

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:

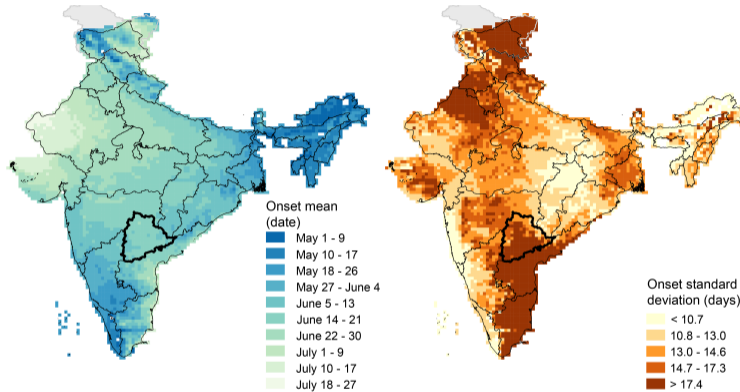
- Uninsured risk leads farmers to underinvest (Rosenzweig and Binswanger 1993)
- This in turn raises the agricultural productivity gap between rich and poor countries (Donovan (2021))

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

We introduce a new tool: 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

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:



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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

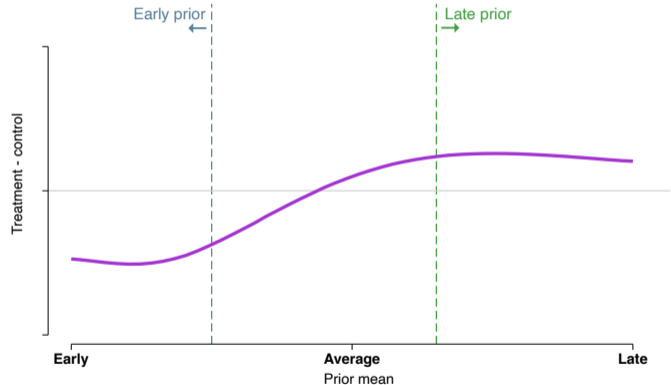
- Monsoon onset forecast
- Useful only over Kerala (not ag region)
- Issued \approx 14 days in advance
- Quantity forecast uncorrelated with actual rainfall (Rosenzweig & Udry 2019)

Science of monsoon has not changed \rightarrow even as variability increases, PIK forecast is viable

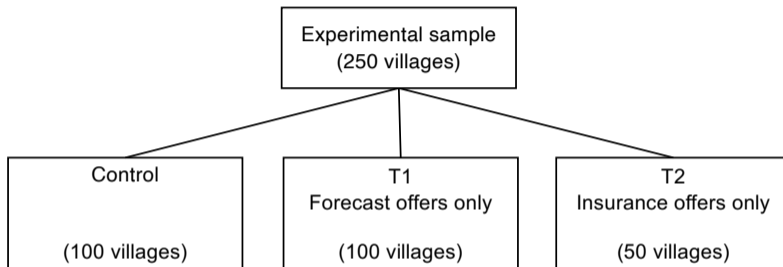
Theory: The effect of the forecast depends on farmer beliefs

In a simple model, the forecast:

- Causes farmer to update beliefs
- Allows a farmer to optimize inputs to states
- Direction of adjustment depends on a farmer's prior

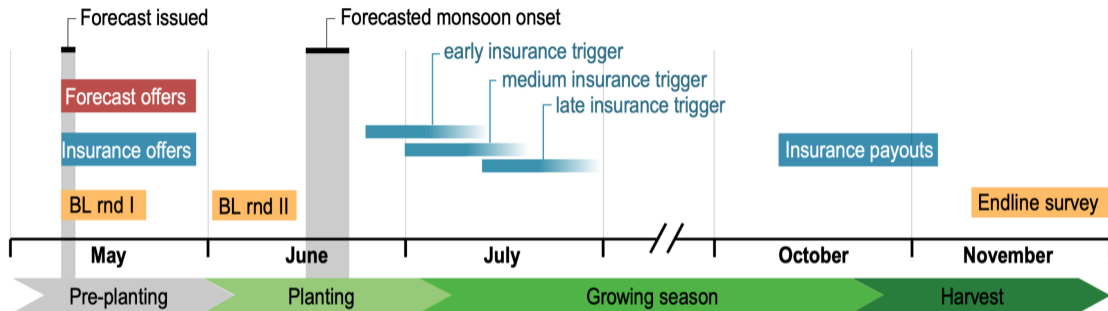


We use a cluster-randomized trial to evaluate the impacts of forecasts



- Sample frame: Villages in Mahabubnagar and Medak districts with low levels of irrigation
- Village-level randomization stratified by district, sampled 5-10 farmers per village
- Implemented in partnership with ICRISAT
- Pre-analysis plan registered with *JDE*

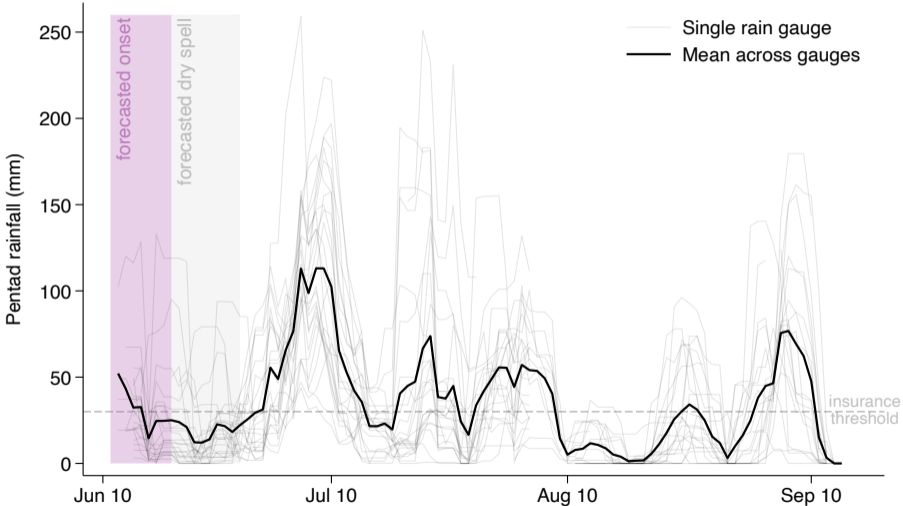
Our experiment took place in Kharif 2022



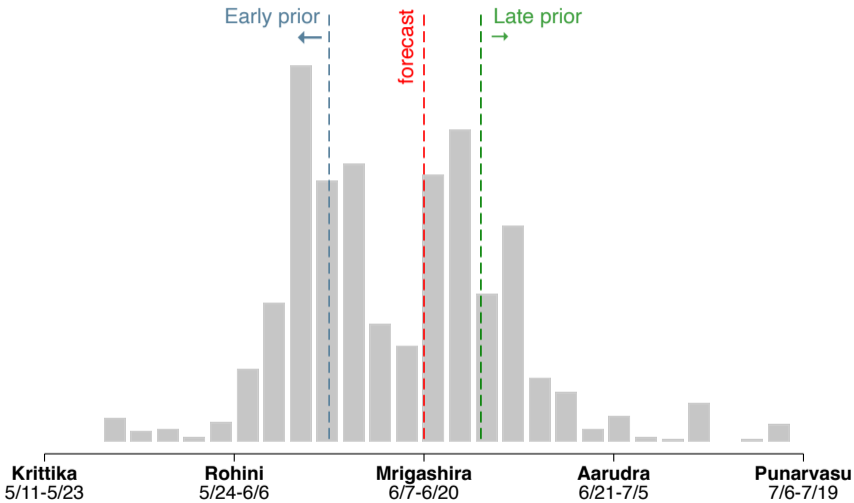
Key survey details:

- **Baseline I:** Elicits priors before forecast was presented
- **Baseline II:** Elicits posteriors after forecast was presented
- **Endline:** Collects growing season details (crops, inputs, yield, profit, etc)

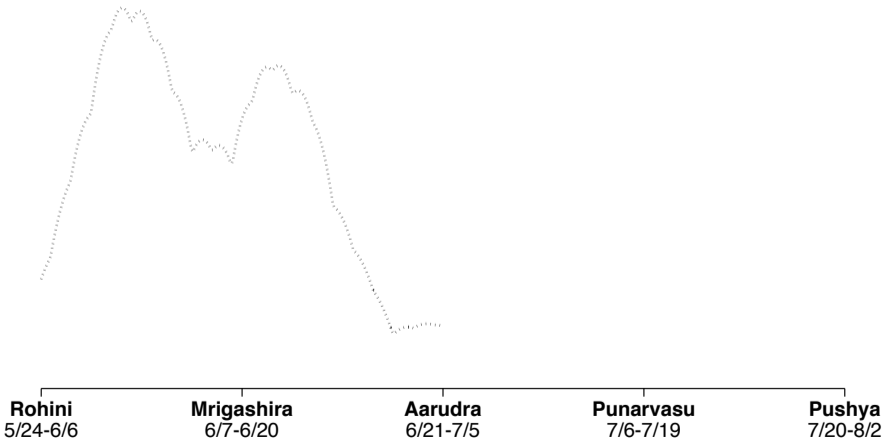
The 2022 forecast was accurate



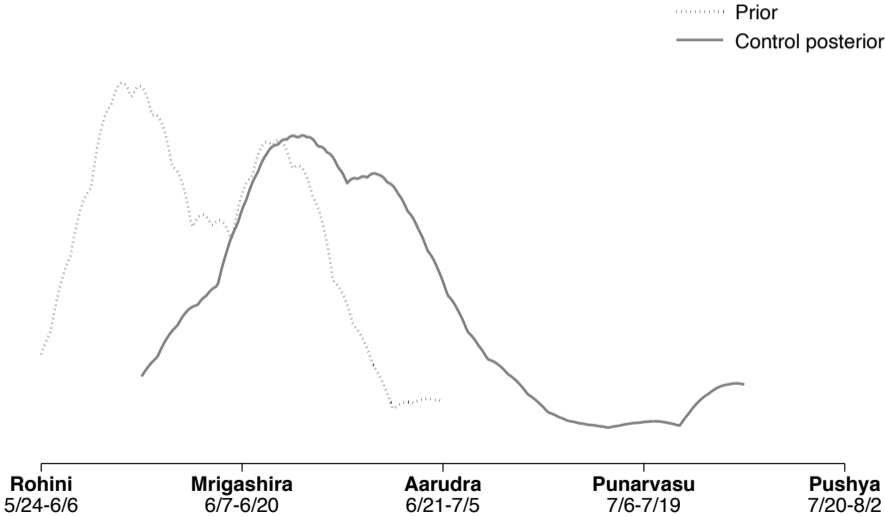
Farmers' priors are centered on the onset date



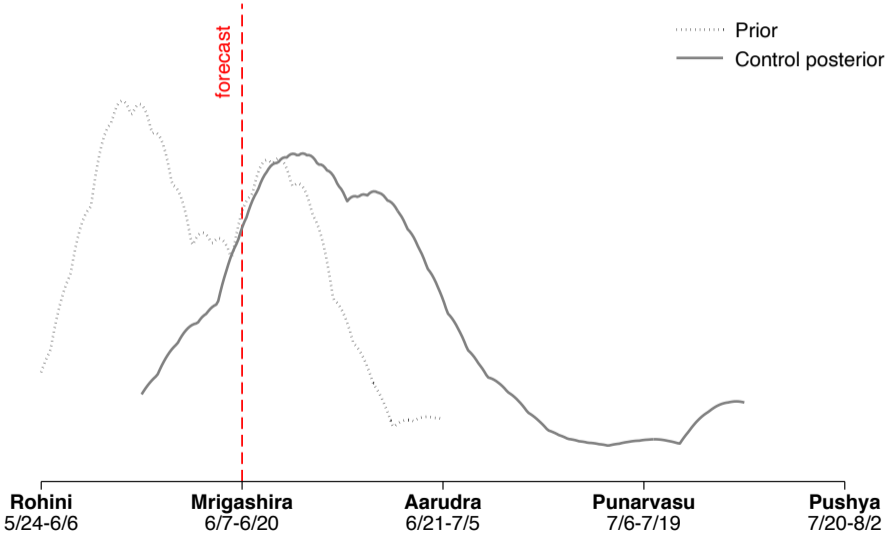
The forecast shifts farmers' posterior beliefs toward the forecast



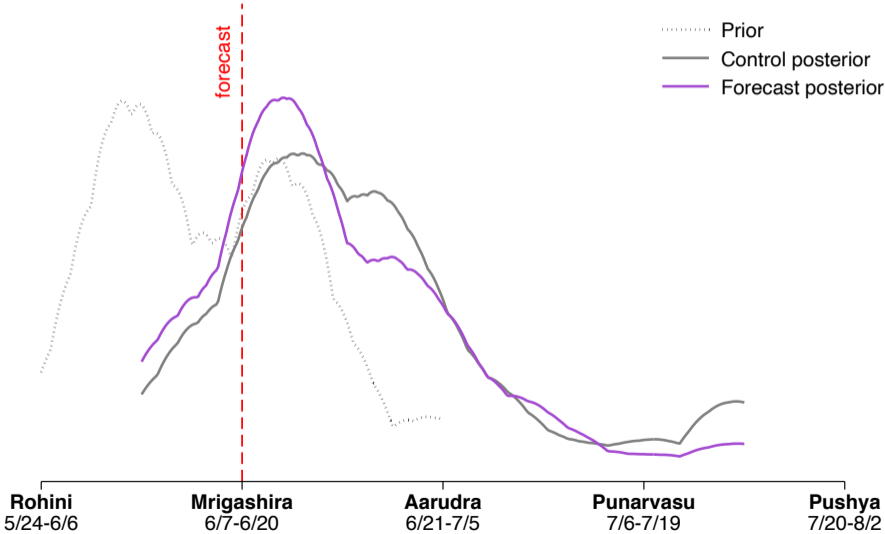
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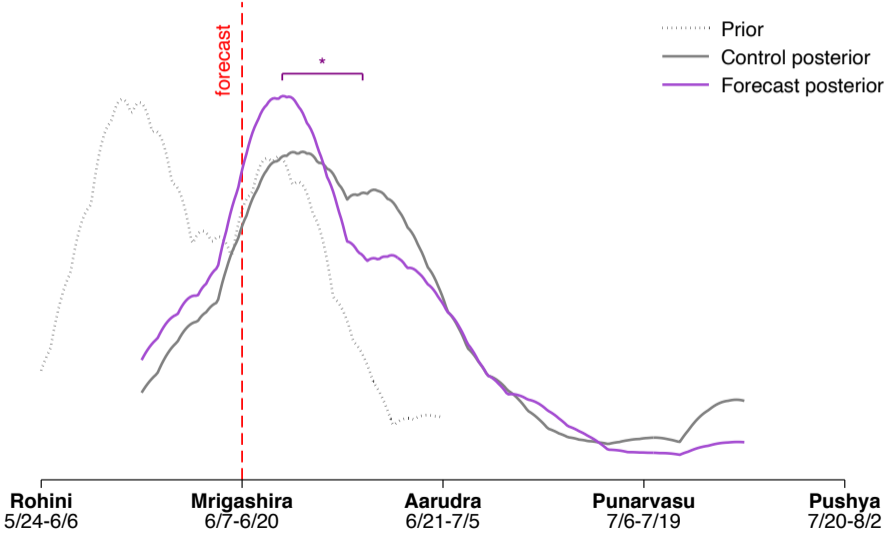


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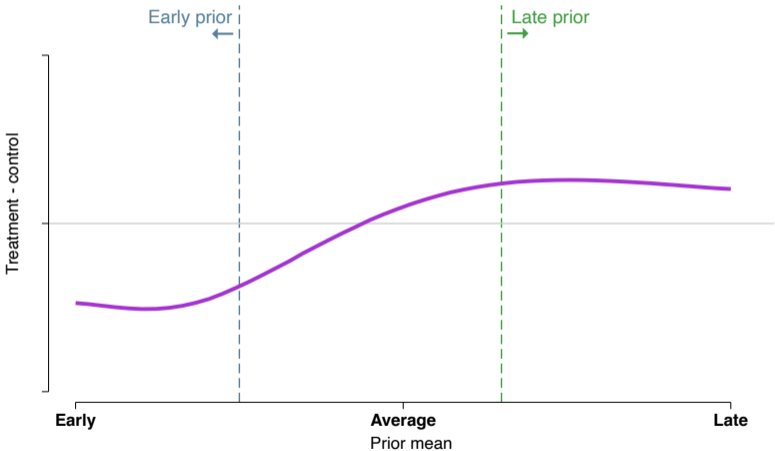


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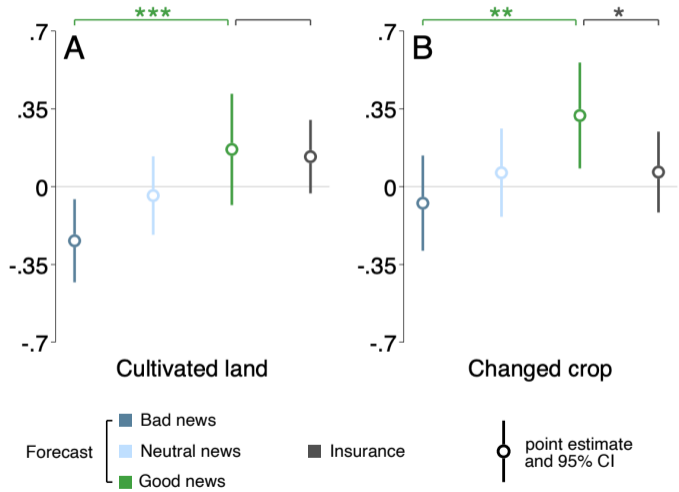
▶ Reg



Recall theoretical prediction: expect heterogeneity by beliefs

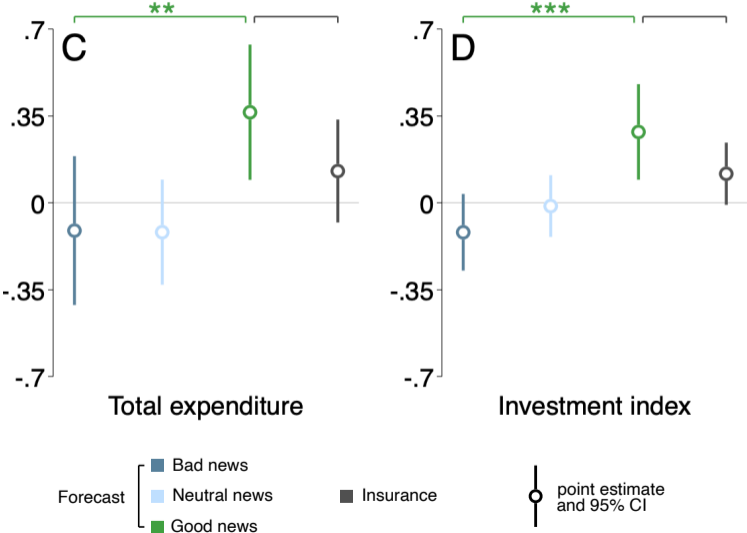


The forecast substantially changes land use and cropping



Effects driven by new cash crops for good-news farmers

Farmers change investments in response to the forecast

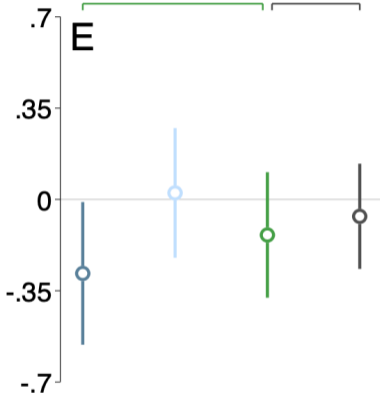


Negative agricultural profits for bad news, null for others

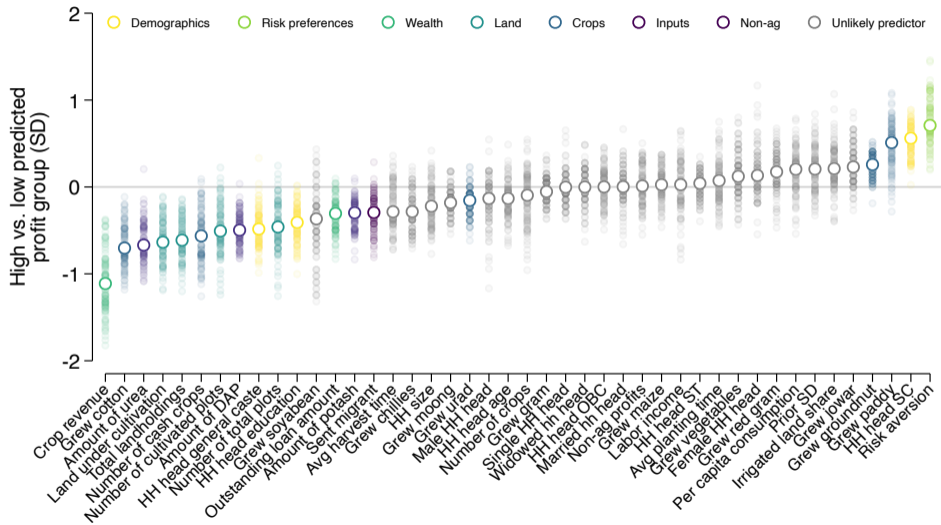
Bad: Invest ↓, profits ↓

Neutral: No Δ

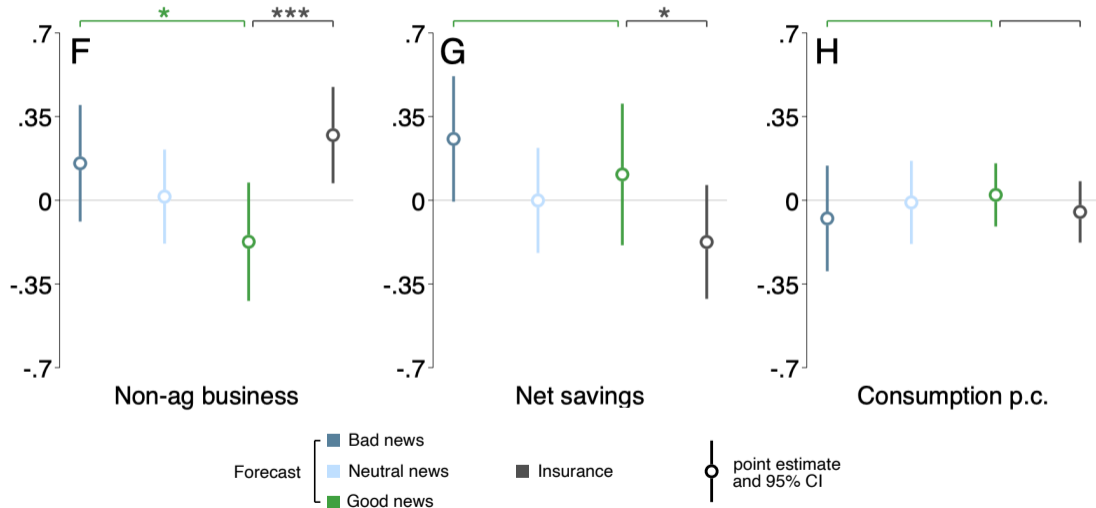
Good: Invest ↑, profits **no** Δ?



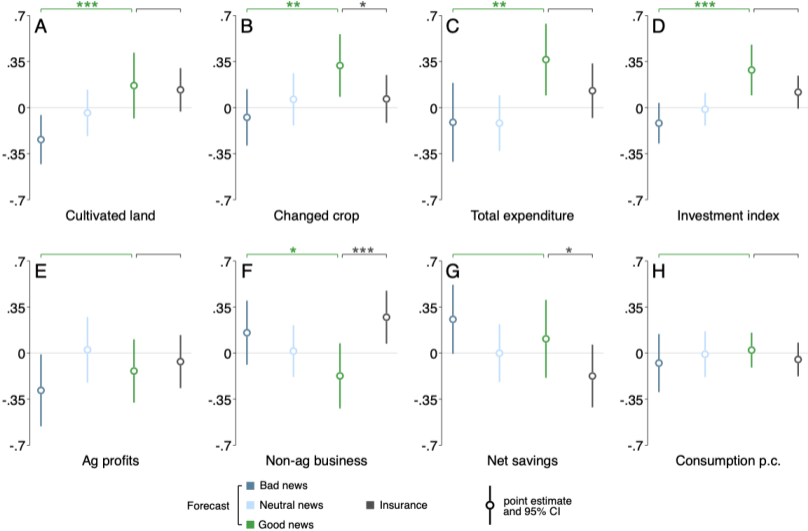
If anything, higher (predicted) profit effects among least well-off



Suggestive evidence that all forecast farmers are weakly better off



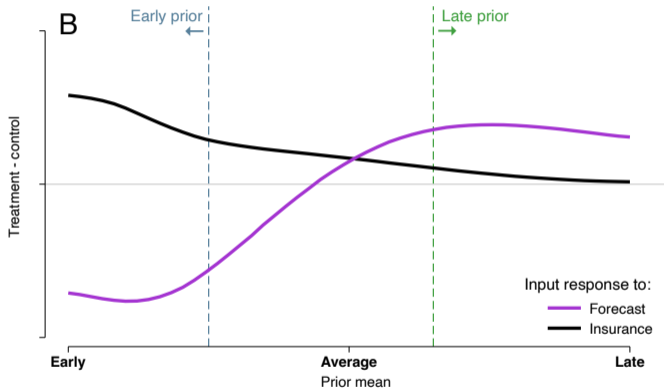
Summary of results thus far



Theory predicts different responses to the forecast vs. insurance

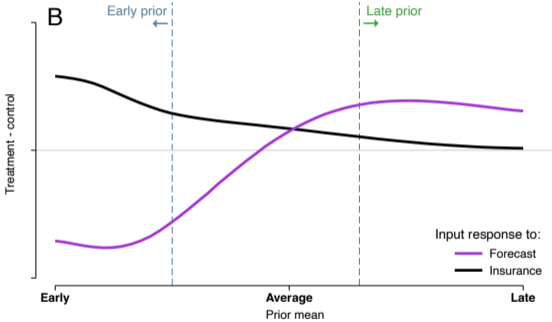
Insurance effects in the model:

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

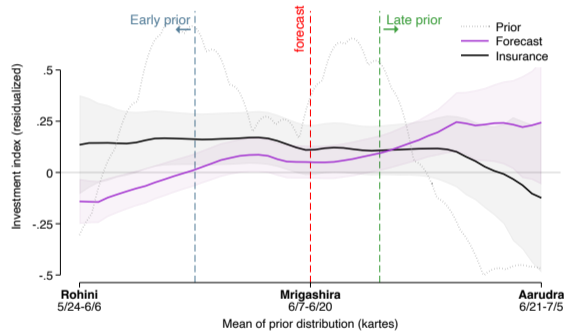
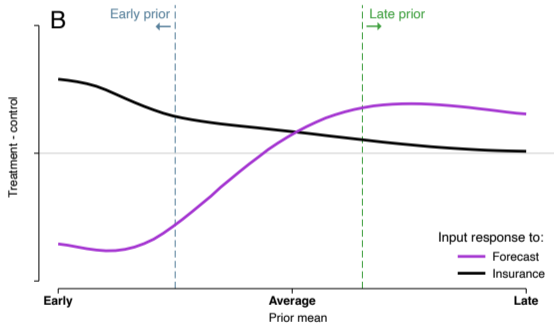


⇒ Clear contrast in responses to insurance vs. forecasts by prior beliefs

We take these predictions to the data...



..and find evidence in support of them



We demonstrate forecasts' potential as climate adaptation

We use simple theory and an RCT to study a new and an old approach to coping with risk

Forecasts:

- Shift farmers' beliefs about monsoon onset towards the forecast
- Heterogeneity by priors: good news invest more, bad news less, and change crops
- Profit heterogeneity suggests helps poor most; weak positive welfare effects

Insurance:

- Insurance causes farmers to expand operations
- Increases in expenditures, no change to cash cropping
- Heterogeneity by priors: optimistic do more, pessimistic do nothing

To come:

- Complementarities between forecasts & insurance; trust effects
- Scale (?)

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Thank you!
Comments? Questions?
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