Designing the Revenue Insurance Pattern for Selected Agricultural Crops in Iran (Khuzestan Province)

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Abstract: In this study by designing the pattern of revenue insurance for two crops (wheat and barley) in Khuzestan province, the fair premium was calculated, because the main stage in determination of the premium, is forecast of studying variables, by using price and yield data for irrigated wheat and barley in Khuzestan province for years (1981-2009) and the ARIMA method the price, yield and income for each hectare of these crops has been estimated for 2010. Then by using the bootstrapping simulation method and individual farmers yield information (that was available for time period (2000-2009) revenue premium for each hectare of crops was calculated. The results of this study showed that the barely due to having higher price fluctuation than wheat, has higher premiums in the coverage levels of 50,75 and 90 percent. Also yield premium for these crops in Khuzestan province is less than the revenue premium in the same year.

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1- Introduction

Today, supplying the food needs of society is one of the most important challenges of countries. The increase of production level and yield of agricultural crops greatly depends on investing and employing appropriate technologies in this field. This important target will be achieved by providing necessary infrastructure for investment activities. With respect to Iran's natural and economic conditions, producing agricultural crops is one of the most risky economic activities. Risks like flood, storm, coldness, torrential rains, plant pests and diseases, hail and attacks of wild animals and so on, cause a lot of damages to the agriculture sector. On the other hand, governments have always tried to support this sector by making appropriate supportive actions like giving subsidies, giving inputs like fertilizer and toxin, setting custom tariffs, tax exemptions and bank facility. But the mentioned items are not always sufficient to guarantee having income from the sector. Therefore, the insurance of agricultural products has been introduced and advised as an effective tool in solving the mentioned problems. The insurance of agricultural products has the maximum operational capabilities and capacities for coping with the mentioned risks and it is one of the most appropriate mechanisms securing investors in the agriculture sector. But insurance is a cost consumer tool. So, designing new insurance models in a way that they could stabilize the income of the producers of this sector in one hand and could reduce executive costs on the other hand is naturally one of the most crucial challenges between researchers of risk management and product insurance fields. Those insurance models and risk management methods of agricultural products which are always implemented by governments, for example performance insurance, have been designed for performance risk management or development of stock markets as well as price management of future markets. On the other hand, they do not solve many challenges of insurance fund of agricultural products, including higher losses of this fund and increasing rate of excessive indemnity. Therefore, we are about to design an income insurance plan by which insurance executive costs as well as other costs related to the implementation of the insurance of agricultural products in this province are minimized in one hand and on the other hand a comprehensive system is designed and substituted with a multiple and disharmonic system. This objective is in line with guaranteeing producers' income policy.

To prepare income insurance pattern, (Makki and Somwaro,2001) evaluated factors affecting the participation of agriculturists in product insurance designs using Artificial Neural network techniques. The result of their study showed that choosing of insurance type by agriculturists depends on risk level, insurance price and subsidies rate of the insurance. Implementation of approaches like Adjusted Gross Revenue insurance (AGR), which guarantees total

farm revenue, save account and agriculturists deferred tax was advised across each region for protecting them against annual income fluctuation.

(Mishra et al,2005) studied the impacts of revenue insurance on the inputs used by agriculturists including prices of fertilizers and pesticides. Using Probit method they showed that the purchase of revenue insurance results in the reduction of the use of fertilizers by the agriculturists who cultivate fall wheat while expenses of pesticides showed no significant change.

(Salami et al,2008) in a study named "revenue insurance, an approach in the reduction of production risk and price fluctuations in poultry industry of Iran" used expected utility-based methods and found that the revenue insurance premium per broiler is a competitive and acceptable value compared with current insurance premium which only covers production risks.

(Borzo,2009) carried out a study about preparing revenue insurance pattern for Corn and potato in Kerman Province using bootstrapping simulation method. The obtained results indicate that due to higher revenue fluctuations compared with Corn, potato has better condition for creating revenue insurance In Kerman Province and assigned higher premium compared with Corn in different coverage levels to itself.

By conducting studies about the revenue insurance, it was found a very beneficial tool which covers price and yield risks at the same time. For this reason, this study designed a revenue insurance pattern for both wheat and barley crop in Khuzestan Province. Both crop are strategic crops of this province and assign one fourth of country's crop insurance level to themselves.

2- Materials and Methods

In the process of designing revenue insurance pattern, first of all price and yield risks are measured and then premium is determined. The methods of determining premium are expected utility and statistical methods. The statistical methods themselves include probability distribution and simulation approaches. In current study, due to some limitations of the expected utility and probability distribution methods, bootstrapping simulation method was used. In fact, this method is a Monte Carlo simulation attempting to achieve a premium value, which should be close to real value as much as possible, by simulating information based on their history as well as resampling all deviations of the model which has been designed for this reason (Atwood et al, 1997). One of the advantages of the bootstrapping method is that in this method it is not necessary to know the probability distribution of each variable. Instead, by predicting price and yield variables as well as appropriate design of model this method could derive a value to insurance premium which is closer to real one (Kianirad, 2004). In the following paragraphs, the steps of the bootstrapping simulation are presented for selected agricultural products in Khuzestan Province:

1-Obtaining critical revenue level per hectare crop

$$\hat{\mathrm{Re}}v_{i89} = \hat{R}_{i89}\hat{P}_{i89} \quad (1)$$

$$\mathrm{Re}v_G 89 = Cov.\mathrm{Re}vi89 \quad (2)$$

$$\mathrm{Cov} = \mathrm{Coverage\ \ Level\,(ex.75\%)}$$

$\hat{P}_{i89}$ = prediction of the price received by producer per Kg of i crop in year 2010.

$\hat{R}_{i89}$ = prediction of yield per hectare crop in year 2010

2-Obtaining the yield trend of the Province

This relation shows the deviation of the predicted yield from real one or in other words it is yield deviation in the selected Province.

$$\mathrm{R_t} = \hat{\mathrm{R}}_t + \mathrm{e_t^R} \quad (3)$$

$\mathrm{R_t}$ = Real yield in year t

$\hat{\mathrm{R}}_t$ = predicted yield in year t

$\mathrm{e_t^R}$ = yield deviation in year t

3- applying producers' yield to estimate the residual of the yield deviations of individual producers from total yield of the province

$$d_t^f = y_t^f - R_t$$

$$\bar{d}^f = \frac{1}{T}\sum_{t=1}^{T_f} d_t^f = \bar{y}^f - \bar{R} \quad (4)$$

$$e_t^f = d_t^f - \bar{d}^f = \left(y_t^f - \bar{y}^f\right) - \left(R_t - \bar{R}\right)$$

$\mathrm{d_t^f}$ = the deviation of the yield of each producer $\left(\mathrm{y_t^f}\right)$ from the total yield of the Province in the same year $\left(\mathrm{R_t}\right)$

$\bar{\mathrm{d}}^{\mathrm{f}}$ = mean of the deviations of producers' yield during previous years $\left(\mathrm{y^f}\right)$ from the mean of total yield of the Province in the same years (R)

$\mathrm{e_t^f}$ = residuals of deviations

In this study, the difference of the yield of each farmer from the mean of his/her yield in past 10 years was calculated.

4-Estimation of Relationship between Price and yield Distribution

$$P_{89}^{S} = \hat{P}_{89}\left(1 + a_2^{P}\left(\frac{R_{s89}}{\hat{R}_{s89}} - 1\right) + e_t^{p}\right) \quad (5)$$

Next, 1000 random sampling with replacement selected by the deviations of relations (3), (4) and (5) and simulated yield and price were calculated for year 2010 using the sampled deviations. Multiplying them by each other gave simulation revenue for each farmer. Finally, the simulated and guaranteed revenues were compared together in different coverage levels in the relation (2). When the simulated revenue was less than the guaranteed revenue, the difference was considered as the expected indemnity. The expected indemnity is the base for calculating fairly premium. The amount of the expected indemnity is derived from the following equation:

$$\text{indemnity} = \text{Max}\ \left[\left(0, R_R - R_C\right)\right] \quad (6)$$

Also, real insurance premium is derived from the following formula) Kiani rad, 2004):

real premium= | Fair premium | 0.9 (7)

In mentioned simulation method, the first step is the prediction of yield and price and consequently revenue variables. Autoregressive Integrated Moving Average (ARIMA) method was used to predict model's components. This method is one of the quantitative-single variable prediction methods. It should be mentioned however, such prediction models could be used if some measures like time trend, short-term and long-term cycle are available in series. For this reason, before using the mentioned prediction methods, Durbin-Watson test defined that whether data are random or not. Box-Jenkins methodology was used to perform prediction process through ARIMA time series.

3- Results

First of all, it was defined that whether the price and yield variables of wheat and barley crops of Khuzestan Province are random or not. Table 1 shows the results.

Table 1. Evaluation the type of the trend of pattern's variables

Variable	Durbin- Watson Stat	type of trend
Wheat price	1/48	Non-Random
Wheat yield	2/01	Non-Random
Barley price	2/39	Non-Random
Barley yield	1/88	Non-Random

Also, tables 2 and 3 show the test results of Dickey-Fuller and Phillips-Perron for the pattern's variables.

Table 2. Investigating the stationarity of the pattern's variables using Dickey-Fuller and Phillips-Perron tests

Variable	ADF		PP	
	Level	First Difference	Level	First Difference
Wheat price	4/11	-2/63	2/069	-3/09
Wheat yield	-1/47	-2/66***	-1/25	-8/67***
Barley price	-0/65	-5/22***	-0/45	-7/26***
Barley yield	-3/16	-5/54***	-3/084	-17/46***

According to the evaluation of Autocorrelation diagram and other related tests, the series of price and yield variables of wheat and barley are integrated of order 1. after determining the degree of difference d, in order to define parametric orders using (Pesaran and Pesaran,1997) method, at first some models with different orders of p and q were estimated and then the best order of ARIMA was obtained using Akaike and Schwarz-Bayesian and R^2 indexes so that a model with the minimum Akaike and Schwarz and maximum R^2 is selected. Finally, following additional investigations, ARIMA (6, 1,2,6) and ARIMA (2,1,2) were obtained for the price and performance of wheat, respectively. For barley, ARIMA (1, 1, 2) and ARIMA (4,1,4) were obtained for the price and performance, respectively.

When the best model of variables was determined, the variables of wheat and barley price, yield and revenue were predicted for year 2010. Table 3 shows the result of predictions.

Table 3. Predicted pattern variables for year 2010

Variable	Amount of Forecast
Wheat Yield (Kg per hectare)	1304/068
Wheat Price (Risal per Kg)	4515/397
Wheat Revenue (Rials per hectare)	5888383
Barely Yield (Kg per hectare)	1727/154
Barely Price (Rials per Kg)	2929/120
Barely Revenue (Rials per hectare)	5059041

Then, the predicted revenue was calculated for both products in different coverage levels. Table 4 shows the results.

Table 4. Predicted revenue level in different coverage levels

coverage levels (Percent)	50	75	90
Wheat Revenue (million Rials per hectare)	2/944	4/416	5/3
Barley Revenue (million Rials per hectare)	2/53	3/794	4/553

In next step, the price and yield of both crops was simulated for each individual farmers. By multiplying the variables by each other, simulated revenue was derived and by use of its difference from the predicted revenue, the mean of the expected indemnity was calculated. Table 6 shows the results.

Table 5. Mean of expected indemnity and loading coefficient of 0.9 (real premium) for different coverage levels of wheat and barley

coverage levels (Percent)	50	75	90
Wheat Revenue (million Rials per hectare)	0/817	1/504	2/013
Barley Revenue (million Rials per hectare)	2/293	3/637	4/465

In Khuzestan Province, in a similar crop year the amount of yield premium, without applying tariffs and subsidies, are 0/68 and 0/61 million Rials for wheat and barley, respectively.

4-Discussions

Based on the mentioned issues, in the event of applying revenue insurance in Khuzestan Province, wheat crop would have lower premium compared with barley because its price risk is lower than barley due to guaranteed price policy and benefiting from higher subsidies. The obtained value for revenue premium of wheat is very close to the yield premium in Khuzestan Province in a similar crop year. As a result, it could be stated that the revenue premium of wheat crop could compete with current premium in the Province. For barley, the revenue premium is higher than the yield one in Khuzestan Province because it has higher price risk. Therefore, it has assigned higher revenue premium to itself. Regarding the fact that the problems and challenges of every insurance plan will appear by a pilot performance of the plan in a specific zone, therefore this plan should be performed at least for three years in the regions in which the fluctuations per hectare (product), including price and yield fluctuations, cause a lot of losses and damages to producers. About the method of implementing the plan, establishment of agricultural products stock market is recommended in order to determining the guaranteed revenue level by using this market prices. This results in obtaining an premium which is very close to the real value. The revenue insurance could be employed in several crop at the same time. but define premium in this state, the performance information of individual farmers who cultivated two or more crop at the same time was required but unfortunately it was not available and it could be proposed as a field for future researches.

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