FONDATION POUR LES ÉTUDES ET RECHERCHES SUR LE DÉVELOPPEMENT INTERNATIONAL

What policy in poor agricultural countries affected by climate change?*

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Climate change has recently been explicitly recognized as an important component of countries' vulnerability. Three features characterise the countries eligible for the allocation of adaptation resources: they are more exposed to the negative effects of climate degradation because of their dependence on agriculture; because of market imperfections they are not insured against climate, which increase the probability of falling into poverty traps; finally they deserve more international development assistance as they are not responsible for most of the climate change that occurs. In this short policy brief we do not address the last point, which is about the principles behind the allocation of ODA and adaptation resources (see Guillaumont, 2013, for a recent proposal of aid allocation), but we examine two adjustment mechanisms to cope with weather shocks: internal migration and microfinance to insure farmers against negative climate events .

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Agricultural and Poor countries more affected…

Climate is an important risk factor for the majority of the developing countries for two reasons:

- First, because they rely on rain-fed agricultural production and thus remain highly vulnerable to weather conditions, but also because the share of food in the households' budget may amount to up to two thirds (Cranfield et al., 2003).
- Second, agriculture is known to be a risky activity, and poor countries turn out to be under-insured, if not uninsured at all.

Since there is a clear link between income growth and risk-reducing environment (Blankespoor et al., 2010), in the absence of insurance market, poor countries report high losses and income stagnation magnifies their vulnerability. Lack of insurance market implies that farmers hit by a natural disaster or weather anomaly cannot resort to credit to smooth their consumption and are pushed to sell their assets. Credit conditions in these regions are often characterized by high interest rates (because of the risk premium) and/or high collateral requirements. Insurance could loosen these credit constraints by assuring lenders that debts will be repaid if a disaster happens.

According to Carter and Barret (2006), the asset impoverishment is the main cause of poverty traps, as weather shocks alter fundamentally asset holdings. Uninsured farmers have to sell their assets in order to repay their debts and smooth their consumption, which pushes them into poverty traps. In other words, progressive climate shocks and intensification of recurrent shocks are likely to transform a situation of transitory poverty into a situation of structural poverty (poverty traps), from which it is difficult, if not impossible, to escape.

Moreover, when risk adverse farmers perceive their activity as risky, they might underinvest in expensive environment-friendly technologies, because of the fear of losing their assets, which can be one important factor behind the weak environmental performance of the poor countries.

First adjustment strategy: internal migration

When credit and insurance markets are absent and other adaptation measures are not fully efficient because of high spatial correlation of weather risk, the only way to escape from weather-induced poverty at the individual level is migration, even though it is often perceived as a forced and last resort strategy. Environmental induced migration can be both international, passing through urbanization (Guillaumont, Maurel and Simonet, 2013, Maurel and Tuccio, 2013), but also internal. The case investigated in Kubik and Maurel (2014) is an illustration of the latter type of migration. It is based upon a rich dataset of Tanzanian households , Tanzania National Panel Survey.

Tanzania offers a nice illustration of the link between climate and migration, as the country presents a wide range of natural environments-agroecological zones in Tanzania range from arid or semiarid zones, subhumid highlands, plateaux, alluvial plains and coastal zones (DePauw, 1984) - implying a quite important intra-regional environmental mobility. Even though Tanzania cannot be considered to be a drought-prone area to the same extent as Ethiopia or Sudan, the country registered two important drought events in the last decade, leading to severe agricultural losses, whereas other parts of the country are subject to flooding. According to the FERDI indicator of vulnerability to climate change (see Guillaumont and Simonet, 2013 for the presentation of the indicator) that is based upon physical criteria - flooding due to sea level rise, aridity, rainfall instability, and temperature instability - Tanzania is a vulnerable country.

Kubik and Maurel (2014) offers two impor-

tant findings. First it provides micro-evidence of the indirect effect of climate on migration in developing countries, which works through the impact of weather shocks on agricultural yields[1]. Second, the room for adjustment through migration seems to be limited: an increase in temperature anomalies by one standard deviation decreases the agricultural income by 10 %, which in turn impacts the probability of sending one or more migrants by 7.6%. Internal migration is linked to international migration as the former induces a downward pressure on urban wages which act as a push variable in the decision to migrate abroad.

Combes, Ebeke and Maurel (2011) have shown that remittances contribute to reduce the number of working poor. Moreover, Combes and Ebeke (2012) show that remittances significantly reduce household consumption instability in case of natural disasters: a ratio of remittances over GDP equal to 3% has a fully-stabilizing impact. More importantly, in case of agricultural shocks, remittances are shown to be a hedge against those shocks and fully stabilize them when the ratio is equal to 10%.

Given the stabilizing role of remittances on household consumption, the international community needs to take efforts to reduce the current high transaction costs of remitting money to labor-exporting countries. High transaction costs act as regressive tax on international migrants, who often tend to be poor and to remit small amounts of money with each transaction. Lowering the transaction cost of remittances would help to increase the economic welfare-increasing impact of international remittances.

Given the restrictiveness of migration policies in developed countries, migration cannot be considered as the primary solution for coping with climate-related risk. Other strategies must be implemented, like agricultural insurance, which is a strategy to adapt to climate change in the medium run by limiting its negative effects on consumption. Encouraging the use of better technologies should be also promoted for addressing the longer-term objectives, but this is beyond the scope of this analysis. We expose below a project of feasibility of such an insurance system, which is being currently developed in China, and which can be seen as sort of laboratory for the developing world.

Microfinance as a way to avoid poverty traps: the Chinese case

A recent paper in The Economist (4th January, 2014) points to the inequality between rich and poor countries with respect to climate change: only rich countries seems to be in a position of buying crop insurance, which has failed to take off in much of the developing world. In 2012, according to the International Labour Organisation, only 2.5% of Africans used microinsurance. Are the contracts too expensive and not attractive enough? In countries like America and Canada, that can afford it, insurance contracts are subsidised by over 50%. In China, farmers pay only 20% of the actual premium, the rest being paid by the Chinese government. But despite this important subsidy, many farmers decide to not participate to this program so that about 60% of cultivated land remains uninsured.

A team of researchers in France (Cerdi in Auvergne, CNRS-Paris 1 in Paris), China (Institute of Agricultural Economics and Development of the Chinese Academy of Agricultural Sciences) and the US (University of California – Davis), associated with Groupama, is currently investigating the feasibility of a index insurance, which is expected to be more efficient. It is based upon remote sensing technologies and aims at obtaining a better prediction of crop yield, making the insurance cheaper.

China is a good example of what could be done in African countries. The country of-

1. Maurel and Tuccio (2013) provide a macro-evidence of the link between climate, agricultural income, and international migration.

fers a wide range of economic situations, from extreme poverty to emerging regions where the economic take off is taking place. Climate change is a key concern for the country: according to Wheeler (2011), who offers a methodology designed to quantify Vulnerability to Climate Change, China comes respectively third and first in 2008 and 2015, in terms of extreme weather risks. The country has faced in recent decades an unprecedented rainfall and flooding, which has pushed a huge number of rural individuals into poverty. 855 million Chinese people have received assistance from the government over the last decade according to the Ministry of Civil Affairs[2].

China can be considered therefore as a sort of laboratory, where any experiment to address climate-induced consequences can produce policy recommendations for other developing countries. The design of an insurance system, which would offer a better protection to farmers is such a research experiment.

Farming is known to be a risky activity by nature, and the two main sources of risk are yield uncertainty and price volatility: farmer cannot perfectly predict their yield at the time they plant because of variations in weather and prices can vary greatly between planting time and harvest time, or from one harvest season to another, making price expectations difficult. These risks are known to have several negative impacts:

- Ex-post effect: if a disaster happens, uninsured farmers often have to sell their assets in order to repay their debts and smooth their consumption pushing them into poverty traps. Insurance helps farmers cope with such disasters and prevents them from falling into poverty traps.
- Ex-ante effect: when risk adverse farmers perceive their activity as risky, they might underinvest in new business opportunities because of their fear of losing their assets . Insurance can unlock investment opportunities by reducing risk and softening collateral requirements for loans.
- Rural Exodus: Farming is often perceived as a risky activity compared to employed work in the cities. Making agricultural activities less risky, we might be able to reduce migration towards cities, which is a pressing issue in China where rural worker leave their birthplace for bigger cities (outside of the hukou system) and give up their social rights (social security, etc.) and family life.

The traditional insurance systems that exist in China as in many other countries do not work because they do not fit the reality of climate disasters:

- First, the losses caused by those disasters are highly correlated inside regions, and therefore most farmers suffer the same loss at the same moment.
- Second, the administrative costs make traditional contracts too expensive. Once a farmer experiences a significant loss due to one of the disasters listed in the insurance contract, he must contact the insurer, who sends an expert to the field, and must check any claim that farmers make. As a result contracts are not attractive enough to farmers. In China, only 40% of lands are insured.
- Third, coverage levels are often low compared to the actual loses farmers experience. The Multiple Peril Crop Insurance scheme offered in China only covers production costs, with maximum payment reaching about 70% of non-labor production costs

The project mentioned above aims at thinking out better insurance products that solve these three weaknesses of conventional insurance by:
(1) Combining index insurance and conventional insurance to minimize basis risk,
(2) Combining yield and price insurance to cover revenue risk
(3) Using remote sensing technologies to pre-

2. Source: ChinaDaily.com.cn - October 13th, 2012

dict yield at a low level of aggregation

Index insurance is not new: instead of measuring individual farmers' losses, such insurance product measures large shocks that affect every farmer in a region and indemnifies them without the need for individual field visits. Indemnity payment is not decided by an expert assessment but by an index (for example, the average yield in the village). If this index passes a given trigger (for example if the village-level average yield threshold falls below 70% of its normal value), every insured farmer in the county receives an indemnity computed according to the loss measured at the village level. This approach significantly reduces management costs for the insurance company, making insurance affordable to a larger number of farmers.

Such index insurance, because it does not determine indemnity payments based on individual farmer's losses suffer from basis risk, the probability that a farmer experiences a significant loss but the index does not capture it either because other farmers in the village did not suffer from the shock or because the index is simply unable to measure such kind of disaster (a rainfall-based index cannot capture the effect of strong winds).

Combining index insurance and conventional insurance allows to overcome this issue at a minimal cost: farmers will be offered to subscribe an Individual field visits option so that if the farmer considers that he should receive a payment which the index did not trigger or if he considers that payments are low compared to his actual loss, he would have the right to claim an expert field visit to measure his crop loss. An adjustment to his indemnity payment would then be made if he actually experienced a loss greater than predicted by satellite imagery. In order to limit adverse selection effects, the price of this option will depend on the coverage level chosen for the index component of the contract. Indeed, this coverage level reveals farmers' sensitivity to shocks and allows us to adjust premiums to farmer's risk, reducing adverse selection effects.

Recent years, concerns about cereal prices stability have been growing. The question is of particular importance for crop growers who have to make production choices several months before they know the price at which their harvest will be sold. Combining yield insurance and price insurance would allow farmers to stabilize their revenues. With this option, if the futures price of November maize quoted at the Dalian Commodity Exchange market decreases between February (planting time) and November (harvest time), insured farmers will receive an indemnity covering the gap between expected and actual revenues.

Last but not least, this project proposes to make use of the most recent developments in remote sensing technologies for the construction of the index. While many index insurance projects rely on weather indices (rainfall, temperature, wind speed, etc.), the index developed here focuses on plant's health (measured by NDVI, Evapotranspiration, Green Leaf Area Index, etc.), which is known to be a better predictor of the quantities actually harvested. Also, while weather index insurance often relies on weather stations, this project makes use of a remote sensing technology that allows us to make yield predictions at a high level of precision (a pixel is generally smaller than 1km2). It has been shown (Gommes and Göbel, 2013) that for weather stations to accurately reflect farmers weather conditions, they should not be located to more than few kilometers from the insured fields. In the case of Ethiopia, the authors show that if we want the rainfall measurement error to not exceed 10%, then the farm to be insured should be at a distance inferior to 4km from the weather station.

Another advantage of an insurance that apply the same way to many farmers facing the same shock is that they can be easily offered to a group. Individual insurances, even weather in-

dex based, are difficult to sell - only about 5% of farmers have taken it up in areas of India where it is available. However, a new paper by de Janvry, Dequiedt and Sadoulet (2014) states that whereas individuals often undervalue weather insurance, offering it to groups of farmers may encourage a greater take-up. This theoretical finding is confirmed at the empirical level by Dercon et al. (2014): when groups of Ethiopian farmers belonging to iddirs (informal financial and social clubs) were given information about the benefits of weather insurance, the take-up increased from just 2% to 36%.

Conclusion

Above all, agricultural revenue insurance is a tool to help farmers cope with shocks that affect their revenues so that its true value really appears when negative shocks occur. It does not directly impact farmers' adaptation to climate change, nor does it help farmers to apply more efficient resource management methods. However, insurance is a keystone for the adoption of technologies able to fulfill these two objectives. Insurance, by making farming less risky, unlocks the demand for investment in new technologies. We see three forms of investment that our insurance product could help spread in China:

Investment in climate change resilient technologies: These technologies exhibit less sensitivity to climate change (i.e., drought resistance seeds), so that farming revenues are less dependent on climate variability.

Investment in high yield technology: The growing demand for biofuels, which is often designated as the main explanation of recent increases in food prices (see Headey D. and Fan S., 2008), which arms the most vulnerable populations, requires higher yield. Investment in more productive varieties is important to avoid rising food prices. Furthermore, recent trends in Chinese yields tend to decrease relative to US maize yield as a consequence or rural/urban migration (see Rozelle S., Taylor E., and de Brauw A., 1999). Indeed , since migrant farmers don't invest in their plots.

Investment in resource efficient technologies: in an environment characterized by increasing resource scarcity (soil quality, water, etc.), it is important to support farmers into the transition towards more sustainable farming activities. Resource efficient technologies help farmer reduce input waste so that they decrease costs and promote more sustainable farming activities. Our project builds on the latest development in satellite based precision agriculture to help farmers in this respect.

This increase in the demand for new technologies will be accompanied by an increase in the demand for formal credit because these kinds of investment cannot be funded by families' resources. This would put too much risk on families' assets. Instead, these investments must be funded by credit. But this increase in formal credit demand cannot be met without increase in formal credit supply, which is restricted in China. Indeed, the use of land titles (farmers' main asset) as collateral to a loan is forbidden in China, so that formal credit is limited. Insurance can be used as a collateral to a loan (indemnities serve first to repay the loan, and indemnities beyond the value of the loan go to the farmer). In that case, insurance not only increases demand for credit, it also increases supply (see Carter M.R., Galarza F., and Boucher S, 2007), making the transition towards better production practices more likely.

Another consequence of risk in agriculture in rural exodus: Farmers leave the countryside for the cities, leaving their land under-exploited and accentuating the demographic pressure in urban areas. It is important to think of mechanisms that make agriculture an attractive activity compared to the life in the cities. Agricultural revenue insurance is one tool that could improve agriculture's attractiveness.

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