Long-range forecasts as climate adaptation: Experimental evidence from developing-country agriculture

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Climate change will harm the world's farming poor

65% of the world's working poor depends on agricultural livelihoods (Castaneda et al 2010)

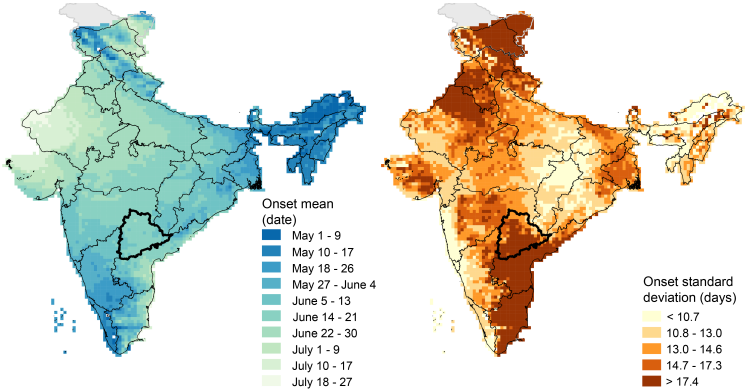
Agricultural risk is significant in poor countries:

- Uninsured risk leads farmers to underinvest (Rosenzweig and Binswanger 1993)
- This in turn raises the agricultural productivity gap between rich and poor countries (Donovan (2021)

Climate change is disrupting weather patterns

- Timing of rainfall is becoming more variable

These issues are particularly salient in Indian monsoon-fed agriculture



- 70% of rainfall: during the monsoon season; highly variable (Kumar et al 2013)
- Climate change is increasing India's rainfall variability (Auffhammer and Carleton 2018)
- Relevant beyond India: $>$ 33% of global pop lives in the Asian monsoon region

Current adaptation tools are limited

Monsoon delay is a large correlated shock

- Predicting monsoon arrival is nearly impossible for farmers on the ground
  - Farmer beliefs are accurate on average, but predicting particular realization is difficult
- Informal mutual insurance arrangements are unlikely to help when everyone affected
- Formal insurance markets largely do not exist, government insurance program has collapsed
  - Index-insurance has promising theoretical properties but has proven very hard to implement
- New seed varieties (e.g. drought tolerant) work well in lab, but are difficult to spread and lock farmers into single crop

These constraints limit the ability of farmers to effectively adapt to monsoon variability

Long-range monsoon forecasts

Long-range monsoon forecasts:

- Provide information about the monsoon well in advance of its arrival (4-6 weeks)
- Provide information relevant to the full growing season, not just tomorrow
- Come in two types:
  - Onset timing: Says when the monsoon will arrive
  - Quantity: Says how much rain will fall

Forecasts are promising:

1. Farmers have inaccurate beliefs about onset, and demand for information is high
2. Forecasts can be delivered at low cost (e.g. via SMS)
3. They enable non-marginal behavioral change

Important note: Monsoon forecasts are **distinct from** short-range weather forecasts!

Our forecast is a significant advance over previously-available options

Our forecast:

POTSDAM INSTITUTE FOR
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- Monsoon onset forecast
- Useful over agricultural regions (Telangana)
- Correct 10 / last 10 years
- Issued $\approx$ 40 days in advance

Existing forecast:

India Meteorological Department
Ministry Of Earth Sciences
Government Of India

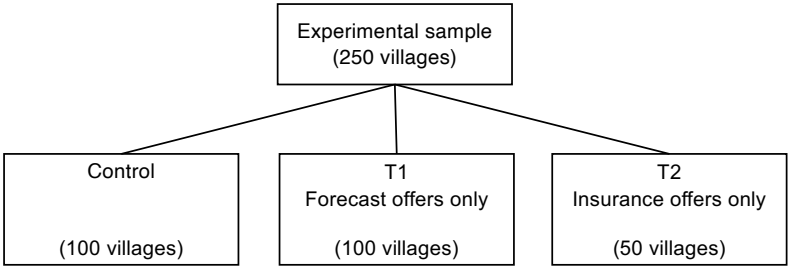
- Monsoon onset forecast
- Useful only over Kerala (not in ag regions)
- Issued $\approx$ 14 days in advance

Evaluate a new climate adaptation approach: monsoon forecasts

This paper: What are the causal impacts of long-range monsoon forecasts for farmers?

- How do forecasts affect farmer beliefs?
- How do farmers adjust their *ex ante* inputs in response to the forecast?
- What effects does the forecast have on agricultural outcomes and welfare metrics?
- How do these impacts compare to those of index insurance?

We use a cluster-randomized trial to study these questions



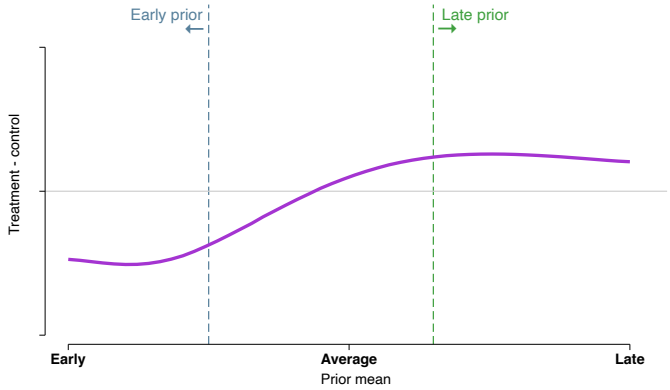
Forecast effects depend on beliefs

In the model, the forecast:

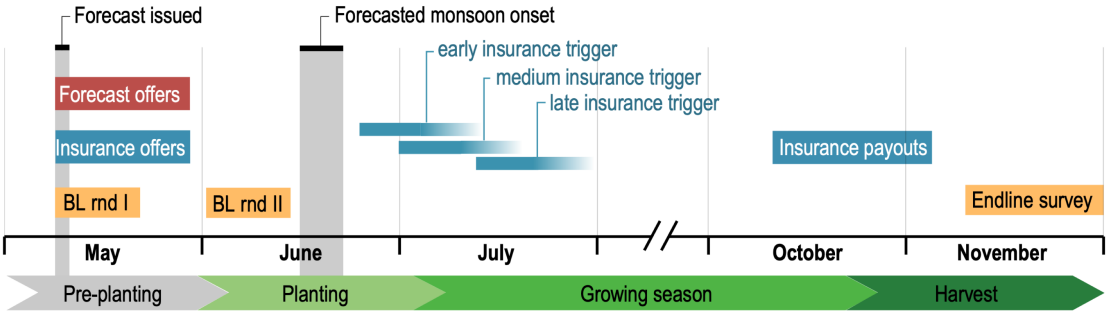
- Causes farmer to update beliefs
- Allows a farmer to optimize inputs to states

→ Direction of adjustment depends on prior

Our forecast realization was for an average year

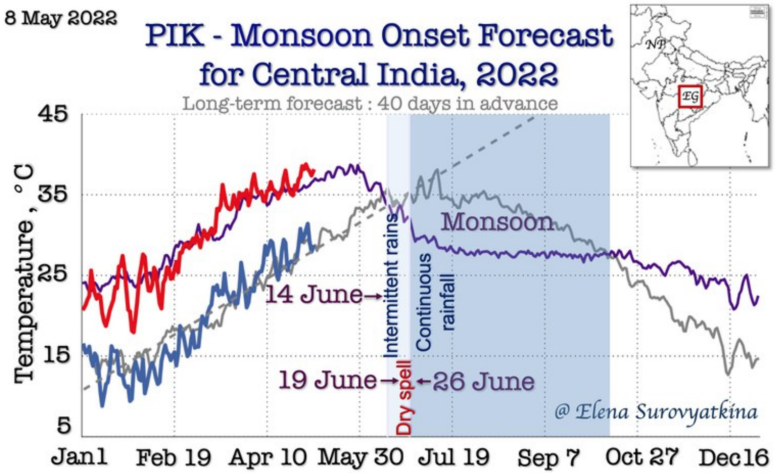


The experiment took place in Kharif 2022



- BL I: Priors followed by offers; growing season plans
- BL II: Posteriors, 2021 planting decisions
- Monsoon onset: Close to average; forecast was correct
- Insurance: 115/250 farmers received payouts
- Endline: Full cropping details, ex post consumption etc

The 2022 forecast was accurate (& the monsoon a bit later than average)



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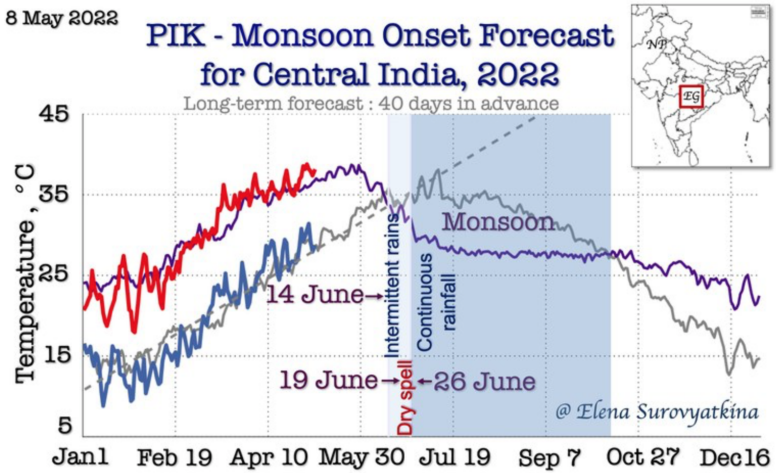
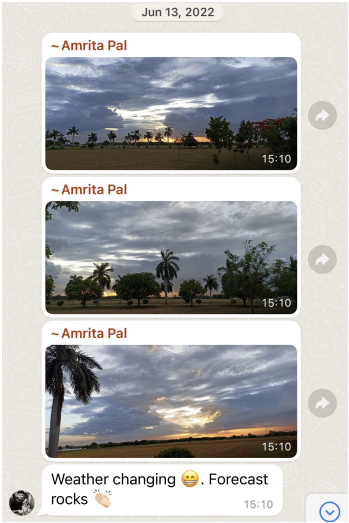
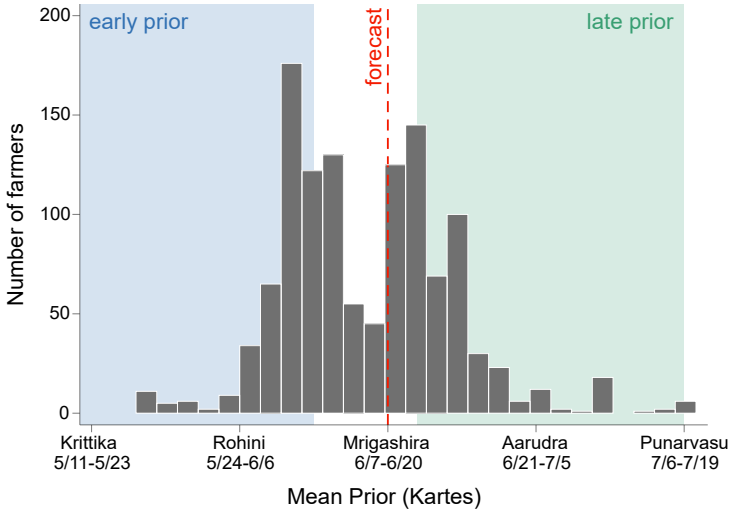
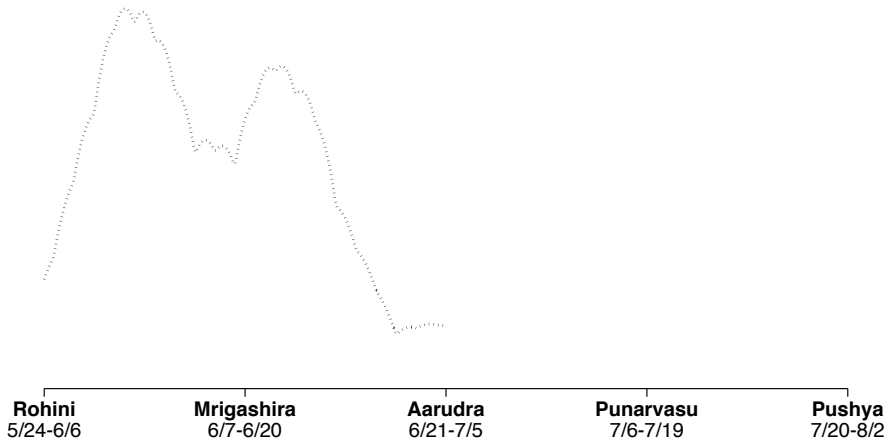




Farmers' priors are centered on the onset date



The forecast shifts farmers' posterior beliefs toward the forecast



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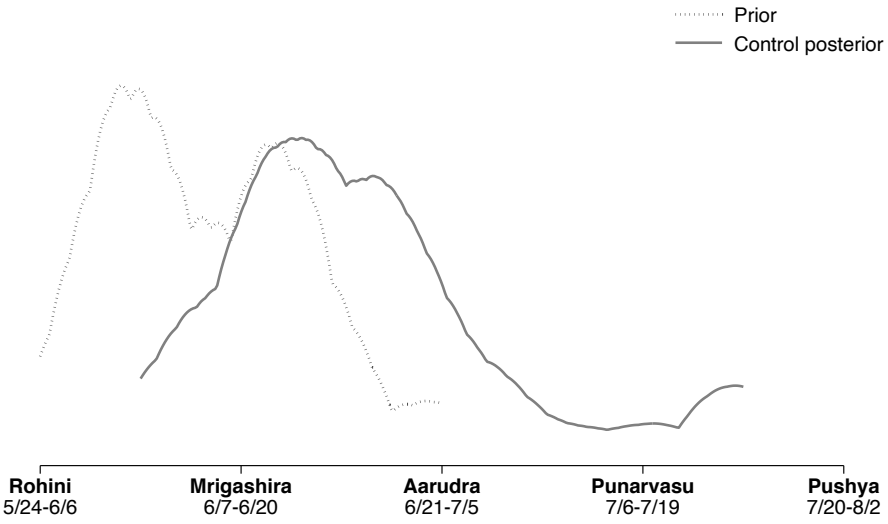

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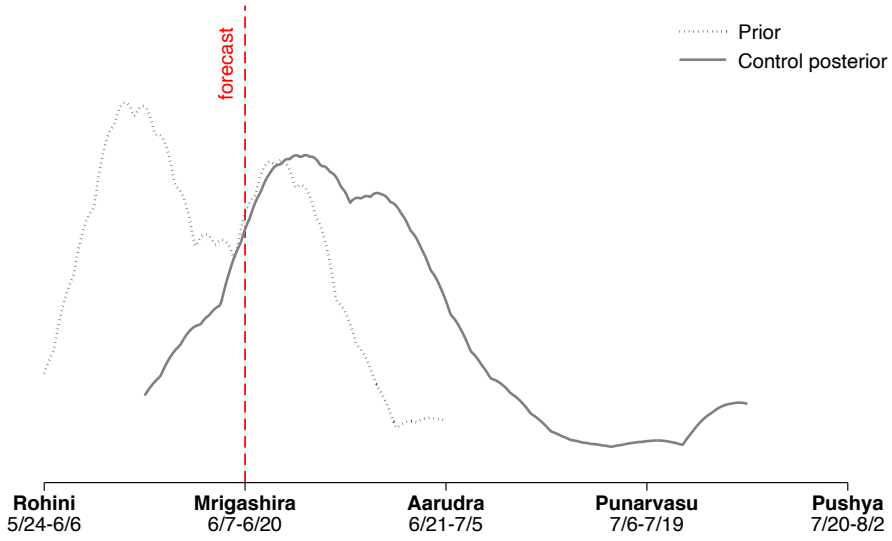

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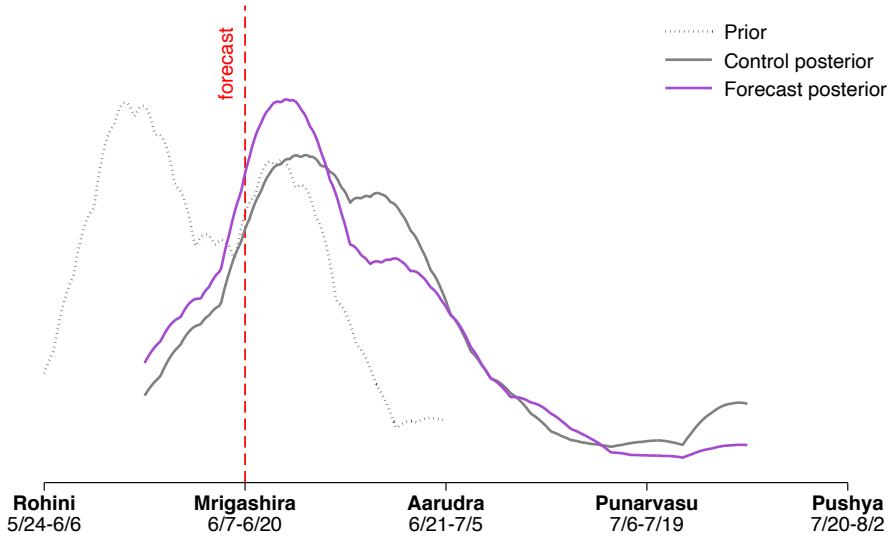

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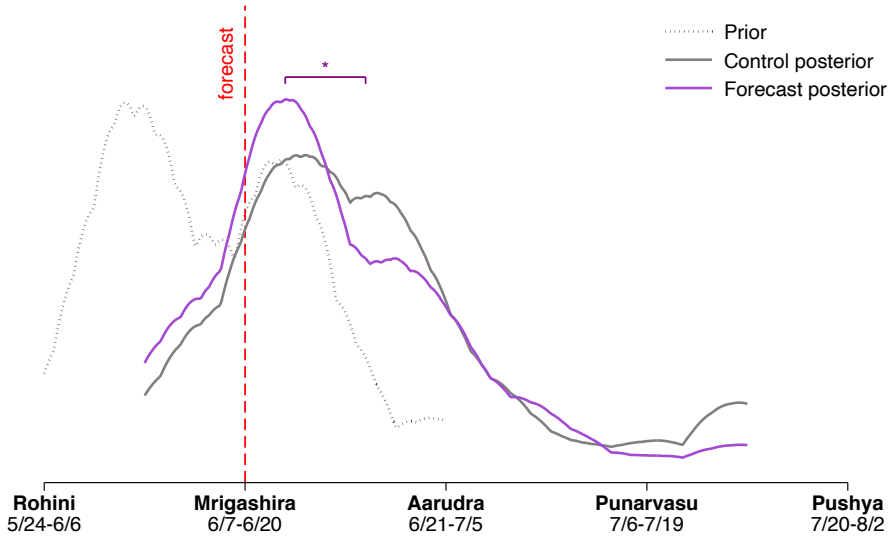
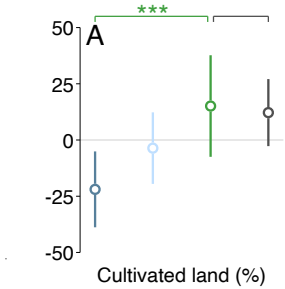


Summary of ex-ante and ex-post results



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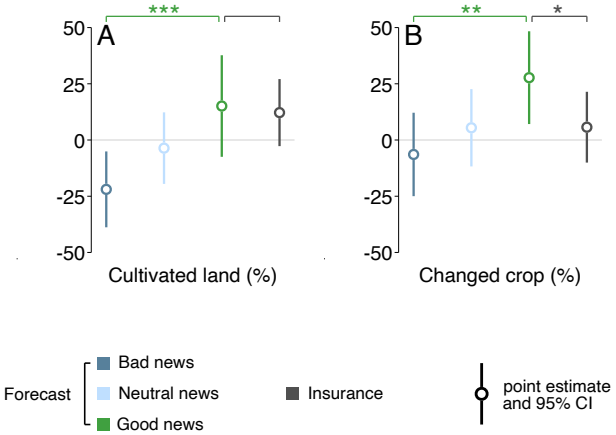

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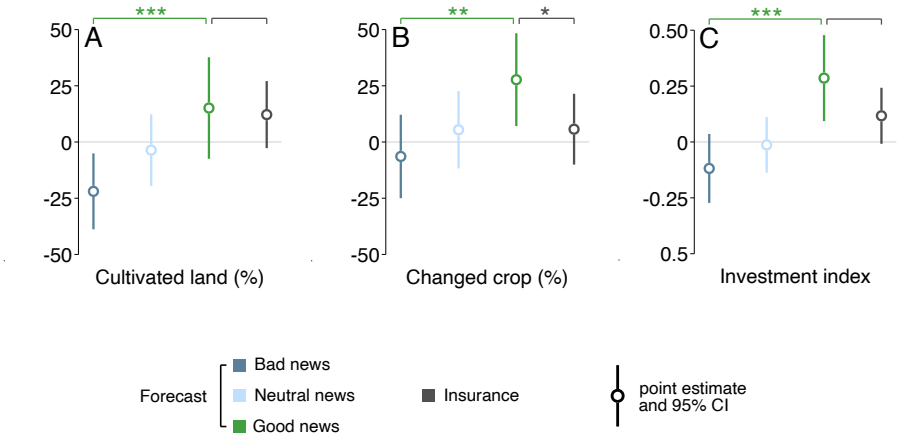

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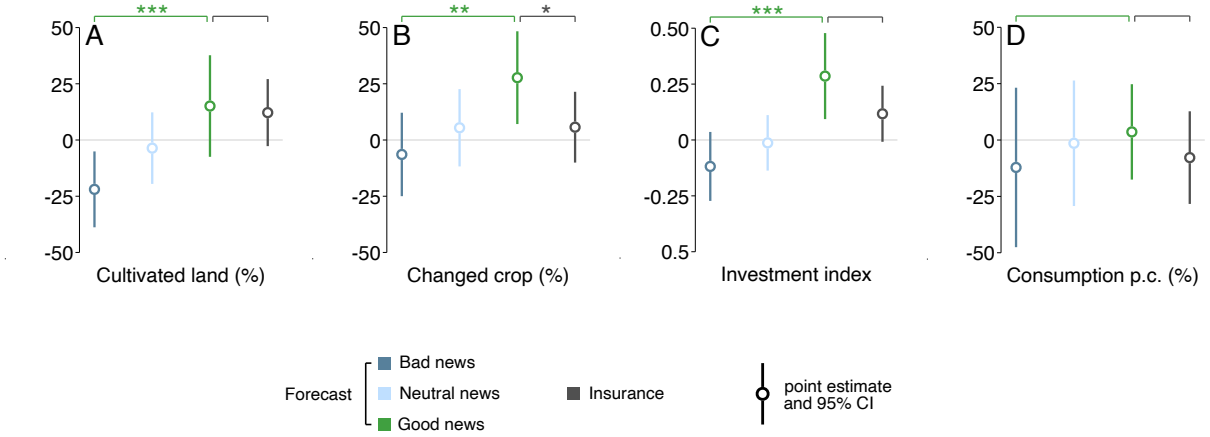
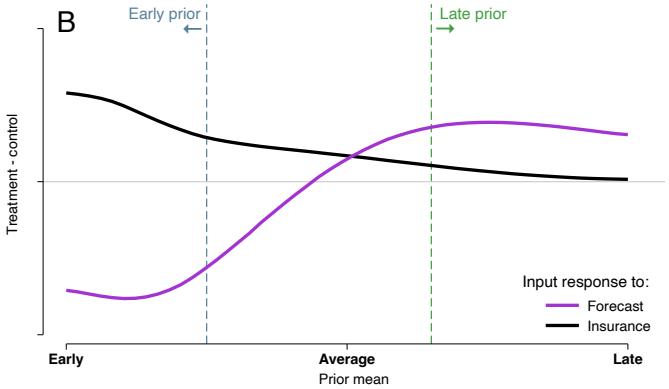


Priors matter for insurance too

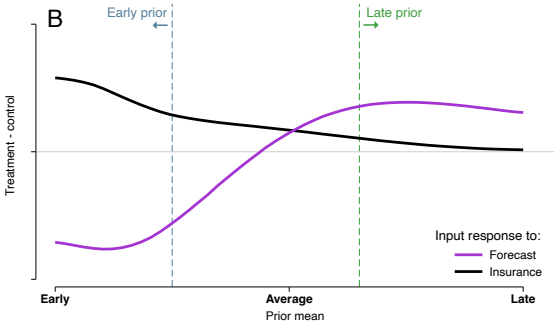
Model Insurance treatment:

- Induces all farmers to (weakly) increase investment
- Does not allow farmers to optimize to specific state
- "Optimistic" farmers respond, "pessimistic" farmers do not



⇒ Clear contrast in responses to insurance vs. forecasts by prior beliefs.

Empirics match theory



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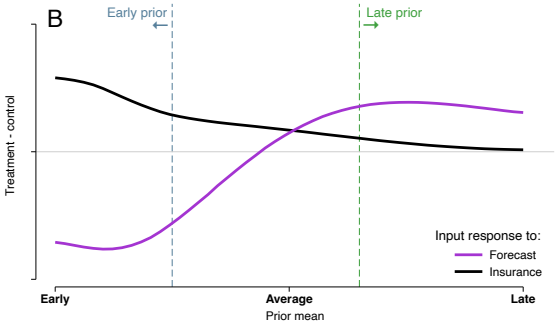

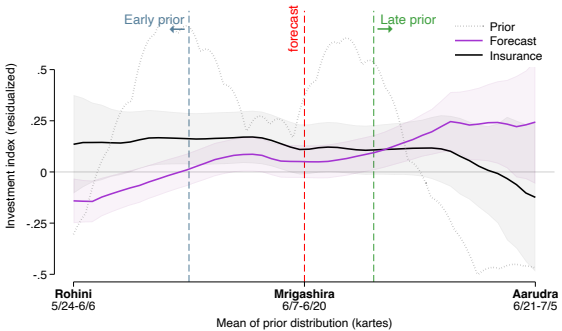

Summary of Results

Forecasts:

- Forecasts shift farmers' beliefs about monsoon onset towards the forecast
- Farmers tailor inputs: good news $\uparrow$, bad news $\downarrow$

Insurance:

- Insurance causes farmers to expand operations
- Increases in expenditures, no change to cash cropping

To come:

- Learning
- Insurance and forecast interactions

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Thank you!
Comments? Questions?
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