Adoption and Impact of Index-Insurance and Credit for Smallholder Farmers in Developing Countries: A systematic review

Authors: Marr, Ana; Winkel, Anne; van Asseldonk, Marcel; Lensink, Robert; and Bulte, Erwin

1. Rationale

Farmers in most developing countries are mainly smallholders, with average farm size of 1-2 hectares. They tend to be constrained in investing in productivity-enhancing technologies because of limited household resources combined with lack of access to external finance on which they depend (Tadesse 2014). Smallholders often do not have access to credit provided by banks or special rural credit institutions. One of the constraints on such lending is the limited amount of collateral to securitize the repayment of the loan. This means that banks will have little recourse against defaulting borrowers. As a result, high-return economic cropping activities that typically require significant up-front investments (e.g. enhanced seeds and fertilizers) may be hampered by these credit constraints (Boucher et al., 2008).

Provision of insurance can encourage higher supply of credit, both the implied demand for credit and supply thereof, and thus enhance agricultural inputs use. However, there is a lack of growth due to underdeveloped and imperfect markets for inputs, insurance and credit (Carter and Barrett, 2006; Cole et al., 2012) causing among others credit rationing. In the environment of underdeveloped and imperfect markets, a combined approach is needed (Alderman and Haque, 2007), as separate access to each of these is seriously restricted.

More insight into the impact of linking insurance and credit is needed since there is limited information in the literature regarding the potential effect of bundling insurance and credit, for example on the extent to which insurance would reduce the cost of borrowing and make credit more accessible to the smallholder farmers (Tadesse et al., 2015). In this paper we review the most recent scientific literature on one specific form of insurance: index-insurance. As is well known; important advantages of index insurance are low administrative costs and the elimination of moral hazard. An important disadvantage is basis risk (see below). In this review paper we discuss the determinants of demand for index-insurance, the impact of index-insurance on smallholder livelihoods, and the existing links between index-insurance and credit. In this meta-analysis, we identify key discoveries on the potential of index-insurance in enhancing credit supply for smallholders and thus farm productivity. We focus on index-based insurance products since it offers a tentative potential for coping with losses in lower income countries (Skees, 2008).

2. Dataset

Combining credit and insurance, or bundling index insurance with credit, is a practice that is widely discussed in literature but up to now rarely examined empirically. Published studies were retrieved following a systematic literature search in Scopus and Web of Science. Relevant empirical articles were identified by using the following criteria search algorithm: "insurance" and ("weather" or "micro" or "area-based" or "rain*" or "livestock" or "index"), and (("empiric*" or "experiment' or "trial" or "RCT" or "impact") or ("credit" or "loan*" or "debt" or "finance")). We identified 1133 related papers, 110 of which were selected as closely matching the study criteria. This first level of screening was based on abstract review of all

the citations retrieved and all citations were discarded if they were clearly not related to empirical studies. After removing duplicates and second level of screening involving full-text article review, 45 papers were included in the current analysis. The framework for addressing insurance and credit issues, in the following sections, entails three subsequent themes, namely adoption of insurance, impact of insurance, and links between insurance and credit.

There are several points to highlight from the assessment of papers in the systematic review. Empirical methods used most frequently in cross-sectional adoption studies are based on willingness-to-pay techniques or (framed) field experiments. Panel data designs based on annual household surveys of adopters and non-adopters to study adoption and/or impact are less frequently applied. Randomised control trials of commercial insurance products are, with some exceptions, rarely used. However, it should be noted that more recent studies on insurance are able to move beyond stated preferences by conducting field experiments. The research on bundled financial products is more novel and rests mainly on theoretical models, although some (framed) field experiments have also been conducted.

3. Adoption of insurance

In general, analysed studies revealed that demand for index-insurance has been low. Stated willingness-to-pay is nonetheless substantial in some studies; up to approximately 90% of participants want to pay for insurance products, see e.g. Carter et al (2014) and Heenkenda (2011). Actual demand is much lower, varying from 2% to 40% or 50% maximum, and with many studies indicating an uptake of less than one fourth.

In this section, three key factors, comprising twelve indicators, that help explain demand for insurance are addressed, namely (1) risks; (2) behaviour; and (3) credit and liquidity constraints. The set of indicators related to risks are key to the neoclassical determinants of demand (i.e. risk aversion, risk, risk mitigation, basis risk and price). It appears, however, that they are insufficient in explaining the low demand for index-insurance. Hence, other behavioural indicators (i.e. understanding, trust and education) as well as indicators capturing credit and liquidity constraints (i.e. wealth, liquidity, credit and income) are assessed too. Jointly, these three factors cover the main aspects of research conducted on index-insurance so far. Each of the aforementioned factors and indicators are elaborated on and research findings are summarized in Table 1, 2 and 3 in the Appendix.

It should also be noted that the determinants of demand for index-insurance are partially different from the determinants of demand for indemnity insurance. Index-insurance suffers from basis risk (i.e., index measurements does not match an individual insured's actual losses), whereas Indemnity insurance does not (but to a lesser extent un-indemnified losses might occur). This makes index-insurance a more uncertain and complex problem, which results in other drivers of demand. Yet both covers are subject to other risks (e.g., delays in disbursement and underwriter default).

3.1 Risks

Risk aversion
Theory predicts that insurance participation increases with risk aversion, as more risk averse decision makers are willing-to-pay more for the possibility to hedge risk. However, most empirical research consistently finds the opposite effect. In his 'Theory of rational demand for index insurance', Clarke (2011) states that uncertainty about the insurance product itself might decrease demand. Purchasing the product becomes a gamble or lottery in itself, which could or could not pay off. (As a result of the view, some studies have included ambiguity aversion as an additional factor explaining demand (Bryan, 2010; Elabed & Carter 2015)). Clarke concludes that for insurance premiums above actuarially fair values, demand will be

humped-shaped in risk aversion. This is indeed in line with the sign of the estimation results of Hill, Robles and Ceballos (2013), but these results were not statistically significant.

Production risk
In the presence of high production risk, demand for insurance is expected to be higher. On the other hand, smallholders might purposefully choose low levels of production risk. Investing in low-risk low-return rather than high-risk high-return activities produces a more stable stream of (low) income (Morduch, 1995). Thus, it is unclear whether a more risk prone environment leads to higher insurance demand, as lower levels of production risk could also result from imperfect insurance. In perfect markets, however, smallholders can insure risky activities, which could greatly improve their productivity.

Empirical research that includes measures of risk indicate an ambiguous relation between amount of production risk and insurance uptake. Jensen, Mude & Barrett (2014a) find a negative albeit insignificant effect of the variance in livestock mortality on uptake. A similar effect is found by Vandeveer (2001) who measured the effect of the number of indicated risks on insurance uptake. Bogale (2015) finds a positive but insignificant effect of the perceived risk on uptake. No firm conclusions can be drawn yet.

Risk mitigation
It is expected that with a larger variety of risk mitigation strategies, the demand for insurance will be lower. Giné et al (2010) even state that index-insurance can only improve welfare if other risk-sharing mechanisms are insufficient. These strategies include, but are not limited to off-farm employment, planting a mix of crops, receiving remittances and credit. Dercon et al (2014), however, emphasize the benefits of index-insurance to groups that are only able to cover idiosyncratic risk in an informal manner. For these groups, index-insurance could be complementary to existing risk mitigation strategies to cover covariate risk too.

Basis risk
Demand for index-insurance is theoretically predicted and empirically confirmed to decrease at relatively high levels of basis risk. An increase in basis risk indicates a decrease in the correlation between individual losses and the indexed parameter, which makes the associated insurance indemnity relate imperfectly to one's loss. An increase in basis risk thus devalues the product and limits demand. Various studies using proxies for basis risk veritably find a negative and significant effect of basis risk on demand.

This effect of basis risk interacts with other factors, such as price and (informal) idiosyncratic risk sharing. Hill, Robles & Ceballos (2013) find that as the farm is located closer to the weather station, the elasticity of demand is high. For more distant locations demand becomes low. Jensen, Barrett & Mude (2014b), however, show that for low levels of observed design error demand is not responsive to changes in price, whereas demand does respond to price changes if the observed design error is of a high level. It is nonetheless subject to debate whether distance to the weather station and observed design errors are similar proxies for basis risk.

Furthermore, Mobarak and Rosenzweig (2012) find that as basis risk increases, people of castes sharing idiosyncratic risks are more likely to purchase insurance than people from casts not sharing idiosyncratic risk. Similarly, Dercon et al (2012) conclude that index insurance and informal risk sharing are complements, as index-insurance mitigates covariate risk and informal risk sharing mechanisms concern idiosyncratic risk.

Price
In general, it is predicted that if price rises, demand falls (Clarke 2011). Empirical research confirms this prediction, although the effect of price on demand is not consistent across all research (see e.g. Elabed & Carter 2014). Important determinants are coverage and loading.

The latter means that if the loading factor increases, due to for example administration cost, demand will fall. Strikingly similar steep elasticities were found by Karlan et al., 2015 and Mobarak and Rosenzweig (2012), with 11% and 15% purchase at market prices, 42% and 38% purchase at a 50% discount (roughly actuarially fair prices), and 67% and 60% purchase at a 75% discount. As indicated before, the interaction with basis risk could shed more light on the relation between price and demand.

3.2 Behaviour

Understanding and previous insurance experiences
One of the main reasons for low take up is said to be limited understanding of the workings of insurance and limited financial literacy. In order to increase demand, various studies have attempted to educate potential buyers. Educational or experimental games increase take up (see e.g. Hill, Robles & Ceballos, 2013; Gaurav, Cole & Tobacman, 2008). Although this seems arguable at a theoretical level, empirical research is still ambiguous. It appears that educational games slightly increase take up, but improving understanding of the product could also lower uptake among those that were overly optimistic in the product.

In general, previous pay-outs have a much stronger effect on demand for insurance. Indeed, Berhane et al (2013) observe that "nothing sells insurance like insurance pay-outs". This is confirmed by Cole, Stein and Tobacman (2014) who found that both previous pay-outs experienced by oneself and previous pay-outs to village members increase demand. Over-inference from current pay-outs could nonetheless misrepresent the indemnity one could reasonably expect.

Trust
Strongly related to understanding are trust and education. Trust in the financial institution providing the insurance is considered important by for example Karlan et al (2014). Triggered insurance pay-outs should be processed as soon as possible without delays in disbursement to afford clients access to emergency cash. It is important to ensure that the participating financial institutions are sound and resilient, capable of delivering promised payments in the event of a disaster. Mistrust in the insurance company hence lowers demand. Empirical evidence about the magnitude of the effect of trust is still lacking.

Education
The level of education and training is often used as a proxy for financial literacy and understanding of the insurance product. The effect of education on insurance take up, however, is sometimes positive, sometimes negative, and often insignificant. For example Cole et al (2013) conclude that their education module aimed at increasing take up had no effect, but that trust and liquidity constraints are more important. In general, extension programs for promoting innovative rural insurance (and credit) in developing countries should be tailor-made to the local production and associated risks (Shee et al, 2015) in order to have impact.

Various explanations for the limited effect of education on uptake have been suggested. On the one hand, Chantarat, Mude and Barrett (2009) suggest that the effect of education might be understood better with an interaction term. They show that the effect of education on uptake is larger for households that perceive the risk of losses to be high. Clarke and Kalani (2011), on the other hand, propose that it is not education or years of schooling that matters most, but rather a basic level of literacy.

3.3 Credit and liquidity constraints

Wealth

In neoclassical theory, demand for insurance is independent from one's wealth. Insurance merely transfers wealth from high states to low states. In the presence of basis risk, however, index-insurance could worsen the lowest possible state and improve the best possible state (Clarke 2011). As a result, Clarke predicts that the effect of wealth on insurance demand is ambiguous. If insurance is a normal good, demand increases with wealth, but if insurance is an inferior good, demand decreases with wealth. De Nicola and Hill (2013), however, predict that demand for index-insurance will be hump-shaped in wealth. Wealthier households purchase more index-insurance than poor households, up to the point that they can self-insure their assets.

The prediction of De Nicola and Hill is in line with the findings of Clarke and Kalani (2011) who indeed find that the demand for wealth is inverse U-shaped in the amount of wealth. They proxy wealth with livestock and land assets, but only find the predicted effect for livestock, as all land in Ethiopia is state-owned and does not allow one to invest in it. All other empirical research does not report non-linear relationships. Consequently, the empirical results are rather mixed. Chantarat, Mude and Barrett (2009), for example, find a negative effect of wealth on insurance coverage levels. They explain this by considering wealth as a buffer stock and a form of risk mitigation, so that high levels of wealth enable self-insurance and diminish the need for alternative forms of insurance.

Liquidity
Giné et al (2010) indicate that 80% of the people who did not purchase insurance mentioned insufficient funds as the most important reason for remaining uninsured. Credit markets are thus failing alongside insurance markets. Indeed, most research demonstrates a positive relation between liquidity and insurance take up. If a high cash reward prior to purchasing insurance is given, insurance take up increases (Cole et al, 2013). Karlan et al (2014), find however that capital constraints are not binding in insurance take up. If smallholders are offered insurance, they are able to find ways to finance it.

Credit
Empirical research so far is mixed. For example, Chantarat, Mude and Barrett (2009) find that credit-constrained households choose a larger coverage than non-constrained households. If households do not have other coping mechanisms, such as credit, insurance is needed. This particular risk mitigation strategy, however, is perceived differently by Giné, Townsend and Vickery (2008), as they find that credit constraints limit insurance take-up.

Income
In theory, income should not affect demand for index-insurance. However, as income serves as an indication of wealth and functions as a buffer stock or risk mitigation strategy, a connection between income and insurance demand can be expected. In fact, some studies find a positive and significant effect of income on insurance demand. Chantarat, Mude and Barrett (2009) indeed explain that income is driving insurance demand through the wealth effect.

4. Impact of insurance

In order to measure the impact of index-insurance, various methods have been employed. Some impact assessments are solely based on theoretical models. These findings are partially confirmed by (framed) field experiments. The amount of empirical evidence, however, is still very limited. Table 4 in the Appendix summarizes the outcome of studies measuring the impact of index-insurance. In these studies, the common treatment was (access to) index-insurance. In this section, the impact of insurance on production decisions, investment and welfare are further elaborated upon.

In general, the effect of insurance on production decisions, investment and welfare seems to be positive. Starting with the theoretical models, it has been predicted that index-insurance increases investment (De Nicola and Hill, 2013). Elabed et al (2013) foresee that index insurance will lead to an increase in the number of smallholders as well as the area planted and will encourage investment in profitable, but risky crops, as credit rationing will diminish. The effect of insurance on general welfare seems to be positive too. De Nicola (2015) and De Nicola and Hill (2013) indicate a positive effect of insurance on consumption, although income may fall at first as a result. Their findings suggest that the welfare gains are larger for poor households.

The effect of index-insurance has to some extent been confirmed empirically. Cheng (2014), for example, finds that credit diverters choose to invest more credit in production when index insurance becomes available. Credit diversion occurs when borrowers divert production loans away from productive investment towards consumption, which is a type of moral hazard behavior (Cheng, 2014). Cole, Giné and Vickery (2013) study the changes prior to the growing season and find that insured farmers invest more in risky crops and in economies of scale, but do not use more inputs. Similarly, Karlan et al (2014) demonstrate that insurance leads to shifting towards a more risky portfolio of crops, although the higher harvest value does not necessarily outweigh the extra expenditures. Jensen, Barrett & Mude (2014a) also find that households with insurance increase investments in livestock health services and experience an increase in milk production and total income.

In these studies, various explanations for the positive impact of insurance are put forward. Jensen, Barrett and Mude (2104a) suggest that insurance leads to a reduction in precautionary savings, which subsequently leads to an increase in investment. McIntosh, Sarris and Papadopoulos (2013) propose that index-insurance does not necessarily increase investments, but leads to a protection of those who already have higher levels of investment. They thus suggest that the role of index-insurance is palliative rather than transformative. Janzen and Carter (2013) explore an alternative mechanism. They state that insurance can be beneficial in different ways for households above and below a certain asset threshold. With insurance, households below the asset line are prevented from cutting down consumption, whereas households above the asset line do not sell their assets during a shock if they are insured.

Nonetheless, not all findings on impact have been positive. Farrin and Murray (2014) report a negative effect of insurance on wealth as in good years farmers pay a premium but do not receive an indemnity payment, while Mishra (1994) finds that the availability of insurance eventually leads to larger inequality. Karlan et al (2014), lastly, provide some evidence that the insurance grant improves household welfare for some individual measures, but not for an aggregate measure of household welfare.

Compared to other insurance products, it has been suggested that an interlinked or bundled contract dominates either credit or insurance (De Nicola and Hill 2013). Carter, Cheng & Sarris (2013) claim that an interlinked contract will always outperform self-insurance, while insurance only outperforms self-insurance if the household has a high level of collateral. According to De Nicola (2015) insurance increases welfare more than either savings or credit.

One of the main drawbacks of index-insurance, however, arises from relatively high levels of basis risk and loading costs. However, loadings are seldom reported and cases reported focus on small-scale donor funded experiments, making a comparison with more matured indemnity based insurance products difficult. In most models, the welfare gains are large provided that basis risk and loading costs are sufficiently low (De Nicola, 2015; Elabed et al 2013; Carter, Cheng & Sarris, 2013). If this does not hold, a simply savings account can

easily outperform the benefits of index-insurance (De Nicola & Hill, 2013). This is confirmed by Jensen, Barrett & Mude (2014a). They find that index-based livestock insurance reduces covariate risk and leads to improved semi-variance in livestock survival rates, as long as the premium is actuarially fair and not commercially loaded.

5. Bundling insurance with credit

Turning to the link between index-insurance and credit, several research lines in the literature can be explored. Some studies focus on the combined impact of credit and insurance while other studies seek to understand the effect of insurance on credit or vice versa. This latter type of research ties in with the question of whether these products are complements or substitutes. Again other studies focus on comparing different types of financial products. In this section, several of these topics are further elaborated upon. Please refer to Table 5 in the Appendix for a full overview of these studies.

The model provided by Carter, Cheng and Sarris (2011) provides a useful starting point. They compare three types of insurance: a formal insurance contract, implicit insurance through a loan, and self-insurance. Comparing self-insurance with implicit insurance through a loan, they find that some farmers with high collateral choose not to borrow as they do not want to put their collateral at risk. These farmers are so-called risk-rationed if no insurance is available. This risk constraint could alter in the presence of formal insurance. If insurance is available, the asset-rich farmers do borrow. Index insurance decreases the risk they face, which leads to lower default rates as well as a lower probability of losing one's collateral. Thus, farmers with high collateral gain from the stand-alone insurance as they bear all the risk of losing the collateral themselves. On the other hand, farmers with little collateral choose to borrow if the interest rate is not too high, as high interest rates serve as a substitute for collateral. These farmers are price rationed if they cannot afford the high interest rate. As these farmers have little collateral, they do not bear the risk of losing it either. Purchasing an insurance contract is thus beneficial to their lenders, but provides little additional benefits to the borrowers. Providing the farmers with a stand-alone insurance contract does not alter the terms of borrowing. Concerning the combined impact of credit and insurance, Carter, Cheng and Sarris (2011) predict that more credit and better technology will be available with an interlinked contract compared to a default state of self-insurance. Interlinked contracts also perform better than standalone insurance contracts, as interlinked contracts lead to better technology use for both low and high levels of collateral, whereas standalone insurance contracts only lead to better technology use for high levels of collateral compared to self-insurance. Farrin and Miranda (2014), however, predict that technology use will be highest among households with only insurance compared to households with a bundle. This finding is probably related to the ease of default, as default with little punishment provides incentives to use higher levels of technology. In De Nicola (2015) and De Nicola & Hill (2013) the welfare gains for various financial products are calculated on the basis of data from Burkina Faso and Senegal and Ethiopia, respectively. Compared to index-insurance, insured credit has even larger welfare gains in the Ethiopian context but not in the west-African countries.

Most studies find a positive relation between access to credit and insurance demand. Several studies report that access to credit leads to larger willingness-to-pay (Bogale, 2015; McIntosh, Sarris and Papadopoulos, 2013; Hill, Hoddinott & Kumar, 2011). Similarly, it is found that access to credit leads to larger index-insurance take up (Giné, Townsend & Vickery, 2008; Clarke & Kalani, 2011). Exceptionally, Chantarat, Mude & Barrett (2009) state that credit-constrained households insure more, as insurance demand increases if other risk mitigations strategies, such as credit, are insufficient.

The effect of insurance on credit is contested. Insurance could unlock credit and lead to larger investments, but could also lead to undesired side effects such as higher default rates. Carter et al. (2007) consider that index based insurance could limit the risk of insolvency of the lender due to covariate risk or might improve the repayment rate and variation in repayment of the borrowers (Mishra, 1994). Although a stand-alone insurance contract does not by definition lead to lower interest rate, lenders could choose to do so. Indeed, Mahul and Skees (2007) observe that lenders lowered interest rate and were willing to lend more. This could prevent the microfinance institution from becoming insolvent in case of systemic default (Farrin & Miranda, 2014). Index based insurance seems to be likely to relax supply-sided constraints, i.e. quantity rationing, too (Giné & Yang, 2009). Similarly, McIntosh, Sarris and Papadopoulos (2013) as well as Elabed et al (2013) report that index-insurance could help to unlock agricultural credit by limiting credit constraints. Carter, Cheng and Sarris (2011) state that more credit could be taken out with insurance and even more with an interlinked contract.

Two studies, however, point at negative rather than a positive effect of index based insurance on credit supply. Clarke and Dercon (2009) suggest that insurance could possibly crowd-out credit if insurance changes the behavior of the borrower. A stand-alone insurance product could increase the minimum welfare level that can be reached in case of strategic default by the borrower. In this way, quantity rationing could become more severe. Farrin and Miranda (2013) confirm that the possibility exists that banks are willing to lend less if the borrower has acquired a non-interlinked insurance contract, because insured borrowers have higher default rates than uninsured borrowers. Farrin and Miranda (2014) compare two scenarios, one in which the indemnity of the insurance is paid to the borrower and one in which the indemnity is paid to the lender and deducted from the required repayment. The authors also compare these two scenarios to two benchmarks: one in which households have only credit and one in which households have taken up credit and insurance independently. They find that default rates are higher in the scenario in which the indemnity payment is paid directly to the household instead of the bank. The bundled products, however, have lower default rates than the situations with only credit or independent offering of credit and insurance, as defaulting on the bundled product would bar the household from taking out both credit and insurance in the future. Strikingly, default rates for the situation with credit and insurance offered separately are larger than for credit only. Negative spillovers could arise, in line with the predictions from Clarke & Dercon (2009). It is also found that the propensity to borrow is larger with the bundled contracts than the other contracts.

Little empirical evidence on the effect of index based insurance on credit rationing exists, but some studies provide more insights. In an experimental game conducted in China, Cheng (2014) studies the effect of offering index based insurance to risk rationed households. He finds more than half of the farmers that are risk rationed decide to apply for credit when insurance is made available to them. Additionally, roughly two thirds of the credit diverters choose to use their loan for productive investment rather than consumption when insurance is made available. The rationale behind this finding is that insurance reduces production risk, while the risk associated with using the loan for consumption stays constant or might even increase as the households pays for the premium but do not invest.

Further insights are provided in the work by Giné and Yang (2009). They offered maize farmers in Malawi the choice between a loan and a loan plus insurance, which indemnifies if rainfall is insufficient. Although they expected that farmers would prefer the insured loan over the stand-alone loan, demand for the stand-alone loan was 13% higher than for the insured loan. Insurance did not lead to higher demand for credit. However, the authors suggest that the limited liability clause of the stand-alone loan provided some implicit form of insurance. As suggested by Carter et al. (2011), a stand-alone insurance product (which effectively was

the product studied by Giné and Yang) does not provide additional benefits to farmers with low collateral.

Verteramo-Chiu et al. (2012) conduct a study on the determinants of risk rationing. Although they too expected that insurance would have a negative effect on risk rationing, they find that risk rationing takes place despite the presence of insurance markets. The authors suggest that while absence of insurance may be a sufficient condition for risk rationing it may not be a necessary condition.

Groh and McKenzie (2014) focus on risk rationing too by randomly offering current borrowers the opportunity to purchase an insurance product to hedge the risk of political uncertainty and macroeconomic instability. They tested whether the offer of insurance leads to an increase in in the likelihood of renewing one's loan. Although they encountered a large demand for insurance, the insurance offer did not affect borrowing behavior. As an explanation, it is suggested that the insurance does not cover the type of risk that hinders the investments made by small and medium enterprises.

Miranda and Gonzalez-Vega (2011) uncover some of the dynamics how lenders might manage their equity risk when borrowers are required to purchase index-insurance. Similar to suggestions of Carter, Cheng and Sarris (2013), higher wealth levels are associated with larger repayment as the threat of being permanently excluded from the market limits default. Considering the effect of subsidies on the insurance premium, Miranda and Gonzalez-Vega find that default rates increase if borrowers are required to purchase unsubsidized insurance, i.e. above actuarially fair levels, as the premium creates a disincentive to repay one's loan. In contrast, default rates slightly decrease with subsidized insurance, i.e. below actuarially fair levels. As a consequence, requiring borrowers to purchase unsubsidized insurances reduces and destabilizes bank equity growth. On the contrary, equity growth would increase and stabilize if the bank would purchase insurance itself.

The above survey clearly shows that the link between credit and insurance is still highly uncertain. As a consequence, the relevance of bundling credit and insurance is contested. Some studies point at positive effects of a combined product. Yet a recent rigorous analysis by Karlan et al (2014) suggests the opposite. They study the effects of insurance and capital grants on investment and welfare among Ghanaian farmers. Comparing farmers who only received the insurance grant with farmers who received both an insurance and a capital grant, they find that the former do not invest less than the latter. Apparently, farmers with solely insurance are able to find credit to increase investments. This indicates that insurance is able to overcome investment obstacles, whereas a lack of credit is not the bottleneck to investment. The policy conclusion that can be drawn from their analysis is that bundling (rainfall) insurance with credit may not be useful after all.

6. Concluding remarks

In the current review, the determinants for demand for index-insurance, the impact of index-insurance and the links between credit and index-insurance have been discussed. Although many studies on these topics have been conducted in recent years, much empirical research still has to be conducted in order to truly understand the workings of index-insurance.

Concerning the determinants of demand, a number of indicators deserve additional attention. For example, it is not confirmed yet that demand is indeed hump-shaped in risk aversion and the functional form of this relationship should be tested in more detail. This also holds for the magnitude of the effect of trust and education on actual insurance demand. Furthermore, it is unclear to what extent other risk mitigation strategies form complements or substitutes to

index-insurance. Understanding how index-insurance could work together or replace existing mechanisms is key to evaluating the decisions taken by smallholders

As becomes clear in this review, the impact of index-insurance has only been understood to a limited extent. Some positive effects of index-insurance have been established, yet a number of adverse net income effects results have been reported too. Thus, more research is needed in order to verify to what extent insurance is really beneficial for smallholders. This research could also focus more on differential ways in which insurance could prove advantageous, for example by distinguishing between income smoothing and income enhancing effects of index-insurance.

Another research venue is to assess the impact of bundled products, for example the combination of insurance and credit. Limited rigorous empirical research on the workings of these bundled products has been conducted. For example, it is unknown to what extent credit suppliers would react to the insured status of farmers or what the preferences of farmers are when it comes to a mix of financial products. In addition, several researchers have suggested that microfinance institutions or banks could insure themselves against covariate risk, yet no empirical evidence about this insurance mechanism has been conducted so far. One of the only rigorous analysis that is available is by Karlan et al. (2014), who identify the absence of insurance – rather than credit – as the binding constraint. Their main message seems not to be in favour of bundling credit with insurance. However, their analysis refers to one country –Ghana– only, and it has yet to be verified to what extent their results will hold for other countries, and other insurance products.

References

Alderman, H. and Haque, T. (2007) Insurance Against Covariate Shocks: The Role of Index-Based Insurance in Social Protection in Low-Income Countries of Africa. World Bank Working Paper No.95, Africa Region Human Development Department, The World Bank, Washington, D.C., 2007.

Berhane, G., Clarke, D., Dercon, S., Hill, R. V., & Taffesse, A. S. (2013). *Insuring against the weather.* ESS Research Note No. 20.

Bogale, A. (2015). Weather-indexed insurance: An elusive or achievable adaptation strategy of climate variability and change for smallholder farmers in Ethiopia. *Climate and Development, 7*(3), 246-256.

Boucher, S.R., Carter, M.R. and Guirkinger, C. (2008). Risk rationing and wealth effects in credit markets: Theory and implications for agricultural development. American Journal of Agricultural Economics, 90(2): 409-423.Brick, K., & Visser, M. (2015). Risk preferences, technology adoption and insurance uptake: A framed experiment. *Journal of Economic Behavior & Organization.*

Bryan, G. (2010). Ambiguity and insurance. *Unpublished manuscript.*

Carter, M. R. and Barrett, C. B. (2006) The economics of poverty traps and persistent poverty: an asset-based approach. *Journal of Development Studies*, 42(2), 179-199.

Carter, M. R., Cheng, L., & Sarris, A. (2011). The impact of interlinked index insurance and credit contracts on financial market deepening and small farm productivity. In *Annual Meeting of the American Applied Economics Association, Pittsburgh PA, July* (pp. 24-26).

Carter, M., Guirkinger, C., & Serfilippi, E. (2014). *Discontinuity of preferences and insurance demand: Results from a framed field experiment in Burkina Faso.*

Chantarat, S., Mude, A. G., & Barrett, C. B. (2009). Willingness to pay for index based livestock insurance: Results from a field experiment in northern Kenya.

Cheng, L. (2014). The impact of index insurance on borrower's moral hazard behaviour in rural credit markets.

Clarke, D. J. (2011). *A theory of rational demand for index insurance.* Department of Economics, University of Oxford.

Clarke, D., & Dercon, S. (2009). *Insurance, credit and safety nets for the poor in a world of risk.*

Clarke, D., & Kalani, G. (2011). Microinsurance Decisions: Evidence from Ethiopia.

Cole, S., Giné, X., & Tobacman, J. et al. (2013). Barriers to household risk management: evidence from India. *American Economic Journal. Applied Economics, 5*(1), 104.

Cole, S. A., Giné, X., & Vickery, J. I. (2013). How does risk management influence production decisions? evidence from a field experiment. Evidence from a Field Experiment (July 1, 2013). *World Bank Policy Research Working Paper, (6546).*

Cole, S., Stein, D., & Tobacman, J. (2011). *What is rainfall index insurance worth? A comparison of valuation techniques.*

Cole, S., Bastian, G., Vyas, S., Wendel, C.and Stein, D. (2012) The effectiveness of index based micro-insurance in helping smallholders manage weather-related risks. London: EPPICentre, Social Science Research Unit, Institute of Education, University of London.

De Nicola, F. (2015). Handling the weather: insurance, savings, and credit in West Africa. *World Bank Policy Research Working Paper, (7187).*

De Nicola, F., & Hill, R. V. (2012). Interplay among credit, weather insurance and savings for farmers in Ethiopia. *In The 2013 North American Winter Meeting of the Econometric Society.*

Dercon, S., Hill, R. V., Clarke, D., Outes-Leon, I., & Taffesse, A. S. (2014). Offering rainfall insurance to informal insurance groups: Evidence from a field experiment in Ethiopia. *Journal of Development Economics, 106*, 132-143.

Elabed, G., Bellemare, M. F., Carter, M. R., & Guirkinger, C. (2013). Managing basis risk with multiscale index insurance. *Agricultural Economics, 44*(4-5), 419-431.

Elabed, G., & Carter, M. (2014). Ex-ante Impacts of Agricultural Insurance: Evidence from a Field Experiment in Mali.

Elabed, G., & Carter M.R. (2015). Compound-Risk Aversion, Ambiguity, and the Willingness to Pay for Microinsurance. Journal of Economic Behavior and Organization, 118, 150-166.

Farrin, K., & Miranda, M. J. (2013). Premium Benefits? *A Heterogeneous Agent Model of Credit-Linked Index Insurance and Farm Technology Adoption.* In 2013 Annual Meeting, August 4-6, 2013, Washington, DC (No. 149666). Agricultural and Applied Economics Association.

Farrin, K., & Murray, A. G. (2014). The effect of index insurance on returns to farm inputs: Exploring alternatives to Zambia's fertilizer subsidy program.

Gaurav, S., Cole, S., & Tobacman, J. (2011). Marketing Complex Financial Products in Emerging Markets: Evidence from Rainfall Insurance in India. *Journal of Marketing Research*, *48*(SPL), S150-S162.

Giné, X., Menand, L., Townsend, R. M., & Vickery, J. I. (2010). *Microinsurance: A case study of the Indian rainfall index insurance market.* World Bank Policy Research Working Paper Series.

Giné, X., Townsend, R., & Vickery, J. (2007). Statistical analysis of rainfall insurance payouts in southern India. *American Journal of Agricultural Economics, 89*(5), 1248-1254.

Giné, X., & Yang, D. (2009). Insurance, credit, and technology adoption: Field experimental evidencefrom Malawi. *Journal of Development Economics*.

Groh, M., and McKenzie, D. (2015). *Macroinsurance for Microenterprises: A Randomized Experiment in Post-Revolution Egypt.* World Bank Working Paper No. 7048.

Heenkenda, S. (2011). Prospective demand for an index-based microinsurance in Sri Lanka.

Hill, R. V., Hoddinott, J., & Kumar, N. (2013). Adoption of weather-index insurance: Learning from willingness to pay among a panel of households in rural Ethiopia. *Agricultural Economics, 44*(4-5), 385-398.

Hill, R. V., & Robles, M. (2011). F*lexible insurance for heterogeneous farmers: Results from a small scale pilot in Ethiopia.* IFPRI discussion papers, 1092.

Hill, R. V., Robles, M., & Ceballos, F. (2013). *Demand for weather hedges in India: An empirical exploration of theoretical predictions* (Vol. 1280). International Food Policy Research Institute.

Hill, R. V., & Viceisza, A. (2012). A field experiment on the impact of weather shocks and insurance on risky investment. *Experimental Economics, 15*(2), 341-371.

Janzen, S. A., & Carter, M. R. (2013). The impact of microinsurance on consumption smoothing and asset protection: Evidence from a drought in Kenya.

Jensen, N., Barrett, C. B., & Mude, A. (2014a). *Basis risk and the welfare gains from index insurance: Evidence from Northern Kenya.* MPRA Paper No. 59153

Jensen, N., Barrett, C. B., & Mude, A. (2014b). *How basis risk and spatiotemporal adverse selection influence demand for index insurance: Evidence from Northern Kenya.* MPRA Paper No. 60452.

Jensen, N., Barrett, C. B., & Mude, A. (2014c). *Index insurance and cash transfers: A comparative analysis from Northern Kenya*. MPRA Paper No. 61372.

Karlan, D., Osei, R., Osei-Akoto, I., & Udry, C. (2014). Agricultural decisions after relaxing credit and risk constraints. *The Quaterly Journal of Economics,* 597-652.

Mahul, O., & Skees, J. R. (2007). *Managing agricultural risk at the country level: The case of index-based livestock insurance in Mongolia.* World Bank Policy Research Working Paper, (4325).

Manuamorn, O. P. (2007). *Scaling up microinsurance: The case of weather insurance for smallholders in India.* World Bank, Agriculture & Rural Development Department.

Marenya, P., Smith, V. H., & Nkonya, E. (2014). Relative Preferences for Soil Conservation Incentives among Smallholder Farmers: Evidence from Malawi. *American Journal of Agricultural Economics, 96*(3), 690-710.

McCarthy, N. A. (2003). *Demand for rainfall-index based insurance: A case study from Morocco* (Vol. 106). International Food Policy Research Institute.

Mcintosh, C., Povell, F., & Sadoulet, E. (2015). Utility, risk, and demand for incomplete insurance: Lab experiments with Guatemalan cooperatives.

Miranda, M. J., & Gonzalez-Vega, C. (2010). Systemic risk, index insurance, and optimal management of agricultural loan portfolios in developing countries. *American Journal of Agricultural Economics*, *93*(2), 399–406.

Mishra, P. K. (1994). Crop insurance and crop credit: Impact of the comprehensive crop insurance scheme on cooperative credit in Gujarat. *Journal of International Development, 6*(5), 529-567.

Mobarak, A. M., & Rosenzweig, M. R. (2012). Selling Formal Insurance to the Informally Insured,' SSRN Scholarly Paper 2009528.

Mobarak, A. M., & Rosenzweig, M. R. (2013). Informal risk sharing, index insurance, and risk taking in developing countries. *The American Economic Review, 103*(3), 375-380.

Morduch, J. (1995). Income smoothing and consumption smoothing. *The Journal of Economic Perspectives*, 103-114.

Norton, M., et al. (2011). Investigating demand for weather index insurance: Experimental evidence from Ethiopia. *In Annual Meeting Agricultural and Applied Economics Association, Pennsylvania.*

Patt, A., Suarez, P., & Hess, U. (2010). How do small-holder farmers understand insurance, and how much do they want it? Evidence from Africa. *Global Environmental Change, 20*(1), 153-161.

Shee, A., Turvey, C.G. and Woodard, J. (2015). A field study for assessing risk-contingent credit for Kenyan pastoralists and dairy farmers. Agricultural Finance Review, 75(3), 330 – 348.

Skees, J.R. (2008). Challenges for use of index-based weather insurance in lower income countries." Agricultural Finance Review, 68(1), 197-217.

Stein, D. (2011). *Rainfall index insurance in India* (Doctoral dissertation, The London School of Economics and Political Science).

Stein, D., & Tobacman, J. (2011). *Weather insured savings accounts.*

Tadesse, M.A. (2014). Fertilizer adoption, credit access, and safety nets in rural Ethiopia. Agricultural Finance Review, 74(3), 290 - 310.

Tadesse, M.A., Shiferaw, B.A., and Erenstein, O. (2015). Weather index insurance for managing drought risk in smallholder agriculture: lessons and policy implications for sub-Saharan Africa. Agricultural and Food Economics 3(1), 1-21.

Vandeveer, M. L. (2001). Demand for area crop insurance among litchi producers in northern Vietnam. *Agricultural Economics, 26*(2), 173-184.

Verteramo-Chiu, L., S. V. Khantachavana, and CG. Turvey, (2014). Risk rationing and the demand for agricultural credit: a comparative investigation of Mexico and China. Agricultural Finance Review, 74(2), 248-270.