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CAP Direct Payments and Economic Resilience of Agriculture: Impact Assessment

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Abstract: This study presents an innovative approach to measuring the impact of EU CAP direct payments on the economic resilience of agriculture at a sectoral level. The construct of resilience is approached from the perspective of the resilience of the main functions of the sector. The overall level of direct payments impact on sectoral economic resilience is seen as a weighted sum of the payments' impact on the resilience of the main economic functions of the sector. Such an approach, allowing for a comprehensive estimate of subsidy impact on the most essential areas of agriculture, is universal and can be adapted to measure economic resilience of other economic sectors. For the empirical application we used panel data from 27 EU countries over the period 2005–2019. The results revealed that the overall impact of direct payments on the economic resilience of agriculture across EU-27 was positive. However, the influence of the payments on different key functions of the sector diverged. The most evident and alarming negative changes in the economic resilience levels were observed in terms of efficiency of farms. Negative impact on separate indicators may pose a risk that the influence of direct payments on economic resilience of agriculture may not be sustainable in the longer run.

Keywords: Common Agricultural Policy; economic resilience; direct payments; agriculture; EU-27

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1. Introduction

In the face of the increasing frequency and magnitude of various perturbations (especially climate-related, although not exclusively), resilience is becoming a key concept in the discussions of sustainable development and long-term viability of agricultural systems [1,2]. Since the agricultural sector assures food security, ensures employment in rural regions [3], facilitates economic growth [4], and contributes to economic viability in a country during economic downturns [5], the resilience of the sector may well be considered an important precondition of sustainable growth of the whole national economy.

Although resilience in agricultural contexts has received a lot of academic attention in recent decades, most of the share of research is focused on resilience of agro-ecosystems [6–9], whereas research on the economic resilience of agricultural systems is quite scarce and fragmented [10]. Moreover, it must be emphasized that the concept of resilience in the economics literature in general is still quite ambiguous, since the multidimensionality of the resilience phenomenon together with the complexity of dynamic systems makes it hard to operationalize and evaluate [11].

Meanwhile, one of the most important practical issues is how to increase the resilience of agriculture (or how to avoid its deterioration) in the face of increasing challenges. Governmental policies are assumed to have a significant impact on the resilience [12–15]; however, such issues as how much influence various support measures have and even what the direction of their influence is have no sound empirically grounded answers, thus hindering construction of more effective support measures. The European Union dedicates vast financial support to the agricultural sector every year: The support for agriculture in 2014–2020 reached almost 40% of the whole EU budget [16]; for the new financial period of 2023–2027 this share, although smaller, will still account for more than 30% of total EU budget. However, empirical evidence on how these flows of financial funds influence the resilience of the sector is very limited.

This paper aims to contribute to filling this gap by estimating the impact of direct payments (DPs), which encompass around 70% of all financial support for the sector, on the economic resilience of agriculture in EU-27 countries. The scientific novelty of the proposed methodology also relies on the aggregate-level approach towards the resilience of agriculture, since typically, research on factual agricultural resilience is considered at the micro level [17–19]. Moreover, panel data methods, expert assessment, and multi-criteria decision-making methods are combined to derive the composite score of the DPs' impact on resilience.

The paper is structured as follows: Section 2 introduces a review of different perspectives on the economic resilience notion, its operationalization, and measurement. In addition, a discussion on DP impact on various indicators of agriculture is provided. Section 3 describes evaluation methods used to determine the impact of DPs on the resilience of the agricultural sector. Data characteristics, the results, and a discussion are provided in Section 4. Conclusions are presented in Section 5.

2. Theoretical Background

2.1. Resilience Concept and Its Measurement

One of the most widely used definitions of resilience refers to resilience as the capacity of a system to withstand or recover from various shocks, if necessary by undergoing adaptive changes to its structures and social and institutional arrangements, so as to maintain or restore its previous developmental path, or transit to a new sustainable path characterized by a fuller and more productive use of its physical, human, and environmental resources [20,21]. This definition encompasses three dimensions of the resilience phenomenon. The first dimension—capacity to absorb disturbances—reflects the short-term ability of a system to maintain its functionalities and performances despite the disturbance. The adaptability dimension is concerned with how fast (and to what extent) the economic system is capable of recovering after the disturbance. The transformational dimension of resilience, also called adaptability by some authors [22,23], reflects the capacity of the system to transfer to a qualitatively better growth path after the crisis.

Such multidimensionality allows for a comprehensive view, both short and long term, on resilience; however, it also poses a risk of potential conceptual collision, since different resilience dimensions may not necessarily be combined [24,25]. Although the high absorption capacity of a system may contribute to its better adaptation to future challenges, the opposing scenario may very well be possible [26–28], and thus, investing in one dimension may inhibit development of capacities necessary for the other dimensions.

Besides the three dimensions, two types of resilience—specified and general—have been distinguished in the academic literature [29,30]. "Specified" resilience refers to a system's capacity to deal with a specific disturbance(s), e.g., the resilience of large-crop farmers to the COVID-19 virus. Meanwhile, "general" resilience is concerned with a system's capacities to react to various kinds of disturbances [20,31]. The distinction here is important for several reasons. First, similar to the relationship among different dimensions, an increase in one may lead to a decrease in the other [32,33], e.g., increasing a system's resilience to the COVID-19 pandemic might lead to its declining resilience to other types of disturbances. Second, measurements of specified resilience in most cases would differ from the ones used to evaluate general resilience [30]. As a multi-sided construct, the resilience concept is not easily applicable for empirical measurement. Although there is a wide array of studies presenting ways to operationalize resilience and measure it empirically [1,15,34–43], a consensus on how resilience should be measured has not been achieved yet. Nevertheless, two approaches are prevailing in the economics literature: (1) assessing resilience via indices based on the characteristics of the relevant system (and its environment), and (2) estimating it via indices based on the key functions of a particular economic system.

Indices based on the relevant system's characteristics are calculated from a variety of indicators that are supposed to impact the resilience of the system, e.g., [43], composed a resilience index for the agricultural sector out of such indicators as market efficiency level, inoperability, dependency on strategic imports, export concentration, debt level, Human Development Index, etc.). A wide variety of such indices has been suggested in the literature (among others, [38,40–42,44]). The indicators used for the construction of this type of index differ significantly among the various indices, as the authors tend to include quite different variables (with either equal or different weights) to account for resilience. However, the construction of indices by including variables potentially influencing resilience suggests that such indices reflect more resilience capacity rather than actual resilience. The other approach to resilience index formation is based on the usage of the key functions of a particular system to construct it. This method of resilience operationalization allows actual resilience to be evaluated, as the indices are focused directly on the impact of perturbations on the key functions of the system. Such an approach, used by many researchers [12,45–47], is comparatively much less subjective and can be easily adaptable to various systems across time and space (contrary to resilience measurement via indices based on influencing factors).

The multidimensional and multifaceted nature of the resilience phenomenon has led to a high diversity of resilience measurement methods. However, the analysis of the literature on economic resilience suggests that two main factors influence the choice of the resilience estimation measures: the type and the dimension of the resilience in focus.

Probably the most widely researched resilience area is the absorption dimension of specified resilience [21,48,49]. For the estimation of this resilience area, the changes (either absolute or relative) in the key performances due to the disturbances are usually evaluated. For example, Martin et al. [12] suggested using the national capacity to absorb shock as a counterfactual, when the contraction in a region is compared with the contraction experienced at the country level. Kitsos and Bishop [39] compared the decline in the regional employment rate to the average of the four minimum employment rates during the given period. Gong et al. [50] contrasted key economic growth rates before and during the crisis. Recovery time and extent are some of the most frequently used measures of the adaptability dimension of specified resilience. In this line, Bristow and Healy [51] and Angulo Mur and Trivez [25] used three years as a recovery threshold to interpret whether the system was resilient. Similarly, Hill et al. [48] used four years as a maximum recovery period for a system to be indicated as resilient. Others used comparative recovery times, contrasting the recovery times of separate regions to the recovery times of the whole country [12,21]. Others estimated resilience by comparing the recovery time with "the duration and time-path of economic activity in the absence of resilience in relation to investment in repair and reconstruction" [36].

General resilience has received relatively less attention than specified resilience. Walker and Salt [52] even doubted whether it is possible to quantify general resilience, taking into account the complexity of complex adaptive systems and the potentially huge numbers of interacting system attributes influencing resilience. However, there are empirical studies on general resilience. Many of them focus on the robustness dimension of general resilience. A widely used measurement of this resilience area [17,53] is the volatility of the appropriate performance indicators. Volatility shows how intensely a system reacts to a number of disturbances during a certain period of time and thus indicates whether the general robustness of the system is increasing (if volatility is declining) or decreasing (if volatility is growing).

The research on the adaptability dimension of general resilience covers mostly theoretical discussions on the topic [20,25,54], and empirical studies are quite scarce. Several authors performing empirical studies using quantitative methods for assessment of the adaptation of general resilience analyzed resilience via the growth of the system's key functions [47,55,56]. Since many authors refer to the adaptability dimension of resilience as a return to some previous growth path [57–59] and since general resilience is concerned with at least several disturbances, the recovery from those perturbations to the previous growth path can be assumed to be the maintenance of it (or, in a better case, transformance into a better one) in the long run. Moreover, many researchers agree that perturbations and recoveries from them affect the growth path of a relevant system. If a system cannot fully recover from a crisis, its subsequent growth path reflects an inferior growth trajectory, whereas a quick and full adaptation of the system either does not change the previous growth path or transforms it into a qualitatively better one [12,37]. Thus, the growth path of a system can be assumed to portray its adaptability. Subsequent growth of indicators, reflecting essential functions of the system, can be used to estimate the general adaptability of that particular system. In summary, since resilience is a multifarious construct and there may be trade-offs among different dimensions (and types) of resilience [27,28], the measurement of the individual types and dimensions of resilience may require separate estimations, using different measurement methods. This paper focuses on the adaptability dimension of general resilience, which has received relatively little academic attention, but is essential for sustainable growth in the future [23].

2.2. Economic Resilience of Agriculture and CAP Direct Payments

Based on the discussion above, factual resilience of the agricultural sector could be measured via an index, composed of indicators reflecting the main functions of the sector. Following Volkov et al. [47], we singled out three main socio-economic functions of the agricultural sector that would be evaluated in relation to the economic resilience of the agricultural sector:

→ The production of food and other bio-based resources at affordable prices;
→ The assurance of farm viability;
→ The creation and maintenance of decent jobs.

These three functions of agriculture are supposed to be positively impacted by CAP DPs, as they reflect several main CAP goals, such as warranting a sufficient level of income for farmers and assuring a safe, healthy, and quality food supply. The research on DP impact on the economic resilience of agriculture is scarce, and many of the studies are based on qualitative, rather than quantitative, methods [60–62]. On the other hand, there is a wide array of studies analyzing DP impact on various agricultural indicators, and their empirical results suggest that the impact of direct payments on agriculture is ambiguous. In this line, a lot of studies are dedicated to determining DP impact on farm profitability—either how DPs influence changes in farm profitability (farm income, gross/net, margin, ROA, ROE, farm net value added) or how they impact the variability of farm income [63–69]. The findings of these studies reveal that DPs may both positively and negatively affect farm profitability. For example, Kryszak and Matuszczak [67] found a positive relationship between DPs and farm income in the EU. Lehtonen and Niemi [70] simulated a scenario with a 20% reduced CAP budget and found that decreased DPs would negatively affect farm income in Finland, but to a different extent among different regions. Enjolras et al. [63] concluded that whereas in Italy farmers used CAP payments to increase their income and to reduce its volatility, in France farmers tended to substitute these payments to production. Kravcáková et al. [71] observed a negative link between subsidies and ROA.

The other widely researched area of DP impact is how DPs influence farm productivity and efficiency [72–77]. The results again are quite contradictory. For example, some authors found that decoupled payments positively impacted farm productivity [78,79] and farm technical efficiency [75]. Garrone et al. [76] also found a positive relationship between DPs and labor productivity; however, they noted that the direction of the effect depends on the type of subsidy: The influence of decoupled subsidies tended to be positive, whereas that of coupled Pillar I subsidies was negative. Staniszewski and Borychowski [77] found that the relationship between subsidies and efficiency depended on the size of farms, and a positive effect was observed only for the largest farms. Pechrova [73] concluded that direct payments tended to increase farm inefficiency. These results suggest that the influence of DPs on the resilience of the function "assurance of farm viability" might be relatively small due to DPs' multi-directional effects.

The same ambiguous results were found for DP impact on agricultural production. A number of researchers found a negative CAP subsidy effect on plant production, especially in new member states [80–83]. On the other hand, other authors revealed a positive influence [84,85] on the agricultural output. A large number of authors concluded that DPs have a significant impact on agricultural employment [86–92]. The majority of these studies analyzed the impact of DPs on total employment trends, and some analyzed DP impact on family and hired labor separately. Dupraz et al. [93], Kaditi [94], Mantino [95], and Garrone et al. [92] detected a negative DP impact on both family and hired labor, whereas some authors [87] found decoupled subsidies to have had no impact on employment. These results allow it to be assumed that DP impact on the resilience of the other two key functions of agriculture might as well be relatively small.

The ambiguity of DP influence on the agricultural sector is based on the empirically verified grounds that DPs may impact key variables of the sector in quite contradictory ways. These contradictory outcomes are mainly related to the changes in the farmers' behavior due to direct payments. It has been theoretically and empirically proven that even decoupled direct payments continue to affect farm management and production decisions, which in turn result in changes in farm performance [83,96,97] at both micro and meso levels. There are several main channels through which direct payments may indirectly affect the performance of the agricultural sector—first, by influencing farmers' behavior (risk management behavior [98–100], the structure of production and farmers' orientation to the market [101–103], motivation to work efficiently and expand operations [96,104], farmers' investment decisions [105,106], and business termination and exit from the market decisions [107,108]), and second, by stimulating a price increase of land and land rent [109]. Due to the limits of this paper, the direct payments effects will not be analyzed in more detail; however, a short discussion will be provided in the results section, analyzing the obtained results of this study.

3. Methods

The goal of this paper is to assess direct payments' impact on the actual resilience of the agricultural sector. Based on the discussion provided above, resilience was measured via an index composed of the variables reflecting the core functions of the sector, which, as identified above, are (1) delivery of affordable agricultural goods, (2) assurance of farm viability, and (3) creation and maintenance of decent jobs. The indicators corresponding to each of the functions were adapted from the study performed by Volkov et al. [47], but with some modifications. Foreign trade balance of agricultural and food products, used by Volkov et al. [47], was changed into the output value of agricultural goods, as it better reflects the function "delivery of affordable agricultural goods"; foreign trade balance may be increasing even in the cases when the output of the agricultural sector is decreasing, which is not a preferred tendency. Access to credit was not included in this study due to the lack of data; however, the indicators reflecting the function "assurance of farm viability" were supplemented by an expense-to-income ratio indicator, enabling a more comprehensive view on farm viability. The indicators of the function "creation and maintenance of decent jobs" were modified to reflect only salaried employment, since maintaining overall employment levels (out of which in many countries a large part is constituted by unproductive and not perspective very small self-employed farmers) in agriculture have negative economic consequences due to slowing down economic restructuring in the sector, which is necessary for increasing its competitiveness and resilience. The indicator "labor productivity" was added to the set of indicators of employment function as a necessary attribute, reflecting quality of employment [110]. All indicators used in this study are provided in Table 1.

Table 1. Core functions of the agricultural sector and their indicators, used for measuring agricultural resilience.

Function	Indicators of the Functions	Unit	Type	Source
Delivery of affordable agricultural goods (P)	Ratio of the retail prices of food to the retail prices of all consumption goods	%	Cost (−)	EUROSTAT
	Agricultural goods output, index	%	Benefit (+)	EUROSTAT
Assurance of farm viability (V)	Net profit margin (including subsidies)	%	Benefit (+)	FADN *
	Expense-to-income ratio	%	Cost (−)	FADN
	Debt-to-assets ratio	%	Cost (−)	FADN
Creation and maintenance of decent jobs (J)	Salaried agricultural labor input, index	%	Benefit (+)	EUROSTAT
	Labor productivity	EUR/AWU	Benefit (+)	EUROSTAT
	Wages per salaried employees	EUR/AWU	Benefit (+)	FADN

* Farm accountancy data network.

The assessment of the impact of DPs on agricultural resilience consisted of several stages, resulting in a composite impact index. In the first stage the impact of DPs on the growth of separate resilience indicators was detected. Then the expert survey was performed to determine the weights of the resilience indicators. Finally, the index of the composite DP impact on the economic resilience of agriculture was constructed using multicriteria methods.

Evaluation of direct payment impact on the growth of resilience indicators. Since the focus of this paper is on the adaptability dimension of general economic resilience of the agricultural sector, which, as discussed above, can be measured via growth of appropriate indicators, the impact of DPs on the growth of appropriate indicators was evaluated. To estimate this impact, fixed effects (FE) and random effects (RE) [111] models and a one-step system (generalized method of moments (GMM) [112] were used. Panel diagnostics were performed: An F-test was conducted to check whether the FE model was adequate, in favor of the pooled OLS model alternative; a Breusch–Pagan test was carried out to check whether the RE model was adequate, in favor of the pooled OLS model alternative; and a Hausman test was completed to check whether the random effects model was consistent, in favor of the fixed effects model. GMM was performed where endogeneity issues were expected, especially when lag of the dependent variable was used in the regression. To transform skewed data to approximately conform to normality, log transformations were performed. Auxiliary regression for a non-linearity test (squared terms) was performed. To test model fit, the RE and FE models were tested for normal distribution, autocorrelation, cross-sectional dependence, and heteroscedasticity (only FE models). If there was substantial serial correlation and/or heteroscedasticity, panel-robust standard errors were used. A Pesaran CD test for cross-sectional dependence did not allow the hypothesis of cross-sectional dependence to be rejected when country-specific time trends (CSTT) were used. However, when the models were run with time dummies instead of CSTT, the Pesaran CD test showed no cross-sectional correlation. Therefore, no cross-sectional correlation could be assumed even in cases with CSTT.

Since 8 indicators were selected to reflect 3 main agricultural functions, 8 models were constructed as provided below. Fixed-effects models were used for the estimation of the DP impact on (1) agricultural output, (2) ratio of the retail prices of food to the retail prices of all consumption goods, (3) farm profitability, (4) salaried employment, and (5) wages for agricultural employees:

$$\text{lnAO}_{it} = \beta_0 + \beta_1\text{lnDP}_{it} + \beta_2\text{lnUAA}_{it} + \beta_3\text{lnPR}_{it} + \beta_4\text{TYP}_{it} + \beta_5\text{lnTUAA}_{it} + \beta_6\text{CSTT}_i + e_{it} \quad (1)$$

where lnAO_{it} represents the index of agricultural goods output for country i in time t, log-transformed; β_j represents the parameter coefficients to be estimated; lnDP_{it} is the log of direct payments per ha in country i in time t; lnUAA_{it} is the log of farm-utilized agricultural area in country i in time t; lnPR_{it} is the log of farm productivity, measured as output per ha, in country i in time t; TYP_{it} is the farm crop output share in total output in country i in time t; lnTUAA_{it} is the log of total UAA in country i in time t; CSTT_i is country-specific time trends (i = 1, . . . , 27); and e_{it} is idiosyncratic error.

$$\text{lnFP}_{it} = \beta_0 + \beta_1\text{lnDP}_{it} + \beta_2\text{GP}_t + \beta_3\text{MP}_{it} + \beta_4\text{lnLC}_{it} + \beta_5\text{lnUN}_{it} + \beta_6\text{CSTT}_i + e_{it} \quad (2)$$

where lnFP_{it} represents the ratio of food prices to the prices of all consumption goods in country i in year t, β_j represents the parameter coefficients to be estimated, lnDP_{it} is the log of DPs per ha in country i in time t, GP_t is the global food price index in time t, MP_{it} is the price index of the means of production in country i in time t, lnLC_{it} is the log of labor costs (wages and salaries) in country i in time t, lnUN_{it} is the log of total unemployment in country i in time t, CSTT_i is country specific time trends (I = 1, . . . , 27), and e_{it} is idiosyncratic error.

$$\text{PR}_{it} = \beta_0 + \beta_1\text{lnDP}_{it} + \beta_2\text{SMR}_{it} + \beta_3\text{lnUAA}_{it} + \beta_4\text{TYP}_{it} + \beta_5\text{asinDAR}_{it-1} + \beta_6\text{CSTT}_i + e_i \quad (3)$$

where PR_{it} represents average farm profitability for country i in year t, measured as net profit margin; β_j represents the parameter coefficients to be estimated; lnDP_{it} is the log of direct payments per ha in country i in time t; SMR_{it} is the ratio of output selling price to the price of the means of production in country i in time t; lnUAA_{it} is the log of farm-utilized agricultural area; TYP_{it} is the farm's crop output share of total output in country i in time t; asinDAR_{it} is the debt-to-assets ratio of an average farm in country i in time t, lagged (1st order), arcsine transformed; CSTT_i are country-specific time trends; and e_{it} is idiosyncratic error.

$$\text{lnSE}_{it} = \beta_0 + \beta_1\text{lnDP}_{it} + \beta_2\text{lnUAA}_{it} + \beta_3\text{lnPR}_{it} + \beta_4\text{TYP}_{it} + \beta_5\text{lnLC}_{it} + \beta_6\text{CSTT}_i + e_{it} \quad (4)$$

where lnSE_{it} represents salaried employment for country i in year t, measured as an index, log-transformed; β_j represents the parameter coefficients to be estimated; lnDP_{it} is the log of DPs received per ha in country i in time t; lnUAA_{it} is the log of farm-utilized agricultural area in country i in time t; lnPR_{it} is the log of farm productivity, measured as output per ha in country i in time t; TYP_{it} is the farm crop output share of total output in country i in time t; lnLC_{it} represents labor costs in country i in time t; CSTT_i are country-specific time trends; and e_{it} is idiosyncratic error.

$$\text{W}_{it} = \beta_0 + \beta_1\text{lnDP}_{it} + \beta_2\text{lnNET}_{it} + \beta_3\text{lnPR}_{it} + \beta_4\text{UN}_{it} + \beta_5\text{CSTT}_i + e_{it} \quad (5)$$

where W_{it} represents wages for agricultural employees in country i in year t, log transformed; β_j represents the parameter coefficients to be estimated; lnDP_{it} is the log of direct payments per ha in country i in time t; lnNET_{it} is the average net earnings in all economic activities in country i in time t, log transformed; lnPR_{it} is the log of farm productivity, measured as output per ha, in country i in time t, log transformed; UN_{it} is total unemployment in country i in time t, log transformed; CSTT_i is country-specific time trends; and e_{it} is idiosyncratic error.

Random-effects models were used for the estimation of the DP impact on farm efficiency and labor productivity:

$$\text{lnFE}_{it} = \beta_0 + \beta_1\text{lnDP}_{it} + \beta_2\text{SMR}_{it} + \beta_3\text{TYP}_{it} + \beta_4\text{asinDAR}_{it} + \beta_5\text{lnLI}_{it} + \beta_6(\text{lnLI}_{it})^2 + \beta_7\text{lnAvFC}_i + \beta_8\text{lnAvUAA}_i + \beta_9\text{td}_t + (v_i + e_{it}) \quad (6)$$

where $\mathrm{lnFE_{it}}$ represents the farm expense-to-output ratio (log-transformed) for country i in year t; β_j represents the parameter coefficients to be estimated; $\mathrm{lnDP_{it}}$ is the log of DPs per ha in country i in time t; $\mathrm{lnAvUAA}_{\mathbf{i}}$ is the log of the average farm-utilized agricultural area in country i; $\mathrm{TYP}_{\mathbf{it}}$ is the farm's crop output share of total output in country i in time t; $\mathrm{asinDAR}_{\mathbf{it}}$ is the debt-to-assets ratio of an average farm in country i in time t, arcsine transformed; $\mathrm{lnLI_{it}}$ is the log of total labor input in country i in time t; $\mathrm{lnAvFC_i}$ is the log of the average fixed capital per worker in country i; $\mathrm{td_t}$ is the time dummies (t = 1, . . . , T − 1; T = 14); and $\mathrm{e_{it}}$ is idiosyncratic error.

$$\mathrm{lnLP_{it}} = \beta 0 + \beta_1 \mathrm{lnDP_{it}} + \beta_2 \mathrm{lnSCit} + \beta_3 \mathrm{TYP_{it}} + \beta_4 \mathrm{lnUAA_{it}} + \beta_5 \mathrm{lnFCit} + \beta_6 \mathrm{lnAvFC_i} + \beta_7 \mathrm{lnAvUAA_i} + \beta_8 \mathrm{AvTYP_i} + \beta_9 \mathrm{td_t} + \mathrm{e_{it}} \quad (7)$$

where $\mathrm{lnLP_{it}}$ represents farm labor productivity for country i in year t, measured as output per worker (total agricultural output (production value at producer price, values at constant prices) divided by total labor force input (AWU)), log-transformed; β_j represents the parameter coefficients to be estimated; $\mathrm{lnDP_{it}}$ is the log of DPs per ha in country i in time t; $\mathrm{lnSC_{it}}$ is the log of total specific costs of a farm in country i in time t; $\mathrm{TYP_{it}}$ is a farm's crop output share of total output in country i in time t; $\mathrm{lnUAA_{it}}$—is the log of farm-utilized agricultural area in country i in time t; $\mathrm{lnAvUAA_i}$ is the log of average farm-utilized agricultural area in country i in the period 2005–2019; $\mathrm{lnFC_{it}}$ is the log of fixed capital per worker in country i in time t; $\mathrm{lnAvFC_i}$ is the log of average fixed capital per worker in country i in the period 2005–2019; $\mathrm{AvTYP_i}$ is the average farm crop output share of total output in country i in the period 2005–2019; $\mathrm{td_t}$ is the time dummies (t = 1, . . . , T − 1; T = 14); and $\mathrm{e_{it}}$ is idiosyncratic error.

One-step system GMM was used for the estimation of the DP impact on farm solvency:

$$\mathrm{asinFS_{it}} = \beta_{0} + \beta_1 \mathrm{y_{it-1}} + \beta_2 \mathrm{lnDP_{it}} + \beta_3 \mathrm{Prof_{it-1}} + \beta_4 \mathrm{TYP_{it}} + \beta_5 \mathrm{lnUAA_{it-1}} + \beta_6 \mathrm{td_t} + \mathrm{v_i} + \varepsilon_{\mathrm{it}} \quad (8)$$

where $\mathrm{FS_{it}}$ represents the farm debt-to-assets ratio for country i in year t, arcsine transformed; β_j represents the parameter coefficients to be estimated; $\mathrm{y_{it-1}}$ is a first-order lag of the farm debt-to-assets ratio, $\mathrm{lnDP_{it}}$ is the log of DPs per ha in country i in time t; $\mathrm{Prof_{it-1}}$ is a first-order lag of the farm net profit margin in country i in time t; $\mathrm{lnUAA_{it-1}}$ is a first-order lag of the log of utilized agricultural area of a farm in country i in time t; $\mathrm{TYP_{it}}$ is the farm crop output share of total output in country i in time t; $\mathrm{td_t}$ is the time dummies (t = 1, . . . , t − 2; t = 13); $\mathrm{v_i}$ is the time invariant unobserved effect, and $\varepsilon_{\mathrm{it}}$ is idiosyncratic error.

An expert survey was performed to determine the local and global weights of separate resilience indicators. The experts were selected on the basis of 2 main principles: (1) The person works directly in the field of agriculture or agrarian economics or agrarian policy, and (2) the length of service of the person in the relevant field is not less than 10 years. According to Beshelev and Gurvich [113], the number of experts should be at least the number of indicators evaluated in the group plus 1, although a larger number of experts reduces the likelihood of anomalies or marked subjectivity in the result obtained. A total of 15 experts participated in the questionnaire survey. The Kendall concordance coefficient [114] was used to determine the consistency of the estimates.

Index construction. To calculate the composite index of the DP impact on the economic resilience of agriculture according to the functions defined and the selected indicators assigned to the functions (Table 1), the multi-criteria decision-making method of simple additive weighting (SAW) was applied. This approach is highly operational and relies on the additive function [47]. The method criterion $\mathrm{S_j}$ accurately reflects the main idea of quantitative multicriteria methods, i.e., combining the values and weights of indicators into one measure—a criterion of the method.

Using this method, the following formula was applied [115]:

$$S_j = \sum\nolimits_{i=1}^{m} \omega_i \widetilde{r}_{ij} \quad (9)$$

where ω_i is the weight of indicator i, and $\widetilde{r}_{ij}$ is the normalized value of indicator i for function j.

The weights of each function and separate indicators of the functions were obtained from the expert survey.

Since calculating the DP impact, logarithmic transformation of the DP values had to be performed. The subindices (and the general index) were calculated as a change, which would be obtained due to a change in the amount of DPs (with other variables keeping constant). Therefore, $\widetilde{r}_{ij}$ was calculated in two ways, depending on whether the resilience indicator was log-transformed.

When β_{DPi} is the estimated regression coefficient for lnDP, as estimated in FE/RE/GMM models for resilience indicator *i*, when resilience indicator *i* is not log transformed:

$$\widetilde{r}_{ij} = \Delta r_{ij}/\overline{r}_{ij} \times 100\% \quad (10)$$

where Δr_i is the change in resilience indicator *i*, induced by a change in DPs (other variables keeping constant), and $\overline{r}_i$ is the mean value of indicator *i*.

$$\Delta r_{ij} = r_{\mathrm{ij}}(\mathrm{DP}_2) - r_{\mathrm{ij}}(\mathrm{DP}_1) = \beta_{\mathrm{DPi}} \times [\ln(\mathrm{DP}_2) - \ln(\mathrm{DP}_1)] = \beta_{\mathrm{DPij}} \times [\ln(\mathrm{DP}_2/\mathrm{DP}_1)] \quad (11)$$

when β_{i} is the estimated regression coefficient for lnDP, as estimated in FE/RE/GMM models for resilience indicator *i* when resilience indicator *i* is log transformed.

$$\widetilde{r}_{ij} = \ln(\mathrm{r_{ij}}(\mathrm{DP}_2)) - \ln(\mathrm{r_{ij}}(\mathrm{DP}_1)) = ((\mathrm{DP}_2/\mathrm{DP}_1)^{\beta_{\mathrm{DPij}}} - 1) \times 100\% \quad (12)$$

4. Data, Results, and Conclusions

4.1. Data

The research focused on the period 2005–2019 and covered 27 EU countries (including United Kingdom and excluding Croatia, which joined the EU in 2013, much later than the other new member states, which joined the EU in 2004).

The analysis of the indicators of the function "delivery of affordable foods" showed that the agricultural output, although quite volatile, exhibited a positive tendency (Figure 1). The ratio of the retail prices of food to the retail prices of all consumption goods was increasing, meaning that the prices of food were growing relatively faster than the prices of all consumption goods; however, this increase was quite slight (Figure 1).

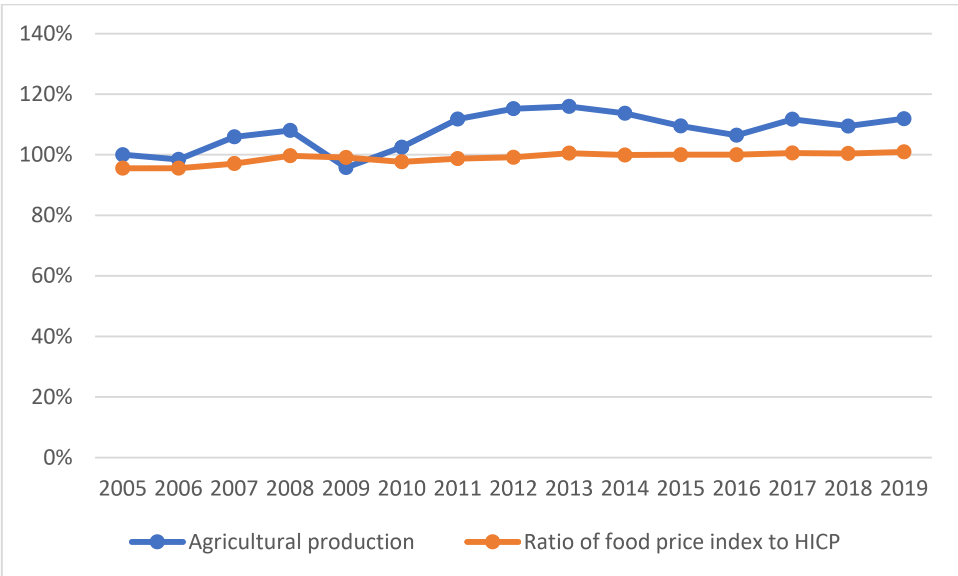

Figure 1. Index of agricultural goods output in EU-27 and ratio of the retail prices of food to the retail prices of all consumption goods in 2005–2019. Source: compiled by authors based on the data provided by EUROSTAT.

Farm viability indicators were relatively stable over the period of analysis; however, a slight decrease in farm profitability and farm expense-to-income ratio was observed (Figure 2).

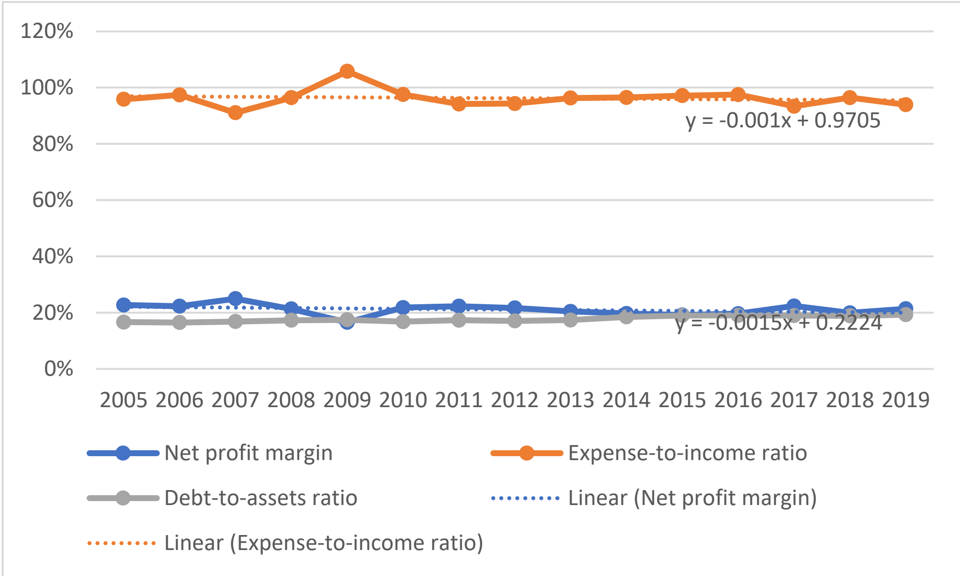

Figure 2. Average net profit margin (including subsidies) expense-to-income ratio and debt-to-assets ratio of commercial farms in EU-27 in 2005–2019. Source: compiled by authors based on the data provided by FADN.

Wages for agricultural workers in the EU-27 steadily grew from the beginning of the period (Figure 3a). However, employment of hired employees slightly decreased in the 2007–2011 period, after which employment started to grow again up until 2016, followed by a slight decrease afterwards. The labor productivity steadily and significantly grew throughout the period (labor productivity almost doubled since 2005), with a single decrease in 2009 (Figure 3b).

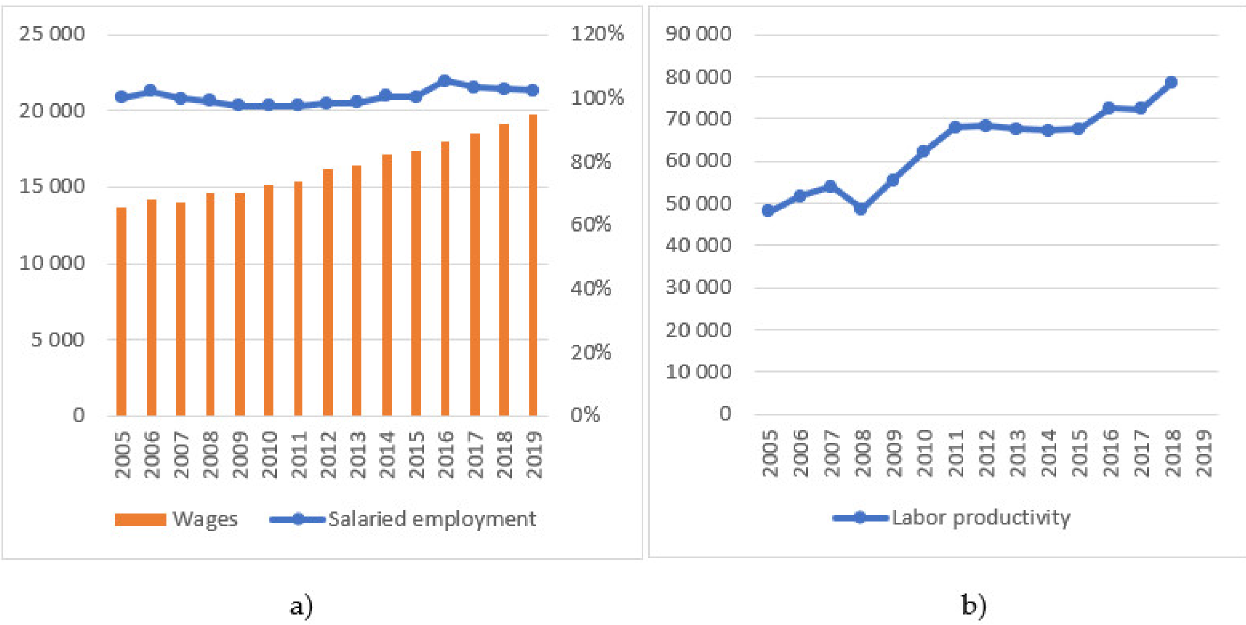

Figure 3. (**a**) Index of salaried employment (%) and wages (EUR/AWU) in EU-27. (**b**) Labor productivity in EU-27 in 2005–2019, EUR/AWU. Source: compiled by authors based on the data provided by EUROSTAT and FADN.

The average DPs level in the EU-27 rose during the research period of 2005–2019 (Figure 4); however, different tendencies were observed in old and new member states (MS): In OMS the DPs exhibited a tendency to decrease, which is due to declining total amounts of financial funds allocated to DPs in most OMS in the last decade (except for Spain, Portugal, Finland, Sweden, and the UK). Meanwhile, average DP amounts in NMS increased due to the convergence principle between OMS and NMS and subsequently growing amounts of funding coming from the European Agricultural Guarantee Fund (EAGF) for NMS.

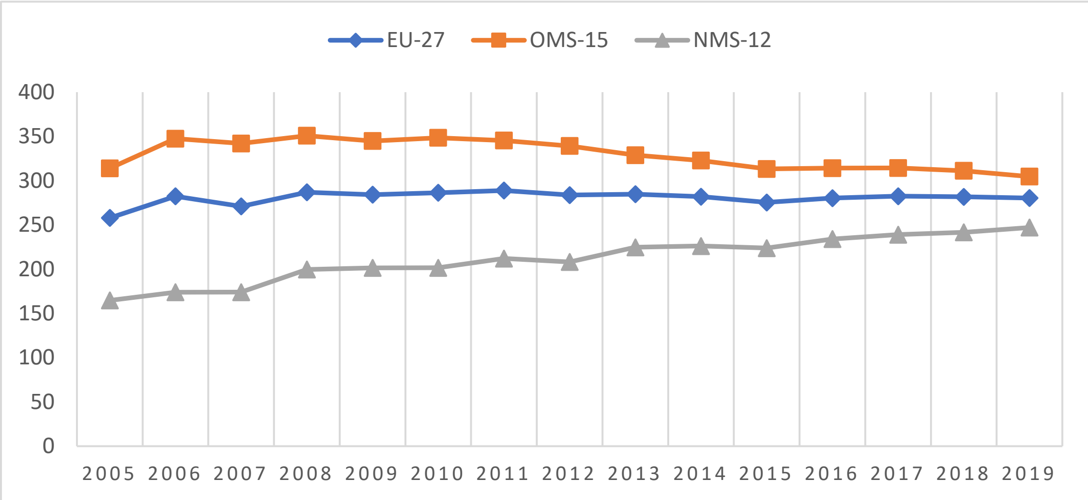

Figure 4. DPs per ha in the EU-27 in 2005–2019, EUR (FADN).

Summary statistics for variables used in the models are provided in Appendix A (Table A1).

4.2. Results and Discussion

Results of the Evaluation of Direct Payments Impact on Individual Resilience Indicators.

Model for DP impact on agricultural production. Table 2 reports the results for panel fixed-effects estimation. (Due to the paper's limits, the results for country-specific time trends or time dummies (as applicable to other models in this paper) are provided in the annex.) The results revealed a significant negative impact of DPs on total agricultural output—a 10% increase in DPs, leading to a decrease of the expected agricultural output by 1%.

Table 2. Modeling results for the model of direct payment impact on agricultural production.

Dependent Variable: Agricultural Production		*Coefficient*	*Std. Error*	*p-Value*	*Significance*
Const	β_0	1.54	1.61	0.348	
ln DPs	β_1	−0.1	0.05	0.0395	**
ln UAA	β_2	0.14	0.05	0.015	**
ln Output per ha	β_3	0.51	0.06	<0.001	***
Crop output share in total output	β_4	0.27	0.15	0.084	*
ln Total UAA in a country	β_5	−0.1	0.19	0.602	

Observations: 400. Robust (HAC) standard errors. Within R-squared = 0.68. Significance levels: $p < 0.01$ ***, 0.05 **, 0.1 *.

The observed negative impact is in line with the conclusions of the other authors, including Doucha and Foltýn [80], Chrastinová and Buriánová [81], Mala et al. [82], and Opatrny [83]. The negative influence may have been caused by several earlier documented DP effects stimulating non-preferrable changes in farmers' behavior, such as decreasing motivation to produce [96,116] shifts in production structures [117,118], changes in risk management behavior [100,119], etc.

Model for DP impact on ratio of food prices to prices of consumer goods. The impact of DPs on the food price ratio was negative, but statistically only marginally significant ($p = 0.065$) (Table 3).

Table 3. Modeling results for the model of direct payment impact on ratio of food prices to prices of consumer goods.

Dependent Variable: Ratio of Food Prices to Prices of Consumer Goods		*Coefficient*	*Std. Error*	*p-Value*	*Significance*
const	β_0	−0.19	0.14	0.166	
ln DPs	β_1	−0.03	0.02	0.065	*
Global food price index	β_2	$1.90 \times 10-^{4}$	0	0.242	
Price index of means of production	β_3	0.001	0	0.001	***
ln Labor costs	B_4	0.04	0.03	0.172	
ln Total unemployment	B_5	0.002	0.01	0.839	

Observations: 394. Robust (HAC) standard errors. Within R-squared = 0.79. Significance levels: $p < 0.01$ ***, 0.1 *.

These findings were not unexpected. Without DPs, a food price increase would be expected, since farmers would be trying to keep farm business profitability up to some level [66,120]. By receiving DPs, farmers can afford to accept lower purchase prices for their agricultural goods [121,122]. Moreover, DPs can provide farmers with the relevant funds to invest in increasing farm efficiency, which in turn could reduce production costs and potentially food prices [123]. According to Brady et al. [66], DPs may influence generations of additional supply, which could also lower output prices, resulting in lower food prices and in turn lower the food and all consumption goods price ratio.

Model for DP impact on farm profitability. The results showed that DPs tended to exert a positive influence: A 10% growth in DPs would encourage an increase in farm net profit margin by 0.008 percentage points (Table 4). This was an expected result, which is also in line with the conclusions of the other studies [67,70,124].

Table 4. Modeling results for the model of direct payment impact on farm profitability.

Dependent Variable: Net Profit Margin		*Coefficient*	*Std. Error*	*p-Value*	*Significance*
const	β_0	−0.7	0.2	0.002	***
ln DPs	β_1	0.08	0.03	0.017	**
Ratio of output sell price to the price of means of production	β_2	0.38	0.06	<0.001	***
ln UAA	β_3	0.004	0.04	0.918	
Crop output share in total output	β_4	0.2	0.06	0.004	***
Debt to assets ratio (lag 1)	β_5	−0.002	0.01	0.22	

Observations: 367. Robust (HAC) standard errors. Within R-squared = 0.56. Significance levels: $p < 0.01$ ***, 0.05 **.

However, it may be assumed that this impact is relatively small since a number of authors have documented a negative or an ambiguous impact of DPs on various farmers' managerial decisions, which in turn affected farms' profitability. In this line, Enjolras et al. [63] found that DPs may be used as a partial substitute for production. Balezentis et al. [125] suggested that CAP payments may undermine motivation for higher market integration, subsequently affecting profit margins of farms. Brady et al. [66] argued that DPs may be constraining income growth in productive regions by slowing down structural change. These negative impacts may be decreasing positive direct effects of DPs on farm profitability.

Model for DP impact on farm efficiency. Similar results were revealed by both RE and FE models. According to them, DPs tended to statistically significantly positively influence the farm expense-to-output ratio (Table 5), meaning that increasing DPs tended to increase inefficiency. These results confirm the findings of many other studies [73,126,127].

Table 5. Modeling results for the model of direct payment impact on farm efficiency.

Dependent Variable: Expense-to-Output Ratio		RE Model				FE Model		
		Coefficient	*Std. Error*	*p-Value*	*Significance*	*Coefficient*	*p-Value*	*Significance*
Const	β_0	0.25	0.24	0.293		0.07	0.796	
ln DPs	β_1	0.07	0.03	0.023	**	0.07	0.045	**
Ratio of output selling price to the price of means of production	β_2	−0.34	0.08	<0.001	***	−0.35	<0.001	***
Crop output share in total output	β_3	−0.36	0.1	<0.001	***	−0.34	0.002	***
Debt-to-assets ratio	β_4	0.003	0.003	0.331		0.002	0.528	
ln Total labor input	β_5	−0.22	0.1	0.028	**	−0.21	0.057	*
squared ln Total labor input	β_6	0.09	0.03	<0.001	***	0.09	0.007	***
ln average fixed capital per worker	β_7	−0.05	0.02	0.007	***			
ln average UAA	β_8	0.1	0.03	0.003	***			
Observations: 394. Robust (HAC) standard errors			$R^2 = 0.55$				$R^2 = 0.37$	

Significance levels: $p < 0.01$ ***, 0.05 **, 0.1 *.

DPs may exert a negative impact on efficiency in several ways. Minviel and De Witte [104] and Patton et al. [96] argued that farmers' motivation and subsequently efforts to work efficiently may be reduced if subsidies compose a larger part of their income. In addition, by providing necessary financial funds, DPs enable marginal farmers to stay in the market, lessening their motivation to improve their performance [116]. Furthermore, DPs may also encourage overinvestment in capital, resulting in allocative inefficiency [106,128]. DPs encourage increases in prices of land and land rent [129–131], thus having the potential to contribute to increasing costs and subsequently decreasing efficiency. It must be noted, however, that some studies, contrary to the above-described ones, have found DPs to be positively influencing efficiency [75,78,79]. The ambiguity of results provided by different studies again suggest that DPs may have both positive and negative effects depending on how they are used by the farmers.

Model for DP impact on farm solvency. The results showed that DPs tended to have a positive influence on the farm debt-to-assets ratio; however, this influence was not statistically significant (Table 6). These findings should not be seen as unexpected. Although DPs directly increased the assets owned by the farm and thus should have been contributing to decreases in farms' debt-to-assets ratios, these subsidies improved farmers' access to credit [132] and thus may subsequently have led to a higher borrowing and increased debt-to-assets ratio.

Table 6. Modeling results for the model of direct payment impact on farm solvency (time dummies were included in the primary model, but the Wald joint test for time dummies suggested that none of them were significant, and therefore time dummies were removed).

Dependent Variable: Debt-to-Assets Ratio		*Coefficient*	*Std. Error*	*p-Value*	*Significance*
Const	β_0	−21.39	20.97	0.308	
Debt to assets ratio (lag 1)	β_1	0.93	0.12	<0.001	***
ln DPs	β_2	2.72	2.85	0.339	
Net profit margin (lag 1)	β_3	−3.88	9.25	0.675	
Crop output share in total output	β_4	10.55	8.54	0.217	
ln UAA (lag 1)	β_5	1.95	1.55	0.209	

Number of instruments = 15. Test for AR(1) errors: z = −2.71 [0.007]. Test for AR(2) errors: z = −0.21 [0.834]. Sargan over-identification test: Chi-square(9) = 10.45 [0.301]. Wald (joint) test: Chi-square (5) 983.2 [0.0000]. Observations: 374. Significance levels: $p < 0.01$ ***.

These results confirmed the findings of other authors [133], although there were also examples of opposite direction, stating that subsidies should stimulate the decrease in the debt-to-asset ratio [134].

Model for DP impact on salaried employment. The results showed a negative DP impact on salaried employment in agriculture (Table 7), which was statistically significant.

Table 7. Modeling results for the model of direct payments impact on salaried employment.

Dependent Variable: Salaried Employment		*Coefficient*	*Std. Error*	*p-Value*	*Significance*
const	β_0	5.5	0.49	<0.001	***
ln DPs	β_1	−0.16	0.06	0.007	***
ln UAA	β_2	−0.05	0.09	0.574	
ln Labor productivity	β_3	−0.02	0.05	0.681	
Crop output share in total output	β_4	0.004	0.18	0.981	
ln Labor costs	β_5	0.04	0.05	0.427	

Observations: 401. Robust (HAC) standard errors. Within R-squared = 0.64. Significance levels: $p < 0.01$ ***.

These findings are in line with those of the other researchers [81,92,95]. Negative effects may be exerted via several channels. Introduction of the single-farm payment scheme in 2005 may have stimulated the decline in agricultural employment, since production levels for receiving subsidies were no longer required and thus hired labor may have been released [82]. The shifts in production structures, moving from more to less labor-intensive production (especially grains), which was documented in at least several new member states [95,117], could also be contributing to the decrease in the demand for hired labor. Decreasing motivation to produce, prompted by DPs [95,135], may slow down the use of hired labor. Support may also encourage farms to change their capital–labor combination [106] and thus negatively influence their demand for labor.

Model for DP impact on labor productivity. The results revealed a positive and statistically significant impact of DPs on labor productivity (Table 8). The results obtained by both the RE and FE models were very similar.

Table 8. Modeling results for the model of direct payment impact on labor productivity.

Dependent Variable: Labor Productivity		RE Model				FE Model		
		Coefficient	*Std. Error*	*p-Value*	*Significance*	*Coefficient*	*p-Value*	*Significance*
Const	β_0	−7.27	1.21	<0.001	***	−2.33	0.003	***
ln DPs	β_1	0.31	0.06	<0.001	***	0.31	<0.001	***
ln Total specific costs	β_2	0.13	0.06	0.023	**	0.11	0.089	*
Crop output share in total output	β_3	0.59	0.29	0.042	**	0.6	0.043	**
ln UAA	β_4	−0.25	0.19	0.187		0.08	0.61	
ln Fixed capital per worker	β_5	0.2	0.07	0.004	***	0.21	0.008	***
ln Average fixed capital per worker	β_6	0.37	0.08	<0.001	***			
ln Average UAA	β_7	0.12	0.14	0.396				
Average Crop output share in total output	β_8	0.05	0.8	0.954				
Observations: 401 Robust (HAC) standard errors		$R^2 = 0.83$				$R^2 = 0.72$		

Significance levels: $p < 0.01$ ***, 0.05 **, 0.1 *.

These findings are in line with the conclusions of other researchers [76,79]. DPs enable farmers to overcome financial constraints; if farmers are encouraged to invest in modernization or expansion of the farm, a positive impact on labor productivity is expected [105]. It is interesting to note, however, that opposite results were also confirmed [136,137]. Decreasing motivation to produce [96,116,138] due to the subsidies may reduce labor productivity. Some authors, therefore, stated that the positive relationship between DPs and labor productivity may be artificial, i.e., attained more by a decrease in unproductive labor units or shifts in production structure than actual increases in productivity [139].

Model for DP impact on wages of agricultural employees. The results showed a positive relationship between DPs and wages of agricultural employees; however, it was not statistically significant (Table 9).

Table 9. Modeling results for the model of direct payment impact on wages of agricultural employees.

Dependent Variable: Wages		*Coefficient*	*Std. Error*	*p-Value*	*Significance*
Const	β_0	2.86	0.86	0.003	***
ln DPs	β_1	0.03	0.05	0.584	
ln Net earnings in a country (total NACE)	β_2	0.53	0.11	<0.001	***
ln Labor productivity	β_3	0.12	0.06	0.047	**
ln Total unemployment	β_4	−0.01	0.02	0.469	

Observations: 391. Robust (HAC) standard errors. Within R-squared = 0.93. Significance levels: $p < 0.01$ ***, 0.05 **.

A negligible impact of DPs on wages was expected, since the contribution of other factors, especially the level of wages in other economic sectors in the country, should be much more important [140]. Of course, DPs may exert indirect effects on wages, but they may also be ambiguous, as discussed above, due to the contradictory effects of DPs on farmers' behavior. Overall, the literature on the subsidy–wage relationship (namely, for hired labor) is quite scarce.

In summary, the results of this study showed that DPs had a statistically significant effect on six out of eight resilience indicators, out of which, taking into account the goals of the CAP, only the food price ratio, farm profitability, and labor productivity were influenced positively. On the other hand, farm efficiency, total agricultural production, and hired employment rates in the agricultural sector were affected negatively.

Results of the expert survey. The expert survey was used to determine the weights of the individual resilience indicators (Table 10).

Table 10. Weights of individual functions and their indicators (results of expert evaluation).

Function	Average Score	St. Dev.	Local Weights		Global Weights	
Agricultural Functions						
Production of affordable food and other bio-based resources (P)	4.89	0.33	ω_1	0.4		
Assurance of farm viability (V)	4	1	ω_2	0.32		
Creation and maintenance of decent jobs (E)	3.44	0.73	ω_3	0.28		
Indicators						
Agricultural goods output	4.44	0.53	ω_1^1	0.49	w_1^1	0.19
Ratio of the retail prices of food to the retail prices of all consumption goods (–)	4.67	0.5	ω_2^1	0.51	w_2^1	0.2
Farm Profitability (subsidies included)	4	1.32	ω_1^2	0.32	w_1^2	0.1
Farm efficiency (subsidies excluded) (–)	4.5	0.76	ω_2^2	0.36	w_2^2	0.12
Farm Solvency (–)	4	0.5	ω_3^2	0.32	w_3^2	0.1
Salaried employment	3.11	0.93	ω_1^3	0.26	w_1^3	0.07
Labor productivity	4.22	0.97	ω_2^3	0.36	w_2^3	0.1
Wages for agricultural employees	4.56	0.53	ω_3^3	0.38	w_3^3	0.11

Note: (–) indicates that a certain criterion negatively contributes to the agricultural resilience.

The answers of the experts in assessing the weights of the indicators were consistent. Kendall's concordance coefficient of expert answers in estimating the weights for the resilience functions was equal to 0.94, for function P indicators (W_P) it was equal to 0.93, for V function's indicators (W_V) 0.83, and for function's E indicators (W_E) 0.92.

The results showed that "production of affordable agricultural products" was considered the most important function of agriculture, followed by "assurance of farm viability." The least important agricultural function, according to the experts, was "creation and maintenance of decent jobs."

Results of the index construction. The DP impact coefficients for each indicator were aggregated to estimate both DP impact on the resilience of each key agricultural function as well as DP impact on the whole economic resilience of the agricultural sector (direct payment impact index (DPII)). The index and its subindices were calculated using the multi-criteria SAW method using the weights obtained in the expert survey. The index (and subindices) was constructed to reflect a percentage change in resilience (or a certain function in the case of subindices) due to a certain change in DPs—in our case an increase in DPs by 10% (with other variables keeping constant) (Table 11).

Table 11. Subindices of DP impact on the performance of key functions of the agricultural sector in EU-27.

Index/Subindices	Key Function	Value
DPII		0.37%
$DPII_{production}$	Delivery of affordable food and other bio-based resources	−0.34%
$DPII_{farm\_viabilityn}$	Assurance of farm viability	0.97%
$DPII_{jobs}$	Creation and maintenance of decent jobs	0.68%

The results showed that an increase in DPs by 10% would positively stimulate the performance of two key agricultural functions—"farm viability" and "salaried employment," whereas "delivery of affordable food and other bio-based resources" would be impacted negatively. Overall, an increase in DPs by 10% would encourage an increase in economic resilience of the agricultural sector by 0.368%.

The negative impact of DPs on the function "delivery of affordable food and other bio-based resources," which experts rated as the most important one, was determined by the negative DP effect on agricultural output as the influence on food prices turned out to be positive (decreasing food price ratio). The analysis of earlier research enabled several transmission channels of this negative influence to be distinguished. First, DP influence changed in farmers' motivation to produce and manage business in the most efficient way overall. According to the motivation crowding effect, subsidies may undermine (or under certain conditions, stimulate) motivation to act in a certain way [141]. Thus, farmers' efforts in their agricultural businesses may be reduced if a substantial part of their income is guaranteed by the subsidies [104]. Farmers may be discouraged to use the maximum potential agricultural area for production, to use qualitatively better inputs, or to make other production and management decisions negatively impacting the farm's output. Since such decisions are systematic, i.e., made by many farmers, they have a significant influence on the total agricultural output in a country. Moreover, if DPs help the farmers to avoid bankruptcy, then these farmers have less motivation to improve their competitive standings, as they would inevitably be forced to do in the case without support in order to stay in business [116]. Moreover, farms may become more inclined to invest in subsidy-seeking rather than in productive agricultural activities. Finally, since DPs are tied to land, farmers may be spurred to change their production structures in favor of produce requiring larger areas, such as crop farming. The shift of production, mainly from animal husbandry to crop farming, has been documented in at least several new member states [116–118]. Although these unfavorable effects may be at least partly compensated by the positive impact of DPs on improving access to credit and increasing investment capacity, which subsequently may result in increases in productivity, the net effect seems to be negative.

The function "assurance of farm viability" experienced the strongest influence from DPs, which was not unexpected, since DPs directly augment farmers' financial funds. According to the results, a change in DP level by 10% would stimulate a change in farm viability by 0.967%. However, this positive impact masks important concerns. DPs unquestionably increase farm profits, especially in the short term. However, DP impact on farm efficiency appears to be negative. Decreasing farms' efficiency leads to decreasing farms' competitiveness and profitability and subsequently to increasing need for more subsidies, and thus the vicious circle rotates further on. This is strongly related to the above-discussed relationship between DPs and motivation.

The positive relationship with DPs was also revealed for the third key agricultural function, "creation and maintenance of decent jobs." Growth of DPs by 10% would tend to encourage growth of this function by 0.682%. This positive impact was determined by

DPs' positive effect on labor productivity, which is one of the key factors strengthening the agricultural sector and its further development. However, salaried employment was affected negatively. The decrease in overall employment in agriculture was observed across all EU countries, and in general was not considered negative, since this enabled the restructuring of the sector into a more competitive one. However, this is usually the case when employment in the sector decreases due to the exit of small relatively unproductive subsistence and semi-subsistence farms, employing mostly only the farmer himself and to some extent his family members. However, this was not the case with the decreasing numbers in salaried employment. The tendency for DPs to stimulate a decrease in hired labor suggests that several processes in addition to technological advancement may have been happening. Firstly, due to DPs, farms have less motivation to produce and/or change the production structure to one requiring lower labor input, so they may reduce the number of employees. This consideration supports the findings of Mantino [95]. Second, farmers may be overinvesting in capital, thus negatively affecting the demand for labor [142]. Finally, DPs are inhibiting sector restructurization and slowing down the expansion of perspective viable farms, which could be hiring more paid labor.

DP impact on the above-described functions determine the overall impact of DPs on economic resilience of the agricultural sector. The revealed impact is positive: An increase in DPs by 10% would encourage growth of overall sector's resilience by 0.368%. DPs are an important instrument to hold up farmers' income and thus contribute to their viability at least in the short term. However, this positive impact could be considered relatively small, as the overall resilience was curtailed by negative DP influence on three (out of eight) resilience indicators. Moreover, DPs may influence resilience elements in contradictory ways, therefore lessening the net positive effect even on those indicators that were documented to be positively impacted by DPs. These findings suggest that one of the major issues of DPs in relation to resilience is concerned with the side effects of these subsidies changing farmers' behavior in non-preferable ways. Furthermore, although it is not the focus of this paper, the costs are another important issue related to DPs. Agriculture is the most subsidized sector, receiving more than 40% of the total EU budget (of which about 70% was allocated to DPs) in 2005–2019 and around 30% in the upcoming financial period. These costs, together with a relatively small impact on agricultural resilience, which is a necessary precondition for the sector's sustainable development, raises serious questions of the cost-effectiveness of this support system.

5. Conclusions and Policy Implications

Resilience is a multifaceted phenomenon encompassing several types and dimensions of a system's (potential) reactions to perturbation(s). Such multidimensionality has resulted in a quite loose usage of the concept in the literature and diversity of resilience measurement methods. In this paper, the most-often-used methods of resilience operationalization are presented, and a categorization into two main groups—measuring actual resilience and resilience potential—is suggested. In addition, a grouping of ways to measure actual resilience is proposed, based on the type of resilience and its dimension in focus, distinguishing four resilience quadrants.

From the methodological perspective, this study introduces a new innovative framework for measuring subsidy impact on sectoral economic resilience. The composite impact indicator allows the effects of potential intervention measures to be modeled and the effects of factual interventions on resilience of the whole sector to be evaluated. It can also be used to prioritize governmental support measures among each other.

The empirical application revealed that overall DPs have a positive impact on the economic resilience of agriculture in the EU-27. This positive effect was determined mainly by DPs' positive influence on farm profitability, labor productivity, and the ratio of food prices to prices of all consumer goods. The influence on farm solvency and wages of hired agricultural employees appeared to be insignificant. The negative impact was observed on farm efficiency, total agricultural production, and salaried employment. These negative effects, especially on farm efficiency, raise serious concerns of whether the overall positive DPs impact on farm viability and subsequently economic resilience of agriculture is sustainable, especially keeping in mind that the signs of a vicious circle are emerging: the more payments farmers obtain, the less motivated they are to act in the most effective and efficient manner to adapt to the changes in the market and environment, which leads to decreased income and increased need for subsidies. Farmers' declining motivation to act effectively and to adapt to the changes in the market is probably the most alarming aspect, revealed by the negative impact of DPs on farm efficiency, since it may undermine the development of farmer adaptation capacities necessary for the resilience of individual farms and the whole sector in the long run. Given that the current CAP DP system has other serious drawbacks (distribution of payments, leakage to land and land rent prices, etc.), a radical transformation of the CAP DP system is recommended.

Based on the discussion and conclusions, several policy recommendations are offered. First, DPs should not be linked to land. This would allow various negative side effects to be avoided, including land and land rent price increase, growth of the income gap among large and small farms, and waste of support on "couch-farmers." Second, instead of tying payments to land, they should be linked to specific preferred behavior, thus enabling a more efficient and effective increase in resilience, and not slowing down the restructurization process, which is necessary for a more a competitive and resilient agricultural sector. Several types of behavior are confirmed to significantly positively influence resilience: learning, collaboration, innovation, and participation. Accordingly, linking payments to such preferred behaviors should be a prospective way of increasing resilience and farmers' income in addition avoiding negative side effects. Third, coupled payments should be averted due to their significant negative effect on farmers' orientation to the market. Income support for specific sectors may be necessary in the case of crisis; however, subsidies should not exceed income loss compensation up to a minimum level—otherwise, farmers' motivation to manage their risks properly could be impaired.

Given the relatively small positive impact on resilience of the agricultural sector, the issue of cost-effectiveness arises, as in 2005–2019 almost 40% of the total EU budget was dedicated to CAP, out of which around 70% was paid as DPs. This could be a fruitful direction for future research. The other potential research areas encompass, but are not limited to, assessing DP impact on overall resilience of agriculture, including the environmental dimension; estimating influence of other support schemes on the resilience of agriculture; etc.

The limitations of this study (empirical evidence based on the aggregate EU level) suggest expanding this research to a regional, state, and/or micro level to capture the heterogenous effects that DPs can have on different subsectors or farms of different sizes. This would allow it to be revealed whether the determined effects (especially in terms of farm viability) prevail across different EU countries, regions, subsectors, and farms, or whether there are significant differences. A natural direction for such research would be to explore DP impact on economic resilience of agriculture separately for EU old and new member states.

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Appendix A

Table A1. Descriptive statistics for the variables used in the empirical models.

Variable	Unit of Measure	Obs.	Mean	Std. Dev.	Min	Max
Direct Payments	EUR/ha	401	310.46	224.08	61.58	2306.3
UAA	Ha	401	75.61	100.63	2.56	615.33
Agricultural production index	%	405	107.75	14.72	76.08	150.92
Crop output share in total output	%	401	0.52	0.14	0.11	0.75
Output per ha	EUR/ha	401	2794.9	3148.7	484.53	15.739
Global food price	Index, %	405	100.14	11.22	76.8	118.8
Prices of means of production	Index, %	398	110.45	9.06	83.68	134
Food price HICP ratio	%	405	0.99	0.04	0.83	1.16
Net profit margin	%	401	0.21	0.12	−0.22	0.5
Debt-to-assets ratio	%	400	17.82	14.67	0.03	60.23
Ratio of output sell price to the price of means of production	%	398	0.97	0.09	0.76	1.32
Expense-to-output ratio	%	401	0.96	0.17	0.59	1.75
Fixed capital per worker	EUR/AWU	401	2.6×10^5	2.9×10^5	9000.8	1.32×10^6
Total labor input	AWU	401	2.35	2.58	1.02	20.73
Salaried employment index	%	405	100.41	24.54	49.65	198.57
Labor productivity	EUR/AWU	405	52.26	46.73	5.18	230.99
Total specific costs	EUR	401	60,199	65,489	3453	3.32×10^5
Wages per AWU	EUR	401	16,301	10,060	1905	44,897
Net earnings in a country (total NACE)	EUR	391	18,887	10,764	2605.9	42,584
Labor costs (wages and salaries)	Index, %	405	91.66	17.3	32.2	170.6
Total unemployment	%	405	8.46	4.29	2	27.5

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