ANALYSIS OF FARMERS' STATED RISK USING HYPOTHETICAL LOTTERIES AND THEIR PERCEPTIONS OF CLIMATE CHANGE IN THE NORTHWEST OF MEXICO

Miguel Angel Orduño[a], **Zein Kallas**[b] **and Selene Ivette Ornelas**[c]

[a] *Institute for Research in Sustainability Science and Technology (IS-UPC), Polytechnic University of Catalonia (Barcelona, Spain, miguel.angel.orduno@upc.edu)*

[b] *Center for Research in Agrofood Economy and Development (CREDA-UPC-IRTA),*

Polytechnic University of Catalonia, Institute of Agrifood Research and Technology (Castelldefels, Spain, zein.kallas@upc.edu)

[c] *Faculty of Mathematics and Statistics (FME-UPC), Polytechnic University of Catalonia (Barcelona, Spain, selene.ivette.ornelas@upc.edu)*

Summary:

The risk attitude affects farmers' production and investment decisions. It is a factor related to their environmental attitudes and towards climate change (CC). The multiple price list (MPL) method was applied to identify the level of stated risk by farmers and subsequently related to their socioeconomic characteristics, environmental attitudes and CC' perceptions. The data was collected through a face-to-face survey of 370 farmers in irrigation district 076 in northwestern Mexico. The results showed a risk level of 0.32 according to the Constant Relative Risk Aversion (CRRA) coefficient, locating farmers of the region in a risk-averse group. The heterogeneity analysis showed that socioeconomic factors and perceptions of CC are related to the farmers´ stated risk. Farmers who are young women, with a tendency to use public support for structural investment, were shown to be risk-tolerant. Farmers considered floods, hail, diseases, pests, and weed growth incidences to be the most frequent weather patterns in the region.

Key words: risk attitude, farmers, multiple price list, lotteries and climate change.

1. Introduction and Objectives

Climate change is one of the greatest challenges of our times. The way in which weather patterns occur represents a risk, especially for agricultural production due to floods, storms, droughts and hail. Farmers' perceptions of CC are increasingly playing an important role in agricultural output and farmers' decisions at farm level [Makuvaro, et al; 2018]. These perceptions are multidimensional and are mainly related to farmers' risk attitudes. Several determinants can be related to the farmer's risk attitude. The socioeconomic characteristics of the farmer may also be associated with the determination of risk attitudes [Kallas, et al; 2010]. Their attitudes concerning the environment may also directly impact their decisions, with a certain level of uncertainty. This study aims to analyze the farmers' stated risk attitudes in an agricultural region in northwestern Mexico, using the MPL method and analyze the heterogeneity of the risk attitude with farmers' opinions concerning the environment and perceptions of CC. Finally, identify attitude patterns, which allow for the differentiation of groups of producers whose characteristics aid in understanding the decisions that they make regarding their activities in order to inform policy makers on farmers' preferences.

2. Methodology

Data was collected from 370 farmers from the irrigation district DR076 located in the Carrizo Valley in the state of Sinaloa in Northwestern Mexico were interviewed, using semi-structured face-to-face questionnaire and stratified by, age, gender, size and region.

2.1. Farmers' environmental attitudes

The New Ecological Paradigm (NEP) scale was used to analyze farmers' environmental opinions. This scale has sixteen statements that express a positive or negative evaluation of the environment, reflects the way in which the human being conceptualizes nature and the way he/she behaves in relation to it [Gomera, et al. ; 2013]. Uses a 9-point Likert type scale (1 absolutely disagree and 9 absolutely agree) to evaluate the statements.

2.2. Farmers' perceptions of climate change

The perception of CC was analyzed by asking farmers whether he/she has observed variability in certain meteorological events related to the climate. To address this issue, an array of statements, collected from a literature review related to CC was evaluated, according to the farmer's perception, also using a 9-point Likert scale.

2.3. Farmers' risk attitudes

The MPL model contains eight scenarios, with a pair of hypothetical lotteries (option A and option B), with constant probabilities, where one option must be chosen (relates the levels of risk aversion with a gain). In option A (safe option), the probability of obtaining the amount presented is 100% and in option B (risk option), the probability is 50% to obtain the amount of ($ 100) and 50% to obtain ($ 0) in all scenarios. The safe amount presented in option A in each scenario is modified incrementally ($ 100, $ 75, $ 60 $ 50, $ 40, $ 30, $ 20 and $ 10) [Brick et al., 2012; Holt and Laury, 2002].

3. Results

The stated risk level using the MPL was 0.32, defining farmers in region as risk averse. The analysis of heterogeneity showed that women are more risk-tolerant than their counterparts (39% of men are risk-tolerant, 61% of women are risk-tolerant). The subsidy was related to farmers' risk level. Farmers who receive economic support and use it in structural investment at farm level are more risk-tolerant. Farmers "over 60" show that the experience acquired over time allow them to have less risk aversion.

The Principal Component Analysis (PCA) carried on the CC items associated to risk (Figure 1), showed that first component characterizes farmers' perception of weather patterns (floods, hail, diseases and pests), and the second characterizes the impact on their agricultural productivity. The farmers´ distribution (point´s cloud), shows that most of the risk-tolerant farmers (red points) are located on right of first dimension, exhibiting a higher perception of weather patterns related to CC; also they are more concentrated in the upper part of the second dimension, showing their perception that CC has a high impact on their production. Results showed that highly risk-tolerant farmers are those that are prone to using structural investment subside. Risk-neutral farmers do not have well-defined perceptions regarding CC, nor the effects that CC could have on their productivity.

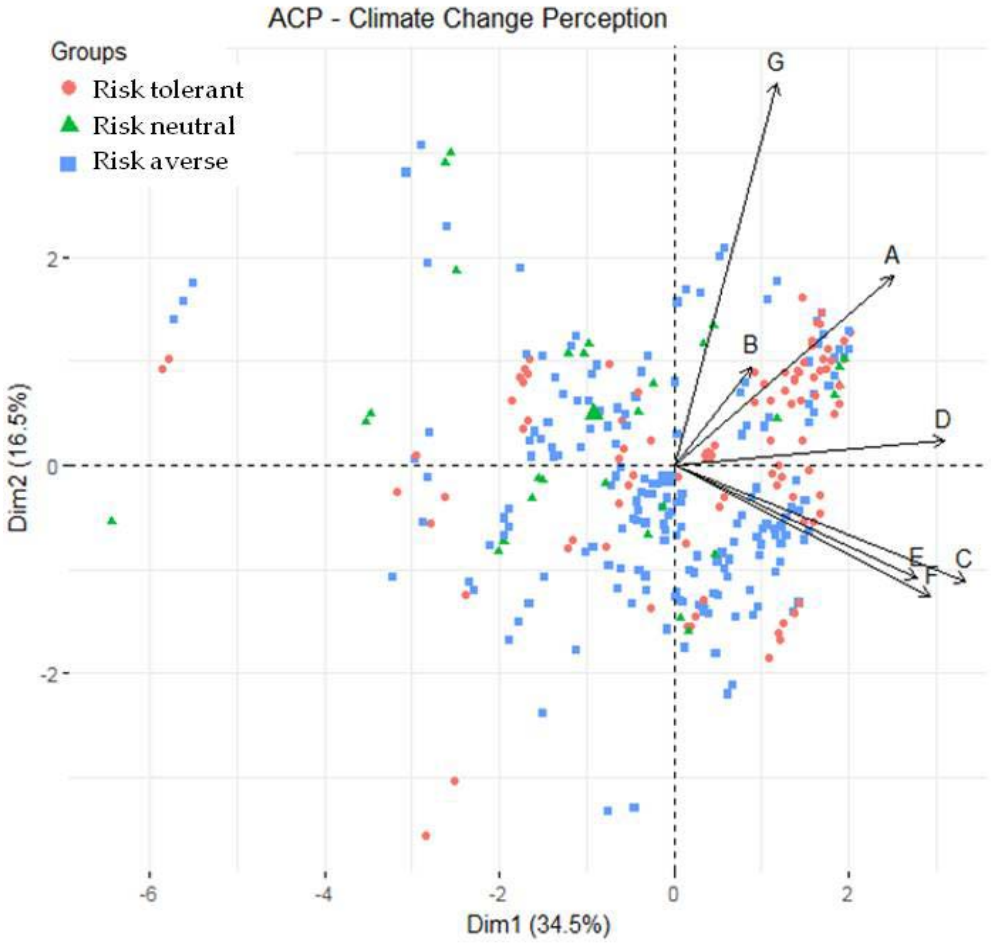
The PCA carried on the environmental attitudes associated to risk (Figure 2), showed two dimensions: ecocentric and anthropocentric attitudes. The dispersion of points showed that farmers with risk-tolerant attitude (red dots) have positive perception towards ecocentric attitudes. There is no clear trend in the environmental attitudes of risk-averse farmers. However, its risk-averse attitude does not exclude its possible adoption of positive actions towards the environment (Dörshner and Musshoff, 2013).

4. Conclusions

The MPL method was demonstrated as a valid approach to measure the stated risk in the agricultural sector in Mexican farmers' sample. Farmers in the region exhibited risk aversion attitude. They recognize the importance of improving the commercialization of their crops and the effectiveness of treatments against diseases and pests. Farmers' perceptions of CC showed a higher incidence of pests and diseases in their crops, increases in weeds, an increase in temperature and changes in the timing of rainy periods.

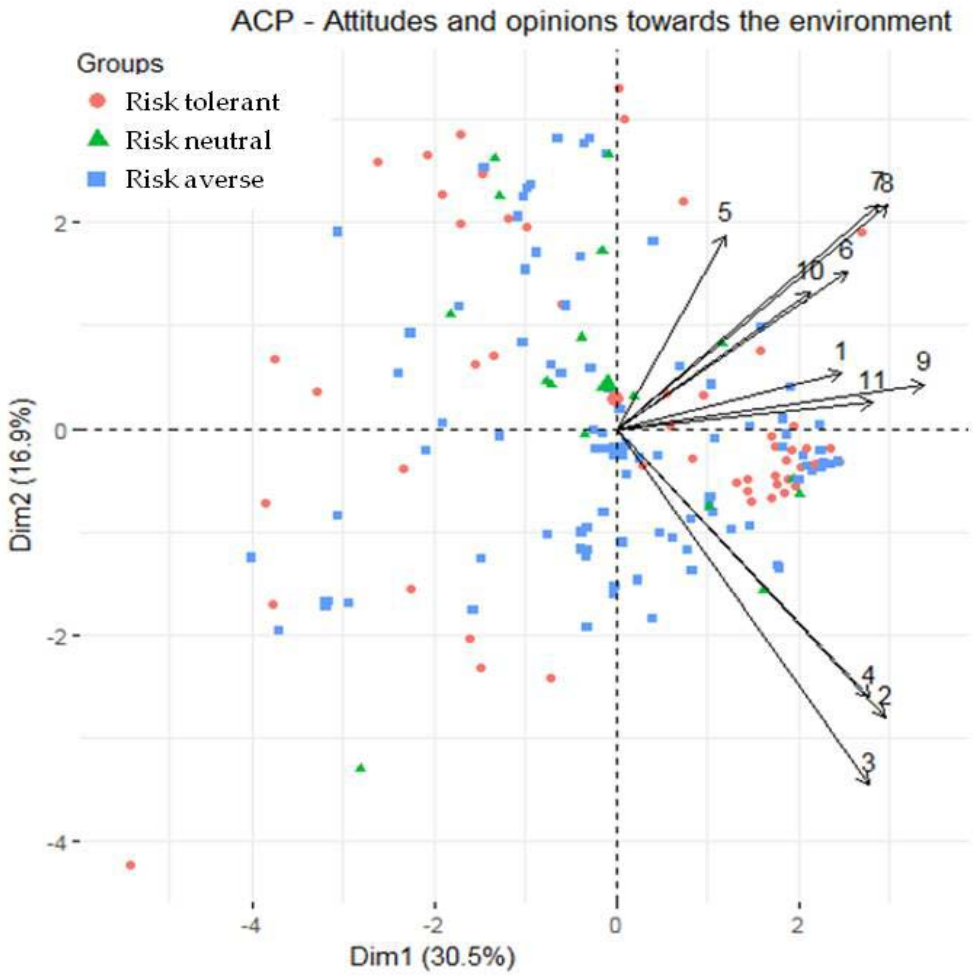
Gender and age were related to risk attitude. Women in the region were more risk-tolerant than men and more likely to use public support to invest at the farm level. Farmers older than 60 years were more risk-tolerant than young people. being the risk-tolerant more aware of the effects of CC in production, they proved to be in agreement with the statements of sustainable development related to the environment that can generate greater resilience in the region. It is recommended that these farmers participate more in the process of generating public agricultural policies.

Figure 1. *Farmer´distribution according to their climate change perceptions.*



*(**A**) Impact of global warming on their crops; (**B**) Percentage of climate change influence on production costs; (**C**) Temperature increase; (**D**) More episodes of floods; (**E**) More episodes of hail; (**F**) More diseases and pests; (**G**) Changes in weed development.*

Figure 2. *Farmers´distribution according to their environmental opinions.*



*(**1**) A global ecological crisis is exaggerated; (**2**) The balance of nature supports the impact of industrialized countries; (**3**) Humans may be able to control nature; (**4**) Human ingenuity ensures that earth is not uninhabitable; (**5**) The interference of the human being in nature has disastrous consequences; (**6**) The human being abuses the environment; (**7**) The balance of nature is delicate and easily alterable; (**8**) We are approaching the limit number of people that the earth can hold; (**9**) The earth has limited resources; (**10**) The land has abundant resources; we just have to learn how to exploit them; (**11**) Sustainable development needs a balanced situation.*

5. Bibliography

Brick, K.; Visser, M. and Burns, J. (2012). Risk Aversion: Experimental Evidence from South African Fishing Communities. *Am. J. Agric. Econ*, 94, 133–152.

Dörschner, T. and Musshoff, O. (2013). Cost oriented evaluation of ecosystem services under consideration of income risks and risk attitudes of farmers. *Environ. Manag* 127, 249–254.

Gomera, A., Villamandos, F. and Vaquero, M. (2013) Construction of indicators of environmental beliefs from the NEP scale. *Acción. Psicol*, 10, 149–160.

Holt, C.A. and Laury, S.K. (2002). Risk Aversion and Incentive Effects. *Am. Econ*. Rev. 92, 1644–1655.

Kallas, Z., Serra, T. and Gil, J. (2010). Farmers' objectives as determinants of organic farming adoption: The case of Catalonian vineyard production. *Agric. Econ.* 41, 409–423.

Makuvaro, V., Walker, S., Masere, T.P. and Dimes, J. (2018) Smallholder farmer perceived effects of climate change on agricultural productivity and adaptation strategies. J. *Arid Environ*. 152, 75–82.