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Analysis

Price vs. weather shock hedging for cash crops: Ex ante evaluation for cotton producers in Cameroon ☆

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ABSTRACT

In the Sudano–Sahelian zone, which includes Northern Cameroon, the inter-annual variability of the rainy season is high and irrigation scarce. As a consequence, bad rainy seasons have a detrimental impact on crop yield. In this paper, we assess the risk mitigation capacity of weather index-based insurance for cotton farmers. We compare the ability of various indices, mainly based on daily rainfall, to increase the expected utility of a representative risk-averse farmer.

We first give a tractable definition of basis risk and use it to show that weather index-based insurance is associated with a large basis risk, whatever the index considered. It has thus limited potential for income smoothing, a conclusion which is robust to the utility function. Second, in accordance with the existing agronomical literature we find that the length of the cotton growing cycle, in days, is the best performing index considered. Third, we show that using observed cotton sowing dates to define the length of the growing cycle significantly decreases the basis risk, compared to using simulated sowing dates. Finally we find that the gain of the weather-index based insurance is lower than that of hedging against cotton price fluctuations provided by the national cotton company. This casts doubt on the strategy of supporting weather–index insurances in cash crop sectors selling at international market prices without recommending any price stabilisation scheme.

1. Introduction

Traditional agricultural insurance suffers from an information asymmetry between the farmer (agent) and the insurer (principal), and thus requires costly damage assessment. Moral hazard issues indeed stem from the incentive for the farmer to reduce effort put into production when he knows that a bad yield will be compensated. An emerging alternative is insurance based on a weather index used as a proxy for crop yield (Berg et al., 2009). In such a scheme the farmer pays an insurance premium every year and receives an indemnity if the weather index falls below a determined level (the strike). Weather index-based insurance (WII) does not suffer from the two shortcomings mentioned above: the weather index provides an objective, and relatively inexpensive, proxy of crop damages. However, its weakness is the basis risk that comes from the imperfect correlation between the weather index and the yields, or more precisely losses, of farmers contracting the insurance.

This paper therefore assesses WII contracts which aim at sheltering farmers against drought risk. Insurance indemnities are triggered by low values of the index supposed to explain yield variation. This kind of insurance makes it possible to pool risk across time and space in order to limit the impact of weather shocks on producer income.

A recent but prolific literature about WII in low income countries has analysed the impact of pilot programmes through ex post studies. The take up rates have been very low in those studies (in particular the two case studies in India: Giné et al., 2008 and Cole et al., 2013 and one in Malawi: Giné and Yang, 2009). These low take-up rates have been puzzling researchers (Karlan and Morduch, 2010). Several explanations have been proposed and tested in other recent ex-post studies: steep price elasticity; existing informal risk sharing networks (Cole et al., 2013; Karlan et al., 2012; Mobarak and Rosenzweig, 2013); lack of trust or financial literacy (Cai et al., 2012; Giné et al., 2012; Hill et al., 2011), compound risk aversion (Elabed et al., 2013) and ambiguity aversion (Bryan, 2013).

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However, the possibility of the benefit of WII being too low given the basis risk and the costs of running the scheme has still not been ruled out and the question of the interest of such products for development still remains unsolved (Barnett et al., 2008; Binswanger-Mkhize, 2012). Surprisingly there are few ex ante assessments of the benefits from, and basis risk of, WII in the long run. Ex ante estimations give a long run view and show anticipated gains in terms of consumption smoothing for farmers in ideal conditions. If these anticipated gains are low, they provide a simple explanation of the observed low take-up rate.

There are several studies looking at the ex ante benefit from WII in other locations and for other crops (Breustedt et al., 2008 in Kazakhstan; Vedenov and Barnett, 2004 in the US; Berg et al., 2009 in Burkina-Faso, De Bock et al., 2010, in Mali). These studies showed in particular that using a cross-validation technique is necessary to avoid over-fitting, and that at best, these insurances can bring a significant benefit only for a few crops and locations among those analysed. The study with the closest target is de Bock et al. (2010) who studied the potential of index insurance for cotton in Mali but the match of annual rainfall and yield data was reduced to 3 districts due to data availability and to only one district because of a lack of correlation between the weather index and yield in the two others.

In this paper, we look at the potential benefit cotton farmers could gain from index insurance and at the design basis risk associated with various weather indices, by comparing it to area–yield insurance, i.e. an index perfectly correlated to observed cotton yield in the relevant location. We made this assessment using state-of-the-art techniques: we tested two utility functions, using several levels of risk aversion in the range of the results given by a field experiment and we used a cross-validation technique, controlling for over-fitting. To our knowledge, there is no similar work assessing the magnitude of basis risk of WII in the long run and for several localities using empirical data.

We use aggregated data, which prevents from studying the effect of idiosyncratic shocks that are known to be significant (Leblois et al., 2013), but we also compare area–yield insurance to what can be considered as a benchmark risk management tool in the case of cash crops i.e. the hedging of intra-seasonal price fluctuations already offered by the national cotton company through a forward pricing mechanism. As in the other ex ante studies noted above, we do not consider the potential impact of insurance on farmers' behaviours (mainly risk taking and intensification) and on market access (mainly input and credit), limitations on which we will come back to later.

The next section describes the cotton sector in Cameroon while the third is dedicated to describing the data and the methods. In the fourth section we present the results before concluding.

2. Cotton Sector in Cameroon

2.1. Recent Trends

According to Folefack et al. (2011), cotton is the major cash crop of Cameroon and represents the major source of income, monetary income in particular, for farmers (more than 200,000 in 2010) of the two northern provinces: *Nord* and *Extrême Nord*. It is grown by smallholders with an average of about 0.7 ha per farmer dedicated to cotton production in the whole area.

At the peak of production, in 2005, 350,000 farmers cultivated 232,000 ha while, between 2005 and 2010, the number of farmers and the area cultivated with cotton dropped by 40%. Farmers abandoned cotton production after experiencing a dramatic reduction in their margin due mainly to an increase in fertiliser prices.

There are also significant weather-related risks. Cotton is indeed rainfed in almost all producing countries of sub Saharan African, and largely depends on rainfall availability. The impact of a potential modification of rainfall distribution during the season or the reduction of its length has recently been found to be of particular importance (cf. Section 3.2) and could even be higher with an increased variability of rainfall (ICAC, 2007, 2009) that may occur under global warming (Roudier et al., 2011). Moreover, farmers unable to reimburse their input credit at harvest[1] are not allowed to take an input credit (for cotton but also for food crops) from the national cotton company during the next year. A situation of unpaid debt would thus be detrimental to cotton farmers in the long run (Folefack et al., 2011).

Lastly, the sector also faces other challenges: an isolation of the North of the country and a decline in soil fertility due to increasing land pressure.

2.2. Purchasing Price fixation, Current Hedging and Input Credit Scheme

In Cameroon, the cotton society (Sodecoton), like its Malian, Senegalese and Chadian counterparts, is still a national monopsony (Delpeuch and Leblois, 2013). It is thus the only agent to buy seed cotton from producers at a pan-seasonally and -territorially fixed price. It then gins the cotton and sells the fibre on international markets.

As already mentioned by Makdissi and Wodon (2004), price stabilisation has an impact on production decisions since it insures producers against intra-seasonal variations of the international cotton price by guaranteeing the announced price.

The cotton sector's institutional setting is also characterized by input provision. Costly inputs are indeed provided on credit by the national companies before sowing, ensuring a minimum input quality. Such inputs are made available in remote areas in spite of a substantial cash constraint that characterizes the sowing period corresponding to the end of the lean season: the so-called 'hunger gap'. Inputs are distributed at sowing (from May 20 onwards, depending on the latitude) and reimbursed at harvest. The amount of credit is deducted, at harvest, from the purchase of seed cotton.

3. Data and Methods

3.1. Area and Data

The cotton administration counts 9 regions divided into 38 administrative Sectors. Cotton farmers are grouped into producer groups (PGs), roughly corresponding to the village level. There were about 2000 active PGs in 2011, which represented an average of about 55 PGs per Sector (the spatial administrative unit used throughout this article).

Yield and profit per hectare are provided by the Sodecoton at the Sector level from 1977 to 2010. It is an aggregation of data from the producer groups' level used for the internal accounts of the national company. As the company is the only buyer and the only input provider in the country, it is an exhaustive database of the cotton producers in Cameroon. Area and production (used to calculate yield) and inputs excluding labour costs (used to calculate profits) are also very reliable because the company follows each growing campaign closely. Agronomic data are matched to a unique meteorological dataset built for this study. It includes daily rainfall and temperatures (minimum, maximum and average) coming from different sources,[2] with at least one rainfall station per Sector (Fig. 1, a sector represents about 900 km^2).

We use ten IRD and Global Historical Climatology Network (GHCN) weather stations of the region: six in Cameroon and four in Chad and Nigeria.[3] Because of the low density of the network of weather stations,

[1] The standing crop is used as collateral and credit reimbursement is deducted from farmers' revenue when the national company purchases the cotton, cf. Section 2 for further descriptions.

[2] *Institut de la Recherche pour le Développement* (IRD) and Sodecoton's high density network of rain gauges.

[3] National Oceanic and Atmospheric Administration (NOAA), available at: www7.ncdc.noaa.gov.