Estimation of Cattle Insurance Demand in Turkey through Count Data Method: The Case of TRA1 Region

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ABSTRACT
Agriculture sector faces natural, social and economic risks resulting from its production structure. One of the strategies to be used to transfer such risks is agricultural insurance. It was aimed in the present study to estimate the demand of farmers for cattle insurance (CI) and determine the effective factors which can increase the share of premium production of CI in total premium production of agricultural insurance in TRA1 Region. Data were obtained from 122 farms determined using proportional sampling method in the provinces of Erzurum, Erzincan and Bayburt (TRA1 Region) through a questionnaire survey. Count Data Model was used in convenience with the aim of the study. According to the results obtained, when premium cost of CI increased 3 folds, then the number of animals desired to be insured decreased by nearly 1-fold. In addition, when the budget allocated for agricultural production and the probability of animal disease both increased by 1%, the number of animals desired to be insured increased by 1.56% and 0.61%, respectively.

INTRODUCTION
Agriculture as a sector is the indispensable part of overall economic system. Importance of the sector in overall economic system can be estimated by the share of value added it creates (Ege, 2011). In Turkey, the rate of agriculture sector is 6.6% in GDP, 11.3% in employment in 2018 (TIM, 2018. Such data is important to imply that the sector still maintains its rightful place in economy and human life. Because agricultural production is an economic activity based on natural conditions, it faces many risks and uncertainties. Agricultural insurance, natural (hail, frost, drought etc.) affecting agricultural production, social
(migration, war) and economic risks (such as inflation, fluctuations in oil, product and input prices) are one of the easiest ways to overcome their impact (Ikikat Tümer, 2011; Terin and Aksoy, 2015; Ikikat Tümer et al, 2019).

In the total world agricultural insurance premium production, vegetable product insurance is ranked first with 90% and animal life insurance is ranked second with 4% rate (Yazgı and Olhan, 2017). In Turkey, these figures are 55% for crop product insurance and 34% for cattle insurance. The rate of insured animal livestock was 0.05% in 2006 going up to 4% by 2018 (TARSIM, 2020). However, it may be thought when the number of animal livestock is considered which is 14 million that the rate of livestock animals to be insured is 96-97%.

Farm owners working in accordance with the commercial regulations in TRA1 NUTS II Region, covering the provinces of Erzurum, Erzincan and Bayburt and having severe continental climatic characteristics, need to use their own resources at their best under risks and uncertainties. Therefore, understanding consumer behaviours, determination of marketing strategies for farms and consumer demand estimation analysis are also strategically important in agricultural policy making in Turkey.

Articles about insurance demand have been getting more attention in recent years. Cotton producers' insurance claim in Burkina Faso (Sarfilippi et al, 2015), corn producers' insurance claim against climate change in Bangladesh (Akter et al, 2017), flood insurance claim in the Netherlands (Robinson and Botzen, 2020), climate change and index insurance demand (Dougherty et al) in Tanzania., 2020) have been calculated. Kim et al., (2005) also calculated the factors influencing the adoption of best management practices by cattle producers analyze using negative binomial regression analysis.

Demand and demand flexibilities of agricultural insurances have an important share in planning newly developing agricultural insurance sector and shaping its organisation in Turkey. Demand estimation is needed by agricultural insurance companies and TARSIM (Agricultural Insurance Pool) in planning insurance production. Demand flexibilities are important information sources for future prospects and projections.

Aimed of this present study was to determine the effective factors on the increase of the share of CI premium production in total agricultural insurance premium production and to estimate the demands of farmers for CI who conduct agricultural activities in TRA1 NUTSII Region. It was also targeted to create source for public and private institutions to provoke and raise agricultural insurance awareness.

**MATERIAL and METHOD**

Main material of the study is made up of production data obtained from farmers living in TRA1 NUTSII Region (covering the provinces of Erzurum, Erzincan and Bayburt) in 2009. Sampling volume was calculated using proportional sampling method. $p=0.5$ was taken to reach the maximum sample volume. (Newbold, 1995).

\[
n = \frac{N \times p \times (1 - p)}{(N - 1) \times \sigma^2 + p \times (1 - p)}
\]

\[
n = \frac{61832 \times 0.5 \times 0.5}{61831 \times 0.00205 + 0.5 \times 0.5} \approx 122
\]

\[
\sigma_p^2 = \left( \frac{r}{Z_{\alpha/2}} \right)^2, \quad \sigma^2 = \left( \frac{0.075}{1.645} \right)^2 = 0.00205
\]

In the formula; \(n\): sample size, \(N\): number of farms in the population, \(\sigma^2\): variance of the ratio, \(r\): margin of error allowed from the average (7.5%), \(Z_{\alpha/2}\): value (1.645), \(p\): shows the possible proportion of producers (50%).

122 the survey was distributed proportionally to provinces, districts and villages, taking into account the number of farmers. Totally 122 questionnaire survey forms were completed in 3 provinces, 15 districts and 30 villages, and the obtained data were used in analyses.

**Count Data Models**

Count data is referred to the number of repetitions of any given event as the result of the trials conducted at a definite time. The number of cigarettes consumed on a day, customers coming to a shopping centre during daytime, forest fires occurring in a year, yearly CI etc. can be given as example for count data (Frome et al., 1973: Deniz, 2005). When dependent variable represents events seen in a certain time period, Poisson and Negative Binomial regression analyses can be used (Frome et al., 1973;McCullagh and Nelder, 1989: Cameron and Trivedi, 1998). In Poisson distribution, average and variance refer to the same value. If the distribution is not even and equal, over-or under-dispersion can be seen. On such conditions, poisson regression cannot be applied. When variance is larger than average Negative Binomial Regression (NBR) models are applicable (Cameron and Trivedi, 1998; Winkelmann 1998, 2008). NBR uses log link function between dependent variable and independent variable vector. NBR model is given as follows

\[
Pr(y_i = 0, \alpha) = \frac{\Gamma(y_i + \alpha^{-1})}{\Gamma(\alpha^{-1})} \left( 1 + \frac{\lambda}{\alpha} \right)^{y_i} \left( 1 + \frac{\lambda}{1 + \lambda} \right)^{\alpha - y_i} > 0 \quad (1)
\]

where \(\alpha\) is the additional parameter value.
representing the degree of over-dispersion. If $\alpha$ is zero then NB and poisson refer to the same dispersion. The bigger the value of $\alpha$ is, the more the dispersion of data is. Average and variance are defined in NBR model as follows (Lawless, 1987; Lambert, 1992; Cheung, 2002).

$$E(y_i|x_i) = \lambda_i$$

(2)

$$Var(y_i|x_i)_{NB} = \lambda_i(x_i) + \alpha \lambda_i^2$$

(3)

Standard Poisson and Zero Inflated NB count data can be used to express additional zeros in dependent variables. Alternative regression method in the modelling of dependent variable $y_i$, where zero values are too high, is Zero Inflated Negative Binomial Regression (ZINB) model. The model can be written as follows.

$$\begin{align*}
\pi_i & = \frac{1}{1 + \alpha \lambda_i} \\
\Pr(i) & = \begin{cases} 
\pi_i & y_i = 0 \\
(1 - \pi_i) \left( \frac{y_i + 1}{\alpha} \right) \left( \frac{1}{1 + \alpha \lambda_i} \right)^{y_i} (\lambda_i \alpha_i)^{y_i} & y_i = 1, 2, 3, ...
\end{cases}
\end{align*}$$

(4)

$\Gamma$ is gamma function and $\alpha$ is dispersion parameter. Average and variance in ZINB model can be expressed as follows.

$$E(y_i) = (1 - \pi_i) \lambda_i$$

$$Var(y_i)_{ZINB} = (1 - \pi_i) \left[ 1 + \lambda_i (\alpha + \pi_i) \right] \lambda_i$$

(5)

Farmers’ desire to make CI was evaluated through binomial method (e.g. Logit, Probit) in zero inflated count data model while standard count model was used to analyse the number of animals for which farmers desired to make CI (Cameron and Trivedi, 1998). It was determined that some of the epidemic veterinary disease were seen beginning from 20 years ago to recent years. Based on such findings, animals were supposed to catch illness in the probability rates of 5%, 7.5%, 10%, 12.5% and 15%. The number of animals up to ten for which farmers wanted to make insurance in a year time under the risk of a certain disease tried to be determined.

In the model, since $\alpha$ is >1, over dispersion is in question in data clusters. In a such situation, Negative Binomial Regression was used more preferably (Cameron and Trivedi, 1998; Yeşilova et al., 2007). Binomial Logit Model was shaped for the farmers wanting not to make CI (Table 3). Dependent variable is farmers’ decision to make CI. In order to compare the results of Logit model and Count Data model of Negative Binomial Regression, signs of variables obtained as the result of Binomial Logit model were reversed and commented (Isgın et al., 2008; Bilgic et al., 2009).

In ZINB model, the number of animals for which farmers desired to make CI is dependent variable. Depending on the number of animals, farmers don’t want to make CI due to the factors such as lack of income or awareness and therefore, dependent variable gets the value of zero and ZINB regression model was used in the study.

RESULTS and DISCUSSION

The result of analysis indicated that 56.6% of the farmers surveyed were those who prefer prudent and least risky investments and were in the risk averse group. Yet, 22.1% of farmers were risk-takers, stable, capable of managing risk, economically most ideal, and were in the risk-neutral group until they expected income get the highest. The proportion of adventurous farmers who like risky investments in the region was 21.3% and they were in the risk-taking group (İkikat Tümer and Birinci, 2013).

Their ages ranged between 22 to 80 (mean age was 45.15) of years and mean education time was 6.52 years. Mean number people of households was found to be 5.95 and 2.98 of whom were working in agricultural production. Farmers interviewed stated that they had an average experience of 27.53 years in agricultural production. Among the farmers participating in the study, 29% did not have any membership of a cooperative (Table 1). Social security is the provision of an income guarantee with people on which they can live against the risks including the possibility of losing their jobs current and in coming years (Anonymous, 2009). The rate of farmers under the umbrella of social security in the study area was 83% (Table 1), which was 93.43% in whole country (SGK, 2019). The types of agricultural production activity the interviewed farmers conducted in the region were detected to be plant production, animal production and both in the rates of 18.85%, 5.74% and 75.41%, respectively. Mean yearly income of the farmers participating in the study by completing questionnaire surveys was found to be ¥13,322,13, ¥9,109,02 of which was found to be left for agricultural production again. The rate of farmers working also out of agriculture sector was determined to be 43% and obtain a mean yearly income of ¥7,592,31 from the activities out of agriculture.

Farmers participating in the study were found to possess 98.76 da land and 14.69 livestock animals on the average. Mean daily milk yield of livestock animals in the farms in the region was determined to be 4.58 kg/day. Farmers were determined to be aware of agricultural insurance in the rate of 32% and 57% of them stated that they wanted to make insurance for plant products. Farmers producing animal productions stated that they wanted to make insurance for only 1.78 of 10 livestock animals.
Cost of one dairy livestock animal was ₺2000 in the provinces of Erzurum, Erzincan and Bayburt in 2010. Totally 55 of 122 farmers interviewed wanted to make insurance for at least one of their animals. In other words, the rate of farmers desiring to make CI for at least one animal was calculated to be 45.10%. Mean number of animals for which farmers desired to make CI was found to be 1.78. Among 122 farmers, 67 (54.90%) did not want to make insurance for none of their 10 animals. Therefore, the rate of zero observation should be taken into consideration. The rate of farmers desiring to make CI for more than 3 and 4 animals was found to be 61.81% and 38.18%, respectively.

In the Logit model, the dependent variable was the decision of farmers to take out cattle insurance. In the ZINB model, the number of animals desired to be insured was a dependent variable.

According to the alpha test result (p<0.01), hypothesis is rejected and NBR analysis is decided. When variance of the dependent variable (2.913) is greater than its mean (1.78), ZINB regression models are appropriate to use (Cameron and Trivedi, 1998; Winkelmann 1998, 2008).

There was positive relationship between desire to make CI and the membership of a cooperative. Farmers member of a cooperative were open to innovations and new ideas more than others and wanted larger number of animals to be insured compared to others. This relation was statistically significant (p<0.10). Making CI is negatively affected by farmers’ ownership of investment out of farms. Farmers having investment out of farm relied on this investment and did not want to make CI. This relation was statistically significant (p<0.10). There was a positive relationship between making CI and daily milk yield per cow. As the rate of milk provided per cow increases, desire to make CI increased to ensure the survival of animals. Such a relationship was statistically significant (p<0.05). Table 2 gives the factors affecting the number of animals desired to be insured in a year. Dependent variable is the number of animals for which farmers were open to innovations and wanted larger number of animals to be insured. The number of animals desired to be insured was statistically significant (p<0.05) (Table 2).
Table 2. The number of animals for which farmers wished to make CI

<table>
<thead>
<tr>
<th>Variables</th>
<th>Decision of cattle insurance</th>
<th>The number of animals desired to be insured</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Büyükbah hayvan hayat sigortası kararı</td>
<td>Sigortalatılması istenen hayvan sayısı</td>
</tr>
<tr>
<td></td>
<td>Coefficient</td>
<td>t value</td>
</tr>
<tr>
<td></td>
<td>Katsayı</td>
<td>t değeri</td>
</tr>
<tr>
<td>Constant</td>
<td>0.6826</td>
<td>0.6160</td>
</tr>
<tr>
<td>Age</td>
<td>0.5290</td>
<td>1.2350</td>
</tr>
<tr>
<td>Experience</td>
<td>-0.6813</td>
<td>-1.0180</td>
</tr>
<tr>
<td>Education (those educated secondary school:1, other:0)</td>
<td>-0.0288</td>
<td>-0.2080</td>
</tr>
<tr>
<td>Number of individuals employed in agriculture</td>
<td>-0.0288</td>
<td>-0.2080</td>
</tr>
<tr>
<td>Agricultural Income</td>
<td>-0.0001</td>
<td>*</td>
</tr>
<tr>
<td>Budget</td>
<td>0.0002</td>
<td>*</td>
</tr>
<tr>
<td>Disease probability of animals</td>
<td>0.0515</td>
<td>**</td>
</tr>
<tr>
<td>CI premium price</td>
<td>-0.0078</td>
<td>**</td>
</tr>
<tr>
<td>Rate of arable land ownership (50 da and more:1, other:0)</td>
<td>-0.8779</td>
<td>-1.4510</td>
</tr>
<tr>
<td>Membership of a cooperative</td>
<td>-1.4494</td>
<td>***</td>
</tr>
<tr>
<td>Owning an investment apart from farm</td>
<td>1.1919</td>
<td>***</td>
</tr>
<tr>
<td>Milk yield per cow (l/day)</td>
<td>-0.2227</td>
<td>**</td>
</tr>
<tr>
<td>Erzurum</td>
<td>0.2878</td>
<td>0.4250</td>
</tr>
<tr>
<td>Erzincan</td>
<td>0.7643</td>
<td>1.0200</td>
</tr>
<tr>
<td>Neutral risk group</td>
<td>0.4276</td>
<td>0.6200</td>
</tr>
<tr>
<td>Alfa</td>
<td>2.0729</td>
<td>*</td>
</tr>
<tr>
<td>Log Likelihood</td>
<td>170.2711</td>
<td></td>
</tr>
</tbody>
</table>

AIC: 2.0729

There was a negative relationship between the number of animals to be insured and the cost of CI premium. As the latter increased the number of animals to be insured decreased. Such a condition was suitable with economic theory and the relationship was statistically significant (p<0.05). When CI premium price increased by 1% the number of animals to be insured decreased by 0.0299 (-0.0078*3.8305=-0.0299, where -0.0078 is the coefficient of CI premium price (Table 2) and 3.8305 is the (conditional mean) estimated value of the number of animals desired to be insured by farmers (Table 4). Farmers in neutral risk group wanted significantly more animals to be insured than others (p<0.01).

Table 3 represents conditional and unconditional flexibilities. Unconditional flexibility is calculated for all farmers. Conditional flexibilities are evaluated in the study since they are related to farmers desiring to make CI (67 farmers). There was a negative relationship between making CI and the rate of income from agriculture. When agricultural income increases by 1% then the number of animals desired to be insured decreases by 1.75%.

There was a positive relationship between the desire to make CI and the budget left for agriculture. When the budget increased by 1%, the number of animals desired to be insured increased by 1.56% (Table 3). There was a positive relationship between the probability of making CI and animal diseases. When the probability of veterinary diseases increases by 1% the number of animals desired to be insured increases by 0.61%. In addition, a negative relationship was detected between desire to make CI and insurance premium cost. When CI premium cost increased by 1%, the number of animals desired to be insured decreased by 0.87%. There was another positive relationship between the desire to make CI and the group neutral.
to risk. The number of animals for which those in neutral group desire to make insurance is 0.23% larger than the others (Table 3).

Table 3. Conditional and unconditional flexibilities

<table>
<thead>
<tr>
<th>Variables</th>
<th>Conditional flexibility</th>
<th>Indirect flexibility</th>
<th>Unconditional flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Koşullu elastikiyet</td>
<td>Dolaylı elastikiyet</td>
<td>Koşulsuz elastikiyet</td>
</tr>
<tr>
<td></td>
<td>Coefficient Katsayı</td>
<td>t value t değeri</td>
<td>Coefficient Katsayı</td>
</tr>
<tr>
<td>Constant</td>
<td>1.116 **</td>
<td>2.0320</td>
<td>-0.3385</td>
</tr>
<tr>
<td>Age</td>
<td>0.4182</td>
<td>1.1170</td>
<td>-0.5161</td>
</tr>
<tr>
<td>Experience</td>
<td>-0.0890</td>
<td>-0.4260</td>
<td>0.2769</td>
</tr>
<tr>
<td>Education (secondary school:1)</td>
<td>-0.0073</td>
<td>-0.0540</td>
<td>0.0426</td>
</tr>
<tr>
<td>Population employed in agriculture</td>
<td>-1.7513</td>
<td>*-4.2480</td>
<td>1.5599</td>
</tr>
<tr>
<td>Income obtained from agriculture</td>
<td>-0.6077</td>
<td>**2.2150</td>
<td>0.6077</td>
</tr>
<tr>
<td>Disease probability of animals</td>
<td>-0.8714 **</td>
<td>**2.2500</td>
<td>0.0224</td>
</tr>
<tr>
<td>Rate of arable land ownership (50 da and more:1)</td>
<td>0.2062 **</td>
<td>2.2630</td>
<td>0.2062 **</td>
</tr>
<tr>
<td>Membership of a cooperative</td>
<td>-0.1647</td>
<td>-1.1210</td>
<td>-0.1504</td>
</tr>
<tr>
<td>Owning an investment apart from farm</td>
<td>-0.1479</td>
<td>-1.1910</td>
<td>-0.0608</td>
</tr>
<tr>
<td>Milk yield per cow (l/day)</td>
<td>0.0059</td>
<td>0.0690</td>
<td>-0.1118</td>
</tr>
<tr>
<td>Erzurum</td>
<td>-0.1479</td>
<td>-1.1910</td>
<td>-0.0608</td>
</tr>
<tr>
<td>Erzincan</td>
<td>0.0059</td>
<td>0.0690</td>
<td>-0.1118</td>
</tr>
<tr>
<td>Neutral risk group</td>
<td>0.2301 *</td>
<td>4.8160</td>
<td>-0.0469</td>
</tr>
</tbody>
</table>

* ** *** statistical significance at 0.01, 0.05 and 0.10 probability levels.

Bayburt is taken to be reference group.

Table 4 gives the real and estimated averages of the probability of farmers’ desire to make CI. According to real values, although 45.08% of farmers desired to make CI, this rate was determined to be 50.41% in the model and 54.92% and 49.59% of farmers undesired to make CI in real and model, respectively. There is a difference of 5.33% between real and estimated values, and such a difference shows that the model is close to real values.

Conditional average means the average yearly number of animals to be insured by only the farmers desiring to make CI. This number was estimated to be 3.95 in real values while 3.83 in the model. The difference between two values is 0.12, which is very close to real value.

The number of animals desired to be insured in real values from surveyed 122 farms was estimated to be 1.78 while being 1.85 in model. The difference between two values is 0.07, which shows that the model reflects real values very well.

Table 4. Conditional and unconditional averages

<table>
<thead>
<tr>
<th></th>
<th>Real (Gerçek) Average value (Ortalamada değer)</th>
<th>Estimated (Tahmin) Average value (Ortalamada değer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>0.4508</td>
<td>0.5041</td>
</tr>
<tr>
<td>Conditional average</td>
<td>3.9455</td>
<td>3.8305</td>
</tr>
<tr>
<td>Unconditional average</td>
<td>1.7787</td>
<td>1.8527</td>
</tr>
</tbody>
</table>

Note: Probability means the chance to make CI by giving 1 and 0 to whoever desired and undesired to make CI, respectively. Conditional average means the average number of animals to be insured by only the farmers desiring to make CI. Unconditional average means the average number of animals to be insured by both the farmers desiring and undesiring to make CI.
CONCLUSION
In the present study, it was aimed to estimate the demand of farmers performing agricultural production activities in TRA1 NUTSII Region for CI. Data were obtained from the region through questionnaire forms from 122 farms.

The study shows that various factors may affect CI trends. In this respect, it was determined that when income from agriculture increased by 1%, the number of animals to be insured decreased by 1.75%. Yet, while the number of animals to be insured increased by 1.56% the budget rested for agricultural production increased by 1%. In addition, it was determined that as the insurance premium cost increased, the number of animals to be insured decreased, which is also confirmed by demand theory. However, when the probability of animal (veterinary) disease increased by 1%, the number of animals desired to be insured increased by 0.61%. Distribution map of veterinary diseases should be prepared throughout the country, required measures should be taken for the diseases and farmers should be aware of such consequences.

The study results indicated that the number of animals for which farmers wish to make insurance was estimated to be 3.83 per farmer. In addition, when insurance premium cost increased by 1%, the number of animals desired to be insured decreased by 0.87%. Farmers’ attention should be attracted to the insurance by applying discounts in insurance premiums in order to increase the number of insured livestock animals (at present 3%) and premium production (34% at present).

It is possible to state that farmers have yet not developed consciousness towards insurance. Therefore, they should be informed through mass communication devices such as television, radio and SMS about the importance, types and scopes of agricultural insurances, insurance premium account, toll detection and compensation payments. After that, seminars should be organised to transform farmers about agricultural insurances by determining pilot zones.

Statement of Conflict of Interest
Authorshavedeclarednoconflict of interest.

Contribution of the Authors as Summary
Authorsdeclaresthecontribution of theauthors is equal.

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