Economic Viability Meets Environmental Resilience: Advancing Agriculture through Synthetic Biology

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Abstract

The financial viability of agricultural holdings is a crucial component of sustainable agriculture. Farming properties ought to generate enough revenue to meet all of their expenses. This study included the proposal of an economic profit indicator as well as an entrepreneurial revenue indicator. Economic profit takes into account the expenses of missed chances, or "opportunity costs," as opposed to entrepreneurial gain. For this objective, three measures of the potential costs of the capital, labor, and land production variables were constructed and computed. To determine if a holding is risky or sustainable, a business viability index is developed in order to evaluate the economic profit between various holding groups. This indicator is composed of the commercial income statistic and the differentiation between commercial income and economic profit. It was verified that large holdings with a focus on grazing cattle are among the most economically vulnerable subjects using FADN data from a five-year time period. The share of sustainable ownership in milk production-focused companies was greatest. Small holdings are most in risk from a size perspective, and this was shown to be the case for all production foci. On the other hand, the category of feasible holdings includes bigger and extremely large holdings.

Keywords

Economic Viability, Environmental Resilience, Agriculture, Synthetic Biology

1. Introduction

In addition to dealing with various long-term problems, the Common Agricultural Policy also needs to cope with recent problems. To put it simply, the EU Policy of Common Agricultural (PCA) seeks to promote farm incomes in order to achieve a productive, balanced agriculture over the long run. An emphasis on reciprocal reciprocity amongst many various components, with an emphasis on the environment, is the aim of a green Europe, a relatively new concept. Nonetheless, it is important to consider the financial viability of farming businesses when formulating new policy objectives [1]. The research focuses on the dual farm structure, which is characterized by the unique traits of two groups of agricultural firms and is especially common in countries where agriculture has undergone a revolution. In agriculture, dual farm structures are rather uncommon among EU nations, and the EU approach utilized usually is insufficient for them. We thus moved on with the suggestion of a technique that will enable an impartial evaluation of farmers' financial circumstances in this unusual setting. The aim of this research is to provide data for the evaluation of farms in an environment such as the Czech Republic where there is a significant dual farm structure [2]. In EU countries, agricultural properties' financial health is assessed using data from a Farm Accountancy Data Network (FADN) sample survey. One need for entry into the EU is the creation of a FADN survey and the management of it in accordance with standardized guidelines. These FADN survey data have been accessible in the Czech Republic since 2004. Using FADN data has a number of benefits. The database includes details on the holding's composition as well as its expenses, earnings, financial standing, subsidies obtained, and economic outcomes. A recurring survey is carried out each year when the same similar metrics are available [3].

A unified approach guarantees comparability between the various EU member states. A broad range of classification makes it possible to get results for many kinds of holdings. Thorough knowledge of the financial management of farming businesses from a microeconomic perspective is supported by the careful monitoring of firm-level information. Furthermore, the methodological guarantees include guaranteeing that the data is representative in terms of geography, production focus, and economic magnitude, in accordance with the common typology of farm holdings within the European Union [4]. Although there are many benefits to using the FADN database, there are certain things you should be aware of. These limitations stem mainly from changes in the economy and society, as well as changing requirements for environmental and agricultural regulations.

Interpreting results in a temporal context is challenging because of things like evolving methodological standards. Moreover, depending too much on a small number of publicly available and closely watched indicators could make it difficult to adjust to changing regulatory changes [5]. The primary focus of this article is the FADN standard results, which are important metrics that are often used by the European Commission and EU member states as definitive indicators of economic management in agricultural holdings [6]. These metrics, which are calculated with consistency,

provide insight into the financial situation of farming businesses. There are worries again about the possible consequences of policy changes for particular types of farms as the EU gets ready for a new Common Agricultural Policy (CAP). Because farms in the EU have different structures in different countries, using FADN impact indicators to assess revenue does not provide a uniform picture of farms. The Czech Republic is one of these nations, where the dual structure of farms is particularly noticeable. The stark contrast between the two enterprise group's best characterizes the dual structure of farms. One of the groupings in the Czech Republic is a collection of big firms, which, although having fewer farms, generates the majority of the country's agricultural output. Big businesses are better able to get bank loans since they are recognized as legal organizations.

The second category consists of smaller companies. These are mostly family farms that rely heavily on owned land and unpaid labor. Due to these variations, it is impossible to determine the true harm that changes in the effects of agricultural policy pose to farmers. Numerous factors included in standard findings are thought to be indications of the agricultural holdings' financial performance [6]. These include farm net value added, which is computed as gross farm income less depreciation; farm net income, which is obtained by deducting all external factors from total production and then adding the remaining subsidies and taxes on investments; and gross farm income, which is obtained by deducting intermediate consumption from total production and adding the remaining current subsidies and taxes [7]. The sum of all external components includes interest paid, rent, and salaries. Interestingly, the ultimate computation does not include the expenses related to unpaid labor, owned land, or equity capital available to agricultural holdings. To put it simply, opportunity costs which stand for the worth of possibilities lost are used to evaluate these elements. When assessing a holding's long-term sustainability, opportunity costs are a critical factor to take into account. The agriculture of the Czech Republic is unique in the EU because of its two-fold structure. There are large estates that effectively manage their property on the one hand, and use outside capital on a smaller scale, mostly through the employment of hired workers. However, smaller organizations typically family farms manage their property as well, but they depend less on outside funding, mostly on the labor of unpaid family members [8].

The agricultural landscape of the Czech Republic is more complicated than that of other EU countries because of this particular duality. In light of this, it is unclear if the farm net income indicator which ought to indicate the overall profit from operations is the best choice for comparing the financial performance of all Czech Republic-based agricultural enterprises. The authors are trying to figure out how to create an indicator that would address the deficiencies of the impact indicators that are now in use. This indicator is termed the economic viability index. The goal is to make it possible to evaluate the effects of policies from the standpoint of the production sector and farm size without having to keep family farms and formal organizations apart. This entails evaluating the risks to both business groupings impartially. The uniqueness of the research may be attributed to the development of a method that allows economic subjects with different business strategies to be evaluated for economic feasibility. It makes outcomes comparable in a dual-character business environment, allowing for more precise policy measure formulation in the area of agriculture. In this study, opportunity costs for labor, land, and capital were evaluated for different agricultural specialties and economic size classes [9]. A grading system for economic viability was also created, using which farms were categorized as either sustainable or endangered. By using data based on the FADN approach; this methodology may be applied to additional EU countries in addition to the Czech Republic [10]. The research's conclusions have important ramifications because they deepen our understanding of farms' economic viability and make it easier to modify agricultural policy to meet the unique requirements of farmers. This study looks at how opportunity costs might be used to assess the viability of Czech farms financially, how opportunity cost indicators might be created, how to use the FADN database to extract economic indicators that are conclusive, and how the outcomes could be evaluated.

2. Sustainability and Viability

The Common Agricultural Policy (CAP) is developed strategically, prior policy initiatives' efficacy is evaluated, and the economic (income) standing of agricultural holdings is determined by the European Union using the FADN as a fundamental tool. Basically, the main goal is to make sure that agriculture works. This includes things like food production, biodiversity, environmental integrity, healthy soil, healthy rural landscape development, and most importantly, the sustainability of agricultural holdings. Consequently, by collaborating with other national support mechanisms and policies, the PCA (Policy Coordination Arrangement) seeks to promote long-term sustainability in the industrial, economic, environmental, and social domains. In a recent study, Darnhofer examines the potential for altering the PCA and holdings' methodology in order to promote resilience and sustainability [11]. The profitability, productivity, and viability of agricultural holdings are a few examples of indicators that show how sustainable their economy is. Using supplemental data from the FADN survey, the viability of economically sustainable agriculture was examined; comparing eight states, they found that Germany had the most percentage of economically sustainable holdings while Poland had the lowest. The writers came to the conclusion that the definition of "economic viability" may be found in several places in the literature.

But the focus is on how the farmer can support himself. Returns on on-farm investment are also required in certain research [12]. Divergent opinions exist over whether viability should be seen as an opportunity cost metric or as a farm household welfare metric. This research uses indicators developed from the accounting results and the anticipated opportunity cost value to evaluate the profitability of agricultural holdings. Using FADN data, the EU pilot research

examined the viability of eight EU member states. The wide viability model, which distinguished between vulnerable and sustainable farms, was built as follows:

$$\frac{IFF-OCC}{HWF}>AS$$

The variables IFF, OCC, HWF, and AS represent Income of family farm, Own Capital Cost, and Average Salaries, respectively. The economic viability of farms (EVF) indicator was developed by Hlavsa et al. and is among the most recent outcomes to be released. This indicator, which is derived using the following formula, solely takes opportunity costs of capital and labor into account.

$$EVF=\frac{ANVF-PR-(IP+CCO)}{S+CLO}$$

Where S is salaries, CCO is costs of capital opportunity (including land), PR is paid rent, IP is interest paid, ANVF is addition of net value in farm, and CLO is costs of labor opportunity. If the EVF value of an agricultural holding is more than one, it is considered economically viable. From the perspective of its further development, a holding is deemed unviable if it is less than or equal to one [13]. Farm holdings through the FADN survey from 2005 to 2014 were categorized by the European Commission in 2019 based on their farm net income before depreciation and opportunity expenses. Based on the data, four classifications were created: Income exceeds opportunity costs; (2) income is increasing; (3) depreciation is delayed; and (4) there is financial hardship. The largest proportion of holdings classified as class 3 and class 4 occurred in 2010. However, the share of the sustainability group of holdings (class 1 and 2) was largest in 2008. An assessment of the costs of missed opportunities is used to evaluate the profitability of agricultural properties. If the holdings decide not to manage the agricultural business activity, it is a squandered opportunity to employ their productive characteristics. The benefit of this strategy is that it allows one to compare the financial outcomes of assets that primarily rely on outside resources with those of holdings that employ internal resources. Additionally, opportunity costs must be taken into account for a more impartial evaluation of economic return due to the variations in the composition and level of use of own production factors among various kinds of agricultural holdings [9]. Own production factors have opportunity costs equal to external factors, which are not taken into account in the last management metric.

3. Opportunity Costs

Opportunity costs are the expenses incurred by missed opportunities and are calculated for production components in agriculture, such as equity capital, owned land, and unpaid labor. There is no opportunity costs included in the FADN business data source. Off-farm income is a significant factor in determining the overall economic sustainability of holdings and is crucial in evaluating the circumstances surrounding smaller holdings. This information is not present in the FADN system and cannot be obtained by any other means than direct research; as a result, it is frequently left out of the viability evaluation [14]. For instance, these data were enhanced in the FLINT project. The money that an entrepreneur might obtain were they to give up their entrepreneurial endeavors and take a job as an employee is expressed by the opportunity costs of unpaid labor. There are significant potential costs associated with this item for small-scale single proprietorships. The various writers favor various methods for calculating wage expenses, which are then used to the estimation of the value of unpaid work [15]. Here, one may take into account both the job relationship within and outside of agriculture, as well as whether or not the employer is located in the same region.

Wage expenditures are used to determine the amount of unpaid labor; in the FADN system, the input value of unpaid labor (FWU) indicator tracks this amount. For this aim, the European Commission 2022 calculates the average hourly regional income of paid workers in agricultural holdings in the FADN database, along with the number of hours worked by unpaid labor. When there are few farms in an area, the value of the national average is considered. Because investing one's money in a firm has a bigger risk than that of a creditor, equity capital has higher opportunity costs than external capital. Furthermore, the ability to deduct cost interest and lower income tax is lost for an entrepreneur employing equity capital. This is another reason why, when evaluating the financial status of assets, it is necessary to take the cost of equity capital into account [16]. A substitute expense for employing equity capital may be, for instance, money deposited into a savings account or profits from real estate or securities investments. The capital asset pricing model of capital asset (PMCA), the dividend growth model, and the arbitrage pricing model are a few of the techniques used for equity capital valuation. The intricacies of agricultural holdings are best suited for more sophisticated financial models created for massive corporations, especially when it comes to precisely determining the worth of held property. Using these algorithms to estimate land costs might lead to erroneous conclusions. Nonetheless, when assessing the profitability of agricultural holdings, some researchers choose to take into account the total worth of all owned property rather than just the land value. Some studies, on the other hand, use a more sophisticated approach, using an equity capital valuation procedure after subtracting the value of agricultural land. This method makes it possible to estimate the opportunity cost of the land production component independently. An interest rate equal to a particular percentage of the equity capital value is used to determine the opportunity costs of equity capital [17]. Different interest rates can be used to achieve convergence and conform to industry requirements.

These may be the long-term interest rate on government bonds from the European Central Bank, the yield on ten-year government bonds from Eurostat, or the long-term interest rate on own property from the Global Insight database [15].

Each of these interest rates is used as a reference point to determine the opportunity costs related to equity capital, resulting in an evaluation of agricultural assets that is more accurate and contextually relevant. Furthermore, some writers take into account a risk premium which may be calculated in a number of ways for capital deposits made in a hazardous environment. Damodaran discloses, under an indicator called the total equity risk premium, the amount of the risk premium related to doing business in a certain country. Using a uniform value of 3% for property valuation, Agri Benchmark (a network of agricultural economists, producers, specialists, and advisors in significant sectors of the agricultural chain; agribenchmark.org (accessed on September 10, 2022)) adopts a different methodology because the results can be compared across different European countries [18]. The returns from an owned piece of land's alternate usage are represented by its opportunity costs. The farmers may sell or rent their land if they chose not to engage in commercial activities. Soil is unique among production inputs since it is immobile and non-reproducible. Since land is a fixed asset with no depreciation, there are several ways to calculate its opportunity costs. Certain scholars place a high value on land that is included in equity capital without being treated as a separate entity. One method for determining the worth of held property that accounts for possible revenue from a lease is to use the average rental rate within a certain holding or area. Another approach for those thinking about selling property is to take the average market price of the holding or area's agricultural land into account. This offers a starting point for determining a possible selling price. In addition, the agri benchmark uses a methodology that accounts for rent-equivalent components to determine the value at which a farmer would be prepared to sign a new lease [19]. This dynamic method takes into account the leasing viewpoint and adds to a thorough comprehension of the opportunity costs related to agricultural property.

4. Materials and Methods

The Czech Republic is the location of the case study. An 82.5% percent of the 64152 registered farmers are family farms, while the other 18.02% are formal companies. Approximately half (53.5%) of the nation's land is used for agriculture, which also generates 2% of its GDP. There are 4.20 million hectares of agricultural land in the Czech Republic, of which 3 million hectares are arable. The main crops produced in 2022 were legumes (44000 ha), sugar beet (62000 ha), oilseeds (445000 ha), cereals (1335000 ha), and other crops. Regarding animals, the Czech Republic places a high priority on producing meat, milk, and eggs. There are 1.40 million raised beef cattle, 1.50 million pigs, and 23.80 million fowl in the world. Every agricultural technology is equivalent to those of the nearby EU nations. With organic farming accounting for more than 15.03% of land and more than 19.03% of beef cattle in 2020, its significance is growing. For this work, the Czech FADN database was used. The data set was utilized for the 2017-2021 five-year time period as a multiannual average should be used to assess the economic sustainability [20]. Based on the EU's typology of agricultural holdings, agricultural holdings were categorized into groups that focused on mixed crops, milk, grazing livestock, and field crops. Furthermore, assets were divided into four categories based on their economic size: small (EUR 9000-60000 of standard output (SO), medium (EUR 51000-510000 of SO), big (EUR 510000-1100000 of SO), and very large (EUR 11000,000 or more of SO).

The proposed method takes ownership of land, own labor, and positive values of equity capital's opportunity costs into account after deducting the value of owned agricultural land. An indicator of the opportunity cost opportunity of land (CO) was found through a literature search. The computation involves multiplying the hectares of land possessed by the rent amount in the designated area, which is obtained from the FADN database. This method takes into account the current situation of the agricultural land market. This research also makes use of the cost opportunity of labor indicator (COLI), which is computed by multiplying the input of unpaid work by the average farm wage in the region. The FADN CZ database is the source of both figures. The costs of capital opportunity (CCO), which deducts the equity from the value of the land, held in its ultimate form, is the final component taken into account. The interest rate is then multiplied by this difference [21]. The cost of equity capital is evaluated using the agro benchmark approach, which accounts for the risk premium by using a standard 3% interest rate on long-term government bonds. The overall opportunity costs are calculated as the sum of the individual components described above.

$$TOC=COLI+OCL+OCA$$

Where COLI stand for the cost opportunity of labor indicator, OCL for the opportunity cost of land, OCA for the opportunity cost of assets, and TOC for total opportunity cost. The farm net income, including investment subsidies, is calculated using the FADN standard findings as the final economic indicator [22]. Farm net revenue must be subtracted from investment subsidies to calculate entrepreneurial income. The equation below is used to determine Business profits using basic FADN indicators:

$$BP=TO-MC+BCST-EC-D$$

Where TO stands for total output, MC for Moderate consumption, D for depreciation, EC for external Cost, and BCST for balance of current subsidies and taxes. Accounting profit, in general, is defined as income less costs. Economic

profit is obtained by deducting the entrepreneur's production elements' opportunity costs derived from this indication. Business profits may then be obtained by using the FADN system's indicators and the following equation:

$$BP=TO-MC+BCST-EC-D-TCO$$

Where TO be total output, MC is Moderate consumption, EC is external Cost, D is depreciation, and TCO is total cost of opportunity costs. Additionally, BCST stands for balancing current subsidies and taxes. Next, an index of agricultural assets' economic viability is computed using the following straightforward yet intricate equation:

$$IEV=\frac{EI}{EI-EP}$$

Where EP stands for Business profit, EI for entrepreneurial income, and EVI for the index of economic viability. A cutoff of 1 for the economic viability index has been established. A farm that has an economic viability rating of 1 is not profitable or losing money. Long-term viability is probable for farms with an economic viability index greater than 1. The farm is doing better when the index result is higher since it generates a larger economic profit [23]. When opportunity costs are taken into account, farms with an economic viability score below one experience a loss. The threat and risk of quitting the company and jeopardizing the farm's profitability increase with decreasing numbers. Consequently, farms run at a loss even before opportunity costs are subtracted. An agricultural holding that is sustainable over the long run is indicated by an economic viability index score greater than 1. On the other hand, a result of one or less indicates that the holding's survival is in jeopardy because it lacks the resources for additional expansion or that a reduced level of life on farms must be provided in lieu of the holding.

The Mann-Whitney U test was used to determine if there were statistically significant differences between two independent groups that were classified according to their economic size and agricultural style. The purpose of this nonparametric test is to examine a single continuous variable with a nonparametric distribution [24]. Evaluating the economic viability index among various farm groups was the test's main goal. When there are significant imbalances in the number of participants between the two comparable groups, when the data deviates from standard distribution patterns, or when the data is ranked, the Mann-Whitney U test becomes especially useful. Because of its use, reliable statistical comparisons are possible under a wide range of circumstances. Effective data processing and analysis required the use of statistical software from TIBCO. This program made it easier to analyze economic viability indicators in detail and allowed for a more in-depth investigation of the variations in farm groups' economic size and farming practices [25]. The use of the Mann-Whitney U test, bolstered by sophisticated statistical instruments, contributes a degree of accuracy and consistency to the evaluation of economic viability within the agricultural domain.

5. Results

There are notable discrepancies in the statistics when comparing various agricultural practices and the differences across farms with varying financial situations within a particular specialty. Interestingly, farms that produce combined crops and milk have the highest workloads. There is a clear pattern: small and medium-sized farms use labor from a larger percentage of their workers, but big and extremely large farms mostly rely on paid labor. The scale of operations has a significant impact on the financial environment since larger holdings, which account for over 40% of cattle farm assets overall, have easier access to outside funding. Both the percentage of land held and the percentage of permanent grassland consistently drop as holdings get larger. The inverse connection emphasizes how agricultural techniques vary with scale. Analyzing opportunity costs shows clear trends: smaller and medium-sized farms have larger percentages of potential costs, highlighting the effect of size on resource distribution [26]. On the other hand, very big and massive farms exhibit relatively minimal impact from opportunity costs on their operations. Taking grazing cattle holdings into consideration reveals further subtleties.

The farm net value added per annual work unit (AWU) is lowest among those that prioritize meat production, and greatest among those that prioritizes milk production. These results highlight the variety of agricultural practices in the Czech Republic and highlight the need for more study, especially in examining methods to improve the sustainability of small- and medium-sized farms in the country, such giving them a higher share of resources. These findings are summarized in Table 1, which offers an overview of average values for a few chosen variables [27]. This enables a comparison examination of various holding groups that are divided into categories based on economic sizes and agricultural practices. This thorough investigation clarifies the complex processes forming the Czech Republic's agricultural environment.

Farming	Field Vegetables				Milk			
Scale of Economy	Little	Moderate	Large	Extremely Large	Little	Moderate	Large	Extremely Large
No of surveys	242	1205	314	408	30	272	66	242
Each year's work unit /100 ha	4.98	3.00	2.01	1.99	7.99	3.99	2.95	4.01
livestock section /ha forage crops	.27	.62	.22	.39	2.00	2.00	2.00	2.01
portion of unpaid work (percentage)	95.00	69.93	12.00	3.00	99.91	69.01	3.92	0
Total debt divided by total assets (percentage)	6.00	17.01	28.00	28.99	4.00	16.90	35.90	39.01
A portion of the leased land (percentage)	46.00	62.96	79.01	79.00	36.95	55.02	84.01	84.01
Ratio of permanent grasslands (percentage)	8.99	5.97	5.00	3.91	57.02	53.97	53.01	34.01
Total yield for each hectare (ZCK)	33057	29776	34542	46602	43,125	47674	40816	55138
Overall usage of intermediates per ha (ZCK)	22226	19785	23303	33847	29900	31208	31340	42305
Excl. all subsidies for investments per ha (ZCK)	8365	7882	8527	9824	11308	13738	14093	17998
The net value added of farms per AWU (ZCK)	12271	12933	15639	17675	19142	23613	18604	23785
Overall ex-subsidies for investments divided by overall output (percentage)	32.97	29.92	26.97	25.98	29.02	34.96	37.93	34.99
Farming	Field Vegetables				Milk			
Scale of Economy	Little	Moderate	Large	Extremely Large	Little	Moderate	Large	Extremely Large
Total opportunity expenses per ha (ZCK)	17801	7251	1986	2039	31621	12758	2173	2220
Total costs plus opportunity cost divided by total costs	61.17	80.21	94.32	95.70	52.10	76.70	95.48	96.93
Farming	Grazing Livestock				Mixed			
Scale of Economy	Little	Moderate	Large	Extremely Large	Little	Moderate	Large	Extremely Large
No of surveys	633	499	37	11	223	440	178	1003
Each year's work unit /100 ha	4. 00	1.98	2.01	3.01	8.01	2.99	3.01	3.01
livestock section /ha forage crops	.56	.59	.70	.83	2.01	.88	.90	2.01
portion of unpaid work (percentage)	97.01	53.01	2.00	.92	98.97	81.00	5.02	.12
Total debt divided by total assets (percentage)	8.99	19.94	28.01	42.99	6.02	17.01	32.01	37.01
A portion of the leased land (percentage)	52.02	64.00	77.02	83.01	35.01	60.01	81.97	82.01
Ratio of permanent grasslands (percentage)	88.97	85.01	72.94	40.01	39.09	30.01	31.96	16.01
Total yield for each hectare (ZCK)	16290	14919	18061	34595	36573	31794	30735	51374
Overall usage of intermediates per Ha (ZCK)	16453	14412	17602	25724	22998	22508	24039	39131
Excl. all subsidies for investments Per ha (ZCK)	143101	15166	14848	12338	9594	10677	10894	13325
The net value added of farms per AWU Per ha (ZCK)	8580	11849	11787	16685	16088	14335	13852	19622
Overall ex-subsidies for investments divided by overall output (ZCK)	136.01	146.01	105.00	37.01	50.91	50.03	46.03	29.00
Total opportunity expenses per ha (ZCK)	15332	6134	1643	1474	30129	11533	1974	1973
Total costs plus opportunity cost divided by total costs (percentage)	61.01	79.01	95.01	97.03	54.02	74.01	94.94	97.01

Table 1. Averages of a few chosen indicators across the time 2017-2021

It is evident that, given the circumstances in the Czech Republic, the type of farm has an impact on its economic sustainability. Grazing cattle farms often have the lowest economic viability index [28]. The milk farms had the highest viability. All producing foci's small-sized holdings have the lowest possible level of the financial sustainability index. The most vulnerable areas are tiny mixed farms and field crops. Large mixed farms and crops, on the other hand, might

be considered economically viable since they attain the maximum level of economic viability. Large farms with an emphasis on milk production and grazing cattle have the highest economic viability ranking. Large and huge farms that prioritized mixed farming and field crops were shown to have the largest margin of economic sustainability between the upper and lower quartiles [29]. Small mixed and milk farms, on the other hand, have the least fluctuation in this parameter. Table 2 displays the outcomes of the economic viability index distribution. Big farms that grow field crops, big farms that produce milk, and large farms that produce mixed crops all had an intriguing discovery in the lower quartile. Even though the median value of these farm groups reaches relatively high levels, they have a negative index in the lowest quartile. Even before deducting the opportunity costs, the farms in these groups had poor economic outcomes.

Sets	Mean	Median	Lower Quartile	Upper Quartile	SD	Coff.fac.
Field crops	**2.01**	**1.15**	**.31**	**1.97**	**3.03**	**198.82**
Little	.43	.44	.13	.77	0.98	247.43
Moderate	0.99	0.99	.48	1.96	1.97	162.89
large	3.01	3.00	.42	5.02	5.01	169.25
Extremely large	2.01	2.02	−.09	4.01	4.02	224.02
Milk	**2.01**	**2.02**	**.52**	**2.63**	**2.23**	**137.85**
Little	.58	.51	.25	.84	.53	89.78
Moderate	2.00	2.011	.75	3.01	2.05	122.08
large	2.01	.92	−.21	3.01	3.04	181.28
Extremely large	2.01	2.01	.45	3.01	1.99	137.31
Grazinglivestock	**.98**	**.74**	**.26**	**2.01**	**2.00**	**173.99**
Little	.60	.46	.15	.87	.83	135.91
Moderate	2.00	0.99	.58	3.01	3.00	163.16
large	2.00	2.00	.42	3.01	2.06	116.16
Extremely large	1.99	2.01	.99	4.01	2.01	80.10
Mixed	**2.00**	**.99**	**.17**	**1.97**	**3.01**	**224.27**
Little	.48	.42	.17	.71	.55	115.56
Moderate	.99	.98	.29	2.00	2.05	168.93
large	2.00	0.99	−.28	3.04	4.01	220.14
Extremely large	2.03	2.01	.09	3.01	2.99	223.88

Table 2. Economic viability index descriptive statistics

Similar research was done by Hlavsa et al., who took into account differences in the production emphasis of agricultural holdings. Using the FEV indicator (Equation (1)) to identify the least resilient holdings within the cattle grazing group, their findings closely align with previous viability results. Holdings with mixed products came in second. Interestingly, the group of holdings specialized in milk production was shown to have the highest value when using the economic viability index created by this study [30]. This disparity highlights how complex economic viability evaluations may be, with several metrics producing disparate outcomes. Examining sustainable (viable) holdings revealed clear trends. In this case, holdings with a focus on field production had the best economic viability, according to the FEV indicator. Holdings were divided into two classes to offer a quantifiable measure of economic viability: (1) endangered holdings, which had an economic viability index of one or below; and (2) viable holdings, which had an economic viability index greater than one. A fascinating distribution was found by doing a five-year longitudinal analysis, with 50% of the holdings being categorized as viable and a slightly greater number (50.1%) falling into the threatened group. This equitable distribution highlights the unstable economic environment that agricultural holdings confront and the necessity of focused interventions to improve viability, especially for those that are endangered. By illuminating possible areas for governmental action and assistance, these findings advance a thorough understanding of the economic dynamics within various production priority groups. Milk production accounts for the biggest percentage of viable assets (61%) of all holdings. This livestock grazing specialty contains the same percentage of endangered properties.

Field production holdings in the viable group, which have an average economic viability index value of 3.04, are in the best possible situation [31]. With an economic viability value of 0.44, mixed production holdings are in the least advantageous position within the threatened category (Table 3). The largest percentage of small farms, whose poor economic viability index reduces the group average overall, is the cause.

Sets	**Measure of Economic Viability**		**Percentage of observations shared**	
	Threatened	**Workable**	**Threatened**	**Workable**
Field crops	**-.43**	**2.98**	**47.0**	**52.9**
Little	.23	0.98	85.0	16.0
Moderate	−.13	1.99	46.0	53.9
Large	−1.99	5.03	28.9	70.9
Extremely large	−2.03	4.01	42.0	59.0
Milk	**−.20**	**3.01**	**39.0**	**60.9**
Little	.39	NO	81.9	17.9
Moderate	.04	3.01	36.0	65.0
Large	−.49	4.01	51.9	48.0
Extremely large	−.50	3.01	33.9	65.9
Grazing livestock	**.17**	**1.98**	**62.0**	**39.0**
Little	.32	2.01	80.0	21.0
Moderate	−.19	3.01	41.0	58.9
Large	−.05	3.03	34.0	67.0
Extremely large	NO	NO	N0	NO
Mixed	**−.45**	**3.02**	**51.0**	**50.0**
Little	.33	2.00	88.0	11.9
Moderate	.06	1.97	52.0	49.0
Large	−.91	4.00	46.0	53.2
Extremely large	−.96	2.98	43.0	58.0

Table 3. Enterprise representation according to economic viability class

A more thorough examination based on economic size revealed that the group of sizable field crop farms had the highest percentage of viable holdings. Big grazing animal farms and very big milk farms closely trail this category. Groups with modest holdings across all production foci had the largest percentage of threatened holdings (80% of farms and more). Nearly 88% of threatened farms are represented in the group of small mixed farms (Table 3). To investigate potential variations in the distribution of the economic viability index among holdings with different production orientations and sizes, statistical studies were performed for the entire dataset as well as its split depending on the economic viability class [32]. Our study also examined this feature and found statistically significant variations in numerous production directions, building on the work of Hlavsa et al. who performed variance analysis for groups of holdings in areas with natural limits (ANC). When we looked at the economic viability index, which includes opportunity costs for each of the three production components, we found that almost every combination we looked at had a notable and statistically significant distribution variance.

This emphasizes how production orientations, economic viability, and agricultural holding sizes interact in complex ways. Remarkably, the distribution hypothesis was consistent only in five cases, indicating the distinct economic dynamics in these particular settings. One interesting discovery for endangered farms was that, for three combinations of field crops and mixed farms, field crops and dairy farms, and milk and mixed farms, the distributions of the economic viability score were statistically comparable (see Table 4). This shows that these couples within the viable farm category have comparable opportunity costs and a certain amount of economic resilience. The aforementioned findings enhance our comprehension of the intricate dynamics at play in various production orientations and scales, underscoring the significance of customized interventions that address the unique obstacles encountered by heterogeneous agricultural properties [33]. To assist stakeholders and policymakers in creating focused initiatives to support the economic sustainability of agricultural companies, the statistical analyses offer a strong basis for identifying regions where economic viability indices differ considerably.

Comparative Sets X-Y	Total of Rank X	Total of Rank Y	F	C	p-Value	NO. Of Analysis X	N0.Of Analysis Y
All							
Mixed-field crops	3565208	4456809	1871488	−3.300	0.002	1841	2166
Grazing livestock field crop	1774567	3808246	1082491	−7.156	0.000	1177	2166
Milk-field crops	886083	2951754	607059	2.753	0.007	606	2166
Mixed-grazing livestock	2860667	1688971	996895	3.646	0.000	1841	1177
Mixed-milk	2174735	815502	481015	−5.019	0.000	1841	606
Grazing livestock milk	960846	626027	268770	−8.462	0.000	1177	606
Threatened farms							
Mixed-field crops	876973	1007740	445917	−1.956	0.052	929	1014
Grazing livestock field crop	676525	827722	314132	4.969	0.000	722	1014
Milk-field crops	151151	628227	114636	0.883	0.379	236	1014
Mixed-grazing livestock	696321	664106	265265	−7.224	0.000	929	722
Mixed-milk	530347	146521	99291	−2.121	0.035	929	236
Grazing livestock milk	353966	103482	75752	2.440	0.016	722	236
Workable farms							
Mixed-field crops	918044	1213038	501716	−1.756	0.080	913	1152
Grazing livestock-field crops	309073	982957	205333	−6.772	0.000	456	1152
Milk-field crops	273173	885832	204538	−1.168	0.244	371	1152
Mixed-grazing livestock	660459	274571	170831	5.330	0.000	913	455
Mixed-milk	583733	238672	167405	−0.220	0.828	913	371
Grazing livestock-milk	171901	168826	68161	−4.705	0.000	456	371

Table 4. Analyzing statistically significant differences between agricultural company groups with different production orientations in the distributions of the economic viability index

The findings support the notion that various agricultural groups have varied levels of economic viability from an economic perspective. Livestock that is allowed to graze is distinct from other groupings. This is a result of the majority of these farms being small farms. The majority of them are sizable cow breeding farms situated in mountainous and foothill regions, which need to be kept up even if their output has decreased. Based on the findings, which are covered in the next part, it is verified that this is the company category that is most in risk. An important effect of this element was found while analyzing the variance in the economic viability index's mean value (median) in relation to farm size. The same distribution's null hypothesis was only accepted between the small- and medium-sized endangered farm groups. Testing further pairings confirmed a statistically significant variance in the distribution among holdings of varying sizes (Table 5). These outcomes demonstrate the twin farm structure's effects. Big farms are perhaps the most environmentally friendly. This result is consistent with the Czech agriculture policy's new strategic plan, which emphasizes small farm support.

Comparative Sets X-Y	Total of Rank X	Total of Rank Y	F	C	p-Value	NO. Of Analysis X	N0.Of Analysis Y
All							
Extremely large- Little	2631206	1242732	611606	15.412	00.000	1661	1124
Extremely large-Moderate	3507809	4784821	1874743	3.4520	00.001	1661	2413
Extremely large-large	1819895	714733	441265	−3.632	00.000	1661	592
Little - Moderate	1416103	4833779	784977	−20.154	00.000	1124	2413
Little -large	837313	632443	206187	−12.903	00.000	1124	592
Moderate -large	3509278	1001230	599200	−6.012	00.000	2413	592
Threatened farms							
Extremely large- Little	416700	870512	186519	−13.903	00.000	679	927
Extremely large-Moderate	471531	1065852	241350	−11.925	00.000	679	1076
Extremely large-large	310827	91031	67160	2.029	0.044	679	219
Little - Moderate	923237	1079766	494036	−0.287	0.776	927	1076
Little -large	582238	72704	48833	11.872	00.000	927	219
Moderate -large	745818	90755	66884	10.005	00.000	1076	219
Workable farms							
Extremely large- Little	639379	56233	36730	13.757	00.000	983	198
Extremely large-Moderate	1314833	1375209	480756	11.030	00.000	983	1338
Extremely large-large	629197	289495	146544	−5.690	00.000	983	374
Little - Moderate	98670	1078677	79167	−9.051	00.000	198	1338
Little -large	29708	133029	10205	−14.192	00.000	198	374
Moderate -large	1034720	428187	140267	−12.937	00.000	1338	374

Table 5. Analysis of statistically significant differences in the distribution of the economic viability index between different sized groups of agricultural holdings

6. Discussion

The evaluation of entrepreneurial income is added to the generally used indicator "a" (farm net value added per annual work unit, or AWU) in the European Union to offer a typical measure of farm economics and earnings. The Czech Republic's distinct dual farm structure, however, makes it more difficult to interpret these signs across a range of farm types. A significant number of relatively small farms with low proportions of owned land and unpaid labor define this dual structure [34]. There are also a lot of small and medium-sized businesses (SMEs), mostly family farms, with a somewhat different distribution of owned land and unpaid labor. As opposed to EU countries with a more uniform (non-dual) farm system, it becomes more difficult to determine the actual economic state of farms in the Czech Republic. Opportunity costs become apparent as a critical component when doing a thorough analysis of the true economic status of farms. The Czech strategic plan for the Common Agricultural Policy (CAP) 2023+ clearly demonstrates this evaluation process by designating a sizeable portion of the budget 23% for the "redistribution of direct payments," which are explicitly directed at smaller farms. By using a component of the basic income support system (BISS) for an extra payment per hectare for the first 150 hectares of every farm, regardless of its overall size, the policy highlights the commitment to assisting smaller farms.

Using particular agricultural holdings as case study cattle grazing farms in the Czech Republic, for example previous research's data and insights highlight the difficulties faced by individuals involved in large-scale production, especially in remote areas with few options for alternative livelihoods. Despite these obstacles, farming operations especially for those that focus on grazing cattle are essential to the survival and future development of rural villages [35]. This emphasizes how vital these farmers are to maintaining and directing the development of rural communities. Strictly

concentrated milk production holdings are less efficient and can become more successful by diversifying their activities, according to study on the technical efficiency of milk farms in EU member states. However, even though mixed holdings provide the majority of the milk produced in the Czech Republic, this article highlights the larger risk of these types of holdings using the economic viability indicator. Additionally, because particular CAP measurements vary, the sort of production emphasis also affects how expenses (such as rent) develop. [36]verified that the extent of their agricultural holdings in Europe boosts their economic benefit. This is in line with the discovery that larger holdings exhibit stronger resilience, whereas small holdings face threats to their capacity to remain economically viable under the circumstances prevalent in the Czech Republic. The economic feasibility of Italian farms was examined by Coppola et al., who likewise made a similar recommendation.

Furthermore, Biagini et al. came to the conclusion that the benefits of the large-scale farm structure may also apply to the efficiency of money made possible by CAP projects. The category of the smallest businesses has a large percentage of vulnerable businesses. Leaving agriculture for these firms carries a considerable risk. This raises the question of why these companies continue to operate in the agricultural sector and why they do not seek out alternative sources of income. Farms' money earned outside of the farm may be one of the causes. Family farms may get a sizable portion of their total revenue from sources outside of the farm. Nevertheless, this revenue is not currently tracked by the FADN system. Particularly important distinctions exist in Czech agriculture between agricultural holdings in terms of size, production focus, and natural environment. The financial viability of agricultural assets is one of the main facets of sustainability in agriculture. A metric known as the economic viability index was developed for its evaluation. Agricultural properties were divided into two categories based on the index: viable and endangered. Estimates of the opportunity costs associated with labor, land, and capital are included in this index. Large holdings with a focus on cattle grazing have been identified as one of the most economically threatened issues, according to data from the five-year time series [37]. The fraction of sustainable holdings that was greatest was observed in milk production-focused holdings. Smallholdings are most at risk from a size perspective, and this was shown to be the case for all production orientations. On the other hand, the category of feasible holdings includes bigger and extremely large holdings. The necessity to sustain the resilience and viability of larger, more widespread farms is confirmed by this conclusion.

These farms are mostly utilized for cattle grazing. Due to their distant locations, these farms require sustainable maintenance. To prevent rural areas from being abandoned, agriculture is crucial for maintaining jobs and social contact. One pertinent use of this kind of assistance is redistribution. One of the impact assessment variables used to determine it was this technique. Small farms are also the target of the redistribution, which accounts for a sizable portion of direct payments on the first 150 hectares. The significant value of this support in the Czech Republic is exceptional from the perspective of EU policy since it also highlights the necessity of supporting small farmers. To advance this research, a more thorough analysis of the category of endangered holdings across all size ranges might be conducted, with an emphasis on determining the reasons for their unavailability [38]. These results may be useful in determining appropriate CAP measures to boost the resilience of the susceptible farms our study identified. Simultaneously, the suggested indicator has the potential to be employed in estimating the effects of upcoming agricultural policies, optimizing them, and assessing the efficacy of existing instruments. Any dual structure raises issues such as the effectiveness of flat policy initiatives [39]. More research is encouraged in order to better understand how agricultural policy instruments should respect the extreme dual structure of Czech farms, enhance the economic viability of smaller farms, and increase internal (national) convergence in this area among different farm categories. The results of this study raise another significant and delicate political question: how resilient are small farms in the Czech Republic in general, and what factors help them to survive and grow their businesses? However, sociologists should be asking questions like these.

7. Conclusion

To sum up, evaluating an agricultural holding's financial sustainability is essential to maintaining sustainable agriculture. The study introduced two critical metrics enterprise income and economic profit for assessing the financial performance of farmed assets. After accounting for opportunity costs associated with labor, land, and capital production components, a comprehensive economic viability index was developed. By helping to classify holdings as either sustainable or at danger, this index offers important information regarding the state of their economy. Based on FADN data spanning five years, the results show that big holdings with an emphasis on grazing cattle emerged as particularly economically fragile. On the other hand, businesses focused on the production of milk showed a greater percentage of sustainable ownership. The study revealed that smallholdings are more vulnerable to economic risks in all production foci, underscoring the difficulties encountered by smaller farming enterprises. The differences between economic profit and entrepreneurial income provide insight into the economic dynamics across various holding companies. The study is significant because it emphasizes how crucial it is to take opportunity costs into account when assessing the actual economic health of agricultural operations. Ultimately, the findings point to a dynamic environment in which variables including size, production emphasis, and management techniques affect an agricultural holding's capacity to make a profit. Policymakers and other stakeholders should address the unique difficulties that various holding types confront in order to support sustainable agriculture, providing customized assistance to strengthen their financial resilience. In addition, continuous observation and flexible approaches are necessary to guarantee the long-term financial viability of varied farming activities.

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