

## Assessing government grants: evidence from greenhouse tomato and pepper farmers in Kosovo

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### ABSTRACT

Genetic matching with an evolutionary algorithm was applied to evaluate the impact of the Ministry of Agriculture, Forestry and Rural Development (MAFRD) grant programs to support greenhouse vegetable production in Kosovo. The primary contribution of the paper is to assess whether grants have an impact on the farmers' gross seasonal revenue after matching similar grantees to non-grantees. The findings showed that greenhouse tomato grantees make 2,151.80 euros more per growing season in comparison to the non-grantees (95 % confidence interval -324.71 to 4,628.31 euros). Similarly, greenhouse pepper grantees make 2,866.69 euros more per growing season compared to non-grantees (95 % confidence interval 446.42 to 5,286.96 euros). The study identified farmers' education and region as important matching variables which may be of interest to policy researchers in Kosovo.

**Key words:** greenhouse economics; genetic matching; government farm grants; Kosovo agriculture

### IZVLEČEK

#### UGOTAVLJANJE UČINKOVITOSTI VLADNIH POMOČI: PRIMERI PRIDELOVALCEV PARADIŽNIKA IN PAPIRIKE V RASTLINJAKIH NA KOSOVU

Genetsko ujemanje in razvojni algoritem sta bila uporabljena pri vrednotenju vpliva programov pomoči Ministrstva za kmetijstvo, gozdarstvo in razvoj podeželja pri vzpodbujanju pridelave zelenjave v rastlinjakih na Kosovu. Glavni pripevek te raziskave je ocena pomoči na sezonski bruto prihodek kmetov, ki so vladno pomoč dobili v primerjavi s tistimi, ki je niso prejeli. Izsledki so pokazali, da je pomoč pri pridelavi paradižnika v rastlinjakih prispevala 2.151,80 EUR več na sezono v primerjavi s tistimi, ki pomoči niso dobili. (95 % interval zaupanja je znašal -324,71 do 4.628,31 EUR). Podobno je pomoč pri pridelavi paprike v rastlinjaku dala za 2.866,69 EUR več na sezono v primerjavi s tistimi, ki pomoči niso dobili (95 % interval zaupanja je bil 446,42 do 5.286,96 EUR). Raziskava je pokazala, da sta izobrazba kmetov in območje pridelave pomembni vplivni spremenljivki, ki bi lahko zanimali raziskovalce agrarne politike na Kosovu.

**Ključne besede:** ekonomika rastlinjakov; genetsko ujemanje; vladna pomoč kmetom; kmetijstvo Kosova

## 1 INTRODUCTION

The development of Kosovo's agriculture has long been adversely affected by the Kosovo war, a conflict that shaped the dynamics of the agricultural sector and left it vulnerable with large losses of productivity. After the war, the newly formed government of Kosovo invested in agriculture to reestablish a well-functioning economy. Over the last decade, some government investments in the form of competitive grants were

targeted to support greenhouse farming. Across Kosovo, tomatoes and peppers are among the main crops grown in greenhouses. In Kosovar greenhouses, tomatoes are more common than peppers (Kaciu, 2008), however, the Ministry of Agriculture, Forestry and Rural Development or MAFRD (2016) suggests that the cultivation of both of these crops have increased since the end of the war.

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In Kosovo, agricultural production has intensified because of increasing support through grant programs (Miftari et al., 2016). These grants have helped support desperately needed upgrades in farm facilities. These grants may also affect farmers' gross revenue levels, however, details regarding gross revenue changes are lacking. Similarly, reliable evidence regarding the relationship between government financial support and higher gross farm revenue per growing season could be valuable to policy makers. This study considers whether awardees of the MAFRD grants for the purchase of new greenhouses (grantees) have gross seasonal revenues that differ from non-grantees. We chose to examine the tomato and pepper crops because of their increasing levels of production in a greenhouse setting and because tomatoes and peppers remain among the main vegetables produced in Kosovo (Kaciu et al., 2016). In fact, vegetable farms are among the highest income generating farms (Martinovska Stojceska et al., 2008). Understanding the gross revenue impacts of the grant programs are also important given the increasing inequality in productivity between small and large greenhouse tomato and pepper farms. This may be one factor that is leading to different gross seasonal revenue levels.

Governmental reports address the effectiveness of the MAFRD grant programs (MAFRD, 2017), but empirical

studies on the effects of these grants to advance the greenhouse vegetable subsector are lacking. Without the backing of empirical evidence, conclusions reached about the effectiveness of MAFRD's provision of grants for the greenhouse farmers can be misleading. It is important to know what factors impact greenhouse tomato and pepper farmers' ability to win grants. One approach to understand the gross revenue differences between farmer grantees and non-grantees is the use of matching to compare grantees to similar non-grantees. There are many methods available to perform matching and no consensus has emerged in the literature as to the best matching method (Stuart, 2010; Ruiz et al., 2017). There are several studies which have reviewed propensity score matching methods (see e.g. D'Agostino, 1998; Terza et al., 2008; Caliendo & Kopeinig, 2008).

A review of the literature revealed no studies since the early 2000s that have looked at the financial determinants of the greenhouse tomato and pepper production in Kosovo. A matching method known as genetic matching was selected to estimate casual treatment effects of the farmers who received an MAFRD grant. The analysis using this method allows us to quantify the treatment effects of grants on the farmers' gross revenues.

## 2 MATERIALS AND METHODS

### 2.1 Data

The data for the study were obtained from surveys completed by greenhouse tomato and pepper farmers in Kosovo from June to August 2017. Two research surveys (one for each crop) were developed to interview the farmers. There were three steps involved in gathering data from the field: (a) prioritize municipalities and villages with a greater number of farmers growing greenhouse tomatoes and peppers; (b) interview farmers over the age of 18; and (c) evaluate the data for quality and outlying values. The initial sample covered 136 greenhouse farms which, after accounting for data outliers, decreased to 127 greenhouse farms. The farmers producing tomatoes were from the four regions of Ferizaj, Gjakova, Peja and Prizren and those producing peppers were from the four regions of Ferizaj, Gjakova, Peja and Mitrovica.

### 2.2 Descriptive Statistics

The summary statistics of the covariates used for analysis are separated by grant status (grantee or non-grantee) for both greenhouse tomato and pepper farmers

(Table 1). These covariates included distance to market in km, education in years, experience in years, and region indicators that take values of 0 or 1. The grantees producing tomatoes are located on average 12.9 km further away from the market than non-grantees and they have roughly two more years of education than non-grantees. However, there is no large difference in years of experience (0.11 years) between grantees and non-grantees producing tomatoes. The majority of these grantees (50 %) are from the region of Prizren. The largest percentage of non-grantees (32 %) are also from the region of Prizren. While grantees producing peppers are located on average only 3.2 km further away from the market than non-grantees and they have roughly three more years of education than non-grantees. The mean level of experience is 5.75 years among grantees showing that these farmers do not have extensive experience in growing greenhouse peppers. Similarly, non-grantees have only one more year of experience than grantees. Grantees producing peppers come mainly from the region of Peja (38 %), however, non-grantees are mostly from the region of Ferizaj (31 %).

**Table 1:** Descriptive statistics of the covariates by grant status

Grant Status Covariates (x)	Grantees				Non-Grantees				
	Mean	St. Dev.	Min	Max	Mean	St. Dev.	Min	Max	
<i>Tomato Farmers</i>					<i>Non-Grantees</i>				
	N = 10				N = 77				
Distance to market in km	28.23	27.52	0.30	66	15.36	14.11	0.50	62	
Education in years	12.20	5.01	8	20	10.48	2.95	8	20	
Experience in years	9.60	3.41	5	17	9.71	7.72	2	30	
Region of Ferizaj	0.30	0.48	0	1	0.16	0.37	0	1	
Region of Gjakova	0.10	0.32	0	1	0.04	0.20	0	1	
Region of Peja	0.10	0.32	0	1	0.06	0.25	0	1	
Region of Prizren	0.50	0.53	0	1	0.32	0.47	0	1	
<i>Pepper Farmers</i>					<i>Non-Grantees</i>				
	N = 8				N = 32				
Distance to market in km	28.38	20.58	10	60	25.22	21.45	3	84	
Education in years	13.88	4.22	8	20	11.06	2.65	8	15	
Experience in years	5.75	2.92	2	9	6.41	2.80	2	13	
Region of Ferizaj	0.25	0.46	0	1	0.31	0.47	0	1	
Region of Gjakova	0.25	0.46	0	1	0.13	0.34	0	1	
Region of Peja	0.38	0.52	0	1	0.13	0.34	0	1	
Region of Mitrovica	0.13	0.35	0	1	0.09	0.30	0	1	

### 2.3 Methods

Early work to develop propensity score matching (PSM) was conducted by Rosenbaum and Rubin (1983), and has become a widely used approach to estimate causal treatment effects (Caliendo & Kopeinig, 2008). Propensity score matching can be performed using various methods to match subjects. One method includes genetic matching as a multivariate matching method. In this study, the genetic matching algorithm is used to find covariate balance after matching between MAFRD grantees and non-grantees. The implementation of this method enables us to estimate the average treatment effect on the treated (ATT), which we use to assess the average differences in the farmers' gross seasonal revenue between grantees and non-grantees. According to Diamond and Sekhon (2013), genetic matching is performed by reducing a generalized version of the Mahalanobis distance (GMD). In contrast to the Mahalanobis distance, genetic matching includes an extra weight parameter  $W$ .

$$\text{GMD}(X_i, X_j, W) = \sqrt{(X_i - X_j)^T (S^{-1/2})^T W S^{-1/2} (X_i - X_j)}$$

From equation (1),  $X_i$  and  $X_j$  are covariates from farmers  $i$  and  $j$ , respectively. The matrix from the model contains the covariates described in Table 1.  $W$  is a  $k \times k$  positive definite weight matrix,  $S$  is the sample covariance of matrix  $S$ , and  $S^{-1/2}$  is the Cholesky decomposition of  $S$  (Diamond & Sekhon, 2013). Replacement was used to ensure that a farmer who received a grant (treatment group) has a proper match with a non-grantee (control group). It is noted in the

literature that matching with replacement can provide better matches (Stuart & Rubin, 2008), and is preferred to use in methods with a control group that has similar values relative to a treatment group (Dehejia & Wahba, 2002). Lastly, we do our analysis with the help of the R-CRAN package "Matching" pioneered by Sekhon (2011).

### 2.4 Considerations in covariate selection

Four factors that we measure may have influence on a MAFRD grantee's ability to match with a non-grantee. The first covariate is distance to market in km. Farmers' markets bring consumers closer to producers (Ling & Newman, 2011), and the farmer's distance to market may impact both produce quantity and ability to sell the produce in a timely manner. Distance from farm to market can also be an important factor determining the farmer's access to the product markets (Ahmed, et al., 2016).

Agricultural education may influence productivity gains (Fintineru & Madsen, 2012). An earlier study that used propensity score matching found that education was positive and significant for cherry production (Ali et al., 2013). In a later study, education was found to be a contributing factor affecting the farmer's income (Panda, 2015). Based on these previous studies, we concluded that education was an important matching variable. Farm experience is included as a matching variable for similar reasons. Farmers' years of experience vary by region in Kosovo when growing greenhouse tomatoes and peppers. For example, given the strong tradition of tomato production in the region

of Prizren, it is expected that Prizren greenhouse tomato producers may have more years of farm experience than producers in other regions. For greenhouse pepper producers, however, years of farm experience may differ little from region to region.

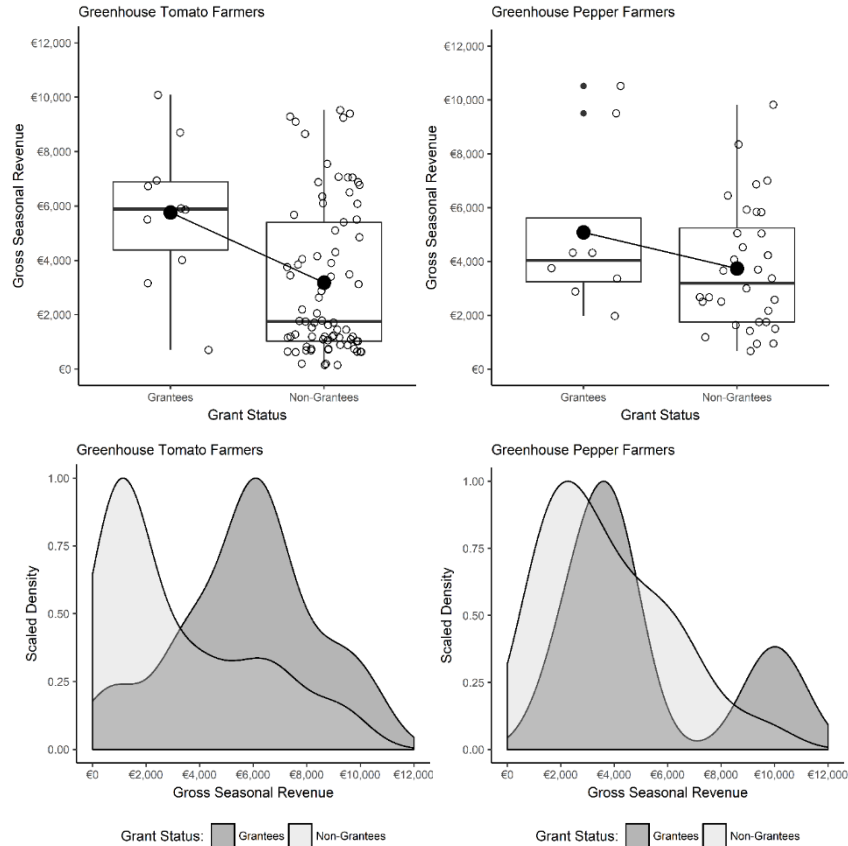
Lastly, we consider using covariates to control for four greenhouse tomato and pepper producing regions. Potentially, region may be an important variable in

matching MAFRD grantees to non-grantees. For example, Kosovo's regions can have differences in the production of greenhouse vegetable crops because of the climatic conditions, or because of regional differences in family farming traditions. However, reasons may vary as why farmers from one region or another are more or less likely to acquire government farm grants. Therefore, it is important to use the covariate region in the matching procedures.

### 3 RESULTS AND DISCUSSION

When analyzing gross revenue per growing season, it was suggested from both groups of farmers that grantees compared to non-grantees were associated with higher revenue levels (Figure 1). The box plot analysis from Figure 1 shows that farmers producing tomatoes who received MAFRD grants have a mean of 5,759.30 euros while non-grantees have a lower mean of 3,178.84 euros of gross revenue per growing season. Grantees producing peppers suggest a mean of 5,080.43 euros while non-grantees suggest a lower mean of 3,739.02 euros of gross seasonal revenue. Figure 1 indicates also that when observing the densities of both groups of farmers, grantees highlight higher seasonal revenue levels than non-grantees. There were only few grantees producing tomatoes and peppers with gross seasonal revenue greater than 10,000.00 and less than 3,000.00 euros. However, there were more non-grantees

producing tomatoes and peppers with revenue levels less than 3,000.00 euros. Considering that grants could have a positive impact on farmers' gross seasonal revenues, we estimated possible differences using gross seasonal revenue as the outcome variable in the model. As explained above, covariates including distance to market in km, education in years, and farm experience in years were used in the matching of greenhouse tomato and pepper grantees to non-grantees. Depending on the region, however, farmers were sometimes from different locations. For the matching of greenhouse tomato grantees to non-grantees, we included the regions of Ferizaj, Gjakova, Peja and Prizren. While, the regions of Ferizaj, Gjakova, Peja and Mitrovica were used in the matching of greenhouse pepper grantees to non-grantees.



**Figure 1:** Greenhouse Tomato and Pepper Farmers’ Gross Seasonal Revenue Levels

The average treatment effect on the treated (ATT) estimates revealed significant differences in gross seasonal revenue among greenhouse tomato and pepper farmer grantees and non-grantees. There was a statistically significant impact of grants for both greenhouse tomato and pepper farmers (Tables 2 and 3). Table 2 shows a positive and marginally significant ( $p < 0.1$ ) ATT among greenhouse tomato farmers. The estimate of a difference of 2,151.80 euros in gross

revenue per growing season was estimated for grantees relative to non-grantees. The 95 % confidence interval is -324.71 to 4,628.31 euros per growing season. However, it should be noted that the study contains a smaller sample of farmers than was desired. Therefore, ATT results could vary with a larger sample. The findings here suggest that it is possible MAFRD grant programs positively affect gross seasonal revenue levels of greenhouse tomato farmers that were awarded grants.

**Table 2:** Greenhouse Tomato Grantees’ Average Treatment Effect on the Treated

Outcome Variable	Greenhouse Tomato Grantees					
	Unit	Mean	T-stat	p-value	95% CI	
					Lower	Upper
<i>Gross Seasonal Revenue</i>						
Estimate	euro	2,151.80	1.703	0.088*	-324.71	4,628.31

Note: T-stat, t statistic; CI, confidence interval. The statistical significance of the estimate is denoted by \* $p < 0.1$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.01$ .

Similarly, Table 3 shows a positive and significant ( $p < 0.05$ ) ATT for greenhouse pepper farmers. The

estimate of a difference of 2,866.69 euros in gross seasonal revenue was suggested for grantees relative to

non-grantees. The 95 % confidence interval is 446.42 to 5,286.96 euros per growing season. The MAFRD grant

programs seem to influence positively the gross seasonal revenue levels of greenhouse pepper farmers.

**Table 3:** Greenhouse Pepper Grantees’ Average Treatment Effect on the Treated

Outcome Variable	Greenhouse Pepper Grantees					
	Unit	Mean	T-stat	p-value	95% CI	
					Lower	Upper
<i>Gross Seasonal Revenue</i>						
Estimate	euro	2,866.69	2.322	0.020**	446.42	5,286.96

Note: T-stat, t statistic; CI, confidence interval. The statistical significance of the estimate is denoted by \*p < 0.1; \*\*p < 0.05; \*\*\*p < 0.01.

The evolutionary algorithm of genetic matching determines the weight each covariate receives (Diamond & Sekhon, 2013). These weights are used in the matching estimate of the ATT. Improvements in the standardized mean difference (SMD) between pre and post matched samples are influenced by these covariate weights. Covariate balance results for tomato producers are presented in Table 4. There was a slight improvement in the mean value of distance to market. This covariate’s SMD went from 46.77 to -36.95 showing that it was not considered important by the algorithm. In fact, distance to market had a low weight of only 3.86. Education in years showed a mean improvement of roughly a year and a half of education. Its SMD reduced from 34.34 to 5.99, and with a much

larger weight of 601. Although experience in years had a relatively high weight of 440, yet its SMD did not improve. Regions of Ferizaj, Gjakova, and Peja marked SMD improvements from 29.84 to 0, 19.30 to 0, and 11.10 to 0, respectively. The three regions showed balance in mean values in the post-match phase (Table 4). Accordingly, the three regions were assigned high weights (594, 655, and 619) which could support the improvement in balance for these region indicators. However, region of Prizren registered a smaller improvement in its SMD and mean value. This covariate highlighted only a weight of 229. Overall balance was favored for the measure of education and indicators for the regions of Ferizaj, Gjakova, and Peja.

**Table 4:** Greenhouse Tomato Covariate Balance Results

Covariate	Pre-Match (N=87)			Post-Match (N=10)		
	Grantees	Non-Grantees	d	Grantees	Non-Grantees	d
Tomato Farmers						
Distance to market	28.23	15.36	46.77	28.23	38.40	-36.95
Education in years	12.20	10.48	34.34	12.20	11.90	5.99
Experience in years	9.60	9.71	-3.36	9.60	9.90	-8.81
Region of Ferizaj	0.30	0.16	29.84	0.30	0.30	0
Region of Gjakova	0.10	0.04	19.30	0.10	0.10	0
Region of Peja	0.10	0.06	11.10	0.10	0.10	0
Region of Prizren	0.50	0.32	33.27	0.50	0.40	18.97

Note: N, number of observations; d, standardized mean difference.

As in the case of tomato farms, distance to market similarly continued to have an imbalance in in the post-matched sample of pepper farms. This measure received a low weight of 126. Likewise, education in years did not show a large reduction in its mean or SMD. Its SMD decreased from 66.59 to 38.47 and it had a weight of 225. Experience in years had the highest weight (909) and the balance improved from -22.51 to -8.57. The SMDs of regions of Ferizaj and Gjakova decreased from -13.50 to 0 and 27 to 0, respectively. The two regions showed balance in the post-match phase (Table 5). In

addition, the former region had a weight of 814 and the latter a weight of 899. Region of Peja had a small balance in its mean and SMD and a low weight of 71. While the mean of region of Mitrovica improved, its SMD degraded from 8.84 to -35.36. However, this indicator had a very small weight (4.94) among the covariates. In comparison to greenhouse tomato farmers, balance was favored partly for the covariate experience in years and indicators for the regions of Ferizaj and Gjakova.

**Table 5:** Greenhouse Pepper Covariate Balance Results

Covariate	Pre-Match (N=40)			Post-Match (N=8)		
	Grantees	Non-Grantees	d	Grantees	Non-Grantees	d
Pepper Farmers						
Distance to market	28.38	25.22	15.33	28.38	27.50	4.25
Education in years	13.88	11.06	66.59	13.88	12.25	38.47
Experience in years	5.75	6.41	-22.51	5.75	6.00	-8.57
Region of Ferizaj	0.25	0.31	-13.50	0.25	0.25	0
Region of Gjakova	0.25	0.13	27.00	0.25	0.25	0
Region of Peja	0.38	0.13	48.31	0.38	0.25	24.15
Region of Mitrovica	0.13	0.09	8.84	0.13	0.25	-35.36

Note: N, number of observations; d, standardized mean difference.

## 4 CONCLUSIONS

The presence of the government grant programs as an agricultural policy may provide the opportunity to promote Kosovo's greenhouse production given that each year more and more farmers apply to the MAFRD grant programs. In this study, important matching variables for greenhouse tomato farmers were education and indicators for the regions of Ferizaj, Gjakova, and Peja. While indicators for the regions of Ferizaj and Gjakova and partly experience in years were most important for greenhouse pepper farmers.

Policy researchers in Kosovo may take interest in the evidence of the positive gross seasonal revenue difference of 2,151.80 euros for the greenhouse tomato grantees relative to the non-grantees, and 2,866.69 euros for the greenhouse pepper grantees relative to the non-grantees. This evidence may help to identify which group of greenhouse farmers are likely to be influenced from the MAFRD grant programs. The study results should also be of interest to nonprofit organizations and agencies for development that invest to help MAFRD's efforts in Kosovo for the provision of new and upgraded

farm facilities and greenhouses. Regarding the impact estimates, this study found the genetic matching method with a good convergence of the results with our sample of surveyed farmers. Despite the large or small mean differences of the covariates pertaining to the greenhouse tomato grantees and non-grantees prior to matching, the genetic matching method provided a significant improvement in the covariate balance. Nevertheless, it should be noted that the study contained a sample of farmers that was not sufficiently large, and ATT results could vary with a larger sample.

In conclusion, these overall results suggest that grants awarded to the greenhouse farmers improved their gross revenue levels per growing season. Greenhouse tomato and pepper MAFRD grantees attained higher gross seasonal revenue levels relative to the non-grantees. Considering balance on the covariates, it was found that based on the farmers' education and depending on the region, balance was possible for MAFRD grantees and non-grantees.

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