Determinants of agricultural labour productivity across the European regions

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1. Introduction

The European Union (EU) is characterised by large territorial and demographic disparities that constitute an impediment in achieving the integration and cohesion objectives. The inclusion of territorial cohesion in the Lisbon Treaty, as one of the three main pillars of the EU Cohesion Policy, aims to reduce the disparities between the economies of well-performed regions and those whose development is lagging behind. The variation in productivity rates among economic sectors decisively affects the existence of such territorial discrepancies. Significant and persistent differences exist among European regions in labour productivity (Basile, 2008), one of the main indicators of economic performance. The magnitude of such territorial asymmetries in labour productivity across EU is significantly greater in the agricultural sector than in the secondary and tertiary sectors (Ezcurra et al., 2008; Giannakis and Bruggeman, 2015).

Agricultural productivity enhancement has been an overarching objective of the Common Agricultural Policy (CAP) throughout its history; from the mid-1960s through the investment support in agricultural holdings to the current programming period (2014-2020) through the farm modernization scheme in Axis 1 of the rural development policy. Most studies on agricultural labour productivity explore its convergence or divergence across time periods (e.g. Alexiadis et al., 2013). In this study, we focus on the causes of the differences in agricultural productivity across the EU regions. It is of interest to investigate why similar labour-intensive farm practices yield a high value added per labour unit in some regions, while in others the value added remains at lower levels. Although there are plenty of physical, technical and human capital factors for enhancing agricultural productivity, it is nevertheless possible to identify common pathways from success stories. The identification of the determinants of productivity growth can contribute to a better understanding of the weaknesses that do not allow the full exploitation of productivity potential and reduce regional disparities.

Within this context and taking into consideration the wide diversity of agriculture across the EU, the objectives of this paper are (a) to identify the differences in the labour productivity of agriculture across EU regions, and (b) to investigate the factors behind the highly differential performance of farm labour in terms of value added across EU regions. The study applies a cross-regional analysis on the distribution of agricultural labour productivity, using NUTS 2 regions as a referencing spatial unit for the empirical analysis.

2. Methodology

2.1 Cluster analysis

Cluster analysis is a multivariate statistical technique that entails the division of a large group of observations into smaller and more homogeneous groups. Cluster analysis can be applied to classify EU regions according to differentiated labour productivity.

2.1.1 Application

Labour productivity is measured as the gross value added (GVA) per annual work unit (AWU). *K*-means and two-step clustering methods were used to classify EU regions according to differentiated agricultural labour productivity. The variable was averaged across a 5-year reference period (2008-2013) to mitigate year specific effects in farm performance due to fluctuations in production and input/output prices and in climatic conditions. Cluster analysis wasperformed in SPSS 13.0 and the prearranged number of clusters came from the applied Ward’s method.

2.2 Ordered logistic regression analysis

An ordered logit model was applied to analyse the factors that affect the agricultural labour productivity across EU-27 NUTSII regions. The dependent variable of the model represents the ordered categories of regions with different agricultural labour productivity. The model estimates the cumulative probability of achieving highest labour productivity category versus all lower categories. The variance inflation factor (VIF) was calculated to determine whether the explanatory variables are correlated.

2.2.1 Application

The explanatory variables of the model were averaged across a five-year period (2008–2013) to mitigate a year specific effect in labour productivity, as explained previously. All calculations are done in STATA 12 econometric software package. The explanatory variables of the regression model are age, agricultural education, pluriactivity, farm size, type of tenure, productive specialization, soil erosion, less favoured areas (LFA) and population density. The age of the farm population is expressed as the share of farmers older than 65 years. Age is commonly used as a proxy for managerial skills and reveals farmers' aptitude to innovate and intercept funding opportunities (Ezcurra et al., 2011). Agricultural education is expressed as the share of farm holders with basic or full agricultural training. Farm size is expressed as a share of agricultural holdings utilizing 50 hectares of UAA or more. It is expected that the relationship between labour productivity and farm size is positive owing to the presence of economies of scale (Bakucs et al., 2013; Ezcurra et al., 2011). Similarly, the use of 'non-owned' inputs in the production process could affect the labour productivity. Here, the percentage of rented agricultural land is used to assess this impact. Increasing the share of rented land could improve productivity owing to technological scales (Ezcurra et al., 2011, Karagiannis and Sarris, 2005). The farm productive specialization is expressed by two variables, namely, the percentage of specialized holdings in grazing livestock and the percentage of specialized holdings in granivores (pigs, poultry and rabits). Farmers' engagement in other gainful activities other than farming is usually negatively related to labour productivity (Schmitt, 1988).

The share of utilized agricultural land in LFAs is used to assess the effect of unfavourable environmental conditions on farm growth. Farms located in LFAs are generally less productive (Giannakis and Bruggeman, 2015; Bojnec and Latruffe, 2013). Soil erosion is one of the major soil threats in the EU, with negative impacts on crop production and ecosystem services (Panagos et al., 2015). Here, we use soil erosion by water (tonnes/ha/year), which accounts for the greatest loss of soil in Europe (Panagos et al., 2015). This indicator was estimated by the Revised Universal Soil Loss Equation model (RUSLE2015). Finally, population density expressed in persons per km^2 is used as a proxy for access to consumers. The main markets of agricultural products are located in urban centers and therefore affect the type and the intensity of the farm production (Polyzos and Arabatzis, 2006).

Definitions and descriptive statistics of all the variables used in the analysis are shown in Table 1.

Table 1. Description of the predictor variables used in the ordered logistic regression model (2008-2013) and summary statistics.

Variables	**Definition**	**Average**
AGE	Share of farmers older than 65 years (%)	27
FEDUC	Share of farmers with basic or full agricultural training (%)	40
PLUR	Share of farmers with other gainful activity (%)	38
TENUR	Share of rented agricultural land (%)	42
FSIZE	Share of farm holdings with 50 ha utilized agricultural area or more (%)	19.6
GRAZE	Share of farm holdings specialized in grazing livestock (%)	46
GRANIV	Share of farm holdings specialized in granivores (%)	5
EROS	Soil erosion by water (tonnes/ha/year)	2.68
LFA	Share of utilized agricultural area in less favoured areas (%)	0.48
POPDENS	Population density (persons per km2)	330

3. Results

Both *K*-means and two-step clustering methods identified three clusters of regions, namely, the ones with high, medium and low labour productivity. The high labour productivity cluster accounts for 6 regions with an average GVA of 192,871 €/AWU, the medium labour productivity cluster accounts for 94 regions with an average GVA of 52,082 €/AWU, while the low labour productivity cluster amounts to 145 regions with an average GVA of 18,529 €/AWU. The highest labour productivity appears in the NUTS2 -

Mellersta Norrland (SE32) region (248,145 €/AWU) followed by the Praha (CZ01) (206,419 €/AWU). On the contrary, the lowest labour productivity rates appear in two Polish regions, namely, Podkarpackie (PL32) (1,350 €/AWU) and Malopolskie (PL21) (1,952 €/AWU).

The farm size variable (FSIZE), which is a very important factor for farm performance, was excluded from the regression model to mitigate multicollinearity effects (VIF: 3). The results of the ordered logistic regression model after the exclusion of the FSIZE are presented in Table 2.

Table 2. Logit coefficients and odds ratio of agricultural labour productivity of 245 EU-28 NUTSII regions for the 2008-2013 period.

	Coefficients	Std. Error	Odds Ratio	Std. Error	p
AGE	-0.894	1.870	0.408	0.764	0.633
FEDUC	1.548	0.902	4.702	4.244	0.086
PLUR	-1.077	1.068	0.340	0.364	0.314
TENUR	1.807	0.797	6.091	4.860	0.024
GRAZE	2.140	0.826	8.504	7.028	0.010
GRANIV	-6.811	3.460	0.001	0.003	0.049
EROS	-0.412	0.125	0.662	0.083	0.001
LFA	-2.295	0.607	0.100	0.061	0.000
POPDENS	0.0004	0.0002	1.0004	0.0002	0.072

Log likelihood = -121.01

p-value = 0.000

Pseudo R^2 = 0.346

* For the Germany the data refer to NUTSI regions

Model results indicate a positive relationship between farm education and labour productivity. Increasing the share of farmers with agricultural training by 1% increases the probability of attaining high labour productivity rates by a factor of 4.7. Similarly, the effect of increasing the scale of rented land is positive as it increases the odds for achieving high productivity by 6.1 times. The ageing farm population and the engagement of farmers to other gainful activities have a negative effect on labour productivity, but both variables were not found to be statistically significant. Regional agricultural sectors specialized in grazing livestock are 8.5 times more likely to develop high labour productivity rates, while sectors specialized in granivores are 0.001 times less likely to do so. Population density has a minor positive effect on agricultural labour productivity. Both the soil loss rates and the share of agricultural land under LFAs decrease the likelihood of achieving high productivity by a factor of 0.66 and 0.10, respectively.

5. Conclusions

The cross-regional analysis of the agricultural labour productivity revealed that significant differences exist within the EU-27 countries. The results of the regression model highlight the importance of both farm structural and environmental factors in enhancing agricultural labour productivity. The findings also confirm the importance of rural development policy measures and stress the need for further regionalization and targeted support of CAP through the second pillar.

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