EFFICIENCY OF WIND INDEXED TYPHOON INSURANCE FOR RICE

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Abstract

Index-based weather insurances are innovative tools for mitigating weather risks in agriculture. Several donor agencies and development organisations are investing substantially to propagate these programmes in developing countries. However, often due to high basis risks, these products mitigate risk only through diversification effect, thereby defeating the intended purpose. Besides, they send confusing messages to the farmers regarding the very concept of insurance. Therefore, this paper investigates the efficiency of two such index-based weather insurances in Philippines, designed to mitigate rice yield loss caused by strong typhoon winds. The insurance products are designed assuming negative linear correlation between wind speed and rice yield. To verify, we used satellite data and GIS tools to tabulate typhoon wind speeds, concurrent crop stage and the subsequent rice yield in five provinces which have both the programmes. Regression analyses and Ramsey RESET tests confirm that rice yield loss is not a function of incident typhoon wind speed, irrespective of the crop stage. Basis risk estimations, based on minimum variance hedging ratio for a risk averse expected utility maximising consumer show that the products entail basis risks of the order of 99%. Typhoons damage all crops, but wind indexed insurance is inadequate when the insured crop has low head weight and is agile like rice, since wind onslaughts do not determine the degree of yield loss. Notably, a thorough burn analysis for basis risk is a necessity before investing time and money implementing index-based weather insurance schemes as a tool for poverty alleviation.

Keywords: Basis risk, Typhoon, Index-based Insurance.

Introduction

Agriculture is highly affected by vagaries of weather. This has grave implications in developing countries where lack of safety nets render poor farmers vulnerable to vicious circle of poverty (Alderman, 2008). Index based risk transfer products (IBRTP)[1] have been piloted and implemented in various forms in several countries over the last decade (Skees et al., 2007). It is argued that the inherent limit to the development of crop insurance markets is moral hazard, under which the insured individuals behave more riskily because of having insurance and thus increase the probability of adverse outcomes. Another is adverse selection, under which individuals with higher than average risk seek insurance and those with lower than average risks find it uneconomical. Added to the limits, monitoring small individual risks is expensive, and the fact that many shocks are co-variate makes it hard for insurance providers to spread their own risks. A novel innovation is insurance indexed to an objective indicator of weather, such as rainfall or temperature. Since weather is not affected by individual behaviour, index based insurance can address both monitoring

[1]Instead of referring to these products as index-based weather insurance, Skees and Barnett (2006) refer to these products as Index based risk transfer products or IBRTP since structurally they are open-ended. In the economic literature, they take the form of contingent claims. However, in the legal and regulatory environment, they can either be structured as insurance or derivatives. In developing countries, where derivative markets are unlikely to be properly regulated, they are commonly structured as insurance products.

costs and moral hazard. Besides, there is no risk of adverse selection since climatic events are non-idiosyncratic. Basis risks resulting from the difference between actual loss and the indemnification however, remains a big problem for IBRTP (Woodard and Garcia, 2007), inversely affecting their efficiency as hedging instruments. Such IBRTP not only fail to indemnify the actual loss of the farmer or a part thereof, but due to lack of correlation also send confusing messages to the farmers regarding the very concept of insurance. This is damaging for the micro-insurance sector since IBRTP with high basis risks may be perceived more as a means of portfolio diversification than a risk mitigating product. This is reflected in the findings of Giné et al. (2008), where they find that risk averse farmers in South India abstain from buying rainfall IBRTP.

In Philippines there are similar insurance programmes that hedge rice yield losses against high winds caused by typhoons. These products assume a negative linear relation between wind speeds and rice yields. In this paper we try to estimate their efficacy by estimating the basis risks, through the correlation of the pay-off and the actual loss. In the first section, we discuss the insurance products. The second section provides an explanation of data collected to check the validity of the underlying assumption of these insurance products. The third section studies the effect of typhoons in Philippines on rice crops through series of regressions. In the next section we derive basis risk based on minimum variance hedging ratio for a risk averse expected utility maximising consumer. Further, we calculate the correlation between the pay-offs of the respective insurance products and the actual losses, net of fair premia, to arrive at an estimation of basis risk. In the final section we conclude and discuss opportunities of further research. Beside commenting on efficiency of wind indexed insurance, this paper also contributes to the growing literature on the effects of various weather events on agriculture and crop production.

This particular case of wind indexed insurance for rice in Philippines was selected since Global Climate Change, is expected to trigger more frequent and stronger typhoons (Solomon et al., 2007). Rice farming is the largest single use of land for producing food, 90% of which is produced in Asia. Rice production totalled 662 million tons in 2008/09 out of which only 4-5% was exported from the country of production (IRRI, 2010). Rice fields cover 11% of the Earth's entire arable land, or more than 500 million hectares, making it one of the most important economic activities on earth. Rice eaters and growers form the bulk of the world's poor and it is grown on more than 250 million Asian farms, mostly smaller than one hectare. It is eaten by nearly half the world's population and it is the single largest food source for the poor (IRRI, 2010). In addition, Philippines is a major rice producer and importer, it is also a country of primarily rice eaters, who are mostly poor. Hence it is important to investigate the effects of typhoons on rice in Philippines under present conditions as a basis to assess future threats under an aggravating Climate Change scenario. Besides, some of the major rice growing areas of the world, namely in Southeast Asia and on the Indian sub-continent, are exposed to weather extremes like cyclones and typhoons. Therefore the implications of this research have international relevance.

The Insurance Products

Two organisations henceforth referred to as A and B[2] have launched insurance programmes to hedge the effects of typhoons on rice, with wind speed as the index correlated to yield loss. While

[2]Organisation "A" is an insurance company and "B" is an international development organisation. This paper has been written with their permission, on the basis of information provided by them and the authors gratefully acknowledge their cooperation in this regard.

organisation A has a nation wide insurance programme, B provided it only for the Panay islands (marked in Figure: 1) in 2009 as a pilot. Panay comprises of five provinces namely Aklan, Antique, Capiz, Iloilo and Guimaras. In this paper we are going to discuss the effects in the first four provinces since, Guimaras has been excluded owing to lack of yield data. This allows us the opportunity to make a comparative study of the products of both the organisations.

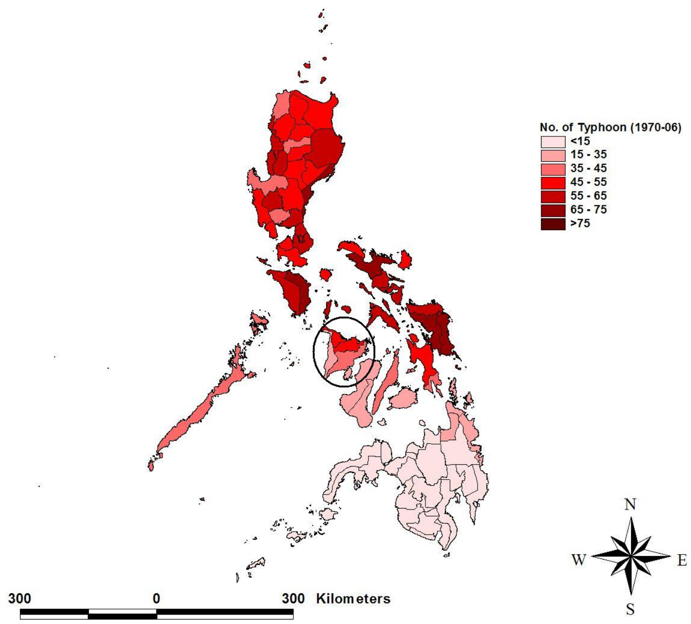

Figure 1: Number of incident typhoons per province (1970-2006). Panay Island is enclosed in the circle. *Source: own analysis.*

Organisation A runs a nation-wide insurance programme and has a diverse set of products. The product of interest for us is the “Rice and Corn Crop Insurance”- which insures against natural calamities (typhoons, floods, drought, earthquakes and volcanic eruptions), plant diseases and pest infestation. The National Government provides premium subsidies up to a maximum of 4.9% of the sum insured. This is not entirely an Index Based Risk Transfer Product, since certain aspects are assessed by an assessor ex-post. After the occurrence of a typhoon the inspectors visit the insured fields and determine certain factors like: the period of time for which the field was exposed to the typhoon (6, 12 or 24 hours) and the level of maturity of the standing crop (booting, flowering or mature). Based on these two factors and the speed of wind, which is objectively measured by a meteorological station, the extent of loss is calculated according to a “Revised Claim Settlement Approach and Loss Prediction Table (RECSAP)” (refer to Table: 1). For the purpose of comparative analysis we simulated the pay-offs assuming 6 hour exposure. Under this assumption their loss prediction model shows a linear relation as shown in Figure: 2; with values of r^2 as high as 0.98 (booting stage) and 1.0 (flowering and maturity stage). The bend in the “Yield loss %” observed at a wind speed of 150 km/h is speculative and not reported or derived from any scientific literature.

The organisation B is an international development organisation well known in the field of providing micro-insurance for the poor. They have designed a similar product and have carried out a pilot in the Panay islands. For pay-off calculation they used the formula:

Table 1: Revised Claim Settlement Approach and Loss Prediction Table of Organisation A.

Growth stage	Period of exposure (hours)	Wind velocities (km/h)		
		70-100	101-150	>150
		Estimated yield loss (%)		
Booting	6	<10	10-15	15-25
	12	10-15	15-25	20-30
	24	15-20	20-30	25-35
Flowering	6	10-15	15-25	25-35
	12	15-25	25-30	30-40
	24	25-30	30-35	35-50
Maturity	6	<10	10-15	15-20
	12	10-15	15-20	20-25
	24	15-20	20-25	25-30

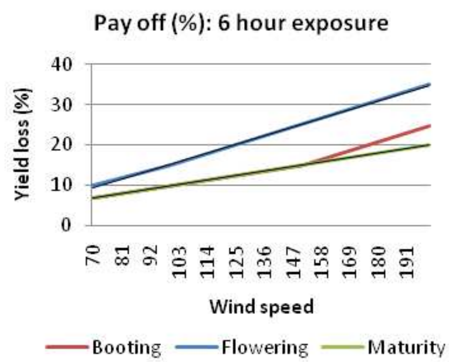

Figure 2: Graphical representation of Payoff matrix of Organisation A designed for entire Philippines.

$$Payout = W \times D \times S$$

Where, W is the wind speed, D is the distance parameter and S is the sum insured. Since in our data matrix we have recorded provinces within 50 km (100km diameter) of the eye of the typhoon (to be discussed in detail in the next section), we shall overlook the distance parameter since in our case all the provinces are expected to have 100% of the calculated pay-off (refer to Table: 2). As seen in Figure: 3, though their regression of yield loss percent on wind speed seems to have a step function, it was clarified that it is not based on any scientific literature but used merely to simplify the pay-off matrix. Step functions are generally used in cases where the slope of a function is very small, which does not seem to be the case in their model. Besides the function has a strong linear trend with r^2 as high as 0.96 . Therefore in our study we first checked the rate at which increase in wind speed decreases rice yields in order to verify this basic assumption of both the products.

Table 2: Pay-off Matrix of Organisation B designed for Panay Island.

Tropical Cyclone Type	Maximum Sustained Minute Wind Speed (km/h)	Damage Description	Payout % Sum Assured
Tropical Depression	< 95	N/A	0%
Tropical Storm	95 to 117	N/A	0%
Category 1	118 to 152	Minimal	20%
Category 2	153 to 177	Moderate	60%
Category 3	178 to 209	Extensive	90%
Category 4	210 to 250	Extreme	100%
Category 5	> 250	Catastrophic	100%

Distance parameters:

- 100% of the payout for tracks within 50km radius
- (Max(150 – Distance(km),0)/(150-50))% for tracks up to 150km radius
- 0% for tracks over 150km

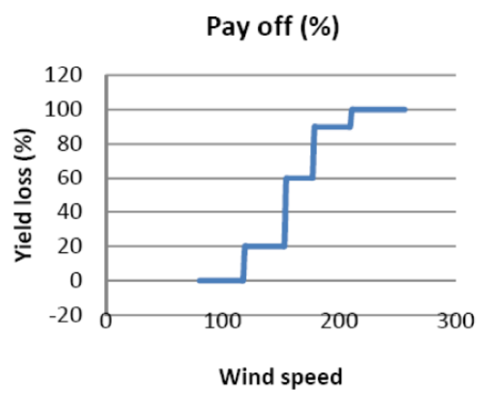

Figure 3: Graphical representation of Pay-off Matrix of Organisation B designed for Panay Island.

Data

Satellite data on typhoon tracks obtainable from Joint Typhoon Warning Centre was used to compile database on typhoons passing through the Philippine isles from 1970 through 2006. The GIS software Arc view 3.2a was used to record the provinces which have been affected along with the time of incidence and recorded wind speed. The diameter of a typhoon may vary from 220-890 km, the smallest ones having around 220 km diameter. Therefore a "footprint zone" was superimposed along the typhoon track, with a diameter of 100 km, to obtain a generalised area of potential typhoon damage, mainly because organisation B had projected a footprint radius of 50 km for 100% indemnification. The rice yield data from 1970 through 2005 was obtained from the Philippine Rice Statistics Handbook published by the Bureau of Agricultural Statistics. The data were tabulated in the following format:

- YEAR
- PROVINCE
- CROPPING SYSTEM: Irrigated, Rain-fed and Aggregated yield across both systems
- SEASON: Dry season (January – June) and Wet season (July – December)

The Model

In the earlier section we presented evidence that, the products of both organisations indicate an assumption of negative linear relationship between wind speed and rice yield losses. To verify, we analyse a linear regression using parameters of both products. The regressors are a mix of the factors shown in both the products. From the IBRTP of "A" we take crop stages as a dummy regressor. We excluded the period of exposure since we took data at 6 hour interval; similarly distance parameter seen in product of "B" is excluded due to aforementioned reasons. In addition to that we included a year variable to detrend the data and a seasonal variable to elucidate the effect of wet and dry seasons on the yield of rice. The model we estimated was as follows:

$$\begin{aligned} yield_{(yr,pr,s,sys)} = \alpha_1 s_{(dry,sys)} + \alpha_2 s_{(wet,sys)} + \alpha_3 yr + \alpha_4 ws^{max}_{(yr,pr,s,cr_{(st_1)})} \\ + \alpha_5 ws^{max}_{(yr,pr,s,cr_{(st_2)})} + \alpha_6 ws^{max}_{(yr,pr,s,cr_{(st_3)})} + \alpha_7 ws^{max}_{(yr,pr,s,cr_{(st_4)})} + \varepsilon_{(yr,pr,s,sys)} \end{aligned} \quad (1)$$

where,
sys: refers to the cropping system, in this case irrigated, rain-fed or aggregate yield;
s: refers to the season, in this case dry (Jan-Jun) or wet (Jul-Dec);
pr: refers to province yr: refers to year, in this case 1970 to 2005;
yr: refers to year in this case 1970 to 2005[3];
$yield_{(yr,pr,s,sys)}$: is the yield of rice in a particular system, in a season, of a province in a year;
$s_{(dry,sys)}$ and $s_{(wet,sys)}$: are two dummy variables for the season being dry or wet in a particular cropping system;
$ws^{max}_{(yr,pr,s,cr_{(st_x)})}$: is the max recorded wind speed at a particular crop stage of rice in a season of a year at a province;
$cr_{(st_x)}$: refers to the crop stage which is an ordinal classification of the four months (110 days) of the rice crop into four stages (refer to Appendix- A)
ε: refers to white noise

Results

We estimated the model with EViews6 using Least Square (NLS and ARMA) method, with White Heteroskedasticity consistent Standard Errors and Covariance. The sample size was 72 for Aklan, Antique, Capiz and Iloilo (2 seasons for 36 years). Additionally we did Ramsey-RESET Test for functional forms, but owing to the insignificance of subsequent fitted terms we stuck to the linear model, which seemed better owing to the low AIC and BIC values as compared to models with other functional forms. We also tried to see if seasonal differences are significant in terms of the effect of wind in the different crop stages. An F-test for joint test of significance of regression coefficients proved the difference to be statistically insignificant.

As seen in Table: 3, α_1 is the expected yield in dry season, and α_2 in the wet season in the respective cropping systems in 1969 expecting no typhoon. The standard errors (written in italics)

[3]Since rice yields at a national level across all cropping systems, shows steady rise from 1970 through 2005 with occasional lows without major structural break, we did not try to separate yield losses from the deterministic trend by subtracting central tendency using tools like ARIMA models, robust double exponential smoothing, and spline regression as suggested by Skees et al. (1997).

of these coefficients show that they are highly significant as expected. α_3, which is also highly significant is the expected rate at which yield has increased over the period of time. The other four coefficients quite contrary to popular belief are all highly insignificant. Showing conclusively that there is no or very little effect of wind speed on rice yields, across systems and provinces. It also means that stage of the crop at which it occurs is of no importance, and the same goes for the season when it occurs.

Basis Risk

Basis risk has been cited as a primary concern for the implementation of weather hedges (Turvey, 2001; Turvey et al., 2006; Deng et al., 2007; Brockett et al., 2005). An estimation of basis risk is particularly important in the agricultural arena, where the acceptance of weather insurance has been impeded by a lack of knowledge concerning their use and performance (Woodard and Garcia, 2007). Since in this case we are dealing with insurance products and since Philippines has no Derivative Market we do not adopt the methodology suggested in Woodard and Garcia (2007) instead we take up a method, whereby basis risk is estimated directly from coefficient of correlation, based on minimum variance hedging ratio for a risk averse expected utility maximising consumer. The hedging error (HE) for such a consumer is defined as:

$$HE = X - aY \tag{2}$$

where, X is the loss net of fair premium, Y is the payoff net of fair premium, per unit insurance policy and a is the hedging ratio. Therefore,

$$E(X) = E(Y) = 0 \tag{3}$$

and have finite moments for the random variable X and Y. The basis risk may hence be defined as the Standard Deviation of the hedging error:

$$\sqrt{Var(X - aY)} \qquad \text{(from :2)}$$

Minimisation of variance of HE expressed by $min_a\left[Var(X - aY)\right]$ yields the minimum variance hedging ratio $a^\star$, for which we derive:

$$\begin{aligned} min_a\left[Var(X-aY)\right] &= min_a\left[Var(X) - 2aCov(X,Y) + a^2Var(Y)\right] \\ &= min_a\left[E(X^2) - E(X)^2 - 2a[E(X,Y) - E(X)E(Y) + a^2E(Y^2) - E(Y)^2\right] \\ &= min_a\left[E(X^2) - 2aE(X,Y) + a^2E(Y^2)\right] \qquad \text{(from : 3)} \end{aligned}$$

Taking F.O.C with respect to a equated to 0:

$$\begin{aligned} \frac{d\left[E(X^2) - 2aE(X,Y) + a^2E(Y^2)\right]}{da} &= -2E(X,Y) + 2aE(Y^2) \\ \text{or,} \quad -2E(X,Y) + 2aE(Y^2) &= 0 \end{aligned} \tag{4}$$

Which gives the minimum variance hedging ratio $a^\star$as:

Table 3: Results of the regression. The expected value of the respective coefficients. The numbers in italics represent the respective standard errors.

PROVINCES	CROPPING SYSTEM	α_1	α_2	α_3	α_4	α_5	α_6	α_7
AKLAN	AGGREGATE YIELD	1,1276	1,241	0,0613	-0,0003	-0,0013	0,0004	-0,0012
		0,1011	***0,0924***	***0,0037***	***0,0008***	***0,002***	***0,0021***	***0,001***
	RAINFED	0,977	1,0769	0,0395	-0,0008	-0,0006	0,0014	-0,0004
		0,0684	***0,0725***	***0,0029***	***0,0007***	***0,0023***	***0,0017***	***0,0012***
	IRRIGATED	1,5432	1,7136	0,0722	-0,0015	-0,0032	0,001	-0,001
		0,1452	***0,1403***	***0,0053***	***0,0012***	***0,0019***	***0,003***	***0,0015***
ANTIQUE	AGGREGATE YIELD	1,5232	1,511	0,0465	-0,0016	0,0043	-0,0022	0,0019
		0,0788	***0,0955***	***0,0034***	***0,0013***	***0,0039***	***0,0013***	***0,002***
	RAINFED	1,2288	1,2213	0,0293	-0,0014	0,0023	-0,0001	0,0006
		0,0847	***0,0898***	***0,0035***	***0,001***	***0,0036***	***0,0023***	***0,0018***
	IRRIGATED	2,3428	2,3064	0,0343	-0,0029	0,0038	-0,0031	0,0052
		0,1283	***0,1251***	***0,0046***	***0,0018***	***0,005***	***0,0023***	***0,0033***
CAPIZ	AGGREGATE YIELD	1,551	2,0165	0,026	0,0006	-0,0005	0,0008	-0,0028
		0,1372	***0,105***	***0,0042***	***0,0008***	***0,0024***	***0,0013***	***0,0014***
	RAINFED	1,5307	1,9789	0,021	0,0006	-0,0006	0,001	-0,0025
		0,1043	***0,1106***	***0,0044***	***0,001***	***0,0035***	***0,0027***	***0,0018***
	IRRIGATED	2,3157	2,9988	0,0194	-0,0004	0,0004	0,0002	-0,004
		0,1877	***0,1938***	***0,0067***	***0,0014***	***0,0029***	***0,0021***	***0,002***
ILOILO	AGGREGATE YIELD	1,466	1,7487	0,0405	0,0004	0	0,0013	0,0012
		0,0976	***0,0982***	***0,0039***	***0,0008***	***0,0021***	***0,0033***	***0,0014***
	RAINFED	1,3051	1,5444	0,0302	0,0002	0,0021	0,0015	0,0008
		0,089	***0,0934***	***0,0038***	***0,0008***	***0,0033***	***0,0024***	***0,0014***
	IRRIGATED	2,2645	2,1801	0,0352	-0,0006	-0,0003	-0,0003	-0,0015
		0,0464	***0,0467***	***0,0017***	***0,0003***	***0,0007***	***0,0007***	***0,0006***

$$
\begin{aligned}
a^\star &= \frac{E(X,Y)}{E(Y^2)} \qquad \text{(from :4)} \\
&= \frac{\rho_{X,Y}\sigma_X\sigma_Y}{\sigma_Y^2} \\
&= \rho_{X,Y}\frac{\sigma_X}{\sigma_Y}
\end{aligned} \tag{5}
$$

Since Pearson's Product Moment Correlation Coefficient of X and Y, $\rho_{X,Y}$ may be alternatively expressed as:

$$
\begin{aligned}
\rho_{X,Y} &= \frac{Cov(X,Y)}{\sqrt{Var(X)Var(Y)}} \\
&= \frac{E(X,Y) - E(X)E(Y)}{\sigma_X\sigma_Y} \\
\text{or,} \qquad \rho_{X,Y} &= \frac{E(X,Y)}{\sigma_X\sigma_Y} \qquad \text{(from : 3)} \\
\text{or,} \quad E(X,Y) &= \rho_{X,Y}\sigma_X\sigma_Y
\end{aligned}
$$

Substituting a by $a^\star$ we get basis risk as:

$$
\begin{aligned}
\sqrt{Var(X - a^\star Y)} &= \sqrt{Var(X) - 2a^\star Cov(X,Y) + a^{\star 2} Var(Y)} \\
\text{or,} \qquad \sqrt{\sigma_X^2 - 2\rho_{X,Y}\frac{\sigma_X}{\sigma_Y}\rho_{X,Y}\sigma_X\sigma_Y + \rho_{X,Y}^2\frac{\sigma_X^2}{\sigma_Y^2}\sigma_Y^2} &= \sqrt{\sigma_X^2 - 2\rho_{X,Y}^2\sigma_Y^2 + \rho_{X,Y}^2\sigma_Y^2} \qquad \text{(from :5)} \\
\sqrt{\sigma_X^2(1-\rho_{X,Y}^2)} &= \sigma_X\sqrt{(1-\rho_{X,Y}^2)}
\end{aligned}
$$

Standardising the above expression, we derive the basis risk as:

$$
\sqrt{(1-\rho_{X,Y}^2)} \tag{6}
$$

We simulated the expected payoff of the insurance products and correlated it with the actual losses, net of fair premium. Assuming the sum assured for a particular season of a year to be the trend value, we simulated the yield loss on the basis of observed yield. The correlation in case of both products are extremely low (refer to Table: 4). Translated in terms of basis risk (written in bold italics), none of the products seem to be feasible due to the large basis risks (approximately 94-99%) involved. At this level the insurance no longer hedges rice yield losses due to typhoons but functions as derivatives based on wind speed completely uncorrelated to yield loss. Such products which are originally designed to help the poor hedge their livelihood risks fail mainly on two fronts. Firstly, they fail to hedge the underlying risk, thereby defeating their very purpose and secondly, they send confusing messages to the targeted farmers who are often poor and lack adequate financial literacy. Although they do mitigate the risks to household income through diversification effect, they no longer can be termed insurance since the original purpose stands defeated.

Table 4: The respective correlation coefficients $\rho_{X,Y}$ and the corresponding estimated basis risk derived from Eq: 6 (in bold italics).

PROVINCES	ORGANISATION A		ORGANISATION B	
	IRRIGATED	RAINFED	IRRIGATED	RAINFED
AKLAN	-0,0192	-0,0403	-0,0226	-0,0423
	0,9998	***0,9992***	***0,9997***	***0,9991***
ANTIQUE	-0,1102	0,1234	-0,1177	0,1216
	0,9939	***0,9924***	***0,9930***	***0,9926***
CAPIZ	-0,1080	-0,0412	-0,1049	-0,0407
	0,9941	***0,9992***	***0,9945***	***0,9992***
ILOILO	0,3313	0,1370	0,2361	0,1484
	0,9435	***0,9906***	***0,9717***	***0,9889***

Conclusion and outlook

Rice fields are damaged by typhoons (Lansigan et al., 2000). Philippines has seen 220 typhoons of various intensity in the period between 1970 and 2009. Whether it is the wind or the accompanying flash flood that causes it is an important question to be investigated if we intend to find a insurance against this recurrent phenomenon. In this paper we have disproved the relation of wind speed on rice yields. However, we observe that this might have to do with the low head weight of the crop. In case of crops like maize or other vegetable crops, high winds might be detrimental and is hence worth researching. It is also of interest to further investigate the effect of flash floods on rice yields. Since, historical data regarding flash flood incidences are not available, one has to come up with innovative methods to estimate the extent of flash floods. One possibility might be modelling the angular acceleration of typhoon systems. Since dry air is heavier than moist air, typhoons decelerate after precipitating heavily. This is one of the main reasons why they grow weak on land and gain strength on water bodies which supply them with heat and moisture (Brand and Blelloch, 1972; Gray, 1968). Modelling angular deceleration might give a picture of the extent of incident flash floods and hence serve as an index. Flood indexing therefore seems to be a possible option that can hedge against typhoons with better efficiency. But the central message is that no matter which instrument is applied to hedge the effects of typhoons or any other weather phenomenon, a thorough burn analysis needs to be done to check for the extent of basis risk, before implementation so as to improve the efficacy of Index based weather insurance as an instrument of poverty alleviation.

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Appendix A

Crop Stages

- "Stage 0": in this case refers to typhoon free seasons for the province. This is not a stage of the crop but a parameter of the model to avoid a dummy variable trap.
- "Stage 1": refers to the seedling stage of the crop and also when there is no standing crop. This is more a stage of the field than the crop. The two different conditions are recorded in one, since it is believed that typhoons have no effect on the yield when it strikes at the seedling stage (pers. comm. with Agronomists at International Rice Research Institute, Philippines).
- "Stage 2": refers to the vegetative stage of the crop. It is usually found between the 6th and the 10th week as well as between the 27th and 31st week of the year in the dry and wet season crop respectively. It is termed as booting stage in Table: 1.
- "Stage 3": refers to the reproductive stage of the crop. It is usually found between the 10th and the 15th week as well as between the 31st and 36th week of the year in the dry and wet season crop respectively. It is termed as flowering stage in Table: 1.
- "Stage 4": refers to the maturity stage of the crop, which marks its maturity and harvesting stage. It is usually found between the 15th and the 19th week as well as between the 36th and 40th week of the year in the dry and wet season crop respectively.