Weather Forecasts, Agriculture and Poverty in Mozambique

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Overview

1. Weather fluctuations and crop yields

2. Modeling weather forecasts

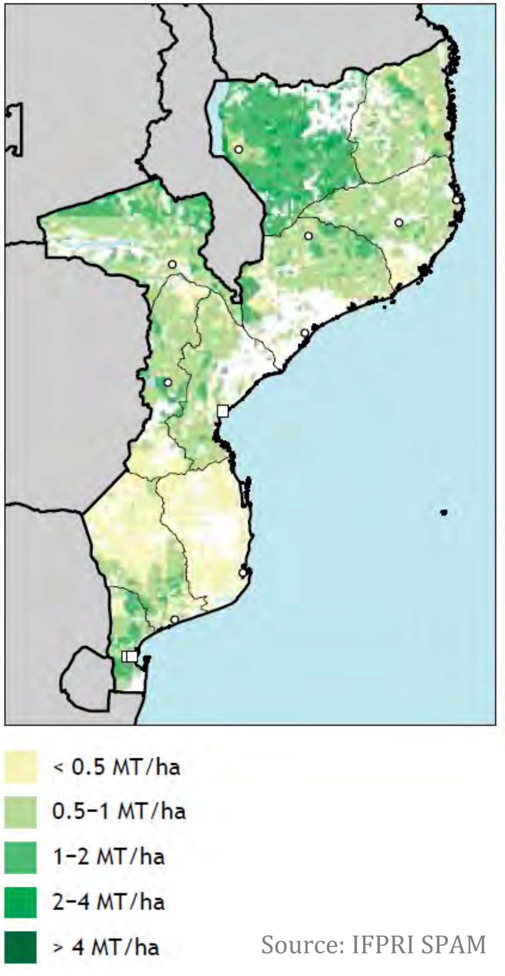
3. Simulation results

4. Conclusions

Weather and Crop Yields

- Estimate the affect of historical weather variability crop yields
  - 45 years of historical weather data (1960-2005)
  - DSSAT crop models for 8 crops (maize, sorghum, potatoes, etc.)
  - High resolution modeling: 50km x 50km pixels
  - Results aggregated to three regions (north, center, south) using interpolated crop production estimates (SPAM)

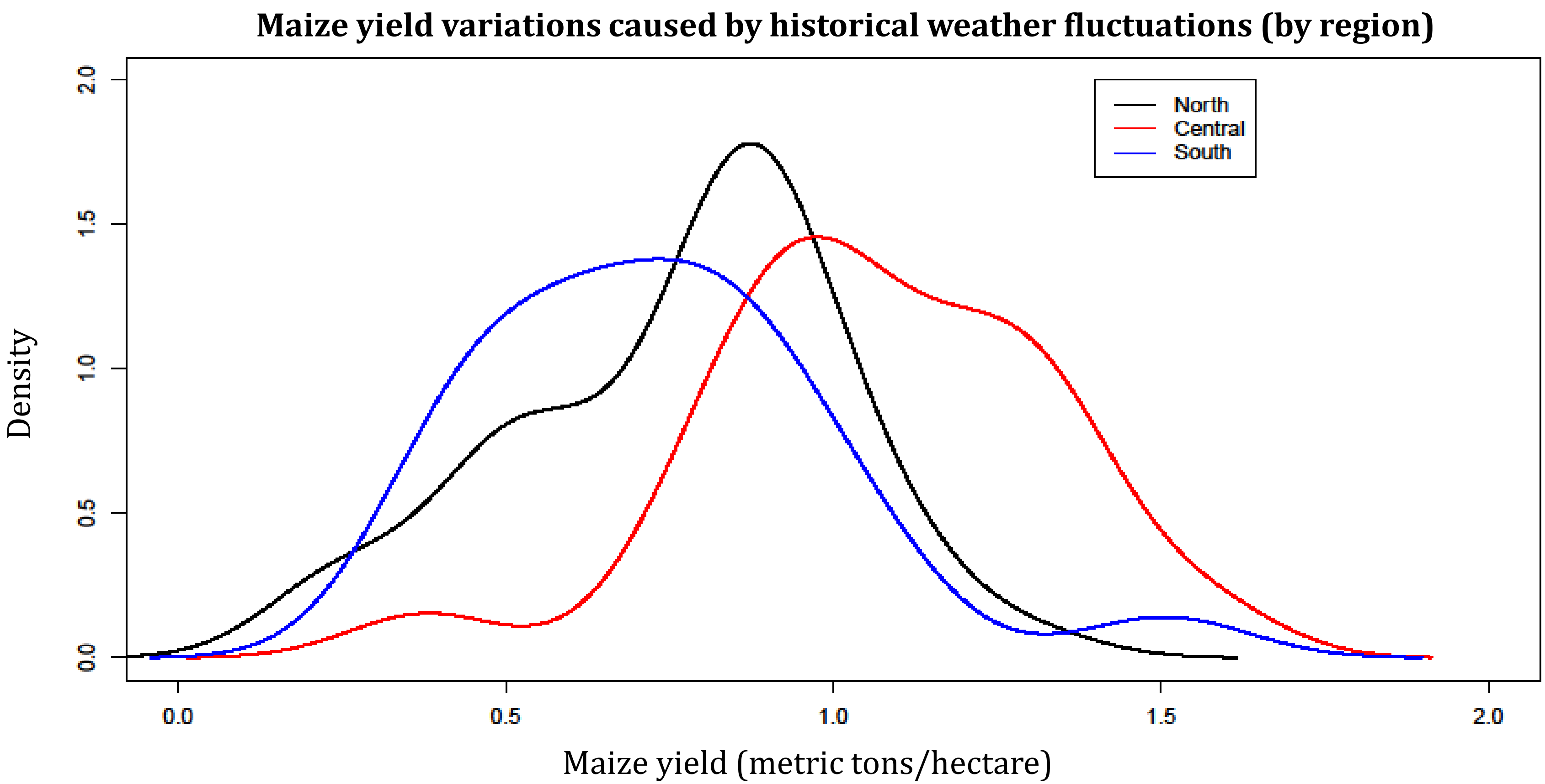
Maize yields, 2000



Source: IFPRI SPAM

Crop Model Results (1)

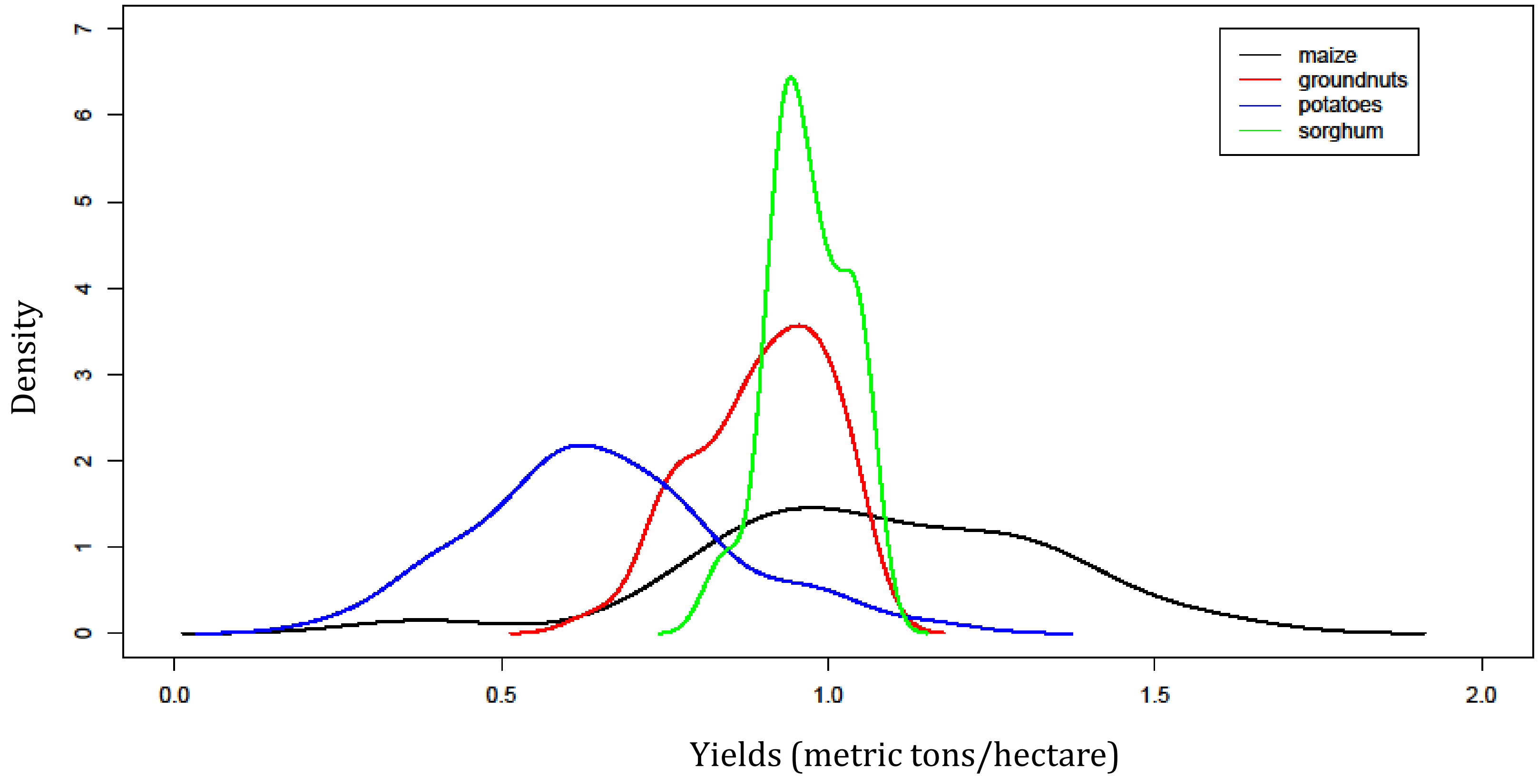
- Weather variation causes substantial variation in maize yields
  - But effects vary considerably across sub-national regions



Crop Model Results (2)

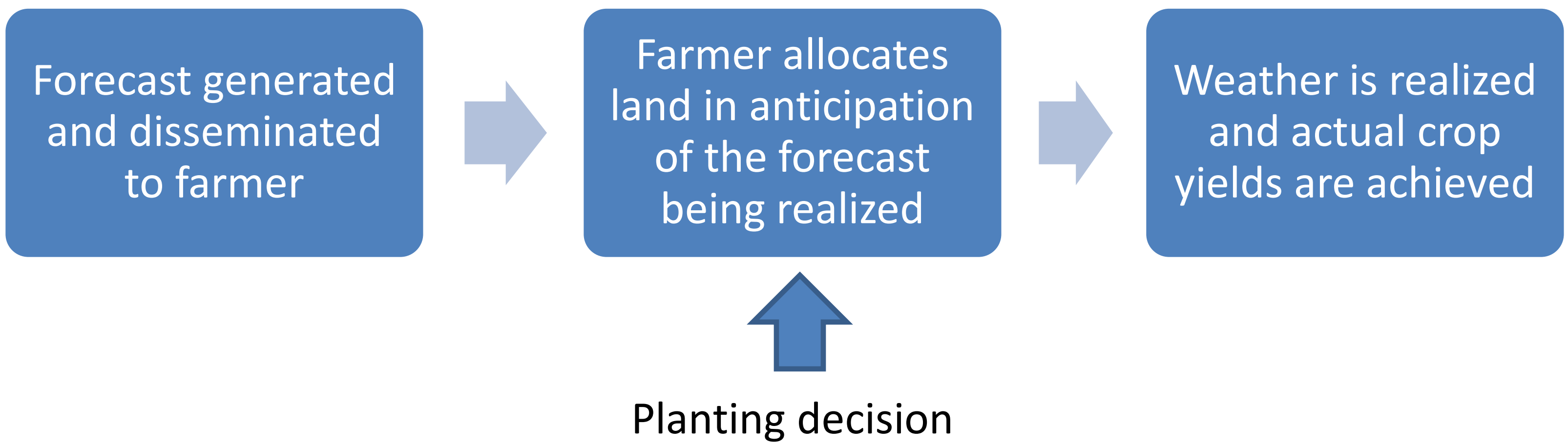
- Weather effects vary by crop based on their physiology and location within each region

Yield variations in center region caused by historical weather fluctuations (by crop)



Using Forecast Information

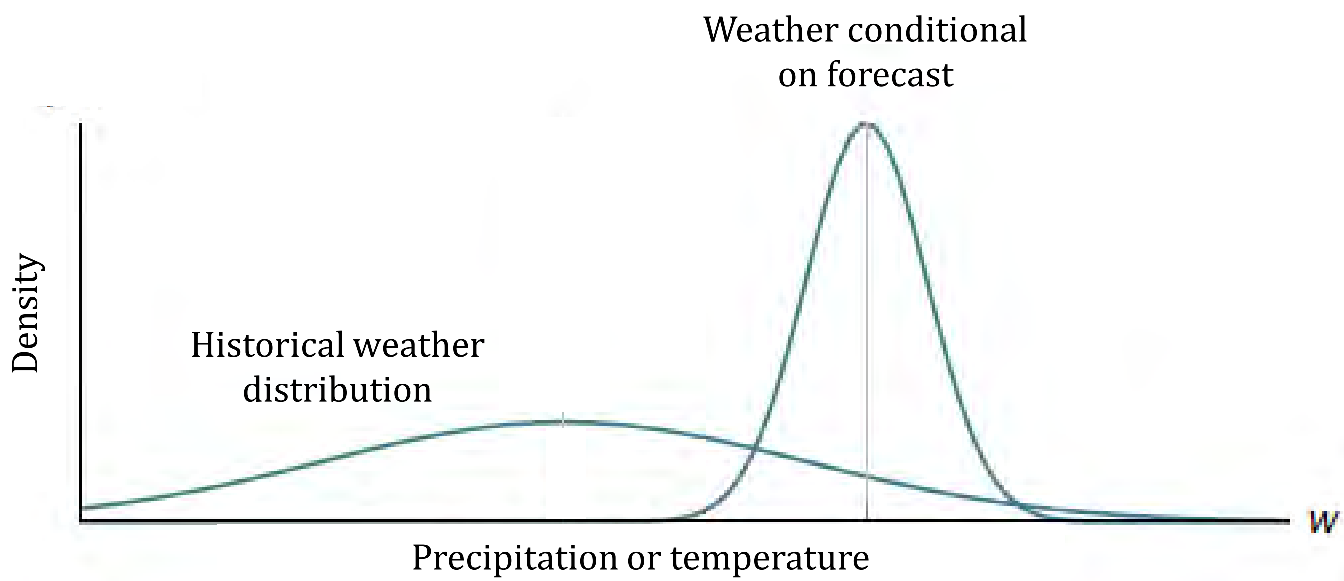
- Three step simulation



- Perfect information (forecast = weather): Optimal planting allocation
- Imperfect (forecast ≠ weather): Planting may not be optimal

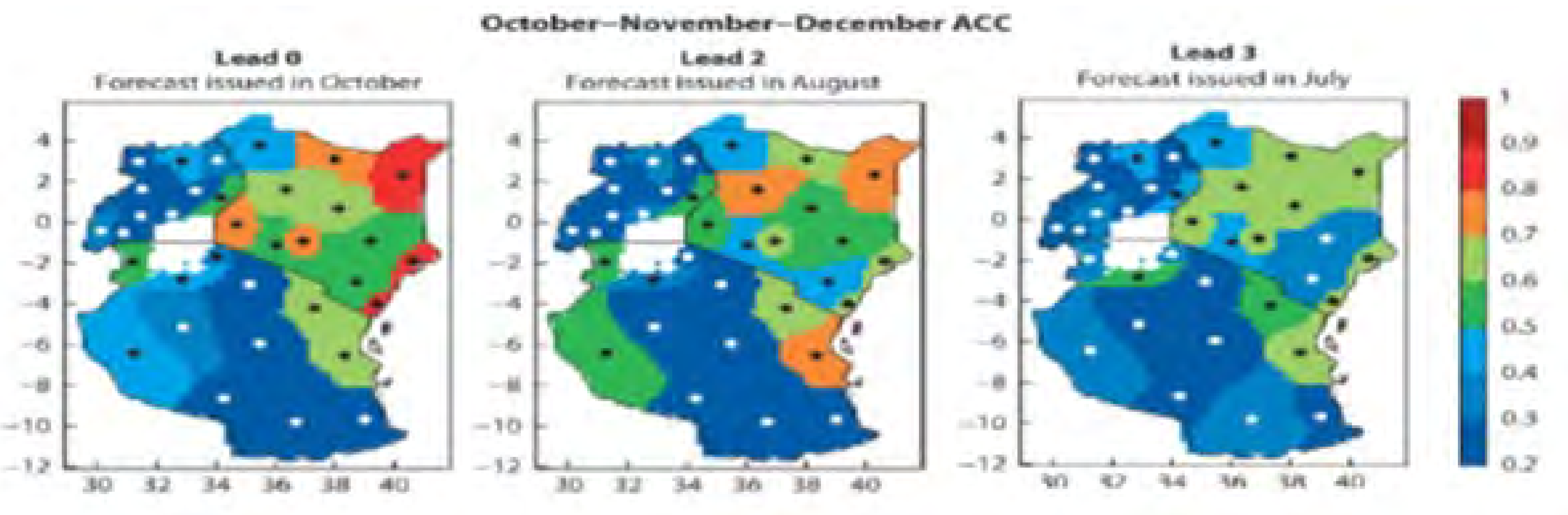
Weather Forecasts

- Forecast skill
  - Measures how well a forecast corresponds with reality (i.e., correlation between annual historical forecasts and observed weather outcomes)
  - The higher the skill, the closer we get to perfect information



Forecasting in Eastern/Southern Africa

- Forecast's usefulness depends on its accuracy and lead time
  - Extension agents need time to disseminate information to farmers, and farmers need time to adjust their planting decisions
  - As the lead time increases, skill decreases
  - Correlation ("skill") of 0.5 is considered useful (NOAA)

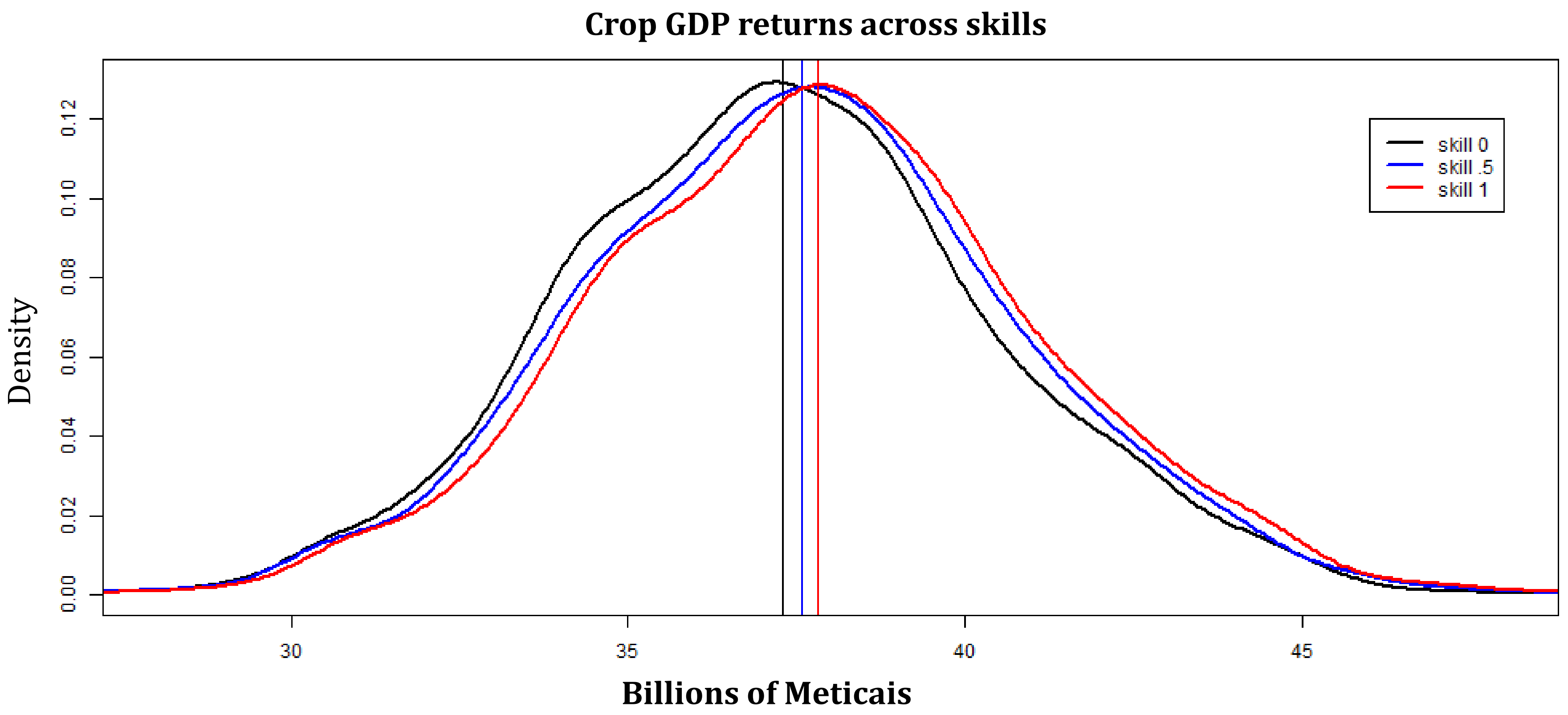


Economywide Model of Mozambique

- Detailed economic structure (from a 2007 SAM):
  - 56 sectors (22 in agriculture) in 3 regions (north, center, south)
  - 10 regional household groups (rural/urban; expenditure quintiles)
- Factor markets
  - Land can be allocated across crops based on relative prices
  - Labor mobile across farm/nonfarm sectors, but not regions
  - New capital and land are mobile, but fixed after planting period ("putty-clay")

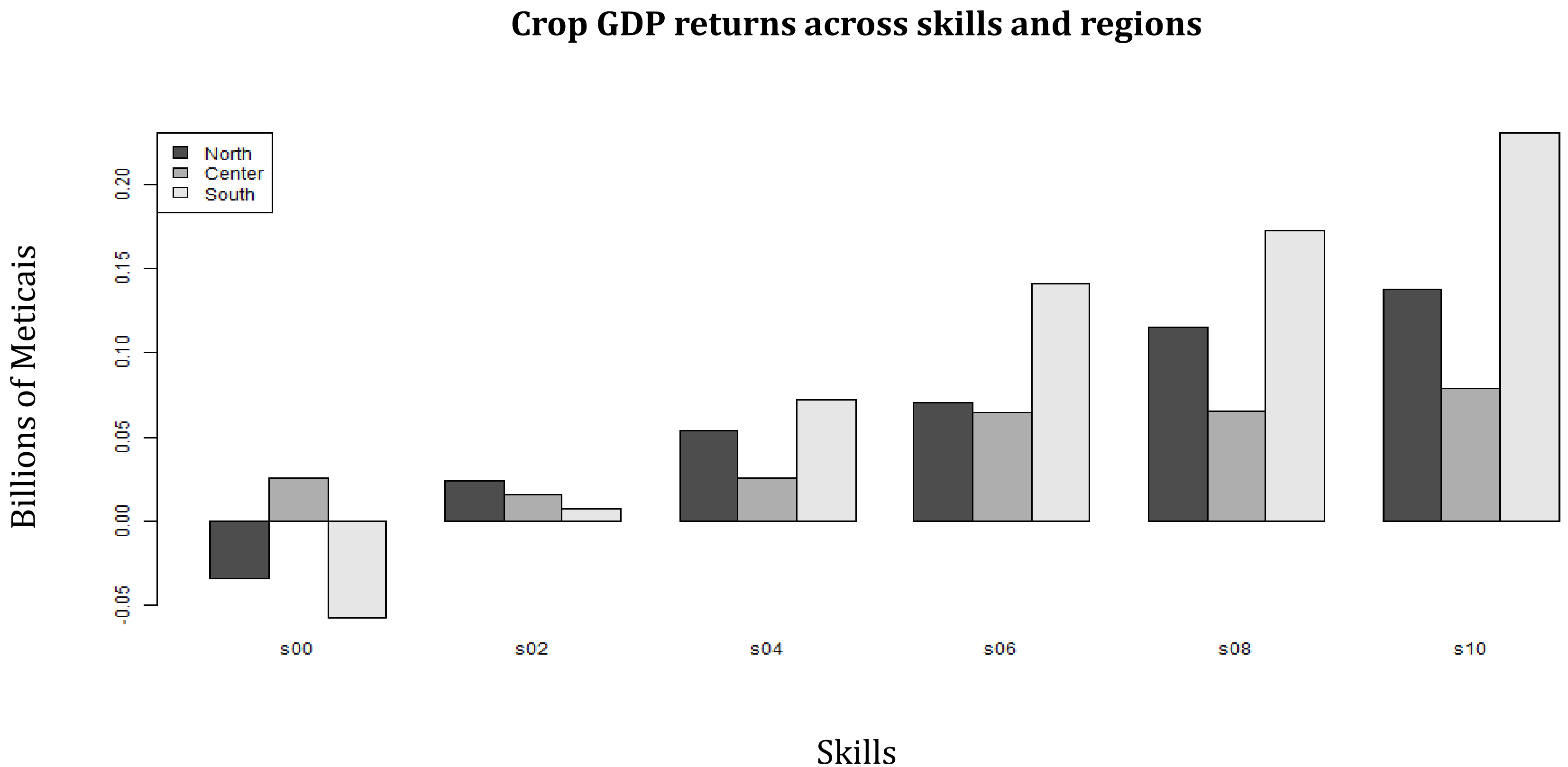
Results: Crop GDP (1)

- Forecast information allows for more optimal land allocation
  - On average, crop GDP is 1.2% higher with a perfect forecast (compared to having no forecast information)



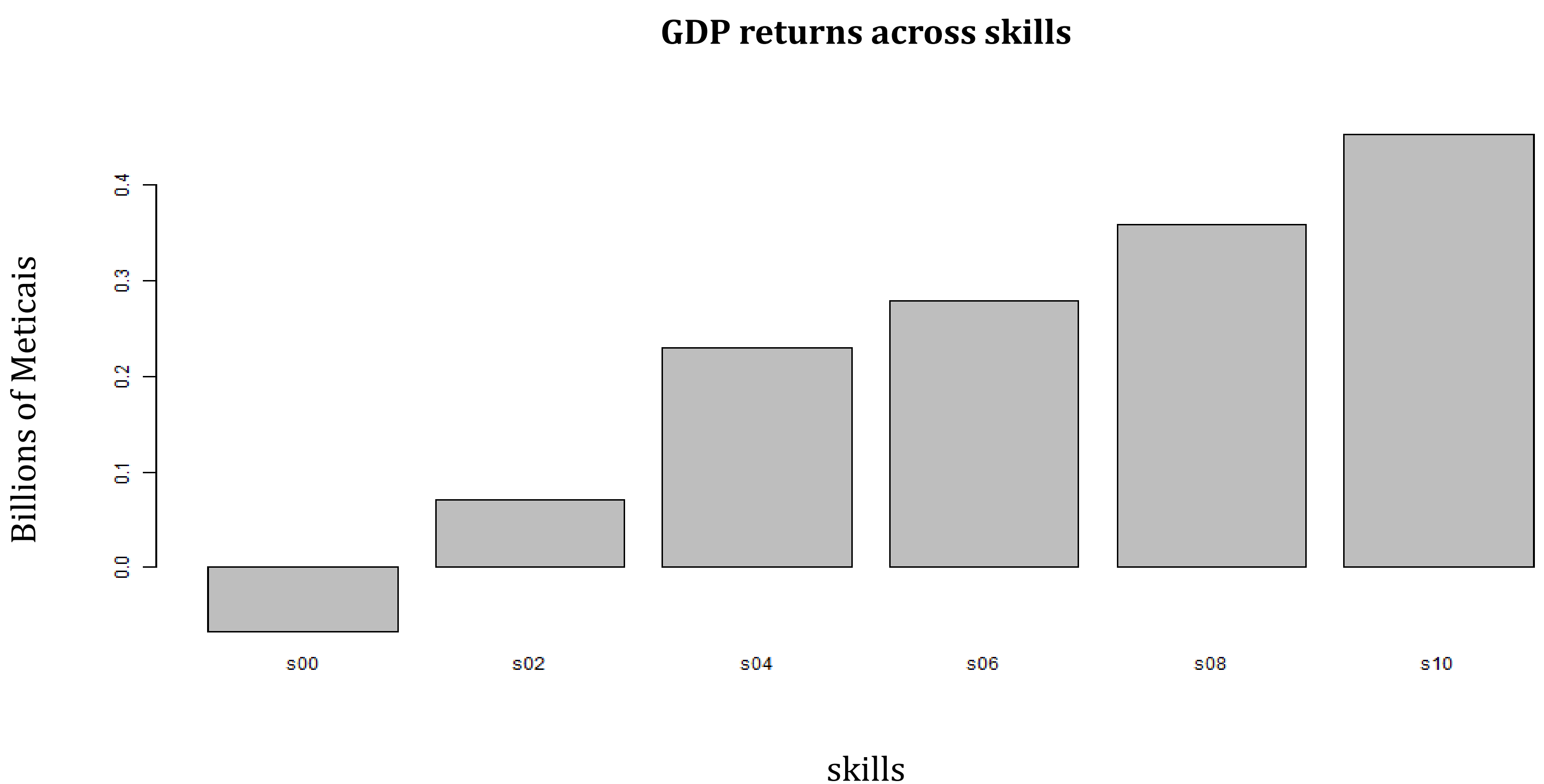
Results: Crop GDP (2)

- Returns to forecast information rise with skill, but vary across regions (highest in the South)



Results: Total GDP

- Having accurate weather forecasts could increase total GDP in Mozambique by 17.6 million USD (in 2007 prices)



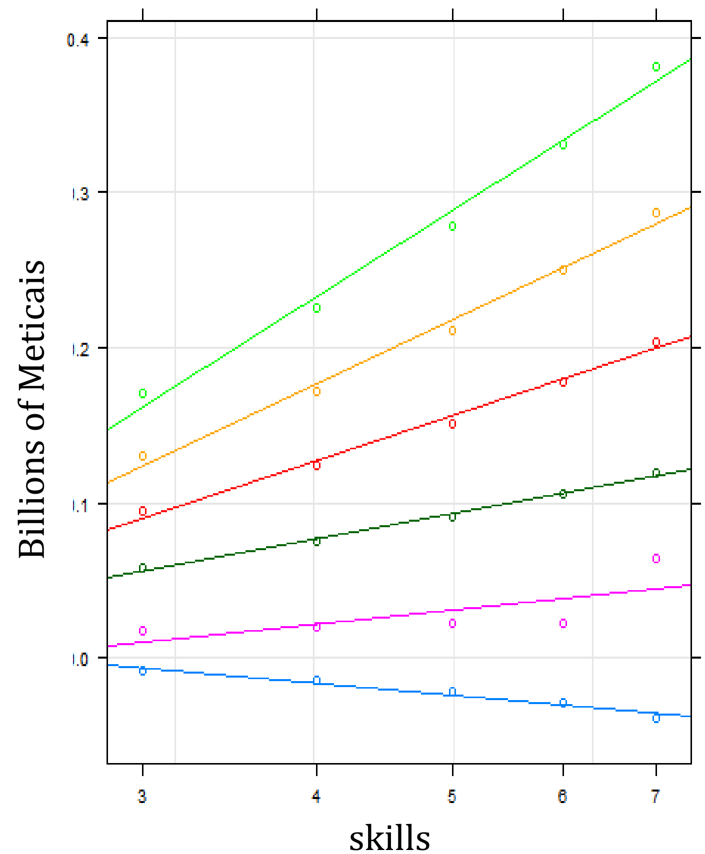
Confidence and Coverage

- A forecast may have high skill but farmers don't believe it
  - e.g., farmer is risk averse and trusts own experience of historical weather instead of the forecast
- Similarly, a forecast may have high skill, but a short-lead time makes it difficult to reach all farmers in time
  - **Full confidence/coverage**: Farmer plants according to forecast
  - **Zero confidence/coverage**: Farmer plants based on past trends (i.e., historical mean weather outcome)
  - **Intermediate confidence/coverage**: Weighted combination of forecasted and historical mean weather

$$c * Forecast + (1 - c) * History$$

Results: Skill vs. Coverage

- Returns to forecasts depend on reaching enough farmers and building confidence in the forecast
- Disseminating bad information has negative returns
- Achieving a skill forecast of at least .1 is needed
  - Excludes the cost of generating and disseminating forecast information



Conclusion

- Accurate and timely forecast information is valuable
  - Could increase Mozambique's GDP by as much as 17.6 million USD each year
  - Should ideally be reduced by the cost of the forecast and dissemination
- Generating forecasts of sufficient skill are possible
  - Skill for East Africa: 0.5 (10 million USD for Mozambique)
- Longer lead times mean lower skills (and lower returns)
  - An efficient extension system for disseminating information is essential
- Conversely, investing in extension without improving forecast accuracy can make farmers worse off
  - Current emphasis on getting climate information to smallholder farmers may be premature