agriculture

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Who Is Afraid of Biotic Threats? An Econometric Analysis of Veneto Wine Grape Farmers' Propensity to Insure

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Received: 26 June 2020; Accepted: 1 August 2020; Published: 6 August 2020

Abstract: This paper aims at understanding what affects farmers' choices to buy insuranceagainst biotic threats. Using a survey-based dataset with 1187 observations on Veneto wine grapes farms, we regress a probit model with endogenous variables with a maximum likelihood (ML) routine. The results corroborate the microeconomic theory according to which risk-adverse individuals are more propense to insure. In our framework, the farmers' socioeconomic characteristics are treated as endogenous variables, which exist/are predetermined before the choice to insure (or not). This paper discusses the results in a policy perspective.

Keywords: risk aversion/propensity; probit with endogenous regressors; maximum likelihood estimation routing; insurance market; missing markets

1. Introduction

The determinants affecting farmers' choices to insure against biotic and abiotic threats represent an important topic in agricultural economics research. The economic literature, in fact, has broadly analyzed the factors and underlying reasons that spur farmers to stipulate contracts against risks.

In this perspective, the literature on agricultural insurance is overly broad and addresses many facets of the issue. Lyu and Barrè [1] categorized such literature, which was very differentiated for methodologies and applications, into two main streams of research: (1) demand for agricultural insurance participation ([2–6], among the others) and (2) willingness-to-pay for agricultural insurance ([7–10], among the others).

The present study aims at understanding what affects farmers' choices to insure. It (partially) follows both streams of research. We analyze, in fact, a latent demand for agricultural insurance (as in the second stream of research). However, we do not use willingness-to-pay (WTP) elicitation methodologies. We attempt to operationalize neoclassical microeconomic theory on risk preferences and consequent choice to/not to insure. In this perspective, the paper aims at understanding both (1) the factors that affect farmers' choice to insure and (2) the characteristics of a potential, latent demand for insurance contracts against biotic risks.

The research differs from the referenced literature in three perspectives. To our knowledge, it is the first attempt to perform such a type of analysis in the context of wine grape production in the Veneto region. The econometric analysis relies on a survey-based dataset, with 1187 observations on Veneto wine grapes farms, consorted in a large institution (VI.VO Cantine, Cantine Viticoltori del Veneto Orientale). Secondly, it adopts an empirical strategy (probit with endogenous regressors) that, to our knowledge, was never applied before for such studies. In our framework, the farmers' socioeconomic characteristics are treated as endogenous variables, which exist/are predetermined before the choice to insure (or not)against biotic threats. Third, it focuses on risks (and relative insurance) generated by biotic threats. The latter are important to study since biotic threats might have hampered famers' incentives to adopt more organic agricultural practices.

The paper is organized as follows. Section 2 contains the material and methods. Section 3 presents the econometric results. Section 4 discusses the results in a policy perspective. Section 5 concludes.

2. Material and Methods

This section explains the economic theory that inspires the empirical strategy. It also illustrates the rationale beyond the selection of the econometric model and provides a description of the dataset.

2.1. Microeconomics of Insurance and Risk Aversion

In the context of expected utility theory, risk aversion implies a concave Bernoulli utility function. Concavity (or strict concavity) implies that the marginal utility of money is decreasing; therefore, at any level of wealth endowment (w), the utility gain from an extra euro is smaller than the absolute value of the utility loss of having a euro less. This implies that a risk of gaining or losing a euro with even probability is not worth taking (see [11]).

From the general theoretical rule, we can derive an application for insurance in the agricultural sector. Consider a strictly risk-averse farmer, with a Bernoulli utility function $u(.)$ on amounts of money, and with an initial wealth endowment (w) and the risk of a loss of euro (D). The probability of the loss is π. They can buy insurance. One unit of insurance costs q euro and pays 1 euro if loss occurs. Thus, with α units of insurance, the wealth of the individual becomes $w - \alpha q$ if no loss occurs. It will be $w - \alpha q - D + \alpha$ if loss occurs.

The farmer's decision problem is to choose the optimal level of α (with $\alpha \geq 0$), e.g., how many units of insurance they should buy.

The (expected) utility maximization problem is as follows:

$$Max\ (1-\pi)u(w-\alpha q) + \pi u(w-\alpha q - D + \alpha) \quad (1)$$

For α to be optimal, the following first order condition (F.O.C). must be satisfied:

$$-q(1-\pi)u'(w-\alpha * q) + \pi(1-q)u'(w-D+\alpha * (1-q)) \leq 0 \quad (2)$$

with $\alpha* > 0$.

Suppose now that the price q of one unit of insurance equals the expected cost of insurance. Then, $q = \pi$ and the F.O.C: requires the following to be true:

$$u'(w-D+\alpha * (1-\pi)) - u'(w-\alpha * \pi) \leq 0 \quad (3)$$

with $\alpha* > 0$.

If $u'(w-D) > u'(w)$, then $\alpha* > 0$ and therefore,

$$u'(w-D+\alpha * (1-\pi)) = u'(w-\alpha * \pi) \quad (4)$$

because $u'(.)$ is strictly decreasing. This implies the following:

$$w-D+\alpha * (1-\pi) = w-\alpha * \pi \quad (5)$$

Equivalently, $\alpha* = D$.

The farmer decides to insure completely. The individual final wealth is then $w - \pi D$, independent of the occurrence of loss. Economic theory suggests that a risk-adverse farmer will fully insure if the insurance price is actuarially fair. This means that the premium equals the expected value of the payout (see [11]).

2.2. Empirical Strategy

The surveyed theory suggests that the population of strictly risk-averse farmers will choose to insure fully. In this perspective, the empirical strategy aims at modelling the relationship between the probability to fully insure against a loss and the degree of farmer risk adversity/propensity. The latter variable(s) in our setting is/are made dependent on a set of socioeconomic characteristics. In particular, we expect to find a positive/negative relationship between risk-adverse/risk neutral-taker farmers, as highlighted in Equation (6).

$$\underset{}{Probability\ to\ fully\ insure} = f(\underset{(+)}{Risk\ Averse\ Farmer(.)},\ \underset{(-)}{Risk\ Neutral/Taker\ Farmer(.)}) \quad (6)$$

The probability that the farmer fully insures positively/negatively depends on the farmer's risk aversion/propensity. If such testable relationships might appear straightforward, it is interesting to simultaneously determine what factors affect the risk aversion or propensity or the farmers' preference for risk. Following the literature, we attempt to explain that preference structure as depending on a set of socioeconomic indicators used in the literature. Those include age, education, wealth of the farmer, and management and organizational structure that the farmer chooses to apply to their business. In our framework, therefore, the farmers' choice to fully insure against risk/damage depends on the farmer's risk aversion as risk preference that is (pre)determined by a set of socioeconomic characteristics.

More technically, we model such relationship as shown in Equation (7).

$$P\{y_i = 1 \big| x_i\} = G\{z_i(x_i),\ \beta\} \quad (7)$$

The equation says that the probability (P) that y_i equals 1 (the farmer fully insures against the risk of a loss due to a biotic/abiotic threat) is an empirical (β) function (G) of the vector x_i of exogenous characteristics (containing information on the socioeconomic profile of the farmer) and on one endogenous regressor z_i (the farmer's aversion to risk, a variable that is simultaneously determined with the binary dependent variable). In particular, the probability that a farmer insures against (1) downey mildew, (2) powdery mildew, (3) botrytis, and (4) wood disease depends on the risk aversion of the *i*th farmer. Such variable is the endogenous variable that affects the independent variable and is simultaneously determined by the instrumental vector of variables z_i, the socioeconomic characteristics that are predetermined with respect to the model (and therefore are exogenous) and affect both the farmers' preference towards risk and the choice to (fully) insure against the selected risks.

The probit with endogenous regressors empirical model was estimated in STATA 12 (StataCorp LLC, College Station, TX, USA) with the maximum likelihood routine.

2.3. Data

Data were gathered through the administration of surveys to 1187 wine grapes' farmers. Farmers were consorted within the wine cooperative VI.VO Cantine, located in the Eastern Veneto region. The cooperative gathers wine grapes' yearly output from the producers and deals with the wine production and sales. Then, the cooperative redistributes the sale profits to the grape producers according to a criterion based on the quantity and quality of supplied wine grapes. Onofri et al [12] present a thorough analysis of the economics of cooperative wineries. The 1187 respondents replied to the survey during the annual grapes' conferment. They represent around one third of Veneto wine grapes and wine production.

The surveys are semi-structured and contains 22 questions, grouped in 4 different thematic areas: (a) socioeconomic information about the respondent; (b) farm organization and economic characteristics; (c) strategies to enhance environmental, landscape, and sustainable practices; and (d) strategies for technological innovation for the vineyard and water management. For a thorough description of the dataset, see [13].

For the sake of our analysis, we have used just a part of the dataset. We have used selected variables from section (a) and (b) and a part of section (c), related to the method of managing the defense against biotic adversities.

Table 1 presents the selected variables description and statics.

Table 1. Variables in the descriptive statistics.

Socioeconomic Information about the Respondent/Farmer					
Variable	**Description**	**Min**	**Max**	**Mean**	**St. Dev.**
Age	Age of the farmer	21	93	63	13.31
Duration	Duration of the farming activities in years as a proxy for experience	4	106	30	16.42
Education	School degree held by the farmer	43.97% of the farmers hold a primary school degree; 35.55% have a middle school degree; 19.63% have a high school diploma; 5.39% have an undergraduate university degree. 0.25% hold a Ph.D).			
Land Legal Entitlement	Legal title for land exploitation	67% of the respondents own the vineyards land; 25% of the respondents rent the land; 8% use the land for free			
Dedication	Whether the farming activity is performed full/part time	73.8% manage the farm full time; 26.2% of the sample manages the farm part-time			
Farm Organization and Economic Characteristics					
Variable	**Description**	**Min**	**Max**	**Mean**	**St. Dev.**
Dimension of the Farm/Property	Dimension of the owned farm in land hectares	0	100	74.74	37.74
Dimension of the Farm/Rent	Dimension of the rented farm in land hectares	0	100	16.38	32.06
Dimension of the Farm/*Comodato Gratuito*	Dimension of the farm used for free in land hectares	0	100	5.78	20.43
Legal Organization of the farm	Type of legal regulation applicable to the farm	Single farmer/entrepreneur: 89% of the sample; 11% of the respondents are organized in capital companies.			
Type of farming Practices	Conventional/integrated or organic cultivation practices	Most farms (83%) are managed using the conventional agricultural models; 16.4% adopt an integrated viticulture management, while only 0.6% of winegrowers apply a organic protocol and with a similar percentage the principles of biodynamic production			
Biotic Threats and Risk Perception					
Downey Mildew	Farmers' perception of the biotic threat on a scale from "very low" to "very high"	No answer: 14.83% of the respondents Very low: 41.79% Low: 4.8% Average: 14.74% High: 3.12% Very high: 20.72%			
Powdery Mildew	Declared choice to insure against biotic threats	No answer: 33.7% of the respondents Very low: 26.84% Low: 4.3% Average: 8.85% High: 1.1% Very high: 25.22%			
Botrytis	Declared choice to insure against biotic threats	No answer: 35.30% of the respondents Very low: 25.07% Low: 4.13% Average: 10.11% High: 0.93% Very high: 24.47%			
Wood disease	Declared choice to insure against biotic threats	No answer: 33.87% of the respondents Very low: 26.34% Low: 2.78% Average: 7.83% High: 1.35% Very high: 27.83%			
Risk aversion	The variable was constructed using microeconomic reasoning as explained in the text below. It takes the value of 1 when the respondent is risk averse and 0 otherwise.				

More in particular, producers' age ranges: 47.3% of the respondents are over 65 and 47.8% are between 40–65. Only 4.9% of the respondents are below 40. Around 40% of the farms were established before 1980; 42% of the farms were created between 1981 and 2007; and the remaining 28% was settled after 2007, most probably contextual to the Prosecco booming cycle and the enlargement of the territories devoted to Prosecco production. With reference to the farm dimension, almost 40% of respondents manage small farms with a surface area of less than 1 ha. Around 33% are farms, with a dimension of the cultivable land ranging from 1 to 3 ha; around 20% are farms with 3–10 ha. About 7% are with area larger than 0 ha. Different management choices are motivated by trade-offs between time, costs, and sustainability requirements, still resolved in function of the first two factors.

The risk preference structure of the farmers was implicitly derived by applying the theory in order to interpret selected answers to a question in the survey. We have used the methodology based on observed economic behavior of farmers (see [14] for a survey on methods for measuring the farmers' risk preferences in Europe). The authors distinguish between two main groups of methods. The first is constituted by the corpus of studies based on observed economic behavior from secondary data used to measure risk preferences from secondary data. The main principle underlying these methods is to estimate risk preferences by comparing the observed behavior of agricultural producers with respect to input and output choices to behavior predicted by theoretical models incorporating risk and risk preferences. Observed behavior methods imply eliciting a latent not directly observed variable from a directly observable behavior/statement. The second approach relies on studies based on elicited preferences from primary data are rely on two main methods: (1) methods based on multi-item and scale-based questions; (2) Methods based on lottery-choice tasks, such as incentive-compatible experimental lotteries that are generally executed as artefactual field experiments.

In our case, the sample of farmers that performs conventional agricultural practices were asked to state the conditions under which they would/would not swap to organic or biodynamic practices (that are more profitable but also riskier). Among the presented reasons (costs constraints, technological constraints, preferences, tradition, time span, and idiosyncratic production/investment/inputs), the survey explicitly stated the "high risk" possibility that the swap would generate. In this perspective, 65% of the respondents chose the high-risk option/answer. We have interpreted such a sample of respondents as the sample of risk-adverse population, whose risk preference is characterized by a concave Bernouilli utility function. In fact, those respondents reveal a preference structure at which, at any level of wealth endowment w, generated by conventional agricultural practices, the utility gain from an extra euro (from swapping to organic/biodynamic) is smaller than the absolute value of the utility loss of having a euro less. The risk-averse respondents are able to economically perform the switch (they did not choose the high cost/costs barriers-technological barrier answers possibility). However, they prefer to perform the conventional agricultural practices (less economically costly (without computing externalities) and less profitable) for the sake of risk aversion in a strict microeconomic fashion: they prefer not to make (potential) losses rather than having extra (more than proportional) gains (from the swap to organic/biodynamic more profitable practices). Such respondents represent the sample of averse-to-risk farmers as defined in a strict microeconomic context of choice under uncertainty. Such a variable represents our endogenous variable.

It is worth highlighting the difference between Risk preference and risk perception. Sitkin and Pablo [15] defined the main difference between risk perception and risk preference. They defined the risk perception as the observed likelihood of a person taking or avoiding risk. Risk perception can be altered when subjects' alternatives are influenced by situational factors such as outcome framing or prior outcome history. On the other hand, risk preferences are defined as the character trait of being attracted or repelled by risks, which is classified as a stable personal trait and cannot be influenced by situational factors.

On this line of research, especially the work of Serra et al. [16] shows that conventional farmers may be willing to become organic farmers if there is a perceived reduction in risk, derived from the conversion. These findings are consistent with the results derived by Chavas and Holt [17], Gardebroek [18] and Lien [19] among the others, and suggest that some people may not adopt organic farming techniques unless some risk-reducing mechanisms are available in the market. The propensity to adopt organic can therefore be a measure of risk preference.

3. Results

After several checks, the econometric results of the probit model(s) with endogenous regressors are presented in Table 2.

Table 2. Probit with endogenous regressors.

	Probability to Fully Insure against Downey Mildew	Probability to Fully Insure against Powdery Mildew	Probability to Fully Insure against Botrytis	Probability to Fully Insure against Wood Disease
		Estimated Coefficients		
Risk Aversion	1.34 ***	1.57 ***	1.62 ***	1.81 *
Constant	−1.1 ***	−1.75 ***	−1.94 ***	−0.2
Instruments: Age, Elementary School Degree, Middle School Degree, University Undergraduate Degree, Landowner				
		Econometric Diagnostics		
Log likelihood	−1348.71	−988.45	−957.14	−1072.69
Wald test of exogeneity	0.12 Prob > chi2 = 0.72	0.81 Prob > chi2 = 0.36	0.62 Prob > chi2 = 0.43	2.52 Prob > chi2 = 0.11

*** 1% statistical significance; ** 5% statistical significance; * 10% statistical significance.

Instruments have been selected after several attempts that proved both econometrically and economically robust and consistent given data availability. Results show that the probability that a farmer insures against the damages caused by downey/powdery mildew, botrytis, climatic disasters, and frost positively depends on the risk-adverse profile of the farmer, which in turn depends on a set of selected socioeconomic variables (age, education, running a conventional farm, being the owner of the land, proxy of wealth, and large land-owned parcels) that are treated as instruments.

Our modelling strategy treats socioeconomic variables as exogenous covariates that affect (ex ante) the risk attitude of the farmer, who, in turn, will choose whether to insure. The impact of the socioeconomic variables has been preliminary tests using a univariate probit model presented in the Appendix A.

Our results, though partially comparable given the peculiar modelling strategy, corroborate the mainstream literature results in two perspectives. First, we find that the probability to buy agricultural insurance in our application against biotic threats, (positively) depends on the (adverse) risk profile of the farmer. Second, such results rely on the use of variables commonly used in the literature, even with a plethora of different methods and applications, like farmers' age, experience, and education level. Our results differ for the application to biotic threats, since most studies consider insurance for revenue, yield, and hail protection. In addition, our dataset is lacking information on farmers' wealth indicators (even if the legal entitlement of land can be a proxy, since landowners have larger pieces of land). Variables like experience and farms duration did not perform well when used, differently than other studies (for instance, the seminal Sherrich et al. [2].

The results corroborate the microeconomic theory, according to which risk-adverse individuals are more propense to insure.

4. Discussion

Empirical results show a significant quota of latent demand for insurance against biotic threats.

A quick survey on the regulatory current situation shows a missing (insurance) market. In Italy, in fact, the insurance system of agricultural firms in Italy is regulated by the law (legislative decree of March 29, 2004, No. 102, financial interventions in support of agricultural enterprises, modified and integrated by legislative decree n. April 18, 2008 No. 829. Every year, the management of risks in agriculture is defined by a ministerial decree, the most recent of which is Ministerial Decree No. 642/01/21/2019, modified for the terms of implementation by Ministerial Decree No. 15253/03/29/2019).

Insurance coverage is divided into four main types of packages: A, B, C, and D. All packages cover against selected climatic risks: (1) catastrophic risk: flood, drought, and frost; (2) frequency risk: hail, wind, excessive rain, and excessive snow; and (3) ancillaries risks: sunstroke, hot wind, and thermal shock. Considering the public subsidy that contributes up to 70%, the packages are divided in (A) contract covering all risks; (B) contracts covering all of (1) and at least one of (3); (C) contracts covering at least three risks to be chosen among (2) and one from (3); and (D) contracts covering all of (1).

In Italy, the subsidized agricultural insurance market covers 19% of gross production of vegetable crops and 9% of the agricultural area used nationally. It is also concentrated on specific products and territories. Over two thirds of the products insured are represented by wine grapes, apples, maize, rice, and industrial tomatoes, followed by pears, soft wheat, and nectarines. Corn, rice, and wine grapes alone cover 53% of the insured national territory. Northern Italy concentrates 81% of the values and 86% of the insured areas against 10% and 8% of Central and 9% and the 6% of Southern Italy. In particular, two thirds of the insured values are found in Emilia Romagna, Veneto, Lombardy, Trentino Alto Adige, and Piedmont.

In Veneto, there is a tendency to choose package C (€222 million in 2015), followed by B (€122 million in 2015) and A (€86 million in 2015). Recently, however, the bureaucratic difficulties to get public subsidies combined with the contraction of public contributions have favored a return to single-risk contracts, which insures only a specific type of risk. Those contracts are less costly but do not benefit from any kind of facilitation and prove insufficient to cover the multiplicity of risks to which a farm is exposed.

A missing (insurance) market emerges: there is a significant latent demand for insurance against biotic threats, and no contracts are offered on the supply side against those risks and possible damages. This might also explain the reluctance of farmers to swap to organic agricultural practices, as a policy suggestion based on the economic and econometrics results.

The main reasons behind this failure in the development of insurance for biotic threats is related to the lack of information about risks linked to plant disease. Differently from abiotic risks, applied modelling of crop diseases and pests has been dominated by short term, tactical questions, such as the development of support capabilities to schedule scouting or pesticide applications (Donatelli et al. [20]). Consequently, there is a need to design protocols which can guide the collection of the experimental data needed to calibrate and evaluate crop loss models, including both epidemiological and crop data (Willocquet et al. [21]). This does not allow for the development of market product (insurance).

The second limitation of such a tool is the problem of moral hazard. Farmers injured by a plant disease may reduce or avoid bearing additional costs to reduce the impact of a pest infestation, increasing the compensation payed by the insurance company. Good practices associated with risk coverage may reduce this problem as well as the introduction of a maximum amount of indemnification by the application of an overdraft in the compensation.

Within this context, mutual funds can be effective instruments. Mutual funds, in fact, compensate and integrate farmers financial capacity by managing a shared risk of their members instead of assuming individual farmers' risks. This allows for the management of the uncertainty about the level of risk. The main limitation of this tool may be related to the fact that risk uncertainty may hamper the willingness to pay of farmers for protection against biotic threats/risk which may be extremely low. The current Common Agricultural Policy (CAP) is therefore largely supporting this tool, giving the possibility to cover up to the 70% of the farm payment for the fund coverage (reg. EU 1305/2013). Italy placed a total amount of 50 million € for the period 2015–2020 to support such a tool, and from 2020, the firsts mutual funds covering risk related to plant diseases (for grape, corn, and wheat) is expected to be recognized by the Italian Ministry of Agriculture.

5. Conclusions

In this paper, we have tested the microeconomic theory on insurance incentives, with an application to wine grapes farmers in the Veneto region in Italy. We have modelled a probit with endogenous regressors and tested it with survey data. Empirical results confirm the microeconomic theory, according to which risk averse farmers are willing to fully insure against (biotic) risks.

The empirical result, therefore, indicate that there might be a large latent demand for insurance against biotic risks. Such demand, however, is not potentially faced by proper insurance supply. The insurance is not actuarially fair, since, at the moment, the insurance market does not supply that kind of coverage in Italy.

The main reasons behind this failure in the development of insurance markets and products in agriculture also represent an incentive to develop further research in the field.

Author Contributions: Conceptualization, V.B.; formal analysis, L.O.; investigation, S.T.; methodology, L.O.; supervision, V.B.; visualization, S.T.; writing —original draft, L.O.; writing—review and editing, L.O and S.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: The authors are very grateful to the two anonymous referees for their useful comments. The usual disclaimer applies.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Preliminary to the regression of the probit model with endogenous variables, we have selected the instruments among the available data and variables with a socioeconomic content. For this purpose, we have regressed a probit model describing the relationships between risk aversion and socioeconomic variables. After several checks, we have selected those instruments that better performed in the probit model, as reported in Table A1.

Table A1. The dependent variable is risk aversion.

Independent Variable	Estimated Coefficient
Age	0.005
Middle School Diploma	0.22 ***
University Undergraduate Degree	−0.1 *
Conventional Farm	0.17 ***
Landowner	0.002 *
Land Renter	−0.0008
Constant	−1.52 ***
Pseudo R^2 = 0.47	
Prob > chi2 = 0.0004	

*** 1% statistical significance; ** 5% statistical significance; * 10% statistical significance.

The probability that the farmer is risk averse positively depends on advanced age, low education level, ownership of the land, and the performance of conventional farming models. The probability that the farmer is risk averse negatively depends on high education level and lease of the land. The profile of a risk-averse farmer sketches an aged individual with low education levels that performs conventional farming methods and owns the land.

References

1. Lyu, K.; Barre, T. Crop Insurance Program Purchase Decision and Role of Risk Aversion: Evidence from Maize Production Areas in China. In Proceedings of the 29th International Conference of Agricultural Economists, Milan, Italy, 8–14 August 2015; Available online: https://ageconsearch.umn.edu/record/212199 (accessed on 20 April 2020).
2. Sherrick, B.; Barry, P.J.; Ellinger, P.N.; Schnitkey, G.D. Factors Influencing Farmers' Crop Insurance Decisions. *Am. J. Agric. Econ.* **2004**, *6*, 103–114. [CrossRef]
3. Falola, A.; Ayinde, A.E.; Agboola, B.O. Willingness to Take Agricultural Insurance by Cocoa Farmers in Nigeria. *Int. J. Food Agric. Econ.* **2013**, *1*, 97–107.
4. Sadati, A.; Ghobadi, F.R.; Sadati, S.A.; Mohamadi, Y.; Sharifi, O.; Asakereh, A. Survey of effective factors on adoption of crop insurance among farmers: A case study of Behbahan County. *Afr. J. Agric. Resour.* **2010**, *16*, 2237–2242.
5. Boyd, M.; Pai, J.; Zhang, Q.; Wang, H.H.; Wang, K. Factors affecting crop insurance purchases in China: The Inner Mongolia region. *China Agric. Econ. Rev.* **2011**, *3*, 441–450. [CrossRef]
6. Kumar, D.S.; Barah, B.C.; Ranganathan, C.R.; Venkatram, R.; Gurunathan, S.; Thirumoorthy, S. An Analysis of Farmers' Perception and Awareness towards Crop Insurance as a Tool for Risk Management in Tamil Nadu. *Agric. Econ. Res. Rev.* **2011**, *24*, 37–46.
7. Akhter, A. Farmers' Willingness to Pay for Index Based Crop Insurance in Pakistan: A Case Study on Food and Cash Crops of Rain-fed Areas. *Agric. Econ. Res. Rev.* **2013**, *26*, 241–248.
8. Ramasubramanian, J.A. Willingness to Pay for Index Based Crop Insurance in India. Ph.D. Thesis, University of Sussex, Brighton, UK, 2012.
9. Hill, R.V.; Hoddinott, J.; Kumar, N. *Adoption of Weather-Index Insurance: Learning from Willingness to Pay among a Panel of Households in Rural Ethiopia*; CSAE Working Paper WPS/2013-02; International Food Policy Research Institute: Washington, DC, USA, January 2013; Available online: http://www.csae.ox.ac.uk/conferences/2011-EDiA/papers/345-Kumar.pdf (accessed on 20 April 2020).
10. Chen, Z.; Ling, Y.; Li, W. Measurement and Regression Analysis on Farmers' Willingness to Pay for the Agricultural Insurance. Case Study of Tobacco Insurance in Xingshan County. *South China J. Econ.* **2008**, *7*, 22–35.
11. Mas-Colell, A.; Whinston, M.D.; Green, J.R. *Microeconomic Theory*; Oxford University Press: Oxford, UK, 1995.
12. Onofri, L.; Barisan, L.; Boatto, V. Rules, Organizational Structures and Economic Performance: The case of Prosecco Cooperative Wineries in the Treviso Area. *Riv. Econ. Agrar.* **2016**, *1*, 86–96.
13. Bolzonella, C.; Boatto, V.; Teo, G.; Pomarici, E. Analysis of the propensity to sustainability of wine grape growers: A case study in Veneto. In Proceedings of the LV Sidea Conference, Perugia, Italy, 13–15 September 2018.
14. Iyer, P.; Bozzola, M.; Hirsch, S.; Meraner, M.; Finger, R. Measuring Farmer Risk Preferences in Europe: A Systematic Review. *J. Agric. Econ.* **2020**, *71*, 3–26. [CrossRef]
15. Sitkin, S.; Pablo, A. Reconceptualizing the Determinants of Risk Behavior. *Acad. Manag. Rev.* **1992**, *17*, 3–26. [CrossRef]
16. Serra, T.; Zilberman, D.; Gil, J.M. Differential uncertainties and risk attitudes between conventional and organic producers: The case of Spanish arable crop farmers. *Agric. Econ.* **2008**, *39*, 219–229. [CrossRef]
17. Chavas, J.P.; Holt, M.T. Economic behavior under uncertainty: A joint analysis of risk preferences and technology. *Rev. Econ. Stat.* **1996**, *78*, 329–335. [CrossRef]
18. Gardebroek, C. Comparing risk attitudes of organic and non-organic farmers with a Bayesian random coefficient model. *Eur. Rev. Agric. Econ.* **2006**, *33*, 485–510. [CrossRef]
19. Lien, G. Non-parametric estimation of decision makers' risk aversion. *Agric. Econ.* **2002**, *27*, 75–83. [CrossRef]
20. Donatelli, M.; Magarey, R.D.; Bregaglio, S.; Willocquet, L.; Whish, J.P.; Savary, S. Modelling the impacts of pests and diseases on agricultural systems. *Agric. Syst.* **2017**, *155*, 213–224. [CrossRef] [PubMed]
21. Willocquet, L.; Savary, S.; Fernandez, L.; Elazegui, F.; Teng, P.S. Development and evaluation of a multiple-pest, production situation specific model to simulate yield losses of rice in tropical Asia. *Ecol. Model.* **2000**, *131*, 133–159. [CrossRef]