Explaining Weather Related Credit Risk of Agricultural Lenders: Precipitation vs. Evapotranspiration Index

Freya von Negenborn, German Development Institute, Bonn
Ron Weber, Georg-August-Universität Göttingen, KfW Development Bank, Frankfurt
Oliver Musshoff, Georg-August-Universität Göttingen
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Introduction

• Undercapitalization of small-scale farmers in developing countries

• Agricultural microfinance regarded more risky (Weber & Musshoff, 2012)
  – Esp. weather and price risks

  → Weather influences agricultural productivity and producer’s annual cash-flow → and therefore capacity to handle instalment payment in due time (Binswanger & Rosenzweig, 1986)

• Weather index-based insurances widely discussed in the literature
Idea and hypothesis

• Examine the impact of weather on the credit risk in agricultural lending in Madagascar
• Compare the explanatory power of precipitation and evapotranspiration (ETa) indices (aggregated bank level, branch level) for agricultural credit risk
• Hypothesis:

“The explanatory value of an ETa index is higher than the explanatory value of a precipitation index.”
Weather and agricultural production
- Mean of monthly precipitation in the central highland of Madagascar 2015
Weather and agricultural production
- Rice production in the central highland of Madagascar

Major weather risks

Crop cycle

Major season

Minor season

Source: Own illustration based on expert interviews and Huke, 1990

Legend:

heat and insufficient rain

excessive rain
Data

AccèsBanque Madagascar (ABM)

- Micro- and small business bank
- Micro loans since 2007, agricultural micro loans since 2011
- Nine branch offices providing agricultural loans
  - Agr. sector represents 6% of total portfolio
  - Mainly small-scale farmers with wet rice in terrace cultivation
- Agr. loans: ~110€ - 4,000€, monthly interest rates 3.75% - 5%
Methodology

• Definition of the dependent variable as ‘credit risk’

• Specification of different weather indices that serve as independent variables of substantial interest through correlation analyses

• Assessment of the explanatory power of the indices through a sequential logit model (SLM)
Dependent variables: definition of credit risk

- Credit risk: ability/disability of clients to make their instalment payment in due time → four credit risk indicators (CRI):
  - CRI 0: all loan instalments were paid on time
  - CRI 1: at least one of the instalments was overdue by 1 to 14 days
  - CRI 15: at least one of the instalments was overdue by 15 to 29 days
  - CRI 30: at least one of the instalments was overdue by at least 30 days

<table>
<thead>
<tr>
<th>Credit risk indicators</th>
<th>Unit</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRI 0</td>
<td>1/0 a)</td>
<td>0.499</td>
</tr>
<tr>
<td>CRI 1</td>
<td>1/0 a)</td>
<td>0.433</td>
</tr>
<tr>
<td>CRI 15</td>
<td>1/0 a)</td>
<td>0.033</td>
</tr>
<tr>
<td>CRI 30</td>
<td>1/0 a)</td>
<td>0.035</td>
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a) Dummy variable: 1 = yes, 0 = no. Mean values for dummy variables (1/0) indicate ratios.
Independent variables: Specification of weather indices

• Monthly accumulated index (precipitation and evapotranspiration)
• Reflection of both flowering and harvesting period in the index
• Indices identified through correlation analyses and logistic regression analyses

→ Assumption that farmers assigned to the same branch experience the same weather patterns
→ Assumption that weather data of month \( x \) in year \( t \) also influences the CRI for the remaining months of the respective year as well as for the \( x \) first months of the subsequent year
Sequential logit model (SLM)

• Response categories of the dependent variables that can only be reached stepwise (Tutz, 2005)
  → Three transitions in this model:
    – (CRI 1 + CRI 15 + CRI 30) versus CRI 0
    – (CRI 15 + CRI 30) versus CRI 1
    – CRI 30 versus CRI 15

• **Independent variables**: indices of flowering and harvesting period for evapotranspiration and precipitation, respectively
• **Control variables**: loan and socio-demographic characteristics
Estimation results of the SLM

- Precipitation index: significant information in harvesting season
  -> Does not serve as adequate index regarding flowering season
- Evapotranspiration index: significant information in flowering and harvesting season
- -> Adequate for both seasons

Confirmation of the hypothesis

The explanatory value of an ETa index is higher than the explanatory value of a precipitation index for the credit risk
Recommendations derived from the analysis

1. Index-based insurance design based on an evapotranspiration index

2. Both flowering and harvesting periods included as part of the underlying index

3. Tailor indices and trigger points to each branch
Limitations

• Timespan of the data very short (5 years)
  → No calculation of the impact of less frequent but high damage risks possible

• No intensity-related variables taken into account in the analyses
  → e.g. use of fertilizers, irrigation systems, number of family members working in the farming activity

• Application of the results to other crops than wet rice in terrace cultivation questionable
Thank you!