››› Materials on Development Financing

No. 6, March 2017

Insurance Against Weather-Related Risks in Developing Countries – What is known about Impact

Author: Alberto Machemer

KfW

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Abbreviations

AHW	–	Animal husbandry worker
DD	–	Difference-in-difference (approach)
DDD	–	Triple difference (approach)
e.g.	–	for example, [exempli gratia]
esp.	–	especially
i.e.	–	that is to say, [id est]
insign.	–	insignificant(ly)
ITT	–	Intention-to-treat (approach)
IV	–	Instrumental variable (approach)
LMIC	–	Low- and middle-income countries
MFI	–	Microfinance institution
MI	–	Microinsurance
neg.	–	negative(ly)
PICO	–	Participants, intervention, comparison, outcomes
pos.	–	positive(ly)
RCT	–	Randomised controlled trial
resp.	–	respectively
sign.	–	significant(ly)

Preface

Insurance has the potential to mitigate the negative effects of natural disasters (e.g. droughts or hurricanes) and can therefore enhance households' resilience, particularly in developing countries. On the one hand, insurance enables agricultural households to invest in innovative technologies and increase production and income. Moreover, insurance can create incentives to use more resilient technologies and means of production, thus increasing profits over the long term (*ex ante* effect). On the other hand, insurance payments contribute to smoothen household cash flows, consumption and asset accumulation when a disaster has occurred. Thereby an insurance scheme helps to reduce or even to prevent negative consequences such as food scarcity or the forced sale of productive assets (*ex post* effect).

This study, which is the result of a master thesis under the supervision of Prof. Eva Terberger, director of the Independent Evaluation Unit of KfW Development Bank, provides a comprehensive overview of the current state of the academic literature on the welfare effects of microinsurance. It compares different academic studies which investigate the impacts of insurance on investment and production behavior, on asset accumulation, income and consumption levels, as well as on saving and borrowing decisions at the household level.

When assessing the welfare effects of insurance, the following issues should be kept in mind: first, the overall evidence is still very restricted, with most studies being work in progress. Moreover, a large part of the studies focuses on the ex ante effect and therefore on production and investment behaviour of agricultural households preceding a catastrophe. Until now there have hardly been any studies on the effects in the aftermath of a disaster. Finally, there are few studies which provide solid evidence on the causal link between insurance and welfare. Up to now, only two studies (which are not part of this review) were published in peer-reviewed journals: both of them investigate the ex ante effect and find a causal link between insurance protection and the investment and production activities of agricultural households. Karlan et al. (2014) show that insured farmers in Ghana cultivate larger areas of land, use more resources to cultivate land and invest more in seeds than comparable, uninsured farmers. Similarly, Mobarak and Rosenzweig (2013b) prove that in contrast to uninsured farmers, insured farmers in India invest in rice varieties that are less affected by droughts and therefore generate greater profits.

1. Introduction

Weather-related risks and induced shocks are affecting the poor all around the world and constitute a severe threat, even more in times of global climate change. Natural weather induced disasters affected 139 million people and caused $73 billion in total damage in developing regions in 2014, with a strong increase in these figures over the past years[1] (CRED 2015). In comparison, the global figure is only slightly higher with 142 million people affected and $98 billion in damage. It hence seems as if the poor mostly bear the growing burden of weather risks. This is even more alarming since the poor are especially vulnerable to weather shocks as they seldom have any means to protect themselves against or deal with such disasters.

Microinsurance (MI) – an insurance against pre-defined risks tailored to the needs of the poor – has been promoted as a potential solution by experts, academics and practitioners. The global MI market has seen a strong development, with 263 million people insured in 2013, from 78 million in 2005 (Leach et al. 2014: 7; Churchill & Matul 2012: 11). MI targeted at weather risks, such as droughts, floods, storms, rainfalls, is one part of this market.

MI is a current hot topic in academic research (Carter et al., 2014). A major question aims on its impact, i.e. whether MI helps protecting the poor from weather shocks and improves or secures their well-being. However, no true systematic analysis solely focusing on weather-related MI impact has been conducted to date. The review attempts to analyse impact evaluations on weather-related MI in order to see if an impact exists, how big it is, where it occurs, and who benefits. This study contributes to filling the research gap between the poor increasingly being affected by weather shocks, the rise of MI in research and the lack of an explicit weather-related MI impact review. This is done via a systematic literature search on rigorous weather-related MI impact evaluations and a thorough analysis and synthesis of the findings. As such, this review is the first of its kind to solely focus on weather-related MI impact.

The review applied the subsequently described methodology. Studies are included in this review if they analyse weather-related MI, focus on the poor in low- and middle-income countries and have been published after 2000. The search resulted in 7 studies meeting all the inclusion criteria and 3 secondary studies, which do not fully meet the inclusion criteria but depict interesting and relevant insights. In six of the seven studies, the level or unit of analysis is on the household level. In all studies MI covers several risks at once, with floods or heavy rainfall (5 studies) and droughts (4 studies) being the most common risks insured. Regarding the type of insurance, 4 of the included studies contain index-based insurance constructs while 3 studies deal with conventional indemnity-based insurance forms.

The included studies dealt with a various numbers of measured outcomes. Thus the impact of weather-related MI was assessed for certain defined outcome

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[1] Figures are extracted from the CRED global disaster database "EM-DAT", for Africa, Asia, Caribbean, Central and South America, disaster classification 'natural' (meteorological, hydrological, climatological).

groups. The overall impact shown in this review is based on the aggregation of single study findings assessed in the synthesis and shall only give indicative assessment on MI impact. The depicted results of this review must be treated with caution as they are based on aggregated assessment of the included studies' findings and their specific contexts. Additionally, the findings of the review are partly based on non-rigorous studies with risks of biases. Only one study – by Cole, Giné & Vickery (2013) – was assessed with a total low risk of bias. The generalisability of the depicted results thus is limited.

The impact of weather-related MI found per outcome group is as followed:

a) Production & investment decisions

Four of the included studies deal with the effect of weather-related MI on production and investment decisions ex-ante to weather-related shocks. All studies seem to indicate that MI leads to input investment choices at a higher risk-return level, i.e. a positive direct effect on overall higher risk-return investment profiles. Although the findings stem from studies with different levels of methodological rigorousness, two studies of relatively higher quality and lower risk of bias confirm the causal effect and secure the validity of findings.

b) Production results & productivity

Regarding MI's impact on production outcomes ex-post to weather-related shocks, the two included studies by Cai et al. (2009) and Cai (2013) show that insurance positively affects production outputs, securely backed by the statistical power of the results and magnitude of the measured effect sizes.

c) Loans & debt

The impact of MI on loans and debt is reviewed by two studies which find different (significant) impacts: Cai (2013) with a positive MI impact on borrowing loan size and Dietrich & Ibanez (2015) with a negative impact on total and informal loans. On the first sight, these results seem contradicting. However, the respective contexts need to be considered (whether loans help to secure liquidity until MI payouts are payed or fast MI payouts make loans obsolete).

d) Assets

In three investigated studies the researchers analyse the impact of weather-related MI on the poor's privately held assets. The studies find partly insignificant, partly significant positive effects of MI on asset value. Due to differing designs and levels of internal validity of the studies, a solid estimation of the true effect sizes must be assessed critically.

e) Consumption

MI's impact on ex-post consumption behaviour is analysed by two of the included studies. In both studies, weather-related MI is associated with a positive effect on consumption (mainly in terms of food). Yet, the studies' limited statistical power calls for attention of concluding thoughts on that matter.

f) Savings

Three of the reviewed studies deal with MI impact on households' savings. A significantly positive effect can be attributed to the savings amount, shown by two studies with a relatively high statistical power of its results.

g) Income

Only one study explicitly assessed MI impact on households' income. The study shows no positive significant impact.

In general, for all studies, findings are based on a rather short time horizon of the studies. This might limit the generalisability of the findings, but also calls for mid- to long-term analyses of MI impact.

The results of the impact analysis are portrayed in Figure 1.

Apart from the 7 included studies, the systematic literature search revealed further studies, which do not fully meet the inclusion criteria, yet contain insightful content to the matter of the review. An example is the study by Hill & Viceisza (2012), who conduct a 'framed field experiment', simulating a common farmer investment decision under weather uncertainty with and without MI in an artificial environment (i.e. a game simulation, and thus the study was excluded). In this simulation, MI leads to higher risk investment decisions – namely in fertilizer – as well as to higher returns. Furthermore, two highly relevant studies are not included in the review Mobarak & Rosenzweig (2013) and Karlan et al. (2014). Although they smoothly fit this review's theme, they were, however, not included in this review as they do not primarily focus on this review's framed causal scheme.

The review is structured as follows. Chapter 2 familiarises the reader with the background. Chapter 3 outlines the used methodology of this review. Chapter 4 describes the results of the review. Search results and included studies' characteristics are shortly described (4.1, 4.2.). The remaining part of chapter 4 contains the MI impact analysis: First, an assessment of the studies' bias risks affecting impact findings (4.3), and second, a detailed qualitative synthesis (4.4). Chapter 5 concludes the findings and gives an outlook on the limitations of systematic reviews based on rigorous impact evaluations.

Figure 1: Overview of MI impact per outcome group
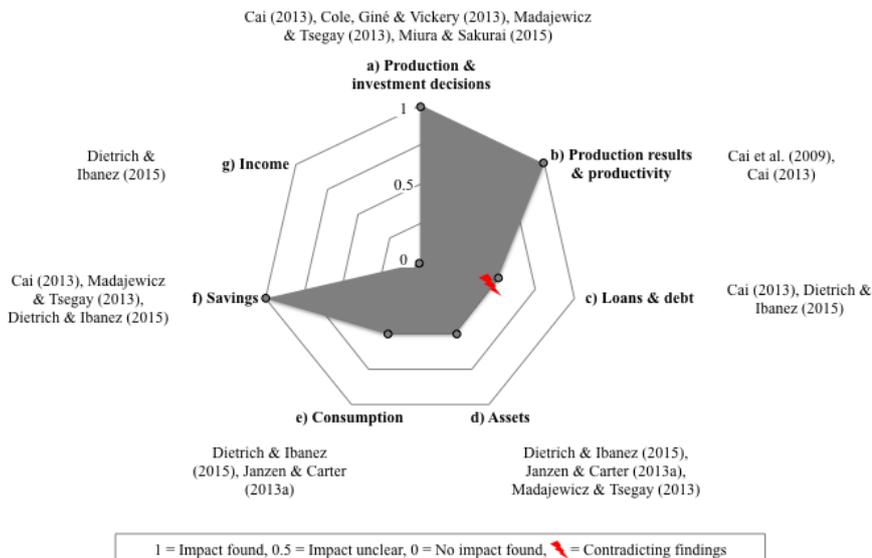
Note: The illustration is based on chapter 4.4.1. Overall impact assessments per outcome group must be treated with caution as they are aggregated from single study result assessments, the narrative synthesis and a limited amount of studies.
Source: own construction

2. Background

2.1. The problem of weather-related risks and poverty

Natural disasters and meteorological and hydrological catastrophes around the world are an ever present and increasing danger, not only in the light of climate change. Especially poor people in developing regions suffer heavily from the impact of nature's devastating power, threatening their fragile livelihood. Previous to shocks, they do not possess the means to accumulate assets as collateral and have volatile income making saving nearly impossible (Hellmuth et al. 2009: 1; Cole et al. 2012: 1). They are further seldom equipped with solid disaster prediction measures and have low chance to escape the remote rural areas. After weather-related incidents, the costs to cope with the consequences are substantial and can lead to poverty (Dercon 2004: 9ff; Janzen & Carter 2013b: 2; De Bock & Ontiveros 2013: 2). Thus, as it is hard to prepare for shocks ex-ante and since long time is needed to recover from weather-related incidents ex-post, weather risks destroy livelihoods, push households into poverty or make it impossible to escape poverty for people already living below the poverty line.

When shocks interrupt the poors' path of economic growth setting them back into poverty academic research often refers to poverty traps (Barnett et al. 2008: 1767-1769; Morsink et al. 2011: 3-7). Microfinance made it its goal to help the poor escape this trap. In the field of microfinance, MI has emerged as one key idea of the solution to deal specifically with the poors' vulnerability to unexpected shocks and risks, preventing them from being driven into greater poverty.

2.2. The concept of microinsurance

MI is similarly defined as regular insurance, resembling a formal financial insurance product. Yet MI differs in certain aspects: It provides low-priced products tailored to a specific clientele – the poor – with vastly different income and risk profiles than those of traditional insurance holders (Apostolakis et al. 2015: 148; Cohen et al. 2005: 319f; Churchill 2007: 402f).

MI aims to reduce vulnerability of the poor against risks and hazards, for example by risk-pooling, risk reduction, shock-absorption and income stabilisation (Apostolakis et al. 2015: 147; Morsink et al. 2011: 1 and stated references). Ultimately this may result in a way out of the poverty trap. In the context of weather-related risks, these can include droughts, floods, storms, rainfall, weather-induced crop and cattle diseases, tsunamis, tornados, hails, wildfires or heat waves. Insured assets of the poor, in turn, range from crop, harvest, livestock to housing, property and farming equipment (see e.g. Churchill & Matul 2012; Radermacher et al. 2009; Radermacher et al. 2010).

Regarding the provider, MI is delivered as a formal insurance by institutions such as insurance companies, microfinance institutions (MFI) or governments (Young et al. 2006: 4f). Informal, group-based and self-insurance mechanisms serve as

opposing forms (Barnett et al. 2008: 1770). Regarding the recipient, MI can be given to insurance holders on 3 levels: On the micro level, policyholders are individuals, households or small business owners. On the meso level, aggregates such as communities, farmer associations or input suppliers are insured to protect their members and assets. On the macro level, governments in developing countries use MI in development and disaster management while the money value insured vastly exceeds the usual 'micro' range (Churchill & Matul 2012: 93-98, including exemplary case studies; Müller et al. 2014: 11f).

Further, MI can be differentiated by its contractual mechanisms into 2 main types. The first type is the conventional indemnity insurance, which however is not believed to work in weather-related and agricultural MI due to restricting factors such as high administrative costs to verify losses.

A second, more recent type of MI is index-based (or parametric) insurance. Insurance payout is based on an objectively observable, publicly verifiable, non-manipulable value that is closely related to the risk factor and correlated with the implied loss. Once a threshold of the index is reached, payouts are triggered (Hellmuth et al. 2009: 3; Miranda & Farrin 2012: 393; Carter et al. 2014: 6f). Index insurance is a highly cost effective type of MI solving problems of adverse selection and moral hazard as no individual claim verification is needed. Successful MI impact case studies across developing countries seem to back this theoretical rationale (see e.g. Hellmuth et al. 2009; Greatrex et al. 2015). However, index insurance inherits the major drawback of basis risk. Basis risk means that index triggered indemnity payments will not perfectly correlate with individual loss value due to the discrepancy of area-wide measured shocks and local shock impact on individual policyholders (Doherty & Richter 2002: 11; Miranda & Farrin 2012: 394f; Carter et al. 2014: 6f; Churchill & Matul 2012: 239-242). Especially if index measure stations are few and weather impact locally differentiated, index insurance remains low quality (Carter et al. 2014: 7). Concluding, indemnity and index insurance appear as two MI types across a range from individual to collective insurance incident verification.

As a research field, MI has gained substantial attention among academic scholars over the recent years. However, the focus has been rather on health than on weather-related insurance, such as in agriculture (Cole et al. 2012: 6; Radermacher et al. 2010). Two issues regarding MI in general, have been dominating MI: 1) The riddle of why take-up and demand penetration remain low compared to e.g. informal insurance, despite MI provision (Mobarak & Rosenzweig 2013a: 375; Miranda & Farrin 2012: 392). 2) The unclarity about its effectiveness and impact, as findings remain mixed and some experts cast doubt on its promise to help the poor (Cole et al. 2012: 1). Thus the ultimate questions remain: Does MI help the poor in dealing with risks, leading out of poverty and towards their well-being; and if so, how strong is the impact? Moreover, could a low, insufficient impact of MI – if studies can prove this – be a cause for the remaining low MI take-up rates? To answer these questions, it is necessary to first understand how MI works.

2.3. Rationale and outcomes of microinsurance interventions

In the light of weather-related risks and its consequences, the poor make decisions to avoid taking risks (Rosenzweig & Wolpin 1993). Such decisions are made twofold: Risk management decisions ex-ante and risk coping decisions ex-post to a realised shock (Dercon & Kirchberger 2008: 2f; Apostolakis et al. 2015: 147; Janzen & Carter 2013b: 6ff). All ex-ante strategies come at high costs, such as limiting the use of modern inputs, holding inefficient asset portfolios or leading to low asset accumulation. This in turn and at times of shocks can lead to not only

temporal, but persistent poverty (Dercon & Kirchberger 2008: 3). Ex-post, the poor use risk coping strategies in which they might need to reduce consumption (e.g. food, education, health) or deplete assets (Elabed & Carter 2014: 3f; Dercon & Kirchberger 2008: 3). Other risk coping decisions include child labor, costly financial adjustments through dissaving and indebtedness as well as labor adjustments through migration for income remittance, which is seen as an incomplete form of self-insurance (Carter et al. 2014: 4; Clarke & Wallsten 2003: 4-7).

In theory, the poor should be able to improve their risk management (ex-ante) and risk coping (ex-post) decisions when covered by MI.

Ex-ante, MI can facilitate more productive and cost-efficient strategies (e.g. agricultural input factors, livestock or damage prevention) with the money which is saved to absorb potential shocks in the case of not having MI (Cole et al. 2012: 1; Churchill & Matul 2012: 59f). Several authors empirically show that with MI, policyholders engage in higher risk-return decisions – e.g. higher-yield rice in India, seeds in China or cotton in Mali (Mobarak & Rosenzweig 2012; Cai et al. 2015; Bellemare et al. 2013) – leading to improved well-being and a position above the poverty line (Morsink et al. 2011: 4; Müller et al. 2014: 9). Further, MI coverage gives the poor the safety of being insured and able to cope with risks, generally affecting risk management behaviour (Dercon & Kirchberger 2008: 1; Janzen & Carter 2013b: 6f). In case of agricultural activities, MI lowers the production risk and in turn should increase the expected return. This might be achieved by increasing inputs, such as fertiliser, since reduced production risk makes investments more profitable at the margins. This might also be achieved by switching to higher-yield inputs or better production techniques (De Nicola 2012). Finally, MI might improve ex-ante decisions as it allows policyholders to access credit for investments. Implied increased profits can be used to pay the insurance premium, knowing that payouts in case of shocks would cover the credit repayments (Greatrex et al. 2015: 6).

MI should also have an effect on ex-post decisions. The premium payout covers losses in case of shocks and, in addition, avoids costly coping strategies, leaving future income opportunities intact (Dercon & Kirchberger 2008: 1; Janzen & Carter 2013b: 6f). In addition, MI can reduce the extent and speed of asset depletion to cope with shocks preventing the poor to fall into the poverty trap. However, this effect might be small for the poorest since they do not own (many) assets (Morsink et al. 2011: 4; De Bock & Ontiveros 2013: 4; e.g. Janzen & Carter 2013b). Ultimately, MI payments decrease income volatility leading to consumption smoothing and reduce the need to sell assets in case of shocks (Rosenzweig & Wolpin 1993).

However, despite argumentations and findings as these mentioned and some successful pilots in developing countries, several researchers cast reasonable doubts on MI's positive impact to reduce poverty (Banerjee & Duflo 2011; Binswanger-Mkhize 2012).

2.4. Relevance of the review

MI is a hot topic among academic researchers today and has recently seen further growth as several applications have been examined, e.g. crop or property (Radermacher et al. 2010: 3). While the focus of MI research in its early days was rather on understanding how it works, the focus shifted towards verifying and estimating its impact (Churchill & Matul 2012: 36). Evaluating the impact is important as it defines the value of MI to stakeholders, first and foremost the poor.

The status quo of research on MI impact is that there is a slight consensus in theory and anecdotal evidence exists. Research is keen to find practical evidence and

uni-directional answers. Meaning, whether there really is an impact and if so, how big it is (Churchill & Matul 2012: 36).

Reviews on MI impact have so far mainly focused on health and life insurance, and other MI fields have played minor roles or have only been represented by a few studies included in the reviews (Churchill & Matul 2012: 59; Carter et al. 2014: 8f). Systematic reviews specifically on weather-related MI have hardly been done. Weather-related MI as a hot topic and diverse forms and applications have spurred new studies since 2012, calling for a systematic review especially focusing on MI impact.

2.5. Objectives and rationale of the review

The objective of this review is a systematic assessment and analysis of high quality research regarding evidence about the impact of MI on the poor to deal with weather-related risks in developing countries.

Leading thoughts guiding this review include:

- Impact of weather-related MI on:
  a) Ex-ante risk management decisions and investment behaviour
  b) Ex-post shock coping decisions
  c) Overall alleviation of poverty and increase of well-being
- Beneficiaries and victims: For whom does MI work, for whom does it not work?
- Potentially insufficient weather-related MI impact as a cause for poor take-up rates

In accordance with the *PICO* format[2] of leading questions for systematic reviews, this review is framed as follows:

For people and households in developing, low- and middle-income countries (*participants*), do weather-related MI (*intervention*), compared to no, informal or conventional insurance (*comparison*), help or harm to deal with weather-related risks and improve well-being (*outcomes*)?

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[2] PICO (Participants, intervention, comparison, outcomes) as suggested by the Cochrane Handbook for Systematic Reviews (Higgins & Green 2011).
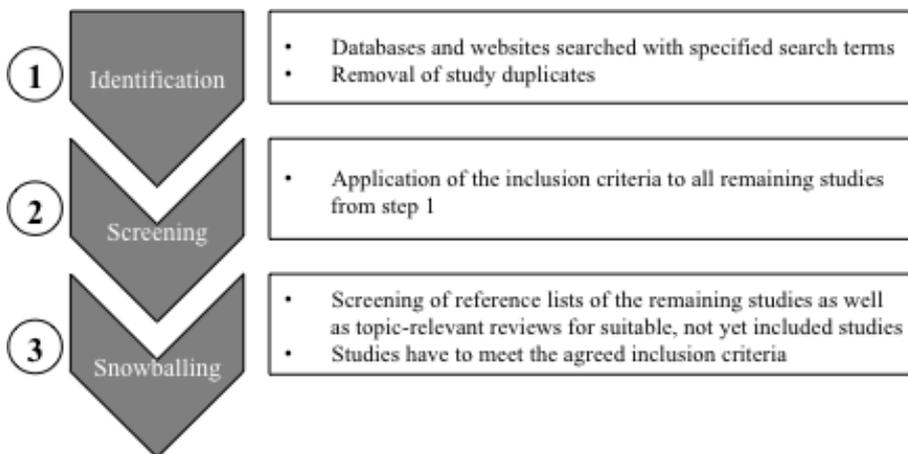
3. Methodology

3.1. Systematic literature search and inclusion/exclusion criteria

The criteria for studies to be included in the review comprise 5 groups. 1) Population and context: Studies will be included if they focus on 'the poor' in low- and middle-income countries and on the individual, household or small local group level, both in rural and urban areas. 2) Interventions: The review will only deal with studies that analyse weather-related MI as defined in the protocol and the second chapter. 3) Outcomes and measures: No specific criteria on outcomes and measures are set in order to ensure the inclusion and analysis of different and new outcomes as well as to depict research gaps. Yet, a connection to poverty reduction and increase of well-being must be given. 4) Study design: Only the most rigorous impact evaluations will be included, meaning studies designed as randomised controlled trials (RCT). Studies using quasi-experimental designs of high quality will only be included if no reasonable amount of RCTs is being found. 5) Further criteria: Studies have to be written in English or German and must have been published after 2000 and independently (not funded etc.).

The process of the systematic literature search comprises 3 steps, as seen below.

Figure 2: Literature search and selection process - Methodology

①	Identification	• Databases and websites searched with specified search terms • Removal of study duplicates
②	Screening	• Application of the inclusion criteria to all remaining studies from step 1
③	Snowballing	• Screening of reference lists of the remaining studies as well as topic-relevant reviews for suitable, not yet included studies • Studies have to meet the agreed inclusion criteria

Source: own construction

3.2. Risk of bias assessment – Methodology

This chapter shortly explains the approach of the analysis outlined in chapter 4.3. Most academic studies are to some extent subject to a range of biases. Biases can be seen as systematic errors, or deviations from the truth (Higgins & Green 2011: chapter 8.2). Therefore, they constitute a hazard to the studies' internal

validity[3], ultimately threatening the results of the analyses and conclusions of this review. It is hence important to critically analyse the selected studies in regard of occurring biases. The validity of studies does not only rely on the study design itself but also on its executed strategy described in the studies. Hence both aspects – chosen study design and execution of methods – will be critically examined in chapter 4.3, based on the bias definitions in Appendix A1. For each bias within each study, the potential level of risk is then assessed: low risk or high risk if the bias is likely resp. not likely to be present, or unclear risk if a lack of information or uncertainty over the potential of the bias is given.

3.3. Synthesis of evidence and impact analysis – Methodology

Based on the systematically selected studies, evidence on the effects and impact of weather-related MI will be synthesised and analysed.

The narrative synthesis will describe the primary studies' findings and attempt to arrive at an overarching causal evidence or story, bringing together the insights of the studies. It will be structured along certain grouped outcome-types, such as production results, assets or consumption. The full list of aggregated outcome groups can be found in Appendix B3. Additionally to the 7 selected studies, findings of 3 secondary studies, which do not fully meet the inclusion criteria but depict interesting and relevant insights, shall be shortly reviewed.

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[3] Some biases also affect the construct and external validity. As the focus of this review is on the causal impact of MI, the author will mainly focus on biases affecting the studies' internal validity. Nonetheless, the generalisation of findings and potential problems will be touched upon at a later point.

4. Results

4.1. Search results and study selection

In the first step – Identification – several electronic databases and relevant websites were searched with search terms based on the aforementioned protocol. These searches resulted in 1,161 total hits.

In the second search step – Screening – the author screened all remaining studies applying the outlined process and inclusion/exclusion criteria as stated in chapter 3.1. The most restricting inclusion criteria during the search turned out to be the study design. Despite a rigorous and extensive systematic literature search, only one true RCT study was found randomising the provision of weather-related MI to treatment and control group (Cole, Giné & Vickery 2013). Hence, and in accordance with the protocol, the study design criterion was adapted, leading to the inclusion of five quasi-experimental studies (using e.g. difference-in-difference (DD), triple-difference (DDD) or instrumental variable approaches). Further, one study using an ITT approach was included. The second step –Screening – left 7 studies for further detailed analysis.

The third step – Snowballing – did not yield any additional studies fully meeting the inclusion criteria. The complete systematic literature search including all 3 steps was conducted between 23.10.2015 and 29.10.2015. The process and the results are depicted in figure 3 below.

In total, the systematic literature search resulted in 7 studies meeting the inclusion criteria (adapted compared to the protocol, as explained above) and available for further analysis. All 7 studies are listed with their characteristics and along the coding items in Appendix B2.

Three additional studies are worth mentioning here that fit the inclusion criteria on a first view, but were excluded due to specific non-fit reasons.[4] They will not be analysed in chapter 4.3. and 4.4.2., but will be shortly discussed as secondary priority in chapter 4.4.1. as they might generate new insights when compared to the main studies.

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[4] Hill & Viceisza (2012); Mobarak & Rosenzweig (2012); Mobarak & Rosenzweig (2013).

Figure 3: Literature search and selection process - Results
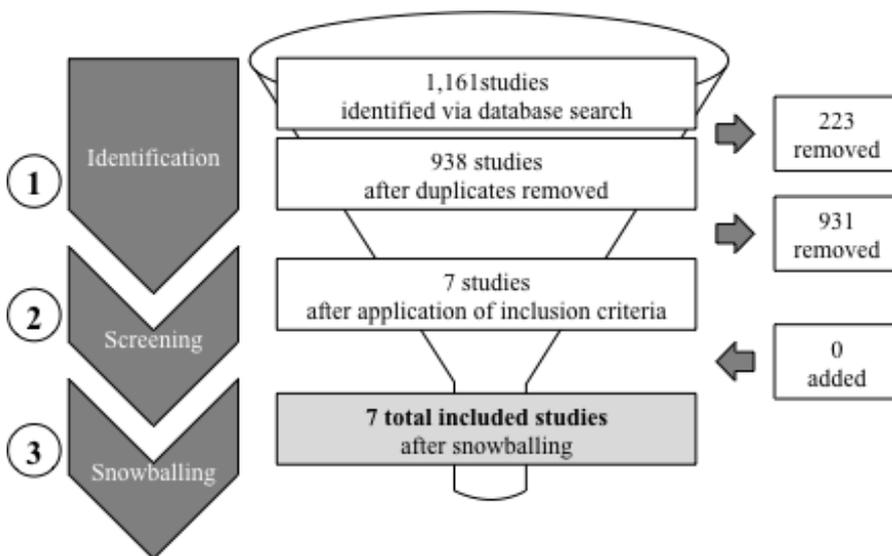
Source: own construction

4.2. Study characteristics

Population and context

The 7 studies included in this review span across 3 continents, with 3 studies localised in Asia, 1 in South America and 3 in Africa. Cai et al. (2009) analyse poor, sow (swine) producing farmer households in the Guizhu province in the poor and rural regions of Southwest China. Similarly, Cai (2013) focuses on the poor, rural mountain area of Jingxi province in Southeast China, analysing tobacco crop farmers. Cole, Giné & Vickery (2013) set their study in the southern, semi-arid region of India where small agricultural farmers have to deal with rainfall shocks during monsoons. In Colombia Dietrich & Ibanez (2015) study tobacco farmers strongly affected by climatic shocks. The 3 remaining studies are all set in Central East Africa: Janzen & Carter (2013a) analyse pastoralist farmers in northern Kenya dealing with extreme droughts. Finally, while the study by Madajewicz & Tsegay (2013) considers smallholder crop farmers in drought prone northern Ethiopia, the one by Miura & Sakurai (2015) similarly deals with small-scale crop farmers in semi-arid tropics of Southern Zambia threatened by strong rainfall variability.

Intervention:

In all studies insured risks by the MI contracts range from windstorms, blizzards, hail, thunder to floods, heavy rain and monsoons to extremely high or low temperatures, droughts and weather induced landslides. In all studies MI covers several risks at once. Further, MI contracts included in this review are aimed at protecting two of the households' main agricultural income sources: Livestock such as sows (2 studies) and crop (5 studies).

Regarding the type of insurance, 4 of the included studies contain index-based insurance constructs while 3 studies deal with conventional indemnity-based insurance forms.

Outcomes:

Analysed outcomes regarding ex-ante impact are production behaviour, agricultural decision-making and investment choices (input factors, technologies, etc.).

Outcomes relate to timing of crop sowing, diversification of crops, shifts in risk-return combinations of crop and decisions on input factors such as fertilizer or land. Ex-post related outcomes studied comprise the amount produced (e.g. sows in Cai et al. (2009)), improvement in productivity and crop yields, savings, borrowing behaviour, loan amounts, assets accumulation and consumption. Outcomes are analysed both short- and long-term.

Study design, types and analytical methods[5]:

As indicated previously, only Cole, Giné & Vickery (2013) use a RCT design. Although all 7 studies rely on control groups and randomisation at some point, only this study randomizes the MI provision to the experimental groups. The remaining included studies rely on quasi-experimental approaches where no randomised allocation of MI provision takes place but is used in other forms, e.g. selecting sample households. These studies use statistical methods to control for potential omitted variables and biases.

All included studies are listed in Appendix B2 along study characteristics and coding items, such as those discussed in this chapter.

4.3. Risk of bias assessment – Results

The table assesses the risk of each bias per study regarding the biases defined in appendix A1.

Table 1: Risk of bias assessment – Results

Biases	Cai et al. (2009)	Cai (2013)	Cole, Giné & Vickery (2013)	Dietrich & Ibanez (2015)	Janzen & Carter (2013a)	Madajewicz & Tsegay (2013)	Miura & Sakurai (2015)
Selection	low	high	low	low	high	high	High
IV estimator	unclear	n.a.	n.a.	n.a.	high	n.a.	Low
Haw-thorne	unclear	low	low	low	unclear	unclear	Unclear
John Henry	unclear	low	low	low	unclear	unclear	High
Confounding	high	unclear	low	low	high	high	Unclear
Spill-over	low	low	low	high	unclear	unclear	High
Total bias risk	medium	medium	low	medium	high	high	high

Note: n.a. = Bias is not applicable for this study
Source: own construction

4.4. Synthesis of evidence and impact analysis – Results

4.4.1. Qualitative narrative synthesis
This part of the synthesis is structured along several grouped outcome types that have been studied by the 7 selected studies. The synthesis of evidence on outcome findings will follow the procedure described in chapter 3.4.

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[5] Explanations and details can be found for example in: De Bock & Ontiveros (2013), Duflo et al. (2007), Grimm & Paffhausen (2014), Higgins & Green (2011), Waddington et al. (2012)

Table 2: Overview of impact per outcome group

Outcome group	Impact level	Studies	Overall impact assessment
a) Production & investment decisions	Ex-ante	Cai (2013), Cole, Giné & Vickery (2013), Madajewicz & Tsegay (2013), Miura & Sakurai (2015)	Impact found
b) Production results & productivity	Ex-post	Cai et al. (2009), Cai (2013)	Impact found
c) Loans & debt	Ex-post, ex-ante	Cai (2013), Dietrich & Ibanez (2015)	Impact unclear (contradicting findings)
d) Assets	Ex-post	Dietrich & Ibanez (2015), Janzen & Carter (2013a), Madajewicz & Tsegay (2013)	Impact unclear (impact partly found)
e) Consumption	Ex-post, (ex-ante)	Dietrich & Ibanez (2015), Janzen & Carter (2013a)	Impact unclear (impact partly found)
f) Savings	Ex-post	Cai (2013), Madajewicz & Tsegay (2013), Dietrich & Ibanez (2015)	Impact found
g) Income	Ex-post	Dietrich & Ibanez (2015)	No impact found

Note: Overall impact assessments per outcome group must be treated with caution as they are aggregated from singly study result assessments, narrative synthesis and limited amount of studies.
Source: own construction

Table 3: Production & investment decisions

Outcome group	Impact level	Study	Outcome(s)	Direction and significance of treatment effect	Magnitude of treatment effect	Statistical power
a) Production & investment decisions	Ex-ante	Cai (2013)	Crop choice (diversification/focus)	Pos. sign. effect*** on crop focus (insured crop)	29% less diversified (crop diversification measured via 1 minus Herfindahl index)	High
	Ex-ante	Cole, Giné & Vickery (2013)	Investment composition: • Cash crop choice (risk-return) • Investment in inputs for cash crops (seeds, fertilizers, manure, pesticide, irrigation, hired labor, area of land sown)	Pos. sign. effect*** on: • Cash crop, i.e. crop focus, higher risk-return • Cash crop cultivated area • Input investments for cash crop farming	• 12% more likely to plant cash crops if MI given • 27% increase in cash crop land planted • 24% increase in input investments (monetary value)	High
	Ex-ante	Madajewicz & Tsegay (2013)	Production investments: Use of fertilizer	Pos. sign. effect** on improved fertilizers used, on average across all treatment areas	No aggregate info given	Low
	Ex-ante	Miura & Sakurai (2015)	• Input usage (riskier, more profitable): Field size, fertilizer used • Sowing timing (risk-return decisions) • Seed types	• Pos. sign. effect** on field size and fertilizer used • Pos. sign. effect** on early planting • Insign. effect on seed types	• 13% increase in average maize plot size and 35% more fertilizer used if MI given • 5 days earlier planting	Low

Note: The significance levels of the treatment effect are ***p<0.01, **p<0.05, *p<0.1. The magnitudes of the treatment effects are based on respective statistical model outputs and group comparisons. The overall assessment of statistical power is based on statistical significance, sample size and the magnitude of the treatment effect.
Source: own construction

a) Production & investment decisions

In the following paragraph, the analysis focuses on MI impact on farmers' ex-ante production and investment decisions to weather-related shocks. Four of the included studies deal with this outcome, more specifically the effect on crop choice or investment in other inputs. Cai (2013) and Cole, Giné & Vickery (2013) find that MI provision has a statistically significant positive effect on crop focus. This means that farmers diversify less in planted crop increasing their risk taken and choose crops with higher returns. Cai (2013) finds a treatment effect at a 1% significance level via a Herfindahl index calculation in the DDD model. This indicates that production becomes 29%[6] less diversified in the treatment group. The result is valid after controlling for certain household characteristics and including all 3 control groups into the DDD approach (see also Appendix B2). Crop focus relates especially to insured crop, proving MI's effectiveness and its purpose. Cole, Giné & Vickery (2013) depict a significant positive effect on cash crop focus. Farmers decide to start growing the two main cash crops common in the area, implying a higher risk-return choice. The probability of planting cash crops increases by 12% if farmers are insured and did not focus on cash crops in the previous seasons. The treatment effect is robust to heterogeneity (e.g. differing wealth or education levels) and results in a value of 0.065 in the RCT tobit model significant at 5%. Both studies show that MI leads farmers towards choosing higher risk and return crops. The lower measured effect compared to Cai (2013) could be due to different methodological approaches. It could also be due to the more rigorous RCT design in Cole, Giné & Vickery (2013) preventing an overestimation of the true effect, e.g. caused by the prevalent selection bias in the study by Cai (2013). Largest sample sizes of all 7 studies, decent take-up rates (with the effectively used sample size still being high) and highly significant treatment effects of reasonable size indicate a high statistical power of the results.

MI impact is also measured regarding investments in other agricultural inputs. Cole, Giné & Vickery (2013) find that treated households significantly increase input investments only for cash crops, regardless of whether farmers already planted them earlier (significant at 1%). Inputs include fertilizers, land size planted, pesticides and hired labor. Hence, MI seems to cause a proactive allocation shift in production investment composition towards higher-risk-return cash crops. This effect is even stronger among more educated farmers, in terms of years of schooling. However, the effect is insignificant when looked at all crops together. This even strengthens the idea of a causal effect of MI on high-yield cash crops and a more riskier ex-ante production strategy. Miura & Sakurai (2015) detect a positive effect on sowing timing (i.e. earlier planting, increasing risk to shocks), on field size (i.e. larger by 13% in the treatment group) and on fertilizer usage (i.e. increased use of expensive fertilizer). All these findings imply decisions towards a higher risk-return level. The effects are significant on both household and plot level after controlling for endogeneity in insurance demand and after comparing all 3 treatment groups to control group 2 (no MI). Hence, MI provision seems to encourage farmers to adopt risky but profitable inputs and to shift production modes, enabling them to achieve higher yields. However, no significant effect was detected on new maize seeds used (i.e. instead of low risk, recycled seeds from the previous season) and use of early maturity maize seeds. Finally, Madajewicz & Tsegay (2013) find a significantly positive effect on fertilizer usage. Additional more findings were found regarding input investments, e.g. on improved seeds, but were only significant for a minority of studied villages.

All stated studies seem to indicate that MI leads to input investment choices at a higher risk-return level, i.e. a positive direct effect on overall higher risk-return investment profiles. This is in line with theoretical argumentations outlined in chap-

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[6] Percentage increase is based on resp. statistical model outputs for the experimental groups. The treatment effect magnitude shall from here on be displayed in % increase between groups rather than absolute values as models and output values differ per study. This makes interpreting the treatment effect size easies and more applicable.

ter 2.3. In combination with the safety from MI itself against shocks, farmers' expected return ought to increase, contributing to improved well-being and a position above the poverty line. The treatment effects seem steady even when controlled for confounders. Yet, the effect sizes differ vastly per study due to heterogeneity in the approaches (statistical models, impact measures, etc.). Thus, the absolute values of the effect are hardly comparable and call for effect size calculation later done in the meta-analysis. It is worth mentioning that the effect on investment in other inputs seems relatively weaker than the effect on crop focus. The seemingly contradicting findings of Cole, Giné & Vickery (2013) and Miura & Sakurai (2015) regarding MI impact on land size calls for further critical assessment: While the latter find a significant positive impact on cultivated land size, the former only find a clearly insignificant effect. On the one hand, Cole, Giné & Vickery (2013) could underestimate the effect due to restrictions on land size in certain regions (simply no additional land given) or the relative short time span of Cole, Giné & Vickery (2013)'s study of 7 months not allowing to increase land size that fast. On the other hand, Miura & Sakurai (2015) could be overstating the true effect due to a high risk of selection bias caused by using a quasi-experimental approach – instead of a RCT as Cole, Giné & Vickery (2013) do. Finally, small sample sizes might cause problems in effect estimation. Madajewicz & Tsegay (2013) rely on the smallest sample size of all studies, which might have caused them to depict significant findings across all villages only for a limited number of outcomes. Similarly, Miura & Sakurai (2015) report several insignificant findings on outcomes that should theoretically be impacted, e.g. input of new, improved maize seeds. Hence and in line, most insignificant findings are reported in studies with small samples size, calling to attention the problem of low statistical power.

Table 4: Production results & productivity

Outcome group	Impact level	Study	Outcome(s)	Direction and significance of treatment effect	Magnitude of treatment effect	Statistical power
b) Production results & productivity	Ex-post	Cai et al. (2009)	Tendency to raise number of sows	Pos. sign. effect**	0.76 (0.82) additional sows raised after 3 (6) months if MI provided	Medium
	Ex-post	Cai (2013)	Tobacco production amount	Pos. sign. effect***	1.161 mu (22%) more tobacco produced in treatment group	High

Note: The significance levels of the treatment effect are ***p<0.01, **p<0.05, *p<0.1. The magnitudes of the treatment effects are based on respective statistical model outputs and group comparisons. The overall assessment of statistical power is based on statistical significance, sample size and the magnitude of the treatment effect.
Source: own construction

b) Production results & productivity

Two studies analyse how MI impacts production outcomes ex-post to weather-related shocks. Cai et al. (2009) show that sow insurance positively affects production outputs of sow farmers. By using an IV regression method the authors depict the causal effect of MI on the number of sows raised, with 0.76 (0.82) additional sows raised after 3 (6) months if MI is provided, significant at a 5% level. Focusing on tobacco farmers instead, Cai (2013)'s DDD approach results in on average 1.161 mu[7] (22%) more tobacco production in the treatment group after

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[7] 1mu = 0,067 hectare.

insurance provision, significantly positive at a 1% level. These findings are robust even after controlling for a year dummy and vast household characteristics. Further, the effect is seen to be stronger for households with a) higher yearly income, potentially explained by the high production cost of tobacco cultivation relative to that of other crops; b) larger household size and higher level of education. This, however, might be specific to tobacco production, as it requires more labor and thorough technical knowledge to reach high yield and quality.

The effect on production is logical and consistent with theoretical arguments – as explained earlier – that as the expected return increases once MI is provided, households are stronger incentivised to invest more heavily in production. The effect might also be driven by a causal implication of the ex-ante effects, namely the increased input investments in order to produce more productively. When comparing the two studies, the time horizon is worth mentioning. While both studies analyse the short-term impact and detect valid results, Cai (2013) also reveals that a long-term effect persists over an extensive time of 8 years. The findings of Cai et al. (2009) need to be assessed with caution regarding the control group due to a specific group design with a focus on incentive schemes rather than binary MI provision choice. Yet, the two-stage regression model intents to correct for incentive schemes. In contrast, findings of Cai (2013) seem more reliable in the context of this review due to the suitable design chosen. Ultimately, both studies rely on a solid sample size, low attrition, significant effects and reasonable treatment effect magnitude, indicating a high statistical power of the results.

Table 5: Loans & debt

Outcome group	Impact level	Study	Outcome(s)	Direction and significance of treatment effect	Magnitude of treatment effect	Statistical power
c) Loans & debt	Ex-post	Cai (2013)	Borrowing loan size	Pos. sign. effect**	972 RMB increase in loan size for tobacco households in treatment regions	High
	Ex-post, ex-ante	Dietrich & Ibanez (2015)	i. Total loan amount ii. Informal loans: Acquisition, debt repayment usage iii. Formal loans: (Lower) interest rates, (longer) maturity v. Use of loan for production/ consumption	i. Neg. sign. effect* ii. Neg. sign. effect** iii. Pos. sign. effect** iv. Neg. insign. effect	For example, estimated marginal effect: Reduction of 200,000 COP (approx. 100 USD) of informal loans if all household-types in treatment group are viewed	High

Note: The significance levels of the treatment effect are ***p<0.01, **p<0.05, *p<0.1. The magnitudes of the treatment effects are based on respective statistical model outputs and group comparisons. The overall assessment of statistical power is based on statistical significance, sample size and the magnitude of the treatment effect.
Source: own construction

c) Loans & debt

Academic research also studies the impact of MI on farmers' debt management. By using an ITT approach, Dietrich & Ibanez (2015) analyse the effect of MI access on loan amount, including private loans such as tobacco company, bank, informal and cooperative loans. They find that MI access significantly decreases total loan value of tobacco farmers and that the effect is mainly driven by informal loans: Estimations with a random effect tobit model confirm a significantly negative effect of MI access on informal loan usage and a reduction of 200,000 COP[8] of informal loans. The effect persists both short- and long-term and also for tobacco farmers actually taking-up MI. The results are further significant for the subgroup of weather-shock affected tobacco farmers (ca. 80% reported weather-related shocks) who had fewer informal loans than the control groups. The heterogeneity of households' wealth level does not affect results as both poor and wealthy households significantly benefit from MI access regarding informal loan reduction. In addition, the authors find that MI access increases the use of loans with lower interest rates and longer maturities. Furthermore, the authors reveal interesting insights by segmenting the analysis by loan usage: Loans used to repay debt (mainly costly, informal loans) are foremost reduced, implying a desired effect of MI to reduce risk of over-indebtedness and ultimately the risk of falling or remaining below the poverty line. However, the analysis only depicts a small insignificant (negative) effect on loans used for productive investments or consumptions, which may not be easy to interpret: If loan size (e.g. for consumption) increased before MI as a risk coping strategy, the negative effect might be reasonable. Loans used for productive investments however should be positively affected, as argued in

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[8] Approximately $100.

chapter 2.3. It hence is necessary to further drill down the analysis by loan type, i.e. consumption vs. production separately. The data given in this study does however not allow that.

The study by Cai (2013) is relevant yet another time, in this context regarding loan and debt impact. The results from the DD and DDD analyses show that MI provision increases tobacco farmers' loan borrowing – in terms of average loan size – and that the effect persists both short and long-term. The results indicate a significantly positive effect of around 972 RMB compared to the control group, implying a 25% increase relative to ex-ante average loan size of tobacco households in treatment regions.

As it can clearly be seen, the two studies show an inconsistent and opposing tendency of MI impact on loans, with both negative and positive impacts, depending on detailed specifications of loans (e.g. loan usage). Foremost, this is in line with theoretical argumentation that MI might have a negative effect of debt repayment loans, while having a positive effect on productive investment loans (see chapter 2.3). However, some results are inconsistent and some analyses too superficial, calling for attention: First, the small negative MI effect in Dietrich & Ibanez (2015) for productive loans seems to contradict academic argumentation (i.e. higher risk-return production calling for investments, paid via debt and repayment secured via MI). It could be a faulty logic in the theoretic causal model. However, and probably more likely, the results might be misleading due to a) the ITT approach including a high number of eventually non-insured households in the treatment group; b) the high number of debt-free households and the two-stage modeling of loan take-up; and c) no separate analysis of productive and consumptive loans. After all, the effect is small and insignificant. Second, the analyses by Cai (2013) regarding a positive MI impact on loans are not detailed enough to generate clear causal implications. The author analyses the total loans at once neglecting any segmentation. This allows no drill down into segments – e.g. loan use for debt repayment vs. production investments – constituting a shortcoming compared to Dietrich & Ibanez (2015). Yet, a segmented analysis is needed: The total positive effect could come from an increase in production investment loans, as even reasoned for by Dietrich & Ibanez (2015) (MI reduces risk with productive investments and thus increases access to credit, Dietrich & Ibanez (2015: 16f)). But since Cai (2013) does not provide any information about the share per loan use in the total loan size, the impact might also be driven by other loan effects. Thus no solid causal inference can be drawn from those findings. Concluding, the studies show the need to analyse MI impact on loans separately per loan use or type as theoretical argumentation regarding causality and effect direction differ. Further, as authors' argumentations are less than rigid, the theoretical causal model regarding this outcome should be strengthened to guide upcoming research.

The two different study approaches – treatment provision vs. ITT – and their effect on findings bear further interesting insights. In Dietrich & Ibanez (2015), the measured effect size should be considered a lower bound of the treatment effect due to the ITT approach. Not all farmers who were offered MI did in fact participate and buy MI. Thus, treatment could be higher if provision of MI was randomised and actually insured vs. non-insured were compared. In other words, the given significantly positive effect clearly indicates an impact of MI on loans and debt management. In addition, the low risk of selection bias reduces the risk of overstating the true effect. Regarding the downside, the full true treatment effect magnitude is not revealed as some non-insured households are included in the treatment group due to the ITT approach. Also, if non-treated but offered farmers are included, can a causal impact of MI truly be explained? Technically, the question here is whether MI access (instead of provision and treatment) has an impact. But what is intended to be answered is whether MI has an effect, implying MI provision. On the other hand, the MI access question can be considered closer to reality, given low MI take-up rates in several countries, as mentioned earlier (see chapter 1 and 2.2.)

and given that no one can be forced to take-up MI. Hence, maybe insights of analyses about MI access (instead of provision) are more valuable for policymakers. Nonetheless, the framing of the research question and following causal analysis is key to understanding the findings and inferences.

Comparing the time horizons the two studies are similar as they both study short and long term impacts – with Cai (2013) analysing a longer time span. Hence, the time horizons offer no explanation for partly opposing findings. Ultimately, both studies rely on a large sample size, with Cai (2013) using the largest of all included studies. The ITT approach by Dietrich & Ibanez (2015), in addition, prevents drop-outs and secures a large effective sample size strengthening statistical power of the results.

Table 6: Assets

Outcome group	Impact level	Study	Outcome(s)	Direction and significance of treatment effect	Magnitude of treatment effect	Statistical power
d) Assets	Ex-post	Dietrich & Ibanez (2015)	i. Total value of assets ii. Liquid assets iii. Productive assets	i. Insign. effect ii. Pos. sign. effect** iii. Insign. effect (No effect on neither liquid nor productive asset given for poor households)	For values please refer to table 5 in the study, specification are also reported per wealth level	Medium
	Ex-post	Janzen & Carter (2013 a)	Asset depletion	Neg. sign. effect: • with IV model** • with Heckmann and DD***	22-36% reduction in likeliness to sell livestock	High
	Ex-post	Madajewicz & Tsegay (2013)	i. Number of oxen ii. Value of all livestock owned	i. Pos. sign. effect** ii. Insign. effect (depending on the district)	For effect sizes per district please refer to the findings section in the study	Low

Note: The significance levels of the treatment effect are ***p<0.01, **p<0.05, *p<0.1. The magnitudes of the treatment effects are based on respective statistical model outputs and group comparisons. The overall assessment of statistical power is based on statistical significance, sample size and the magnitude of the treatment effect.
Source: own construction

d) Assets

Three of the included studies investigate the impact of weather-related MI on the poor's privately held assets. Dietrich & Ibanez (2015) depict no effect of MI on the total value of tobacco farmers' assets and no significant effect on their productive assets. However, if land property is excluded from total assets and liquid assets are focused on, a significant effect for the treatment group is shown. This effect on liquid assets is especially strong for households that are actually hit by a weather-related shock during the study period. The authors inspect the effects on assets in more detail by focusing on households with different wealth levels (measured by assets): For poor households no effect neither on total nor liquid nor productive

assets can be shown. This evidently weakens the argumentation of MI to help the poor. Yet, for asset-rich households, a significantly positive effect is revealed for liquid as well as productive assets. Janzen & Carter (2013a) reveal that insured households are (ex-post) less likely to draw down assets. This counts especially for livestock, the primary assets hold by poor, Kenyan pastoralist farmers in their study setting. Therefore, MI seems to improve the farmers' ability to recover after droughts, increasing their resilience to weather-related shocks and ability to generate income. The effect is seen to be larger for livestock-rich households. Regarding treatment effect size, IV model results estimate insured households to be 36% less likely to sell assets in form of livestock. Similar statistically significant results (22-29%) are found for other methods (Heckmann model, DD analysis). Lastly, Madajewicz & Tsegay (2013) measure assets by the number of oxen, the most valuable farming animal and essential, long-term asset for farming in their setting. The study is set across a variety of villages and districts and results in a significant increase in the number of oxen on average. The authors further show that the effect persists both short and long-term (3 years). Depending on the district the number of oxen increases by 0.18-0.25 oxen for the insured compared to the control groups, from an average of 1.53 oxen owned per household in the beginning of the study period. Some districts even suffered a decline in the number of oxen, especially when hit by a shock. This behaviour shows the risk coping mechanisms of asset draw downs in case of shocks. However, no effect can be shown on total value of livestock – only insignificant effects in some districts. This, however, could be due to selling other livestock to compensate for and buy oxen as well.

The studies' findings reveal certain insights. As MI ought to affect investment decisions and higher yield production as seen, Dietrich & Ibanez (2015) should have seen a significant impact on production asset value, at least long-term. This is, however, not the case. Only insignificant effects are detected, even after 3 years, although the positive effect direction is in line with theoretical predictions. This might again be due to the ITT approach, underestimating effects and not revealing the true, full effect size. Madajewicz & Tsegay (2013), in contrast, show an increase in productive assets in form of the number of oxen. However, the results are only an average across several districts with heterogeneous effect sizes despite characteristic similarities. In addition, the different results in the studies might be due to diverse measures for productive assets (farming equipment vs. oxen) as well as regional (Colombia vs. Ethiopia) and agricultural (tobacco vs. crop/livestock) differences in the two study settings. Regarding liquid assets, the effect in Dietrich & Ibanez (2015) is clearly visible, indicating MI's potential for shock protection. The weak findings for MI impact by Dietrich & Ibanez (2015) are strengthened by Janzen & Carter (2013a). They show the same impact tendency since their shown negative effect on asset depletion equals the proven positive effect on asset value. The authors further reveal a stronger effect size than Dietrich & Ibanez (2015). On the one hand, this might be due to their treatment approach design. On the other hand, it might as well be due to their rigorous study executions: A larger sample size, a thorough sampling methodology and a clear experimental group arrangement and comparison. However, the chosen quasi-experimental design and accompanied high risk of biases could overestimate or distort true effect sizes. Hence, in total it is hard to give a solid estimation on the true effect size based on those studies.

Table 7: Consumption

Outcome group	Impact level	Study	Outcome(s)		Direction and significance of treatment effect		Magnitude of treatment effect	Statistical power
e) Consumption	Ex-post, ex-ante	Dietrich & Ibanez (2015)	i.	Total consumption expenditures	i.	Pos. insign. effect	OLS regression coefficients vary between 0.01 and 0.22 (please see table 5 of study for details)	Low
			ii.	Food consumption	ii.	Pos. insign. effect		
			iii.	Non-food consumption	iii.	Pos. insign. effect		
	Ex-post	Janzen & Carter (2013a)	i.	Human capital investments: Meal reduction	i.	Neg. sign. effect***	Probabilities for meal reduction/ food aid dependence reduced by 27-50% depending on model used (for details please see tables 5-7 in the study)	Medium
			ii.	Food aid dependence	ii.	Neg. sign. effect***		

Note: The significance levels of the treatment effect are ***p<0.01, **p<0.05, *p<0.1. The magnitudes of the treatment effects are based on respective statistical model outputs and group comparisons. The overall assessment of statistical power is based on statistical significance, sample size and the magnitude of the treatment effect.
Source: own construction

e) Consumption

There are two studies that analyse the impact of MI on ex-post consumption behaviour – both also included in the previous section on asset impact. Dietrich & Ibanez (2015) examine the MI impact on total consumptions as well as separately on food and non-food consumption of pastoralist farmers. The scholars find no significant effect for neither of the three outcome categories when inspecting the whole total sample. Even when looking at sub-samples such as shock experiencing households, asset-poor and asset-rich households, results remain insignificant for each of the three outcome categories. As seen by the ITT coefficients in the OLS regression, however, the effect directions are positive, meaning MI leads to an increase in consumption of the treatment group. This is valid for all outcome categories and sub-samples, as expected by theoretical argumentation (chapter 2.3). The coefficient is larger for households hit by a shock. Farmers do not seem to reduce their consumption in order to cope with shocks, especially when in distress. Using an IV estimation, Janzen & Carter (2013a) find that MI provision and payout lead to 27% less households using reduction of meal consumption as a drought coping strategy in the treatment group compared to the control group. These highly significant findings are valid across other analytical methods used (e.g. Heckmann and DD model), with the effect size varying between 28-36%. In addition and strengthening the results, calculated robust standard errors are small in size across all methods. Yet, there is the possibility that households 'receive' their consumption from elsewhere in case of shocks. Therefore, the authors run additional analyses on MI impact on consumption resistance and self-reliance, especially regarding food, being typical for the poor regions in Kenya. Analogously to the previous estimations, the authors run the analyses on the outcomes 'food aid' and 'support from others'. The results show that insured households are 42-

50% less likely to rely on food aid or support from others (more than normally) during droughts, with high statistical significance across all analytical methods and corrections.

In comparison, the two studies show the same tendency in effect direction. Weather-related MI is associated with a positive effect on consumption (mainly in terms of food). Yet, the studies differ largely in effect sizes and significance of findings. The insignificance of the results by Dietrich & Ibanez (2015) might lie in the low demand elasticity of food and the low share of non-food on total household consumption expenditures, as argued by the authors. On the other hand, the in-significant results strike as surprising since other positively impacted outcomes might interactively influence consumption: Other shock coping strategies can be used instead, e.g. increased debt with better conditions than the informal loans (as partly seen in part c) of this chapter) and farmers now may rely on increased short-term savings since those increase for treated households (as it will be partly seen further below in f)).

The two studies could further differ in results due to their study design and risk of biases, similarly as outlined in part d) regarding assets. The ITT approach used by Dietrich & Ibanez (2015) might underestimate the true effect size, as non-insured households included in the treatment group distort true impact magnitude. The quasi-experimental approach by Janzen & Carter (2013a) and the high risk of biases (see chapter 4.3.), on the other hand, may lead to overestimated effect sizes. In summary, the true effect size can hardly be assessed based on the in-cluded studies. Lastly, the statistical power of results calls for cautious assessment of the findings. The used sample sizes of both studies are relatively small com-pared with the other included studies in this review. While Janzen & Carter (2013a) rely on 600-1000 households for their impact estimations, depending on the method used, Dietrich & Ibanez (2015) include less than 500 households. In addition, the sample of the latter study is rather homogenous with similar tobacco farmers from a vicinity area with little differences in measured household charac-teristics. This further decreases the statistical power and thus the reliability of findings. Contrary, however, the high significance level of the findings by Janzen & Carter (2013a) boost their statistical power. Ultimately, the insignificant findings and low statistical power in Dietrich & Ibanez (2015) alarm us of a potential type II error: Is no significance detected because there is no MI effect given or is it be-cause of the low power? Meaning, does the low power cover the true significance of the effect size?

Implications on the findings – despite their significance – are that increased food security reduces the risk of malnourishment and saves households' income gen-erating ability. This in turn leads to greater shock resilience and poverty reduction. Together with MI's positive impact on assets, as seen before, this implies that MI can promote asset smoothing without negatively affecting consumption. Lastly, it would be insightful to see whether MI also impacts non-food consumption, e.g. education or number of kids in school, essential for the poor to escape the poverty trap long-term

Table 8: Savings

Outcome group	Impact level	Study	Outcome(s)	Direction and significance of treatment effect	Magnitude of treatment effect	Statistical power
f) Savings	Expost, (ex-ante)	Cai (2013)	i. Level of saving ii. Increase in savings rate iii. Saving composition	i. Pos. insign. effect ii. Neg. sign. effect** (short- and mid-term) iii. Pos. insign. effect	1.24pp (30%) lower increase in savings rate if treated with MI	Low
	Expost	Madajewicz & Tsegay (2013)	Amount of savings	Pos. sign. effect** (short-term)	123% increase in savings of treated households across all districts, with strong variations per district	Medium
	Expost	Dietrich & Ibane z (2015)	Amount of savings (chance to fall into low, medium, high category of savings)	Pos. sign. effect**/*** (total sample, subsample of shock households, subsample of poor households)	11% less likely to fall into low savings category (total sample) if MI access given	High

Note: The significance levels of the treatment effect are ***p<0.01, **p<0.05, *p<0.1. The magnitudes of the treatment effects are based on respective statistical model outputs and group comparisons. The overall assessment of statistical power is based on statistical significance, sample size and the magnitude of the treatment effect.
Source: own construction

f) Savings

The systematic search resulted in 3 studies that deal with MI impact on households' savings. Cai (2013) investigates three saving outcomes of Chinese tobacco farmers: The net savings, the composition of savings (fix- vs. flexible-term savings) and the saving rate (net savings relative to income). Relying on quasi-experimental DD and DDD models, the author finds only an insignificant negative impact of MI on households' net savings and none on the saving composition. The households' saving rate, however, is significantly affected by MI provision. Insured households increase their saving rate less (by 1.24 percentage points) than households in the control group. This is equivalent to a 30% decrease in households' saving rate. The effect persists even after controlling for additional household characteristic (e.g. household size, income, education level and age of the household head). Yet, it is only visible in the short-range of the 8-year sample period. Contrary to these findings stand the ones by the remaining two studies. Madajewicz & Tsegay (2013) find a significant, positive impact with insured farmers increasing the amount of savings by 123%, on average across all districts, from an average of 365 Ethiopian birr in the beginning of the study. The impact magnitude and significance vary, however, across districts and villages. Further, insured female-lead households increase the amount of savings less then male-lead households. This might be due to other prioritisations in agricultural inputs over savings. Similarly, Dietrich & Ibanez (2015) observe a positive impact of MI on savings, yet from a different edge. They divide the households into 3 categories of amounts saved – low, medium, high savings class – over the treatment period of 3 years. Across the whole sample, findings indicate that MI access leads to a lower chance of falling into the low saving category by significant 11%. For the

sub-sample of households experiencing a shock, the significantly positive treatment effect is even higher. If the impact is analysed regarding wealth, separately for asset-rich and asset-poor households, the effects draw a satisfying picture: Although rich households do not benefit from a positive effect of MI on savings, poor households in fact do. The underlying mechanism might be that in absence of MI poor households deplete savings in cases of shocks and thus profit from the safety of MI, while rich households might be able to use other coping strategies. This would be in line with the theoretical argumentations by academic scholars (see chapter 2.3). On a related note, the earlier discussed impact on liquid assets (see part d)) could partly be understood as savings. Nonetheless, the treatment effect directions and magnitudes seem similar to the ones for savings.

In comparison, there does not seem to be a full accordance of results regarding savings. While Madajewicz & Tsegay (2013) and Dietrich & Ibanez (2015) find significant positive impacts on saving amounts, Cai (2013) detects insignificant and significant negative effects on net saving amount resp. saving rates. These findings seem to have no logical accordance and depict a partly contradicting picture, yet the studies focus on different specific outcomes. The reasons may be diverse and hard to uncover. In the case of Madajewicz & Tsegay (2013), the results differ strongly per district and village and thus the true treatment effect might not be as clear as depicted by the overall, averaged effect size. As for Dietrich & Ibanez (2015) the high significance of the results strikes as surprising for the applied ITT approach and analysis execution (as discussed in the previous parts of this chapter). This does, however, even strengthen their findings. In the case of the contrasting findings by Cai (2013), the results seem not surprising when looked at the purpose specific study's argumentation. The author derives the predicted impact from a thorough theoretical two-stage model. The negative effect on savings in the second stage, as argued, results from an increase in consumption due to MI, leading to a 'safe' decline in savings short-term. The increase in consumption is in line with previous findings (part e)). However, even when focusing on specific time horizons, as for example a short-term impact, the contradiction of findings cannot be resolved. The reasons for that may vary. First, these three studies are among the most heterogeneous ones in comparison, regarding study design, approach, models, sampling etc., affecting study results. Second, even theoretical argumentations, leading the following empirical evaluations, differ for MI impact on savings. For example, some authors argue that safety through MI reduces necessity of saving buffers. While others point out that the possibility and financial independence of households increases with MI, and hence savings might increase (see also chapter 2.3). Further, the complexity of MI causal impact theory increases as MI affected variables have interdependent effects on and interactions with each other. For example, it could be that savings increase with MI, but after all, the saved amounts are invested in production in order to generate income (making the studies' time horizons an important factor once again). Lastly, the results may strongly depend on the study-specific settings. The poorest will hardly be able to save, while the relatively poor (e.g. lower-middle-income) might be able to make savings and dissave in case of shocks (Hellmuth et al. 2009: 1; Cole et al. 2012: 1; Janzen & Carter 2013b: 6). Nonetheless, a partially discrepancy of the findings leaves questions about the 'why' and 'how' of the causal impact of MI on savings. This calls for further, more segmented evaluations as well as for deeper research on clear causal models of MI impact, including various affected outcomes and their interaction effects. Bottom line, however, the two studies by Madajewicz & Tsegay (2013) and Dietrich & Ibanez (2015) indicate a clear positive, high power picture of MI impact on savings, especially on savings amount.

Table 9: Income

Outcome group	Impact level	Study	Outcome(s)	Direction and significance of treatment effect	Magnitude of treatment effect	Statistical power
g) Income	Ex-post	Dietrich & Ibanez (2015)	Income and tobacco income	Pos. insign. effect for total sample and sub-samples	-	Low

Note: The significance levels of the treatment effect are ***p<0.01, **p<0.05, *p<0.1. The magnitudes of the treatment effects are based on respective statistical model outputs and group comparisons. The overall assessment of statistical power is based on statistical significance, sample size and the magnitude of the treatment effect.
Source: own construction

g) Income

Only one study explicitly assessed MI impact on households' incomes and based on all studies included in the review, income rather constitutes a secondary, non-intermediate outcome. Dietrich & Ibanez (2015) analyse farmer's income by two measures separately: Their total income per capita as well as their income per capita generated through tobacco farming, mainly targeted by the weather-related MI. The ITT regressions, however, show no significant MI impacts. Neither for one of the income measures on the total sample, nor for them on the sub-samples of households experiencing shocks, poor or rich households. Reasons for the insignificance might be the time horizon. As the weather-related index insurance is a new product introduced in the villages, farmers' confidence in MI and their change in risk-taking behaviour might take more time than given by the study's time horizon. The effect on income might then be rather seen in the long run.

From those results only it is hardly possible to make any inferences on true causal MI impacts. This realisation is also picked up by Cole, Giné & Vickery (2013). Although the authors do not explicitly test ex-post income impacts, their ex-ante MI evaluation on production behaviour impact theoretically implies income-smoothing effects. Yet, the authors call for explicit research and impact evaluations on MI's effect on income. Income remains a causally complex affected MI outcome. It is normally volatile in poor regions, influenced by many factors in the life of the poor and its sensitivity highly depends on the study setting. Hence, specific and rigorous evaluations are needed to measure the true effect size of MI on income. Nonetheless, potential positive effects on income could be a major MI impact lever, powerful to help the poor out of poverty and into well-being, since income remains a crucial and vital factor in the life of the poor more than it does in developed countries.

4.4.2. Further studies

As previously mentioned, the systematic literature search revealed 3 additional studies. They do not fully meet the inclusion criteria, yet contain insightful content to the matter at hand of this review. Hill & Viceisza (2012) take a different research approach than all the included studies. The authors conduct a 'framed field experiment' in the form of a simulated, controlled framed game protocol (being the main reason for the study's exclusion). The authors modeled a common farmer investment decision under weather uncertainty with and without MI, namely buying high-risk-return fertilizer or holding cash. Over 261 Ethiopian farmers play a total of 12 sessions of the 4-round game that is derived from a two-period theoretical choice model. The farmers' returns depend on a stochastic model including weather probabilities. Randomisation takes place at several levels (MI provision, assigned weather situation, etc.). The study's focus is similar to the ones discussed under

part a) on production and investment decisions and the findings tilt in the same direction: MI leads to higher risk investment decisions – namely in fertilizer – as well as to higher returns. The authors' reasoning is very close to the one by Cai et al. (2009) and based on similar theoretical foundations, although being published almost at the same time. Despite its special character, the study has certain advantages: The mandated MI provision reduces selection bias and increases the power of the results. This is hardly possible in natural settings, as with RCT. It is, however, not as realistic as real life MI markets. Further, the game protocol is less constrained, e.g. regarding credit and trust. Still, the DD analysis allows to control for certain confounding factors (wealth, order effects, socioeconomics, etc.). Bottom line, findings indicate a significantly positive impact of MI on fertilizer purchase and thus higher return yields (+29%) and even larger if participants had to pay for the MI.

The comprehensive impact evaluation by Mobarak & Rosenzweig (2012) set in India focuses primarily on MI demand (being the main reason for the study's exclusion) - Namely the impact of informal risk-sharing and basis risk on index insurance take-up. Relevant, however, is a minor part of the study that evaluates formal MI impact on risk-taking in comparison with informal loans common for poor rural regions. The strict RCT design, solid sampling methodology (over 5,500 households from 62 villages) and rigorously executed analysis make the findings worth mentioning. Based on an extensive theoretical model the authors find that formal MI increases risk-taking as insured households significantly plant portfolios of rice with higher yield, yet with less drought resistance. This in turn is bound with higher expected returns and should lead to greater welfare and income. Informal insurance, on the other hand, decreases risk-taking, especially after adverse shocks. Hence, in the light of these negative effects of informal insurance MI's positive impact shines even brighter. Similar to Hill & Viceisza (2012), Mobarak & Rosenzweig (2012) confirm the findings discussed in a).

Lastly, Mobarak & Rosenzweig (2013b) show a glimpse of MI's negative side. The MI impact evaluation on the meso- and macro-level – the main reason for the study's exclusion – deals with the agricultural labor market in 3 Indian states. Besides farmer households, agricultural wage laborers (non-farming households) are included in order to examine general equilibrium effects: MI impact on labor supply, labor demand and equilibrium wages. Similar to Mobarak & Rosenzweig (2012) and unlike most of the included studies, the authors rely on a rigidly executed RCT design, solid sampling methodology and clear randomisation. Their key take-away is that MI impact differs depending on the recipient. MI offered to farmers induces a switch to riskier, high-yield production methods, in line with previously mentioned findings in part a). However, implications are that output, labor demand and equilibrium wages become more rainfall sensitive. The overall impact indicates that selling MI only to land-owning farmers and precluding the landless laborers from the MI market leaves laborers worse off. Even compared to the case of no MI being introduced at all. Hence, welfare costs are born by the poorest, namely the landless laborers. For most MI markets around the world, it is common practice that MI is targeted at farmers only (Mobarak & Rosenzweig 2013b: 27). Thus, such negative MI sides are important to analyse if the true MI impact is to be estimated. Nonetheless, the question remains whether the study's setting and findings are generalizable, since the Indian MI market has some specific characteristics. On the other hand, and although not as common, MI can also be sold to agricultural wage laborers in form of income safety against weather shocks. The effect is that wages are positively smoothed induced by changes in labor supply. If MI is offered to both parties at the same time, findings indicate that the opposing sensitivity effects cancel each other out, leaving a net effect of only slight increases in wages.

The overall impact assessment per outcome group is based on the aggregation of single study findings assessed in the synthesis (chapter 4.4.1.) and shall only give

indicative assessment on binary MI impact, i.e. MI impact is rather given or not. The shown results must be treated with caution as they are based on aggregated findings from the studies and their specific contexts. The generalizability of the depicted results thus is limited.

5. Conclusion

This review's systematic literature search resulted in 7 studies analysing weather-related MI impact on the poor. All studies deal with farmers facing the risk of weather shocks in poor regions around the world as well as with weather-related MI interventions. Compared to other, more extensive systematic reviews on adjacent topics this review contains a smaller number of included studies, given the selection criteria and process (see e.g. Grimm & Paffhausen (2014) and Cole et al. (2012) with 54 resp. 13 studies included).

In order to depict an indicative picture of weather-related MI impact the author grouped the analysed outcomes in the included studies. Per group, the studies differ strongly in what and how they measure MI impact exactly, e.g. production amount (maize, sows, tobacco) or loans (informal, formal, value, interest rate, etc.). MI seems to have most constant, significantly positive effects on directly production related outcomes ex-ante to weather shocks. Treated farmers seem to engage in higher risk-return decisions regarding input factors, such as crops, fertilizers or land size. These findings are even valid for different settings and are found in 4 studies, one of them the only RCT included in this review. Ex-post to weather shocks, MI seems to increase production results and productivity, such as maize yield. Further, significantly positive impact is found for farmers' savings (amount of savings) and assets (value of liquid assets, less asset depletion). Yet, these findings need to be treated with caution as they are partly based on non-rigorous studies with risks of biases. For other outcomes, however, no impact was found or the studies' findings depict an unclear picture. Insignificant effects were found e.g. for income and certain consumption and asset types. Regarding loans and debt, the two relevant studies even present contradicting findings (positive vs. negative) in general, despite high significance and statistical power of the results.

What we learned from the synthesis is that sub-categories matter when assessing true impact. Although effect sizes and significances remained low for outcome groups in general, impact was found for certain specifications: Productive vs. consumptive loan use, productive vs. liquid assets, high vs. low household wealth level, etc. Furthermore, theoretical foundations matter as they form the basis of the impact evaluations. Yet, in the case of weather-related MI, this basis is partly unclear and contradicting impact predictions exist. This calls for further research in theoretical, causal MI models in this rather young academic field.

This review also includes an assessment of the studies' risk of biases since biases can negatively influence clear causal inferences. There was only one study – the RCT by Cole, Giné & Vickery (2013) – that was assessed with a total low risk of bias. Unfortunately, this study's rigorous impact analysis only focused on ex-ante production and investment decisions. All the other findings are based on non-experimental studies. These studies include a variety of biases with some of them even assessed to be of high risk (see chapter 4.3). This can cause distortions when making causal inferences and was thus considered in the synthesis of the evidence.

Overall, the results of this review give mixed answers to the review's lead questions stated in chapter 2.5. The evidence regarding weather-related MI impact on ex-ante risk management decisions is rather clear. It seems to increase investments in risky inputs while serving as a safety net in case of weather shocks, thus increasing farmers' expected returns in total. The evidence regarding weather-related MI impact on the ex-post shock coping decisions is diverse and partly unclear. Some evidence is given, such as on asset depletion or asset value, while the effect on other outcomes, such as income as well as loans and debt remains low or unclear. Some positive effects of weather-related MI are clearly linked to increased well-being (e.g. higher farming returns). Thus the lead questions – whether MI can help to alleviate poverty and increase well-being – can partly be answered with a 'yes'. Nonetheless, this review cannot give a clear, unique answer on the absolute, true impact of weather-related MI at this point. Similarly, this review cannot clearly answer the question whether MI's impact is a cause for its low demand in some markets. It seems that some impact is given and that other causes as mentioned in chapter 1 are more influential regarding low take-up. Yet, maybe this exact non-definite answer on MI impact affects its take-up as the MI story seems not too convincing based on the evidence. Finally, this review shows the large gap of evidence on weather-related MI impact at the time. Given the large heterogeneity across the included studies and the rather small sample size, it is difficult to identify the true impact of weather-related MI.

Research on weather-related MI seems to be at an early stage. On the one hand, more rigorous empirical research on weather-related MI impact is needed to be able to synthesis and meta-analyse the true effects. On the other hand, solid theoretical causal frameworks and structured, agreed-upon outcome hierarchies are needed. To date no unified theory basis is used in the few empirical evaluations. Further research recommendations include finding and agreeing on absolute measures for MI impact, acknowledging the importance of sub-categories and the need to drill-down impact analyses as well as thoroughly evaluating moderating factors of weather-related MI impact.

Lastly, a critical examination of this review remains. First, due to the problems encountered during the review process the author focused rather on comparing effect directions and significances and was not able to conduct a quantitative analysis of MI impact. This clearly limits the quality of this review's evidence. Second, the systematic literature search in large, general databases created much noise in the results and some relevant studies might not have been detected. A complete analysis of all extensive search runs (several 100,000 hits for some databases, see Appendix B1) was not possible due to time and resource constraints. On the other hand, specialised databases may have been too narrow to reveal additional studies and might only include similar evaluations. A wider and more extensive literature search might have resulted in additional, relevant hits. Nonetheless and as weather-related MI is still a young research field there might just not exist many relevant studies yet. Third, the generalizability of the results is limited due to the small sample size and the differing measured outcomes of the included studies. Thus, the author focused rather on the evidence gaps and future research recommendations than on the external validity of findings. Fourth, the indicative, relative rather than absolute displayed impact sizes call for cautious assessment. They are hardly comparable as they are based on different study approaches and statistical model outputs as well as on aggregated outcome groups. Fifth, it might have been interesting to consider common, upcoming intervention types, such as credit and insurance bundles. This might widen the study pool and generate additional insights into weather-related MI impact.

6. Appendix

Appendix Part A: Methodology

Appendix Part B: Results

Appendix Part A: Methodology

Appendix A 1: Risk of bias assessment

Bias	Description and occurrence criteria
Selection bias	Systematic differences between baseline characteristics of the groups that are compared, especially due to the allocation process. Bias is given if there is not enough evidence showing that the allocation mechanism generates equivalent groups. The groups are not balanced on observables, and not all relevant confounders are taken into account in the analysis: • Does the allocation mechanism generate equivalent groups? • Does the model of participation capture all relevant observable and unobservable differences in covariates between the groups? • Are any unobservable, characteristical differences among groups likely to exist? • Is there any evidence of self-selection? And is there any control for it? Especially in studies using a DD approach: • Do trends in characteristics of compared groups differ? • Is any time varying selection bias or time invariant unobserved heterogeneity in pre-test characteristic differences of groups given?
IV estimator biases (IV approach)	a) Biased instrumental variable estimator: Bias is given if no independence of parts of the instrumental variable (IV) with respect to the unobserved characteristics affecting the outcome is given (violation of exclusion restriction) b) Weak instrument bias: Bias is given if the instrument does not properly explain program participation
Hawthorne effect	Bias is given if there is evidence that subjects modify an aspect of their behaviour being experimentally measured simply in response to the fact that they know that they are being studied • Are differences in outcomes across the groups influenced by participant motivation as a result of program implementation and/or monitoring?
John Henry effect	Bias is given if there is evidence for an experimental bias introduced by a reactive behaviour by the control group
Confounding and group equivalence, including potential omitted variables and attrition	How well do the studies control for external confounders (such as omitted variables) and other factors that may invalidate group equivalence during the process of implementation of the program (such as non-random attrition). Attrition is given if systematic differences between groups in withdrawals from a study are observed as either participants are omitted despite data being available, or participants drop out unexpectedly. • Is the method of analysis adequately executed? • Are the groups balanced on observables, and all relevant confounders taken into account in the analysis? • Is non-random attrition a threat to validity?
Spill-over effects	Bias is given if there is evidence that the program influences the outcome of the individuals in the comparison group (including compensating investments for the comparison groups).

Source: Based on Waddington et al. (2012); De Bock & Ontiveros (2013); Grimm & Paffhausen (2014); Higgins & Green (2011): 8.4.2., 8.4.2.a.

Appendix Part B: Results

Appendix B 1: Search log – Databases and search terms used and hits recorded

Database / website searched	Link
Google scholar	https://scholar.google.com/
Social Science Research Network (SSRN)	http://papers.ssrn.com/sol3/DisplayAbstractSearch.cfm
British Library of Development Studies (BLDS)	http://bldscat.ids.ac.uk/cgi-bin/koha/opac-search.pl
Joint Libraries of the World Bank and IMF (JOLIS)	http://external.worldbankimflib.org/uhtbin/webcat/
Science Direct - Elsevier	http://www.sciencedirect.com/science/search
3ie impact evaluation repository	http://www.3ieimpact.org/en/evidence/impact-evaluations/impact-evaluation-repository/
Abdul Latif Jameel Poverty Action Lab (J-PAL)	http://www.povertyactionlab.org/evaluations
Research for Development (R4D) – Department for International Development (DFID)	http://r4d.dfid.gov.uk/Search/SearchResearchDatabase.aspx
Climate-Eval	https://www.climate-eval.org/search/node
Microinsurance Network	http://www.microinsurancenetwork.org/resources
Microinsurance Centre	http://www.microinsurancecentre.org/resources/documents.html

Source: own construction; Last checked: January 14th, 2016

Appendix B 2: Included studies – Overview and characteristics

	Cai et al. (2009)	Cai (2013)	Cole, Giné & Vickery (2013)	Dietrich & Ibanez (2015)	Janzen & Carter (2013a)	Madajewicz & Tsegay (2013)	Miura & Sakurai (2015)
Title of study	Microinsurance, Trust and Economic Development: Evidence from a Randomised Natural Field Experiment	The Impact of Insurance Provision on Households' Production and Financial Decisions	How Does Risk Management Influence Production Decisions? Evidence from a Field Experiment	Impact of Weather Insurance on Small Scale Farmers: A Natural Experiment	The Impact of Micro-insurance on Asset Accumulation and Human Capital Investments: Evidence from a Drought in Kenya	Managing Risks to Agricultural Livelihoods: Impact Evaluation of the HARITA Program in Tigray, Ethiopia, 2009–2012	The Impact of Formal Insurance Provision on Farmer Behaviour: Evidence from rural Zambia
Author(s)	Hongbin Cai, Yuyu Chen, Hanming Fang, Li-An Zhou	Jing Cai	Shawn Cole, Xavier Giné, James Vickery	Stephan Dietrich, Marcela Ibanez	Sarah Janzen, Michael Carter	Malgosia Madajewicz, Asmelash Haile Tsegay	Ken Miura, Takeshi Sakurai
Year of publication	2009	2013	2013	2015	2013	2013	2015
Type of publication	Working paper (NBER)	Working paper (MPRA, University of Michigan)	Working paper (The World Bank)	Discussion paper (Courant Research Center)	Research paper (ILO)	Evaluation report (Oxfam America)	Discussion paper (PRIMCED)
Language	English	English	English	English	English	English	English
Region	Asia	Asia	Asia	South America	Africa	Africa	Africa
Country	China (Southwest)	China (Southeast)	India	Colombia	Kenya (northern)	Ethiopia	Zambia
Population and context	Farmers, poor rural households; agriculture, sow production; Guizhou province, low-income region (p.11)	Tobacco (crop) farmers; tobacco sensitive to weather shocks; Jiangxi province, poor rural mountain area	Farmers, small agriculture households; semi-arid region with rainfall shocks especially during monsoon as main production and income risk	Poor, small-scale tobacco farmers, strongly affected by climatic shocks and highly vulnerable to poverty; 2 big tobacco firms contracting farmers, firms used for comparison as only 1 firm offered insurance to	Poor pastoralist farmers, livestock as primary asset and source of income; extreme droughts; Marsabot district in northern Kenya	Smallholder crop farmers, agriculture households; drought-prone northern state of Tigray in Ethiopia	Small-scale, rural farmers; Semi-arid tropics, southern province of Zambia; people depend mainly on rain-fed agriculture, maize as major staple food produced, high fluctuations in maize yield due to strong

				farmers			rainfall variability; mostly no access to irrigation systems to deal with rainfall risk
Time of study	11/21/07 to 12/25/07, 5 weeks experiment	2000-2008, long-term view included	June to December 2009, 7 months	2009-2012, household characteristics date back to 2005	2011-2012, household data dates back to 2009	2009-2012, two intervention periods used	2012-2014, household data dates back to 2011
Intervention details	Formal indemnity insurance for sows against common risk of rural farmers as e.g. pig disease, mortality, wind storms, blizzards, thunder, floods (p.8). Each sow has an identification number to be reported in case of a shock in order to receive a payout.	Indemnity-based weather insurance in tobacco production; tobacco production is greatly influenced by weather risks, e.g. floods, heavy rain, windstorm, extremely high or low temperatures; subsidised, mandatory, formal indemnity insurance	Rainfall index insurance for farmers at the start of the monsoon, mitigating their exposure to rainfall risks. Insurance provision shall influence subsequent production decisions. Intuition: MI makes risky activities more attractive for risk-averse farmers, by reducing the volatility of returns on production activities.	Agricultural indemnity insurance against climate risks, e.g. crop failure, excessive rain or wind, floods, hail, droughts, land slides; Public, governmental insurance program partly subsidised; Access to rather than provision of insurance is analysed (Intention-to-treat approach).	Index-based drought insurance against weather risks affecting farmers' livestock	Weather-index insurance mainly against droughts (HARITA program); insurance premiums can also be paid with labor to make MI affordable even for poorest, cash-constrained farmers	Agricultural weather-index insurance against extreme rainfall variability, e.g. droughts, floods; high premium rates and low premiums; payouts meant to compensate for input cost when heavy rainfall happens
Unit of analysis	Village level, via AHW (Animal husbandry worker), 1 AHW per village, act as a bridge between MI institutions and farmers in matters of animal husbandry and insurance	Household level, tobacco and non-tobacco farmers	Household level, farmers	Household level, farmers	Household level, farmers	Household level, farmers	Household level, plot level, farmers

Impact focus	Ex-post	Ex-ante, Ex-post	Ex ante, (Ex-post)	Ex ante, Ex-post (partly no specification per outcome)	Ex-post	Ex-ante, Ex-post	Ex-ante
Outcome(s)	Impact on sow production: Positive effect of insuring sows on sow production and efficiency. More produced sows despite already given informal insurance mechanisms proof improved production (p.4f)	Impact on households' production, borrowing, saving behaviour; both short- and long-term	Impact on ex-ante decision making: Investment decision measured by investment in inputs (seeds, fertilizer, pesticide, hired labor, etc.) and in higher-risk-return cash crops (castor, groundnut). Impact on ex-post consumption and income smoothing.	Impact on loan amounts and financial assets; focus on short-term impact	Impact on expected asset accumulation and human capital investment, risk transfer and ex-post shock coping strategies; insurance payout induced by drought in 2011	Impact on a) resilience to drought (drought shock coping strategies, consumption, asset depletion), b) improvement in productivity (production investments, especially in growing seasons with good rainfall)	Impact on farmers' production behaviour and agricultural decision making, especially investment in (profitable) agricultural technologies
Impact findings *(statistically significant effects if not stated otherwise)*	Formal insurance raises farmers' tendency to raise sows, alleviating farmers from poverty; effect is stronger for the high incentive group	MI increases the production amount and (crop) focus; MI increases borrowing (average loan size) and effect persists long-term; MI decreases saving rate, effect persists only short- and mid-term; MI has no significant effect on the level of saving and composition of saving; no	MI has insign. effect on total agricultural investments (e.g. fertilizers, seeds, land size planted) if all crops are studied. Yet, positive significant effect given if main cash crops are analysed: Treated households allocate more inputs to the production of main cash crops. MI causes shifts in investment composition towards higher-risk-return cash crops; Effect is stronger	MI access decreases the chance of acquiring (costly) informal loans and using loans to repay debt; effect persists also for farmers hit by weather shock; MI increases access to use of loans with lower interest rates and longer maturities; MI increases savings and accumulation of liquid assets, especially for poorest households and households hit by shocks;	Insured households are ex-post a) less likely to draw down assets (esp. livestock), improving the ability to recover after droughts, with the effect being larger for livestock-rich households; b) less likely to reduce meals with the effect being stronger for livestock-poor households; c) less dependent on food aid and assistance from others. MI helps households	On average across all 3 studied districts: MI increases savings short term (2009-2010), increases number of oxen (the most valuable farming animal) short and long-term (2009-2010-2012), increases application of compost as fertilizer short-term. Several more findings were depicted, e.g. on improved seeds, but were not significant across a majority of	MI provision leads farmers to sow maize earlier, increasing both yield and risk in terms of rainfall variability, both on household and plot level; insured farmers enlarge maize field size and use more urea fertilizer; all effects are significant even after controlling for endogeneity in insurance demand, valid for all 3 treatment groups compared to both control group, both on

	effect given on households changing from non- to tobacco sector.	among more educated farmers (years of schooling) .	MI has no sign. effect on income, use of loans (productive vs. consumptive), consumption expenditures and value of assets.	to protect assets during shocks, without affecting human capital investments. MI has no effect on diversifying into non-livestock activities.	villages.	household and plot level MI has no sign. effect on new maize seeds used (instead of low risk, recycled seeds from previous season) or use of early maturity seeds
Study design	Quasi-experiment, randomised natural field experiment	Quasi-experiment	Randomised controlled trial (RCT)	Quasi-experiment; ITT approach; natural experiment	Quasi-experiment	Quasi-experiment	Quasi-experiment
Randomi-zation	Randomised assignment of AHWs into 3 performance incentive schemes in terms of number of sow insurance purchased by farmers in their villages (p.10). For the authors' reasoning for the randomisation process please see p.11f. Randomisation tests (mean difference and randomisation probability regression) indicate good quality of randomisation (p.16f). Test for parallel trends	No randomisation across areas with and without treatment, eligible and non-eligible households (tobacco vs. non-tobacco households); Purchase of insurance in treatment area was compulsory (take-up decision not endogenous).	Rainfalls insurance is randomised across sample, half of the farmers receive MI (treatment group), other half does not receive MI (control group, fix cash payment as compensation) Randomisation across households via scratch card, assigning households to either one of the groups independently, randomly and before conducting baseline survey.	No randomisation of intervention across farmers; randomised drawing of farmers for each of the 2 groups separately	No randomisation of intervention across households; treatment and control group drawn by self-selection (later controlled for). Randomisation: a) 60% of households received MI discount coupon, b) randomly selected households participated in experimental game communicating MI concept.	No randomisation in intervention distribution across households; 3 control villages (within each of 3 treatment districts) were randomly selected; households selected randomly from households that purchased and who did not purchase MI in treatment villages, and from households in control villages.	No randomisation in intervention distribution across households; But randomly selected households from households that were offered MI and who were not offered MI (treatment and control group)

	between group villages before the experiment, but different trend between groups after experiment (p.18).		Test reveals no statistically significant differences between treatment and control group.			
Methods of analysis	Instrumental variable regression (insured sows as IV) to test causality of sow insurance and production; OLS regression	Difference-in-difference (tobacco households treatment vs. control area); triple-difference (further control for region-specific trends)	Tobit and probit regression model; heterogeneity test on treatment effect	OLS regression, Heckman selection using, tobit model and inverse Mills ratio; additional robustness check analyses	Heckman selection using probit model and inverse Mils ratio (to control for selection bias), instrumental variable approach, difference-in-difference approach	Difference-in-difference approach (3 periods); conducted twice, one for good rainfall season 2010 (analysis for 2009-2010) and one for drought season 2012 (2009-2012)	Instrumental variable (control function) approach, tobit and probit model
Data source	Data collected by researchers, matched with two other official data sets (p.13)	Household level panel data from 2000-2008, provided by Rural Credit Cooperatives (RCC); data containing administrative and survey data	2/3 of farmers selected via a stratified random sample of land-owning farmers in 37 villages from 2004 study; additional 500 households drawn from 37 villages in 2008. Follow up survey after growing season.	Household-level survey conducted	Household-level surveys conducted (3 rounds, main round right after insurance payout)	Panel data from 3 rounds of surveys	Household survey done in 3 locations alongside Lake Kariba, 3 different datasets used
Sampling methodology	3 AHW groups: No incentive for insured sows (control group), low incentive group (2 Yuan per insured sow), high incentive group (4 Yuan per insured sow) (p.12)	Tobacco farmers from treatment area receive MI; 3 control groups: tobacco households outside treatment area and non-tobacco households both within and outside treatment area (p.2)	2 groups of farmers: Insurance provided vs. no insurance (but cash payment as compensation). Baseline survey conducted to receive data on demographics, farming practices, etc. Concept of insurance was explained to	2 tobacco companies contracting farmers in same region, only 1 firm offering MI access to their contracted farmers; farmer groups are similar in terms of large set of socioeconomic factors before insurance program	2 household groups: Treatment (self-selected take-up of MI) vs. control group (no take-up of MI).	5 villages (tabias) in 3 districts (woredas) were HARITA program and MI was operating; 3 control villages from each district; districts differ in climate, socioeconomics and soil aspects;	Households of 9 villages from 3 locations with slight weather differences; 3 different datasets; 400 households in census survey, 160 households randomly chosen to be offered

			farmers.	was implemented.		surveys were conducted after farmers made MI purchase decision; households were selected using proportional and stratified sampling	MI; 5 groups: Treatment groups 1, 2 and 3 bought MI and received additional free, small payout (75, 50, 25 Zambian Kwacha); control group 1 also bought MI but received no free payout; control group 2 was not offered MI
Sample size	480 villages/ AHWs	6,548 households, 3,580 of them are tobacco households, 1,429 are in the treatment area; farmer households from 12 tobacco counties in Jiangxi, China, 4 counties serve as treatment areas	1,479 small agricultural firms, mostly single families, drawn from 45 villages in two districts in Andhra Pradesh, Mahbubnagar and Anantapur (India)	468 of 2,242 tobacco farmers in the studied regions were interviewed for survey data, either working for tobacco firm A (access to MI, treatment) or firm B (no MI access)	924 randomly selected households in the MI access area	379 households from 8 villages (tabias) in 3 different districts (woredas); 202 households purchased MI and 82 did not within the treatment villages, 95 households in control villages	209 households from 9 villages
Length of follow up	3 and 6 months after insurance was provided	Short- and long-term (8 years)	No exact info given	No exact info given	No exact info given	Short-term (1 year) and long-term (3 years)	No exact info given
Use of control group	1 control group with no incentive paid to AHW per insured sow	3 control groups: Tobacco households outside treatment area and non-tobacco households both within and outside treatment area (p.2)	1 control group: No insurance given, but cash payment equivalent to insurance payout.	1 control group: Farmers of the tobacco firm that did not offer access to insurance	1 control group: Households who despite access did not buy MI	1 control group: Non-insured households from same districts as treated households	2 control groups: Households who bought MI after being offered but did not receive any additional free payout, households who were not offered MI

Source: own construction

Appendix B 3: Overview of studied outcomes per study

	Cai et al. (2009)	Cai (2013)	Cole, Giné & Vickery (2013)	Dietrich & Ibanez (2015)	Janzen & Carter (2013a)	Madajedajewicz & Tsegay (2013)	Miura & Sakurai (2015)
a) Production & investment decisions		X	X			X	X
b) Production results & productivity	X	X					
c) Loans & debt		X		X			
d) Assets				X	X	X	
e) Consumption				X	X		
f) Savings		X		X		X	
g) Income				X			

Source: own construction

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