Prospects for Crop Insurance
In Western Australia

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Multiple peril crop insurance is not a new idea. It has been tried many times with spectacular failures around the world, in South America, Asia, Africa, the United States and perhaps soon, in Europe and Australia. The European Commission (1999) is studying the prospects of a European scheme modeled on the heavily subsidized U.S. scheme. A federal task force recommended against introducing a scheme in Australia, but during the recent elections, farmer interest groups lobbied for crop insurance in Western Australia and the newly elected government allocated a substantial sum of money and set up a task force. The brief of the task force is to implement a pilot program that can evolve into commercially viable crop insurance for Western Australia. Will the task force succeed where the rest of the world has not?

The first question to be asked is, "With so many failures over almost a century, why is crop insurance still on the political agenda?" The obvious answer is that farmers and insurance companies are seeking rents from the government (Goodwin and Smith, 1995). As subsidies are traded away in the negotiations of the World Trade Organization, other forms of subsidies are implemented. It would be hard to view the recent incarnation of crop insurance in the United States in any other way. But perhaps there is a significant demand for insurance and the markets are failing. Insurance may be too difficult for markets to handle. The recent troubles in the insurance industry suggest this. Insurance may not be like other commodities that are traded in smoothly functioning markets.

We take markets for granted. It is easy to forget that markets depend upon ideas and technologies that were once invented by someone. Every market must solve the problems of moral hazard, adverse selection and basis risk. Moral hazard is the name given to the problem of an individual being able to pervert the outcome of a trade once the deal has been signed. Enforceable and verifiable contracts are a must. And so every market has legal and administrative machinery working in the background to make trades fair. Adverse selection is the name given to asymmetric information, information known by one individual and not

another. Insider trading is illegal in every market. Everyone must be guaranteed of the same information. Basis risk is happens when the commodity being traded is not the commodity that an individual wants to trade. Insurance markets have severe difficulties in solving the problems of moral hazard, adverse selection and basis risk.

For an insurer, moral hazard may be the least of the problems. Even so, there are two ways that farmers can pervert a crop insurance contract. Farmers can forget to put on fertilizer or spray for pests or sell their crop privately and forget to tell the insurer. Once the ink is dry on the contract, farmers have significant control over the outcome. This aspect of moral hazard usually is addressed by deductibles, or co-insurance. The insurer will only cover a proportion of production, say 65%. The farmer covers the first 35%. Farmers can also pervert the data used to calculate insurance premiums. They can store grain and smooth out deliveries to make their production look less risky, or they can strike a deal with the neighbours. Weather insurance has been proposed as a way to solve the moral hazard problem, on the thought that farmers can't control the weather. But there may be several rain gauges with a sheet of tin over the top.

For a farmer, moral hazard may be a significant problem. Can the insurer pay the promised indemnities. In much of agriculture, the risks are systemic. When one farmer in Queensland is having a drought, many farmers in Queensland are having a drought. If the insurer does not have enough reserves to pay the indemnities, farmers will not get paid. Recent troubles in the insurance industry suggest that farmers should be wary. This may be one reason why governments are often the insurers of last resort. For example, Exceptional Circumstances claims in Australia cover catastrophic risk over large areas. As a state, Western Australia has low systemic risk and gets very few exceptional circumstances payments. Nearer the coast is a high rainfall zone that does well in dry years and poorly in wet years. Far inland is a low rainfall zone that does well in wet years and poorly in dry years. In between is an intermediate rainfall zone that does well most of the time. Over the past few decades Western Australia, has had reliable production, except in the 2000/01 crop year. If a crop insurance scheme had started in the mid 1990s with premiums calculated on the previous cropping history, even a well-designed scheme would have been bankrupted by indemnity payouts in 2000/01 (van Heemst and Collinson, 2001).

Adverse selection is the reason most crop insurance schemes come a cropper. Farmers know a lot more about their farms than does the insurance company. Verifiable data on farm yields rarely exists. There are two important types of information the farmer knows but the insurer does not. The first type is widely recognized. Because of data problems, premiums are usually calculated on yields for a large area such as a shire. Insurers have no idea which farmers have higher than average yields and which have lower than average yields. If the insurer pays individual farmers when they achieve less than, say, 65% of average area yields, the farmers with less than average yields will often get big payouts and farmers with more than average yields will seldom get payouts (van Heemst, 2001). It seems that one of the best ways to determine which farmers have lower than average yields is to offer a multiple peril crop insurance contract with premiums calculated on area yields. Only farmers with lower than average yields will sign up. In 1974/75, Wesfarmers offered just such multiple peril crop insurance to Western Australian farmers. The scheme went bust after the first year (Collinson, 2001).

A less well recognized but important data problem is the difference in the variability of yields among farms. Farms with less reliable yields should pay higher premiums. However, farmers seldom have a long enough production history to calculate the variability of yields and area yield data masks the differences in variability among farmers. One method of calculating premiums is to recognize that farmers in an area have different average yields but assume they all have the same variability in yields (European Commission, 1999; van Heemst and Collinson, 2002). This seems a reasonable assumption but it is another recipe for insurance disaster. Insurance premiums will be too high for farmers with reliable yields and too low for farmers with less reliable yields. Only farmers with less reliable yields will take out the insurance and the insurer will lose money.

Perhaps someday, with longer production histories, the problem of adverse selection can be solved. For example, in Western Australia, almost all wheat is exported through Cooperative Bulk Handling. There are reliable records of individual farm yields for the past nine years. But this information is commercial and in confidence. As deregulation proceeds, this data source will become less reliable and insurers may have to rely on data provided by farmers.

Because markets must solve the moral hazard and adverse selection problems and these are difficult or impossible to solve for traditional multiple peril crop insurance schemes, markets

for crop insurance don't exist. Other than hail and fire insurance, the U.S. appears to have given up on trying to establish a commercially viable crop insurance industry and simply subsidizes their schemes. Subsidies may be on the political agenda in Europe but not in Australia nor Western Australia in particular. Thus, the only way to make multiple peril crop insurance viable for insurers is to make it compulsory for all farmers. Such a scheme would involve wealth transfers from farmers with high and reliable yields to farmers with low and unreliable yields. In Western Australia, these wealth transfers may be as high as $14 per hectare per year (van Heemst and Collinson, 2002). For this reason, compulsory multiple peril crop insurance is also not on the political agenda.

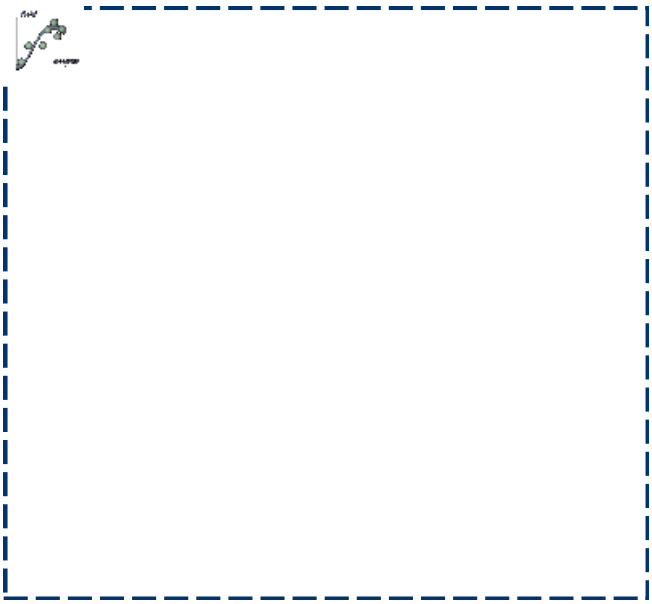
So what is left? Weather insurance is an old idea (Bardsley, Abbey and Davenport, 1984; Quiggin, 1986) being reborn as weather derivatives (Turvey, 2000). If you are staging a rock concert and want to insure against rain on the day, you can now purchase a call option on rainfall from financial institutions (Macquarie Bank, 2002). If you are an electricity utility and want to insure that weather is hot enough to run all the air conditioners and use lots of electricity, your can purchase a put option on temperature. In theory, farmers can also purchase put and call options for too little and too much rainfall. A related idea is to offer put and call options on area yield rather than weather. Weather and yield derivatives immediately solve the problems of moral hazard and adverse selection. Farmers can't affect the weather as they can their own production. Nor do farmers have any better or worse weather forecasts than the insurer. Reliable and verifiable weather histories go back as much as a century. Premium rates can be calculated with confidence.

With weather derivatives, the insurer's problem is easy. However, the farmer's problem is difficult. Farmers will want to insure the outcomes on their individual farms. Anything else is trading as a speculator. Weather at a distant weather station may be poorly correlated with yields on the farm. Poor correlation has been named basis risk. In essence, a weather derivative is a cross-hedge that may be of little relevance to a farmer.

Basis risk is a characteristic of financial markets. Even though financial markets functions well, farmers are not major traders. It takes specialized skills and time to be a financial trader. For these reasons, farmers usually go through an intermediary such as a broker or stock firm. In financial markets, basis risk is manageable because a dollar is a dollar for everyone. If an

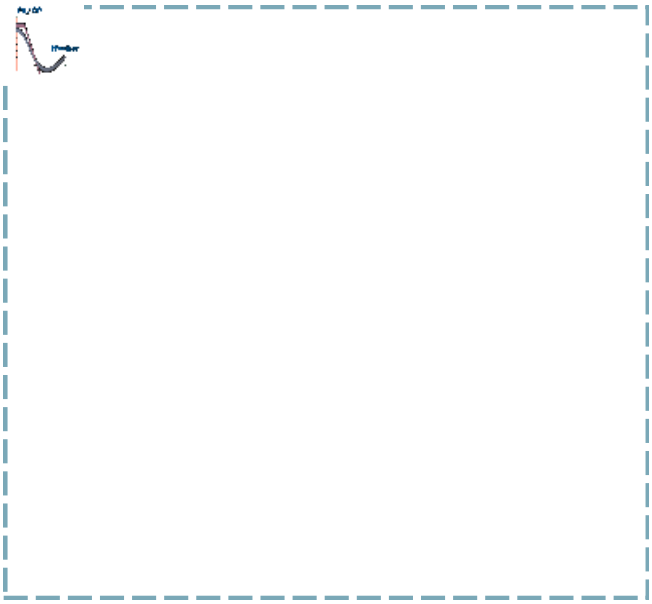
option is in the money, the payout is according to a simple linear function that everyone agrees on.

Financial markets are difficult for farmers to use and weather derivatives will be even more difficult. Basis risk is much greater for weather derivatives than for options on futures, for example. Yield is a complex nonlinear function of weather and other variables, and each farmer has a different nonlinear function. This leads to two forms of basis risk. First, weather will be imperfectly correlated with any model used to predict yields. A hypothetical example for an individual farmer is shown below.



The dots represent seven years of yield history and the smooth curve is fit to the data. The weather is random, but this randomness can be hedged with weather derivatives. However, the imperfect fit of the model leaves variability around the curve shown above. This variability cannot be hedged. The challenge is for a farmer or the farm advisor to fit an agronomic model that fits the data as well as possible and minimises this form of basis risk. Very few farmers or farm advisors are trained statisticians.

The second form of basis risk is more obscure. As for other financial instruments, the pay offs for weather derivatives are linear. A farmer will want nonlinear pay offs, however. This problem is represented below.



The pay off rises linearly and is capped at a maximum. The payoff the farmer would wish is determined by the agronomic yield curve, set on its head, and multiplied by the price of the commodity. The farmer may wish to receive a pay off at both low and high rainfall. In addition, the shape of the pay off curve will affect the actuarially fair premium for the weather derivative. As a result, the pay off and the premium are not correctly calculated for an individual farmer, increasing the basis risk.

Managing basis risk is the challenge ahead. Traditional multiple peril crop insurance is not, and probably never will be, commercially viable. Many countries and insurers have had a go at solving the problems of moral hazard and adverse selection. None have succeeded. There have been no intellectual breakthroughs recently and there are very few new ideas in crop insurance. Almost every possibility and combination of possibilities has been tried without success. There is no reason to think future attempts will succeed.

Crop insurance based on an agronomic model is not a new idea either. Canada implemented such a scheme with some success, or at least not failure. So the ideas of weather insurance related to farmer's yields through an agronomic model is not new. Have there been any breakthroughs that might make this approach succeed in the future? Well yes. The recent offering of weather derivatives will make it possible for brokers, agricultural firms and farm advisors to offers services to farmers. Graphical information systems make it possible to triangulate weather stations and find weather series that are highly correlated with weather on individual farms. More sophisticated statistical methods make it possible to fit an agronomic

model with few data points. All this could be combined in a user-friendly computer program that could be used at the point of sale, in other words, on the farmer's kitchen table. Still it would be prudent to think small. Farmers are survivors in a risky business. Only a few farmers hedge against financial risks. Even fewer may hedge against weather risks.

At the beginning of this paper, we argued that markets are technological inventions to solve the problems of moral hazard, adverse selection and basis risk. If these problems can be solved, a market will function with low administration costs. We, and all other commentators, argue that moral hazard and adverse selection have not and probably will not be solved for multiple peril crop insurance. This leaves weather derivatives and the problem of basis risk. Can technologies help us reduce basis risk to manageable levels? Basis risk for weather derivatives is more difficult to manage than for financial instruments, but at least there is hope.

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