Relationship between education and production value of small and medium family farms in Poland

Jan Polcyn
Stanisław Staszic State University of Applied Sciences in Pila, Poland
ORCID: 0000-0001-7847-2743, e-mail: Jan.Polcyn@puss.pila.pl

Sebastian Stępień
Poznan University of Economics and Business, Poland
ORCID: 0000-0001-9475-8418, e-mail: Sebastian.Stepien@ue.poznan.pl

Aleksy Kwiliński
The London Academy of Science and Business: London, United Kingdom
ORCID: 0000-0001-6318-4001, e-mail: a.kwilinski@london-asb.co.uk

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Abstract: Scientific reports indicate a very important role of human capital manifesting itself as a significant impact on the gross domestic product. Since agriculture creates a significant part of the gross domestic product, it may be assumed that human capital significantly influences production in this sector of the economy. A significant role in the global agricultural production is played by small and medium family farms, in particular, their important role in maintaining biodiversity and providing traditionally produced food. Taking into account the above dependencies, the aim of the study was to verify the influence of the education of the owners of small and medium farms on the production value. Small and medium family farms in Poland have been analysed. After analysing a variety of definitions, the qualification criteria for this group of farms included the area of the farm (up to 20 ha), the value of standard production (up to 25 thousand EUR), and the share of own labour involved in agriculture (at a minimum level of 75%). The data for analyses were obtained through surveys conducted on a sample of 710 farms from Poland. The surveys were carried out in 2019. The following variables were included in the analysis: farm area, total farm output value per ha and per farm member, and a synthetic measure of human capital. The TOPSIS-CRITIC method was used to determine the synthetic measure of human capital, and the following were included in the said measure: age of the farm manager, participation in continuing education, and education of the farm manager. The analysed farms were divided into two classes according to their education, i.e. one class consisted of farms where the owner had a university degree and the other class consisted of farms where the owner had a secondary or lower secondary education. Contrast analysis was conducted between the determined classes.

The analyses conducted in this study indicate a significant relationship between the farm owner's education and the value of total farm production per ha and per farm member. A more favourable value of total farm production per ha and per farm member was found in farms where the manager had a higher vocational education or master's degree. This difference should not be explained by the farm's production scale and size when compared to the farms of a larger area with University educated farm owners, because the difference in area between the classes of these farms was too small.

Key words: human capital**,** TOPSIS-CRITIC, small farms, farmers' education

JEL: Q00, Q14, E24

Introduction

Human capital is perceived as an important factor influencing the economy, in the scientific literature it is even reported to be responsible for several per cent of GDP growth

[Sardadvar & Vakulenko, 2021; Landau, 1983; Barro, 2001; Arefieva et al., 2021; Dalevska et al., 2019; Kharazishvili et al., 2020; Kwilinski et al., 2020]. It is also an obvious fact that the agricultural sector is involved in the production of GDP and this means that this sector should also be influenced by human capital. However, it should be remembered that in the case of human capital connected with agriculture, we may speak of human capital specific to agriculture, referred to as industry-specific human capital. When considering problems related to human capital in agriculture, it should be kept in mind that this figure is significantly influenced by inherited knowledge, passed on from older generations, most often parents. Moreover, usually young entrants to agriculture, before taking over a farm from an early age, participate in agricultural production processes thus acquiring practical skills for later independent farm management. Taking the above into account, we should remember the special role related to the processes of capital inheritance in farms and the creation of particuler, industry-specific human capital.

In view of the above premises, the aim of the study was to verify the influence of the education of owners of small and medium farms on the production value.

Literature review

According to Adam Smith, human capital is considered to be a generalized characteristic of the quality and capacity of human labour, thus constituting a major source of income and factors promoting labour productivity growth [Smith, [1776] 1998].

The definition given by Smith has already been modified many times and contemporary human capital is understood as a resource of knowledge, skills, abilities (including creativity and mental abilities), human impulses for productive work acquired through education, training or based on practical experience, and having high economic significance [Juliya, 2015; Abazov, 2021; Dementyev & Kwilinski, 2020; Dzwigol et al., 2020].

The human capital theory views investment in health policy and health care as critical elements of human capital building. The health insurance system plays an important role in the context of maintaining adequate levels of health care [Inwood, 2017; Trushkina et al., 2020; Yelnikova & Kwilinski, 2020].

Nowadays, mainly due to the dynamic development of new technologies, human capital is seen as a key source of the strongest competitive advantage of companies. Today,

success no longer depends on improving productivity, but on human capabilities derived from human capital. In view of the above, one of the main aspects of human capital creation becomes ensuring the availability of a continuous training process, which ultimately leads to prolonged professional activity and increased competitiveness of organizations [Kogovsek & Kogovsek, 2013; Bogachov et al., 2020; Dzwigol et al., 2020; Kuzior et al., 2019].

The availability of high-quality food affects the shaping of human capital - such thinking justifies the impact of low-quality food products on human health, fitness and the intellectual development of the younger generation [Gorbunova et al., 2015]. There are known studies that show a correlation between environmental care and farmers' education [Chen et al., 2021].

Studies conducted in Bulgarian and Hungarian farms focused on crop production or dairy production have shown the relationship of human capital between age and education [Mathijs & Vranken, 2001].

In turn, German studies show that farms with higher income capacity are more willing to invest in agriculture-specific human capital. Furthermore, empirical analyses conducted within the cited studies indicate positive rates of return from farmer education. However, there is a correlation indicating lower returns from farmer education than from other professions [Bartels, 1996].

Some studies indicate age as a key factor in the human capital model [Barry et al., 2020].

Studies conducted in the UK led to the conclusion that development-oriented human resource management strategies put older employees at risk, in relation to younger employees. However, some high-performance work practices show that older employees achieve greater benefits in relation to younger employees. However, a limitation in the organisation of production processes may be the over-representation of older employees who have adopted fixed positions related to the evaluation of their activities satisfactory to themselves [Haile, 2021].

The neoclassical approach to human capital indicates that individual employee characteristics, such as age and education, increase learning efficiency and are decisive in directing employees to train [Barry et al., 2020].

Observations related to a business' decision-making indicate that age, rather than education, is the key factor in deciding whether to send an employee for training [Barry et al., 2020].

Surveys conducted in Poland on farm efficiency show that the farmer's education and socio-demographic factors play a key role in this respect. Along with an improvement in education, the attention is mainly paid to higher education, farmers' awareness of the use of subsidy schemes, debt, and innovative solutions is increasing. Moreover, there is also an increasing interest in precise farming, which directly translates into better technological and financial efficiency of farms [Pastusiak et al., 2021].

Studies conducted in the USA indicate that the farmer's education has a significant impact on the productivity of modern agriculture. In addition, analysis of historical data also indicates that the network of common schools had a positive impact on the application of innovation in agriculture [Parman, 2012].

Research methodology

Small and medium family farms from Poland were analysed. Analysing a variety of definitions, as qualification criteria for this group of farms, the area of the farm up to 20 ha, the value of standard production up to 25 thousand EUR, and the share of own labour involved in agriculture at a minimum level of 75% were adopted.

The data for analyses were obtained through surveys conducted on a sample of 710 farms from Poland. The surveys were carried out in 2019.

Farms for analysis were divided into two classes according to education. Class A consisted of farms where the owner did not have any education or had the following education: primary, junior high school, general secondary, secondary vocational, or post-secondary. Class B comprised farms where the owner had higher vocational education or a master's degree.

Data were collected through face-to-face interviews by farm advisors or specialised companies. The interview had a structured questionnaire containing four thematic blocks of questions: socio-economic sustainability, environmental sustainability, market linkages, and general farm characteristics. To ensure correct data collection, the main studies were preceded by pilot studies. The pilot studies included several interviews in selected farms in

order to check the correctness and clarity of the questions included in the questionnaire. As a result of the pilot studies, incomprehensible questions were removed or corrected, and appropriate comments were added to other questions.

The value of total farm production per ha was used in the analyses, additionally, this value was converted per farm member. The second variable used in the analyses was the area of the farm. In addition, a variable describing the human capital of the farm was used, with this variable consisting of three values: age of the farm manager, education, and participation in continuing education. The synthetic variable of human capital was developed according to the procedure described below.

The variables used for the synthetic measure of human capital, in the case of stimulants, were subjected to zero unitarisation according to formula (1), while in the case of destimulants, the following formula was applied (2).

$$stimulant: z_{ij} = \frac{x_{ij} - min_i\{x_{ij}\}}{max_i\{x_{ij}\} - min_i\{x_{ij}\}}, (i = 1,2, \dots, n; j = 1,2, \dots, k; from \in [0,1] (1)$$

where:

$min_i\{x_{ij}\}$ – minimum value of function j,

$max_i\{x_{ik}\}$ – maximum value of function j,

i – object (in the analysed case the farm).

$$destimulant: z_{ij} = \frac{max_i\{x_{ij}\} - x_{ij}}{max_i\{x_{ij}\} - min_i\{x_{ij}\}}, (i = 1,2, \dots, n; j = 1,2, \dots, k; from \in [0,1] (2)$$

where:

$min_i\{x_{ij}\}$ – minimum value of function j,

$max_i\{x_{ik}\}$ – maximum value of function j,

i – object (in the analysed case the farm).

Subsequently, weights for the selected variables were determined using the TOPSIS-CRITIC method (designation of criteria through the correlation between criteria). In the TOPSIS-CRITIC method, weights are determined on the basis of standard deviations and correlations between variables. A characteristic feature of this method is that relatively higher weights are assigned to characteristics that have a high coefficient of variation but low correlation with other characteristics [Borychowski et al., 2020]. The weights of the variables were determined according to the following formulas:

$$w_j = \frac{c_j}{\sum_{k=1}^{m} c_k}, j = 1,2, \dots, m; c_j = s_{j(z)} \sum_{k=1}^{m} \left(1 - r_{ij}\right), j = 1,2, \dots, m \ (3)$$

where:

c_j – a measure of the information capacity of characteristic *j*,

$s_{j(z)}$ – standard deviation calculated based on the normalised values of the characteristic *j*,

r_{ij} – correlation coefficient between characteristics *j* and *k*.

The next step was to multiply the established normalised values of the variables by the appropriate weighting factors. Using the values of the variables after the weighting process, the Euclidean distances of the individual units from the development pattern and anti-pattern were calculated according to the following formulas (4) and (5):

$$d_i^+ = \sqrt{\sum_{j=1}^{k} (z_{ij}^* - z_{ij}^+)^2} - distance\ from\ the\ development\ pattern\ (4)$$

$$d_i^- = \sqrt{\sum_{j=1}^{k} (z_{ij}^* - z_{ij}^-)^2} - distance\ from\ the\ development\ anti-pattern\ (5)$$

where:

$$z_j^+ = (max(z_{i1}^*), max(z_{i2}^*), \dots, max(z_{ik}^*)) = (z_1^+, z_2^+, \dots z_i^+)$$

$$z_j^- = (min(z_{i1}^*), min(z_{i2}^*), \dots, min(z_{ik}^*)) = (z_1^-, z_2^-, \dots z_i^-)$$

In the next step, the value of the synthetic characteristic q_1 is determined according to the following formula (6):

$$q_i = \frac{d_i^-}{d_i^+ + d_i^-}, (i = 1,2, \dots, n) (6)$$

Table 1 presents the list of variables used in the TOPSIS-CRITIC analysis and the weights of the individual elements.

Table 1. List of variables used to create the synthetic measure of Human Capital

Name of the synthetic measure	Name of the variable	Type of the variable (stimulant/destimulant)	Weight
Human Capital	Age of the farm's manager	Destimulant	0.825
	Education of the farm's manager	Stimulant	0.070
	Participation in the continuing education	Stimulant	0.105

Source: own elaboration based on the conducted analyses

It is generally assumed that work experience increases with length of service, however, when considering this aspect, it is necessary to take into account the nature of the work performed. If the work performed consists mainly of simple physical activities, assuming that the employee's physical fitness deteriorates with age, we come to the conclusion that human capital decreases. It would be more appropriate to say that it is not the definitional human capital that decreases but the physical fitness. Following the aforementioned dilemma, it was decided to treat the employee's age as a destimulant. Treating age as a distimulant in human capital measurement is also supported by general health conditions, which deteriorates systematically with the age of the employee.

Analysis of the results

As a result of the process of determining the weights carried out with the TOPSIS-CRITIC method, we can see that the greatest importance in the synthetic measure of human capital was assigned to the variable: age of the farm manager (weight 0.825). Then, the next weight was assigned to the variable: participation in continuous education (weight 0.105). The lowest weight in the human capital measure was assigned to the variable: education of the farm manager (weight 0.070). The recognition of age as an important factor in the measurement of human capital is also confirmed by other scientific studies. Furthermore, it is indicated that age, rather than education, is the main factor determining whether employees are sent for training [Barry et al., 2020]. The relationships obtained in the present analyses are confirmed by the cited scientific reports (Table 1).

Farms grouped according to the education class of the owner of the farm indicate a more favourable material situation in farms where the owner has a higher vocational education or a master's degree (class B). In this class of farms, we can observe a higher value

of farm production in total per ha and per farm member, the difference in the discussed case being about PLN 400. It should also be noted that in class B (farmers with higher education), we can observe a larger area of farm by more than 2 ha (2.41 ha), but this difference does not seem to justify such a large difference in the scale of production to explain the higher value of production of a farm in total (Table 2).

Table 2. Characteristics of farms grouped by education class *

Class	N	Area of the farm (ha)	Total value of production from the farm per ha and per farm member (PLN)	Synthetic measure of human capital
A	601	13.73	1940.19	0.389232
B	109	16.14	2368.94	0.538297
Total / Average	710	14.10	2006.01	0.412117

**Class A: no education, education: primary, vocational, general secondary, vocational secondary, post-secondary;*

class B: first-degree education (bachelor's degree, engineer's degree) and second-degree education (master's degree)

Source: own elaboration based on the analysed data

There was also a difference in the synthetic measure of human capital in favour of class B (0.149065) (Table 2). However, the interpretation of this difference should be approached very cautiously because it also includes education, which was the criterion for dividing the surveyed farms into analytical classes.

It is generally acknowledged that a systematic increase in education should result in a systematic increase in farm productivity. In the conducted studies, a significant difference was found only between university education and the other levels of education. This may indicate a decrease in the quality of education in recent years, as we are currently observing an increase in the universality of education in recent years (more young people have an education). In view of the above, two important components of human capital, age, and the level of education, function simultaneously in this situation.

Table 3: Evaluation of contrasts

Name of the variable	N	Class by education	SS_{effect}	Contrast (1;1)
Area of the farm (ha)	601	A	538	0.90
	109	B		
Value of production from the farm in total per ha and per farm member (PLN)	601	A	16960889	0.60
	109	B		
Synthetic measure of Human Capital	601	A	2	0.23
	109	B		

Source: own elaboration based on the analysed data

The performed analysis of contrasts indicates that a change in the area of a farm from class A to B explains about 90% of the difference between the level of education in the analysed classes (Table 3). On the other hand, the difference between class A and B determined on the basis of the level of education explains about 60% of the difference in the value of production from a farm in total. The same difference between classes A and B explains only 23% of the difference in the synthetic measure of human capital, but at this point, it should be noted that this measure also includes information about the level of education of the owners of the farm.

Conclusion

The analyses conducted in this study indicate a significant relationship between the farm owner's education and the value of total farm production per ha and per farm member. A more favourable value of total farm production per ha and per farm member was found in farms where the manager had a higher vocational education or a master's degree. This difference should not be explained by the farm’s production scale and size when compared to the farms of a larger area with University educated farm owners, because the difference in area between the classes of these farms is too small.

What is surprising is the lack of significant differences between the lower levels of education of farm owners, especially between secondary and other levels of education. This may indicate a significant decline in the quality of education in recent years. This suggestion, however, certainly requires further research targeted at the level of farmers'

education and the value of farm production measures obtained by them. Such studies should include bigger research samples and very precisely capture the regional variation.

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Appendix A Tests of significance

Effect	Multivariate Tests of Significance; Sigma-restricted parameterization; Effective hypothesis decomposition					
	Test	Value	F	Effect df	Error df	p
Intercept	Wilks	0.199299	945.4701	3	706	0.000000
	Pillai's	0.800701	945.4701	3	706	0.000000
	Hotellng	4.017578	945.4701	3	706	0.000000
	Roy's	4.017578	945.4701	3	706	0.000000
Class - Farm owner's education	Wilks	0.939960	15.0318	3	706	0.000000
	Pillai's	0.060040	15.0318	3	706	0.000000
	Hotellng	0.063875	15.0318	3	706	0.000000
	Roy's	0.063875	15.0318	3	706	0.000000

Appendix B Tukey's HSD Test

Dependent variables - value of total farm production per ha and per farm member		
Approximate Probabilities for Post Hoc Tests Error: Between MS = 9155E3, df = 708.00		
Class - education level of the farm owner	A	B
A		0.173492
B	0.173492	

Dependent variables - synthetic measure of human capital		
Approximate Probabilities for Post Hoc Tests Error: Between MS = ,05464, df = 708,00		
Class - education level of the farm owner	A	B
A		0.000009
B	0.000009	

Dependent variables - area of the farm		
Approximate Probabilities for Post Hoc Tests Error: Between MS = 63.794, df = 708.00		
Class - education level of the farm owner	A	B
A		0.003698
B	0.003698	