According to the World Bank, around 2.2 billion people, or almost 31% of the global population, live on incomes less than $1.25 a day, with 3.6 billion living on less than $2 per day [1]. People living on such low incomes usually have no access to formal financial services. In particular, they often have little access to formal risk management solutions, including traditional insurance products. As a result, the world’s poor are often the most exposed to the impact of many high-risk events that can cause financial difficulties in their lives.

This article gives an introduction to one possible approach to mitigating the impact of high-risk events on low-income groups: microinsurance.

1 What is microinsurance?

Microinsurance in simple terms means insurance for poor people in low-income economies. The way insurance works is that premiums are collected from a, preferably, diversified risk group and this money is used to pay claims to members of this group when an insured event takes place. Microinsurance differs from traditional insurance in its target market (low-income groups), its low premiums (to ensure affordability), and its product design (tailored to meet the needs of the poor). More detailed information about microinsurance can be found in Allianz (2010) [2] and the International Labour Organisation (2012) [3].

2 Why microinsurance?

Microinsurance has the potential to play a crucial role in reducing poverty and in improving living standards for poor communities in low-income countries. The poor in such countries are vulnerable to many high-risk events that can cause financial shocks in their lives. Some of these risks are ill health, death, fire, floods, livestock losses, crop destruction, and job loss. Their risk mitigation and coping strategies include low-risk investments (liquid assets) and informally supporting each other within communities. The consequences of these strategies are low returns for participants (which limits their effectiveness). For example, in Bangladesh, a village has about 2,000 people of which a community would be considered a group of about 20 people who live close to each other. If these risk strategies fail then those affected are often forced to sell their assets or, in extremis, take their children out of education – this has ramifications across generations. Since various other tools can be used to manage the risks of the poor, such as credit, savings, social protection programs and donor programs, a 100% microinsurance take-up by the poor is not expected. However, microinsurance has advantages over other risk-coping programs. Insurance is not contingent on disaster relief from government or donor funds as long as the provider is adequately capitalised and reinsured. Therefore, large claim payments can be made when need is highest. In contrast, social protection programs and donor funds have to cease providing financial support when they run out of funds. Insurance is contractual and is less vulnerable to an unstable political economy. In this way, insurance differs from credit or savings, which generally tend to be driven by interest rates; from government protection funds, which may vary if the national budget is reviewed; and from donor programs, which may require government permission for implementation and no guarantee of continuity. The main advantages of microinsurance over other programs are that it provides tailor-made risk mitigation solutions for the poor, gives access to finance in some cases, for example crop insurance, and allows the poor to better access services on a day-to-day basis where other programs would not be implemented, for example health microinsurance.

3 Microinsurance products

Microinsurance products cover a wide range of risks such as those relating to health, life, credit, crop and cattle. These can be offered as stand-alone insurance products covering one risk category or as a more comprehensive and effective packaged product that bundles together the higher risk events. For example, in Bangladesh the SAJIDA Foundation [4] offers a bundled microinsurance product that covers health, life, fire losses, and provides some educational and legal benefits. Similarly CIC in Kenya has a bundled product that includes funeral, personal accident, inpatient health coverage, and disability income loss.

4 Weather index microinsurance

4.1 The need for crop microinsurance

In low-income countries, a high proportion of people depend directly on agriculture with farming at a subsistence level prevalent. These subsistence farmers and their families are highly vulnerable to adverse weather events, such as droughts, and the impact of such events can have long-term effects on communities. Informal risk mitigation strategies are particularly vulnerable to severe weather events, because as a result of localised pooling of risks, everyone in the pool needs help at the same time. Crop microinsurance can potentially provide a useful way for farmers to manage their risk, especially the risk of severe events that affect a whole village or region.

Crop microinsurance provides further benefits beyond direct protection from agriculture losses. Microfinance lenders are usually more willing to provide loans and are often prepared to offer better terms to farmers who purchase crop microinsurance as the risk of default is reduced by the crop microinsurance product. This in turn allows farmers to increase investment in their business.

Weather index insurance is one example of a crop microinsurance product.

4.2 Index insurance

Traditional insurance products sold in a high-income country often offer indemnity-type coverage, that is, the claim payment is made only when an actual loss is incurred and the payout aims to cover the amount of the loss or some other specified amount.
An alternative is an index microinsurance product, such as a weather indexed microinsurance product. Rather than compensating the farmer for their exact losses, a weather index microinsurance product pays out when a specified, measurable event happens. For example, a product in India covering a crop where the yield is sensitive to the amount of rainfall might pay 1,000 rupees for every centimetre of rainfall less than 10 centimetres, as measured at a specified weather station (Figure 1), over the growing season up to a maximum of 5,000 rupees. So, the insurance payout depends only on the specified, measured weather event and on the index used to specify the claim payment.

Weather indexed microinsurance can substantially reduce the cost of providing insurance relative to indemnity insurance. In particular, settling claims is a lot cheaper and faster if the claim depends on an easily verifiable event as there will be no need for a claims adjuster to visit the insured to assess the loss. In addition, since claim payments do not depend on the actual profits or losses incurred by the farmers, there is little scope for fraudulent claims. An additional benefit is that farmers continue to have an incentive to maximise their agricultural output, since the claim payout will be paid if the specified weather event has taken place even if the farmer still manages to create a profitable crop yield.

4.3 Basis risk

However, indexed microinsurance products are not perfect. The fact that claims are linked to an index and not to the actual loss incurred results in what is called a \textit{basis risk}. Basis risk is the risk that there will be a misalignment between the payout defined by the index and the actual loss experience of the insured. The greater the misalignment the higher the basis risk. This means there can be times when the farmer loses his or her crop but the insurance does not compensate for the loss. There may also be times when the farmer does not lose a crop but the insurance still pays out.

4.4 Mathematical solutions

Basis risk is one example of the many problems facing the development of weather index microinsurance. A great deal of work is still to be done in creating the foundations for successful products and mathematical approaches can contribute significantly. For instance, agricultural systems modelling (ASM) techniques help us to understand the interaction between the environment and crop and livestock systems. The relationship between crop yield and rainfall, soil moisture, crop management and crop physiology can be analysed more accurately using ASM. ASM can therefore help in improving the correlation between insurance payouts and losses experienced by farmers, and so reduce the basis risk in indexed crop insurance. ASM can also be used to understand how indexed insurance fits in with the other ways that farmers already manage risk.

In using approaches such as ASM it is important to avoid making the product too complex. Therefore, a key part of the development of successful products is interaction and engagement with the farmers. Feedback from farmers is essential in understanding what risks should be covered and what level of payments should be provided. Feedback sessions can include interviews, surveys and microinsurance role plays and simulation exercises to help farmers understand the risks they face and how microinsurance could help in managing some of these risks. Mathematical techniques can assist in this process. For example, a recent paper by Clarke and Kalani applied Demand Theory techniques to interviews with Ethiopian farmers to model demand for index insurance [5] and Clarke has developed a theory of rational demand for index insurance [6].

As well as the examples above, there are a number of ways that mathematics could be of great help in optimising crop insurance and making it more attractive and therefore more widely accepted. Examples include creating techniques to determine the maximum distance at which a weather station can still be used as the basis for an index and developing mathematically sound approaches for blending historical weather records with satellite data.

Having looked at a more sophisticated microinsurance product we will now look at a product which should be more familiar: life insurance. The next section gives details on the pricing process of one such microinsurance product.

5 How is life microinsurance priced at SAJIDA Foundation?

The typical approach to designing and setting premiums for any insurance product, including microinsurance products, follows what is called the actuarial control cycle as illustrated in Figure 2. This section explains how the control cycle was used in the case of the SAJIDA Foundation’s microinsurance product.

Acquiring comprehensive historical data of the risks faced by the poor in developing countries can be a challenge; hence pricing a microinsurance product can be more difficult compared to pricing a more traditional insurance product. An example from the SAJIDA Foundation (Bangladesh) of pricing a life microinsurance product is illustrated below.

At SAJIDA, a packaged microinsurance product provides life insurance for its insured members. These members are micro-credit borrowers of SAJIDA as well. If a member or her spouse dies, the life insurance coverage provides cash benefit of 4,000 taka (taka is the local currency of Bangladesh and this amount is equivalent to £34) and waives any outstanding loans with SAJIDA up to a maximum limit.

To price the life insurance the risk premium needs to be calculated, which is the expected cost of the claim, excluding expenses and other costs such as commissions not directly related to the claim. The method used to calculate this is to first estimate the number of incurred claims and the total incurred claim amount, then calculate the average cost of a claim and finally multiply this by the probability of death (mortality rate).
At SAJIDA, microinsurance data is electronically reported from front-office branch staff to the Management Information System (MIS) team at the Head Office on a monthly basis. Since the program’s inception, microinsurance transactions were done manually and hence member-level data was not entered in any electronic data format. At the end of every month, the total month-end figures are reported electronically and this aggregate data is then used to conduct pricing reviews and for business monitoring and projection purposes.

The month-end reported microinsurance data includes the closing number of insured members, the number of paid claims and the amount of paid claims. The numbers of paid claims are split by 4 categories of delay time between reported and paid claims. For example, if 10 claims were paid in a month, the data shows 4 claims paid within 0–7 days of reporting, 2 claims paid within 8–15 days of reporting, 3 claims paid within 16–30 days of reporting and 1 claim paid over a month after being reported. For the over 1 month category, we assume all claims are paid within a maximum of 2.5 months.

Historical claims data are used to conduct pricing. The first step is to convert the paid claim figures to incurred figures so that pricing is based on actual incurred losses. Let \( p_i, q_i, r_i, \) and \( s_i \) be the paid claims count in month \( i \) within the four claim delay categories 0–7 days, 8–15 days, 16–30 days, and over 1 month, respectively. We assume that all claims are paid on the 15th of each month and claims are reported exactly at the midpoint of each of the claim delay categories. Hence the number of claims reported in month \( i \) from all paid claims in the same month are \( p_i + q_i \), since these claims are paid within 15 days of reporting, assuming they are reported exactly at the end of the 11th (15th minus 4 days, which is the midpoint of 0–7 days) and at the end of the 3rd (15th minus 12 days, which is the midpoint of 8–15 days) of each month. Claims reported in month \( i \) from next month’s paid claims (month \( i + 1 \)) are \( r_{i+1} \) since \( r_{i+1} \) claims are paid within 16–30 days. If \( r_{i+1} \) is assumed to be the number of claims paid on the 15th of month \( i + 1 \) with a 16–30 day delay then these claims would have been reported in month \( i \), assuming they are reported exactly on the 22nd (15th minus 23.5 days, which is the midpoint of 16–30 days) of month \( i \). Finally if \( s_{i+2} \) claims are paid on the 15th of month \( i + 2 \) with a 1–2.5 month delay then the number of claims reported in month \( i \) from those paid in month \( i + 2 \) are \( s_{i+2} \), assuming they are reported exactly 1.75 months earlier (midpoint of 1 and 2.5 months) i.e. on the 22nd of month \( i \). Using this technique, we can calculate the total number of reported claims in a month using the paid claims. Letting the total reported claims in month \( i \) be \( x_i \), then

\[
x_i = p_i + q_i + r_{i+1} + s_{i+2}.
\]

The next step is to calculate incurred claims, \( y_i \), from these reported claims. If we assume an \( n \)-day delay between incurred and reported dates, where \( n < 30 \) days, and also assume that there is an even spread of claims over the month in every month, then the total number of incurred claims in a month will be the total reported claims in the same month less the reported claims in the 1st \( n \) days of the month, as these claims will be incurred in the previous month due to the \( n \)-day delay. But we will add next month’s 1st \( n \) days’ reported claims as these claims will be incurred in the current month. Therefore total incurred claims in month \( i \) is

\[
y_i = x_i - \frac{n}{\text{number of days in month } i} \times x_i + \frac{n}{\text{number of days in month } i + 1} \times x_{i+1}. \tag{1}
\]

We conduct the same exercise to calculate the amount of reported claims in a month from the total paid claim amount, and subsequently the incurred claim amounts from the reported claims. Here, when going from paid to reported, we use the percentage of number of claims in each of the four delay categories and apply these percentages to the paid amount of claims. For example, 30% of total paid claims in month \( i \) are paid within 0–7 days of being reported and 35% are paid within 8–15 days. In month \( i + 1 \), 33% of the total paid claims are paid within 16–30 days of being reported. In month \( i + 2 \), 20% of paid claims are paid in over a month’s time of being reported.

Let 1,200 taka, 1,100 taka, 1,175 taka be the amount of claims paid in month \( i \), month \( i + 1 \) and month \( i + 2 \) respectively. Then the reported claim amount, \( X_i \), in month \( i \) will be

\[
X_i = 1,200 \times (30\% + 35\%) + 1,100 \times 33\% + 1,175 \times 20\% = 1,378. \tag{2}
\]

The reported claim amounts \( X_i \) and \( X_{i+1} \) in month \( i \) and month \( i + 1 \) respectively can be then be used to calculate the total incurred claim amount, \( Y_i \), in month \( i \) using the same \( n \)-day delay formula above.

Life insurance at SAJIDA Foundation has two elements of cover. One is a fixed cash amount of 4,000 taka and the other is a loan waiver, i.e. all outstanding loans of up to maximum 30,000 taka is waived (since all insurees are also micro-credit borrowers). We first calculate the historical monthly mortality rates from the life insurance product experience. Mortality is the probability of death occurring. It is calculated as deaths occurred divided by the total exposure, which is the total number of active insurance holders. Total monthly exposure is calculated as the average of opening and closing insureds in a month. Since the product provides coverage at death of member or spouse, we can separate out the mortality rates for males and females. At SAJIDA, the
borrowers who are members are females and spouses are males. Therefore, monthly mortality, \( d_i \), is

\[
d_i = \frac{y_i}{\text{average (opening members, closing members)}} + \frac{w_i}{2},
\]

where \( y_i \) is the number of deaths that occurred in a month. This is separately calculated for females and males. The probability of both member and spouse dying at the same time is very low and negligible; hence we assume that the joint mortality is 0. We sum the monthly mortality rates over a 12-month period to get the annual mortality. We can calculate 12-month mortality rates over the last few years on a rolling basis and decide on the best estimate to be used for pricing. Therefore for the fixed cash benefit, the annual risk premium, \( P_f \), will be the probability of death \( \times \) claimable amount,

\[
P_f = \sum_{1}^{12} d_i \times 4,000.
\]

This is again calculated separately for females and males. Next we calculate the monthly average claim amount paid as loan waiver, \( Y_i/y_i \), and we calculate an estimated average claim amount for the year, \( Y \), by taking a 12-month average of the monthly average claim figures,

\[
Y = \frac{\sum_{1}^{12} Y_i}{12}.
\]

We carry out this 12-month average on a rolling basis for about a 2-year period. Due to an increasing trend in loan amounts, we take the maximum of these rolling averages and make an upward adjustment to this figure by applying a percentage increase.

The risk premium for the loan waiver, \( P_l \), is the probability of death \( \times \) average claim amount,

\[
P_l = \sum_{1}^{12} d_i \times Y.
\]

The total annual risk premium, \( P \), for SAJIDA’s life insurance policy is

\[
P = P_f + P_l.
\]

The final chargeable premium is then calculated by applying loading to this risk premium for operational costs, contingency reserve for unexpected high claims costs, and any other costs applicable.

6 How to increase microinsurance take-up?

Consumer literacy is a crucial step for increasing microinsurance take-up, along with awareness amongst other main stakeholders like microfinance institutions (MFIs), governments, banks, insurance companies, etc. It is often the case that the poor who have insurance do not understand what they are covered for and what benefits they have access to, why they pay a premium, nor how the premiums are used. Effective media for raising awareness are through use of radios, DVDs, comics, stage plays with actors as target purchasers, games, word of mouth, and visual print materials for illiterate markets (Figure 3, for example). Mass media campaigns allow for a multiplier effect since communities begin to discuss amongst themselves and as a result learn from each other, but there is little experience because the cost of mass media campaigns is beyond the budgets of most microinsurance ventures. Word of mouth is known to be one of the most successful tools to increase consumer awareness, literacy, and trust. However, for word of mouth to be an effective means of increasing consumer awareness the microinsurance products and process need to be sufficiently simple to be described by lay people without the original meaning being lost.

There are several effective microinsurance distribution strategies. Since premium payment is arduous for the poor, the insurance provider could sell right after harvest season when farmers have cash in hand. The point of sale can be local stores where people can buy insurance directly while shopping or bundled with other goods. An innovative example of a bundled product is sold in India where personal accident insurance is sold automatically with every bag of fertilizer purchased, with the policy wording written on the side of the bag!

Alternatively microinsurance can be offered through microfinance institutions when someone applies for micro-credit or through insurance companies including microinsurance as an extension of their core business. A more innovative approach would be to sell microinsurance through mobile phones either via mobile banking or directly from the cell phone provider. MicroEnsure in Ghana offers microinsurance through mobile phones using a frequent-user model. A mobile user’s premium is paid for by the mobile network operator based on the amount of airtime used. The mobile operators are willing to pay the premium and provide coverage proportional to airtime spent because they profit from increased airtime usage. This is called the freemium model.

Figure 3: Microinsurance leaflet (in Bengali) to increase consumer literacy, SAJIDA Foundation, Bangladesh.
Community-owned insurance products, where the community people are themselves the insurers and insureds, have been in practice for many years in various countries. These are known as self-help groups (SHG) where members themselves are responsible for collecting premiums, managing the premium fund, approving and disapproving claims, and paying out claims from the pool fund. The advantage of setting up this model is that there is arguably more trust and transparency amongst members as the funds are being managed by themselves.

Building trust could be the biggest challenge for microinsurance providers. Over the years in low-income countries, insurance has acquired a negative reputation by not paying out genuine claims either due to weak claims settlement process or else corporate corruption. Therefore people in poor communities tend to mistrust insurance agents who are outsiders because they don’t believe that the ‘outsider’ will make the promised payments once they receive the upfront premium payment. One way of addressing this challenge is assigning trusted agents from their own communities, who will endorse the product. The agents could be local funeral societies, leaders within the communities, or local trusted associations, for instance. The insurance provider must ensure that these agents are trustworthy, will pay out claims in a timely manner, and that there is no room for fraudulent behaviour. A tarnished reputation could take at least a generation to clean up.

7 The actuary’s role

There are several areas where the work of actuaries can make a difference. Ratemaking may be particularly relevant, since products have to offer value for money in order to be sustainable. The quality of data varies and often the data are of poor quality or missing. In these situations actuarial judgment is required to plug the gaps. Actuaries can potentially apply various pricing techniques to improve current methods, in addition to applying their skills in designing products that are simple and more acceptable, for example by reducing or removing exclusions. Actuaries can also help in the ensuring microinsurance businesses set aside sufficient money to cover their future liabilities and to guard against the risk of insolvency. Actuaries can set up processes such as databases, claims processes, and help with risk analysis, business plans and financial projections. Actuaries can also play a huge role in educating all stakeholders such as MFIs, banks, NGOs, reinsurers and governments about microinsurance and how it works.

The microinsurance working party of the UK Institute and Faculty of Actuaries has established a member interest group for members of the actuarial profession. The group’s objective is to facilitate a better understanding of the challenges and successes of this area of work and to promote how actuaries can apply their skills to help in the development of microinsurance. If you are interested in learning more please go to http://tinyurl.com/cjak6jr.

In collaboration with other professionals, a working party of the UK actuarial profession has been working on the assembly of a series of actuarial microinsurance education modules consisting of simple models and guidance documents. The intention is for these to be freely accessible to parties involved in microinsurance in order to improve the available knowledge in this field. If you are interested in learning more or getting involved please go to http://tinyurl.com/98etfx6.

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