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Why Farmers Get Involved in Participatory Research Projects? The Case of Arable Crops Farmers in Greece

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Abstract: This paper seeks to underline the driving factors of farmers' engagement in Participatory Research Projects (PRPs). This is a critical issue for formulating efficient and effective technology transfer channels, essential for improving the operational status of agricultural holdings. A survey was conducted on a sample of 326 Greek arable crops farmers. An explanatory framework consisting of three major factor categories and 11 variables was developed. A logistic regression analysis empirically tests the effect of the variables on the participation of farmers in PRP. Furthermore, the relative importance of variables and factors is extracted with the Shapley–Owen decomposition analysis. The results show that Farmers' Willingness and Social Influences are the factors that mostly affect their decision to engage in a PRP. The farmers' ability consisting of socioeconomic and demographic variables has a small effect on their decision-making process. The estimated effects can help decision-makers to shape and prioritize more targeted policies for farmers' engagement in research. Additionally, this paper sets the basis for shifting research from simple estimations of the effect of variables on farmers' decision-making, to a more comprehensive estimation that also accounts for the strength of these relationships. The paper fills a gap in the literature of studies on farmers' decisions for participating in PRPs, by developing and testing an explanatory framework which also accounts for the relative importance of each factor/variable.

Keywords: participatory research projects; farmers' decision making; explanatory framework; logistic regression; Shapley-Owen; factor analysis

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1. Introduction

The achievement of global agricultural sustainability necessitates the engagement of farmers through the constant modernization of their farms, the adoption of more efficient farming practices being supported by innovative technologies, and the improvement of their productivity [1]. The interrelationship between improvement of production practices and policy instruments, as a means of technology transfer, is proven to be quite strong and effective [2]. The implementation of policies' guidelines by the farmers is constrained by various personal, socioeconomic, geographical, demographic, political, and technological factors [3]. Among the most important means for helping farmers to adopt more sustainable farming practices, is their knowledge capacity around the multiple issues that they are faced with when planning and managing their holdings [4]. The benefits of education and knowledge at the farm level are then translated to significant productivity and income gains of the agricultural sector as a whole [5].

Farmers acquire knowledge through informal and formal channels [6]. The first category includes information flows through social interactions, both physical and digital

(social media), as well as the collection of information by reading of resources such as books, journals, and websites. In the latter category, the most important sources are the enrollment in educational programs, the Extension Services (ES), and the involvement in Participatory Research Projects (PRP) [4]. Such cooperation requires the formation of a consortium consisting of research institutes and market oriented stakeholders, working together for the resolution of specific problems related to the value chain of products. These kinds of projects can either be co-financed on a national or EU basis, or be fully financed by the private sector or cooperatives. Indicative example is the CROPFEED project, co-financed by the Greek General Secretariat of Research and Technology (http://cropfeed.agr.uth.gr). In this project locally produced leguminous crops are being fed to milking cows, aiming to decrease the high dependency of imported GMO soya. Similar rationale follows the Bio-circular project, co-financed by the same authority. The most important formal source of information, especially in developing countries, is this of ES which come up with various settings and objectives across the different parts of the globe. The effectiveness of these kinds of programs still remains under a heavy critique. This is because, despite the documented changes that such projects have brought in several countries [5], many authors believe that their impact would be even greater if they were designated in a more farmer-centered context, lying away from the top-down unidirectional approach that many ES have adopted in the past [7,8]. The need for more farmers' engaging type of extensions projects has led to the development of the so-called Participatory Extension Programs (PEP) which are taking the form of meetings over a predefined period of time, typically 1–3 years and whose targets and objectives are commonly agreed by farmers and researchers [9].

On the other side, PRP could be regarded as similar to the PEP ones, with the exception that they overemphasize the role of experiments and field tests over the soft transferring activities of knowledge and best practices. The projects call for the active participation of farmers toward the joint development of technological and innovative solutions to common challenges and their constant involvement over a rather large period of time [10]. This kind of interaction is considered as an integral part of the more general Farming Systems Research approach which seeks to study in depth all the social, economic, environmental, and governance dimensions of rural life [11]. This kind of knowledge acquisition entails a notion of co-production being set exactly at the intersection of academic and non-academic actors [12] and therefore may prove to be more effective than ESs in triggering farmers' interest and make them work more closely with researchers [8,10,13,14].

Despite the importance of PRPs in fostering sustainability and technology transfer in agriculture, research on the factors affecting farmers' decision-making with regard to their participation or not in a PRP is still scarce. Most of the past studies of farmers' decision-making focused on issues such as participation in Agricultural Environmental Schemes (AES), shift to organic farming, contribution to local conservation, and realization of investments [15,16]. As for decision-making of farmers for participation in knowledge acquisition activities, much attention has been given to the ESs.

Many authors have analyzed the factors affecting willingness to participate in ESs by using, as a proxy, willingness to pay for these services. Authors use a mix of factors in order to explain the variability of Willingness to Pay and Participate (WTPP) which are quite relative with sociodemographic characteristics of farmers (age, education, etc.), their farm and business characteristics (type of farm, income, and tenure), and their characteristics of services provided referring on how these are perceived by the farmers (quality, frequency, scope, distance from farmers, etc.) [17–20]. Some authors have further elaborated on this issue by incorporating some motivational theories, in order to explain farmers' participation in AES. To this end, Moumouni and Streiffeler [21], in their study in Benin, found that two non-exclusive motivational directions, diversion or congruence, were observed in the farmers' sample and that the prevailing direction for each farmer was the result of his/her socioeconomic characteristics and experiences. Finally, Charatsari et al. [22] used the Self-Determination theory in order to identify the basic motivations behind Greek farmers' participation in ESs. Authors used 30 items that loaded in six factors of *Motives* and also

incorporated some sociodemographic variables in a regression model for predicting the participation of farmers in ESs.

The present paper builds on the work done in modeling the behavior of farmers regarding various types of decisions and especially those concerning their participation in ESs. It develops and tests a model for understanding the driving factors of farmers' participation in PRPs which are still understudied in comparison with those of ESs. To do so, an explanatory framework with three main factors' categories and a binomial regression analysis are incorporated into the analysis. Moreover, the paper is innovative in that it does not only capture the effect of the driving factors in the participation of farmers in PRPs, but also estimates their relative importance, compared with this of all other factors. To do so, a Shapley–Owen R^2 decomposition analysis is conducted after the logistic regression analysis.

The paper has two main contributions in the field of farmers' decision-making: First, it extends the empirical analyses of farmers' participation in knowledge acquisition activities to also incorporate PRPs, and second it provides a method for understanding the relative importance of the factors which have not been considered by past relevant studies. This perhaps is the major objective of this study, to shed more light onto how much clear are the benefits for farmers if they decide to be members in groups of PRPs. The up to now, authors' experience on this realizes the farmers' skepticism, but it is not clear their decision-making process to either participate or not in such schemes. The practical contribution of the paper is that it can assist research institutions in identifying more easily potential collaborators based on a range of various characteristics and help policy makers understand the motives and enabling factors of farmers' participation, so as to proceed to the formation of tailor-made policies. Therefore, the objectives of this analysis is to identify both motives and anti-motives for getting involved in PRPs, as well as quantifying their importance. Factor, Regression, and Shapley–Owen decomposition analysis were applied to obtain the results of this study.

The survey was conducted in Greece and the results are very important for the attitude of farmers not only for PRP but for the general research and knowledge activities as well as new technology adoption, because, in contrast with other countries, extension services in Greece are characterized by strong discontinuities [22] and therefore research projects remain the best alternative for farmers' engagement with research. The remainder of the paper is as follows. In Section 2, the methodological framework and the variables selected are presented, in order to model farmers' behavior. In the Results section, the estimated relationships between the variables and the participation of farmers in PRP are analyzed, while the paper finishes with a discussion on the main conclusions and policy implications for fostering farmers' participation in PRPs.

2. Methods and Variables

2.1. Setting the Explanatory Framework

Agricultural scholars have developed a range of theoretical schemes and methods to model the behavior of farmers when they have to make decisions regarding different kind of topics [23]. The types of factors affecting the decisions of farmers, already been used in the agricultural literature, vary according to the type of decision to be modeled by each study [16]. Nevertheless, some basic factor categories remain common among the various frameworks which are mostly related to the characteristics of the farmer and the agricultural holding, the situational factors that may affect the behavior of the farmer, farmers' personal beliefs and attitudes around some relevant issues with the topic of decision, and finally the perception of farmers regarding the different choices related to the decision problem at stake [15,16,24].

Siebert et al. [25], in their review paper on factors affecting farmers' participation in biodiversity policies, provide a good summary of the factors using a three-category explanation scheme. The first category, called "farmers' willingness", is shaped by all perceptions of farmers based on subjective judgments, such as beliefs, interests, values and

awareness of the problem at stake. The second category is this of "direct and wider social influences" and refers to the factors that capture the effect of the social interactions and the influence of the social, political, and economic environment. Finally, the third category is "farmers' ability" and includes their demographic characteristics, the structural characteristics of their farm, and generally all the conditional factors influencing their decision-making process.

On the methodological setting of studies on farmers' decision-making modeling, there could be distinguished two main categories of approaches. In the first category there exist methods that are based on actual observations of field research and surveys to econometrically estimate the effect of various factors on the decision behavior of farmers, while at the opposite side stand methods which are based on experiments, in order to model their decision-making process. The great advantage of econometric methods is that estimations are based on actual data and therefore are more connected to reality. On the other hand, econometric methods cannot be used for ex ante evaluations, a feature that is only feasible with the experimental approach [16,26]. Therefore, it is on the researchers' judgment to select which path better suits their research targets, always considering the kind of data that are available for conducting the analysis.

Considering the scarcity of studies on farmers' decision-making for participation in PRP, the present framework relies on factors that have been used by studies on ES and complement them with some additional factors emanating from the broader literature on farmers' decision-making [17]. These factors have succeeded to identify motivation leading to ES participation, based on relative decision theories [20]. In addition, it should be noted that the variables' selection is also driven by our experience gained through the preparation of two research proposals under a research call for collaborative schemes between universities and farm holdings representatives, co-financed by the European Union (EU) and the Greek State. During our research for receiving some initial expressions of interest from farmers, we came across a generally negative attitude of farmers, which was justified by different reasons. As the replies of farmers were not recorded in the context of a dedicated survey, we cannot document in a quantitative approach the frequencies of the reasons that farmers reported as impeding their participation. However, we can document that the majority of refusals were mainly justified on the lack of trust to universities and the EU, lack of motive, unclear benefits, lack of financial capacity, and a general lack of knowledge around the framework on which the PRPs are built.

Farmers' past activity toward the PRP is modeled by the single question "Did you take part in any PRP in the previous five years?" Before the interview, there was an introductory section for explaining the difference of PRP and ES in order to help them disentangle the two types of projects. We described the PRP as projects in which their involvement is voluntary and long-term (over two years), while it demands the contribution of farmers in physical or monetary capital terms and their active participation in the experimental design and implementation. Given this PRP definition, farmers could respond by yes or no and therefore a dummy variable (Participation) is constructed taking the value 1 for those who replied yes and 0 otherwise.

The fact that this variable measures the actual attitude of farmers, and not their intentions, led us to rely on an econometric formulation. There are many different econometric methods that can be used, in order to test the relationship of various factors on their behavior. As far as the decision for paying and taking part in ES is concerned, methods include simple correlation analyses [18], logistic regression [19,20], censored tobit regression [19], and hierarchical regression [22]. Given the binomial type of the dependent variable, the present paper will rely on binomial logistic regression. A probit model was not selected because the dependent variable is referring to past decisions of farmers and not to their future intentions.

Furthermore, as the paper seeks to extract measures of the magnitude of the effect of the three factors and each of the variables which shapes them, the Shapley–Owen R^2 Decomposition method is employed. This method measures the contribution of the

regression covariates to the formation of the model's coefficient of determination (R^2) and thus it provides an estimation of how much of the model's variability is explained by each variable [27]. By summing up the contribution of each variable, the total contribution of each of the three factors considered by the present study can be extracted. As the basic Shapley–Owen R^2 Decomposition formula is applied on the Ordinary Least Squares (OLS) regression, the modification provided by the Stata Shapley2 post-estimation command [28] is used in the present analysis, as it can decompose the Pseudo R^2 coefficients typically extracted in logistic regression models.

2.2. Selection and Description of the Study Variables

The factors and respective variables used for explaining farmers' participation in PRP are presented in Table 1. We employ the three-category scheme of Siebert et al. [25], incorporating complex constructs for the first category and simpler variables for the other two. The first variable of the "farmers' willingness" category is Perceived Usefulness (PU). This construct measures the perception of farmers regarding the potential benefits that they will acquire from their participation in PRP. The variable has been extensively used under the Technology Acceptance Model (TAM) for modeling the attitude of farmers against new technological solutions [29]. As for research projects, the perceived usefulness has been considered in many of the studies on factors affecting the participation of farmers in ESs. Moumouni and Streiffeler [21] state that farmers will be more easily engaged in ESs when they consider that their involvement will help them reach their targets as entrepreneurs, and for this it is vital that the ES providers showcase the benefits of their services for farmers. In addition, Charatsari et al. [22] found that when farmers believed that their participation in an ES would improve their personal and professional skills and competences, they were more likely to participate in it. The construct in the present paper includes three items (PU 1–3) which capture the farmers' attitude against the usefulness of PRP and are measured by a Likert scale ranging from totally disagree (1) to totally agree (5) according to farmers level of agreement with the respective statements.

The second construct (PU2) measures the trust of farmers to the providers of the PRP. Trust is defined as the degree on that "one party is willing to rely on the actions of another party" [30]. Trust has been used as a predictor of farmers' behavior in quite a few studies with ambiguous results, as its effect seems to be context-dependent and varying according to the type of institutions to whom trust is measured and the type of decisions to be considered [31–34]. As for the ESs, Taylor and Van Grieken [35] showed that trust to service providers improved the acceptance of agri-environmental schemes among the Australian farmers. Finally, trust to the ES providers seems to influence the very likelihood of farmers to participate in them and the further utilization of ES outcomes [7,21,36].

The third construct (PU3) measures the motivation of respondents behind their engagement in farming activities and their overall belief over the scope of agriculture. As Siebert et al. [25] have shown, farmers' values and beliefs play an important role in shaping their behavior. Therefore, their participation in PRP may also be influenced by their beliefs for the role of agriculture and their motivations behind farming engagement [22]. The two items measure the basic motivation of farmers. Largest levels of agreement with the two statements reveal farmers who really enjoy farming and would not easily shift to other occupations. On the other hand, lowest agreement degree is associated with more profit-driven farmers.

Table 1. The explanatory variables of the study.

Factors Category	Variable	Question	Measurement
Farmers' Willingness	Perceived Usefulness (PU)	(PU1) understand the feasibility of research programs to improve the agricultural sector	Ordinal/1-5 Likert scale (Disagree-Agree)
		(PU2) My participation in a research program would increase the prestige of my business.	Ordinal/1-5 Likert scale (Disagree-Agree)
		(PU3) It is worth investing some money to participate in a research project	Ordinal/1-5 Likert scale (Disagree-Agree)
	Trust to Institutions (Trust)	(Trust 1) I feel like a European Union citizen.	Ordinal/1-5 Likert scale (Disagree-Agree)
		(Trust 2) I trust the European Union for providing support in Greek agriculture	Ordinal/1-5 Likert scale (Disagree-Agree)
		(Trust 3) I trust universities in acquiring knowledge for my farm issues	Ordinal/1-5 Likert scale (Disagree-Agree)
	Motives (Mot)	(Mot 1) I enjoy farming activities	Ordinal/1-5 Likert scale (Disagree-Agree)
		(Mot 2) I would hardly abandon farming for another job with the same income	Ordinal/1-5 Likert scale (Disagree-Agree)
Direct and wider social influences	Awareness	I have a good knowledge of some research projects that have been successfully implemented in my area.	Ordinal/1-5 Likert scale (Disagree-Agree)
	Info Engagement (Info)	In the last five years have you been engaged in any of the following activities? Attended a training seminar Attended a workshop Attended a cooperative meeting Attended an online seminar Attended a meeting with other colleagues Formed an inquiry to an agricultural consultant. Formed an inquiry to university	0-7/The sum of the activities that each farmer has undertaken

Table 1. *Cont.*

Factors Category	Variable	Question	Measurement
Farmers' ability	Income	Please indicate in which of the following categories your annual income lies in	1. 0–5000 € 2. 5001–10,000 € 3. 10,001–20,000 € 4. >20,000 €
	Full-Time Farmer (F-T Farmer)	Please indicate if farming is your only occupation	0. No 1. Yes
	Residence	Please indicate if you reside in a place of over 10,000 inhabitants	0. No 1. Yes
	Education	Please indicate the highest level of education you have achieved	1. Primary School 2. Secondary School 3. High School 4. University
	Gender	Please indicate your gender	0. Male 1. Female
	Age	Please indicate your age	Years

The first variable of the "direct and wider social influences" category is labeled as *Awareness* as it captures the awareness of farmers regarding the existence and the results of PRPs. It has been shown by past surveys that farmers acquire knowledge around many agricultural issues by their social interactions with neighboring farmers [25,37]. Moreover, many authors claim that it is more likely for farmers to engage in an activity or adopt a technology when this has been already positively evaluated by their peers and colleagues [32,38]. This is done either because the former engagement of some farmers acts as a best practice diffused by the word of mouth to the other farmers, or through a mechanism of social pressure exerted on the ones that have not yet shown the same behavior [25,39]. Therefore, the inclusion of this variable in the model is done in order to test the hypothesis that farmers who know some colleagues that have been successfully engaged in PRP are more familiar with the subject and they are more likely to take part in a PRP.

The second variable of this category is named Information Engagement (Info), and it measures the overall activity of farmers in acquiring knowledge around farming issues and practices. Farmers were given seven types of information gathering activities and were asked to indicate in which of them they have been engaged during the past five years. It is expected that farmers with a highest activity in acquiring knowledge and a higher inclination to learn new things would be keener on undertaking one additional activity, namely, this of their participation in a PRP. This expectation is based on previous findings such as those in [22], which indicated that farmers who were driven by a higher learning motivation were more likely to engage in ESs. It should be noted that the former participation of farmers in PRPs may also influence their choice to participate in new projects. This question was added so as to incorporate a respective variable into the model but only four farmers demonstrated their participation in PRPs before the considered period. Therefore, it was decided to not include such a measure in the model, as it would provide very little information regarding the actual effect of this variable.

Finally, the "farmers' ability" category is composed by some sociodemographic variables. The first variable is this of *Income*. Farmers with higher income may find it easier to secure and fund their participation in a PRP. Though, the empirical evidence of this relationship from the studies on ESs is somehow ambiguous. For instance, Alexopoulos et al. [17] and Uddin et al. [19] found a positive relationship between income and farmers' willingness to pay for ES but Charatsari et al. [22] found a negative relationship between income and participation in extension services which was statistically significant at the 0.10 level.

In addition, the Full-Time Farmer (F-T Farmer) variable indicates whether the respondents are full-time farmers (1) or they are also engaged in other occupations (0). It is expected that additional income from off-farm activities may help farmers to enroll easier in PRP due to higher liquidity [19]. In addition, the variable Education (E) is incorporated in the model, in order to test if more educated farmers are more enthusiastic to participate in PRP. The positive relationship of education and farmers' engagement has been adequately documented by the past research on ES engagement [18]. Nevertheless, in the study of Charatsari et al. [22] no statistically significant effect of education was found.

Furthermore, the *Residence* variable takes the value 1 for farmers that are located in areas of more than 10,000 inhabitants and 0 for those who live in less populated places. The variable seeks to reveal if the deficit of opportunities potentially associated with residents of less populated rural areas may have an effect on their inclination for joining PRP. This is also the case for ES, where farmers were found to show more willingness to participate in ES when there were plenty of available ES options and in a short distance, as well as higher friction with knowledge diffusors [20,38]. The next sociodemographic variable is this of *Gender*. Despite the fact that the gender of farmers has been understudied in relative literature [16], this is not the case for studies on ES, as nearly all of the reviewed studies incorporated such a measure in their models. It is really interesting, that in most of the studies no significant effect of this parameter likelihood to participate in extension services was found [19,20,22], except for the study of Alexopoulos et al. [17] who found that female farmers were more likely to pay for participating in ES. The last variable is this of *Age*. Empirical research findings on farmers' decision-making denotes that as farmers grow older, they become less open to changes and behavioral shifts. As for the participation in ESs is concerned, findings are mixed with some studies confirming this negative relationship [20,22], while others finding no statistically significant relationship between variables [17,19].

3. Results

The responses used for this empirical analysis are part of a survey implemented during October 2019 in the region of Thessaly which lies at the central part of Greece. For the sample formation, the authors conducted a series of visits to towns and villages of the region. Special focus was given to those with arable crops farms to complete the questionnaire, due to fact that they are the dominant crops of the region. Additionally, we considered essential to narrow down the scope of the survey only on arable crops farmers, in order to avoid extra heterogeneity that could be imposed on the data because of the potential different views and scopes of farmers with different types of farms. The sample was formulating following the stratified sampling approach, having as a reference point the number and the structural characteristics of the agricultural holdings of the region. According to the Greek Payment Authority of Common Agricultural Policy (C.A.P.) Aid Schemes (www.opekepe.gr) [40], in the region of Thessaly there are approximately 42,000 agricultural holdings, specialized on arable crops. Accepting as satisfactory the 95% confidence intervals, the minimum size for this sample is 321 holdings. A team member was present during the completion of the questionnaires and provided any necessary explanations that farmers might had. In total, 326 questionnaires were completed and are being used to test the explanatory framework of the paper. As for the dependent variable, 17% of the farmers have been engaged in a PRP in the previous five years while 83% have not. This figure confirms the rather low engagement of farmers in research activities.

In addition, in Table 2 the descriptive statistics of the items to be used for the composition of farmers' willingness constructs are presented. As can be seen, the highest average score of farmers' agreement with the statements of each item of the perceived usefulness is found for the PU 1 item while the lowest for the PU 3. Thus, it is concluded that farmers understand the feasibility and usefulness of the PRP but are somehow reluctant when it comes to the funding of their participation. It should be noted that the PU 3 highlights also the highest variability among the items of the construct considering the mean and standard

deviation values. In the second construct, the average values of the items follow a similar pattern with those of the first one, as the highest and lowest average values are very similar. The highest average score is found for the Trust 3 item, while the lowest for the Trust 2. It seems that farmers perceive universities as more trustworthy than the European Union as institutes. Finally, the two items of the *Motivation* construct present average values that lie above the medium agreement score of 3. This result signifies that farmers are driven by motives of joy and self-fulfillment rather than a pure profit maximization objective when engaging in farming activities.

Table 2. The descriptive statistics of the Farmers' Willingness constructs' items.

Item	Mean	Std. Deviation
PU 1	3.669	1.345
PU 2	3.355	1.246
PU 3	2.932	1.443
Trust 1	3.110	1.395
Trust 2	2.953	1.415
Trust 3	3.631	1.401
Mot 1	3.963	1.075
Mot 2	3.337	1.496

In addition, the results of the Principal Component Analysis (PCA) with varimax rotation for the validation of the constructs of the farmers' willingness variables category are presented in Table 3. More precisely, Table 3 presents the loadings of the variables on the three factors, the Cronbach's Alpha value of the reliability test for each factor, the Eigen values and the variance explained by each factor, as well as the results of the Kaiser–Meyer–Olkin Measure of Sampling Adequacy and Bartlett's test of sphericity [41,42].

Table 3. Results of the factor analysis for the constructs of the 'farmers' willingness' factor category.

Components	Factor		
	1	2	3
PU 1	0.671		
PU 2	0.846		
PU 3	0.853		
Trust 1		0.851	
Trust 2		0.741	
Trust 3		0.683	
Mot 1			0.799
Mot 2			0.894
Eigen	2.028	1.858	1.671
% of Variance	25.352	23.231	20.889
Cumulative %	25.352	48.583	69.472
Cronbach's Alpha	0.748	0.66	0.700
Tests and Goodness of Fit Indices			
Bartlett's Test	676.772	Sig.	0.000
Kaiser–Meyer–Olkin	0.660		

As can be seen from Table 3, the analysis returned three factors whose eigenvalues exceeded the score of 1 and explain about 70% of the total variance. The items loaded well in the factors as expected, as loadings lie well above 0.60 and no double loadings were observed (the highest second loading was estimated at 0.296). The Cronbach's Alpha for the whole sample is estimated at 0.7 whilst the internal reliability of the three constructs exceeds 0.7 except for the 2nd factor for which Cronbach Alpha lies just a little below the 0.7 threshold. Considering that a Cronbach's Alpha of over 0.7 denotes an acceptable consistency, a value between 0.6 and 0.7 a questionable one, and only when Alpha is found below 0.6 could be considered as a poor fitting, it can be assumed that the general reliability of the items is satisfactory, in order to use the constructs for the succeeding analysis [43]. The quite satisfactory outcomes of the factor analysis are further confirmed from the results of the two tests. More precisely, the Bartlett's test returned a statistically significant estimation which indicates that the items are related and therefore suitable for building the expected structures, while the Kaiser–Meyer–Olkin statistic lies far above the critical value of 0.5 thus indicating that the sample is adequate for factor analysis [42]. After estimating the factor loadings, the scores of each factor are obtained, based on the method of least squares regression analysis [42,44] in order to be incorporated in the succeeding binomial regression model.

Finally, before analyzing the results of the regression analysis, the descriptive statistics of the variables of the other two categories of factors are presented in Table 4. The average value of the *Awareness* variable is 2.23. This tally shows that the average farmer has less than medium knowledge regarding the PRP being implemented in the nearby areas. In addition, the *Info* average (2.75) reveals that farmers in the area usually do not use more than three out of seven total sources of information. Considering the *Income* variable, for which the estimated average value is 3.10, it is concluded that the average farmer earns more than 20K € per annum, which is quite satisfactory for the Greek context. The mean value of the *F-T Farmer* variable (0.68) and *Residence* (0.14) variables verify that about two to three respondents are full-time farmers, while only the 14% of them live in a relatively high populated area. The mean of the *Education* variable is estimated at 2.96, showing that the average farmer has finished High School. The 0.07 estimated mean value of the *Gender* variable denotes that only 7% of the sample are female farmers, and finally the average farmer's *Age* is estimated at 47 years with the minimum age at 18 and the maximum at 83. The above numbers verify the representativeness of the sample, because they follow the structure of the general population of the last census of the country [45]. It should be noted that the region of Thessaly is among the most active and productive regions in Greece in the agricultural sector and thus it can provide a representative picture regarding the overall behavior of Greek farmers when decisions for joining a PRP are at stake [45]

Table 4. Descriptive statistics of the variables of the factor categories "direct and wider social influences" and "farmers' ability".

Variable	Minimum	Maximum	Mean	Std. Deviation
Awareness	1.00	5.00	2.23	1.44
Info	0.00	7.00	2.75	1.53
Income	1.00	4.00	3.10	0.99
F-T Farmer	0.00	1.00	0.68	0.47
Residence	0.00	1.00	0.14	0.35
Education	1.00	4.00	2.96	0.79
Gender	0.00	1.00	0.07	0.26
Age (Years)	18.00	83.00	47.30	13.27

Finally, the results of the binomial regression analysis are presented in Table 5. In the last rows of Table 5, the results of model's goodness of fit tests are presented. The sta-

tistical value of chi-square (84.87) leads to the rejection of the null hypothesis that the coefficients of the model have no effect on the dependent variable. On the other hand, the value chi-square (7.32) of the Hosmer and Lemeshow test, and the lack of any statistical significance of the estimation, signify that the observed values meet the expected ones for the subgroups. The results of both tests confirm the relatively good fit of the model to the survey data. In addition, it should be noted that the Nagelkerke Pesudo-R^2 is estimated at 0.450, the McFadden at 0.345, and the Cox and Snell at 0.267. These figures denote that the selected variables account for a reasonable proportion of the dependent variable's variation, considering that in general the Pesudo-R^2 measures are lower than the R^2 measures of the Ordinary Least Squares regression [40]. Finally, all variables were incorporated in an OLS regression in order to test for potential collinearity. All Variance Inflation Factors (VIF) values were found well below the critical threshold of 10, as the highest VIF value was estimated at only 1.789.

Table 5. Results of the binomial logistic regression model.

Category	Variable	B.	S.E.	Wald	Significance	Exp(B)
Farmers' Willingness	Perceived Usefulness	0.367	0.219	2.800	0.094	1.443
	Trust	0.548	0.241	5.181	0.023	1.731
	Motivation	1.660	0.335	24.531	0.000	5.262
Direct and wider social influences	Awareness	0.563	0.131	18.459	0.000	1.756
	Info	0.367	0.137	7.206	0.007	1.443
Farmers' Ability	Income	0.719	0.267	7.268	0.007	2.052
	F-T Farmer	−1.431	0.531	7.278	0.007	0.239
	Residence	−1.040	0.648	2.573	0.109	0.354
	Education	−0.276	0.306	0.812	0.368	0.759
	Gender	2.226	0.821	7.352	0.007	9.260
	Age	0.006	0.016	0.150	0.698	1.006
	Constant	−5.852	1.543	14.376	0.000	0.003
	Tests	X^2	df	Sign.		
	Omnibus Tests of Model Coefficients	101.042	11	0.000		
	Hosmer and Lemeshov	3.556	8	0.895		

In addition, Table 5 also presents the estimated coefficients (B), the Standard Errors (S.E.) of the estimations, the Wald statistic for checking the significance of the estimations, the significance levels of the estimations, and the odds ratio exp(B). The estimated coefficients of the variables of the farmers' willingness category have all the expected positive sign, but their statistical significance varies, as the PU is only significant at the <0.10 level, the Trust at the <0.05 level, and the Motivation at the <0.01 level. These findings are very interesting, as they show that as far as the beliefs and attitudes of farmers are concerned, it might be the overall stance of farmers against the agricultural occupation that really affects their likelihood for joining a PRP and to a lesser extent their pure judgment regarding the potential benefits that they will acquire from their decision. It is also elicited that farmers will take part in a collaborative project when they trust the organizers. The coefficients of the variables of the second category of factors also yield positive signs and are statistically significant at the <0.01 level. This result shows that the word of mouth remains a strong motivator for pushing farmers to take action, as any previous positive experience of other farmers' is a guarantee for other farmers to follow. In addition, the positive coefficient of the *Info* variable denotes that as farmers get in touch with more actors of the agricultural sector, their inclination to knowledge acquisition gets stronger and their willingness to join PRP is intensified.

As for the variables of the farmers' ability category, the estimated coefficients vary heavily in terms of signs and statistical significance. The estimated coefficient for the *Income* variable is positive and statistically significant at the <0.01 level. This finding clearly indicates that farmers with higher earnings can more easily accommodate their participation in a PRP. In addition, the *F-T Farmer* coefficient is negative and statistically significant at the <0.01 level, too, denoting that part time farmers more easily engage in PRP than their full-time colleagues. These estimations show that it is not only the amount of income but also the source of income that affects the decisions of farmer regarding their participation in PRPs. The *Residence* estimated coefficient value was not significant. As for the *Education* variable, surprisingly, the model cannot confirm any statistically significant relationship between farmers' educational levels and PRP engagement. In addition, the estimation for the *Gender* variable is positive and statistically significant at the <0.01 level, demonstrating that women are more likely to engage in PRP than their male colleagues. It is noteworthy that according to the exp(B) estimations women are nine times more likely to take part in a PRP than men. Finally, the coefficient for the *Age* variable lacks statistical significance, thus showing that the life cycle of farmers is not related to their decisions for engaging in PRP.

Finally, in Figure 1 the results of the Shapley–Owen decomposition analysis and the respective contribution of variables and factors on the determination of the Mc-Fadden Pseudo R^2 coefficient are presented. As can be seen, the most important factor category is this of Farmers' Willingness as it explains 41.36% of the model's variability. Among the variables of this category, *Motivation* is the most important driving force with a relative share of over 30%, followed by *Trust* and *PU*. It should be noted that *Motivation* is the most important variable not only among the variables of farmers' willingness, but also among all the variables of the model. Due to the subjectivity of the above terms, further research is needed to clarify how these are being perceived by farmers. Therefore, the results obtained must be handled with caution. Moreover, the Social Influences category accounts for a large proportion of Pseudo-R^2 coefficient, which exceeds 39%. Between the two variables of this category, *Awareness* seems to have a more significant role than *Info* in explaining farmers' choices to participate in PRPs. Despite the difference between the explanatory power of the two variables, it should be noted that this is lower only than the *Motivation* variable, thus denoting that the social influences have an exceptional role in shaping farmers' choices. Finally, farmers' *Ability* accounts for a lower proportion of model's variability. The most influential variable is *Income* which explains 10% of the Pseudo-R^2 value, while all other variables account for shares well under 3%.

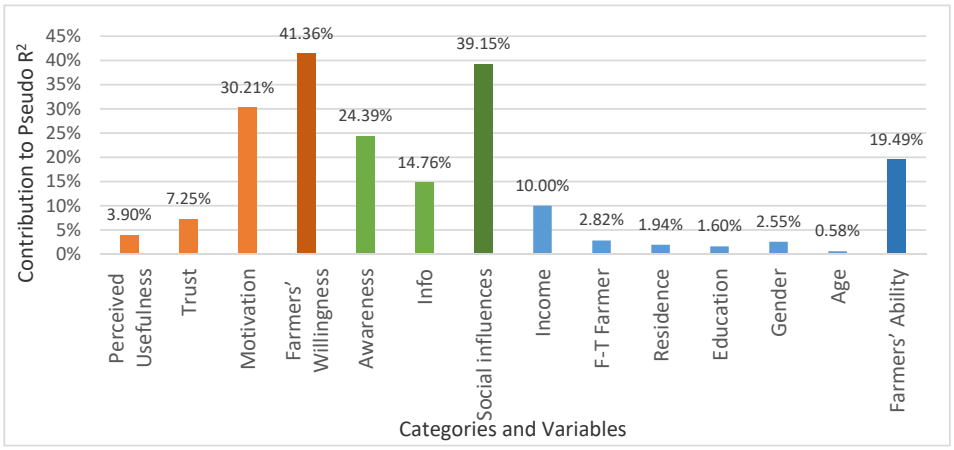

Figure 1. The contribution of the variables and factors' categories on the Pseudo-R^2 coefficient.

4. Discussion

The above analysis sought to reveal the driving factors for farmers' engagement in PRP. This empirical study filled a gap in the relevant literature of farmers' decision-making

for research engagement which, up to now, had merely focused on the drivers of farmers' participation in ESs. This distinction is very critical, especially for countries like Greece, where ESs mechanism remains relatively inefficient and research projects establish the main cooperation links between farmers and researchers. Therefore, these results may help policy makers to draw more efficient policies for engaging farmers in research and knowledge acquisition activities, as what works for engaging farmers in ES may not be equally effective when PRP are targeted. It is also important that the latter requisite a significant funding by the farmers side. Moreover, the paper, by using the Shapley–Owen decomposition, managed to extract measures of the relative magnitude of effect for each particular variable and the general factors categories alike. This ranking may assist policy makers to prioritize their interventions for farmers' engagement considering the scarcity of resources that policy making usually deals with.

The results showed that the decision of farmers to engage or not in a PRP is subject to many factors. Undoubtedly, farmers' willingness as this is expressed by their stance against research but also by their motivation for engaging in farming, have the most significant role in fostering farmers' participation. The statistical significance of the estimations of the category of farmers' willingness variables verifies that research collaboration in agriculture is mostly enhanced when a climate of trust is cultivated and when farmers see agriculture as an activity of joy and self-fulfillment. This finding allows for a very optimistic view of agriculture's future, as it seems that farmers' willingness to learn and cooperate has not been totally dominated by profit seeking behaviors and pure financial cost–benefit way of thinking [46].

Furthermore, the real level of engagement in PRP is not only a matter of beliefs and attitudes, but it also depends on situational and contextual factors. A critical factor is the overall research activity of the community, as farmers more easily engage in PRPs when they know some other peers who have done the same in a successful way. Apparently, their motivation increases when they have a constant contact with actors that promote research. Therefore, the present study illustrates that farmers' enrollment in research activities is expected to have multiplying effects for the whole community, as in this case the best practices are easily communicated among the members of the community, through better understanding of sustainability and productivity standards. Consequently, it is on the research institutions and policy-makers to first plant the seeds of research interest among communities of farmers and support the better dissemination of results, in order other farmers to follow the examples of the ones that already have participated in PRPs. This finding is quite promising for improving the cultivation protocols applied in arable crops, as well as optimizing their production costs, via collaborating with researchers and being active members of interdisciplinary groups formulated for this purpose. Additional strengthening of such relationships will decrease their reluctance to participate in ESs programs and support with their own funding similar activities, improving the effectiveness of this market in the long-term [47,48].

The role of policy makers is equally crucial for eliminating the burdens imposed by the farmers' ability. The fact that this category of factors has a rather small effect on the overall variability of the model denotes that farmers' willingness and their social interaction may be catalysts for overcoming any constraints towards their participation in PRPs. Nevertheless, there are still some issues that should be considered for achieving higher farmer engagement. This analysis has shown that farmers of lower incomes are less keen on participating in PRPs, despite the fact that there is a positive relation between income increase with involvement in PRPs. Considering the positive relationship between a less profit-oriented stance of farmers and engagement in PRPs, we estimate that a considerable proportion of open-minded farmers may be left out of PRPs just because they cannot afford their participation due to income constraints, which is usually the case of arable crops due to their low profitability. In this context, a major issue of equal opportunities is raised by the fact that part-time farmers are more engaged in PRPs than their full-time colleagues. This finding demonstrates that a large proportion of farmers for whom the

research outcomes are primarily addressed, do not have the opportunity to make any substantial contributions to the whole PRP process. This in an issue that has to be searched more, because while the development of the primary sector lies upon the full-time farmers, considerable segments of them do not realize the necessity of obtaining new knowledge, or gaining access to new technology by the alternative ways mentioned in this paper.

In addition to the above, a gap has been also observed in the participation between women and men. The fact that women have been found as more active in PRP than men is very positive for the wider future of female farmers in agriculture, and sets the scene for additional studies towards this direction. On the other hand, the very low proportion of women farmers casts doubt regarding how this gap could affect the largest possible engagement of farmers in PRP. Therefore, if males are not so interested in engaging in PRPs, then the participation rate of the whole community will only increase substantially if men are better motivated to enroll in PRPs, or more women are engaged in farming activities. It should be mentioned though that this finding should be handled with caution, due to the small number of females participants in this survey, compared with the number of males. As for the lack of any statistically significant finding for the other farmers' ability variables, such as their age, education, and place of residence, this could be considered as a satisfactory result, as factors that have been found significant for driving or preventing farmers' participation in ESs participation do not seem to affect their willingness to join PRPs. Therefore, no extra effort is needed by policy-makers to confront any additional gaps emanating from a large number of demographic characteristics of farmers.

The results of the study may help authorities to draw more effective and tailor-made policies in engaging farmers in PRP. This is crucial for enhancing farmers' participation, especially in countries like Greece where engagement is very low. Considering the income barriers and the need to engage more full-time farmers in research, it is advisable that research calls are backed with some incentives or subsidies headed to the low-income full-time farmers, in order to increase participation. Moreover, better communication of the procedures required for farmers' participation as well as the wider dissemination of results could improve the trust and the perceived usefulness of farmers for the research projects, and therefore increase their overall participation levels. In order to achieve this target, farmers with a less profit-oriented engagement with agriculture and those with significant activity in collaborating with others could be used as the group on which any dissemination activities should be based upon, to convey the desired messages to larger groups of the agricultural community. Additionally, future research could also focus on whether the PRP is aimed at improving the efficiency and relevance of the research, compared to specifically empower farmers financially or as a means of technology transfer already obtained without their involvement.

Finally, it should be noted that as with many other studies on farmers' decision-making, the present results should be generalized with caution. The fact that many variables have been found as having a different effect on the decisions of farmers under various studies, hinder the pursuit of a universal theory of farmers' behavior in research and knowledge activities. At the same time, it calls for the enrichment of the relevant literature with more empirical findings, so as to start building a reasonable amount of evidence that could better inform policy-making under different contexts and environments. On this topic, the extensive literature on farmers' decision-making for AES or organic farming should be the main driver for the succeeding research on farmers' engagement in ES, and PRP activities.

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