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Cultivate Crops or Produce Energy? Factors Affecting the Decision of Farmers to Install Photovoltaics on Their Farmland †

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Abstract: The aim of this study was to examine the factors affecting farmers' willingness to invest in photovoltaics as well as the factors affecting the amount of money they would invest. The study was performed on a representative farmer sample in Northern Greece through the use of structured questionnaires. Two models were developed using categorical regression, with the first model indicating that the willingness to invest was mostly affected by the provision of subsidies and the type of cultivation used for the land in question. The amount of money farmers would invest was mostly affected by the number of hectares of irrigated and dry land that famers had, thereby suggesting that the more farmland they own the more the money they would invest. Results raise policy implications as they show an increased interest in installing renewable systems on farmland which, in turn, raises concerns about the agricultural development of the country.

Keywords: farmers' attitudes; agri-food crisis; willingness to invest; photovoltaics on farmland; factors affecting investments

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1. Introduction

Agri-food production is constantly challenged in recent years by various pressures, such as the pandemic and sharp increases in energy prices due to the conflict in Ukraine [1,2]. Despite EU's efforts to tackle the effects of the crisis, food security still relies on a rather volatile environmental and geopolitical context [3,4]. Due to these pressures, a considerable proportion of farmers tend to opt for the installation of photovoltaics on their farmland. This trend, however, may compromise food security and the national agricultural development highlighting the need to dedicate more research on farmers' decision-making. In other words, understanding what affects farmers' decision to install photovoltaics can inform policymaking by pointing at areas that require policy intervention. Hence, this study examines the factors affecting farmers' willingness to install photovoltaics on their farmland, as well as the factors affecting the amount of money farmers would invest in photovoltaics.

2. Methods

The population under study comprised farmer landowners in a typical Greek rural area, the Municipal Unit of Didymoteicho, which is located in Northern Greece. To recruit respondents, the method of simple random sampling was followed with t = 1.96, $p = 0.6$ and e = 6.3%. Hence, according to the formula of simple random sampling, 233 respondents had to participate in this study in order to achieve a representative sample. Then, respondents were administered structured questionnaires which were completed through personal interviews and, in total, 233 landowners participated in the study. To analyze the collected

data, the Statistical Package for the Social Sciences (SPSS) [5] was used and descriptive statistics and categorical regression were specifically applied. Categorical regression was used to build two models, with the first model examining the factors affecting farmers' willingness to install photovoltaics and the second model investigating the factors affecting the amount of money that willing farmers would invest in photovoltaics.

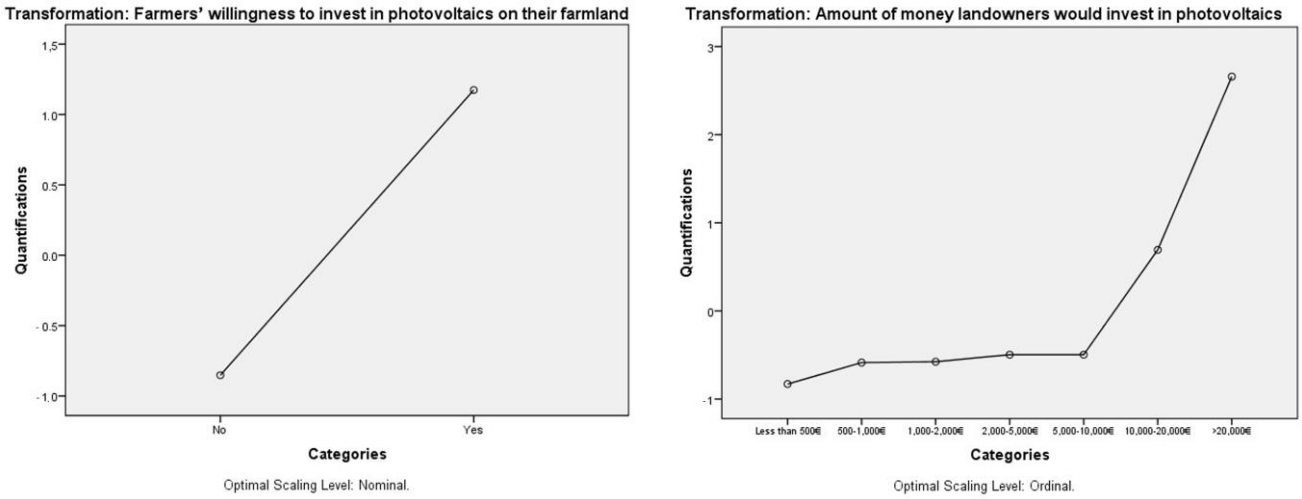
3. Results and Discussion

Regarding respondents' sociodemographic profile, there was an almost equal representation of both genders in the sample, whereby most respondents were married (68.8%) and farming was their main profession (42.9%). As for education level, significant shares of respondents reported being high school graduates (29.8%) and university graduates (14.1%). Respondents reported owning 2272.7 hectares of dry land and 2306.7 hectares of irrigated land. The vast majority of respondents were willing to invest in photovoltaics and they would invest specifically between 10,000 and 20,000 € (17.6%), 2000 and 5000 € (17.2%) and 5000 and 10,000 € (15.9%).

Following descriptive analysis, categorical regression was performed to identify the factors affecting farmers' decision making. Two models were built to explain the dependent variables. In the first model, the dependent variable was "farmers' willingness to invest in photovoltaics on their farmland"; the independent variables can be seen in Table 1. The analysis gave a co-efficient value of multiple determination of $R^2 = 0.310$ and $F = 5.042$, which is statistically important. Taking Figure 1a into account, which displays the transformation plots for the dependent variable, it is indicated that the dependent variable of "farmers' willingness to invest in photovoltaics on their farmland" is mostly affected by the availability of "subsidies for investments in renewables" and a farmer's "level of information about renewable energy investments". Moreover, the dependent variable is affected by the type of crop cultivation, specifically "sugar beet" and "cotton" cultivations, while the number of hectares of dry land that farmers own also exerts a significant effect on the dependent variable. The measures of the relevant importance of the independent variables suggest that "subsidies for investments in renewables" and cultivating "cotton" and "sugar beet" made the highest contribution to the dependent variable.

Table 1. Factors affecting farmers' willingness to invest in photovoltaic systems on their farmland.

Independent Variables	Beta	Std Error	Df	Importance	F
Level of information about renewable energy investments	0.213	0.083	3	0.198	6.656
Subsidies for investments in renewables	0.332	0.063	3	0.330	28.159
The complexity of the licensing process	−0.178	0.067	3	0.087	7.105
Agreement with the installation of solar parks in a location visible from place of residence	0.175	0.112	1	0.110	2.471
Hectares of irrigated land	−0.018	0.110	1	−0.009	0.026
Hectares of dry land	0.166	0.111	1	0.110	2.241
Wheat	−0.078	0.095	1	−0.023	0.668
Cotton	0.239	0.091	1	0.154	6.810
Sunflower	−0.183	0.091	1	−0.035	4.021
Canola	−0.319	0.183	1	−0.079	3.046
Corn	−0.031	0.076	1	−0.006	0.162
Garlic	0.055	0.044	1	0.025	1.624
Sugar beet	0.330	0.174	1	0.138	3.583



(**a**) (**b**)

Figure 1. (**a**) Transformation plots of the independent variable "farmers' willingness to invest in photovoltaics on their farmland"; (**b**) transformation plots of the independent variable "amount of money farmers are willing to invest in photovoltaics".

In the second model, the dependent variable was "amount of money farmers are willing to invest in photovoltaics"; the independent variables can be seen in Table 2. Regarding this model, analysis gave a value of multiple determination of $R^2 = 0.407$ and $F = 5.003$. Taking Figure 1b into account, which displays the transformation plots for the dependent variable, it is shown that the dependent variable is mostly affected by the variables of "hectares of irrigated land", "hectares of dry land", cultivating "garlic" and the "adoption of pro-environmental behavior". Measuring the relevant importance of the independent variables suggests that the "hectares of irrigated land", "hectares of dry land", cultivating "garlic" and "increasing respect from friends and acquaintances" made the greatest contribution to the dependent variable.

Table 2. Factors affecting the amount of money farmers would invest in photovoltaics.

Independent Variables	Beta	Std Error	Df	Importance	F
Hectares of irrigated land	0.480	0.143	3	0.431	3.901
Hectares of dry land	0.457	0.131	3	0.370	3.909
Wheat	−0.188	0.183	2	−0.081	1.060
Cotton	−0.376	0.170	3	−0.047	1.034
Garlic	0.182	0.155	3	0.113	1.380
Sunflower	−0.012	0.161	1	−0.007	0.005
Canola	0.051	0.078	1	0.024	0.425
Increasing respect from friends and acquaintances	−0.264	0.099	3	0.140	7.091
Adoption of pro-environmental behavior	0.217	0.085	4	0.052	6.478
Occupation	0.054	0.055	1	0.004	0.948

4. Conclusions

The type of cultivation affects the willingness to invest as our results suggest that certain types of land cultivation positively affect this willingness. This suggests that farmers may not be satisfied with the revenues from these crops or that the conditions required for these cultivations may be too demanding. From this perspective, farmers may perceive photovoltaics as a safer and easier solution; however, this points to the risk of replacing crop cultivation with energy production, thereby risking the aggravation of the existing agri-food crisis. Moreover, the availability of subsidies positively affects the willingness to invest and could drive farmers to abandon crop cultivation. Therefore, policymakers

should be mindful of being too generous in subsidy schemes but should also try to improve farmer revenues from crop production. Interestingly, the amount of money that farmers would invest was affected by the number of hectares they own. Indeed, the more hectares farmers own the higher the amount of money they are willing to invest in photovoltaics becomes. In other words, ownership of extensive farmland acts as a positive factor for high investments as it allows farmers to continue cultivating their land and to maintain most of their crop cultivations.

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