The potential of index-based weather insurance to mitigate credit risk in agricultural microfinance

Niels Pelka & Oliver Musshoff

Department for Agricultural Economics and Rural Development
Georg-August-Universitaet Goettingen
Platz der Goettinger Sieben 5
D-37073 Goettingen
Germany

Niels.Pelka@agr.uni-goettingen.de

Extended Abstract

Background and Objectives

Microfinancing entails a relatively high risk for financial institutions. Index-based insurances against frequently occurring, but comparatively less severe, loss events have the potential of reducing this risk. This is particularly true for countries that have the typical economic characteristics of a developing country. In countries such as Madagascar, Tanzania or Tajikistan, agriculture is an important economic sector that contributes up to 35% of the gross domestic product. In the near future, insurance policies in general, and index-based insurance policies in particular, could play an important role in the area of agricultural microfinancing along with making an important contribution to the development of the finance sector.

Risks for the banks that are directly connected with the granting of agricultural loans have attracted the attention of agronomic research throughout the last ten years. Given that weather has a significant impact for fluctuations in yield (and therefore fluctuations in income) within agricultural operations, it precedes many subsequent events, such as lack of liquidity. Weather risks influence the profitability of the agricultural production and increase the volatility of the annual cash flow (Binswanger and Rosenzweig, 1986). This endangers the ability of agricultural enterprises to repay their loans on time. The literature identifies three main reasons for the credit loss of agricultural microcredit: First, the weather-related yield risk, second, the variations of yield and quality caused by lack of inputs and third, income fluctuations by erratic product prices (IPA, 2009).

Agricultural enterprises' high dependency on weather risks increases the portfolio risk of microcredit banks, which in turn leads to high risk premiums on the microloans granted to agricultural enterprises. The latter could also explain why empirical research frequently points out that access to financial resources for agricultural enterprises is often strongly rationed (Beck et al., 2006; Diagne et al., 2000; Foltz, 2004; Petrick, 2004; Simtowe et al., 2008). Concerning the topic of the weather conditioned volumetric risk, Giné and Yang (2009) analyze the effect for Malawi of an operating loan in conjunction with a precipitation index-based insurance. In reference to price risks, Shee and Turvey (2012) study the awarding of agricultural development loans in connection with the price risk for pulses in India.

If there is a direct connection between the credit default risk of microcredits and one or more weather indices, it is conceivable that banks could take hedging measures to combat weather risk. In the case of weather conditions unfavourable to agricultural production, the bank receives money from the insurance. Thus, no money would be paid to the borrower from the insurance. In return, however, future payments could be reduced for the borrower in their repayments to the bank (Giné and Yang 2009). The borrower would not have to deal with the supposedly complicated product "weather index-based insurance". The bank would be in a position to reduce its high risk premiums, since the weather index insurance would cover a portion of the risk. In this way, access to financial resources for agricultural enterprises would not be rationed as strongly.

Weather index-based insurance, which is also frequently referred to as a weather derivative, is defined as a contract which guarantees that the buyer receives payments based upon meteorological data. The returns from weather index-based insurance are determined through objectively measurable weather variables which constitute the insurance's index. For instance, it could include the total amount of precipitation in a period relevant to the growing season. Weather index insurance serves to protect against income fluctuations caused by weather.

Since weather index-based insurance is not affected by the problems of adverse selection and moral hazard, they involve low transaction costs, which is a key advantage over yield insurance (Coble et al., 1997; Goodwin, 2001; Berg et al., 2008). However, due to an imperfect correlation between the weather index and the income, the risk reduction potential of weather index-based insurance, is diminished. On the one hand, this basis risk, which remains the responsibilty of the producer, results from the fact that apart from the insurance-related weather variable (e.g., precipitation in May), there might be other influencing weather factors (e.g., temperature in May) that lead to yield variations. It is within this context that literature often refers to the basis risk of production. On the other hand, there is a non-insurable difference between the weather events at the production site and at the reference weather station that is referred to as geographical basis risk.

The objective of this paper is to analyze the link between agricultural microcredits and weather index-based insurance. With this in mind, we pursue the following two objectives:

1. First, to examine to what extent the yield risk is dependent on weather in the countries analyzed. Therefore, weather indices are identified which have a particularly high coherence to agricultural yields. Numerous examples in the literature demonstrate that high correlations between weather indices and agricultural yields lead to considerable hedging effectiveness through weather index-based insurance (Turvey, 2001; Vedenov und Barnett, 2004; Odening et al., 2007; Breustedt et al., 2008; Norton et. al., 2013).
2. Second, we will examine whether the weather indices identified have a significant influence on the credit default risk of microloans. If a significant coherence can be demonstrated, it would be possible to mitigate the default risk of agricultural microloans by purchasing weather index-based insurance.

To our knowledge, this is the first paper investigating whether or not weather variables during specific time periods (e.g. growing season) have a significant influence on the loan defaults of specific agricultural microloans for analyzing the potential of index-based weather insurance to mitigate credit risk in agricultural microfinance.

Data and Methods

Data on the repayment behaviour of microloan borrowers in Madagascar, Tanzania and Tajikistan who have been granted loans from commercial micro finance institutes operating in these countries, constitute the basis of our empirical analysis. The data includes inter alia information on credit default risk, which is specifically described by the so-called Portfolio at Risk (1) (PAR (1)), which states how many of the loan repayments were effected at least one day overdue. The data makes it possible to allocate each borrower to a corresponding bank branch in a specific city. Furthermore, weather data from weather stations in the respective countries that we are examining is used, this data is provided to us by the Deutscher Wetter Dienst (DWD). To identify weather indices with a high coherence to agricultural yields, we work with historical yield data for the agricultural products typical of the countries. The data we use was taken from the bank's Management Information System (MIS) and includes the loan data as well as the corresponding data on the borrower. The loan data (for instance, number of instalments, volume of loan, number of instalments that were not punctually repaid) is automatically compiled by MIS as soon as a loan is paid out. The customer data is manually entered into the MIS by the customer service representatives. Thereafter, obvious input errors and anomalies of the customer data had to be corrected, which was done in agreement with the bank. Furthermore, we did not include loan applications which had been withdrawn by the customer before the bank had decided on them, for which the decision-making process was still ongoing, or for which the data was incomplete.

The coherence of agricultural yields and weather indices is determined with the aid of a correlation analysis. For the weather indices with high correlations on the returns to the agricultural yields, the influence on the credit default risk is determined with the help of a regression analysis. The credit default risk represents the dependent variable. In addition to the specified weather index, the age and sex of the borrower, the average annual income of the enterprise and the geographical location of the responsible bank branch will make up the independent variables.

Conclusive Remarks

This analysis provides important information about the dependence of agricultural defining cultures of the regions considered by one or more weather variables. For potential suppliers of weather index insurance, these results give important information for adapting these insurance instruments to the specific conditions of these regions. Furthermore, this analysis provides important information about the weather impact on the credit risk of specific agricultural microcredit. A high correlation between a weather index and agricultural yields and a direct influence of this weather index on the default risk of agricultural microcredit could allow microfinance institutions to hedge the weather risk using weather index insurance.

References

Beck, T., Demirgüc-Kunt, A., Laevenand, L. and Maksimovic, V. (2006), "The determinants of financing obstacles", *Journal of International Money and Finance*,Vol. 25, pp. 932–952.

Berg, E. and Schmitz, B. (2008), "Weather-based instruments in the context of whole-farm risk management", *Agricultural Finance Review*, Vol. 68 No. 1, pp. 119-133.

Binswanger, H.P. and Rosenzweig, M.R. (1986), "Behavioural and material determinants of production relations in agriculture", *Journal of Development Studies*, Vol. 22, pp. 503–539.

Breustedt, G., Bokusheva, R. and Heidelbach, O. (2008), "The potential of index insurance schemes to reduce farmens` yield risk in arid region", *Journal of Agricultural Economics*, Vol. 59 No. 1, pp. 312-28.

Coble, K.H., Knight, T.O., Pope, R.D. and Williams, J.R. (1997), "An Expected-Indemnity Approach to the Measurement of Moral Hazard in Crop Insurance", *American Journal of Agricultural Economics*, Vol. 79 No. 1, pp. 216-26.

Diagne, A., Zeller, M. and Sharma, M. (2000), "Empirical measurements of households`access to credit and credit constrains in developing countries: methodological issues and evidence", FCND Discussion Paper 90. International Food Policy Research Institute, Washington.

Foltz, J.D. (2004), "Credit market access and profitability in Tunisian agriculture", *Agricultural Economics*, Vol. 30: 229–240.

Giné, X., Yang, D. (2009), "Insurance, credit, and technology adoption: Field experimental evidence from Malawi. Available at: http://siteresourcees.worldbank.org/DEC/Resources/Insurance_Credit_Malawi.pdf, accessed February 21, 2013.

Goodwin, B.K. (2001), "Problems with market insurance in agriculture", *American Journal of Agricultural Economics*, Vol. 83 No. 3, pp. 643-49.

Innovations for Poverty Action (IPA) (2009), "Improving Agricultural Microfinance: Barriers to the supply of agricultural lending in the Philippines", available at: http://www.hss.de/fileadmin/ suedostasien/philippines/downloads/090401-Improving-Agricultural-Microfinance.pdf, accessed February 21, 2013.

Norton, M., Osgood, D. and Turvey, C.G. (2013), "Quantifying spatial basis risk for weather index insurance", *The Journal of Risk Finance*, Vol. 14 No. 1, pp. 20-34.

Odening, M., Musshoff, O. and Xu, W. (2007), "Analysis of Rainfall Derivatives Using Daily Precipitation Models: Opportunities and Pitfalls", *Agricultural Finance Review*, Vol. 67 No. 1, pp. 135-56.

Petrick, M. (2004), "A microeconomic analysis of credit rationing in the polish farm sector", *European Review of Agricultural Economics*, Vol. 31 pp. 77–101.

Shee, A., Turvey, C.G. (2012), "Collateral-free lending with risk-contingent credit for agricultural development: indemnifying loans against pulse crop price risk in India", *Agricultural Economics*, Vol. 43, pp. 1-14

Simtowe, F., Diagne and, A. and Zeller, M. (2008), "Who is credit constrained? Evidence from rural Malawi", *Agricultural Finance Review*, Vol. 68, pp. 255–272.

Turvey, C.G. (2001), "Weather Derivatives for Specific Event Risks in Agriculture", *Review of Agricultural Economics*, Vol. 23 No. 2, pp. 333-51.

Vedenov, D.V. and Barnett, B.J. (2004), "Efficiency of Weather Derivatives as Primary Crop Insurance Instruments", *Journal of Agricultural Resource Economics*, Vol. 29 No. 3, pp. 387-403.