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Aleksandar Miljatović * , Mirela Tomaš Simin , Veljko Vukoje

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Key Determinants of the Economic Viability of Family Farms: Evidence from Serbia

Aleksandar Miljatović *, Mirela Tomaš Simin and Veljko Vukoje

University of Novi Sad, Faculty of Agriculture, 21000 Novi Sad, Serbia

* Correspondence: aleksandar.miljatovic@polj.uns.ac.rs; Tel.: +381/21-4853-239

Abstract: Ensuring a fair income for farmers, as one of the key objectives of the Common Agricultural Policy (CAP), focuses on economic dimension of sustainable agricultural development. Achieving the economic viability of farms is often prioritized in developing countries, as the economic dimension is crucial for the farm survival in the long term. This paper aims to assess the economic viability of farms and to examine the impact of various factors on their viability. The study focuses on family farms that were part of Serbian Farm Accountancy Data Network (FADN) sample over a seven-year period from 2015 to 2021. Farm economic viability is evaluated using the opportunity cost approach. The results have shown that the highest proportion of economically viable farms was found in field crop farming. Conversely, grazing livestock farms were the least economically viable due to extensive farming methods they usually employ. Among the determinants of farm viability, the most important one was the asset turnover ratio, which positively affected the economic viability of all types of farming. The obtained results may help farm managers identify the primary obstacles to achieving optimal performance in the long run. Moreover, agricultural policymakers could improve existing measures and introduce new ones to strengthen the overall economic viability of farms.

Keywords: economic viability; sustainable agricultural development; family farms; opportunity costs; factors of production; FADN

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1. Introduction

The concept of sustainable agriculture is a key component of every major strategic document worldwide. The second of the seventeen Sustainable Development Goals (SDGs) in the 2030 Agenda for Sustainable Development is to End hunger, achieve food security and improved nutrition and promote sustainable agriculture [1]. Additionally, the Farm to Fork strategy, as part of the European Green Deal, aims to accelerate the transition to sustainable food system [2]. Achieving sustainability is not an easy process. Wiśniewska [3] (p. 120) claims that assessing sustainable development is a "complicated, long-term process, considered in an infinite time horizon". The sustainable development is commonly understood through three main pillars: (1) economic, (2) environmental and (3) social. From the farm's perspective, sustainable agriculture can be understood as producing high-quality goods and services under the economic pillar, managing natural resources responsibly under the environmental pillar, and enhancing rural dynamics under the social pillar [4].

In developing countries, the focus is primarily on economic dimension of sustainable development. The main reason is that they have not yet reached an adequate level of economic viability, preventing them from fully addressing the ecological and social dimensions. Farms, as the most important entities in agriculture, cannot survive in long term if they are not economically viable [5], meaning that they need to be capable to ensure a fair income for farmers. Fair income is one of the ten key objectives of the Common Agricultural Policy (CAP), and most European countries incorporated this goal into their agricultural strategic plans for the period 2023-2027. This is one of

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the reasons why numerous authors have recently focused their research on analyzing income viability, fair income in agriculture, and the economic viability of farms [6–12].

The economic viability of farms refers to an analytical concept that encompasses both sustainable farm incomes and adequate returns to factors of production [13]. The fair income for farmers is undoubtedly a prerequisite for the economic viability of farms, as it represents the return to one of the key factors of production – labour. In addition to labour, it is crucial to analyze the returns to the other two factors of production (capital and land) in order to evaluate overall economic viability of farms. The economic literature distinguishes between short- and long-term economic viability [6,11,14], with the long-term viability being the only comprehensive one. Long-term viability encompasses all factors of production, making it a measure of overall economic viability.

Family farms are the predominant business entities engaged in agricultural production globally [15,16], including most European countries [17,18]. Their roll is crucial in improving living standards in rural areas, where agriculture remains the leading industry. The main characteristic of family farms is that they typically rely on their own factors of production (land, labour, and capital), making them as an implicit costs for the farm. This is why an opportunity cost approach [8,19] is commonly used to determine whether investing the own factors of production in agriculture is economically justified, or to assess the overall economic viability of family farms. In addition to farm viability analysis, it is equally important to explore the determinants of economic viability [6,9,14,20]. By analyzing the main internal and external factors, it can be concluded what the primary obstacles are to achieving the highest possible level of economic viability on a farm.

The paper aims to assess economic viability level of family farms and to examine the impact of various internal and external factors on their economic viability. The structure of the paper is as follows. The first part provides the theoretical background of the assessing economic viability issue and identifying potential viability determinants in the economic literature. The next section describes the materials used and the research methodology applied. The main section presents the empirical findings, followed by the discussion. As the final part, the main conclusions and limitations of the research are outlined.

2. Theoretical Background

In the literature, two closely related terms are often mentioned in the context of the economic dimension of sustainable agricultural development: economic viability and economic sustainability. Economic viability of farms refers to their ability to generate sufficient net income from farm operations to cover the opportunity costs of their own factors of production. Economic sustainability, on the other hand, refers to the total disposable income, which includes income from both farm operations and off-farm sources. This makes economic sustainability a measure of the long-term viability of the farm [21].

In the European studies, the focus is primarily on the economic viability of farms. The main reason is the lack of data on farm household income as a whole in the FADN system [8], which serves as the main database for this type of research. In the USA and Canada, the focus is more on economic sustainability, as researchers use specially designed questionnaires for data collection. This approach is known in the literature as a household welfare measure [19].

Economic viability has been defined numerous times in the economic literature, but all definitions share a common idea that viable farms are those capable of generating adequate returns to the factors of production they utilise. This is an opportunity cost approach, which is based on ensuring an adequate standard of living for farm employees. The main question is what means an adequate standard of living, or in other words, what makes the viability threshold. In the case of short-term viability, the threshold is the reference wage that family members or unpaid labour could earn by working off the farm. In long-term viability, the threshold is defined as a reference income that accounts for the total opportunity costs of all factors of production (labour, capital and land) used on the farm.

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The opportunity cost of labour quantifies the best alternative wages that could be earned by the unpaid labour, including the owner or farm manager, family members and other unpaid workers. It represents the reference wage that serves as the viability threshold in calculating short-term economic viability. There are varying opinions in the literature regarding the most appropriate measure for the best alternative wage. The most common approaches are:

1. the minimum wage,
2. the average wage in agriculture and
3. the average wage in national economy.

The use of the minimum wage as a reference can be justified by the fact that agricultural activities often involve elderly and low-qualified workers, who typically face challenges when searching for employment in other, higher-paying sectors [13,14,22]. The average wage in agriculture can also serve as a possible reference wage, considering that farmers typically have a low opportunity cost and working in agriculture is often the best alternative to working at their own farm [23]. The average wage is calculated by dividing total labour cost by the paid labour input, then taking the average value for a specific region or country [7,24,25]. The main shortcoming of aforementioned two approaches is that they may discriminate against agricultural workers and set a very low threshold, which is likely insufficient to ensure an adequate standard of living for the farm manager and family members, which is the key requirement for achieving economic viability. Hence, the third approach uses the average wage in national economy, aiming to address the deficiencies of the first two. The average wage in national economy definitely ensures the best possible alternative wage for unpaid labour [10,11,19,26], without any limitations related to age or qualifications of the farmer. This is particularly relevant because many farmers are highly skilled and qualified for sectors other than agriculture, yet they continue farming for various reasons.

The opportunity cost of capital refers to the best alternative use of the capital invested in agricultural production. In the literature, two main approaches for determining the best alternative are highlighted. According to the first approach, average interest rates calculated based on long-term bonds are used [10,20,27,28]. In the second approach, a reference rate of return of 5% is applied [7,13,14,22], which is typical for countries with underdeveloped financial markets.

When calculating the opportunity cost of capital, an important consideration is how to account for the value of agricultural land. The opportunity cost of land can be evaluated either together with the opportunity cost of capital or separately. In the latter case, the opportunity cost of capital is calculated excluding the land value and focusing instead on the opportunity cost of non-land capital. As a result, the opportunity cost of land is evaluated separately, representing the best alternative use of land allocated to agricultural production. The best alternative use is to rent out the land and earn income through land rent. The question is what return rate should be used, and the answer would be the rate that is appropriate for the specific region. Hence, the land rent should be calculated based on the average rent for the region where the specific farm is located [6,7,12].

The economic viability of farms can be influenced by a variety of internal and external factors. According to the literature, these factors can be categorized into the following groups: basic farm characteristics, socio-demographic characteristics of farm manager, economic characteristics of the farm, risk management and agricultural policy measures.

The economic size of a farm is usually measured based on total income value, total utilised agricultural area, standard output value, etc. Farm size is very important factor that generally has a positive impact on farm viability, as larger and more powerful farms tend to achieve higher levels of economic viability [6,24,28]. The share of rented land, as also one of the basic characteristics of the farm, could have either a negative or positive impact on farm viability. It is believed that a lower share of rented or higher share of owned land provides security to the farm manager, allowing for greater certainty in planning and organizing the production process, including the sowing structure and other activities [29,30]. On the other hand, Barnes et al. [14] state that a higher share of rented land can help a farm achieve an optimal size, which in turn leads to an increased productivity. There are different opinions on the impact of the share of paid labour on farm's economic viability, with

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motivation being the key influencing factor. The higher share of unpaid labour (family members work) reduces labour costs which can positively affect farm viability [9]. Also, their vested interest in the farm's success drives better performance and business development. Conversely, a higher share of paid labour can positively impact farm performance, as paid workers may be more efficient due to the financial benefits they got through the salaries [20].

One of the most commonly used socio-demographic factors is the farmer's age. The age of farm manager often has a negative impact on farm performance, as older farmers are typically less inclined to accept and adapt to market changes, innovations, or take on unnecessary business risks [31]. Younger farmer, on the other hand, tend to embrace new technologies and innovations that can enhance farm performance and, consequently, the level of farm viability [32]. The asset turnover ratio is the key economic characteristic of the farm. This factor positively impacts farm performance, meaning that farms with faster asset turnover tend to have a higher level of economic viability [6,20].

In terms of risk management, income diversification should be considered. Previously, a distinction should be made between agricultural and farm diversification [14]. Agricultural diversification refers to the proportion of the value of a single production line in relation to the total value of agricultural production. On the other hand, farm diversification includes other gainful activities, such as: contracting work, agritourism, processing agricultural products etc. The share of income from other gainful activities in total income represents farm diversification. The impact of diversification on farm viability can be both positive and negative. Some authors claim that diversification has a positive impact because a more diversified production help reduce the risk of failure [9,33]. Conversely, the negative impact of diversification can be attributed to the fact that farmers engaged in multiple activities may have less time to focus on improving farm performance [34].

In addition to the previously mentioned internal factor, it is also important to consider the impact of the subsidy level. It is a policy instrument beyond the control of farm managers, making it an external factor influencing farm viability. A higher share of subsidies in total income can impact economic viability either positively or negatively [9]. The positive impact is linked to the fact that incentives provide stability and certainty in planning future production [35–37], while the negative impact indicates the inefficiency of subsidies, which is particularly recognized in smaller farms [38].

3. Materials and Methods

The analysis was based on data from farms in the Republic of Serbia (RS) that were part of the FADN sample from 2015 to 2021. Specifically, it concerns family farms that were included in the FADN database throughout the entire seven-year period. The total number of analyzed farms, after eliminating observations with extreme values and missing data, was 527.

Farms were divided according to type of farming (TF) into: (1) specialist field crops, (2) specialist permanent crops (vineyards and fruits), (3) specialist milk, (4) specialist grazing livestock (other than milk – cattle, sheep and goats) and (5) mixed. These are dominant types of farming in RS, accounting for approximately 96% of all commercial farms, i.e., those with a standard output (SO) value exceeding 4,000 euros [39]. Compared to the official TF8 classification based on European Union (EU) regulations [40], the specialist horticulture and granivores types of farming were excluded. The main reason for this, aside from the low share, is the specific nature of the production process [41] which gives these types of farming an advantage over others with a significantly lower asset turnover ratio.

Economic viability of farms is assessed using the opportunity cost approach. The focus is on long-term economic viability (LTEV), as it represents the only true measure of economic viability that accounts for the opportunity costs of the three crucial factors of production in agriculture: labour, capital and land. The formula for calculating the economic viability of farms is as follows:

$$\mathrm{LTEV} = \frac{\mathrm{FNI}}{\mathrm{TOC}} \tag{1}$$

where FNI is the value of farm net income and TOC is total opportunity costs.

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Economically viable farms have an LTEV coefficient equal to or greater than 1, indicating their ability to efficiently utilise their own resources. In other words, these farms generate higher income from agricultural production than they would by allocating their factors of production to alternative uses. Total opportunity costs represent the sum of opportunity cost of labour, opportunity cost of non-land capital and opportunity cost of land. The opportunity cost of labour is the product of reference wage and unpaid labour input. The reference wage is average gross wage in national economy for the specific region (administrative district). The gross value is used because the wages paid in FADN is also calculated as gross values. The opportunity cost of non-land capital is the product of total equity (excluding the value of agricultural land) and the 5% rate of return [22,42]. The agricultural land is specific in comparison with other farm assets, which is why the opportunity cost of land is separately estimated as the product of farm's own land and the average land rental fees for the specific region [6].

The economic viability of farms was also examined in the context of various factors that may influence it. In this paper, the following internal and external factors were analyzed: (1) economic size (ES), (2) share of rented land (SRL), (3) share of paid labour (SPL), (4) farmer's age (AGE), (5) asset turnover ratio (ATR), (6) agricultural diversification (DIV) and (7) subsidy level (SUB). The factors and the formulas used for their calculations are presented in Table 1.

Table 1. Overview of variables used in analysis.

Variable	Symbol	Unit of measure	Formula
Economic size	ES	standard output	$SO_y{}^1 = \sum_{i=1}^{n} \bar{v}_{yi} \times u_{yi}$
Share of rented land	SRL	ratio	$\frac{\text{Rented utilised agricultural area (ha)}}{\text{Total utilised agricultural area (ha)}}$
Share of paid labour	SPL	ratio	$\frac{\text{Paid labour input (h)}}{\text{Labour input (h)}}$
Farmer's age	AGE	years	Age of farm manager
Asset turnover ratio	ATR	ratio	$\frac{\text{Total output}}{\text{Total assets}}$
Agricultural diversification	DIV	Herfindahl-Hirschman index	$HHI^2 = 1 - \sum_{i=1}^{n} s_i^2$
Subsidy level	SUB	ratio	$\frac{\text{Total subsidies} - \text{excluding on investments}}{\text{Total income value}}$

[1] SO_y is the value of standard output in a year y; n is number of primary and secondary products in a year y; $\bar{v}_{yi}$ is standard output coefficient for product i in a year y; u_{yi} is the area under specific crop i in crop production or number of livestock units i in livestock production in a year y. [2] s_i is the share of the production value of product i in the total production value. The HHI value ranges from 0, indicating specialized farms that generate income from a single type of production, to 1, representing farms with a more diversified production structure. Source: author's illustration.

The impact of the previously mentioned factors (independent variables) on economic viability (dependent variable) was analyzed using panel regression analysis. Panel data models combine cross-sectional and time series data [43], a combination used in this research, which is why this model is suitable for analyzing factors that may influence farm viability. In its general form, the linear regression model for panel data can be expressed through the following function:

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$$Y_{it} = \beta_{it} + \sum_{k=2}^{K} \beta_{kit} X_{kit} + u_{it}, i = 1, \dots, N; t = 1, \dots, T; k = 1, \dots K \quad (2)$$

where Y_{it} is the value of the dependent variable for the i unit of observation in period t; X_{kit} is the value of the k independent variable for the i unit of observation in period t; β_{kit} represents the value of unknown regression parameters that are variable by observation unit i and period t; u_{it} is the random error, which has an arithmetic mean equal to one and a constant common variance for each i and t.

Before selecting the final specification of the model, the stationarity of a time series should be determined using unit root tests. Only stationary time series can be included in panel regression analysis, while non-stationary series must be transformed before inclusion. If the time series is relatively short, unit root tests tend to have low power and may produce unreliable results [44]. Because of this, in research involving short time series and a large number of cross-sectional units, like the study presented in this paper, stationarity can be assumed. In that case, the large number of cross-sectional units can help mitigate potential non-stationarity issues [45].

To select the final specification of the model, it is essential to test for the presence of individual and time effects. In the fixed effects model specification, an F-test was applied to test for individual and time effects, while in the random effects specification, the Breusch-Pagan LM test was used. The nature of potential individual (and time) effects was determined using the Hausman test, which enabled the choice between the fixed and random effects model specification.

The next step in the analysis is to check for multicollinearity using the Variance Inflation Factor (VIF) test and the Tolerance (TOL) test, which represents the reciprocal of VIF. Next, the basic assumptions of the model need to be examined, including testing for autocorrelation, heteroskedasticity and cross-sectional dependence. Autocorrelation was tested using the Wooldridge test, where the null hypothesis stating the absence of first-order autocorrelation. Heteroskedasticity occurs when the random error in the model is correlated with one or more independent variables. It was tested by applying the White test. Cross-sectional dependence can lead to biased and inconsistent results when evaluating classical models, making it essential to test for its presence using the Pesaran CD test. Finally, if any of the three assumptions mentioned above are violated, the initial model must be transformed.

Based on the selected variables that may affect farm viability, the model can be specified as follows:

$$LTEV_{it} = \beta_{it} + \beta_1 ES + \beta_2 SRL + \beta_3 SPL + \beta_4 AGE + \beta_5 ATR + \beta_6 DIV + \beta_7 SUB + u_{it} \quad (3)$$

where i is the unit of observation - the farm (i = 1, 2, …, 527); t is the each year (t = 1, 2, …, 7); u is the random error.

4. Results and Discussion

4.1. Analysis of the Farm Economic Viability

The long-term economic viability (LTEV) indicator, as a measure of overall farm viability, showed positive values throughout the observed period. The average coefficient exceeds one across all types of farming, indicating that farms can cover the opportunity costs of production factors from their net income (Table 2). As expected, the obtained results differ among various types of farming. The LTEV indicator is highest for field crop farms (2.91), and lowest for grazing livestock farms (1.03). Overall, livestock farms exhibit lower average coefficients of economic viability compared to crop production farms. This corresponds to findings in a Czech study [7].

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Table 2. Descriptive statistics of the LTEV indicator for various types of farming.

Descriptive statistics	Field crops	Permanent crops	Milk	Grazing livestock	Mixed
Mean	2.91	2.49	1.60	1.03	1.30
Median	1.59	1.44	0.96	0.68	0.85
Lower Quartile	0.37	0.49	0.50	0.16	0.36
Upper Quartile	4.16	3.39	1.75	1.40	1.82
Standard Deviation	5.35	3.88	2.44	2.03	1.53
n	254	48	103	56	66
T	7	7	7	7	7
N	1778	336	721	392	462

Source: author's calculation.

The median values of the observed indicator are expectedly lower, reflecting the significantly reduced level of economic viability among farms in the Republic of Serbia. The situation is particularly problematic in milk, mixed and grazing livestock farms, where the median coefficient value is below one. The most endangered definitely are grazing livestock farms, which is in line with Hloušková et al. [12]. They not only exhibit the lowest average and median economic viability coefficients, but they also consistently recorded a share of economically viable farms below 50% (Figure 1). In all observed years, the share of economically viable grazing livestock farms was the lowest, except in 2016, when mixed farms took on this role. Although, there are a noticeable number of farms with very promising prospects, the obtained results clearly indicate that the majority of grazing livestock farms faces serious challenges in achieving economic viability. On the other hand, field crop farms generally recorded the highest share of economic viability, with the exception of 2015 and 2017. They were followed by permanent crop farms, which also exhibit the second-highest average economic viability coefficient among the remaining types of farming.

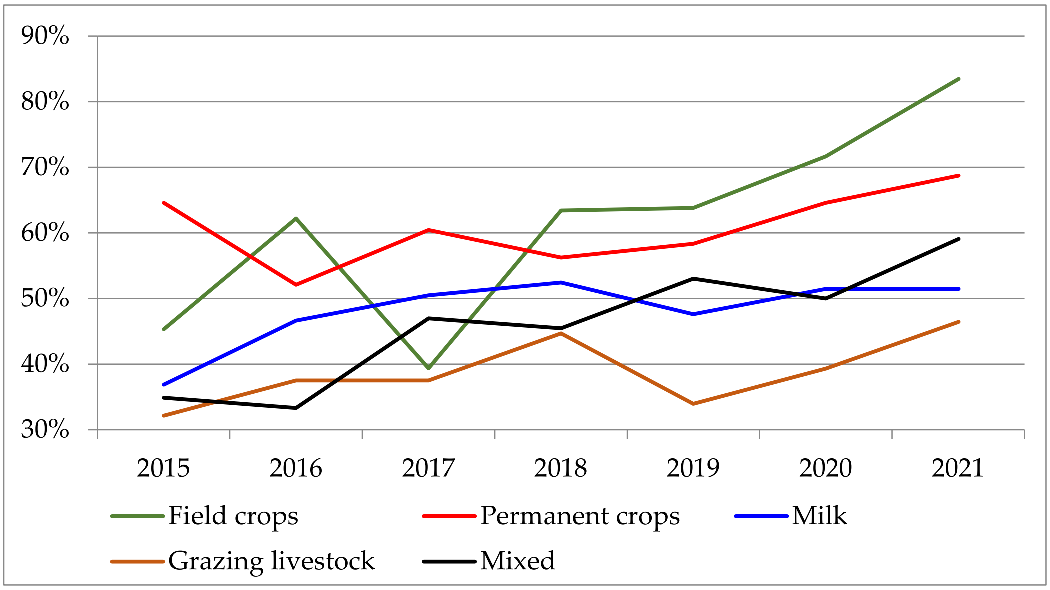

Figure 1. Share of economically viable farms during the period 2015-2021. Source: author's calculation. .

In order to accurately assess the economic viability of farms and vulnerability of those that are not economically viable, the farms were divided into two categories: (1) economically viable – farms with an LTEV coefficient equal to or greater than one and (2) economically non-viable –farms with an LTEV coefficient less than one (Table 3). The proportion of economically viable farms is favorable,

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with 54.38% of the total observed farms being economically viable. The recorded LTEV coefficient of 4.15 in this category of farms is also beneficial, indicating promising prospects for the farms in general. The highest percentage of economically viable farms is recorded in field crop farming (61.30%), closely followed by permanent crop farming (60.71%). These two types of farming also achieve the highest LTEV coefficients within the category of economically viable farms.

Table 3. Categories of farms according to economic viability by type of farming.

Type of farming	Economically viable farms		Economically non-viable farms	
	Share (%)	LTEV (coeff)	Share (%)	LTEV (coeff)
Field crops	61.30	5.10	38.70	-0.56
Permanent crops	60.71	4.24	39.29	-0.21
Milk	48.13	2.82	51.87	0.47
Grazing livestock	38.78	2.59	61.22	0.04
Mixed	46.10	2.47	53.90	0.31
Total	54.38	4.15	45.62	-0.09

Source: author's calculation.

On the other hand, grazing livestock farming recorded the lowest share of economically viable farms (38.78%), as expected. In the category of economically non-viable grazing livestock farms, the average LTEV coefficient is also extremely low, at just 0.04. This indicates that grazing livestock farms are the most endangered, as they are the farthest from the viability threshold among all observed types of farming. Grazing livestock farms are generally extensive farms, often located in areas with natural constraints. These farms are usually managed by elderly farmers who have never worked outside of agriculture. The reason is primarily that they are not capable of doing anything else due to their low qualifications. However, an equally important factor is the agricultural tradition they maintain. The emotional connection to the work they do is undoubtedly a key reason preventing them from leaving agriculture, even though they may not achieve the best economic viability outcomes. Nevertheless, the continuation of their activity is crucial for the development of the remote rural areas [12], where these farms are dominant.

4.2. Exploring the Factors Affecting Farm Economic Viability

In order to examine the relationship between variables in the model, the Pearson correlation coefficient is applied. Due to the extensive data, the results are presented in the appendix (Table A1, Appendix A). The results indicate that the observed variables can be used in panel regression analysis, as only insignificant or weak correlations are recorded. A strong relationship is noticed only between the economic viability coefficient and economic size in milk farms, with a correlation coefficient of 0.7030. However, this result suggests a potential reverse causality [46], meaning that the dependent variable (LTEV) might influence the independent variable (ES) in the model. According to the reviewed literature, no research analyzes the impact of the economic viability coefficient on the economic size of farms. The opposite influence of economic size on the farm viability is often observed in the analysis [6,24,28] and is considered relevant.

The first step in panel regression analysis is to select the appropriate model among the Ordinary Least Squares (OLS), fixed effects model and random effects model. The OLS model is unbiased and efficient when individual and/or time effects do not exist, making it essential to test for their presence. The existence of individual and time effects was tested using the F-test for fixed specification of the model. The results confirmed the presence of individual effects in all types of farming, as the p value is less than 0.05 (Table 4). On the other hand, the presence of time effects is recorded only in field crop and permanent crop farms ($p<0.05$).

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Table 4. Results of testing for the presence of individual and time effects for fixed effects model specification.

F Test	Field crops		Permanent crops		Milk		Grazing livestock		Mixed	
	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value
Individual effect	5.66	0.0000	4.55	0.0000	6.12	0.0000	9.85	0.0000	7.46	0.0000
Time effect	11.51	0.0000	4.50	0.0002	0.34	0.9156	1.13	0.3446	1.12	0.3504

Source: author's calculation.

In the random effects model specification, the existence of individual and time effects was examined using the Breusch-Pagan LM test. Based on the test results, individual effects are found in all types of farming, since the p value is less than 0.05 (Table 5). Conversely, the presence of time effects is confirmed only in field crop and permanent crop farms ($p<0.05$).

Table 5. Results of testing for the presence of individual and time effects for random effects model specification.

Breusch-Pagan LM test	Field crops		Permanent crops		Milk		Grazing livestock		Mixed	
	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value
Individual effect	758.81	0.0000	72.66	0.0000	361.40	0.0000	245.16	0.0000	276.87	0.0000
Time effect	231.24	0.0000	11.36	0.0008	1.81	0.1785	0.01	0.9371	0.07	0.7940

Source: author's calculation.

The confirmed presence of individual (and time) effects in all types of farming clearly indicates that OLS is not an adequate model to use. Therefore, it is necessary to use a model with individual and time effects for field crop and permanent crop farms, and a model with individual effects for milk, grazing livestock and mixed farms. The next step in selecting the final specification of the model is to determine the nature of the effects, i.e., to choose between the model with fixed and random effects. For this purpose, the Hausman test was applied, with the null hypothesis assuming the appropriateness of the random effects model. Since the p value is less than 0.05 in all types of farming except milk farms, the null hypothesis is rejected (Table 6), indicating that for field crop, permanent crop, grazing livestock and mixed types of farming, the fixed effects model should be used. The exception is milk farms, where the null hypothesis is accepted ($p>0.05$), suggesting that the random effects model specification is more appropriate.

Table 6. Results of Hausman's test for panel regression model specification.

Test	Field crops		Permanent crops		Milk		Grazing livestock		Mixed	
	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value
Hausman test	38.04	0.0000	35.60	0.0000	10.19	0.1780	45.25	0.0000	16.76	0.0190

Source: author's calculation.

After selecting the model specification, it is necessary to examine the basic assumptions for applying panel regression analysis. Regarding this, it is crucial to access the presence of multicollinearity. The test results indicate that the VIF values do not exceed 5, and the TOL values

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are not lower than 0.2 (Table 7). This clearly confirms that there is no harmful multicollinearity in the observed models.

Table 7. Results of testing for the presence of multicollinearity.

Variable	Field crops		Permanent crops		Milk		Grazing livestock		Mixed	
	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF	VIF	1/VIF
ES	1.24	0.81	1.09	0.92	1.22	0.82	1.28	0.78	1.43	0.70
SRL	1.28	0.78	1.07	0.93	1.39	0.72	1.45	0.69	1.43	0.70
SPL	1.02	0.98	1.05	0.95	1.07	0.93	1.14	0.88	1.05	0.95
AGE	1.08	0.93	1.11	0.90	1.06	0.94	1.14	0.88	1.19	0.84
ATR	1.14	0.88	1.03	0.97	1.51	0.66	1.20	0.83	1.17	0.86
DIV	1.02	0.98	1.04	0.97	1.14	0.88	1.05	0.95	1.44	0.69
SUB	1.18	0.84	1.03	0.97	1.14	0.88	1.10	0.91	1.13	0.88

Source: author's calculation.

Finally, the models were tested for the presence of autocorrelation, heteroskedasticity and cross-sectional dependence (Table 8). The presence of autocorrelation was tested using the Wooldridge test, and the results confirm the existence of first-order autocorrelation in the models of permanent crop, milk and mixed farms ($p<0.05$). In the models of field crop and grazing livestock farms, the null hypothesis is accepted ($p>0.05$), indicating the absence of first-order autocorrelation. The existence of heteroskedasticity was tested using the White test. Since the p value is less than 0.05 in all types of farming, the null hypothesis is rejected, indicating that heteroskedasticity is present in the models of all types of farming. Finally, the Pesaran CD test was applied to test for the presence of cross-sectional dependence in the models. The results indicate that there is interdependence in the models of field crop, milk and mixed farms ($p<0.05$), while in the models of permanent crop and grazing livestock farms, cross-sectional dependence is not confirmed ($p>0.05$).

Table 8. Autocorrelation, heteroskedasticity and cross-sectional dependence test results.

Test	Field crops		Permanent crops		Milk		Grazing livestock		Mixed	
	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value	Test statistic	*p* Value
Wooldridge test [1]	0.90	0.3418	4.17	0.0422	186.36	0.0000	2.44	0.1189	24.39	0.0000
White test	65.39	0.0000	50.36	0.0000	347.00	0.0000	57.59	0.0000	43.00	0.0000
Pesaran CD test	39.11	0.0000	1.85	0.0647	21.51	0.0000	-0.29	0.7704	6.67	0.0000

[1] In milk type of farming, the Breusch-Godfrey/Wooldridge test was used to assess the presence of first-order autocorrelation, as the classical Wooldridge test is not applicable to the random effects model. Source: author's calculation.

Considering that at least one basic assumption is violated, an alternative specification of the panel regression model with corrected standard errors (PCSE) was used in the research[1]. As far as the results of the previous tests have shown, the fixed effects model specification is the most reliable

[1] The tested OLS, fixed effects model and random effects model, as necessary steps in panel regression analysis, are presented in the appendix (Table A2, A3 and A4, Appendix).

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for use in all types of farming, except for milk farms. Following this, the results of the alternative panel model with fixed individual (and time) effects for field crop, permanent crop, grazing livestock and mixed farms are presented in Table 9. In milk farms, on the other hand, an alternative panel model with random individual effects was applied.

Table 9. Results of the evaluation of the transformed regression model.

Variable	Field crops	Permanent crops	Milk	Grazing livestock	Mixed
Constant	-1.2636	2.3521	-0.6175	-2.8354***	1.2159
	(3.4474)	(1.7650)	(0.6240)	(1.0529)	(1.1316)
ES	4.5639**	-1.3254	10.5597***	6.5013***	5.1540***
	(2.2582)	(2.3708)	(1.5051)	(1.8623)	(1.5541)
SRL	-2.6308	4.4458	-0.3663	-0.2021	-0.6390*
	(2.4846)	(5.0377)	(0.3406)	(1.0940)	(0.3628)
SPL	-0.9284	5.1437*	0.4472	-0.4962	0.0163
	(0.9078)	(2.7556)	(0.5458)	(0.4894)	(0.7220)
AGE	0.0607	-0.0306	-0.0073	0.0091	-0.0367**
	(0.0615)	(0.0316)	(0.0105)	(0.0105)	(0.0177)
ATR	4.1708***	4.0056***	0.7686**	6.2728***	3.9857***
	(0.7137)	(1.0000)	(0.3905)	(0.6777)	(0.3387)
DIV	-2.8316***	-1.0874	-0.0022	0.1170	-0.1882
	(0.8533)	(1.9319)	(0.5877)	(0.8666)	(0.5671)
SUB	-4.5810	-3.0151	0.9453	0.6202	-0.8482
	(6.2941)	(1.9005)	(1.0682)	(0.6254)	(1.1021)
N	1778	336	721	392	462
F-test/Wald chi²	13.9421***	3.1201***	114.3600***	23.0068***	68.8806***
R^2	0.1280	0.1621	0.3256	0.3846	0.4179

Notes: Standard errors are presented in parenthesis. *** level of significance 1%; ** level of significance 5%; * level of significance 10%. Source: author's calculation.

The research results indicate that economic size has a statistically significant positive impact on economic viability in all types of farming, except for permanent crops (Table 9). This is expected, as larger farms are better equipped with machinery and other technical resources. They also have larger land and livestock capacities, as well as newer and more modern buildings for storing finished crop products and housing livestock. That is precisely why these farms are generally characterized by higher labour productivity and production efficiency, enabling them to generate higher incomes and, consequently, achieve a greater level of economic viability [6,12,28,29,47,48]. Conversely, economic size does not have a statistically significant impact on the economic viability of permanent crop farms, which is in line with the findings of Ziętara and Sobierajewska [27] based on research of fruit farms in selected Eastern and Western European countries.

Unlike economic size, the share of rented land and share of paid labour significantly impact economic viability only in one specific type of farming. The share of rented land has a statistically significant negative impact on the economic viability of mixed farms. A higher share of rented land increases the level of uncertainty in the organization and planning of production, particularly in crop farms [29]. They cannot make long-term production plans or plant perennial crops, which directly

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impacts livestock production as well. For this very reason, mixed farms, which are involved in both crop and livestock production, are most negatively affected by a high share of rented land. Vira et al. [30] go even further and claim that a high share of rented land can lead producers to quit agriculture, particularly in the case of small-scale agricultural producers. The share of paid labour, similarly, has statistically significant positive impact only in permanent crop farms. These farms are highly dependent on paid labour, as the nature of the business requires the engagement of a large number of workers during specific, short time intervals. This, of course, cannot be accomplished solely with unpaid labour input. Therefore, the motivation of paid labour [20] and job quality play a crucial role, directly influencing the results achieved in permanent crop farming. Paid labours are specialized in the tasks they perform [49] and, as a rule, achieve higher labour productivity compared to unpaid labour, which typically consists of family members [50,51]. Finally, employing paid labour also entails higher labour costs, but at the same time, it enables farms to generate significantly higher incomes, ultimately leading to a higher level of economic viability.

The farmer's age has a statistically significant negative impact on the economic viability only of mixed farms, at the 5% level. The negative impact of the farmer's age is expected, considering that older farm managers are usually less willing to innovate and make significant changes to the production process. They generally have less energy, find it more difficult to adapt to new technology, and are less willing to increase the intensity of agricultural land use [52,53]. Unlike older farmers, younger farm managers are well-educated and adapt more quickly and easily to market changes [31]. They consistently stay informed about the latest legal regulations [37], agricultural competitions and generally keep up to date with important information relevant to agricultural production.

The asset turnover ratio is the only variable that has a statistically significant impact on the economic viability of all types of farming. It has a positive and highly statistically significant impact at the 1% level, except in the model for milk farms, where the level of significance is 5%. The results indicate that farms with a higher asset turnover ratio achieve higher economic viability coefficients, which is consistent with research conducted by numerous authors [20,47,54,55]. A faster turnover of assets logically indicates a shorter production cycle, meaning a higher intensity of production. This allows for better capacity utilisation and the generation of higher incomes, which consequently leads to a greater level of economic viability of farms.

Further, agricultural diversification has a statistically significant negative impact on the economic viability of field crop farms at the 1% level. Employees on diversified farms must invest significantly more time and effort in performing various tasks on the farm [34]. Unlike them, workers on specialized farms can achieve better results as they are trained for just one or a small group of specific tasks. Accordingly, greater farm diversification could lead to a decrease in efficiency or labour productivity [50] and, ultimately, a reduction in economic viability level. This is particularly characteristic of farms engaged in crop production [56], as is the case with field crop farms. These farms often lack adequate mechanization and other necessary equipment, as well as sufficient labour input to efficiently perform the various tasks required for diverse crop cultivation.

Finally, the subsidy level does not emerge as a variable with a statistically significant impact on the economic viability of farms. It is important to emphasize that only current operations related to production are included here, while subsidies on investments are not. The insignificant effect of subsidies on farm viability is also recognized in Scottish farms [14], which imply the long-term resilience of farms in relation to public support. Slijper et al. [9] take it a step further, arguing that farms receiving more direct payments have a lower probability of being economically viable in the long term. The main reason is that a higher share of subsidies in total income could indicate subsidy inefficiency.

5. Conclusions

Assessing the economic viability of farms is highly relevant analysis, given the essential role of the economic pillar in the sustainable development of agriculture, especially in developing countries.

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An opportunity cost approach is frequently used to measure the economic viability of farms in Europe, offering a way to evaluate the returns to production factors employed in agriculture (labour, land and capital). The primary objective is to ensure that employees in agriculture can meet their basic living needs or maintain an adequate standard of living. In the long-term, the returns to other two factors (land and capital) are also evaluated, making it a comprehensive economic viability analysis.

Our findings indicate that 54.38% of the observed farms in the Republic of Serbia are economically viable. These farms are viable in the long term, meaning that they are capable of earning an adequate return to the factors of production available to them, with an emphasis on ensuring a sufficient living standard for the unpaid labour input (including the farm manager, family members and other unpaid workers). The proportion of economically viable farms varies according to the type of farming. Field crop and permanent crop types of farming exhibit the highest percentage of economically viable farms and the largest economic viability coefficients, meaning that these types generate the highest return rates among all observed farms. On the other hand, milk, mixed and especially grazing livestock farms achieve significantly lower results, indicating that these are the least viable types of farming in RS.

The grazing livestock farms, as obviously the most endangered type of farming, are largely extensive farms and primarily located in remote rural areas. These extensive farms are typically managed by elderly farmers with low qualifications who have been engaged in agricultural production for an extended period. Such farmers are not willing to leave agriculture, even if they do not achieve the best results. The reasons they remain in agricultural production are numerous, but the most significant are the difficulty of finding employment outside their own farm due to low qualifications and the very limited opportunities in these areas for anything other than agriculture.

In terms of the determinants of farm economic viability, based on the conducted panel regression analysis, two factors stand out in particular: the asset turnover ratio and economic size. The asset turnover ratio has a positive impact on the economic viability of all types of farming, as expected. Namely, a faster asset turnover is characteristic of more intensive production with shorter production cycles, which consequently contributes to generating higher incomes. Economic size also positively impacts the economic viability of all types of farming, except for permanent crop farms. Farms with access to significant capacities such as: land, mechanization, buildings etc, have greater potential to generate higher incomes and achieve a higher level of economic viability. For this reason, it is crucial for farm managers to recognize the importance of these and any other analyzed factors to improve the overall situation on their farms.

Besides farm managers, the comprehensive analysis of farm economic viability can also be valuable to various stakeholders in agriculture, including policymakers responsible for agricultural measures, agricultural advisory services, bank and other financial institutions, insurance companies, and others. The research, of course, has certain limitations that should be taken into account when interpreting the obtained results. First, the analysis is based on data from farms in the Republic of Serbia, so a recommendation for future research could be to conduct a similar analysis for a few European Union countries or for a specific region in Europe (e.g., Eastern European or Western Balkan countries). In that case, a potential challenge could be the lack of adequate original data required for the analysis. Secondly, the paper does not cover all potential factors that may have influence the economic viability of farms, as the available FADN database lacks sufficient socio-demographic, ecological and off-farm income data. A potential solution to this problem could lie in the announced conversion of the FADN into the FSDN (Farm Sustainability Data Network), which will include numerous new data from the aforementioned fields. Thus, the inclusion of significantly broader range of indicators could be possible, which may certainly be the focus of future research studies.

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data curation, A.M. and V.V.; writing—original draft preparation, A.M.; writing—review and editing, M.T.S. and V.V.; visualization, A.M.; supervision, M.T.S. and V.V.; project administration, A.M. and M.T.S.; funding acquisition, M.T.S. All authors have read and agreed to the published version of the manuscript.

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Appendix A

Table A1. Correlation matrix results.

Variable	LTEV	ES	SRL	SPL	AGE	ATR	DIV	SUB
				Field crops				
LTEV	1							
ES	0.3590	1						
SRL	0.1590	0.3490	1					
SPL	0.0090	-0.0540	0.0390	1				
AGE	-0.1150	-0.1580	-0.2410	0.0160	1			
ATR	0.2130	0.1120	0.2760	0.1030	-0.1630	1		
DIV	0.0550	0.0700	0.0850	0.0630	-0.0240	0.0780	1	
SUB	-0.1750	-0.3240	-0.2560	-0.0410	0.0790	-0.2220	-0.0860	1
				Permanent crops				
LTEV	1							
ES	0.2610	1						
SRL	0.0940	0.1220	1					
SPL	-0.0380	-0.0130	0.2010	1				
AGE	-0.0510	-0.2130	0.0530	-0.0400	1			
ATR	0.3270	0.0160	0.0220	-0.0110	0.1180	1		
DIV	-0.0580	-0.0900	-0.0070	0.0010	-0.1270	0.0360	1	
SUB	-0.1180	0.0510	-0.0460	-0.0500	-0.0890	-0.1160	-0.0100	1
				Milk				
LTEV	1							
ES	0.7030	1						
SRL	0.1830	0.3140	1					
SPL	0.0310	0.0110	-0.2080	1				
AGE	-0.1720	-0.2020	-0.0610	0.0620	1			
ATR	0.2280	0.3000	0.4470	-0.1190	-0.1300	1		
DIV	0.0760	0.0690	0.0470	0.0310	0.0490	-0.2060	1	
SUB	-0.0130	-0.0650	-0.1370	0.1320	0.0850	-0.2600	-0.1430	1

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				Grazing livestock				
LTEV	1							
ES	0.3630	1						
SRL	0.1700	0.4180	1					
SPL	-0.0360	-0.0220	0.2180	1				
AGE	-0.0130	-0.0450	-0.0910	0.2140	1			
ATR	0.3560	0.2540	0.3490	0.0150	-0.0100	1		
DIV	-0.1250	-0.0810	0.0570	0.0420	-0.1200	-0.0610	1	
SUB	0.0310	0.0540	-0.0790	-0.0210	0.2070	-0.1500	-0.1350	1
				Mixed				
LTEV	1							
ES	0.2000	1						
SRL	-0.0010	0.4310	1					
SPL	-0.1050	-0.1120	-0.1130	1				
AGE	-0.0990	-0.2650	-0.0330	-0.0100	1			
ATR	0.5680	0.0580	0.1200	-0.0730	-0.0730	1		
DIV	-0.1990	0.3190	0.4060	-0.0550	0.1570	-0.2080	1	
SUB	-0.2080	0.0270	0.0720	0.1660	-0.1130	-0.2370	0.1430	1

Source: author's calculation.

Table A2. Results of the Pooled OLS regression model.

Variable	Field crops	Permanent crops	Milk	Grazing livestock	Mixed
Constant	1.4040*	1.4766	-1.2151**	0.1551	0.2017
	(0.7540)	(1.0113)	(0.6003)	(0.6592)	(0.3679)
ES	4.2407***	5.8750***	9.9406***	5.3480***	2.7295***
	(0.3108)	(1.2962)	(0.4180)	(0.9159)	(0.4523)
SRL	-0.3860	1.0483	-0.5143*	-0.3347	-0.8195***
	(0.4381)	(0.8045)	(0.2627)	(0.3665)	(0.2718)
SPL	0.1955	-1.7532	0.2002	-0.3255	-0.3533
	(0.5086)	(1.7179)	(0.4461)	(1.0083)	(0.2738)
AGE	-0.0185*	-0.0190	-0.0085	-0.0030	0.0024
	(0.0110)	(0.0165)	(0.0068)	(0.0086)	(0.0058)
ATR	1.7460***	3.5105***	0.6409***	2.1862***	3.1759***
	(0.2426)	(0.5555)	(0.3028)	(0.3592)	(0.2371)
DIV	0.4839	-1.3373	1.1376***	-1.0149	-0.6678***
	(0.6294)	(1.2021)	(0.6049)	(0.6346)	(0.2515)
SUB	-6.7769	-6.6001*	2.3118*	0.9416	-1.7684
	(5.1089)	(3.3614)	(1.2969)	(0.8955)	(1.2849)
N	1778	336	721	392	462
F-test	48.7130***	11.0993***	102.4460***	15.3304***	41.7632***
R^2	0.1615	0.1915	0.5014	0.2184	0.3917

Notes: Standard errors are presented in parenthesis. *** level of significance 1%; ** level of significance 5%; * level of significance 10%. Source: author's calculation.

Table A3. Results of Fixed effects panel regression analysis.

Variable	Field crops	Permanent crops	Milk	Grazing livestock	Mixed
Constant	-1.2636	2.3521	0.0741***	-2.8354	1.2159
	(1.9608)	(3.8176)	(1.6646)	(2.0674)	(0.9938)
ES	4.5639***	-1.3254	11.6161**	6.5013***	5.1540***
	(0.6850)	(1.4996)	(0.9943)	(1.5112)	(1.0378)
SRL	-2.6308*	4.4458	0.5266	-0.2021	-0.6390
	(1.4513)	(3.1604)	(0.7454)	(0.8945)	(0.5115)
SPL	-0.9284	5.1437	0.5169	-0.4962	0.0163
	(0.9044)	(3.3262)	(1.0506)	(1.1286)	(0.7068)
AGE	0.0607*	−0.0306	-0.0218	0.0091	-0.0367**
	(0.0345)	(0.0704)	(0.0298)	(0.0365)	(0.0167)
ATR	4.1708***	4.0056***	1.0240**	6.2728***	3.9857***
	(0.4210)	(0.5978)	(0.4711)	(0.4812)	(0.3149)
DIV	-2.8316***	−1.0874	-0.7907	0.1170	-0.1882
	(0.9267)	(2.1306)	(0.7554)	(0.7837)	(0.5993)
SUB	-4.5810	−3.0151	0.4351	0.6202	-0.8482
	(4.6660)	(3.1509)	(1.6206)	(0.8610)	(1.2973)
N	1778	336	721	392	462
F-test	31.8084***	7.7679***	267595***	29.3718***	39.8959***
R^2	0.1280	0.1621	0.2346	0.3846	0.4179

Notes: Standard errors are presented in parenthesis. *** level of significance 1%; ** level of significance 5%; * level of significance 10%. Source: author's calculation.

Table A4. Results of Random effects panel regression analysis.

Variable	Field crops	Permanent crops	Milk	Grazing livestock	Mixed
Constant	0.9542	2.3774	-0.6175	-1.1105	0.1120
	(1.1350)	(1.4778)	(0.8358)	(1.0384)	(0.5746)
ES	4.5513***	1.6964	10.5597***	5.7484***	3.5009***
	(0.4451)	(1.3698)	(0.6446)	(1.2415)	(0.6840)
SRL	-1.0175	1.5712	-0.3663	-0.9603*	-0.8759**
	(0.7081)	(1.2403)	(0.4070)	(0.5662)	(0.3832)
SPL	-0.3811	0.3165	0.4472	-0.4106	-0.2396
	(0.6817)	(2.2998)	(0.6799)	(1.0556)	(0.4425)
AGE	0.0007	-0.0286	-0.0073	-0.0004	-0.0053
	(0.0178)	(0.0253)	(0.0120)	(0.0157)	(0.0095)
ATR	2.9606***	3.8230***	0.7686***	4.8244***	3.8140***
	(0.3176)	(0.5586)	(0.3753)	(0.4253)	(0.2721)
DIV	1.4734*	-1.2198	-0.0022	-0.4068	-0.5326
	(0.7672)	(1.5475)	(0.6661)	(0.7194)	(0.3856)
SUB	-5.4417	-3.9635	0.9453	0.5697	-0.6561
	(4.5420)	(3.1074)	(1.4373)	(0.8392)	(1.2217)

N	1778	336	721	392	462
Wald chi²	257.8950***	57.0445***	344.1950***	172.9750***	298.4570***
R^2	0.1272	0.1482	0.3256	0.3106	0.3966

Notes: Standard errors are presented in parenthesis. *** level of significance 1%; ** level of significance 5%; * level of significance 10%. Source: author's calculation.

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