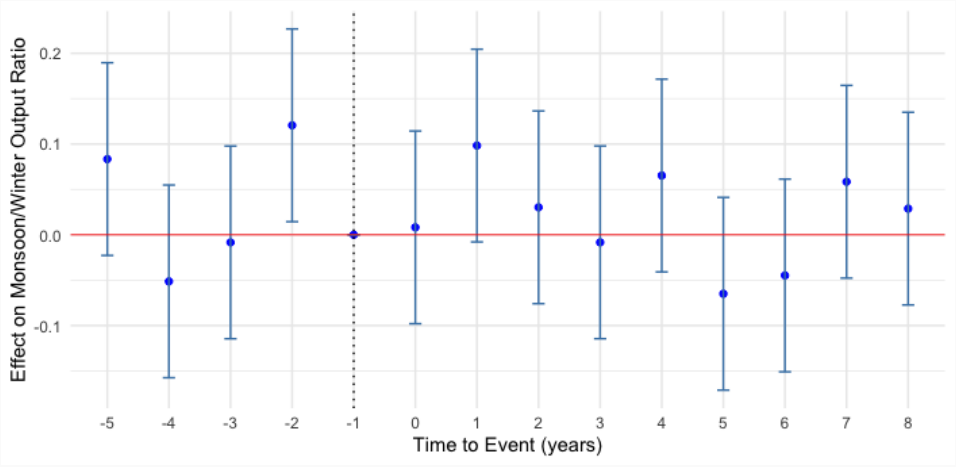
query_text	kcc_ans
information regarding to weather in panipat	Some clouds chance of rain fall today
Weather information of Ghazipur	Kisan bhai apke kshetra mein 16-21 February tak mei...
ASKING ABOUT WEATHER REPORT OF NORTH 24 PAR...	RAINFALL IN NEXT 5 DAYSMM- 481130
Information regarding weather in	Some clouds and chance of rain fall today
Farmer wants to know information about weather in ...	According to metrology department of India there is ...
TELL ME ABOUT WEATHER INFORMATION	NO RAIN POSSIBILITY IN NEXT 5 DAYS BUT CLOUDY SKY
Information regarding weather	
TELL ME WEATHER INFORMATION	NO RAIN POSSIBILITY IN NEXT 5 DAYSBUT LIGHT CLO...
pls tell me weather forcasting	no chance of rain today
weather report	Rather cloudy with a shower
weather report	weather report-cloudy weather prevails from 1st to 4t...
Farmer Asking about weather forecast of Vaijapur tah...	
Farmer asked query on Weather	3 36 24 10 15
Weather report for Thiruvallur	Recommended for today have no rainfall
rainfall of balangir district	rainfall on 510- no rainfall
Information regarding weather of Fatehabad	Some clouds chance of rainfall today

Reduced Form: DiD on Variance

Back

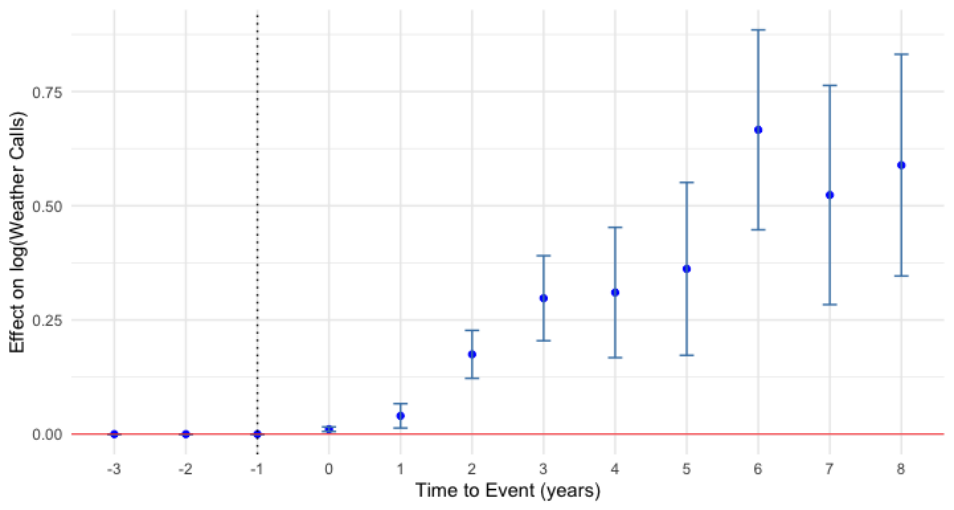


Reduced Form: DiD on Monsoon/Winter Output Ratio

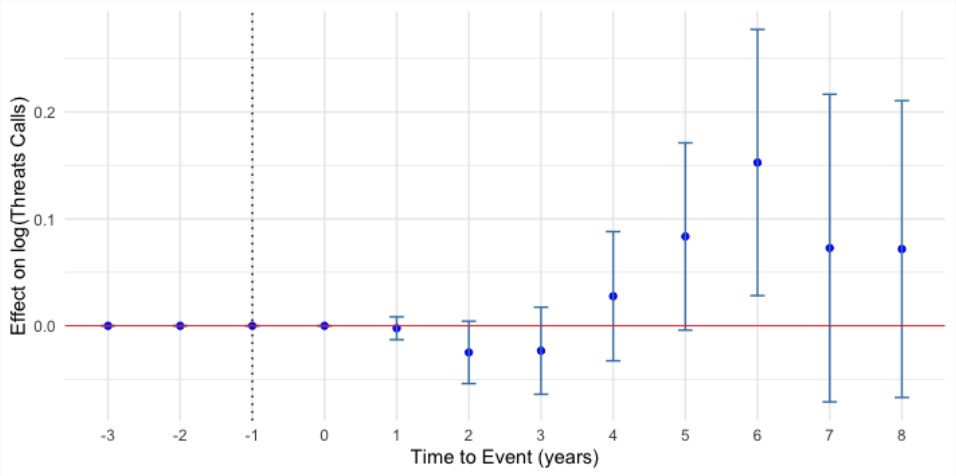


First stage: DiD on Weather Calls

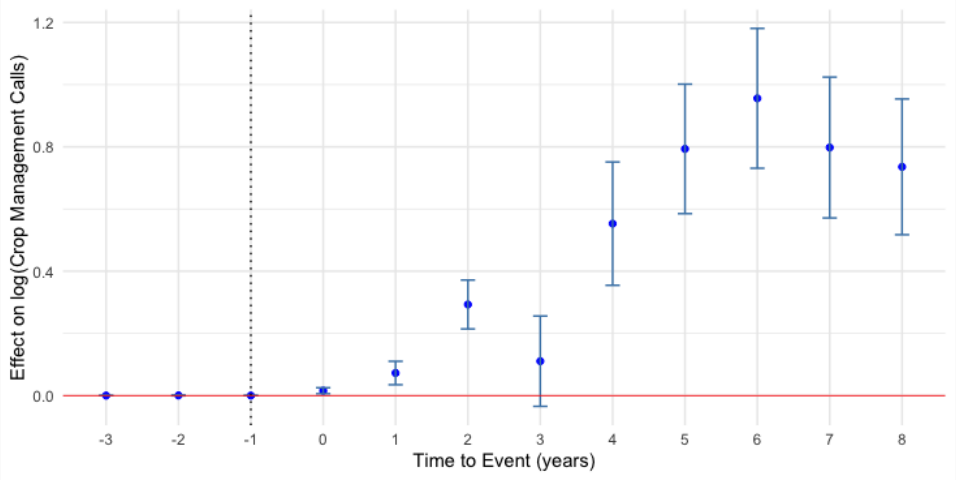
Back



First Stage: DiD on Threats Calls



First Stage: DiD on Crop Management Calls



First Stage: DiD on Governement Schemes Calls

Back