Weather Forecasts, Agriculture and Poverty in Mozambique

Joao Rodrigues

International Food Policy Research Institute, Washington DC

Coauthors:
Claudia Ringler, James Thurlow and Tingju Zhu
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)
Crop Model Results (1)

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

Maize yield variations caused by historical weather fluctuations (by region)
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

1. Forecast generated and disseminated to farmer
2. Farmer allocates land in anticipation of the forecast being realized
3. Weather is realized and actual crop yields are achieved

- 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

\[ c \times \text{Forecast} + (1 - c) \times \text{History} \]
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