SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2026
ORGANIZATION AND MANAGEMENT SERIES NO. 252

PROFITABILITY OF FARMS IN EU MEMBER STATES IN RELATION TO THEIR PRODUCTION POTENTIAL

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Purpose: This study aimed to assess the profitability of farms in EU member states and identify its determinants.
Design/methodology/approach: The research was carried out based on data from the Farm Accountancy Data Network (FADN) Public Database for the years 2013-2023. Based on this data, the indicators of labour and land profitability were calculated. Using a dynamic panel model, the determinants of labour profitability in EU farms were identified, with particular emphasis on variables that describe their production potential.
Findings: The results demonstrate the key role of inertia in shaping labour profitability. Farm economic size and technical equipment showed a marginally significant positive relationship. In contrast, the level of employment per 100 hectares reduced profitability.
Research limitations/implications: Further research should focus on a more in-depth analysis of the mechanisms differentiating profitability within specific types of farms.
Practical implications: Selective support for modernisation processes, particularly those that increase labour productivity, especially in countries with persistently low profitability, should be of key importance.
Originality/value: This study fills a research gap by identifying the determinants of farm profitability in EU member states.
Keywords: profitability, European Union, farms, production potential.
Category of the paper: Research paper.

1. Introduction

Equalising farm incomes among the member states of the European Union remains one of the key challenges of agricultural policy (Smędzik-Ambroży, Sapa, 2020; European Parliament and Council, 2021; Finger, El Benni, 2021, p. 254). Despite similar institutional and legal frameworks resulting from the implementation of the CAP and broad access to markets, the level and dynamics of agricultural income reveal significant spatial heterogeneity (Andrejovská, Glova, 2022, Herman, 2025). Available scientific studies and reports from the

European Commission indicate that in recent years, we have witnessed an increase in the average income from agriculture in EU countries, but the level and pace of this change remain unequal (Skarżyńska, Grochowska, 2021; European Commission, 2023).

Previous research has pointed to the variability of factors shaping farm income. Empirical studies based on FADN or Eurostat data underline the importance of both the resources of production factors and the intensity of their use (Skarżyńska, Grochowska, 2021). According to Poczta et al. (2009), the income situation of farms is mainly influenced by the size of production potential, the intensity of production, and the impact of agricultural policy instruments. Niezgoda (2009) demonstrates that among production factors, capital plays the greatest role in income generation, followed by human labour, whereas, contrary to traditional beliefs, land shows a relatively weak correlation with income levels. Kryszak (2018), in turn, points out that the dominant agricultural model in a given region can modify the significance of individual income determinants, leading to diverse regional effects. Kryszak and Matuszczak (2019) show that farm incomes in the so-called new member states were more sensitive to increasing specialisation, direct payments, and investment inputs, while in the so-called old EU, there was relatively high income elasticity in relation to the labour factor. Barczak (2024, p. 80) demonstrates that income levels are dependent on the type of agricultural production and agro-climatic conditions.

Despite the growing number of analyses regarding agricultural income, the literature still lacks in-depth studies that evaluate the extent to which the production potential of farms, understood as the composition of land, labour, and capital resources, translates into their ability to generate income in the member states of the European Union. In most studies, production potential appears as one of many factors but rarely becomes the main focus of analysis. In light of this, the aim of the present study is to assess the profitability of farms in EU countries and determine the impact of production potential on the level of income achieved.

2. Research methods

Assessments of farm profitability in EU member states were carried out based on data from the Public Database Farm Accountancy Data Network (FADN) for the years 2013-2023. This is the only database that collects information according to uniform principles and where the farms constitute a statistically representative sample of commercial agricultural holdings operating within the European Union (Pawłowska-Tyszko et al., 2023, p. 10). The study was conducted in two stages.

Stage one: In the first stage, indicators of labour profitability were calculated as the ratio of farm income to the number of full-time employees (AWU – Annual Work Unit), as well as land profitability indicators, which are the ratio of farm income to the area of utilised agricultural

land. Based on this, a ranking of the member states was created, along with an assessment of changes in their positions in the years 2013-2023.

Stage two: The aim of the second stage was to identify the key determinants of labour profitability in EU farms, with particular emphasis on variables describing their production potential. For this purpose, the influence of selected independent variables on labour profitability in agriculture, expressed in EUR/AWU in a multifactorial framework, was estimated, considering the time dynamics and individual effects of panel units (27 EU countries). The independent variables included: 1) average area of utilised agricultural land per farm (ha), 2) economic size of the farm (thousand EUR), 3) technical equipment of labour, calculated as the value of fixed assets per full-time employee (EUR/AWU), 4) production intensity, expressed as total costs per 1 ha of agricultural land (EUR/ha), 5) land labour endowment, that is, the number of full-time employees per 100 ha of agricultural land (AWU/100 ha), and 6) the value of investment subsidies per 1 ha of agricultural land. In particular, this study focused on estimating the regression coefficients for each independent variable in a dynamic panel model based on the generalised method of moments (GMM), which allowed for the control of endogeneity and lagged effects.

The study of targeted relationships between multiple parameters and a single outcome variable was performed using a multifactorial model. The choice of model was based on the nature of the panel data, where observations involve repeated measurements for the same units over time, implying the presence of individual effects and potential endogeneity. Due to the dynamic nature of the process, in which the current value of the dependent variable may depend on its previous values, as well as the possibility of unobserved fixed effects, a dynamic panel model based on the generalised method of moments (GMM) was used. This method is particularly suitable for estimating models with lagged dependent variables in short panels, where the number of units exceeds the number of periods, and allows for the control of endogeneity by using internal instruments (Blundell, Bond, 1998).

To balance the scales of the numerical variables, standardisation using the z-score method was applied to the values of dependent and independent variables. This involved subtracting the mean and dividing by the standard deviation, which enabled the harmonisation of the impact of the variables with different units of measurement. The model was defined as a linear dynamic panel model in the general form:

$$y_{i,t} = \rho_1 y_{i,t-1} + \beta' x_{i,t} + a_i + \varepsilon_{i,t} \quad (1)$$

where:

$y_{i,t}$ is the dependent variable for unit *i* in period *t*,

$y_{i,t-1}$ is its one-period lag,

$x_{i,t}$ is the vector of explanatory variables,

ρ_1 is the coefficient on the lag,

β is the vector of coefficients on the explanatory variables,

a_i is the unobserved individual effect,
$\varepsilon_{i,t}$ is the random error term.

The explanatory variables were treated as endogenous, meaning that they could be correlated with random errors in the model. The estimation was conducted using the one-step GMM procedure, employing moment conditions from both the differenced equations (instruments in levels) and the level equations (instruments in differences) (Blundell, Bond, 1998). Nonlinear (squared) moment conditions were not included, as the model assumes linear relationships, which simplifies the estimation and avoids the need for intensive numerical optimisation in the case of simpler structures. The weighting matrix was based on the assumption of independent and identically distributed errors (type "iid.err"), which is the standard choice for models with homoskedastic errors. The standard errors of the estimators were corrected using the Windmeijer (2005) adjustment to account for bias in small samples, instead of the unadjusted or doubly corrected adjustment (Hwang et al., 2022), owing to its sufficient robustness in the context of one-step estimation. No instrument collapsing (Roodman, 2009) was applied, which allowed for the retention of full information from the moments without the risk of excessively constraining the variance of the estimators. The numerical optimisation was based on the BFGS algorithm, which ensured stable convergence in the presence of linear moment conditions (Fritsch et al., 2021).

Model validation included assessing the significance of the dynamic component by analysing the coefficient of the lagged dependent variable, which made it possible to verify whether the dynamics were statistically significant. A test for the presence of second-order autocorrelation in the residuals was conducted, which is crucial for the validity of instruments in GMM models, assuming no correlation in higher-order differences of the residuals. Additionally, an overidentification test (J-test) was applied to assess the validity of the moment conditions and the lack of correlation between the instruments and the residuals. Finally, a test for the significance of all model parameters was performed, confirming the overall adequacy of the specifications. Analyses were conducted using the R statistical language (version 4.5.2; R Core Team, 2025).

3. Results

Figure 1 presents the farm income levels of EU member states in 2023, arranged in descending order, and highlights the changes in the rankings of individual countries compared to 2013.

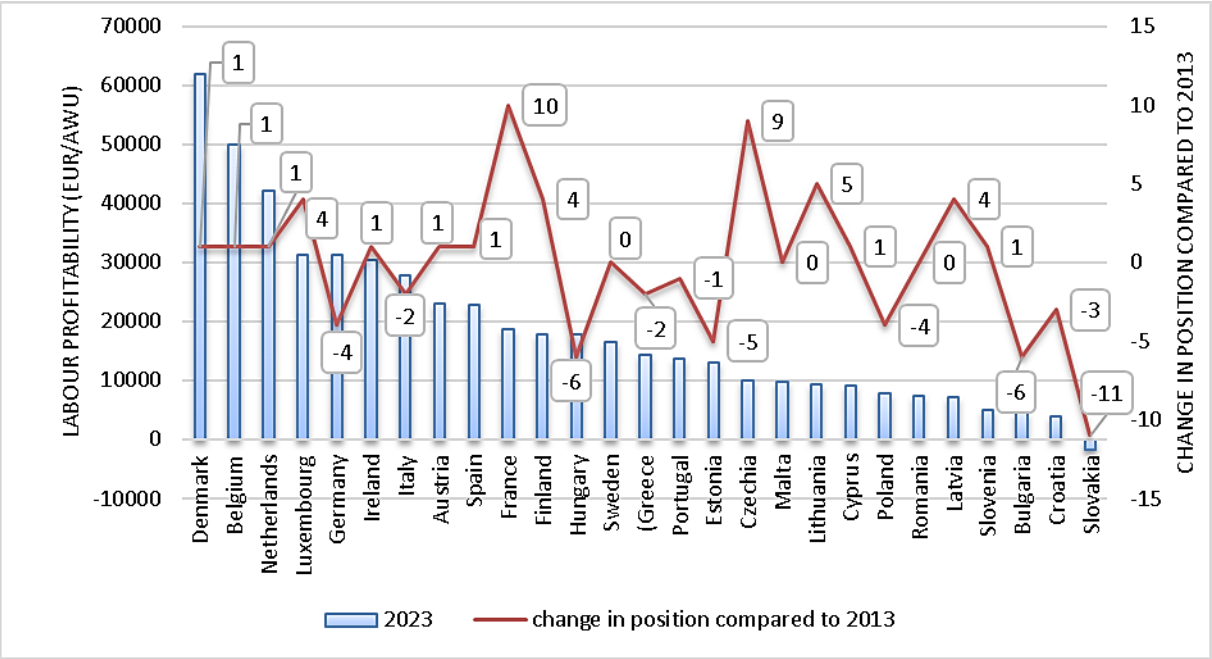


Figure 1. Labour profitability in farms in EU countries in 2023 (EUR/AWU) and changes in ranking compared to 2013.

Source: Own elaboration based on data from the Public Database FADN.

The average income of farms per 1 AWU in 2023 demonstrates pronounced polarisation in the profitability of agricultural labour within the European Union (Figure 1). The highest values of the analysed indicator were recorded in Denmark, Belgium, and the Netherlands (42-62 thousand EUR/AWU), that is, in countries with high production intensity. These countries have further improved their rankings. Significant advances were observed in France (+10), the Czech Republic (+9), and selected Baltic countries (the Czech Republic, Lithuania and Latvia). Simultaneously, Germany's decline in position (-4) indicates a relative decrease in the growth dynamics of work profitability compared to the leaders. A significant deterioration in the positions of Central and Eastern European countries (Hungary, Poland, Bulgaria, Croatia, and Estonia) reflects a slower rate of growth in work profitability, likely due to structural limitations.

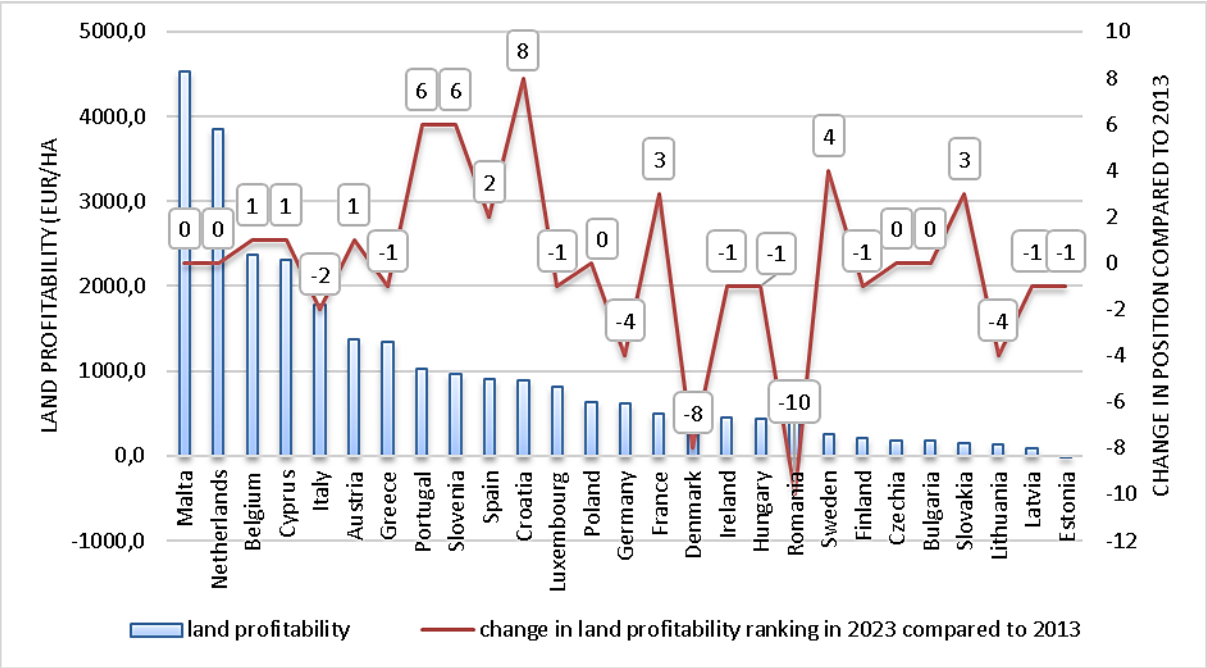
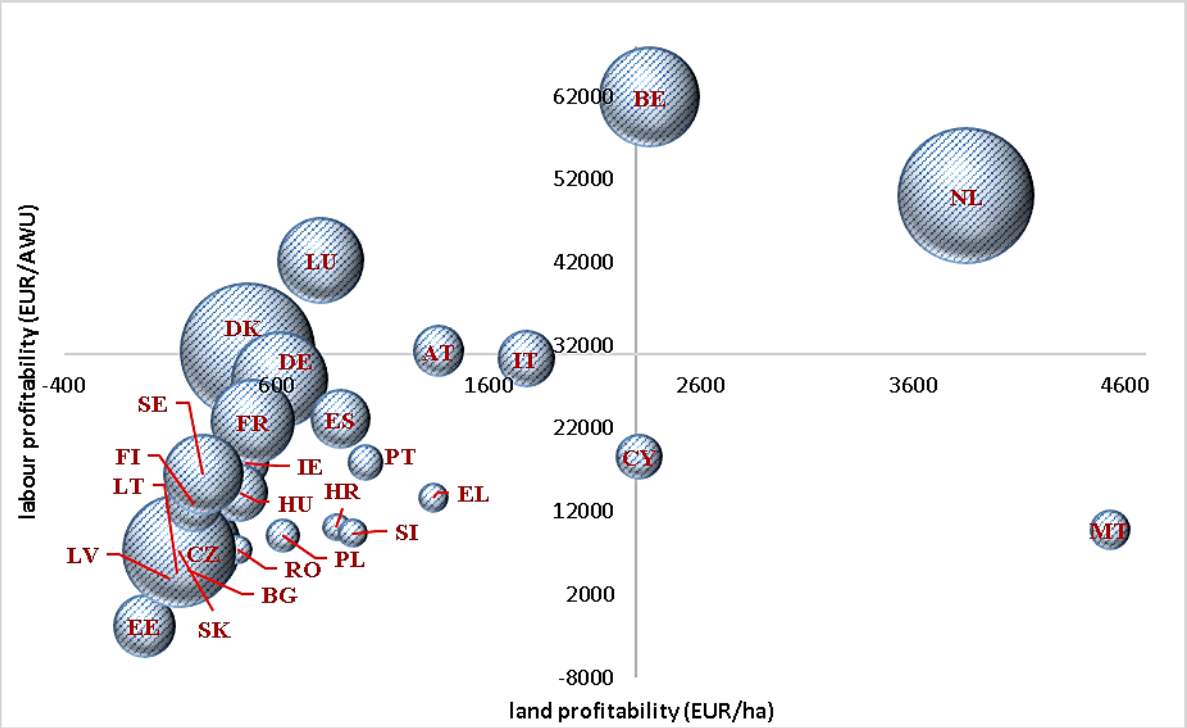


Figure 2. Land profitability in farms of EU member states in 2023 (EUR/ha) and change in profitability ranking position compared to 2013.

Source: Own elaboration based on data from the Public Database FADN.

Land profitability in 2023 showed strong variation between EU countries, from 4,531.9 EUR/ha in Malta and 3,855.4 EUR/ha in the Netherlands to 19.8 EUR/ha in Estonia (Figure 2). The coefficient of variation exceeded 112.9%, decreasing only slightly compared to 2013, when it was 118.5%. The top-ranking countries (Malta, the Netherlands, Belgium, and Cyprus) achieved values above 2,300 EUR/ha, which is 3–7 times higher than countries with average profitability (Poland – 631, Germany – 616, France – 492). Simultaneously, high land profitability does not guarantee an improvement in the relative position. Examples include Italy (down two places) and Denmark (down eight). The largest advances were recorded in Croatia (+8), Portugal, and Slovenia (+6), although their levels of land profitability remained moderate (886-1024 EUR/ha). The sharp drops in Romania (–10) and Germany (–4), as well as the negative land profitability in Estonia, confirm that in some countries, land is no longer a stable source of income. In the next stage of the research, a matrix was created showing the location of individual countries depending on the level of labour and land profitability. The size of the spheres indicates the average economic size of agricultural holdings, which is a measure of a farm's production potential and expresses the sum of the standard output values of all agricultural activities present on the farm (Floriańczyk et al., p. 11) (Figure 3). Based on the data presented, it can be seen that the Netherlands and Belgium combine large production potential with very high labor and land profitability. Malta has very high land profitability, low labour profitability, and relatively small farms. It is difficult to clearly infer the relationship between farm size and profitability. Land profitability does not increase linearly with the economic size of the farms. High values of this indicator are found in countries with economically strong farms (the Netherlands) and in countries with small farms but more

intensive production (Malta, Greece, and Cyprus). There are also countries with relatively large farms that are economically large but do not achieve high labour or land profitability (Czechia, Sweden). Countries with large farm potential and high labour productivity but low land profitability can also be identified (Luxembourg, Germany, Denmark). In addition, there is a group of countries with small average economic farm sizes, which are characterised by low profitability, such as Poland, Bulgaria, Romania, Slovenia, Hungary, Croatia, Lithuania and Latvia.



Note: Country symbols - (BE) Belgium, (BG) Bulgaria, (CZ) Czechia, (DK) Denmark, (DE) Germany, (EE) Estonia, (IE) Ireland, (EL) Greece, (ES) Spain, (FR) France, (HR) Croatia, (IT) Italy, (CY) Cyprus, (LV) Latvia, (LT) Lithuania, (LU) Luxembourg, (HU) Hungary, (MT) Malta, (NL) Netherlands, (AT) Austria, (PL) Poland, (PT) Portugal, (RO) Romania, (SI) Slovenia, (SK) Slovakia, (FI) Finland, (SE) Sweden.

Figure 3. Labour and land profitability in relation to the average economic size of farms in EU member states in 2023.

Source: Own elaboration based on data from the FADN Public Database.

The next stage of the research involved examining the inertia and determinants of labour profitability on EU farms using a dynamic GMM model. The estimation of the dynamic panel model with the one-step GMM estimator revealed significant inertia in farm labour profitability in European Union countries. The model coefficients, presented in Table 1, were estimated using standardised variables, which allowed the effects to be interpreted in terms of standard deviations. The J statistic (Hansen test) was 27 with 49 degrees of freedom ($p = 0.996$), not rejecting the null hypothesis of the validity of the over-identifying restrictions, which confirms the adequacy of the chosen instruments. The second-order residual autocorrelation test (AR(2)) was not significant (statistic = 1.60, $p = 0.109$), indicating the absence of a systematic higher-order autocorrelation and validating the model's structure. The Wald test for all parameters

showed high significance ($\chi^2 = 6068.6$, df = 7, $p < 0.001$), highlighting the overall fit of the model to the data. The overall configuration of the model, with the confirmed validity of the instruments and lack of higher-order residual autocorrelation, provides a solid basis for drawing conclusions about the determinants of agricultural income in the EU, with important implications for sector development strategies.

Table 1.
GMM dynamic model coefficients, $N_{obs} = 270$

Variable	Estimates (β)	SE (robust)	Statistic z	p-value
Labour profitability (EUR/AWU) with a one-year delay	0,30	0,09	3,47	**< 0,001**
Average farm size (ha/farm)	-0,30	0,10	-2,98	**0,003**
Economic size of the farm (thousand EUR)	0,25	0,14	1,82	0,068
Technical labour equipment (EUR/AWU)	0,19	0,10	1,84	0,066
Production intensity (EUR/ha)	0,14	0,09	1,60	0,109
Employees per 100 ha of UAA (AWU/100 ha)	-0,31	0,12	-2,68	**0,007**
Investment subsidies per 1 ha of UAA (EUR/ha)	0,13	0,09	1,44	0,150

Note: SE – standard error; Coefficients were estimated using standardised variables (z-score), which means that the estimate reflects the change in job income by one standard deviation when the given explanatory variable increases by one standard deviation. A total of 56 instruments were used (36 linear from differences, 8 linear from levels, 6 controls from differences, and 6 controls from levels).

Source: Own elaboration based on the panel data.

The profitability of delayed labour exhibited a robust, positive, and highly significant correlation with current profitability ($\beta = 0.30$, $p < 0.001$), indicating clear inertia within the European Union's agricultural sector. Higher profitability in the preceding period contributes to an increase in profitability in the current period. This finding suggests that income advantages in EU agriculture are persistent and challenging to offset rapidly, thereby limiting the pace of convergence between countries and reinforcing the existing disparities. Structural factors also play a significant role. The area of agricultural land per farm demonstrated a significant negative correlation with labour profitability ($\beta = –0.30$; $p = 0.003$), implying that merely expanding the land area without appropriate technological and organizational adjustments in production may result in diminishing returns to scale and reduced labour profitability. The positive, albeit only marginally statistically significant, effect of farm economic size ($\beta = 0.25$; $p = 0.068$) and technical equipment of labour ($\beta = 0.19$; $p = 0.066$) suggest that improvements in labour profitability are primarily associated with capital-intensive modernisation and the enhancement of production potential, rather than simply increasing land or labour resources. Production intensity was not significant ($\beta = 0.14$, $p = 0.109$), which may reflect varied effects depending on farm type and national conditions. The number of employees per 100 hectares of agricultural land had a significant negative impact ($\beta = -0.31$, $p = 0.007$), indicating that excessive intensification of employment per unit of land reduces the profitability. Investment subsidies per hectare did not exhibit a significant correlation ($\beta = 0.13$, $p = 0.150$), suggesting that they did not directly translate into increased labour profitability, and their effects may be indirect or capitalised in other production factors, such as land.

4. Discussion

The results obtained confirm that the labour profitability of farms in the European Union is characterised by lasting and deepening polarisation between countries, which is consistent with the findings of other authors (Skarżyńska, Grochowska, 2021, Herman, 2025). The literature also provides evidence of significant disparities in income levels not only between the groups of old and new member states but also within the "old" EU (Czyżewski et al., 2018, p. 69; Skarżyńska, Grochowska, 2021). This study also confirmed these observations. Kryszak's (2020) research shows that while the growth rates of income between countries in the EU are converging, there is no convergence in the levels of income. The author states that the CAP has succeeded in increasing agricultural income in individual countries and reducing the gap between the income of farmers and non-farmers. However, further narrowing of the agricultural income gap between countries is a significant challenge. This is also highlighted by Finger and El Benni (2021).

Data from 2023 show that countries with high capital intensity, advanced technology, and large-scale production, such as Denmark, the Netherlands, and Belgium, not only maintain their income advantage but also strengthen it. The observed upward mobility in the rankings of France, the Czech Republic, and the Baltic states indicates that improvements in labour profitability are possible beyond the "old" EU countries but require an appropriate combination of conditions. In particular, the Czech Republic case suggests that a larger average farm size can foster growth in labour profitability, although it does not guarantee high levels of profitability (Balmann et al., 2016).

The analysis of the relationship between labour profitability, land profitability, and the economic size of farms reveals a lack of simple linear dependencies. Countries such as the Netherlands and Belgium confirm that combining large-scale production with high intensity and technological advancement enables the simultaneous achievement of high labor and land profitability. Simultaneously, Malta, Greece, and Cyprus show that relatively high land profitability can also occur in systems based on small farms, provided they are characterised by intensive, often specialised production. Skarżyńska and Grochowska (2021, p. 130) argue that the high land profitability of Maltese farms stems from high land productivity and moderately high production costs compared to other countries.

The results confirm that current labour income levels are largely determined by their values in previous periods. The positive, albeit marginally statistically significant, influence of a farm's economic size and the level of technical equipment suggests that improvements in labour profitability are more closely related to capital-intensive modernisation than to the simple expansion of land resources. This aligns with research showing that the competitiveness and income of EU farms grow mainly where economic scale is combined with technological progress and better access to capital (Kusz et al., 2022; Herman, 2025). In light of Barczak's

(2024, p. 93) results, which point to the dominant role of farm specialisation in shaping agricultural incomes, further research aimed at a deeper analysis of the mechanisms differentiating profitability within individual farm types is warranted. The validity of this approach is also supported by the findings of Kusz et al. (2022, pp. 9-15), who demonstrated the varied impact of individual determinants on the incomes of farms of different economic sizes. The conducted research showed a negative impact of the level of labour input intensity relative to UAA on the profitability of labour. This highlights the need to support structural transformations, especially in countries with unfavourable land structures and excessive employment, as frequently highlighted in the literature (Peng et al., 2024; Kołodziejczak, 2025).

5. Conclusion

The research results showed polarisation of labour and land profitability in EU agriculture, as well as a lack of simple correlations between the economic size of farms and their income. The use of the dynamic GMM model revealed significant inertia in labour income, meaning that income advantages are persistent, and changes occur gradually. The positive impact of economic size and technical equipment of labour, together with the negative effect of farm area expansion and excessive labour intensity, indicates that increases in labour income stem primarily from capital-intensive modernisation and productivity improvements rather than simply from scaling up resources.

The results suggest that further strengthening of labour income in EU agriculture requires moving away from a uniform approach focused on supporting the production scale. Selective support for modernisation processes, especially investments in technical capital and technologies that enhance labour productivity, should be of key importance, particularly in countries with persistently low income levels. The negative impact of excessive farm employment highlights the need for policies that support structural changes and modernisation. Improving income in EU agriculture does not depend on a single factor but on a coherent combination of diverse conditions. This should serve as a reference point for further research and for designing future CAP reforms. Further studies should also focus on analysing income and seeking its growth determinants with respect to different farm types. Additionally, it is worthwhile to examine the determinants of income growth separately for the groups of old and new member states.

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