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Determining Wheat Crop Insurance Premium Based on Area Yield Insurance Scheme in Konya Province, Turkey

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Abstract: An area yield insurance program is investigated for wheat produced in Konya Province, Turkey. To compute premium, exponential smoothing is used to establish mean expected yield from historical data. Premiums vary by county and coverage level as expected. At the 80% coverage level, for example, they range from zero for Beysehir and Karaty counties to 18.3 kg da^{-1} for Altıntekin counties. No yield shortfall exceeded 20% of expected county yield during a year over the 1982 through 2004 observation period for Beysehir and Karaty counties. The differences between the highest and lowest expected premium rate for examined counties are 17.8, 19.9 and 18.8 kg da^{-1} for the 90, 100 and 110% coverage levels, respectively.

Key words: Area yield insurance, wheat premiums, Turkey

INTRODUCTION

Although crop insurance is available in some developing countries, only hail insurance historically has been available in Turkey. Despite interest in implementing a crop insurance program to cushion the impacts from reductions in price support and input subsidy programs enacted in 2001, Turkey's government has been hesitant due to actuarial failures of crop insurance programs around the world. However, law 5363, passed on June 21, 2005, requires Turkey's government to implement an index type of crop insurance, either in the form of area yield or rainfall insurance. Private companies will deliver the insurance, with government providing a subsidy to farmers of up to 50% of the actuarially fair premium rate.

To implement law 5363, private companies need information regarding the value of premiums while government needs information on the cost of the subsidies. Numerous studies have examined the performance and premium rates for index insurance, particularly area yield insurance, in both developed and developing countries. Recent studies include Miranda (1991) and Skees *et al*. (1997) for USA, Vandeveer (2001) for Vietnam and Clover and Nieuwoudt (2003) for South Africa. However, no study exists in the context of Turkey's agriculture.

The objective of this study was to estimate actuarially fair premiums for an area yield insurance program in Turkey, specifically for wheat produced in Konya Province by using historical yield data.

MATERIALS AND METHODS

Area yield insurance: Multiple Peril Crop Insurance (MPCI) has been available in the United States (US) since 1939. It also is currently available in Canada, South Africa, Australia and some South American and European countries (Quiggin, 1994). MPCI insures individual farm yield against losses from all perils.

MPCI premiums paid by producers generally have failed to cover indemnities and administrative costs in all of these countries (Quiggin, 1994). The actuarial failure of MPCI has been attributed to two major obstacles: (1) informational asymmetries that give rise to moral hazard and adverse selection (Rothschild and Stiglitz, 1976; Ahsan *et al.*, 1982; Chambers, 1989; Miranda, 1991; Quiggin, 1994) and (2) high systemic, non-diversifiable risk (Miranda and Glauber, 1997). Systemic risk is non-diversifiable because it occurs when a large area, such as a major production region, suffers a drought. Thus, all farmers in the region suffer relatively the same reduction in production, leading to a large rate of insurance indemnity payouts.

As a result of the actuarial failure of MPCI, governments and academic researchers have sought to develop insurance programs that can reduce risk at a lower cost than both traditional risk management strategies and MPCI. One proposed alternative is area yield insurance. In area yield insurance, indemnities and premiums are determined by the average yield of a geographical area as opposed to the yield of an individual producer. For example, an indemnity is paid

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when average yield in a county falls below a predetermined guarantee yield level. All farmers in the county pay the same premium per hectare and receive the same indemnity per insured hectare regardless of a farmer's individual yield.

Well-designed area yield insurance can reduce information asymmetries and administrative costs relative to MPCI (Halcrow, 1949; Miranda, 1991; Mahul, 1999). Area yield insurance should be largely free of moral hazard because an individual farmer can not influence the indemnity payment. Adverse selection should be less because data on area yields are more available and often of better quality than data for yields of individual farms. Administrative costs should be substantially lower as claims and production histories would not need to be verified for individual farmers (Miranda, 1991). In addition, the negative consequences of exposure to systemic risk should be reduced because area yield insurance generally can be more easily sold on global reinsurance markets (Borch, 1990; Doherty, 1997).

On the other hand, area yield insurance has disadvantages relative to MPCI. The major disadvantage is that a farmer can suffer a loss but receive no indemnity payment if average yield for the insurance area exceeds the yield guarantee level. More generally, farmers whose yields are not highly correlated with the area's yield may find an area-yield contract ineffective in reducing their risk. Hence, it is important, in designing area-yield contracts, to minimize the differences between the changes in individual yield and the changes in area yield. This difference is referred to as basis risk. Basis risk can be mitigated through appropriate contract design. Key contract design considerations are the identification of the area to be insured (Skees *et al*., 1997), the indemnity payout rules and the insurance coverage choices (Miranda, 1991; Clover and Nieuwoudt, 2003).

Data: This study was conducted for Konya province, Turkey. It is located in Central Anatolia, a major cereal producing dryland region. Although several crops are produced in Konya province, the dominant crop is wheat. Thus, wheat is chosen for analysis.

The area used for the yield index is the county. Counties are the only area measurement for which sufficient data are available. The State Institute of Statistics (SIS) began reporting average wheat yields for 11 counties in Konya province in 1982. The counties are Beysehir, Cihanbeyli, Seydisehir, Ereğli, Çumra, Ilgın, Kadıhanı, Karapınar, Kulu, Sarayönü and Yunak. At the time this study began, yields were available through 2004. Average wheat yields also are available from SIS for 1992 through 2004 for five more counties: Kratay, Meram, Selçuklu, Emirgazi and Altıntekin. The average wheat yields for these 16 counties are the data set for this study.

Calculation of area yield insurance premium rate: The determination of insurance premium rates starts with the calculation of expected loss (Skees *et al*., 1997). Expected loss can be considered the break-even premium rate, excluding administrative costs (Martin *et al*., 2001). To calculate expected loss, insurance actuaries use historical experience with the insurance product. In the case of yield insurance, historical yield experience is used to calibrate expected distribution of future crop yields (Goodwin and Ker, 1998). It is widely recognized that crop yields are skewed and, thus, not distributed normally (Gallagher, 1987; Nelson and Preckel, 1989; Moss and Schonkwiler, 1993; Ramirez, 1997; Just and Weninger, 1999). Thus, using only the mean and variance to determine premium rates may generate inappropriate expectations on loss. However, a problem arises because no consensus exists on whether skewness is positive or negative, let alone on the degree of skewness. For example, Day (1965) finds positive skewness while Gallagher (1987) and Ramirez (1997) find negative skewness.

To address the problems created by the uncertainty over the parameters of the yield distribution, the commonly accepted procedure at present is to use historical yield shortfalls to calculate premium rates (Goodwin, 1994; Skees *et al*., 1997; Clover and Nieuwoudt, 2003). Historical yield data can be divided into two components: mean yield and deviation from mean yield. Mean yield is considered to be a function of managerial ability and resource endowment, such as quality of the land farmed. The deviation from mean yield, however, is considered to be a function of natural factors, such as drought, excessive rainfall and excessive or low temperature. The purpose of crop insurance is to provide protection against yield shortfalls due to natural factors. Because farmers can not affect area yield, the deviation of area yields from their mean value is more likely to reflect natural factors than is the deviation of individual farmer's yield from mean yield.

The calculation of area premium rates used by this paper follows the procedures in Skees *et al*. (1997). Because yields increase over time, exponential smoothing is used to establish mean expected yield from historical data. The specific procedure used is:

$$fy_{t+1} = \alpha y_t + (1-\alpha)fy_t), \qquad (1)$$

where, fy_{t+1} and fy_t are forecasted area yields for years t+1 and t, respectively, y_t is actual area yield for year t and α is the smoothing constant, which lies between 0 and 1.

Besides capturing technology trends, this method reduces the influence of outliers and is robust under a wide range of circumstances. Also, experiences in other countries suggest that this method can be understood by crop insurance agents and farmers.

The expected break-even premium rate (EPR) is calculated by dividing total indemnity payments, $Indem_t$, by the total numbers of years examined, n:

$$EPP = \sum_{t=1}^{n} Indem_t / n \qquad (2)$$

$Indem_t$ is calculated as the percentage shortfall in area wheat yield:

$$Indem = \max\left[\left(\frac{y_g - y}{y_g}\right)(fy), 0\right], \qquad (3)$$

Equation 3 indicates that a farmer receives an indemnity payment whenever the area yield, y, is less than yield guarantee level, y_g for a given year. y_g is obtained by multiplying the forecast of the area yield, fy, by the coverage level chosen by the farmer.

Measuring yield shortfall as a percentage allows discussions to be standardized across different yield levels. In the extreme case of zero actual yields, the percentage shortfall is 100% and the indemnity is 100% of the coverage protection.

Miranda (1991) shows that a farmer should be allowed to "over insure" the crop if yield variability is greater for the farm than for the area. Conversely, if yield variability is lower for the area than for the farm, a farmer should seek a lower coverage level to reduce risk more efficiently. Therefore, following Skees *et al.* (1997) and Clover and Nieuwoudt (2003), coverage level are set at 80, 90, 100 and 110%.

For ease of presentation, indemnities are measured in kilograms per dekar instead of New Turkish Lira (YTL) per dekar. A dekar is a local measure of area. It equals 0.1 ha.

RESULTS AND DISCUSSION

Eight different values of the smoothing constant, α, are used in Eq. 1 to calculate expected county average yield. The values ranged from 0.1 to 0.9. The value of α chosen for each county was the value that minimized the mean squared forecast error for the county. The selected α for each county and resulting expected average yield for each county are presented in Table 1.

Table 1: Estimated premium rate per dekar by coverage level for wheat, konya province, Turkey, 2005

County	Smoothing Constant (α)	Premium (kg/dekar)by coverage level 80%	90%	100%	110%
Counties with Data for 1982-2004					
Beysehir	0.7	0.0	0.9	6.2	15.8
Seydisehir	0.5	0.2	2.0	6.9	16.0
Cumra	0.9	2.5	6.5	11.3	17.7
Karapinar	0.9	4.8	8.2	12.7	18.9
Ilgin	0.9	5.8	11.1	16.4	24.0
Yunak	0.9	6.0	13.5	21.3	29.8
Kulu	0.9	7.9	16.0	24.1	33.3
Eregli	0.9	8.1	15.6	23.5	31.7
Sarayonu	0.9	10.7	14.8	21.3	30.8
Cihanbeyli	0.5	12.6	18.7	26.1	34.6
Kadihani	0.9	13.3	18.3	24.6	31.1
Counties with data for 1992-2004					
Karatay	0.4	0.0	0.6	6.6	15.7
Meram	0.8	6.4	7.4	10.1	13.2
Selcuklu	0.8	8.5	11.9	14.8	18.3
Emirgazi	0.7	8.9	12.8	16.9	23.2
Altintekin	0.9	18.3	24.9	34.2	47.3

Source: Original computations

Because the calculation are sensitive to the observation period on yield, the results presented in Table 1 are separated out by the two observation periods of 1982 through 2004 and 1992 through 2004.

Given the indemnity payment rule stated in Eq. 3, an EPR is computed for each county and coverage level (Table 1). To illustrate the interpretation of EPR, a farmer in Beysehir County would pay 0.9 kg da^{-1} to obtain coverage of 90% of forecasted average yield.

EPR varies substantively among the counties for a given coverage level. For example, among counties with data from 1982 through 2004, the EPRs calculated for the 80% coverage level range from zero kilograms per dekar (Beysehir and Karaty counties) to 13.3 kg da^{-1} (Altintekin County). The differences between the highest and lowest EPR are 17.8, 19.9 and 18.8 kg da^{-1} for the 90, 100 and 110% coverage levels, respectively.

The zero breakeven premiums for Beysehir and Karaty counties at the 80% coverage level occurs because no indemnities would have been paid during the study period at this coverage level. In other words, no yield shortfall exceeded 20% of expected county yield during a year over the 1982 through 2004 observation period.

As expected, EPR increases as coverage level increases for a given county. In general, the premiums are correlated at the different coverage levels. This finding is supported by other pervious studies (Nelson, 1990; Clover and Nieuwoudt, 2003). Thus, a county with a high premium at the 80% coverage level also has a high premium at the 110% coverage level. However, the rankings do change somewhat as coverage level changes. For example, among counties with the 1984 through 2004 observation period, Kadihani County has the highest premium at the 80% coverage level (13.3s kg da^{-1}). At the 110% coverage level, its EPR (31.1 kg da^{-1}) ranks seventh highest among the eleven counties. This change in ranking may be an artifact of the data set, specifically the relatively small sample size. It may also reflect long-term differences in local weather and agronomic conditions that cause the shape of the yield distribution to vary.

CONCLUSIONS AND POLICY IMPLICATION

Substantial differences are found among the actuarially fair premium calculated for an area wheat yield insurance contract for 16 counties in Konya Province, Turkey. The difference between the lowest and highest estimated premium rates ranges between 13 kg da^{-1} for the 80% coverage level to 20 kg da^{-1} for the 100% coverage level.

Under the recently passed legislation authorizing an area yield insurance program for Turkey, the government can provide a subsidy of up to 50% of the actuarially fair premium. Assuming a 50% premium subsidy and 100% coverage level, the results of this study suggest that the subsidy will vary by 10 kg da^{-1} among the 11 counties that had data for 1982-2004. Expanding the data set to include the five counties that had data for 1992-2004 leads to an even greater difference.

Besides raising the issue of whether it is fair for the subsidy to vary among farmers, the variation in subsidy levels implies potentially significant economic consequences. Assuming that producers are risk averse, the subsidy is likely to increase production because it lowers the risk faced by producers (Binici *et al.*, 2003). More importantly, because the subsidy will be greater for the more risky counties, it will cause production to increase more in the counties with the greatest risk. The increase in production, especially in risky production areas, will in turn increase the cost of the subsidy to the government. In addition, increasing production in risky production areas may in turn increase environmental problems, such those associated with soil erosion.

The results of this study are limited to wheat production in Konya province of Turkey. It is important that studies are conducted for other provinces and crops in Turkey. Nevertheless, the results of this study and their potentially important impacts imply that before implementing an area crop insurance scheme nationally, Turkey's policy makers should conduct pilot programs to assess the impacts and consequences of implementing such a program.

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