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LITHUANIAN CENTRE FOR SOCIAL SCIENCES

Agnė ŽIČKIENĖ

IMPACT ASSESSMENT OF DIRECT PAYMENTS OF EU COMMON AGRICULTURAL POLICY ON ECONOMIC RESILIENCE OF AGRICULTURE

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Abstract

Agriculture's resilience has been identified as one of the main priorities of the 2023–2027 Common Agricultural Policy agenda (EU Commission, 2020), as it is widely accepted that resilience is a key pre-condition for the sector's sustainable development. The goal of resilience growth necessitates an objective evaluation of resilience changes and the estimation of the impact (possibly) made by various factors on resilience. However, the concept of resilience is still very ambiguous, lacking a universally agreed methodology for its evaluation and empirical evidence on how to support policies that influence agriculture's economic resilience. Therefore, the dissertation aimed to assess the impact of direct payments on the economic resilience of agriculture. The study resulted in an integrated index of the direct payments' impact on agriculture's economic resilience.

The following main tasks were resolved during the study: the analysis of the scientific literature was performed to study the nature, development, measurement, and use of the resilience concept and, subsequently, to apply it to the assessment of agriculture's resilience; the existing research on the assessment of direct payments' impact on individual agricultural indicators was systematized; a set of indicators reflecting agriculture's economic resilience was formed; a theoretical model for the assessment of the direct payments' impact on agriculture's economic resilience was created; and its practical adaptability was verified at the level of the EU-27, the OMS-15 and the NMS-12 in 2005–2019.

The dissertation consists of an introduction, three chapters, general conclusions, references, and a list of the author's publications on the topic of the dissertation. The first chapter presents the analysis of the resilience concept, its operationalization and measurement, and the rationale for integrating the resilience construct in the agricultural context. Also, it provides a developed theoretical model of the direct payments' impact on agriculture's economic resilience. The second chapter presents the theoretical model for assessing the direct payments' impact on agriculture's economic resilience and the description of its elements. The third chapter presents the empirical results of the model application in the EU-27, the OMS-15, and the NMS-12. The obtained results were used to formulate conclusions and proposals on how to improve the system of direct payments support.

Six scientific articles were published on the topic of the dissertation; presentations were made at two international scientific conferences; and an internship took place at the University of Łódź (Poland), where the results of the dissertation were presented.

Reziumė

Žemės ūkio atsparumas akcentuojamas kaip vienas pagrindinių 2023–2027 m. BŽŪP darbotvarkės tikslų (ES Komisija, 2020), kadangi plačiai sutariama, jog atsparumas yra būtina šio sektoriaus darnios plėtros sąlyga. Siekiant efektyviai skatinti atsparumo augimą, būtinas objektyvus atsparumo reiškinio pokyčių bei įvairių veiksnių (galimos) įtakos atsparumui įvertinimas. Tačiau atsparumo koncepcija vis dar nėra išgryninta, vis dar nėra visuotinai priimtos atsparumo vertinimo metodikos, taip pat trūksta empirinių įrodymų, kaip paramos politika veikia ekonominį žemės ūkio atsparumą. Todėl pagrindinis šios disertacijos tikslas – įvertinti tiesioginių išmokų poveikį žemės ūkio ekonominiam atsparumui. Galutinis darbo rezultatas – integruotas tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui indeksas.

Darbo metu buvo sprendžiami tokie pagrindiniai uždaviniai: atlikta mokslinės literatūros analizė, siekiant ištirti atsparumo koncepto prigimtį, raidą, matavimą ir naudojimą bei pritaikyti jį žemės ūkio kontekste; susisteminti ankstesni tiesioginių išmokų įtakos atskiriems žemės ūkio rodikliams vertinimo tyrimai; suformuota žemės ūkio ekonominio atsparumo rodiklių sąranka; sukurtas tiesioginių išmokų poveikio žemės ūkio ekonominiam atsparumui vertinimo teorinis modelis bei patikrintas jo praktinis pritaikomumas ES-27, SŠN-15 ir NŠN-12 mastu 2005–2019 m.

Disertaciją sudaro įvadas, trys skyriai, bendrosios išvados, naudotos literatūros ir autorės publikacijų disertacijos tema sąrašai. Pirmajame skyriuje pateikta atsparumo sampratos, jos operacionalizacijos ir matavimo būdų analizė, pagrįstas atsparumo konstrukto integravimas žemės ūkio kontekste. Taip pat sukurtas tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui modelis. Antrame skyriuje pateiktas tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui vertinimo teorinis modelis, aprašyti jo elementai. Trečiame skyriuje pateikiami empiriniai modelio pritaikymo ES-27, bei SŠN-15 ir NŠN-12 mastu rezultatai. Galiausiai, suformuluotos išvados ir pasiūlymai, kaip pagerinti tiesioginių išmokų paramos sistemą.

Disertacijos tema paskelbti 6 moksliniai straipsniai, perskaityti pranešimai 2 tarptautinėse mokslinėse konferencijose, atlikta stažuotė Lodzės universitete (Lenkijoje), kuriame pristatyti ir disertacijos rezultatai.

Notations

Abbreviations

AWU – annual work unit;
CAP – Common Agricultural Policy;
CAS – complex adaptive systems;
DPs – direct payments;
DPIERA index – Index of Direct Payments' impact on Economic Resilience of Agriculture;
EAGF – European agricultural guarantee fund;
EU – European Union;
FADN – Farm accountancy data network;
FE – fixed-effects model;
GMM – general method of moments;
MCDM – multi-criteria decision-making;
MS – member states;
NMS – new Member States;
OMS – old Member States;
RE – Random-effects model;
UAA – utilized agricultural area.

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Introduction

Problem Formulation

In the last decades, due to its vast potential, the popularity of the resilience concept has burst in the field of economics. Resilience is also increasingly included in most policy discussions about agriculture, and its growth is identified as one of the main priorities of the EU Common Agricultural Policy (EU Commission, 2020). However, the resilience concept is still far from clear, as its multidimensionality, together with the complexity of the adaptive systems, makes it hard to operationalize and evaluate (Herrera & Kopainsky, 2015). Subsequently, there is still no universally accepted definition of economic resilience and no agreement on the scope of this concept (Martin & Sunley, 2020; Quendler & Morkūnas, 2020; Wang & Li, 2022). The generally accepted methodology of empirically evaluating the resilience phenomenon is also lacking (Martin et al., 2016). Finally, there is no consensus on the influence made by various support policies (Sanderson, Capon & Hertzler, 2017).

Studies of economic resilience in agriculture are scarce and fragmented. A large share of resilience literature in the agricultural context approaches the issue from either a conceptual (Darnhofer, 2014; Tendall et al., 2015) or a qualitative point of view (Doeksen & Symes, 2015; Darnhofer et al., 2016). Moreover, studies on agriculture's economic resilience usually focus on the micro level (Abson et al., 2013; Peerlings et al., 2014; Hamerlinck et al., 2014; Vigani & Berry, 2018; Borychowski et al., 2020; Wilczyński & Kołoszycz, 2021). Scarce examples of agricultural resilience research at the meso level (Morkunas, Volkov & Pazienza, 2018; Morkunas et al., 2018) are focused on estimating resilience capacity rather than actual resilience. Since the methodological grounds for estimating agriculture's actual economic resilience are very limited, the systematic increase ability is consequently limited as well.

Another problem is that research on how the EU support schemes for agriculture interact with the sector's resilience is also very limited. Although ample research is dedicated to examining how direct payments (further on – DPs) influence various farm business indicators (Rizov et al., 2013; Severini et al., 2016; Vigani & Berry, 2018; Vozárová et al., 2020; Borychowski et al., 2020), there is a clear gap in research quantitatively evaluating the impact of DPs on the economic resilience of agriculture at the meso level (Meuwissen et al., 2019). To significantly contribute to the growth of resilience in agriculture, a more comprehensive understanding is necessary of how the CAP, and especially the most heavily financed form of support, direct payments, affect the sector's resilience.

Relevance of the Dissertation

Modern agriculture and food production systems are facing various increasing pressures, and often, several risk types appear simultaneously, aggravating negative consequences. The increasing frequency and magnitude of adverse events, together with the growing uncertainty in the upcoming future, pose additional challenges threatening agriculture's long-term viability. Therefore, many scientists (Herrera & Kopainsky, 2015; Quendler & Morkunas, 2020) emphasize that the future sustainability of agriculture will increasingly depend on resilience. The COVID-19 crisis has again underlined the importance of resilience in agriculture (Darnhofer, 2020; Štreimikienė et al., 2021; Lioutas & Charatsari, 2021). To increase agriculture's resilience, it must be quantitatively measured, and the main factors stimulating and hindering its growth must be identified.

It is assumed that subsidies impact resilience (Martin et al., 2016; Di Caro & Fratesi, 2018; Ubago et al., 2019); however, such issues as how much influence various support measures have and even what is the direction of their influence, have no sound empirically grounded answers yet, thus hindering the creation of more effective support measures. EU allocates vast financial resources to the agricultural sector: from 2023 to 2027, support for agriculture makes up more than

30% of the total EU budget[1]. DPs comprise approximately two-thirds of this share. The estimation of the DPs’ impact on agriculture’s economic resilience would potentially contribute to achieving two goals, i.e., a more efficient increase of resilience and a more effective allocation of financial funds. Thus, creating a tool for the evaluation of the EU DPs’ impact on agriculture’s economic resilience would be of great scientific and practical value.

Research Object

The research object is the DPs’ impact on agriculture’s economic resilience.

Aim of the Dissertation

The aim of the dissertation is to create and approbate the theoretical model, which would be used to evaluate the DPs’ impact on agriculture’s economic resilience.

Tasks of the Dissertation

To achieve the aim of the dissertation, the following tasks had to be performed:

1. To research the nature, development, measurement, and use of the economic resilience concept and apply it to the assessment of agriculture’s economic resilience.
2. To systematize the existing research assessing the DPs’ impact on individual agricultural indicators.
3. To form a set of indicators reflecting agriculture’s economic resilience.
4. To create a theoretical model for the assessment of DPs’ impact on agriculture’s economic resilience.
5. To verify the practical adaptability of the created model at the EU level.

Research Methodology

To investigate the *object*, the following *research methods* were chosen:

[1] Only the EU’s multiannual financial framework is considered; the funding for an additional next-generation EU recovery instrument is not included.

- Methods of systematic scientific literature analysis and deduction were used to operationalize the resilience concept and select methods for the measurement of the resilience phenomenon.
- Methods of systematic and comparative scientific literature analysis were used to compile a list of agriculture's economic resilience indicators.
- Random effects error component models and generalized method of moments were used to estimate the impact of DPs on the separate indicators of economic resilience of agriculture fixed-effects models.
- An expert survey and the method of indirect weight determination were used to establish the weights of separate agricultural functions and their indicators.
- To integrate the values of the DPs impact on individual resilience indicators into a composite indicator reflecting the impact of DPs on the overall agriculture's economic resilience, a weighted sum was used.
- Methods of statistical analysis, comparison, and generalization were also used in the empirical study.

The Scientific Novelty of the Dissertation

The following new findings in the science of economics were obtained:

1. Economic resilience research has been supplemented by contributing to the operationalization of the resilience concept: resilience capacity and factual resilience have been differentiated, distinguishing the main differences between them. In addition, resilience measurement ways and methods were systematized, suggesting an innovative framework for their grouping depending on the type and dimension of resilience.
2. An original set of indicators has been formed and substantiated to measure the economic resilience of agriculture. The set encompasses three groups of indicators, reflecting the sector's main economic functions: production of affordable food and other agricultural goods, assurance of farm viability, and maintenance and creation of decent jobs.
3. An innovative framework for measuring the DPs' impact on agriculture's economic resilience has been suggested, integrating different quantitative assessment methods. The index of the direct payments' impact on agriculture's economic resilience has been created, and the barely researched DPs' impact on the economic resilience of agriculture has been revealed.

The Practical Value of the Research Findings

The obtained findings may be used by agricultural policymakers at the national and/or EU level to improve the selection and the design of the support schemes and the allocation of funds among them, thus using support more effectively and efficiently, as the DPs impact on agriculture's resilience was determined on the basis of objective quantitative methods, analysis of studies of direct payments' impact on agriculture, and theoretical insights from the resilience research.

The information on sub-indicators, reflecting changes in resilience regarding each function due to the direct payments' impact, could be used by public agencies as a warning information system indicating areas where the support system exhibits its negative or insufficient influence.

The created model of the DPs impact on agriculture's economic resilience has been empirically verified with EU-27, OMS-15, and NMS-12 separately. However, the methodical principles are universal, making the model suitable for application in other contexts and other regions.

Defended Statements

The following statements based on the results of the present investigation may serve as the official hypotheses to be defended:

1. It is appropriate to assess factual agriculture's economic resilience via its main economic functions.
2. It is appropriate to assess the adaptability dimension of the actual general agriculture's economic resilience through the growth of the indicators reflecting agriculture's main functions.
3. The impact of DPs on agriculture's economic resilience could be assessed through the DPs impact on the growth of the indicators reflecting agriculture's main functions, subsequently integrating the impact values into a multi-criteria index.

Approval of the Research Findings

The topic of the dissertation was addressed in six scientific articles, referenced in Scopus and Web of Science databases (Žičkienė et al., 2020; Volkov, Žičkienė et al., 2021; Morkūnas, Žičkienė et al., 2021; Baležentis, Žičkienė et al., 2021; Štreimikienė et al., 2021; Žičkienė et al., 2022). The results were presented at two international conferences: the 26th annual international conference "Research for

Rural Development 2020"; May 13–15, 2020, Jelgava, Latvia; and the 34th EBRS conference, January 6–8, 2021, Athens, Greece. In addition, the research results were presented in VILNIUS TECH doctoral research seminars and a scientific seminar at the University of Lodz during the internship.

The Structure of the Dissertation

The dissertation is structured around three main chapters.

The first chapter provides an overview of resilience phenomenon research in economics. It discusses operationalization issues of the resilience concept, systematizes and categorizes resilience measurement ways and methods, and describes the integration of the resilience concept into the agricultural framework. Also, it reviews the research on DPs impact on agricultural indicators, and concludes by formulating the main tasks of the present investigation.

The second chapter presents the methodology for the assessment of DPs impact on the agricultural sector's economic resilience and describes its elements, sequence of actions, and used methods in detail.

The third chapter presents the research data, the results of DPs impact on separate resilience indicators, the results of the expert survey and the values of the index and its sub-indices of the DPs' impact on agriculture's economic resilience for EU-27, as well as for old and new member states separately in 2005–2019.

General conclusions and recommendations for further research summarize the present study. It is followed by an extensive list of references.

1

Evaluation of the Direct Payments' Impact on Agriculture's Economic Resilience: a Literature Survey

This chapter provides an overview of resilience literature to identify the nature and use of the resilience concept and to analyze ways of resilience assessment. It describes the integration of the resilience concept into the agricultural framework, provides an overview of the CAP support system, with a special focus on direct payments, and presents the constructed theoretical model of direct payments' impact on agriculture's economic resilience. Three scientific publications were published on the topic of the first chapter (Žičkienė et al., 2020; Volkov, Žičkienė et al., 2021; Baležentis, Žičkienė et al., 2021; Štreimikienė et al., 2021; Morkūnas, Žičkienė et al., 2022).

1.1. Resilience Concept and its Development

The concept of resilience originated in materials engineering and had spread to ecology (and socio-ecological systems framework as a separate paradigm) and, from there, to the field of economics. The adoption of a resilience metaphor in economics has not been without criticism and discontent. One of the main arguments of the critics stated that it was not appropriate to transfer analogies from other disciplines since socio-economic systems are fundamentally different from ecological and physical systems. Nevertheless, despite the criticism, the resilience concept has found its way into economics and is increasingly researched and applied. At the time of this study, most resilience research was concentrated on regional and supply chain studies (Hill et al., 2011; Angulo, Mur & Trivez, 2017; Colon, 2017; Hu & Hassink, 2019).

1.1.1. Resilience Concept in Economics

To date, many various resilience definitions have been proposed. Foster (2006) defined an economic system's resilience as its ability to anticipate, prepare, respond, and recover after a disturbing phenomenon. Simmie and Martin (2010) described it as the ability to solve local economic problems in a way that leads to long-term recovery after a recession. Rose (2019) distinguished two types of resilience and defined static resilience as the ability of the system to maintain a high level of functioning when shocked and dynamic resilience as the system's ability and speed to recover. Morkūnas, Volkov, and Pazienza (2018) defined resilience as "the ability of an economy to withstand shocks and reduce the probability of further deep shocks or at least to mitigate the effects of a shock." Tan et al. (2017) referred to resilience as "(1) the long-term capacity to develop new growth paths such as new industries or technological breakthroughs; and (2) the capacity to resist and recover from short-term shocks; and (3) the relationship between the two meanings of resilience, that is, how shocks affect the capacity to develop new growth paths." Despite the multiple numbers of proposed resilience definitions, they can be grouped under several main categories according to the capacities emphasized and the attitude toward a change of internal structures and feedback.

Two main perspectives on resilience can be found in the economic literature: "equilibrium" approaches and "non-equilibrium" or "complex systems" approaches (Kitsos & Bishop, 2018). "Equilibrium" approaches consider an economic system to be relatively simple, homogenous, and stationary, finding itself in some equilibrium or growth path and developing in a linear way (Fagiolo & Roventini, 2016). The shock may push the system out of its equilibrium state or growth path; however, resilient systems either absorb shock or recover to their previous states within some period (Kitsos & Bishop, 2018).

"Non-equilibrium" approaches are based on the complex adaptive systems (CASs) theory. These systems are characterized by heterogeneity, complex nonlinear dynamics, continuous interaction with their environment, and operation under constant uncertainty and change (Scoones et al., 2007). These complex nonlinear dynamics challenge the whole idea of equilibrium, stating that complex adaptive systems are never in equilibrium. Therefore, a return to a previous stable state (equilibrium) after a disturbance may be neither possible (due to constant change) nor desirable. Moreover, the seemingly stable states can suddenly change and become entirely new ones with different structures, controls, and feedback. Thus, resilience is not viewed as a return to some previous stable state but rather as a dynamic, evolutionary capacity to adapt in response to perturbations (Bristow & Healy, 2014).

CASs are composed of many interconnected elements constantly interacting within the system and between a system and its environment, thus generating complex dynamic behavior. The environment, contrary to "equilibrium" approaches, is not considered separate from a system, rather it is closely linked with all other related systems making up an ecosystem, and change is viewed in terms of co-evolution with all other related systems rather than as adaptation to a separate and distinct environment (Martin & Sunley, 2015). As a result of their interconnected structure, CASs also exhibit unexpected emergent properties, i.e., structures or patterns of collective behavior that form in the system, and that cannot be inferred from individual behavior. One such emergent property is self-organization, i.e., spontaneously generated organization by the individual decisions and interactions of the agents themselves and without centralized direction (Klein et al., 2003). The elements of CAS are constantly adapting in reaction to some exogenous or indigenous changes. To adapt, systems change their individual or collective behavior, self-organize and create or re-arrange structures, which through a feedback loop, affect their behavior reciprocally. Change processes at each spatial scale exhibit recognizable common patterns and spatial scaling, i.e., processes at small spatial scales operating faster than those at large spatial scales.

Authors adopting the adaptive approach refer to resilience as a system's capacity to resist shocks and/or recover from them by adapting its structure and organization. For example, Martin and Sunley (2015) referred to regional economic resilience as "the capacity of a regional or local economy to withstand or recover from market, competitive and environmental shocks to its developmental growth path, if necessary by undergoing adaptive changes to its economic structures and its 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." In this approach, the focus is on maintaining the core performances of a system rather than its states or structures. Moreover, maintaining them in most cases would involve changes in their structure or state.

In this approach, resilience is considered a process rather than an end state (Pendall & Cowell, 2009) and may alter depending on the system's characteristics and the direction of its developmental path. Focusing on resilience as a process does not require assumptions about equilibria, although they are not necessarily excluded either (Martin, 2018). One of the other important differences as compared to "equilibrium" approaches is the notion of transformation into a qualitatively better state. Some authors, therefore, refer to this type of resilience as "evolutionary resilience," emphasizing its "bounce forward" rather than "bounce back" notion (Davidou & Porter, 2012). However, in most cases, both notions are used under the "adaptive" resilience framework. In other words, adaptiveness can manifest itself in both ways: a system may undergo various changes to restore its pre-shock performances (i.e., "bounce back"), or it may move to a new (qualitatively better) growth path (i.e., "bounce forward"), where the ability to renew and/or transform is based on the idea (key to this approach) of the system's capability to learn, adapt and renew itself (Colon, 2017).

Both types of approaches have their advantages and disadvantages. "Equilibrium" approaches are relatively simplified; however, they are easier to adopt and replicate. "Non-equilibrium" approaches are more complex yet broader and reflect the real-world economic systems much better and, therefore, recently have been gaining more appreciation than the "equilibrium" ones (Davidson et al., 2016; Volkov et al., 2021). Following this tendency in academic research and based on the notion that the agricultural sector is a complex adaptive system (Darnhofer et al., 2014), this dissertation will further proceed within the "non-equilibrium" adaptive framework.

1.1.2. Dimensions and Types of Resilience

One of the most cited definitions of resilience within the adaptive approach refers to resilience as the capacity of an economic system to withstand or recover from various shocks, if necessary, by undergoing adaptive changes to its structures and social and institutional arrangements to maintain or restore its previous developmental path, or transit to a new sustainable path characterized by fuller and more productive use of its physical, human and environmental resources (Martin & Sunley, 2015; Doran & Fingleton, 2018; Kitsos & Bishop, 2018; Sdrolias et al., 2022). Based on this interpretation, the resilience phenomenon encompasses three dimensions: (1) robustness, (2) adaptability, and (3) transformability.

Robustness refers to the capacity of a system to absorb perturbations to continue functioning and to maintain pre-shock performance levels despite the ongoing perturbations. Robust economic systems are those that do not experience a downturn following a severe shock (Bristow & Healy, 2017). In regional economic literature, an economic downturn is considered to be experienced if "in the year of the shock or the year thereafter, the annual regional growth rate declines more than 2.0 percentage points from the annual regional growth rate over the previous eight years;" and if the eight-year growth rate was 4.0 percent or higher, then the region's growth rate had to decline by more than half of the previous eight-year average growth rate (Hill et al., 2011). This aspect is sometimes called static because it can be attained without repair/reconstruction activities (Rose, 2009). This capacity reflects the short-term system's resilience, whereas the following two dimensions (adaptation and transformation) represent longer-term resilience.

The adaptability dimension underlies the adaptation process after a shock that was not absorbed. Economies are considered adaptive if they recover to their peak levels of performance in three years (Bristow & Healy, 2017, Angulo Mur & Trivez, 2018) or four years (Hill et al., 2011) from the onset of a downturn.

The transformational dimension of resilience reflects the capacity to change some of the components (or linkages) of a system from one form, function, nature, or location to another (but not necessarily irreversibly) and transfer to a qualitatively new status or growth path. This dimension is the most complex since it involves a long-term investment problem. Some authors refer to the two latter dimensions as adaptive resilience, the essence of which is an ability to change as circumstances change, to adapt, and, where appropriate, transform rather than continuing to do the same thing faster and better (Bristow & Healy, 2014).

Such multidimensionality allows considering alternative positive scenarios in response to various perturbations; however, it also includes potential conceptual collision since the relationships between these three different dimensions of resilience are not yet well understood, and they may not necessarily be coupled or mutually exclusive (Cowell et al., 2016; Hu & Hassink, 2020). Scholars argue that there may be trade-offs as well as synergetic effects between these dimensions (Quinlan et al., 2015; Boschma, 2015; Fröhlich & Hassink, 2018). On the other hand, resilience is not a fixed property but rather a process and may evolve (Martin & Sunley, 2015; Fröhlich & Hassink, 2018; Hu & Hassink, 2020) depending on the system's characteristics and the ongoing processes within the systems and outside it. A system considered resilient at one point in time may not be such at another. Therefore, it is essential to understand resilience as a process (Fig. 1.1). Moreover, as a recursive process, meaning that the adaptation processes may lead to changes in a system's state and structure, which in turn may influence the system's robustness to new shocks (Simmie & Martin, 2010). Consequently, it should be focused on whether the system in a period moves into a less or more resilient orientation rather than measuring its resilience at a specific point in time.

In addition to different dimensions, there are two types of resilience distinguished in the literature: specified and general resilience (Folke et al., 2010; Biggs et al., 2012; Scholz, Blumer & Brand, 2012; Meuwisson et al., 2019; Clark, 2021). "Specified" resilience refers to the system's reactions to a particular shock, whereas "general" resilience is concerned with the capabilities that allow superior reactions to various kinds of shocks and perturbations (Folke et al., 2010; Martin & Sunley, 2015). It is important to discern these two kinds of resilience since increasing resilience to some particular kind(s) of disturbances may stimulate the deterioration of resilience to other types of perturbations and vice versa (Clark, 2021). The distinction between the types of resilience must also be made in concern with empirical measurement issues because measuring specified resilience may require different measurement ways and/or methods than measuring general resilience (Meuwissen et al., 2019).

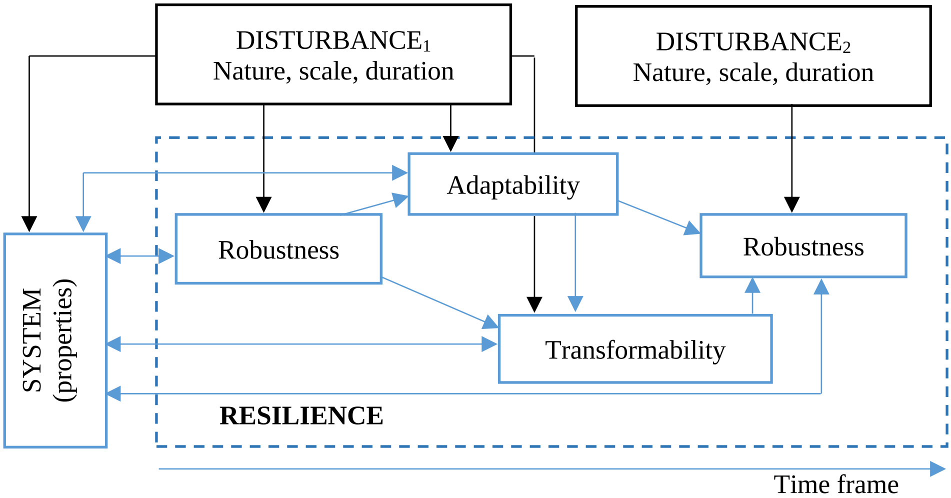

Fig. 1.1. Resilience of an economic system (Source: elaborated by the author)

The multiple dimensions and types of the resilience phenomenon, together with the ambiguity of relationships among them, suggest that the extent of the research analyzing DPs’ impact on all dimensions and types of agriculture’s resilience would be too wide for one dissertation. Therefore, this research narrowed the scope to the general type of resilience and its adaptability dimension. The adaptability dimension was chosen for several reasons. First, one of the main goals of resilience research is to determine the ways to increase resilience; although the system’s robustness is very important, especially in the short run when the shocks hit the system, it is not rational to expect a system to be prepared to absorb all the shocks and perturbations since they differ significantly in nature, scale, duration, and extent. Moreover, as the future is characterized by a fast-changing environment with unknown future challenges, the capacity to prepare for such challenges is very limited. In addition, increasing robustness may negatively impact a system’s adaptability. In this perspective, the capacity to adapt to changes induced by various challenges may be much more important. A similar position was held by Boschma (2015), stating that adaptability and transformability are viewed as essential resilience capacities necessary for sustainable growth in the future. Moreover, it needs to be emphasized that robustness is not always preferable, especially when the system finds itself in a qualitatively low state or growth path. In such cases, high shock absorption capacity may inhibit the system’s ability to transform into a better status. Adaptability is chosen over transformability because full transformations occur over long-time frames (Martin & Sunley, 2015), and, therefore, problems with the empirical data may arise. Second, transformability, looking from a broader perspective, could be considered a part of the adaptation process since transformations occurring due to the changes induced by the perturbation are a sort of adaptation. As regards resilience, general resilience, as the ability to adapt to various kinds of shocks and fast-changing circumstances in an increasingly uncertain future, has become more important than ever before. Scholz, Blumer & Brand (2012) argued that it is namely general resilience that is indispensable for sustainable growth. Due to the great importance of general resilience and the lack of research on the topic, this dissertation will focus on general resilience. The other reasons for this choice are provided in Section 1.1.5.

1.1.3. Operationalization of Resilience Concept

Resilience is a multifarious construct that cannot be measured directly. There have been ample attempts to make the resilience phenomenon clearly distinguishable and measurable by empirical observation; however, there is no consensus on the best measure of resilience yet. Nevertheless, a systematic literature analysis allowed for distinguishing two main approaches to the operationalization of the resilience concept most frequently used in the economic literature: (1) assessment of resilience either via indices, composed of system variables, potentially influencing its resilience (Briguglio et al., 2009; Angeon & Bates, 2015; Morkunas, Volkov & Pazienza, 2018; Stanickova & Melecký, 2018; Feldmeyer et al., 2020; Quendler & Morkunas, 2020; Borychowski et al., 2020); and (2) indices, composed of a variable(s) reflecting key functions/performances of the relevant system (Shutters, Muneepeerakul & Lobo, 2015; Cernay et al., 2015; Martin et al., 2016; Webber, Healy & Bristow, 2018; Kitsos & Bishop, 2018; Doran & Fingleton, 2018; Ubago et al., 2019; Rose, 2019; Levine, Lin & Xie, 2021; Pontarollo & Serpieri, 2020; di Pietro et al., 2021; Wang & Li, 2022).

The former index type is calculated from a variety of factors, covering economic, social, human, environmental, and political dimensions of the relevant economic system that might impact its resilience. For example, Briguglio et al. (2009) constructed their resilience index out of four sub-indices in turn composed of several indicators each: the macroeconomic stability, the microeconomic efficiency, the governance, and the social development sub-index. In their resilience-vulnerability index, Angeon & Bates (2015) included 20 indicators of resilience (such as access to new ICT, approval of environmental treaties, biodiversity reserve, export, financial transfers from abroad, GDP, etc.) and 13 vulnerability indicators. Morkunas et al. (2018) presented an agricultural resilience index using indicators of inoperability, dependency on strategic imports, market efficiency level, debt level, export concentration, economic openness, etc. The indicators used for these, and other indices of the same type, differ significantly, as various authors assumed different contributing factors and their importance to resilience. This resilience assessment has several advantages. First, such indices allow their users to see what factors influence resilience and how strong that influence is. It also enables following the development trends of these factors and detecting the ones most in need of intervention. They also enable easy comparison of several systems. However, such indices are quite subjective (Faggian et al., 2018; Ubago et al., 2019; Volkov et al., 2021). Moreover, as economic systems are complex, their resilience is determined by the interactions among their elements and their environment rather than driven by a steady (set of) component(s) (Scoones et al., 2007). These arguments are in line with Martin and Sunley (2015), who argued that resilience is context specific. Thus, indicators determining the resilience of a particular system, or their importance may vary both across different systems and across time. These dynamics are supported by the fact that, so far, no single (set of) component(s) has been identified as reliable predictors of resilience across economic systems, time, and contexts. For some components, even opposite effects were reported (Hill et al., 2018). Thus, the monitoring of resilience trends over time using such indices may be of little value, which may also be said about its use for comparability among several economic systems. Finally, and most importantly, such measurement reflects the resilience capacity more than actual resilience. Actual resilience is the response to a factual perturbation(s) and shows how the system has reacted to it (them), whereas resilience capacity shows the potential of how a system could react to some future perturbation. Moreover, even if the potential resilience influencing factors (resilience capacity) are evaluated very highly, it does not necessarily mean that the resilience to factual crises would be high. In addition, as discussed above, complex systems are constantly changing, and, therefore, the actual reaction to the crisis may be different across time and space, even when the factors potentially influencing resilience remain approximately the same.

The second approach to measuring resilience via an index is by composing it from the indicators, reflecting the key functions of a particular system. Martin et al. (2016) argued that maintaining (or restoring) profitability, employment, and growth can legitimately be viewed as "core performances and functionalities" in an economic context; thus, their performance levels should be the basis of the resilience analysis. Kitsos (2020) stated that employment and GDP are usually considered to be the main functions of a regional or national economy; therefore, the performance of these indicators reflects the resilience of the regional or national economy. This type of resilience operationalization has several significant advantages. First, it allows focusing on the change in the performance of key functions of the system, which is the key aspect of the resilience definition itself: to withstand or recover from various shocks to maintain the system's core performances and functionalities. In this way, actual resilience and changes in it are observed. Moreover, this resilience index calculation can be easily adaptable to various settings and various systems since it requires only the determination of the system's key functions. In measuring resilience via indices based on system characteristics, a specific adaptation of indicators must be required since, due to the particularities of complex dynamic systems, the resilience impacting factors (or at least the strength of their impact) may be significantly different. The indices based on key functions are much easier (and less time-costly) to calculate, interpret, compare, and replicate (Volkov et al., 2021). Their main disadvantage is the relatively smaller ability to reveal the factors leading to the loss (or increase) of resilience. On the other hand, they are very convenient to use while quantitatively calculating the impact of various factors on resilience, while in other types of indices, this impact is usually subjectively predetermined.

Considering the advantages and disadvantages of the resilience operationalization ways and keeping in mind the main goal of this study, the resilience concept is further operationalized via an index based on the system's main functions.

1.1.4. Measurement of Resilience

Multidimensionality of resilience has led to a high diversity of resilience measurement ways and methods, which makes the use of the concept fuzzy and chaotic. However, the detailed analysis of numerous literature sources allows concluding that the ways of economic resilience measurement differ due to two main factors: the type of resilience that is being analyzed and the dimension of resilience in focus. Based on this observation, four main ways of assessing resilience can be distinguished (Fig. 1.2).

Probably the most deeply researched area is the "specified robustness" (Hill et al., 2011; Obschonka et al., 2015; Rose, 2017; Martin et al., 2016; Doran & Fingleton, 2018; Levine, Lin & Xie, 2021). The main way to measure this type of resilience is by calculating the change in the key performances incurred by the disturbance. Such calculations encompass estimations of either absolute or relative falls due to the perturbation. For example, Hill et al. (2011) identified a 2-percentage point threshold for a decline in annual regional growth rate, which, when exceeded, allows to consider the region as non-resilient. Obschonka et al. (2015) used the percentage change of the regional start-up rates between certain years as a resilience measure of a relevant region. Similarly, Levine, Lin & Xie

(2021) estimated an absolute decline in employment levels during the COVID-19 crisis to reflect the resilience (robustness) of the regions. Schneiberg (2021) measured resilience to the recession shock posed by the financial crisis, calculating the unemployment rate in the peak year minus the rate in the pre-shock year. Martin et al. (2016) investigated how different regions (or localities or cities) are affected by a common (nationwide) recession. They suggested using the national economy's resilience as a counterfactual, where the contraction of a region is compared with the expected contraction, i.e., the contraction that was experienced in the whole country. Similarly, di Pietro et al. (2021) calculated changes in the GDP level as a resilience indicator. Doran and Fingleton (2018) used a state-of-the-art dynamic spatial panel model (DSPM) to obtain counterfactual predictions of employment levels in US metropolitan areas and compare them with actual employment levels. Kitsos and Bishop (2018) compared the decline of employment in the region to the average of the four minimum employment rates during a certain period. Shutters, Muneepeerakul, and Lobo (2015) compared the changes in performance to pre-shock levels. Rose (2009) performed simulations of what would be the maximum potential business interruption loss in the absence of the resilience tactic and compared them to actual losses. Sensier et al. (2016) considered regions as robust (resistant) if "the growth rate of regional employment remains positive during the period of the shock that is experienced in the national (aggregate) series."

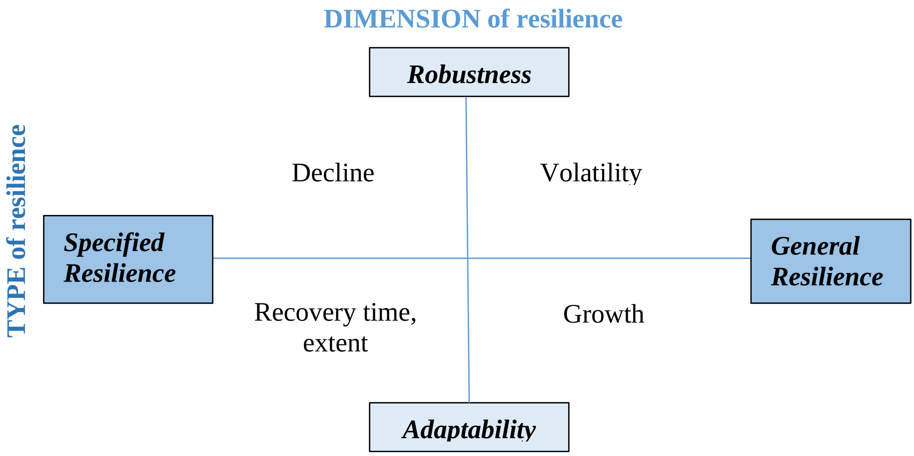

Fig. 1.2. Ways of measuring economic resilience according to resilience type and dimension (Source: elaborated by the author)

Recovery time is probably the most frequently used measure of the adaptability dimension of specified resilience, showing how fast a system recovers and whether it fully recovers to the pre-shock performance levels. If key performances after the shock(-s) do not recover to a certain level, the resilience (adaptability) of the system should be considered low. For evaluating recovery times, either absolute or comparative recovery times are used. Talking about absolute recovery times, economies that recover to their peak levels (of output, employment, etc.) in three (Bristow & Healy, 2017, Angulo Mur & Trivez, 2018) or four years (Hill et al., 2011) from the onset of a downturn are considered resilient. Others use comparative recovery times. Martin et al. (2016) and Doran and Fingleton (2018) compared the recovery time of regional key performances to the recovery times of the whole country's performances. Sensier et al. (2016) consider regions as resilient if they return to their pre-shock peak levels. Rose (2019) measured resilience as the reduction in recovery time with a reference point of "the duration and time-path of economic activity in the absence of resilience in relation to investment in repair and reconstruction." Others analyzed the extent of recovery by comparing the regional employment levels of the first year of the economic crisis and the last year of the economic recovery period and contrasting the difference with one of the national employments (Giannakis & Bruggeman, 2019; Wang & Li, 2022). Similarly, Schneiberg (2021) measured recovery from the shock, calculating the peak unemployment rate during the crisis and subtracting the rate in the post-crisis period.

General resilience is much less researched as compared to specified resilience. Most authors (Abson, Fraser & Benton, 2013; Enjolras et al., 2014; Severini, Tantari & Di Tomasso, 2016; Ženka, Pavlík & Slach, 2017; Lv et al., 2019) investigating the robustness dimension of general resilience (as can be assumed from their resilience definitions) use the volatility of performance indicators as a measurement of this type of resilience. Volatility allows for determining how intensely a relevant system reacts to several disturbances during a longer period, thus indicating if the general robustness of the system is high/increasing (if volatility is declining) or low/decreasing (if volatility is growing). For example, Ženka, Pavlík & Slach (2017) questioned if rural areas could be more resistant and exhibit lower unemployment volatility than urban/metropolitan regions. Lv et al. (2019) measured the resilience of enterprises by financial volatility. Abson et al. (2013) used the variation coefficient of economic returns to study the impact of landscape diversity on the economic resilience of farms. Cernay et al. (2015) analyzed the yield anomaly distribution of diverse grain legumes to compare yield variability. Kumara et al. (2020) composed an index of variations for crop income and crop productivity to reflect farms' resilience (and vulnerability). Benoit et al. (2020) assessed the resilience of sheep-meat farms by calculating the net income coefficient of variation. Some other measurements are used for the robustness of general resilience (Hallegatte, 2014; Meuwissen et al., 2019); however, they are not widely adopted.

The adaptability dimension of general resilience has also received academic attention; however, there is a more theoretical discussion on the topic rather than empirical investigations (Martin & Sunley, 2015; Evenhuis, 2017; Hu & Hassink, 2020). Most of the few empirical studies are conducted using qualitative methods for assessing the adaptation of general resilience (Hervas-Oliver et al., 2011; Carlsson et al., 2014; Meuwissen et al., 2019), focusing rather on resilience-enhancing strategies than the evaluation of actual resilience. To the best of the author's knowledge, only very few studies address the adaptability of actual general resilience quantitatively. Several such studies analyze resilience via the growth of a system's key functions, such as GDP, employment, etc. (Kitsos et al., 2019; Ženka et al., 2021; Volkov et al., 2021). The growth of key performances and their changes may be considered to portray the adaptability dimension of actual general resilience for several reasons. First, many authors refer to the resilience adaptability dimension as a return/recovery to some previous growth path (Martin, 2012; Faggiani et al., 2018; Simonen, Herala, & Svento, 2020; Bănică, Kourtit & Nijkamp, 2020). This logic is also reflected in the measurement of this dimension, i.e., recovery time and/or the extent to a previous maximum or average performance level. Since general resilience is concerned with at least several disturbances, the recovery from those disturbances to some previous growth path levels can be assumed as the maintenance of the growth path (or, in a better case, transformation into a better growth path) in the long run. Many authors agree that crises (and the system's resilience to them) may affect the growth path of a system (Fingleton, Garretsen, & Martin, 2012). For example, suppose a system cannot fully recover from a shock. In that case, i.e., it cannot fully adapt to the negative effects of the perturbation, and its subsequent growth path follows an inferior growth trajectory. And on the contrary, if the system quickly and fully adapts to its previous growth levels, the growth curve of key functions' performance tends upward (Martin et al., 2016; Webber, Healy & Bristow, 2018). From the other side, i.e., from the perspective of the growth paths, if the level of the performances of the system's main function decreases, even though the system's goal is to maintain a non-decreasing level of those results, it can be reasonably concluded that the actual general resilience of that system has been decreasing, due to either sudden crises or slow-burn processes. Therefore, it can be assumed that growth paths portray the resilience of the system, namely, the adaptability dimension of general resilience. As growth paths are determined by the growth of certain indicators, the growth of indicators reflecting key functions of the system can be reasonably assumed to portray the general adaptability of that system.

The other potential way to approach the measurement of the adaptability dimension of actual general resilience is through the goal perspective. The robustness dimension of the specified resilience is concerned with the absorbance of a particular shock at a particular point in time. The adaptability dimension of the specified resilience is related to the goal of a fast return to the previous growth path. The robustness dimension of general resilience is concerned with the reduction in the volatility of the system's main performances. It may be argued, that the essence of the adaptability of general resilience is to avoid negative changes in performance levels of the main functions of the system over a longer run despite various crises, therefore, the adaptability dimension of general resilience can be reasonably assumed to be tied to the goal of maintaining (improving) the previous growth path. General resilience, as compared to the specified resilience, is more concerned with the changes in resilience than the estimation of resilience at a particular point in time, as general resilience is not a fixed property, but depends on the system's internal characteristics and external factors, and therefore may change over time (Martin & Sunley, 2015; Hu & Hassink, 2020). Therefore, growth paths, reflecting the development of the system's main performances, are a good indicator of the adaptability dimension of actual general resilience.

It is important to note that this resilience quadrant (the adaptability dimension of general resilience) closely approaches the sustainability construct, which is focused on satisfying the needs of present generations without compromising the ability of future generations to satisfy theirs with respect to environmental, social and economic considerations (Brundlant, 1987; Luengo-Valderrey et al., 2020). As the literature review shows, many authors agree that resilience and sustainability share a lot of common grounds and, therefore, are often considered part of each other (Marchese et al., 2018; Negri et al., 2021). Some researchers refer to resilience as part of sustainability (Ludwig, Wilmes, & Schrader, 2018; Olfert et al., 2021); some, on the contrary, consider sustainability as a part of resilience (Jain et al., 2017; Gouda & Saranga, 2018; Bag, Gupta & Foropon, 2019). Still, others argue that resilience and sustainability have separate objectives, although the constructs may overlap (Meacham, 2016; Zhang & Li, 2018). Resilience and sustainability both refer to the state of a system over time, focusing on the persistence of that system. Because of this joint focus on system survivability, the two constructs share common research methodologies (Bocchini et al., 2014). And for example, as Saxena et al. (2016) argued, sustainability principles, such as income, well-being, food security, or social status, can be used to evaluate overall community resilience. Thus, the adaptability dimension of general resilience may be exactly the area where the resilience phenomenon overlaps with the sustainability construct. Therefore, using the growth of certain indicators (a method used in estimating resilience) to approximate the adaptability dimension of general resilience should not be considered inadequate but rather a fruitful area of further research on common grounds between resilience and sustainability.

In summary, the measurement of resilience is not uniform and straightforward. Since resilience is a multifarious construct, where relationships among dimensions and types of resilience may not necessarily be coupled or mutually exclusive (Cowell et al., 2016; Hu & Hassink, 2020), it is appropriate to estimate individual types and dimensions of resilience separately, using different measurement methods. It must be noted, though, that several recent studies tried to integrate several resilience dimensions into one measure (robustness, recovery, and the evolutionary component) (Sdrolias et al., 2022; Tsiotas, 2022). However, the different dimensions are estimated separately first and only then integrated into one index, thus not confronting the conclusion that separate types/dimensions of resilience should be measured separately.

1.1.5. Economic Resilience of Agriculture

The resilience phenomenon in agriculture has been widely researched for more than four decades. However, it must be emphasized that most of these studies have been devoted to the resilience of agroecosystems (Carpenter et al., 2001; Lin, 2011; Altieri et al., 2015; Peterson et al., 2018, Ward, 2022), while research on economic resilience in agriculture is scarce and fragmented (Morkunas et al., 2022). A large share of the increasing amount of resilience research in agricultural contexts is focused on the micro level (Vigani & Berry, 2018; Benoit et al., 2020; Chonabayashi et al., 2020; Javadinejad et al., 2020; Wilczyński & Kołoszycz, 2021), whereas resilience exploration at the meso level is still very limited. Moreover, much of this research is dedicated to the assessment of resilience capacity rather than factual resilience (Morkunas, Volkov & Pazienza, 2018; Morkunas et al., 2018; Rao et al., 2019; Quendler & Morkunas, 2020; Michel-Villarreal et al., 2019). Meuwissen et al. (2019), on the other hand, use a multi-method methodology to evaluate all types and dimensions of resilience. Although very comprehensive and detailed, their approach, due to its complexity, is difficult to replicate and apply in different contexts and over time.

In the other vein, Sdrolias et al. (2022) studied the resilience of the agricultural sector in Greece to the financial crisis of 2008 by evaluating both resistance (in terms of statistical differences between the pre-crisis and on-crisis averages of GVA per labor unit) and recovery of the sector (in terms of recovery time to the pre-crisis average) comparing it with different sectors and among different regions. They also measure a coefficient of variation of GVA per labor unit to reflect the evolutionary aspect of resilience. Ringwood et al. (2018) estimated the resilience of different economic sectors to the 2007–2009 national recession as the area below the trend that would be attributed to random variation and dividing the net area of recession response by respective employment level at its peak. Volkov et al. (2021) studied general resilience and its adaptability dimension, quantifying resilience via the growth of an index composed of indicators reflecting the main functions of the agricultural sector. These latter studies are based on resilience evaluation via an index based on the main function of a system. This approach has proved to be a simple and efficient way of measuring actual resilience and is used by many authors in various economic areas (Cernay et al., 2015; Webber, Healy & Bristow, 2018; Kitsos & Bishop, 2018; Doran & Fingleton, 2018; Ubago et al., 2019).

Measurement of resilience, based on the key functions of a system, is well aligned with the definition of resilience used in this dissertation: resilience of agriculture is the capacity of this sector to withstand or recover from various (market, competitive, environmental, etc.) shocks, if necessary, by undergoing adaptive changes to its economic structures and social and institutional arrangements, to maintain its core performances and functionalities within a given period (adapted from Martin & Sunley (2015) and Sensier et al. (2016)). This definition emphasizes the maintenance of key functionalities and performances in the aftermath of the perturbation/-s as the essence of a system's resilience. Since resilience cannot be measured directly, the logic for its estimation is assessing the system's reaction to the crisis/es from the perspective of its key functions, i.e., if the key indicators of the agricultural sector can recover to their performance levels when struck by various crises.

Subsequently, to proceed with the evaluation of the economic resilience of agriculture (and DPs impact on it), the key economic functions of agriculture have to be singled out. Food production at affordable prices, without any arguments, is the main function of agriculture. However, in recent decades, multiple other functions have been attributed to agriculture based on the insight that goods provided by agriculture are not limited to the production of food. Van Cauwenbergh et al. (2007) suggested that agriculture should provide prosperity to the farming community. Agriculture should ensure the economic viability of farms and their survival in the long term in a changing economic context (Latruffe et al., 2016). The European Commission (2001) proposed considering two functions of agriculture (other than food production), namely, environmental and socio-economic functions. The environmental function encompasses ensuring the ecological stability of landscapes, while the socio-economic function is related to ensuring the viability of rural areas and contributing to a balanced territorial development by generating employment in food supply chains. Similarly, Herrera & Kopainsky (2015) stated that apart from ensuring food security, agriculture provides environmental capital (creating and conserving natural capital necessary to supply and sustain the ecosystem services associated with food systems) and social welfare (providing employment, incomes, and wealth). Bryden et al. (2006) added that agriculture also provides other functions such as archeological and historical value, entrepreneurial capital, social cohesion, culture bearing, greenhouse gas sequestration, protection from avalanches and landslips, water/soil/air quality, etc.

Meuwissen et al. (2019) grouped these functions under two broad categories according to the type of goods and services provided:

- Provision of private goods:
  - production of affordable food and other agricultural goods.
  - assurance of farm viability.
  - creation and maintenance of decent jobs.
- Provision of public goods:
  - maintenance of natural resources in good condition.
  - production of recreational, aesthetic, and cultural services.
  - protection of biodiversity of habitats, genes, and species.
  - contribution to balanced territorial development.
  - regulation of floods, avalanches, landslips, etc., and disease control.

In some cases, providing private and public goods and services simultaneously can produce significant synergies; however, in most cases, important trade-offs exist between providing them at a particular scale and between different scales (Biggs et al., 2012); therefore, the results analyzing both types of functions may lead to ambiguous results. This dissertation will focus on the agricultural functions related to the provision of private goods only, as they best represent the economic dimension of the agricultural sector.

As mentioned in Section 1.1.2, due to the necessity to decrease the extent of the research, only the adaptability dimension of general resilience will be explored further in this dissertation. Apart from the reasons provided in Section 1.1.2, some more arguments have grounded this selection. First, one of the main goals of DPs is to ensure resilience in the long run, thus presuming resilience to multiple perturbations rather than some particular one; therefore, the estimation of DPs' impact on general resilience would make more sense and render more benefit as compared to the sector's reaction to some specific crisis. Moreover, as will be discussed in Section 1.3.2., DPs tend to have an ongoing effect on farmers' behavior (changing it cumulatively in the long term); thus, the estimation of DPs' impact on resilience is more valuable from the perspective of general rather than specified resilience. Concerning the dimensions of resilience, the major issue is data availability. Keeping in mind that the robustness dimension of general resilience is usually studied as volatility of relevant indicators, the available data matrix (27 countries, 15 years) is not sufficient for such analysis.

As discussed in Section 1.1.4.2, the measurement of resilience is not straightforward. Especially the estimation of the adaptability dimension has been researched very scarcely and fragmentally. Following a discussion by various authors provided in Section 1.1.4, this area of resilience can be estimated via the growth in indicators reflecting key functions of a certain system (Kitsos et al., 2019; Ženka et al., 2021; Volkov et al., 2021). The analysis of the adaptability dimension of general resilience via the growth path renders several advantages.

First, such estimation allows for measuring the evolvement of resilience. As resilience is a dynamic, constantly changing construct, estimating the direction of the resilience dimension is more valuable than its estimation at some particular point in time. Second, it allows considering long-term stresses, such as climate change, which is particularly important for the agricultural sector, but cannot be measured by the same methods as a short-term crisis. Third, the evaluation of the impact made by various factors on resilience is relatively straightforward, which is important for the interpretation of results and the adaptation of the instrument to other contexts. Other ways of measuring the adaptability dimension of general resilience were also considered. Resilience to several separate crises may be evaluated based on estimation methods used for specified resilience and aggregating them under one index. As the adaptability of specified resilience is usually measured via recovery time (Bristow & Healy, 2017; Angulo Mur & Trivez, 2018), at least several options exist to use recovery times for measuring general resilience. First, the average recovery times after the crises during a certain period. Second, the change in recovery times during that period. However, both methods have serious disadvantages. Crises tend to differ in nature, scope, and extent, which allows assuming that the response to the different crises would also be different. Therefore, the aggregation of recovery times or valuation of their change should be done considering the nature, the scope, and the extent of the perturbation, which would be relatively subjective and not easily interpretable and adaptable to other cases. Moreover, these methods cannot be applied to long-term stresses, which means excluding one of the most important challenges for agriculture, i.e., climate change. In addition, considering the use of aggregate recovery times, it is not appropriate to use in this dissertation since, as mentioned above, DPs tend to have an ongoing effect on farmers' behavior (changing it cumulatively in the long term) and subsequently on various agricultural variables; thus, the estimation of DPs' impact on resilience using aggregate recovery times would be very problematic. In addition, at least several comparable disturbances are needed to use recovery times for resilience estimation. However, in the period 2005–2019 (the last large expansion of the EU was in 2004 when ten new MS joined the union and two more joined in 2007), only one major crisis struck almost all EU MS, i.e., the 2007–2009-year financial crisis. Moreover, the DPs' impact on the resilience to that crisis could not be measured because NMS received the payments only for a very short time and, most probably, could not have already experienced their full impact, especially since changes in farmers' behavior, induced by DPs, appeared only in longer time frames. All countries have also been experiencing climate change, i.e., slow-burn stress, which cannot be compared with the financial crisis, and, therefore, resilience to these perturbations can't be aggregated. Other crises in the period were either minor or struck only separate countries. Consequently, this way of measuring resilience has been rejected. The adaptability dimension of general resilience could also be estimated by measuring the change in recovery extents after various perturbations. The main disadvantages of this way of measurement are like the ones discussed above.

After selecting the growth path as a relatively most advantageous estimation way of the adaptability dimension of general resilience, two main measurement methods were considered: evaluation of resilience via growth of indicators of key agricultural functions and via their simulations (simulating the growth path of certain resilience indicators in a scenario with various levels of DPs and compare it to the actual growth path with a resulting difference as the DPs' impact on sector's resilience. However, this way involves a lot of subjectivity (specifying how different elements of the sector would have been evolving without DPs, especially keeping in mind that different countries would most probably provide their agricultural sectors with some kind of support) and is relatively very difficult and costly to adapt to other contexts. On the other hand, estimating the growth of indicators of key agricultural functions allows bypassing the aforementioned difficulties: (1) it is relatively the most objective way of measuring factual resilience, (2) it allows including long-term stresses into evaluation, (3) it enables to reflect the dynamic nature of resilience, (4) it is easily applicable for measuring the impact of various factors on resilience, (5) it is relatively easily interpretable and adaptable to other contexts. Although it has its disadvantages, e.g., it could not be used to compare resilience between different crises, it is relatively the most beneficial.

Consequently, depending on the goal of direct payments, time frame and availability of data, functionality, and adaptability of the model in construction, measuring the growth of indicators reflecting key functions was selected as the relatively best way to estimate the adaptability dimension of the general economic resilience.

1.2. Common Agricultural Policy, Direct Payments and Their Characteristics

The Common Agricultural Policy (CAP) was introduced in 1962 with the main goals of ensuring food security, market stabilization, a fair standard of living for farmers, and reasonable prices for consumers (European Parliament, 2022). To achieve these goals, CAP interventions in the first period were based on market prices and production support, applying such measures as import duties, export subsidies, and internal market support measures (Erjavec & Erjavec, 2021). This policy framework of enhancing productivity and production amounts has been applied for three decades (except for the introduction of milk quotas in 1984).

However, the policy led to several negative side effects, encompassing huge over-production, very high budget expenditures, and international friction due to the distortion of competition in the world markets (EC, 2009), which substantiated the necessity for reforms. The first main reform of CAP was implemented in 1992 and is known as the "MacSharry reform," which was aimed at increasing the competitiveness of EU agriculture, stabilizing agricultural markets, diversifying production, protecting the environment, and stabilizing EU budget spending (EC, 1991). Subsequently, the market-price support was reduced, and, to compensate for this reduction, payments to farmers were introduced, thus marking the transition from supporting production (i.e., regulating prices) to supporting producers (i.e., supporting their income) (Golub, 2013). Two types of payments were granted during this reform: direct payments coupled with production (specifically to the production of grain, oil seeds, beef, and small ruminants) and accompanying measures.

The next reform step is called "Agenda 2000," which lowered the intervention prices for some key products to the world market-price levels, widened the scope of direct support, and introduced the rural development policy as the second pillar of CAP (Erjavec & Lovec, 2017). The next important step in CAP development started with the Fischler Reform in 2003. This reform was necessitated by further pressures from WTO trade negotiations, upcoming EU enlargement, growing budgetary concerns, and increasing societal pressures to integrate new elements (especially linked to environmental aspects and food safety) into the agricultural policy (Potter, 2006; Erjavec & Erjavec, 2021). The reform replaced coupled support with direct payments. Payments were linked to cross-compliance, i.e., to get payments, farmers had to follow several requirements related to keeping land in good agricultural and environmental condition and respecting statutory management requirements (Council Regulation, 2003). An important element of the reform was strengthening the rural development policy and its support measures. In 2008, with the CAP "Health Check," it was agreed to further liberalize agricultural markets by abolishing milk quotas. The further decoupling of support was continued, the modulation was introduced (reducing direct payments to finance rural development measures), and member states' flexibility in policy implementation was strengthened (Daugbjerg & Swinbank, 2013).

The latest CAP reforms agreed upon in 2013 came into force in 2014–2020. In the new CAP, the main policy objectives for the period were: (1) viable food production, (2) sustainable management of natural resources, and (3) climate action and balanced territorial development. From 2014 onward, a new architecture of direct payments was presented by introducing "greening payments," paid to farmers as a reward for the services delivered to the wider public (such as landscapes, biodiversity, climate stability, etc.) (EC, 2011). The links between the two pillars have been strengthened to meet CAP objectives more effectively with better-targeted instruments (ibid).

The latest agreement on the common agricultural policy (CAP) reform was adopted in 2021 and is foreseen for the period 2023–2027. It has formulated three main CAP goals: (a) to foster a smart, competitive, resilient, and diversified agricultural sector ensuring long-term food security; (b) to support and strengthen environmental protection; and (c) to strengthen the socio-economic fabric of rural areas (European Parliament, 2021).

Direct payments and their characteristics. Direct payments (DPs) were one of the main support systems of the Common Agricultural Policy (CAP further on) from 2005 to 2019. They were introduced into CAP in 1992 after the major CAP reform to prevent a fall in the farmers' incomes after the reduction of the price support for the main agricultural products (e.g., cereals, beef, etc.). In the beginning, DPs were paid based on production levels (a certain crop area and/or animals). However, these payments were inefficient, significantly distorting the market and not encouraging the preservation of the natural environment (Swinbank & Daugbjerg, 2006). Moreover, there was a need to realign the EU CAP with the World Trade Organization's (WTO) "green boxing" process (Olagunju et al., 2020). Therefore, from 2003, further reforms targeted the link between direct payments and production (Howley et al., 2012). Consequently, since 2005, direct payments have gradually decoupled from production. The basic payment scheme (BPS) is made of payments for historical production based on the referential period and is applied mainly in the old member states (OMS).

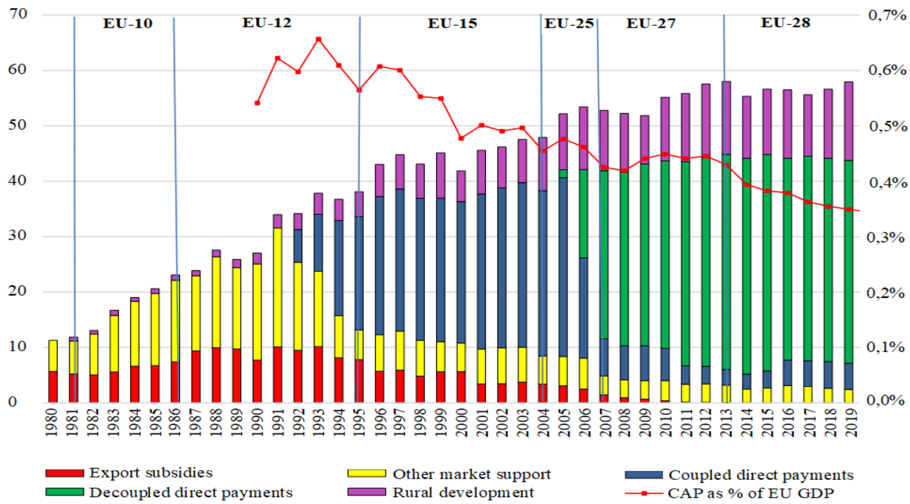

Fig. 1.3. CAP annual expenditure in current prices and CAP reform path (Source: European Commission, DG Agriculture and Rural Development, 2021)

The new member states (NMS) did not have a referential period that could be used to calculate payments. Therefore, a simplified scheme called the single area payment scheme (SAPS) was designed for them. According to this latter scheme, direct payments were paid for the declared land area (a utilized agricultural area) in that particular year. The 2008 and 2013 reforms maintained the market-oriented reform path. At the same time, a new greening scheme was introduced to reinforce the link of decoupled direct support to environmental and climate measures. In the current period of 2014–2021, the main elements of DPs system schemes are coupled and decoupled DPs (with their different combination in different DPs' system schemes). Coupled payments may not exceed 15% of the whole DP financial envelope for a country and are optional.

Since the introduction of the DP system, CAP expenditure on agriculture and rural development has varied from 0.5 to 0.7% of the EU gross domestic product (Fig. 1.3).

Although this share has been decreasing in the last decade, the funding for CAP in 2019 amounted to 38% of the entire EU budget (Fig. 1.4).

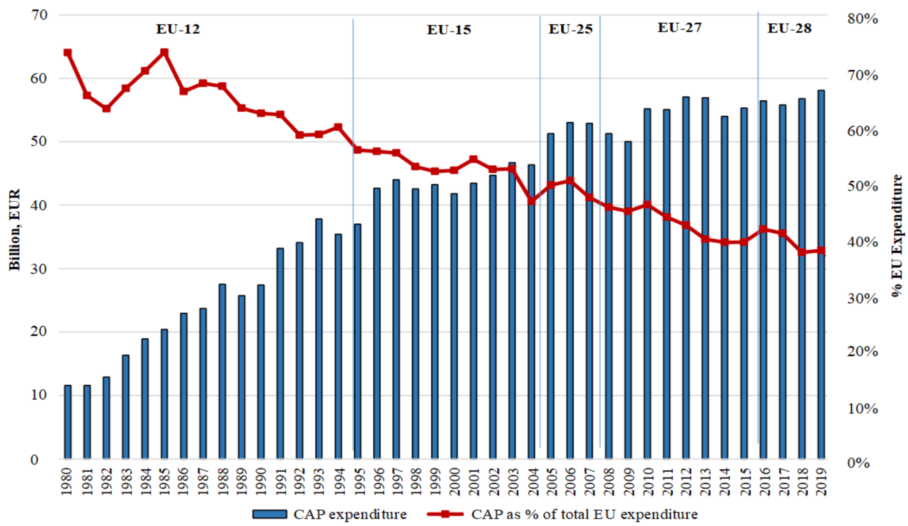

Fig. 1.4. CAP expenditure in the total EU expenditure (constant prices of 2011) (Source: European Commission, DG Agriculture and Rural Development, 2021)

In general, the DPs' level in the EU-27 has been rising during 2005–2019 (Fig. 1.5); however, different tendencies are observed in the old and new MS: in OMS, the DPs exhibit a decreasing tendency, which is due to the declining total amounts of financial funds, allocated to DPs in many OMS in the last decade. Meanwhile, average DPs' amounts in NMS have been increasing due to the convergence principle between OMS and NMS.

Funding for the DPs comprises about 70% of all CAP funds and is the most funded instrument throughout CAP (since DPs' introduction). These payments account for around 77% of the Producer Subsidy Estimate provided by CAP (Severini et al., 2016).

The largest share of DPs is funded by the European Agricultural Guarantee Fund. However, in some of the new EU MS applying SAPS, some DPs were also made from the national budget under the Supplementary National Direct Payments scheme. DPs have been made from the national budget and could have been allocated either for crops/livestock declared in the current year or for crop areas and/or livestock grown and the quantity of milk sold during a given reference period. The payment procedure of supplementary national payments is coordinated with the European Commission on an annual basis.

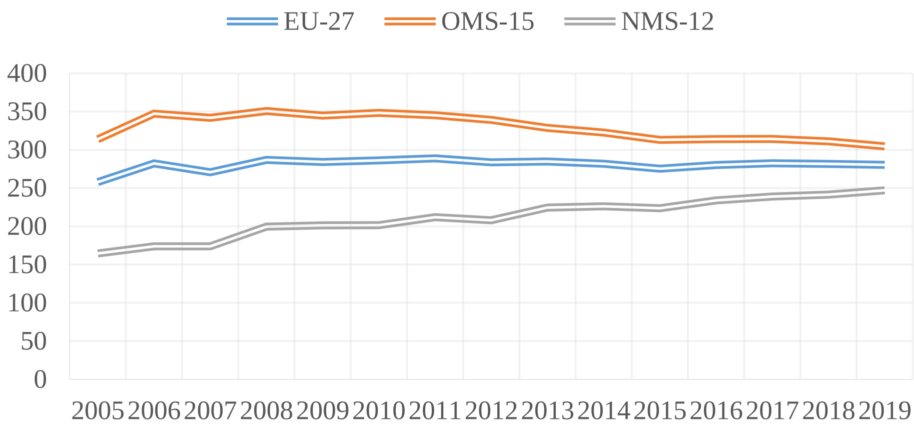

Fig. 1.5. Average DPs per ha in the EU-27, OMS-15, and NMS-11* in 2005–2019, EUR (Source: compiled by the author using FADN data)

*Malta is not included due to its exceptionally high DP-per-ha level in 2005–2008 (more than ten times higher than the average of the rest eleven countries).

Direct payments compose up to 23% of the agricultural income of EU farms (Fig. 1.6) and, therefore, are very important for farmers, the whole agricultural sector, and the entire national economy.

Throughout the CAP's history, its goals have evolved, especially in terms of the environment and rural development, although some of them have remained quite similar: ensuring food safety and security, increasing the competitiveness of the sector, and ensuring the viability of farms. Maintaining/increasing the resilience of farms is an essential condition for achieving these goals. Thus, although resilience has only been identified as a specific target in the most recent financial period (2023–2027), it has existed as a tacit target for a major part of the period.

Assessing the impact of the highest funded support measure, DPs, on resilience is crucial for further progress in increasing agriculture's resilience and improving the CAP and its support structure.

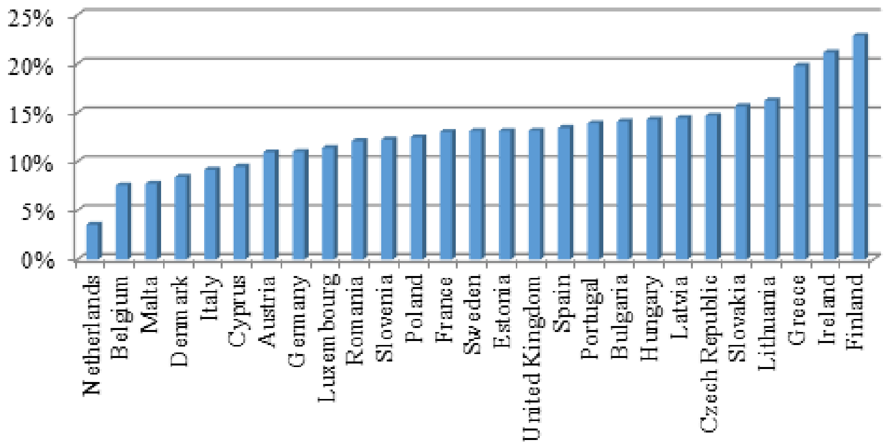

Fig. 1.6. Average share of DPs in the total agricultural output of EU farms by country in 2004–2018, % (Source: FADN, 2021)

1.3. Assessment of the Direct Payments' Impact on Agriculture's Economic Resilience

Governmental policies are acknowledged to influence resilience at various levels; however, how policies enable or constrain resilience remains unclear (Buitenhuis et al., 2020). The CAP relies heavily on DPs to increase farmers' income in the short term; however, what is their influence in the longer run, and how they impact the adaptability of the sector is an open question. Research on the relationship between direct payments (and other types of governmental subsidies) and the resilience of agriculture is very scarce. Moreover, most of the studies dedicated to the topic are based on qualitative research methods. For example, Czekaj et al. (2020) analyzed what resilience strategies small farmers in Latvia and Poland implement in the face of various disturbances and what internal and external resources are deployed in trying to absorb and recover from diverse shocks and stresses. Direct payments are identified as one of the most important strategies to cope with perturbations. Thorsøe et al. (2020) drew on five case studies in five European countries to analyze how farming systems have reacted to the emerging instability of the milk market. Buitenhuis et al. (2020) introduced the Resilience

Assessment Tool (ResAT): heuristics that conceptualizes how policy outputs enable or constrain farming systems' resilience. This tool embraces all three dimensions of resilience (robustness, adaptability, and transformability) and is applied to a Dutch case study, concluding that the CAP and its national implementation strongly support the robustness of the analyzed farming system but that the policy much less effectively influences adaptability and even inhibits transformability. One of the very scarce examples of quantitative research on the subsidies' impact on resilience is provided by Galluzzo (2020). Using Partial Least Square Structural Equation Modeling, he estimated if financial subsidies allocated by the CAP have had a significant impact on the resilience of rural areas. However, his focus was on how CAP subsidies influenced the formation of social capital in rural areas and how these formations sequentially influenced resilience. Borychowski et al. (2020) analyzed the impact of the share of subsidies in farm income on the resilience of small farms in Eastern European countries, concluding that a lower share of income support increases resilience. However, it must be emphasized that in their study, resilience capacity was explored rather than actual resilience. Due to a general scarcity of quantitative research, the extent to which the CAP support policies increase (or inhibit) resilience up to date remains unclear.

On the other hand, the literature on the DPs' impact on various agricultural indicators is very rich. Since agriculture's resilience in this dissertation is evaluated via proxy indicators, it is important to review the current academic literature reviewing the DPs' impact on these indicators.

1.3.1. Direct Payments' Impact on Farm Viability

Many studies are dedicated to analyzing how DPs affect farm profitability (Enjolras et al., 2012; Severini, Tantari & Di Tommaso, 2016; Castañeda-Vera and Garrido, 2017; Brady et al., 2017; Kryszak & Matuszczak, 2019; Kravcáková et al., 2020; Mamatzakis & Staikouras, 2020; Kryszak, Guth, Czyżewski, 2021). Two main directions in this area can be distinguished: studies investigating how DPs impact the profitability growth trends (considered in the form of farm income, gross (net) margin, return on assets (or equity), and farm's net value added) and studies analyzing its volatility and variability. The findings of these studies are ambiguous. For example, Kryszak and Matuszczak (2019), using quantile regression to determine DPs' impact on farm income, state that subsidies had a significant positive effect on income in the analyzed period. Similarly, Biagini, Antonioli, and Severini (2020), using GMM, found that decoupled direct payments provide the highest contribution to agricultural incomes, followed by agri-environmental payments and on-farm investment subsidies, while coupled payments have no significant impacts on farmers' income. Severini, Tantari, and Di Tommaso (2016) and Hayden et al. (2019) found that DPs tend to stabilize farm income. They argued that the high variability of farm income mostly comes from the revenue component. The DPs stabilize farm income mainly because DPs are less variable than the remaining part of income. However, they also state that DPs are not targeted to those farms facing the highest level of income variability (Severini, Tantari & Di Tommaso, 2016). Castañeda-Vera and Garrido (2017) compared the strategies, i.e., CAP direct payments, diversification, crop insurance, and an Income Stabilization Tool, that most effectively contribute to farm income and income stability and the efficiency of public expenditure invested in supporting them. They concluded that direct payments and crop diversification were the most effective measures in decreasing income variability; however, crop insurance and Income Stabilization Tool have the potential for both improving farm resilience to income variability and limiting public expenditure. Lehtonen and Niemi (2018) performed a simulation on how a reduced CAP budget would affect farm incomes in Finland. They found that reducing the CAP budget by 20% would affect farm incomes by 20–25% in southern Finland, while central and northern parts of the country, which are dependent on national payments coupled with dairy and beef production, would be less affected. Enjolras et al. (2012) found that the DPs' impact varies across countries. In Italy, farms use CAP payments to increase their income and reduce its volatility, while French farms tend to substitute CAP payments for production. Kravcáková et al. (2020) used the multi-criteria method TOPSIS and observed a statistically significant negative link between the volume of subsidies per hectare of agricultural land and ROA and interest coverage ratio; however, the significance of this impact varied across legal forms of holdings. Mamatzakis & Staikouras (2020) found that agricultural income had been subdued due to negative shocks in direct payments. Brady et al. (2017) argued that direct payments avoid land abandonment but slow down structural change. Hampering the development of a productive and competitive sector, DPs constrain income growth, primarily in relatively productive regions. Balezentis et al. (2019) performed performing the profitability decomposition and concluded that CAP payments in Lithuania may "distort incentives for higher market integration and, thus, profit margins in the large farms due to unlimited area payments."

The literature analyzing the DPs' impact on farm solvency is much scarcer than on farm profitability and mostly performed in the US. Authors focused on subsidies, and financial leverage relationships tend to conclude that payments have a positive effect. For example, Kropp & Katchova (2011) found that the correlation between the level of direct payments and the term debt coverage ratio for experienced farmers is positive, suggesting that direct payments improved the repayment capacity. However, they also noted that this relationship was not significant for beginning farmers. Ifft et al. (2012) argued that farms receiving DPs were in a stronger financial position than farms not receiving them. Soliwoda (2016) analyzed the DPs' impact on solvency for the EU-28 and found that an increasing level of subsidies encouraged farm managers to use external financing sources, meaning that CAP support beneficiaries were willing to bear a higher level of financial risk and, thus, their debt-to-assets-ratio increased. On the other hand, direct payments may be negatively associated with financial leverage if farmers substitute income from direct payments or other subsidies with farm income and thus become less motivated to replace or retool their fixed assets. Similarly, Skevas et al. (2017) found that most Dutch dairy farms underinvested in capital assets due to DPs during the period 2003–2013.

The other area of significant academic attention is the DPs' impact on farm productivity and efficiency. A lot of authors (Balezentis & de Witte, 2014; Pechrova, 2015; Latruffe & Desjeux, 2016; Martinez Cillero et al., 2017; Garrone et al., 2019; Staniszewski & Borychowski, 2020) analyzed this link; however, the results, similarly to the above discussed DPs' impact on farm profitability, are not unambiguous. Rizov et al. (2013) and Kazukauskas et al. (2014) found that decoupled payments impacted productivity positively. Similarly, Garrone et al. (2019) concluded that, on average, CAP subsidies increase agricultural labor productivity growth. However, if different types of subsidies are analyzed, important heterogeneity of effects is found, i.e., decoupled subsidies have a positive effect on productivity, while coupled Pillar I subsidies slow down productivity growth. Martinez Cillero et al. (2017) analyzed changes in technical efficiency in beef farms and concluded that direct income received in the form of coupled payments had a positive impact on farm efficiency and that this positive effect was maintained after the replacement of coupled payments with decoupled income support. Staniszewski and Borychowski (2020) argued that the impact of subsidies on efficiency depends on the size of farms. A statistically significant stimulating effect of subsidies was identified only in the group of the largest farms. Latruffe & Desjeux (2016) found the effect of a particular subsidy type to be negative or positive depending on the sample's production orientation and the considered performance. The results of Pechrova's (2015) study revealed that DPs and agri-environmental payments tend to increase inefficiency, and Bonfiglio et al. (2018) found DPs to have been negatively associated with technical efficiency. Minviel & Latruffe (2017) have performed a meta-analysis of empirical results on the issue of how public subsidies impact a farm's technical efficiency. They found that, on average, the farm's technical efficiency is negatively associated with the subsidy's income share. Specifically, the magnitude of the overall effect size highlights that a 1-percentage point increase in the subsidy income share leads to a 1.87% decrease in technical efficiency. However, the direction (significantly negative, significantly positive, or non-significant) of the observed effects is sensitive to the way subsidies are modeled in the empirical studies (Minviel & Latruffe, 2017).

In summary, the empirical findings provided above show that the DPs' impact on various farm viability indicators (profitability, solvency, efficiency) is ambiguous, differing across farms and countries. And it is not only the size of the impact but also its direction that differs. Therefore, an assumption can be made that the ambiguity of the DPs' impact on farm performances heavily depends on the indirect effect that DPs may exert on farmers' behavior and other factors that will be discussed in the following section.

1.3.2. Indirect Effects of Direct Payments

It is widely acknowledged that DPs may indirectly influence farm management and production decisions and, in turn, impact farm performances (Patton, Olagunjuand & Feng, 2017). The effects of direct payments on a farm's and the total sector's performance may be positive and negative, mainly depending on their impact on farmers' behavior. The literature analysis allows distinguishing several main channels through which subsidies have the potential to influence farm viability and other performances of the agricultural sector:

1. Influencing farmers' attitudes and behavior:
    a. Farmers' risk attitudes and consequent risk management behavior.
    b. Farmers' orientation to market and the structure of production.
    c. Motivation to work efficiently and expand operations.
    d. Farmers' investment decisions.
    e. Business termination and exit from the market decisions.
2. Stimulating increase of land and land rent prices.

Next, these channels are discussed in detail.

Farmers' risk attitudes and changing risk managing behavior. Direct payments can have an impact on farmers' production decisions by influencing their attitude to risk-taking. The Theory of Behavioral Economics suggests that people spend more as the value of their assets rises (Maki & Palumbo, 2001) since they tend to feel richer even if their income and fixed costs are the same as before, and therefore, they are prone to tolerate a higher level of risk than before. Empirical evidence (Hennessy, 1998; Koundouri et al., 2009) confirms that DPs produce wealth effects: when provided with a steady stream of subsidies, farmers who are risk-averse change their attitude to risk-taking. DPs can encourage farmers to make more risky production decisions, facilitate the subsidization of fixed costs on unprofitable farms and increase non-labor income, allowing farmers to work less but maintain consumption (O'Toole & Hennessy, 2015). Due to the subsidies, the farmer may be more willing to increase production and employ additional production factors, which would prove too risky without payments (Roche & McQuinn, 2004; Koundouri et al., 2009). Farmers may also expand their acreage of riskier crops (Bhaskar & Beghin, 2007; Howley et al., 2012; Burns & Prager, 2016). The higher level of tolerated risk also diminishes demand for insurance (Chakir and Hardelin, 2010; Finger & Lehmannn, 2012) or other forms of risk management (Finger & Lehmann, 2012). So, taking riskier decisions due to the wealth effect induced by direct payments may increase output (Knapp & Loughrey, 2017); however, it may also significantly increase the variability of that output. Banga (2016) argued that since direct payments constitute a relatively stable source of income, they can be considered a form of insurance, which reduces the need for other risk management measures, such as diversification (El Benni et al., 2012; Falco et al., 2014; Morkunas & Labukas, 2020), crop/animal insurance, etc. Therefore, the larger the share of direct payments for the total farm revenue, the less attractive insurance is as a risk management strategy for farmers (Finger & Lehmann, 2012). According to some authors (Hennessy, 1998; Sckokai & Moro, 2006), the insurance effect has a greater impact on farmer decisions than the wealth effect.

Farmers' market orientation and the structure of production. Although the largest share of DPs is decoupled from production, many researchers have proved that these subsidies still affect farmers' production decisions. O'Donoghue and Whitaker (2010) revealed that decoupled payments changed individual acreage decisions significantly, ranging from about 9 to 16%. Howley et al. (2012) suggested that farmers had used decoupled payments to partly subsidize unprofitable farm production. Subsidies were also documented to negatively impact crop diversity (Lazíková et al., 2019), which is often emphasized as significantly increasing the resilience of the farming systems (Bowles et al., 2020; Sanford, 2021). Moreover, DPs tended to encourage producing extensive crops at the expense of intensive sectors (Valkanov, 2013; Ivanov, 2018; Balezentis et al., 2019; Morkunas & Labukas, 2020; Némethová & Vilinová, 2022). According to Ivanov (2018), the shift to crop farming may be encouraged by direct payments covering significantly different shares of expenses for different subsectors: e.g., around 20–30% of production expenses of crop farming and merely 3–5% of the production costs incurred in the intensive vegetable and fruit sectors. Distorting the production structure of recipient farms, DPs may lead them to allocative inefficiency.

This, in turn, can lead to several dangerous consequences. First, when decisions are based on external support rather than market needs and farm competencies, farms tend to operate on a short-term basis without strategical long-term goals and vision, which is indispensable for each farm's development. Since the payback period for most investments is long and has sunk costs, the motivation to invest is substantial only when a certain activity is intended to be performed for at least some specific period. However, there is always a certain level of risk that the support may be discontinued or significantly reduced; therefore, farmers basing their production decisions on available support may not be willing to produce the same sorts of crops/animals after the support is ended, especially if their profitability and competitiveness in the market without subsidies is low. There are also other drawbacks to farmers' decision to switch to the supported sorts of produce. Farmers may lack knowledge and skills as well as the necessary technical and technological capabilities to produce them, which, in turn, leads to relatively lower productivity and/or quality of production, negatively impacting farm viability.

Overcrowding motivation to work efficiently and expand operations. The Motivation Crowding Effect suggests that external monetary incentives, such as subsidies, may undermine or (under specific conditions) strengthen the motivation to act in a certain way (Frey & Jegen, 2001). In this line, Minviel and De Witte (2017) stated that farmers' efforts in farming might be reduced if a larger part of their income is guaranteed by subsidization. DPs may give farmers the potential to capture some level of profits in the form of a lack of effort (Ferjani, 2009; Patton, Olagunju & Feng, 2017). Similarly, if DPs help farmers to avoid bankruptcy, then these farmers have less motivation to reorganize, modernize and improve their performance as they would inevitably be forced to do in the case without support (Ferjani, 2009; Candell et al., 2020).

Investment decisions. DPs may influence farms' performance via investment decisions in several ways. A positive impact is expected if subsidies allow farmers to overcome financial constraints, which hold back investments in modernization or expansion of the farm (Zhu & Oude Lansink, 2010). On the other hand, due to the support, farms may change the combination of capital and labor by investing unreasonably heavily in the capital, which may result in allocative inefficiency (Rizov, Pokrivcak & Ciaian, 2013; Czyzewski, & Smedzik-Ambrozy 2017; Namiotko, 2018; Musliu, 2020).

DPs allow farmers to invest either directly, by adding to the internal farm's financial reserves and thus reducing the need for external financing, or through diminished credit constraints (Roe, Somwaru & Diao, 2002; Latruffe et al., 2010, O'Toole & Hennessy, 2013). Many studies confirm that subsidies reduce credit constraints for farmers (Vercammen, 2007; Kropp & Katchova, 2011; O'Toole & Hennessy, 2013). DPs have the potential to increase the borrower's liquidity and to improve his repayment capacity, both directly and via increased land values (Roe, Somwaru, & Diao, 2003; Vercammen, 2007). Since both indicators are often assessed by creditors, their improvement should increase the possibility of a borrower obtaining credit and/or getting more favorable terms (Kropp & Katchova, 2011).

Business termination decisions. Many studies conclude that the CAP has had a high impact on farm structures in Europe. Happe et al. (2009) found that DPs encouraged those farmers who considered exiting agricultural activities to stay in business. The same conclusion is suggested by Kropp and Katchova

(2011), arguing that decoupled direct payments may keep marginally profitable farmers in the sector. In contrast, Tocco et al. (2013) found that total subsidies were negatively associated with the out-farm migration of agricultural workers in Hungary and Poland; however, they positively correlated with keeping workers in France and Italy. Furthermore, if DPs significantly improve the farm's repayment capacity, the farm becomes more creditworthy, which improves access to capital and may cause some farms to expand. Balmann & Sahrbacher (2014) analyzed the long-term implications of redistributive payments and support for young farmers in several German regions and concluded that extra payments slow down structural adjustments and the benefits for the small farms come at the expense of development perspectives of medium-sized farms. Szerletics (2018) stated that elderly farmers generally are not retiring and passing on their farms to the younger generation, most probably due to additional income obtained from DPs.

DPs impact on land and land rent prices. One of the indirect pathways of the DPs' influence on agriculture's resilience leads through the capitalization of these payments. Most scholars agree that DPs do capitalize on the land and its rent value, and the debatable question lies mainly on the extent of this capitalization.

The capitalization process means increased assets and larger incomes from land rent to landowners; however, they are not always the ones engaged in agricultural operations (Van Herck, Swinnen, Vranken 2013). When this is the case, negative effects for farmers arise. First, when land and land rent prices increase, new-coming and expanding farmers face higher costs (Constantin, Luminita & Vasile, 2017; Bórawski et al., 2019). The consequently reduced transfer of land among different owners pushes up the average cost of production in the agricultural sector (Ciaian et al., 2012).

Michalek, Ciaian, and Kancs (2014) report that capitalization rates of DPs into land values vary across the EU-15 from 4% in Greece to 18% in Portugal, averaging 6–7%. In their meta-analysis of empirical findings, Feichtinger and Salhofer (2013) estimated that an average of 25–36% of all agricultural support schemes are capitalized into land sales prices. Varacca et al. (2021) performed a meta-analysis of the capitalization of CAP direct payments into land prices and concluded that the introduction of decoupled payments increased the capitalization rate, although the extent of this increment hinged on the implementation scheme adopted by MS. Baldoni and Ciaian (2021) found the short-run capitalization rate of decoupled DPs in the EU varied between 9.1% and 46.2%; and that of coupled DPs was between 5.8% and 6%. The long-run capitalization rate of decoupled DPs varied between 11% and 55%, while that of coupled was around 7%. Regarding rental prices, capitalization rates were between 28.8% and 32.1% in the short run and between 154% and 164% in the long run. The exact capitalization rate of DPs on land values and land rents depends on many factors, such as the adopted support model, supply, and demand elasticities, accompanying policy measures, land use opportunity costs, farm behavioral effects, and region-specific aspects, such as credit market imperfections (Ciaian et al., 2012; Góral & Kulawik, 2015). The impact also depends on how these factors interact with subsidies (e.g., subsidies may increase or decrease productivity depending on farmers' behavior) (Ciaian, Kancs & Paloma, 2015).

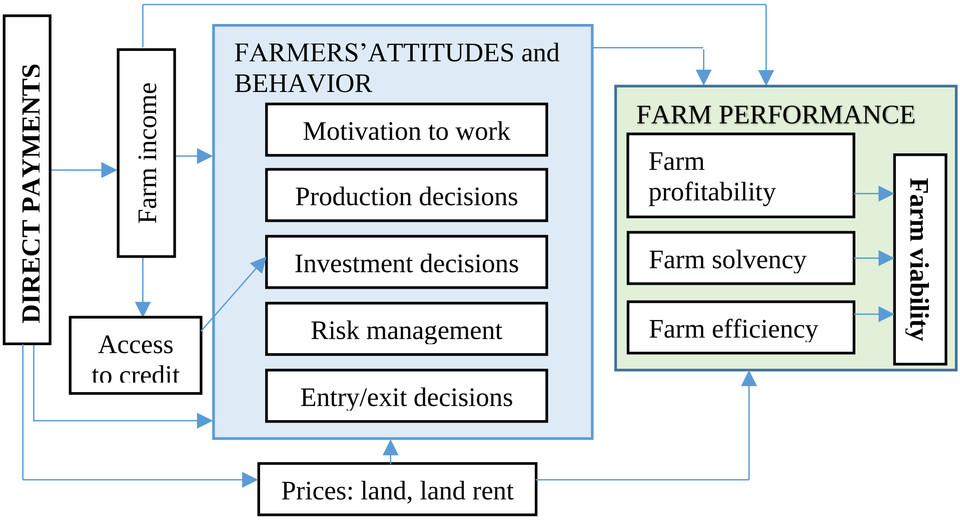

Fig. 1.7. Transmission mechanism of direct payments' impact on farm viability (Source: elaborated by the author)

In summary, DPs tend to have a significant influence on farmers' behavior; however, their strength and direction vary across farms and countries. Thus, besides the direct positive impact on farm income, DPs have the potential to simultaneously indirectly affect various aspects of farm viability (Fig. 1.7), which, in turn, may impact the resilience of the whole agricultural sector.

1.3.3. Direct Payments' Impact on the Production of Affordable Food and Other Agricultural Goods

Empirical findings on the DPs' impact on agricultural production amounts are also diverse. Doucha and Foltýn (2008) and Mala et al. (2014) concluded that increasing CAP subsidies tended to decrease volumes of plant production. Similarly, Opatrny (2018) argued that the Czech Republic would have had a higher food production index without CAP subsidies. The same result is confirmed for Bulgaria (Opatrny, 2018). Toth (2019) noted that one of the reasons for the low overall level of production per hectare is the size structure and subsequent distribution of CAP subsidies. Similarly, Chrastinová and Buriánová (2009) emphasized that although the Slovakian agricultural sector enjoys higher income due to DPs, the production volumes were falling. On the other hand, von Witzke et al. (2010) argued that direct payments stimulated production and investment in agriculture compared to a situation without subsidies; however, they agreed that the magnitude of the DPs' impact on production might have varied considerably. Results by Barnes et al. (2016) showed that 9% of the farmers would exit the industry, and around half of them would decrease herd size and intensity. Kozar et al. (2012) showed that a sharp decline in DPs would significantly negatively affect agricultural gross value added. According to Olagunju, Patton, and Feng (2020), the impact of decoupled payments on livestock production in Northern Ireland was positive and significant but with differential impacts across livestock production sectors. Lehtonen and Niemi (2018) revealed that overall milk production in Finland would not be affected much by a 20% cut in the EU CAP budget, with, however, differentiating impacts in individual regions. Others found that the reduction or abolishment of direct payments would not induce dramatic changes to the agricultural markets of the NMS by 2020 (Chantreuil et al., 2013). Giannoccaro et al. (2015) estimated the impact of the 2013 CAP reform on the livestock sector in several EU countries and found that decoupled payments encouraged the decrease of livestock numbers in many European countries; however, specialist dairy units were expected to increase. Borawski et al. (2020) found that subsidies did not have the expected impact on milk production in the EU.

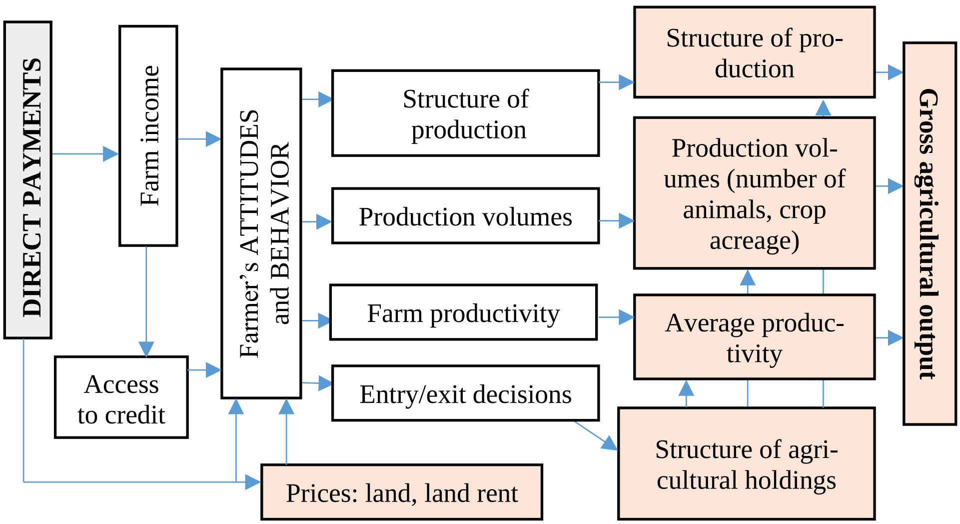

Fig. 1.8. Transmission mechanism of direct payments' impact on country's agricultural output (the orange box filling reflects the meso level, white shows the micro level) (Source: elaborated by the author)

The ambiguity of empirical results on the DPs' impact on agricultural production may be attributed to the differences in the changes in farmers' behavior due to DPs (Olagunju, Patton & Feng, 2020). Based on the above discussion on how DPs influence farmers' behavior, several channels of the DPs' impact on the changes in gross agricultural production can be distinguished (Fig. 1.8).

First, as shown above, DPs have the potential to significantly impact the structure and volumes of a farm's production via production, risk management, investment, business expansion, and termination decisions. Since these effects are systematic, meaning that they change the behavior of a large share of farmers, they consequently affect the gross agricultural output of the country.

A large share of the literature on the relationship between CAP and food prices is dedicated to how DPs impact the price transmission mechanism throughout the supply chain (Bekkers et al., 2017; Rezitis & Pachis, 2018; Antonioli & Santeramo, 2021). However, theoretical and empirical analysis of the DPs' impact on retail food prices is quite limited. One of the scarce examples is a study by Ciliberti & Frascarelli (2015), who showed that the selected DPs scheme might have a negative effect on limiting the price volatility of Italian agricultural commodities. Apergis and Rezitis (2011) argued that CAP reforms (from coupled to more decoupled payments) "caused significant decreases in intervention prices and induced compensation to producers through DPs, which are not related to the level of production, thus causing higher food price volatility." Meyer (2012) argued the decoupling process could have caused several long-run impacts on agricultural markets, including a decrease in food prices in Germany. Stojanovic (2019) and Borawski et al. (2020) document high food price increases in NMS after adopting CAP. However, overall empirical evidence of the DPs' impact on food prices is lacking.

1.3.4. Direct Payments' Impact on Maintaining and Creating Decent Jobs

A large number of authors conclude that DPs have a significant impact on agricultural employment (Petrick & Zier, 2012; Olper et al., 2014; Berlinschi et al., 2014; Rafiaani et al., 2018; Mattas & Loizou, 2017; Garrone et al., 2019a). However, the majority of this research is dedicated to analyzing the DPs' impact on the farmers as self-employed entities or the overall employment trends. Research on hired labor tendencies is much scarcer. However, there is some empirical evidence that DPs do influence the employment of hired labor in agriculture. For example, Kasimis and Papadopoulos (2013) argued that CAP subsidies had an impact on the expansion of salaried agricultural employment, which is required to carry out non-skilled and arduous tasks. On the other hand, Chrastinová and

Buriánová (2009), Dupraz, Latruffe, and Mann (2010), Kaditi (2013), and Mantino (2018) found that decoupled payments negatively affect family and hired labor. Petrick and Zier (2012) found that decoupled subsidies have no impact on employment, and the impact of coupled payments on farm labor markets is ambiguous. Dupraz and Latruffe (2015) concluded that livestock payments would have a negative effect on hired labor. Garrone et al. (2019a) argued that there is no significant association of coupled Pillar I payments with agricultural employment in the EU-27, nor separately in the OMS or NMS. On the other hand, decoupled Pillar I payments have a strongly significant negative effect on the outflow of labor from agriculture in the EU-27 and separately in the OMS or NMS (Garrone et al., 2019a). They also noted that the outflow of hired labor is higher than that of family labor.

The ambiguous results on the DPs' impact on salaried employment trends may be due to the indirect effects of DPs, which may influence the employment of hired workers in both directions, positive and negative. Several main indirect effects of DPs on hired employment may be distinguished. First, DPs impact farmers' production decisions and thus have the potential to affect demand for hired labor (Swinnen & Van Herck, 2010; Dupraz & Latruffe, 2015; Mantino, 2018). Second, DPs influence farm investment decisions. Stimulating the capabilities for farm expansion, DPs may contribute to increasing hired labor demand (Zhu & Oude Lansink, 2010; Kaditi, 2013; Papadopoulos, 2015). On the other hand, due to the support, farms can change the combination of capital and labor by investing more in the capital (Musliu, 2020) and thus decrease their labor demand. Third, the increase in land purchase and land rent prices may lessen farms' financial funds to hire workers for land-renting farms. Finally, Key and Roberts (2008) note that since farmers can derive nonpecuniary benefits from farming, the reception of DPs encourages them to increase their on-farm labor supply by reducing their reliability on off-farm work (El-Osta, Mishra & Ahearn, 2004; Bhaskar & Beghin, 2007). Expansion of family labor work may, in turn, negatively impact demand for hired labor.

The DPs' impact on wages of hired labor in agriculture has been especially rarely analyzed since the majority of literature focuses on the income of farmers, i.e., self-employed persons (Severini, Tantari & Di Tommaso, 2016; Castañeda-Vera and Garrido, 2017; Hayden et al., 2019; Kryszak & Matuszczak, 2019). One of the scarce examples is the study performed by Chrastinová and Buriánová (2009), who stated that due to CAP subsidies, wages of agricultural employees in Slovakia tend to stagnate. However, based on the above-discussed DPs' impact on farmers' behavior, prices, and overall farm viability, it can be assumed that the DPs' influence on wages of hired labor may also be ambiguous, depending on their impact on other variables, such as farmers' behaviors, farm characteristics, etc.

1.3.5. Direct Payments' Impact on Agriculture's Economic Resilience

The comprehensive analysis of the literature on the DPs' impact on various agricultural indicators (provided in Sections 1.3.1–1.3.4) enables to construct of a theoretical model of the DPs' impact on agriculture's resilience, which will serve as a base for the empirical investigation (Fig. 1.9).

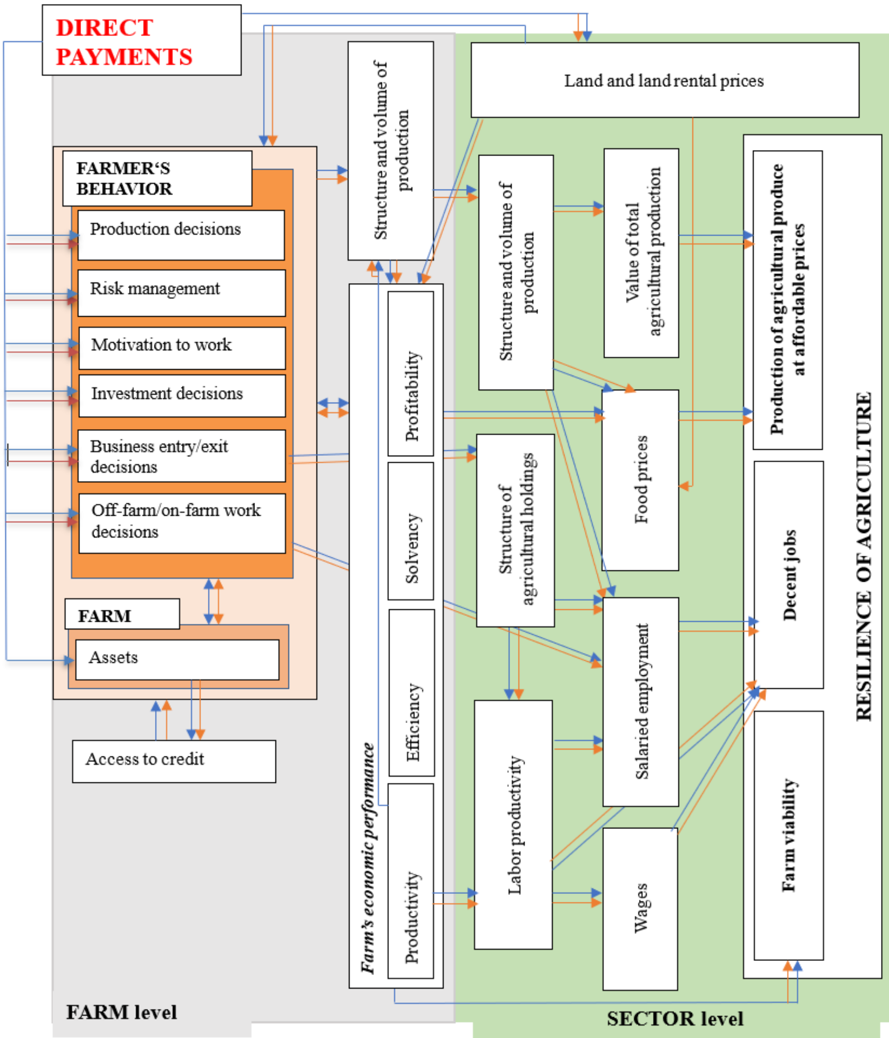

Fig. 1.9. Theoretical model of the direct payments' impact on agriculture's economic resilience (red arrows indicate the negative impact, blue arrows show the positive impact, and black mark composite elements) (Source: elaborated by the author)

The model reveals that DPs' influence on the economic resilience of agriculture is not obviously positive, as would have been expected from the amount of financial funds allocated to this sector. Rather, the DPs' influence is quite ambiguous and not readily understandable. This ambiguity is based on the empirically well-documented fact that DPs may have contradictory effects on the same variable and that these effects are mainly grounded on differences of influence that DPs exert on farmers' behavior. Therefore, it may be hypothesized that the overall DPs impact on the resilience of agriculture in the EU countries should be neither very positive nor very negative, as contradictory effects might cancel out each other. On the other hand, these effects might be different for the OMS and the NMS since the mentality of people, farm wealth, sector structure, and other elements differ remarkably between these two groups of countries, and these differences may have a significant effect on how DPs impact agriculture's resilience in those countries. These hypotheses will be tested during the empirical research.

1.4. Conclusions of the First Chapter and Formulation of the Dissertation Tasks

There is no universally agreed definition of economic resilience yet. Two main approaches to the resilience phenomenon are prevailing: "equilibrium" and "complex systems" ones, with the latter being increasingly used recently. According to the complex systems approach, resilience is a multidimensional construct, encompassing three dimensions: (1) robustness - the capacity to withstand perturbations, (2) adaptability – the capacity to adapt to changes determined by perturbations and (3) transformability - the capacity to qualitatively transform after perturbations. In addition, two main types of resilience are usually distinguished: general (to various crises) and specified (to some specific crisis) resilience.

So far, there is no generally accepted methodology on how to operationalize resilience and measure it empirically. A comprehensive literature review distinguished two main types of operationalization of the resilience concept in economics: (1) assessment of resilience via an index, composed of variables potentially influencing resilience of the system, and thus estimating resilience capacity rather than actual resilience; (2) assessment of resilience via an index, composed of a variable(-s) reflecting key functions/performances of the relevant system, and thus estimating actual resilience. Three key economic functions of agriculture have been distinguished to be used for evaluating the actual agriculture's economic resilience, i.e., production of affordable food and other agricultural goods, assurance of farm viability, and creation and maintenance of decent jobs.

Ways used for the measurement of actual economic resilience were systematized, and the grouping into four categories was proposed: decline levels (absolute or comparative) in key performances to be used to measure the robustness dimension of the specified resilience, recovery speed and extent for the adaptability dimension of the specified resilience, volatility for the robustness dimension of the general resilience, and growth for the adaptability dimension of the general resilience. Subsequently, the growth of indicators of the key agricultural functions was identified as an appropriate measure of the adaptability dimension of actual agriculture's general economic resilience.

CAP support system has evolved throughout its history due to the changing goals and the need to lessen negative externalities induced by the applied support schemes. Since 2007, when decoupled direct payments have become the major support measure of CAP, the system has changed relatively little.

The extant analysis of research on the direct payments' effects on various indicators revealed that DPs might have direct and indirect effects on the indicators of key economic functions of agriculture, performances of which reflect resilience. Due to significant indirect effects (mainly via changing farmers' behavior), the effects of DPs on the same variables may differ in size and even in the direction across farms and countries.

The performed scientific literature analysis gives rise to the following dissertation's objectives to achieve the goal:

1. Constructing the model to assess the DPs' impact on agriculture's economic resilience.
2. To check the practical applicability of the developed model by analyzing the DPs' impact on the resilience of agriculture in the EU-27 and, separately, in the old and new EU member states in 2005–2019.

2

Methodology for Assessing the Direct Payments' Impact on Agriculture's Economic Resilience

This chapter presents the assessment model for the direct payments' impact on agriculture's economic resilience and describes its elements and sequence of actions. The formed list of resilience indicators is substantiated first. Then, the methods are selected for estimating the direct payments' impact on these indicators (fixed and random effects models and generalized method of moments) and described. The chapter offers using an expert survey to determine the weights for resilience indicators and presents the methods for aggregating the direct payments' impact on individual indicators under one index. One scientific publication was issued on the topic of the second chapter (Žičkienė et al., 2022).

2.1. Model of the Direct Payments' Impact on Agriculture's Economic Resilience

The literature review suggests that indicator-based resilience assessment is appropriate for assessing the impact of external factors on resilience due to its conceptual coherence and practical simplicity (Webber, Healy & Bristow, 2018; Obschonka, 2015; Martin et al., 2016; Angulo, Mur & Trivez, 2017; Kitsos & Bishop, 2018; Ubago et al., 2019). Composite indices enable the aggregation of complex, multidimensional realities and simplify the comparison and interpretation (Ubago et al., 2019). An indicator-based integrated index is particularly useful for analyzing and evaluating policy measures (Singh et al., 2009; Štreimikienė & Mikalauskienė, 2009). The resilience issue is not so much a question of whether a sector is fit at a specific moment but more of whether it transforms into a more or less resilient orientation. Therefore, indicator-based integrated indices, allowing for monitoring development over time, are appropriate for assessing the direct payments' impact on agriculture's economic resilience. Integrated indices also enable identifying areas where direct payments have the highest impact, in addition to if that impact is positive or negative, which subsequently enables detecting areas that need improvement.

The model for assessing this impact consists of several stages (Fig. 2.1). In the initial and essential stage, the conceptual base for the development of the evaluation method for the DPs' impact on agriculture's economic resilience was created. The multifarious resilience phenomenon had to be operationalized and integrated into the realms of agriculture for the DPs' impact to be measured.

In the second stage, a set of indicators reflecting the multifaceted phenomenon of agriculture's economic resilience was constructed. An in-depth analysis of the scientific literature was performed to develop this set of indicators. The final result of this stage is a system of eight indicators assessing three key economic functions used to measure agriculture's economic resilience.

In the third stage, the DPs impact on agriculture's economic resilience was determined. This stage encompassed the estimation of the DPs' impact on individual resilience indicators, the performance of the expert survey, and the construction of the composite index of the DPs' impact on agriculture's economic resilience.

In the final stage of the assessment model of the DPs' impact on agriculture's economic resilience, conclusions and proposals amending the DPs support system are offered (Fig. 2.1).

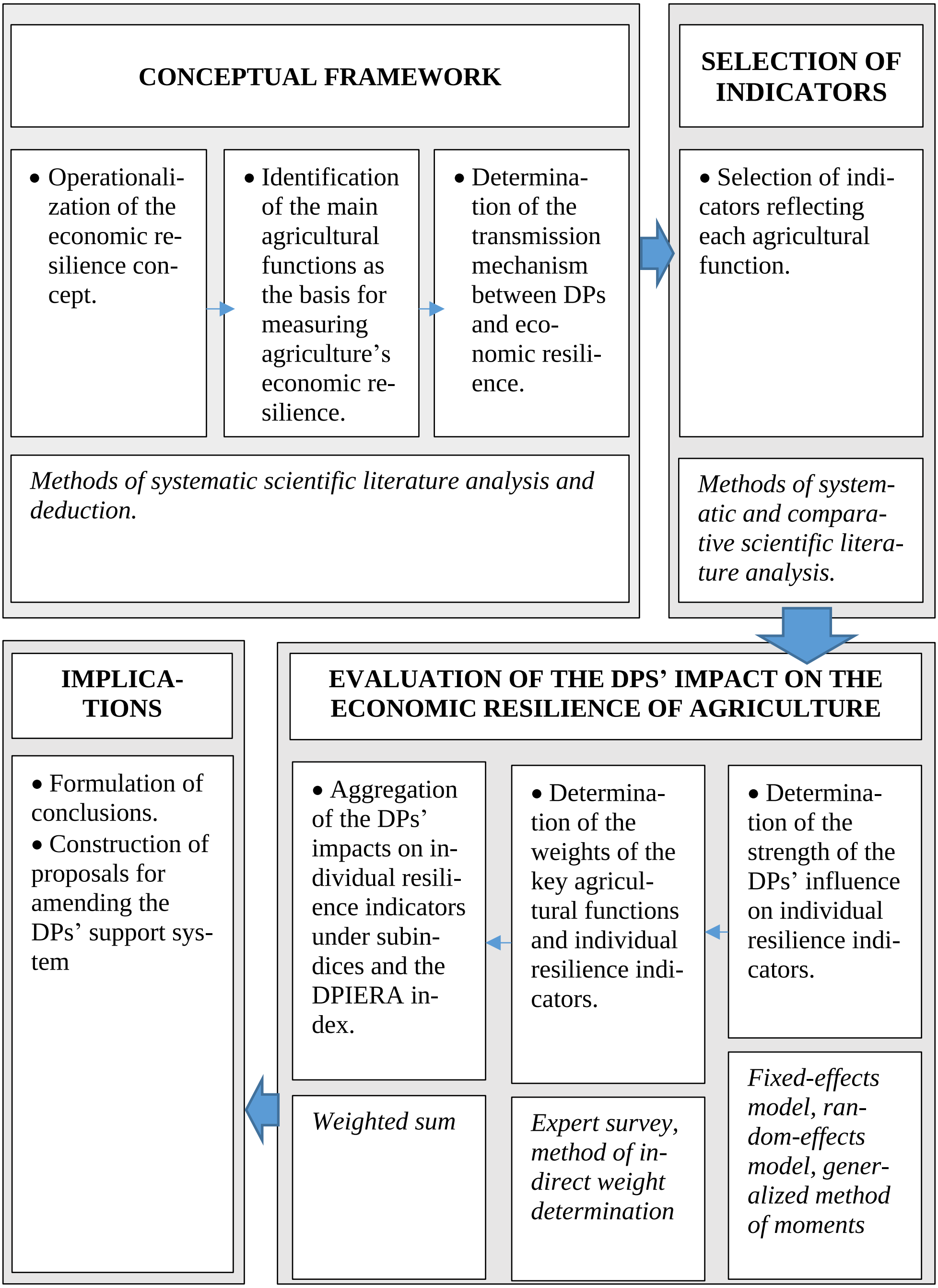

Fig. 2.1. Assessment model of the DPs' impact on agriculture's economic resilience

2.2. Selection of Indicators Reflecting Agriculture's Economic Resilience

Following European Commission (2001), Reytar, Hanson & Henninger (2014), and Moragues-Faus & Marceau (2019), the selection of indicators followed several basic principles: the effectiveness and representativeness of the selected indicators, their availability, comparability, frequency, cost-efficiency, and policy-relevance.

2.2.1. Selection of Indicators Reflecting the Function of Agriculture "Production of Affordable Food and Other Agricultural Goods"

Agricultural production. Production of food (and other agricultural goods) has been measured in several ways. The main indicators used for this purpose are presented in Table 2.1.

Table 2.1. Indicators of Agricultural Production (Source: elaborated by the author)

Dimension	Indicators	Authors
Quantity	Quantity (in energy terms)	European Commission (2001)
	Quantity (in amounts)	Chilonda & Otte (2006)
	Productivity (labor, land, capital, total factor)	European Commission (2001), Chilonda & Otte (2006), IFPRI (2018), Meuwissen et al. (2019)
	Loss of crops/livestock due to pests/diseases	Meuwissen et al. (2019)
	Food balance sheets	Jati (2014)
	Area of production	Nelson & Swindale (2013)
Quality	Nutritional quality	Meuwissen et al. (2019)
	Organic agricultural production (value of gross production, UAA, number of farms)	Meuwissen et al. (2019)
	Share of the value of organic agricultural production in the value of all agricultural production	European Commission (2001)
	Products carrying registered product names (number/sales of products carrying PDO/PGI/TSG labels)	European Commission (2001)

End of Table 2.1

Dimension	Indicators	Authors
Quality	Share of food produced that successfully passes a quality control	Meuwissen et al. (2019)
Value	Value of gross production in agriculture	Macours &Swinnen (2000), Martín-Retortillo & Pinilla (2015)
	Gross value added	European Commission (2001)
	The balance of foreign trade of agricultural and food products	Volkov et al., 2021
Price	Price differentials (domestic price/international market price)	Meuwissen et al. (2019), FAO (2013)
	Absolute prices of certain types of produce	Meuwissen et al. (2019)
	Ratio of the retail prices of agricultural and food products to the retail prices of all consumer goods	Volkov et al. (2021)

Agricultural production amounts best reflect the essence of agricultural production as the agricultural function. The resilience of the agricultural sector, in this case, would be maintaining the levels of production despite various perturbations. However, the quantity of aggregated agricultural production (both in amounts and energy terms), apart from being hard and laborious to evaluate, is also hardly comparable among countries due to different production structures, cultural and food consumption patterns, also a different share of food exports in their total food production. Moreover, since the resilience definition used in this dissertation allows for various changes in economic structures and institutional arrangements, the decreases in the volume of specific production may represent a reaction to changes in consumption patterns and mean increasing rather than decreasing resilience. The issue of comparability also applies to the quality dimension of food production, even without considering that some indicators for this dimension are difficult to obtain for every country. Productivity is a good indicator of the average output per unit; however, it does not fully reveal the whole volume of production in a given system (countries, in this case). Growing productivity may allow for expecting higher outputs; however, output also directly depends on the agricultural area (or the number of animals) dedicated to the production of a certain type of goods. Therefore, changing production structures (either due to changes in the market, in the support systems, or others) can have significant impacts on the whole production amounts (values) without changes in productivity (or amounts can even be lower with increasing productivity, e.g., when the number of producers decreases or the motivation to produce declines (Zhu & Lasink, 2010; Carpentier, Gohin Heinzel, 2012; Rizov, Pokrivcak, Ciaian, 2013). Food balance sheets, showing the trends in the overall national food supply, are useful in making a detailed examination and appraisal of the food and agricultural situation in a country. They are suitable for estimating the overall shortages and surpluses in a country and provide a sound basis for the policy analysis and decision-making needed to ensure food security (FAO, 2021). However, the main issues with food balance sheets (and also other quantity indicators, such as quantity in amounts and loss of crops/livestock due to pests/diseases) are (1) hard integration of the indicators for separate subsectors (that the data is usually presented for) into a unified indicator reflecting food production of the whole agricultural sector; (2) significant difficulties in availability of such data for the various EU countries, that are analyzed in this dissertation.

Value indicators, on the other hand, are easy to obtain for the whole agricultural sector (not only its subsectors), which is the focus of this dissertation. They are also appropriate to estimate the overall trends in the resilience of this function while allowing for internal changes, which may be necessary due to various changes and disturbances and which, in essence, constitute a large part of adaptability. The indicator "Balance of foreign trade of agricultural and food products," used by Volkov et al. (2021), includes not only produced but also processed food products, which is not under the scope of this dissertation. It is also focused on foreign trade and does not explicitly show changes in local production. The value of gross production in agriculture and gross value added in agriculture are among the main output indicators (European Commission, 2001; Macours & Swinnen, 2000; Martín-Retortillo & Pinilla, 2015). They both account well for the total production (local food demand and export amounts of agricultural products), and data for them are frequent, easily available, and comparable. However, the indicator "Value of agricultural production" reflects the purpose of resilience estimation of the agricultural sector slightly better than the indicator "Value added of agriculture," since the former reflects the performance levels of the sector and the latter reflects the output levels, also considering the changes in intermediate consumption (and this makes it possible to achieve increased value added with the lower output if the intermediate consumption also decreases). Thus, the value of gross agricultural production, as reflecting the production of food, is chosen to be one of the indicators for measuring the economic resilience of the agricultural sector. The value of gross agricultural production is estimated using an index of agricultural goods output, calculated as production value at producer prices (real value).

Affordability. The function of agricultural production has a significant emphasis on food affordability, which is one of the main determinants of food access

(Herrera & Kopainsky, 2015). This highlights the importance of agricultural product prices since they determine the type, quantity, and quality of the produce that people of a certain country can afford to consume (Volkov et al., 2021). Different authors use various types of price information: absolute prices of certain agricultural goods in a certain country (Meuwissen et al., 2019), price differentials (FAO, 2013), the ratio of the retail prices of agricultural and food products to the retail prices of all consumer goods (Volkov et al., 2021). Absolute prices of certain agricultural goods or price differentials would not be a good proxy for food affordability since the whole agricultural sector (as opposed to its subsectors) has to be considered, and comparability among different countries has to be ensured. On the other hand, the ratio of the retail prices of agricultural and food products to the retail prices of all consumer goods allows considering the general level of food prices and their changes and, what is especially important, enables estimating if food prices rise relatively faster than the prices of other consumer goods. It cannot be expected that food prices would stay at the same level when general inflation is rising; therefore, if food prices rise at the same level as other consumer goods, the function of the production of affordable food should be considered satisfied. However, if food prices grow faster than those of all consumer goods, the resilience of this function should be regarded as decreasing. This indicator uses consumer-level data to evaluate prices faced by consumers in food markets.

It must be noted that only food prices (instead of all agricultural prices) are considered. This is done for several reasons. First, food production makes up the major share of all agricultural output. Second, food affordability is emphasized in studies analyzing functions of agriculture (FAO, 2013; Meuwissen et al., 2019; Volkov et al., 2021) since food prices directly affect most consumers, thus influencing food affordability.

In summary, the indicators to be used in this dissertation for the evaluation of agriculture's economic resilience, reflecting the key economic function of agriculture, "Production of affordable food and other agricultural goods," are agricultural goods output and the ratio of food prices to the prices of all consumer goods.

2.2.2. Selection of Indicators Reflecting the Function of Agriculture "Assuring Viability of Farms"

Viability is a key term in discussions about the survival of farms (Christensen & Limbach, 2019). Viability, in its strictest business definition, is the ability of a business to cover its costs of production as well as provide a rate of return for the capital invested (Besupariene & Miceikiene, 2020); however, there is no universally agreed definition yet (Spicka et al., 2019). The variety of definitions on farm viability has resulted in a diversity of indicators used for its assessment: the farm's net income (Scott, 2001; Scott, Colman, 2008), the farm's net value added (EC, 2001), the expense-income ratio (Slavickiene & Savickiene, 2014; Miceikiene & Girdziute, 2016), profitability (Koleda & Lace, 2010; Volkov et al., 2021), net worth (EU, 2001), working capital (Jakušonoka, Jesemčika, Ozola, 2008), liquidity (Jakušonoka, Jesemčika, Ozola, 2008), solvency (EU, 2014; Slavickiene & Savickiene, 2014; Miceikiene & Girdziute, 2016; Blazkova & Dvoulety, 2018), return on investment (Scott, 2001; Scott, Colman, 2008; Agrosynergie, 2011; Slavickiene & Savickiene, 2014; Miceikiene & Girdziute, 2016), return on assets (Agrosynergie, 2011; Blazkova & Dvoulety, 2018), equity to long-term investment ratio (Jakušonoka, Jesemčika, Ozola, 2008), equity to assets ratio (Jakušonoka, Jesemčika, Ozola, 2008), liabilities to equity ratio (Jakušonoka, Jesemčika, Ozola, 2008), debt service ratio (EU, 2001), expense-to-income ratio (Miceikiene & Girdziute, 2016). When assessing the economic viability of farms or the agricultural sector, the dependence of farms on support is also often considered (Scott, 2003; Aggelopoulos et al., 2007; Slavickienė & Savickienė, 2014; Tzouramani et al., 2020). Summarizing the literature review, most indicators used for the assessment of farm economic viability are financial indicators. Although non-financial indicators (farm productivity, farmers' education, farm size, age, etc.) and financial indicators together enable a more thorough analysis of the farm viability with strong predictive power for the farm exit; however, they are hard to obtain and many countries do not systematically collect such data. Financial indicators, on the contrary, are widely available and relatively sufficient since they can quite satisfactorily predict the bankruptcy of the farm and its exit from the market.

A thorough analysis of financial indicators used in the literature for estimating viability enables concluding that farm economic viability is mainly measured through profitability, although often, complementary indicators are also used. As Coppola et al. (2020), Tzouramani et al. (2020), FAO (2013), and others stated, financial profitability has been the basis for assessing the viability of farms in the short and medium–long term. Hoppe and Korb (2006), Burns and Prager (2016), and Cradock (2021) argued that farm profitability is one of the most important factors influencing farm survival and determining farm exits. Besusparienė & Miceikienė (2020) added that researchers doubtlessly agree that the profit of the farms is the main factor of economic viability. However, together with profitability, efficiency or productivity, and solvency are the other two dimensions frequently used to assess farm viability (Savickienė & Slavickienė, 2012; Latruffe et al., 2016). Therefore, this dissertation will follow the majority of authors and use indicators reflecting all three areas, namely, farm profitability (Koleda & Lace, 2010; Boyce, 2000; Miceikienė & Girdžiūtė, 2016; Valko, Fekete & Ildiko, 2017; Blazkova and Dvoulety 2018; Christensen & Limbach, 2019; Baležentis et al., 2019; Tzouramani et al., 2020; Coppola et al., 2020; Volkov et al., 2021), solvency (Boyce, 2000; Argiles, 2001; Scott, 2003; Koleda & Lace, 2010;

Savickienė & Slavickienė, 2012; Miceikienė & Girdžiūtė, 2016; Kołoszycz, 2020; Volkov et al., 2021; Cradock, 2021), and efficiency (Scott, 2001; Savickienė & Slavickienė, 2012; Diazabakana et al., 2014; Miceikienė & Girdžiūtė, 2016). The use of those indicators allows for a sufficiently comprehensive and cost-effective evaluation of farm viability.

Profit margin is one of the most popular indicators for farm profitability assessment (Savickiene, Miceikiene & Jurgelaitiene, 2016; Wolf et al., 2020; Pérez-Pons et al., 2020) and for any business profitability assessment in general (Maślanka, 2017; Benitez et al., 2018). Thus, the net profit margin is used in this dissertation to account for farm profitability.

Solvency is usually measured as various ratios of liabilities and assets; however, the debt-to-assets ratio, according to the research of Savickiene, Miceikiene & Jurgelaitiene (2016), is one of the most frequently used indicators for the assessment of farm economic viability in general. Following this tendency, this dissertation included it in the assessment of farm viability and, subsequently, resilience.

The expense-to-income ratio is also one of the most often used indicators of farm viability, as indicated by Scott (2001), Savickienė & Slavickienė (2012), and Miceikienė & Girdžiūtė (2016). This indicator provides insights if farms are operating efficiently. In estimating farm efficiency, subsidies are not considered to get a clearer view of farm viability, i.e., how the efficiency of farms is changing apart from subsidies. Since the income indicator is not so commonly used in analyzing the agricultural economy, as argued by Kelly & Grada (2013), Gollin et al. (2014), and Morkunas, Volkov & Pazienza (2018), it was changed to an affiliated indicator, i.e., the output of the farm.

All three indicators (net profit margin, expense-to-output, and debt-to-assets ratios) adhere to the screening criteria for the suitability of the indicators: availability, frequency, comparability, and policy relevance.

2.2.3. Selection of Indicators Reflecting the Function of Agriculture "Creation and Maintenance of Decent Jobs"

Employment. In the "Communication on the Future of the Common Agricultural Policy," fostering jobs in rural areas and attracting new people into the agricultural sector are identified as key policy priorities (European Commission, 2017). Many studies stressed the necessity to incorporate employment in researching agriculture's economic resilience (Greblikaite et al., 2017; Oliva, Lazzeretti, 2018; Gorb, 2017; Gorb et al., 2018).

The resilience literature has used several indicators to analyze labor markets: employment rates (Fingleton et al., 2012; Shutters, Muneepeerakul & Lobo, 2015; Martin et al., 2016; Sondermann, 2016; Kitsos & Bishop, 2018; Wink et al., 2018;

Ubago et al. 2019), employment growth rates (Hill et al., 2011; Martin et al., 2016; Wolman et al., 2017; Ubago et al. 2019), unemployment rates (Lee, 2014; Angeon & Bates, 2015; Sondermann, 2016; Rios, 2017), claimant count data (Lee, 2014), etc. All of them have their advantages and disadvantages. The claimant count data, apart from being difficult to obtain for all EU countries, may also not include certain groups of workers (e.g., unemployed foreign migrant workers who are ineligible to claim benefits, higher income employees who rely on savings while looking for a new job) (Lee, 2014). Similarly, unemployment data exclude those who retire early in response to a shock and are based on survey data with large sampling errors at a local level (Kitsos & Bishop, 2018). Briguglio et al. (2009) argued that the unemployment rate is associated with resilience because if an economy already has a high level of unemployment, it is likely that adverse shocks would impose significant costs on it and, on the other hand, if the economy has a low level of unemployment, then it can withstand adverse shocks to these variables without excessive welfare costs. However, unemployment rates do not include population groups that, although unemployed, do not actively seek employment (Ilostat, 2021). Moreover, unemployment rates are quite difficult to monitor on a sectoral level (as opposed to regional and national levels) since people with certain specializations may as well work in other areas; or, after various perturbations, change their sectors of employment (Hill et al., 2011). Employment rates, on the other hand, reflect the extent to which available labor resources are being used, as it is an important indicator of economic activity, incorporating both the net impact of demand-side shocks and supply-side responses in the labor market. And although the definition of employment ignores differences in work arrangements (e.g., part-time, discontinuous working time) that influence total work potential and well-being (Brandolini & Viviano, 2018), its merits outweigh the disadvantages. Subsequently, the employment rate is adopted as one of the indicators for the provision of decent jobs function.

Employment usually comprises all persons of working age who were either paid employees or self-employed during a specified period (Ilostat, 2021). However, different tendencies and economic aspects of paid and family work suggest that employment trends in agriculture should be analyzed for paid and unpaid labor force separately since the aggregation of both types of employment may not render reliable conclusions. Hired labor correlates well with the resilience of the whole sector and long-term employment trends, i.e., stronger farms hire more labor, and self-employed agricultural workers, mostly unproductive, leave the market, thus allowing stronger farms to expand. In contrast, maintaining employment rates of unproductive self-employed agricultural workers would have negative economic consequences due to hindering economic restructuring in the sector and, thus, negatively influencing the sector's resilience. On the other hand, self-employed farmers get remuneration from farming business activity; thus, farm profitability indicators closely correlate with farmers' incomes. Contrary to hired labor, which is usually remunerated even if s certain year is unprofitable for the farm, farmers (business owners) may rely on their savings and do not receive a salary from farm income either due to unprofitable year or strategic decisions, such as investment; however, they might receive better remuneration in more profitable years. Therefore, it can be assumed that the farm viability indicator partially covers the employment indicator for self-employed farmers as well. Subsequently, this dissertation researched only salaried employment under the function of the provision of decent jobs.

Job quality. The economic literature on the resilience phenomenon usually analyzes employment rates only. But they have an important limitation, as they fail to provide any indication of job quality. Howell and Okatenko (2010) argued that it is not rational for a given unemployment rate, as the labor market should be judged superior if it generates a lower incidence of jobs paying very low wages or generates a mix of jobs that better matches the workers' desired work hours. Increasingly more authors argue that employment performance indicators must also account for employment quality (Muneepeerakul & Lobo, 2015; Ronzon & Barek, 2018; EC, 2018). Almost every country's economic policy and labor market institutions are designed to affect both the quantity and quality of jobs; thus, the assessments of a country's labor market performance should be made with indicators that capture both dimensions of employment adequacy (Howell & Okatenko, 2010).

During the past three decades, an increasing amount of academic and governmental attention has been focused on the quality of employment. As processes of globalization and liberalization have had a great impact on labor market flexibility, such employment conditions as wages, job stability, and career prospects have become at least as important a study subject as traditional indicators, such as employment or unemployment rates (Burchell et al., 2014). Although the literature on employment quality is very diverse, wages are one of the most important indicators of employment quality, probably included in all employment quality measurements. Wages are also considered an important indicator in economic resilience studies (Hill et al., 2011; Martin & Sunley, 2015). And although wages do not fully compensate for job amenities, it is the primary motivator that encourages people to get a job, and other motivators come into play only when a person secures a certain standard of living. Other most cited components of employment quality (wage inequality, skills, training, and working conditions), although important, have a significant disadvantage, i.e., the availability and comparability of data for these components are very limited. Therefore, this dissertation will assess employment quality via wages.

Labor productivity. Many authors (Shutters, Muneepeerakul & Lobo, 2015; Ronzon & Barek, 2018; EC, 2018) emphasize that it is not only the amount and quality of jobs created/maintained that matters but jobs must also produce enough added value and hence be of a certain minimum quality in productivity terms to be considered quality employment, generating economic growth, and adding to the resilience of the sector. Fedulova et al. (2019) argued that labor productivity reflects "the effectiveness of the national and regional economies, the production efficiency, characterizes the use of living labor in the production process and ultimately determines the standards of living of the population." The higher labor productivity, the higher economic growth, and the higher level of resilience from external challenges and threats from instability (ibid). In this regard, increasing labor productivity is one of the main goals of economic systems. Following this logic, labor productivity is also included in the resilience index calculation.

Labor productivity is usually measured by how much output or value is produced by appropriate labor input (measured either in work hours, persons, or labors costs) (Rawat et al., 2018; Fedulova et al., 2019; Onegina et al., 2020; Pariboni & Tridico, 2020). Similarly, labor productivity in this dissertation is measured by the output produced by one annual work unit (AWU).

2.3. Methods for Evaluating the Impact of Direct Payments on Individual Resilience Indicators

There are ample examples of the quantitative methods used for assessing the effects of various factors on both individual components of resilience and overall resilience in the literature: fixed effects (FE) models (Petrick & Zier, 2012; Kaditi et al., 2013; Brüderl & Volker, 2015; Kitos et al., 2019; Garrone et al., 2019a; Collischon & Eberl, 2020; Kryszak, Guth & Czyżewski, 2021) and generalized method of moments (GMM) (Ullah, Akhtar & Zaefarian, 2018; Doran & Fingleton, 2018; Aderajew et al., 2018; Kripfganz, 2019), random effects (RE) models (Enjolras et al., 2012; Holden & Fisher, 2015; Skevas et al., 2018; Kostlivý & Fuksová, 2019), (partial) OLS regression (Hill & Wolman, 2012; Enjolras et al., 2012; Obschonka et al., 2015; Shutters et al., 2015; Kitsos & Bishop, 2018; Meuwissen et al., 2019), logistic regression (Enjolras et al., 2012; Peerlings et al., 2014; van Asseldonk et al., 2016), multi-level modeling (Vigani & Berry, 2018), structural equation modeling (Herrera & Kopainsky, 2015; Xie et al., 2018), shift-share analysis (Martin et al., 2016; Angulo, Mur & Trivez, 2017), principal component analysis (Ubago et al., 2019), synthetic control method (Opatrny, 2018), stochastic frontier analysis (Pechrova, 2015; Marzec & Pisulewski, 2017), etc. Although there is no single method that would be the most suitable in one case or another, the analysis of multiple literature sources allows concluding that FE, RE, and GMM are among the most applicable methods for panel data; therefore, they will be used in this dissertation as well. Further, all three methods are described in detail.

Fixed effects (FE) models are frequently used in economics, reflecting their status as the "gold standard" (Schurer &Yong, 2012). Gangl (2010) added that the fixed-effects regression method is especially useful in the context of causal inference. While standard regression models provide biased estimates of causal effects if there are unobserved confounders, the FE regression method can (if certain assumptions are valid) provide unbiased estimates in this situation (Brüderl & Volker, 2015). FE regression is one of the most used methods with panel data for determining causal inferences and estimating effect sizes (Brüderl & Volker, 2015; Collischon & Eberl, 2020; Kryszak, Guth & Czyżewski, 2021). The popularity of the FE method mainly lies in its capacity to identify a causal effect under weaker assumptions, as compared to multiple regression (Brüderl & Volker, 2015). The fixed effects regression model is commonly used to reduce the selection bias in the estimation of causal effects in observational data by eliminating a portion of variation thought to contain confounding factors, in other words, by controlling for all level 2 characteristics, both measured and unmeasured (Halaby 2004; Wooldridge, 2016; Mummolo & Peterson, 2017).

Many studies used FE to examine the DPs' impact on various variables using panel data and confirmed its effectiveness (Ciaian & Pokrivcak, 2011; Ifft, Kuethe & Morehart, 2015; Valenti, Bertoni & Cavicchioli, 2020). Probably the main disadvantage of the FE method is argued to be its omission of a large portion of variance; however, this deficiency is not substantially significant for the aim of this dissertation. Therefore, the FE method is chosen to be employed in this dissertation as one of the methods for evaluating the DPs' impact on certain resilience elements.

As mentioned above, the main particularity of a fixed effects model is that it decomposes the unitary pooled error term u_{it} into $\alpha_i + \varepsilon_{it}$, where α_i is a unit-specific and time-invariant component, and ε_{it} is an observation-specific idiosyncratic error.

Consequently, the fixed effects model can be expressed as (Cottrell & Lucchetti, 2023):

$$y_{it} = X_{it}\beta + \alpha_i + \varepsilon_{it}, \tag{2.1}$$

where, y_{it} is the dependent variable observed for cross-sectional unit i at time t; X_{it} is a *1xk* vector of independent variables observed for unit i in time t; β is a *kx1* vector of parameters; α_i is the time-invariant individual effect of each unit and ε_{it} is an observation-specific error; $i = 1,..., N$ and $t = 1,...,T$.

The FE model eliminates α_i by de-meaning the variables using the *within* transformation (Hanck et al., 2021):

$$y_{it} - \overline{y_i} = (X_{it} - \overline{X_i})\beta + \alpha_i - \overline{\alpha_i} + \varepsilon_{it} - \overline{\varepsilon_i} \rightarrow \ddot{y}_{it} = \ddot{X}_{it}\beta + \ddot{\varepsilon}_{it}, \quad (2.2)$$

where $\bar{y}_i = \frac{1}{T}\sum_{t=1}^{T} y_{it}, \bar{X}_i = \frac{1}{T}\sum_{t=1}^{T} X_{it}; \bar{\varepsilon}_i = \frac{1}{T}\sum_{t=1}^{T} \varepsilon_{it}; \alpha_i - \bar{\alpha}_i = 0.$

To account for time-specific shocks common to all the units in a given period, time dummies are included in the fixed effects models. In several models, country-specific (linear) time trends are added to control for unit (country) specific shocks, i.e., each period receives a separate variable in each unit (Pischke, 2005).

For tests of hypotheses concerning the FE coefficients, further assumptions are necessary (Brüderl & Volker, 2015):

- the idiosyncratic errors are homoscedastic and
- serially uncorrelated to obtain consistency of the variance–covariance matrix from which to get the standard errors of coefficients.

To test the model fit, FE models are tested for a normal distribution, heteroscedasticity, autocorrelation, and cross-sectional dependence. If there is a substantial serial correlation, panel-robust standard errors are used. The F test is used to check the hypothesis that the pooled OLS model is adequate in favor of the fixed effects alternative.

The fixed effects model was applied to determine the DPs' impact on the agricultural output, the ratio of food prices to the prices of all consumer goods, the farm net profit margin, salaried employment, and wages.

For the data that were not normally distributed, the log transformation (or arcsine transformation in the case of the debt-to-asset ratio) has been performed.

In cases when a continuous index for the whole research period is not provided (i.e., different base years are used for different periods), the indices for certain periods were recalculated for the base year 2005.

Random-effects error component (RE) models are also known as multilevel models, hierarchical linear models, and mixed models. The RE approach, although more rarely used in practice than FE models, should be a preferred method in many social science studies with panel data (Bell & Jones, 2014). The random effects approach views the clustering of the unit as a feature of interest in its own right and not just a nuisance to be adjusted for (Clarke et al., 2010). This reflects the main advantage of the RE model, i.e., to analyze and separate the within and between components of an effect explicitly and assess how those effects vary over time and space rather than assuming heterogeneity away (as is the case with FE), thus leading to a more detailed description of the relationship under scrutiny (Bell & Jones, 2014). When understanding the role of context (countries, in this case) that defines the higher level, which is of significant importance to a given research question, it must be modeled explicitly, which requires the use of an RE model (Subramanian et al. 2009). Beck and Katz (2007) showed that, with respect to cross-sectional data, RE models perform well even when the normality assumptions are violated. Therefore, they are preferred over "complete pooling" methods, assuming no differences between higher-level entities and FE, which do not allow for the estimation of higher-level, time-invariant parameters or residuals (Bell & Jones, 2014).

RE models have been successfully used in several studies in the economic area, including the studies analyzing the effect of subsidies on farmers' behavior and economic indicators of farm business activities (Enjolras et al., 2012; Holden & Fisher, 2015; Skevas et al., 2018; Kostlivý & Fuksová, 2019). Consequently, this dissertation chose to use the RE approach to model the DP's impact on certain resilience elements. The use of RE models is limited to the cases where the dependent variable is not an index of a particular indicator, and, therefore, it is rational and significant to model higher-order time-invariant parameters. However, in cases where variables are expressed as indices, FE models are preferred since the index, by definition, absorbs all time-invariant country characteristics, and only time-variant parameters impact changes in the index.

For the random effects model, the unitary pooled error term, u_{it}, is decomposed into $v_i + \varepsilon_{it}$, so the model becomes (Cottrell & Lucchetti, 2023):

$$y_{it} = X_{it}\beta + v_i + \varepsilon_{it}. \tag{2.3}$$

However, in contrast to the fixed effects model, the v_is is treated as random (instead of fixed) parameters.

In estimations, random-effects models use generalized least squares (GLS), considering the covariance structure of the error term.

A Conventional FGLS Random Effects Estimator assumes the residuals are independent of the covariates $E\ (\varepsilon_i | x_{i1}, \dots, x_{iT}) = 0$; the errors are correlated within each unit but are uncorrelated across units; and the variance in the composite errors is equal to the sum of the variances in the unobserved effect v_i and the idiosyncratic error ε_i, so the variance–covariance matrix for all disturbances (Cottrell & Lucchetti, 2023). The GLS method may gain greater efficiency (as compared to OLS) when the necessary assumptions for the OLS to be the best linear unbiased estimator (e.g., that the error term is independently and identically distributed) are not met.

To test the random-effects model fit, the Breusch–Pagan test is performed to check the hypothesis that the pooled OLS model is adequate in favor of the random-effects alternative, and the Hausman test is carried out to check the hypothesis that the fixed-effects model is consistent, in favor of the random effects alternative. In addition, random-effects models are tested for normal distribution, autocorrelation, and cross-sectional dependence.

The random-effects model was applied to determine the direct payments' impact on the farm expense-to-output ratio and labor productivity.

The generalized method of moments estimator, developed by Blundell & Bond (1998), has become very widely used. The estimator is designed for "small

T, large *N*" panels, where independent variables are not strictly exogenous (correlation with past and/or current realizations of the error; heteroscedasticity and autocorrelation within units are present) (Roodman, 2009). GMM estimators are often found more efficient than the common method of moments estimators, such as ordinary least squares and two-stage least squares, in the case of a failure of such necessary assumptions as homoscedasticity or non-existence of autocorrelation (Wooldridge, 2001).

GMM has been successfully applied in several studies in the area of agricultural economics and, specifically, in the area of the subsidies' impact on farming business (Lambert & Griffin, 2004; Olper et al., 2012; Garrone et al., 2019). One of the leading applications of GMM in panel data contexts is when a model contains a lagged dependent variable along with an unobserved effect since GMM is well suited for obtaining efficient estimators that account for the serial correlation (Wooldridge, 2001). For this reason, GMM was used in a model with the lagged dependent variable as a predictor.

GMM is a statistical method that combines observed economic data with information on population moment conditions to produce estimates of the unknown parameters of this economic model (Zsohar, 2012). The System GMM estimator encompasses the following assumptions (Roodman, 2009):

- The process may be dynamic, with current realizations of the dependent variable influenced by past ones.
- There may be arbitrarily distributed fixed individual effects.
- Some regressors may be endogenous.
- The idiosyncratic disturbances (those apart from the fixed effects) may have individual-specific patterns of heteroscedasticity and serial correlation.
- The idiosyncratic disturbances are uncorrelated across individuals.
- Some regressors may be predetermined but not strictly exogenous: independent of current disturbances, they may be influenced by past ones. The lagged dependent variable is an example.

A dynamic linear panel data model can be represented as follows (Cottrell & Lucchetti, 2023):

$$y_{it} = \beta_0 + \beta_1 y_{it-1} + \beta_2 x'_{it} + u_{it}. \tag{2.4}$$

$$u_{it} = v_i + \varepsilon_{it}. \tag{2.5}$$

$$E[v_i] = E[\varepsilon_{it}] = E[v_i \varepsilon_{it}] = 0. \tag{2.6}$$

Here, y_{it-1} is the lag of the dependent variable and x'_{it} is a vector of independent variables.

The system estimator used by the software is written as (Cottrell & Lucchett, 2023):

$$\tilde{\gamma} = [\left(\sum_i \widetilde{W}_i' \tilde{Z}_i\right) A_N \left(\sum_i \tilde{Z}_i' \widetilde{W}_i\right)]^{-1} \left(\sum_i \widetilde{W}_i' \tilde{Z}_i\right) A_N \left(\sum_i \tilde{Z}_i' \Delta \tilde{y}_i\right), \tag{2.7}$$

where

$$\Delta \widetilde{y_i} = [\Delta y_{i3} \ldots \Delta y_{iT} \quad y_{i3} \ldots y_{iT}]',$$

$$\widetilde{W}_i = \begin{bmatrix} \Delta y_{i2} & \ldots & \Delta y_{i,T-1} & y_{i2} & \ldots & y_{i,T-1} \\ \Delta x_{i3} & \ldots & \Delta x_{iT} & x_{i3} & \ldots & \Delta x_{iT} \end{bmatrix}',$$

$$\tilde{Z}_i = \begin{bmatrix} y_{i1} & 0 & 0 & \ldots & 0 & 0 & \ldots & 0 & \Delta x_{i3} \\ 0 & y_{i1} & y_{i2} & \ldots & 0 & 0 & \ldots & 0 & \Delta x_{i4} \\ & & & & \vdots & & & & \\ 0 & 0 & 0 & \ldots & \Delta y_{i,T-2} & 0 & \ldots & 0 & \Delta x_{iT} \\ & & & & \vdots & & & & \\ 0 & 0 & 0 & \ldots & 0 & \Delta y_{i2} & \ldots & 0 & x_{i3} \\ & & & & \vdots & & & & \\ 0 & 0 & 0 & \ldots & 0 & 0 & \ldots & \Delta y_{i,T-1} & x_{iT} \end{bmatrix}',$$

and

$$A_N = \left(\sum_i \tilde{Z}_i' H \times \tilde{Z}_i\right)^{-1}.$$

Here, $\tilde{\gamma}$ represents the coefficients of the equation, $\Delta \widetilde{y_i}$ is the first difference vector, $\widetilde{Z_i}$ is the instrument matrix, $\widetilde{W_i}$ is the observed variable matrix, and A_N is the weighting matrix.

The model fit is checked by performing the following tests: (1) test for AR(1) errors ($p<0.05$), (2) test for AR(2) errors ($p>0.05$), 3) Sargan over-identification test ($0.05<p<0.25$), and (4) Wald (joint) test ($p<0.05$) (Roodman, 2009).

The GMM model was applied to determine the direct payments' impact on farm solvency. The model is presented further in the text.

It should be noted that before applying any of the above-mentioned methods, the pooled ordinary least squares (OLS), as recommended (Woolridge, ND), is performed, and only if relevant assumptions do not hold or appropriate tests suggest the FE, RE or GMM should be applied.

The pooled OLS specification is expressed as:

$$y_{it} = x_{it}' \beta + u_{it} \, . \tag{2.8}$$

Here, y_{it} is the observed measures on the dependent variable for cross-sectional unit i in period t, x'_{it} is a $1 \times k$ vector of independent variables observed for the unit i in period t, β is a $k \times 1$ vector of parameters, and u_{it} is an error term specific to unit i in period t (Cottrell & Lucchetti, 2023).

All estimations were conducted using the Gretl software.

2.4. Expert Survey

To determine the DPs' impact on the overall agriculture's economic resilience, which is reflected by three different (possibly competing) functions, it is first necessary to determine the importance of each of these functions. And since each of these functions is also reflected in several (and sometimes competing) indicators, it is also necessary to clarify the relative importance of these indicators in reflecting a particular function. To this end, an expert survey was conducted. The choice of the expert survey method was determined by the specifics of the researched problem, i.e., the issue of the relative importance of functions and their changing tendencies, which cannot be measured directly and is generally subjective, depending on various economic development criteria and other aspects and expert opinion (Baležentis et al., 2021).

The expert survey process included: (1) selecting the expert evaluation method; (2) creating a questionnaire (Annex D); (3) selecting the experts; (4) conducting the survey, and (5) processing the results of the survey.

The chosen method of expert evaluation is a questionnaire survey. This is the most commonly used method of qualitative research. The popularity of a questionnaire survey in social research is due to the scientific value created by qualified professionals interpreting the results (McNeill & Chapman, 2005). In addition, the questionnaire as a survey method is simple to use and usually does not require significant time and financial costs. The basis for questions is the analysis of agricultural functions and the selection of their indicators (Sections 1.1.5 and 2.2.1–2.2.3).

The experts were selected following two main principles: (1) the candidate works directly in the field of agriculture or agrarian economics and agrarian policy; (2) the length of service of the candidate in the relevant field is no less than ten years. According to Beshelev and Gurvich (1974), the number of experts should be at least the number of indicators evaluated in the group plus one, although a larger number of experts reduces the likelihood of anomalies or marked subjectivity in the obtained result. A total of 20 experts were invited to participate in the questionnaire survey. Out of the 20 questionnaires sent, five questionnaires did not return.

A total of 15 experts were interviewed. From them:

- Seven scientists from two scientific institutions: Lithuanian Centre for Social Sciences and Vilnius University.
- Six employees of the leading chain of the Ministry of Agriculture of the Republic of Lithuania.
- Two representatives of agri-business associations.

The experts were asked to attach the level of importance to each agricultural function and the corresponding indicators independently. During the evaluation of the information provided by the experts, the consistency of the expert evaluations was estimated. The Kendall concordance coefficient (Kendall, 1948) was used to determine the consistency of the estimates.

To calculate the coefficient, the ranking of the data provided by the experts was performed, giving the rank *ij* to an object *i* by an expert *j*. In total, there are *n* objects and *m* experts. The total rank of an object *i* is (Kendall, 1948):

$$R_i = \sum_{j=1}^{m} r_{ij} \ (i = 1,\dots,n). \tag{2.9}$$

The sum of squared deviations, *S*, is:

$$S = \sum_{i=1}^{n} (R_i - \bar{R})^2, \tag{2.10}$$

where $\bar{R} = \frac{1}{n}\sum_{i=1}^{n} R_i$.

The concordance coefficient is defined as (ibid):

$$W = \frac{12S}{m^2(n^3-n)}. \tag{2.11}$$

As there are ties in the rankings, the following corrections are recommended to be made (Legendre, 2005). For each expert *j*,

$$T_j = \sum_g \left(t_g^3 - t_g\right) \quad T = \sum_{j=1}^{m} T_j, \tag{2.12}$$

where *g* is all the groups of tied ranks for the expert *j* and t_g is the number of tied ranks.

Consequently, *W* is defined as (ibid):

$$W = \frac{12S}{m^2(n^3-n)-mT}. \tag{2.13}$$

If expert opinions resemble each other closely, the value of the concordance coefficient *W* is close to one; if the estimates differ significantly, the value of *W* is close to zero.

2.5. Construction of the Index

Multi-criteria methods have been increasingly used for the quantification of complex economic and socio-economic phenomena. These methods allow computing composite indices, aggregating several indicators under one umbrella. Many examples are available of the application of the quantitative multi-criteria method in estimating resilience (Morkunas et al., 2018; Slijper et al., 2021). These methods are based on indicators R_i ($i = 1, 2, ..., m$), describing comparative objects A_j ($j = 1, 2, ..., n$), a matrix of statistical data or expert evaluations $R = \| r_{ij} \|$ and the weights vector of the indicators $\Omega = \| \omega_i \|$ ($i = 1, 2, ..., m$). In this dissertation, the principles of multi-criteria methods (the determination of weights and integration of different indicators under one composite measure) are used to determine the DPs' impact on the multidimensional phenomenon of economic resilience of agriculture. None of the specific MCDM methods are applied since, in the case of this study, the focus is not on the choice between different alternatives but on the integration of the DPs' influence on different indicators into one index. Moreover, as the impact may be negative, it is essential to show it is negative, while MCDM methods allow only positive values.

The DPIERA index is calculated as a change, which would be obtained due to a change in the number of DPs (other variables keeping constant). The weighted sum, similar to the SAW method, has been used for the index construction:

$$DPIERA = \Delta R(DPs) = \sum_{i=1}^{m} w_i \widetilde{r_i}\,(DPs). \qquad (2.14)$$

Here, *DPIERA* is the integrated index, ΔR is the change in the economic resilience of agriculture due to a change in DPs, w_i is the weight of a resilience indicator *i*, $\widetilde{r_i}$ is the percentage change of resilience indicator *i* due to a change in DPs, *m* is the number of indicators.

Subindices are calculated analogously.

The weights of each function and separate indicators of the functions are obtained from the expert survey and calculated using the method of indirect determination of weights using the following formula (Podvezko & Podvezko, 2014):

$$w_i = \frac{\sum_{k=1}^{r} c_{ik}}{\sum_{i=1}^{m}\sum_{k=1}^{r} c_{ik}}. \qquad (2.15)$$

Here, c_{ik}(i = 1,…,m; k = 1,…,r) are expert evaluations, *m* is the number of indicators, *r* is the number of experts. The sum of weights is equal to 1:

$$\sum_{i=1}^{m} w_i = 1. \qquad (2.16)$$

Since calculating the DPs' impact, logarithmic transformation of the values of DPs and some resilience indicators had to be performed, $\tilde{r}_{ij}$is calculated in two ways, depending on whether the resilience indicator was or was not 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:

$$\widetilde{r_i} = {}^{\Delta r_i}/_{\bar{r}_i} * 100\%. \qquad (2.17)$$

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

$$\Delta r_i = r_i(DP_2) - r_i(DP_1) = \beta_{DPi} * [\ln(DP_2) - \ln(DP_1)] = \beta_{DPi} * [\ln\left(\frac{DP_2}{DP_1}\right)]. \quad (2.18)$$

Here, β_i is the estimated regression coefficient for *lnDP*, as estimated in FE/RE/GMM models for the resilience indicator *i*, when the resilience indicator *i* is log-transformed.

$$\ln\big(r_i(DP_2)\big) - \ln\big(r_i(DP_1)\big) = \beta_{DPi} * [\ln(DP_2) - \ln(DP_1)], \quad (2.19)$$

which leads to

$$\ln\left[\frac{r_i(DP_2)}{r_i(DP_1)}\right] = \beta_{DPi} * [\ln(DP_2/DP_1)], \quad (2.20)$$

leading to

$$\frac{r_i(DP_2)}{r_i(DP_1)} = (\frac{DP_2}{DP_1})^{\beta_{DPi}}, \quad (2.21)$$

consequently

$$\widetilde{r_i} = \left(\left(\frac{DP_2}{DP_1}\right)^{\beta_{DPi}} - 1\right) * 100. \quad (2.22)$$

The calculated values for the index and its subindices are presented in Section 3.3.2.

2.6. Conclusions of the Second Chapter

The literature review has indicated a lack of theoretical and empirical research on how to assess agriculture's resilience as a whole and the DPs' impact on it in particular. The proposed model for evaluating the DPs' impact on agriculture's economic resilience allows for assessing the DPs' impact on the individual dimensions of economic resilience and the economic resilience of the sector as a whole. It is characterized by its flexibility, relevance, and applicability.

Considering the research conducted by scientists examining the principles of selection of indicators for assessing the functions and performances of agriculture, eight indicators of economic resilience of agriculture were selected:

- Two indicators were selected to reflect the function "Production of affordable food and other agricultural goods": the ratio of food prices to the prices of all consumer goods and the agricultural goods output.
- Three indicators were selected to reflect the function "Assurance of farm viability": the farm net profit margin (including subsidies), the farm expense-to-output ratio, and the farm debt-to-assets ratio.

- Three indicators were selected to reflect the function "Creation and maintenance of decent jobs": salaried employment, labor productivity, and wages.

To evaluate the DPs' impact on the selected resilience indicators, the following most applicable methods for panel data were used:

- Fixed effects (FE) models to evaluate the DPs' impact on the ratio of food prices to the prices of all consumer goods, the agricultural goods output, the farm net profit margin, salaried employment, and wages.
- Random effects (RE) error component models to evaluate the DPs' impact on the farm expense-to-output ratio and labor productivity.
- Generalized method of moments (GMM) to evaluate the DPs' impact on the farm debt-to-assets ratio.

The weights of resilience indicators were determined using the expert survey. Fifteen experts were surveyed, representing the three most important groups: scientists, government, and producers. The method of indirect weight determination was used to calculate the weights. The aggregation of the DPIERA index is based on the weighted sum.

3

Empirical Study of the Direct Payments' Impact on Agriculture's Economic Resilience

This chapter presents the final product of this dissertation, i.e., the index (and sub-indices) of the impact of EU CAP direct payments on agriculture's economic resilience in the EU-27, OMS-15, and NMS-12 in 2005–2018. It also presents the research data and their peculiarities, the results of the models for computing the DP's impact on individual resilience components, and the results of the expert survey, all used to accomplish the main goal, i.e., to estimate the DPs' impact on economic resilience of agriculture. One scientific publication was published on the topic of the third chapter (Žičkienė et al., 2022).

3.1. Research Data and Its Characteristics

The data used in the empirical study encompass average data of representative commercial farms (farms and agricultural holdings) of the EU MS (from the FADN database) and the aggregate data of the agricultural sectors (from the EUROSTAT database). The research period is 2005–2019.

The calculations were done for the whole EU, encompassing 27 countries (including the United Kingdom, but not Croatia). Calculations were also performed for OMS-15 and NMS-12 separately, as agricultural sectors of different EU MS vary greatly in terms of their structure, productivity, and capitalization, determined greatly by different historical contexts (especially being annexed or under the influence of the Soviet Union), which has significantly shaped not only tangible elements of the agricultural sectors but also the attitudes and beliefs of farmers. Moreover, this separation is important since the amount and period of DPs paid to the farmers differs significantly between the NMS and the OMS. The OMS have been heavily subsidizing farmers since the formation of the EU, while the support for farmers in the NMS has been much less and shorter. Various studies have already confirmed differing the DPs' impact on various aspects of agricultural sector performances (Garrone et al., 2019; Bradfield et al., 2020; Coppola et al., 2020; Mamatzakis & Staikouras, 2020; Olagunju, Patton & Feng, 2020; Góral & Soliwoda, 2021; Kryszak, Guth, Czyżewski, 2021). Therefore, the DPs' impact on the resilience of agricultural sectors in the OMS and the NMS presumably differ as well.

The research is based on panel data, which contains: 405 observations, 27 cross-sectional units, and 15 periods (for the EU-27); for the OMS, 225 observations, 15 periods, and 15 cross-sectional units; and forthe OMS, 176 observations, 15 periods, and 12 cross-sectional units, accordingly. The collected data (Table 3.1) is described as an unbalanced panel, but the overall data shortfall did not exceed 5%, so their missingness may be characterized as MAR, i.e., missing at random (Schafer, 1999). The missing data is mainly due to two EU countries, Romania and Bulgaria, which joined the EU only in 2007 and, therefore, their data for two years is missing (applies only to FADN data). The missing data on other variables (independent variables which were controlled for in the models described below) does not exceed 5% either.

Table 3.1. Data on the resilience indicators

Function	**Measure**	**Description**	**Database**	**Missing data (%)**
Production of affordable food and other agricultural goods	Ratio of food prices to the prices of all consumer goods	Annual average index of food and non-alcoholic beverages to annual average index of all-items, HICP, index, 2015 = 100	EUROSTAT	0
	Agricultural goods output	Production value at producer price, real value, index, 2005 = 100	EUROSTAT	0

End of Table 3.1

Function	Measure	Description	Data-base	Missing data (%)
Assurance of farm viability	Net profit margin	(Total Output (SE131) – Total Inputs (SE270) + Total Subsidies$_{_excl_inv}$ (SE605))/ (Total Output (SE131) + Total Subsidies$_{_excl_inv}$ (SE605))	FADN	1
	Expense-to-output ratio	Total Inputs (SE270)/ Total Output (SE131)	FADN	1
	Debt-to-assets ratio	Total Liabilities (SE485)/Total Assets (SE436)	FADN	1
Creation and maintenance of decent jobs	Salaried agricultural employment	Index, 2005 = 100	EURO-STAT	0
	Labor productivity	Total agricultural output (production value at producer price, values at constant prices (2010 = 100)) / total labor force input (AWU)	EURO-STAT	0
	Wages for salaried employees	Wages paid (SE370)/Paid Labor Input (SE020)	FADN	1

Descriptive statistics of the variables used in the models are provided in Annex A.

3.2. Results of the Expert Survey

The expert survey was conducted in November 2021. Fifteen experts were surveyed. All the experts had more than ten years of experience in agribusiness, academia, or government (more in Section 2.3.2). Before conducting the survey, the experts were introduced to the purpose and methodology of the study. Then, they were provided with a questionnaire and asked to provide ratings on the importance of agricultural functions and the importance of separate indicators reflecting those functions, evaluating them on a five-point Likert scale. The average scores provided for each function/indicator (and their subsequently calculated weights) are provided in Table 3.2.

The results show that experts consider the "Production of affordable food and other agricultural goods" as the relatively most important function of agriculture, performances of which should be maintained/recovered amid various crises (average score of 4.89 out of 5). The experts were also most unanimous about the importance of this function, i.e., the standard deviation of the expert scores was only 0.33. In order of importance, next comes the function "Assurance of farm viability," with an average score of 4. However, the scores given by the experts on the importance of this function varied most among all the functions (st. dev. = 0.9). The relatively least important agricultural function, according to the experts, is the "Creation and maintenance of decent jobs," amounting to 3.44 points.

Table 3.2. Weights for the indicators of economic resilience of agriculture (Source: elaborated by the author)

Function, indicator	**Average score**	**St. Dev.**	**Local weights**	**Global weights**
Agricultural Functions				
Production of affordable food and other agricultural goods	4.89	0.33	0.40	
Assurance of farm viability	4.00	0.92	0.32	
Creation and maintenance of decent jobs	3.44	0.73	0.28	
Indicators				
Agricultural goods output	4.44	0.53	0.49	0.19
Ratio of food prices to the prices of all consumer goods (-)	4.67	0.50	0.51	0.20
Farm net profit margin (subsidies included)	4.00	1.32	0.32	0.10
Farm expense-to-income ratio (subsidies excluded) (-)	4.50	0.76	0.36	0.12
Farm debt-to-assets ratio (-)	4.00	0.50	0.32	0.10
Salaried agricultural employment	3.11	0.93	0.26	0.07
Labor productivity	4.22	0.97	0.36	0.10
Wages for salaried agricultural employees	4.56	0.53	0.38	0.11

Note: (-) indicates that an increase in a certain criterion negatively contributes to agriculture's economic resilience.

To reflect the function "Production of affordable food and other agricultural goods," two variables were distinguished. Experts rated the ratio of food price to the prices of all consumer goods as slightly more important (average score of 4.67 out of 5) than the output of agricultural goods (4.44). For the function "Assurance of farm viability," farm efficiency comes as relatively the most important indicator of this function (4.5). Farm profitability and solvency are equally evaluated and a bit lower than efficiency. For the function "Creation and maintenance of decent jobs," wages are by far the most important indicator (4.56), followed by labor productivity. Salaried employment is evaluated as the least important, although the variation of its scores among experts is relatively high.

The consistency of the expert opinions was checked by calculating Kendall's concordance coefficient. The results confirmed that the opinions of the experts were harmonized (Table 3.3). Subsequently, the averaging function was used to aggregate the expert assessments, which implies equal expert importance.

Table 3.3. Concordance coefficients *W*

	Functions of agriculture	Indicators of function "Production of affordable food and other agricultural goods"	Indicators of function "Assurance of farm viability"	Indicators of function "Creation and maintenance of decent jobs"
W	0.94	0.93	0.83	0.92

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

DPs impact on individual resilience indicators is calculated using fixed-effects models, random-effects models, and generalized method of moments. The results are provided in Sections 3.3.1.1–3.3.1.7. Results for the time dummies or country-specific time trends that were included in the models are not shown in the tables due to the dissertation's limits; the complete results are provided in annexes B (for the EU-27) and C (for the OMS-15 and NMS-12).

3.3.1. Direct Payments' Impact on Agricultural Production

The goal of this model is to examine the DPs' impact on agricultural production. The fixed effects (FE) model was used to determine this impact. The conducted F test confirmed the preference for FE against pooled OLS, and the Hausman test confirmed the preference for the FE model.

The following model has been specified:

$$lnAP_{it} = \beta_0 + \beta_1 lnDP_{it} + \beta_2 lnUAA_{it} + \beta_3 lnPR_{it} + \beta_4 TYP_{it} + \beta_5 lnTUAA_{it} + \beta_6 CSTT_i + e_{it}. \quad (3.1)$$

Here, $lnAP_{it}$ represents an index of agricultural goods output for the country i in the year t, log-transformed; β_j represents the parameter coefficients to be estimated; $lnDP_{it}$ is the log of DPs per ha in the country i in time t; $lnUAA_{it}$ is the log of farm-utilized agricultural area in the country i in time t; $lnPR_{it}$ is the log of farm productivity measured as the output per ha in the country i in time t; TYP_{it} is the farm crop output share in the total farm output in the country i in time t; $lnTUAA_{it}$ is the log of total UAA in the country i in time t; $CSTT_i$ are country-specific time trends ($i = 1,\ldots, 27$) (here and further, $i = 1,\ldots, 15$ for OMS models, and $i = 1,\ldots, 12$ for NMS models), and e_{it} is the idiosyncratic error.

The dependent variable, agricultural production, measured as an index of agricultural goods output, reflects the production value at producer price, real value; index 2005 = 100%. The independent variable, direct payments, is all the EU's and national decoupled and coupled subsidies, except for rural development, costs, and purchase of animals (as defined by FADN code SE606). Control variables include productivity, farm size, farm type, and total UAA.

Productivity, as emphasized by many economic models, is one of the key contributors to total production amounts (Mundlak, Butzer & Larson, 2012; Debertin, 2012; Nagyová et al., 2016; Fuglie, 2018). The total factor productivity, which is often used in the production functions, is not used here since, according to Mundlak, Butzer, and Larson (2012), weights of factors based on country averages provide distorted estimates of productivity. Therefore, the productivity is measured by land productivity, which is calculated as the total output (SE131) divided by the total UAA (SE025). The data is obtained from the FADN database.

Changes in a country's average farm size, farm type, and total UAA may have a significant impact on the total production value; therefore, they must be controlled. Farm size is measured as a total farm utilized agricultural area (UAA) (SE025). Data on this variable is obtained from the FADN database. Since the country's average farm typology is considered and more detailed information is hard to obtain, following Mugera & Langemeier (2016), the typology of farms is defined by the share of output produced by crops (SE135) in the total agricultural output (SE131) and the data on this indicator is obtained from the FADN database. The data on the total country's UAA is obtained from the EUROSTAT database.

Since agricultural production indices in different countries exhibit different long-term trends, indicating that a country-common time-varying variable is insufficient to account for the time series properties of the data, country-specific time trends were added to the model. The incorporation of country-specific time trends is important in avoiding spurious regression (Wong & Tang, 2013). Since autocorrelation and heteroscedasticity were observed, robust standard errors, as proposed by Arellano (2003), were calculated.[2] Pesaran's CD test for cross-sectional dependence does not allow to reject the hypothesis of cross-sectional dependence. However, cross-sectional dependence is most probably detected due to the use of country-specific time trends since when the model is run with time dummies instead of CSTT, Pesaran's CD test shows no cross-sectional correlation. Therefore, no cross-sectional correlation can be assumed.

Modeling results. Table 3.4 reports the panel fixed effects estimation while controlling for countries' heterogeneity. Within R-squared (0.68) shows a good model fit. The results reveal a significant negative DPs' impact on the total agricultural output, i.e., a 1% increase in DPs, leads to a decrease in the agricultural output by 0.1%. The observed negative impact is in line with the findings of previous studies (Doucha & Foltýn, 2008; Opatrny, 2018).

Table 3.4. Modeling results for the model "DPs' Impact on Agricultural Production" in EU-27

	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	

Model: fixed-effects, using 400 observations; included 27 cross-sectional units; time-series length: minimum 13, maximum 15; robust (HAC) standard errors; within $R^2 = 0.68$
Here and further on: significance levels: p<0.01***, 0.05**, 0.1*.

This negative relationship between DPs and agricultural production may be caused by several factors. As discussed in Section 1.3.2, DPs may impact farms' productivity via several channels: farms' investment decisions (Zhu & Oude Lansink, 2010; Musliu, 2020), decisions on input volumes and quality (Ferjani, 2009; Patton, Olagunjuand & Feng, 2017), decisions on production structure (Ivanov, 2018; Morkunas & Labukas, 2020; Némethová & Vilinová, 2022), etc. Thus, if the motivation to produce due to DPs decreases in a wider range (or other negative effects increase faster), then the positive effects on investment or farm expansion, increasing productivity, are spread, and the overall effect on production is expected to be negative. Moreover, DPs may provide necessary financial resources

[2] The robust standard errors were used in all the models below. The cross-sectional dependence tests and tests for the normality of residuals were performed for all models. Therefore, it won't be repeated when presenting other models.

for marginal farms to stay in business (Tocco et al., 2013; Peerlings et al., 2014), thus slowing down the sector restructuring and, possibly, inhibiting the more pronounced increase in agricultural production.

Considering control variables, average farm productivity appears to be the most significant positive determinant of the total agricultural output, which is in line with the findings by other researchers (Mundlak, Butzer & Larson, 2012; Debertin, 2012; Nagyová et al., 2016; Fuglie, 2018). Increasing farm size is also a significant positive factor considering total agricultural production, and this is expected since, on average, larger farms are more productive. The changing typology of the farm reveals that an increasing crop share in the total output of an average farm is positively related to the total agricultural output, although this relationship is marginally significant ($p = 0.08$). On the other hand, the relationship between the total UAA in a country and the total output seems to be negative, i.e., increasing used areas of agricultural land does not stimulate an increase in the total output. However, this relationship is not statistically significant.

Similar to the model for the EU-27, the FE model is used to determine the DPs' impact on agricultural production, separately for the OMS and the NMS. The F test confirmed the preference for the FE model against accordingly pooled OLS. The Hausman test could not be performed due to data limits. Both models (the DPs' impact on the OMS and the NMS) show a good fit (Table 3.5).

Table 3.5. Modeling results of the DPs' impact on agricultural production in the OMS-15 and the NMS-12

	OMS				**NMS**		
	Coefficient	**Std. Error**	**Significance**		**Coefficient**	**Std. Error**	**Significance**
Const	3.66	1.16	***		−1.09	0.84	
ln DPs	**−0.12**	0.07			**−0.08**	0.05	*
ln UAA	0.28	0.09	****		0.12	0.07	*
ln output per ha	0.53	0.07	****		0.49	0.08	***
Crop share in output	0.01	0.21			0.36	0.23	
Total UAA in a country	−0.41	0.09	***		0.27	0.09	***
Model: fixed-effects, robust (HAC) st. errors	224 observations Within $R^2 = 0.72$				176 observations Within $R^2 = 0.68$		

The results show quite similar results: DPs stimulate a decrease in agricultural production in old and new MS, although, for the OMS, the relationship is not statistically significant.

As discussed above, these results are not unexpected. A number of studies confirm the negative DPs' impact on production for the NMS (Mala et al., 2014; Opatrny, 2018). Although there are not a lot of studies confirming the same for the OMS, some studies provide evidence that at least some of the OMS tend to substitute CAP payments for production (Enjolras et al., 2012). Martinho (2015) concludes that CAP-decoupled payments have no significant effect on output in Portugal. The lack of statistical significance presumably lies in the contradictory effects of DPs on farmers' behavior (more in Section 1.3.2).

3.3.2. Direct Payments' Impact on the Ratio of Food Prices to Prices of Consumer Goods

The goal of this model is to examine the DPs' impact on the ratio of food prices to the prices of all consumer goods. As in the previous model, the fixed-effects model (FE) was used, specified as:

$$lnFP_{it} = \beta_0 + \beta_1 lnDP_{it} + \beta_2 GP_t + \beta_3 MP_{it} + \beta_4 lnLC_{it} + \beta_5 lnUN_{it} + \beta_6 CSTT_i + e_{it}. \quad (3.2)$$

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

Control variables include prices of production means, global food prices, total labor costs (wages and salaries), and total unemployment. A large amount of research has shown that commodity prices are the main determinant of the increase in producer and consumer prices (Abbott et al., 2008; Ferrucci, 2012; Logatcheva et al., 2019; Prokopenko et al., 2019). Data for prices of production means are obtained from the EUROSTAT database. It is measured as a real index of goods and services currently consumed in agriculture. Index, 2005 = 100%.

Global food prices are the other most significant determinant of consumer food prices (Bekkers et al., 2017). The data for global food prices were obtained from the FAO database. Global food prices are measured via an index. The FAO Food Price Index (FFPI) is a measure of the monthly change in international prices of a basket of food commodities. It consists of the average of five commodity group price indices weighted by the average export shares of each group (FAO, 2021).

The total labor costs (wages and salaries), according to Giannone et al. (2010), influence prices of consumer goods, i.e., higher wages and salaries tend to influence price growth in consumer goods. Data for labor costs are obtained from the EUROSTAT database. It is measured as a labor cost index by NACE Rev. 2 activity, i.e., the nominal value and annual data. Index, 2016 = 100%.

Total unemployment is also argued to have an impact on the prices of consumer goods, i.e., with higher unemployment rates, prices tend to decrease (Islam et al., 2017). Data for unemployment are obtained from the EUROSTAT database. It is measured as a percentage of the active population (from 15 to 74 years of age).

Modeling results. Within R-squared (0.79) shows a good model fit. The DPs' impact on the food price ratio to the prices of all consumer goods appears to be negative, although marginally significant (p = 0.065) (Table 3.6).

Table 3.6. Modeling results for the model "DPs Impact on the food price ratio to prices of all consumer goods" in EU-27

	Coefficient		**Std. Error**	**p-value**	**Significance**
const	β_0	−0.19	0.14	0.166	
ln DPs	$\boldsymbol{\beta_1}$	**−0.03**	**0.02**	**0.065**	*
Global food price index	β_2	1.9e−4	0.00	0.242	
Price index of means of production	β_3	0.001	0.00	0.001	***
ln labor costs	β_4	0.04	0.03	0.172	
ln total unemployment	β_5	0.002	0.01	0.839	

Model: fixed-effects, using 394 observations; included 27 cross-sectional units; time-series length: minimum 8, maximum 15; robust (hac) standard errors; within $R^2 = 0.79$

The analysis of the DPs' impact on food prices for OMS and NMS separately shows similar results (Table 3.7). Although in both groups of countries, direct payments seem to be related to a decrease in food prices, this impact is statistically significant only for NMS (although only marginally).

These results are not unexpected. Without DPs, food prices would probably increase significantly, as otherwise, the agricultural business would be unprofitable, and a significant share of farmers would have to exit the market (Brady *et al.*, 2017; Ciaian et al., 2018). DPs may be allowing farmers to accept lower purchase prices for their produce since DPs cover at least a part of lost earnings (Ciain, Kancs & Paloma, 2015; Ciliberti & Frascarelli, 2019). Moreover, as discussed in Section 1.3.2, DPs may stimulate investment in cost-saving technologies and/or increase productivity, which could reduce production costs and, potentially, food prices (Morkunas, Volkov & Skvarciany, 2021). DPs may also have an impact through an insurance effect on risk mitigation and through farm growth and exit (Cimpoies, 2016). Brady et al. (2017) also added that additional supply generated by DPs could also lower output prices. Lower output prices tend to lower food prices, which, in turn, tend to lower the food and all consumer goods price ratio.

Table 3.7. Modeling results of the direct payments' impact on food prices in the OMS-15 and the NMS-12

	OMS				NMS		
	Coeffi-cient	**Std. Error**	**Signifi-cance**		**Coeffi-cient**	**Std. Error**	**Signifi-cance**
Const	0.30	0.29			−0.27	0.15	*
ln DPs	−0.07	0.05			−0.02	0.01	*
Global food price index	1e−04	1e−04			4.80e−04	0.0003	
Price index of means of production	0.001	4e−04	**		0.001	0.0004	**
ln labor costs	−0.008	0.06			0.04	0.03	
ln total unemploy-ment	0.01	0.01			−0.003	0.01	
Model: fixed-effects, robust (HAC) stand-ard errors	225 observations Within $R^2 = 0.66$				169 observations Within $R^2 = 0.88$		

On the other hand, it is suggested that farmers tend to adjust their production and investment due to DPs (Sckokai & Moro, 2009; Serra et al., 2011; Enjolras et al., 2012). Changing production structure may induce supply shortages of some types of produce and, thus, stimulate price increases for those goods (Meyer, 2012). Subsidies may also induce inefficiencies: farmers may spend more money on inputs than necessary because of the subsidies, hence actually subsidizing input suppliers and increasing average costs (Logatcheva et al., 2019). Overinvestment due to DPs is also revealed in several studies (Rizov, Pokrivcak & Ciaian, 2013; Czyzewski, Smedzik-Ambrozy 2017; Namiotko, 2018), which may further stimulate a rise in output prices. Well-documented growth of land sales and land rent prices, induced by DPs, affect the cost of production and, thus, can also impact the increase of food prices (Meyer, 2012). DPs impact farmers' risk mitigation decisions that can also influence food prices (Sckokai & Moro, 2009; Cimpoies, 2016). This potential two-fold impact of DPs, i.e., influencing food prices in opposite directions, may at least partially explain the overall statistically marginally significant effect (or insignificant effect in the case of the OMS) of DPs on food price ratio to prices of all consumer goods.

3.3.3. Direct Payments' Impact on Farm Net Profit Margin

This model aims to examine the DPs' impact on farm net profit margin. The fixed-effects model (FE) was used to determine this impact. The conducted F test confirmed the preference for FE against pooled OLS, and the Hausman test confirmed the preference for the FE model. Thus, the following model has been specified:

$$FPR_{it} = \beta_0 + \beta_1 lnDP_{it} + \beta_2 SMR_{it} + \beta_3 lnUAA_{it} + \beta_4 TYP_{it} + \beta_5 asinDAR_{i,t-1} + \beta_6 CSTT_i + e_{it}. \quad (3.3)$$

Here, FPR_{it} represents farm net profit margin in the country i in time t; β_j represents the parameter coefficients to be estimated; $lnDP_{it}$ is the log of DPs; SMR_{it} is the ratio of output sell price to the price of means of production; $lnUAA_{it}$ is the log of farm utilized agricultural area; TYP_{it} the farm's crop output share in the total output; $asinDAR_{it}$ is debt-to-assets ratio; $CSTT_i$ are country-specific time trends ($i = 1,\ldots, 27$), and e_{it} is the idiosyncratic error.

The dependent variable is the net profit margin of the farm. A revenue indicator is usually used in estimating the profit margin; however, since the revenue indicator is not so commonly used in analyzing the agricultural economy (Kelly & Grada, 2013; Gollin et al., 2014; Morkunas, Volkov & Pazienza, 2018), it was changed to an affiliated indicator, i.e., the output of the farm. Thus, the net profit margin is calculated as:

$$(\text{Output} - \text{input} + \text{subsidies}_{ex\_inv}) / (\text{output} + \text{subsidies}_{ex\_inv}). \quad (3.4)$$

Data on farm profitability is obtained from the FADN database (the total output (SE131), total inputs (SE270), and total subsidies excluding investment (SE605)).

Control variables include farm size, farm typology, farm financial leverage, and the ratio between the selling price of output and the price of production means.

Production costs and the prices farmers receive for their goods are among the key factors directly contributing to the profitability of farming (as well as other) business (FAO, 2014; Tey & Brindall, 2014; Kaka et al., 2016; Mugera & Langemeier, 2016; Kroupova, 2016). To account for these two variables, the ratio between the selling price of output and the price of production means is included. The selling price of output is reflected by price indices (real) of agricultural goods output (2005 = 100%). The data for selling prices are obtained from the EUROSTAT database. Data on prices of production means are also obtained from the EUROSTAT database. It is measured as a real index of goods and services currently consumed in agriculture. Index, 2005 = 100%.

Farm size is documented as an important determinant of farm profitability and overall viability (Tey & Brindall, 2014; Burns & Prager, 2016; Wolf et al., 2020). Farm size may impact its profitability in a number of ways, thus influencing the whole business viability (Wolf et al., 2016; Naglova & Gurtler, 2016;

Baležentis et al., 2019; Ren et al., 2019). First, depending on their size, farms usually have different possibilities to exploit economies of scale or to access credit markets (Gregg & Rolfe, 2010; Hughes et al., 2012). Secondly, the purchase prices of agricultural produce received by the farmers and input prices often depend on the farm size, with small farms having relatively little bargaining power and getting lower sale prices for their production. Thirdly, the production structure is often correlated with the farm size. Small farms often engage in mixed farming, which further decreases productivity (Baležentis et al., 2019). On the other hand, more specialized large farms face increased production and market risks due to specialization and monoculture cropping. Thus, average farm sizes and their changes are related to farm profitability. Farm size is estimated via utilized agricultural area (ha). Data is obtained from the FADN database (Total Utilized Agricultural Area (SE025)).

It is also important to control for the farm typology since different farming types carry different profit margins. This is documented by Mugera & Langemeier (2016), Greig et al. (2018), Diakité et al. (2019), and Balezentis et al. (2019). Since the country's average farm typology is considered and more detailed information is hard to obtain, Mugera & Langemeier (2016) are followed in this case, and the farm typology is defined by the share of crop output (SE135) in the total agricultural output (SE131).

Financial leverage also impacts farm profitability, as shown by Hadrich and Olson (2011), Tey and Brindal (2014), Mugera & Langemeier (2016), Aderajew et al. (2018), Balezentis et al. (2019), Ma et al. (2020), Goral and Soliwoda (2021). Farms with less leverage, i.e., more use of internal funds over external funds, should gain and sustain profit by reducing financing costs and investing in highly profitable investments (Wu, Guan & Myers, 2014). However, Kay et al. (2012) argued that on the one side, the use of external capital is associated with the need to pay interest, but on the other hand, it allows for the use of leverage, so the impact on efficiency may be two-fold. Purdy et al. (1997) emphasized that leveraged farms are exposed to a higher probability of default and, therefore, might adopt a more cautious strategy. In any case, this factor does influence farm profitability. Financial leverage is estimated as the debt-to-assets ratio (%). Following O'Donoghue & Whitaker (2010) and Olagunju et al. (2020), the first-order lag of the debt-assets ratio is used to account for the endogeneity issue. The data on leverage is obtained from the FADN database (total liabilities (SE485) and total assets (SE436)).

Modeling results. Within R-squared (0.56) shows a quite good model fit. The results show that DPs tend to increase farm profitability: a 10% increase in DPs would stimulate an increase in farm net profit margin by 0.008 percentage points (Table 3.8). This is an expected result since DPs are direct farm income without accompanying costs. These results are in line with the findings of other researchers that found a positive relationship between DPs and farm profitability (Severini & Biagini, 2020; Lehtonen & Niemi, 2018; Kryszak & Matuszczak, 2019; Ciliberti & Frascarelli, 2019).

Table 3.8. Modeling results for the model "DPs Impact on Farm Net Profit Margin" in the EU-27

	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	***
asin Debt to assets ratio (lag 1)	β_5	−0.002	0.01	0.22	

Model: random-effects, using 367 observations; included 27 cross-sectional units; time-series length: minimum 7, maximum 14; robust (hac) standard errors; within $R^2 = 0.56$.

On the other hand, several authors have documented a negative or ambiguous DPs' impact on various farmers' managerial decisions that, in turn, affect the farms' profitability. For example, Enjolras et al. (2012) found that DPs may either: improve farmers' income or substitute CAP payments for production, depending on the country. Mamatzakis & Staikouras (2020) and Kravcáková et al. (2020) found a negative link between the volume of subsidies and farm profitability. Brady et al. (2017) argued that DPs encourage marginal farms to stay in the market and, thus, slow down structural change, which in turn constrains income growth in relatively productive regions. Balezentis et al. (2019) suggested that CAP payments may distort incentives for higher market integration and, thus, profit margins in large farms. Thus, it can be assumed that these indirect effects may decrease the positive impact of DPs on profitability; however, they do not completely neutralize the positive effects, and the overall impact of DPs on farm profitability remains significantly positive.

The other results are in line with the findings of other researchers. Output prices, increasing faster than prices of the production means, increase farm profitability, and similar results are documented in several studies (Kaka et al., 2016; Mugera & Langemeier, 2016; Kroupova, 2016). A high debt-to-asset ratio is a negative determinant of profitability. This is in line with Ferjani and Koehler (2007), Hadrich and Olson (2011), and Kryszak et al. (2021) findings that higher debt relative to equity hinders farm performance and income. Although, in this study, the impact of the debt-to-assets ratio is not statistically significant. The relationship with crop share in output is positive and significant, showing that animal farms suffer from lower profitability as compared to crop farms. As expected, the UAA relationship is positive; however, it is insignificant.

The analysis of the DPs' impact on farm profitability for the OMS and the NMS separately shows similar results (Table 3.9). The DPs impact is significant (although marginally) and positive: a DPs increase of 10% would stimulate an increase in farm profitability by 0.011 percentage points in the OMS and by 0.008 percentage points in the NMS.

Table 3.9. Modeling results of DPs impact on farm net profit margin in the OMS-15 and the NMS-12

	OMS				NMS		
	Coefficient	**Std. Error**	**Significance**		**Coefficient**	**Std. Error**	**Significance**
const	−0.71	0.30	**		−0.66	0.24	***
ln DPs	**0.11**	0.052	*****		**0.08**	0.04	*****
Ratio of output sell price to the price of means of production	0.43	0.09	***		0.35	0.07	***
ln UAA	−0.03	0.07			0.009	0.05	
Crop share in output	0.12	0.11			0.23	0.09	***
asin Debt to assets ratio (lag 1)	−5.6e−04	0.00			−0.002	0.00	*
Model: fixed-effects, robust (HAC) standard errors	210 observations Within R^2 = 0.55				157 observations Within R^2 = 0.57		

These results are in line with the findings of other researchers that determined a positive relationship between DPs and farm profitability in old and new MS (Severini & Biagini, 2020; Lehtonen & Niemi, 2018; Kryszak & Matuszczak, 2019). However, the size and marginal significance of coefficients suggest that DPs, coming as cash income, are not fully transferred to the farms' profits. Increasing land/land rent prices (Michalek, Ciaian & Kancs, 2014; Varacca et al., 2021), lower purchase prices of produced goods (Ciain, Kancs & Paloma, 2015; Ciliberti & Frascarelli, 2019), and decreasing efficiency due to DPs (Minviel & Latruffe, 2017; Marzec & Pisulewski, 2017) may significantly lower the degree of the transference. However, overall, these negative effects do not surpass the direct positive influence of DPs on farm profitability.

3.3.4. Direct Payments' Impact on Farm Expense-to-Output Ratio

The goal of this model is to examine the impact of DPs on the farm's efficiency. Random-effects model (RE) was used to determine this impact. RE models analyze and separate both the within and between components of an effect explicitly and assess how those effects vary over time and space rather than assuming heterogeneity away, thus leading to deeper and better insights (Bell & Jones, 2014). Since farm efficiency differs highly among various EU countries, it is of interest to explicitly model the between components. Moreover, Beck and Katz (2007) showed that, with respect to cross-sectional data, RE models perform well, even when the normality assumptions are violated. Therefore, they are preferred to both "complete pooling" methods, which assume no differences between higher-level entities and FE, which do not allow for the estimation of higher-level, time-invariant parameters or residuals (Bell & Jones, 2014). The Hausman test statistics (H = 6.67 with a p-value = prob(chi-square(9) > 6.67) = 0.67) and Breusch-Pagan test statistics (LM = 1520.4 with a p-value = prob(chi-square(1) > 1520.4) = 0) confirm this choice. The FE model, however, is also performed to compare the results.

Thus, the following model has been specified:

$$lnFE_{it} = \beta_0 + \beta_1 lnDP_{it} + \beta_2 SMR_{it} + \beta_3 TYP_{it} + \beta_4 asinDAR_{it} + \beta_5 lnLI_{it} + \beta_6 (lnLI_{it})^2 + \beta_7 lnAvFC_i + \beta_8 lnAvUAA_i + \beta_9 td_t + (v_i + e_{it}). \quad (3.5)$$

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

Time-variant control variables include farm crop output share in the total output ratio, farm financial leverage (measured as the debt-to-assets ratio, arcsine-transformed), the total labor input (measured in AWU (SE010), log-transformed), and the ratio between the selling price of output and the price of production means. The included time-invariant control variables are the average farm size (measured as the average farm UAA in 2005–2019, logarithm-transformed), farm typology (measured as the average farm crop output share in the total output ratio in 2005–2019), and the fixed capital per worker (measured as the ratio of the total fixed assets (SE441) to the total labor input, measured in AWU (SE010) in 2005–2019, log-transformed). Data on the farm size, farm typology, financial leverage, labor input, and the fixed capital per worker are obtained from the FADN database. The data on the selling price and the price of production means is obtained from the EUROSTAT database.

Time dummies are included to remove the effects of time-specific variables common to all the countries.

Since autocorrelation and heteroscedasticity were observed, robust standard errors, as proposed by Arellano (2003), were calculated. Pesaran's CD test for cross-sectional dependence confirms that there is no cross-sectional dependence. Auxiliary regression for the non-linearity test (squared terms) suggested a non-linear relationship of the dependent variable and independent variable log of the total labor input; therefore, squares of this control variable were included in the model.

Modeling results. The model fit is rather good (R^2 = 55%). The observed DPs' impact on farm efficiency is with a positive sign (Table 3.10) and statistically significant, meaning that increasing DPs tend to increase the expense-to-output ratio, or, in other words, inefficiency. The exact effect of DPs on the farm efficiency could be expressed as follows: a one percent increase in DPs obtained by the farm tends to increase the farm's expense-to-output ratio by 0.07%. Very similar results are obtained by RE and FE models. These results confirm the findings of many authors analyzing the relationship between DPs and farm efficiency, who find that subsidies/DPs negatively affect farm efficiency (Pechrova, 2015; Minviel & Latruffe, 2017; Marzec & Pisulewski, 2017).

There are several channels for DPs to exert a negative impact on efficiency. First, DPs influence farmers' motivation to work efficiently. In this line, Minviel and De Witte (2017) found that farmers' efforts in farming activities may be reduced if a larger part of their income is guaranteed by subsidization. If DPs guarantee higher profits, then they give managers the potential to capture these profits in the form of a lack of effort (Patton, Olagunjuand & Feng, 2017). Moreover, if DPs help marginal farmers to stay in business, then these farmers have less motivation to reorganize, modernize, and improve their performance (including efficiency) as they would inevitably be forced to do in the case without support (Ferjani, 2009). DPs are also documented to increase prices of land and land rent (Patton et al., 2008; Michalek, Ciaian & Kancs, 2014; Varacca et al., 2021), thus, in turn, influencing the rise in costs for farmers renting or purchasing land. The indirect DPs' effects can also be significant. Hennessy (1998), Koundouri et al. (2009), Enjolras et al. (2012), and Knapp & Loughrey (2017) found DPs to be affecting farmers' risk-management decisions, thus influencing both elements of efficiency, i.e., the total inputs and the total output. Moreover, due to the support, farmers may be encouraged to overinvest in the capital, which may result in resource allocation inefficiency (Musliu, 2020).

Table 3.10. Modeling results for the model "DPs Impact on Farm Efficiency" in the EU-27

		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 sell 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	***
asin 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	***			
	R^2 = 0.55					**R^2 = 0.37**		

Model: random-effects, using 394 observations; included 27 cross-sectional units; time-series length: minimum 8, maximum 15; robust (HAC) standard errors.

However, a significant share of studies found a positive DPs' impact on efficiency (Rizov et al., 2013; Kazukauskas et al., 2014; Cillero et al., 2017), mainly by allowing farmers to overcome financial constraints and invest in the farm's modernization or expansion (Zhu & Oude Lansink, 2010). Investing in advanced technologies or the enhancement of a farm's productive capacity increases output and/or decreases specific or fixed costs. However, the results of this study suggest that overall, in the whole EU region, DPs tend to exert a negative influence on farms' efficiency overarching their potential positive effects.

Control variables, the ratio of product sell price to the price of means of production, the average fixed capital per worker, and the crop production share in the total farm output, are inversely related to the farm expense-to-output ratio, as expected, and all of them are significant. Ln average UAA is unexpectedly positively related to the expense-to-output ratio; however, it may, at least partially, be explained by higher depreciation costs. Increasing the debt-to-assets ratio, as expected, tends to increase the input/output ratio, and this is very likely, since higher debt generates higher service costs and, thus, increases the total inputs of the farm; however, it is insignificant. The negative value of the total labor input coefficient can be explained as follows: a higher labor input generates more output, which exceeds related labor costs. However, this relationship is not linear, suggesting that a higher labor input would eventually increase inefficiency.

To determine the DPs' impact on farm efficiency for the NMS and the OMS separately, the FE model was used (although the RE model was more efficient in analyzing the DPs' impact on farm efficiency for the whole EU-27, it cannot be applied when analyzing the NMS and the OMS separately due to a much lesser data volume). The F test confirmed the preference for the FE model against pooled OLS. The following model has been specified:

$$lnFE_{it} = \beta_0 + \beta_1 lnDP_{it} + \beta_2 SMR_{it} + \beta_3 lnUAA_{it} + \beta_4 TYP_{it} + \beta_5 asinDAR_{it} + \beta_6 lnLI_{it} + \beta_7 (lnLI_{it})^2 + \beta_8 lnFC_{it} + \beta_9 td_t + e_{it}. \quad (3.6)$$

Here, FE_{it} represents the farm expense-to-output ratio (log-transformed) for the country i in the year t; β_j represents the parameter coefficients to be estimated; $lnDP_{it}$ is the log of DPs per ha in the country i in time t; $lnUAA_{it}$ is the log of farm utilized agricultural area in the country i in time t; TYP_{it} is the farm's crop output share in the total output in the country i in time t; $asinDAR_{it}$ is farm's debt-to-assets ratio in the country i in time t, arcsine-transformed; $lnLI_{it}$ is the log of the total labor input in the country i in time t; $lnFC_{it}$ is the log of the fixed capital per worker in the country i in time t; td_t is the time dummies ($t = 1,\ldots, T - 1$; $T = 14$) and e_{it} is the idiosyncratic error.

The models' fit is satisfactory (Table 3.11). The results on the DPs' influence patterns on the farm expense-to-output ratio in the OMS and the NMS differ. The DPs' impact in the NMS is significant and positive, meaning that an increase in DPs by 10% would stimulate an increase in the expense-to-output ratio by 1 percent; in other words, it would increase inefficiency. Whereas in the OMS, this impact, although positive, is statistically insignificant.

These results confirmed the findings of other authors. For example, Marzec and Pisulewski (2017) revealed a negative effect of subsidies on farm efficiency in Poland (NMS). Balezentis and de Witte (2014) also suggested that production subsidies might be having a negative effect on the efficiency of Lithuanian (NMS) family farms. Pechrova (2015) found that DPs increase farm inefficiency in the Czech Republic (NMS). In the OMS, the results on the DPs' impact on farm efficiency also tend to suggest a negative influence; however, they are more ambiguous, finding both positive (Cillero et al., 2017; Garrone et al., 2019) and negative effects (Mary, 2013), depending on the country, farm type, farm size, and subsidy type (coupled or decoupled).

Table 3.11. Modeling results of the DPs' impact on the farm expense-to-output ratio in the OMS-15 and the NMS-12

	OMS				NMS		
	Coefficient	**Std. Error**	**Significance**		**Coefficient**	**Std. Error**	**Significance**
const	−0.52	0.97			0.61	0.43	
ln DPs	**0.02**	0.10			**0.10**	0.04	**
Ratio of output sell price to the price of means of production	−0.33	0.12	***		−0.49	0.11	***
ln UAA	0.1	0.11			0.14	0.06	**
Crop share in output	−0.36	0.14	**		−0.47	0.14	***
asin Debt to assets ratio	1.6e−04	0.00			0.003	0.00	
ln Total labor input	−0.61	0.43			−0.23	0.09	**
squared ln total labor input	0.47	0.40			0.09	0.03	***
ln fixed capital per worker	0.05	0.05			−0.08	0.03	**
Model: fixed-effects, robust (HAC) standard errors	225 observations Within $R^2 = 0.41$				169 observations Within $R^2 = 0.53$		

3.3.5. Direct Payments' Impact on Farm Debt-to-Assets ratio

The goal of this model is to examine the DPs' impact on farm solvency. The dynamic panel model, which is a 1-step-system generalized method-of-moments estimator (GMM), is used to determine this impact. This method was selected accounting for the endogeneity issue, which is present due to the use of lagged dependent variable as independent along with an unobserved effect. Moreover, GMM estimators can often be found more efficient than the common method of moments estimators, such as ordinary least squares and two-stage least squares, when such necessary assumptions as homoscedasticity or non-existence of autocorrelation fail (Wooldridge, 2001). If either heteroscedasticity or serial correlation is present, a generalized method of moments' procedure can be more efficient than the fixed effects estimator (more in Section 2.3.1).

Thus, the following model has been specified:

$$asinDAR_{it} = \beta_0 + \beta_1 asinDAR_{i,t-1} + \beta_2 lnDP_{it} + \beta_3 PR_{i,t-1} + \beta_4 TYP_{it} + \beta_5 lnUAA_{i,t-1} + \beta_6 td_t + v_i + e_{it}. \quad (3.7)$$

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

The dependent variable debt-to-assets ratio (%) is arcsine-transformed. Data on farm profitability is obtained from the FADN database (total liabilities (SE485) and total assets (SE436)). Control variables include the first-order lag of the debt-to-asset ratio, farm size, farm typology, and farm profitability. Farm size is emphasized by many researchers as an important determinant of farm solvency (Wolf et al., 2016; Aderajew et al., 2018; Balezentis et al., 2019), as it may impact its solvency in several ways. First, depending on the size, farms usually have different possibilities to access credit markets (Frank & Goyal, 2009; Getzmann, Lang & Spremann, 2010). Second, some authors (Barry, Bierlen & Sotomayor, 2000) find that economies of scale influence farm leverage, and the capacities to exploit economies of scale also largely depend on farm size. Size is also often related to a farm's bargaining power (Graham, Leary, and Roberts, 2015), which is considered to be positively correlated to leverage (Aderajew et al., 2018). Farm size is estimated via the UAA of a farm (ha) (SE025). Data is obtained from the FADN database. The first-order lag of UAA is used.

It is necessary to control for farm profitability since it may significantly impact solvency (Zhao, Katchova & Barry, 2004; Aderajew et al., 2018). According to the pecking order theory, firms prefer financing new investments out of retained earnings rather than through borrowing (Graham, Leary & Roberts, 2015). Subsequently, the more profitable the farm is, the greater its internal capital and the less need for borrowing. On the other hand, lenders are more willing to lend to profitable farms; therefore, their average debt may be higher than that of less profitable farms (Zhao, Barry & Katchova, 2008). Farm profitability is estimated as the farm's net profit margin (%) = (total output (SE131) – total inputs (SE270) + total subsidies excluding subsidies on investment (SE605))/(total output + total subsidies excluding subsidies on investment). The first-order lag of profitability is used. The data is obtained from the FADN database.

Farm typology may also affect farm solvency (Aleknevičienė et al., 2011; Key et al., 2019). Farm type may determine the capital intensity necessary for maintaining business operations. The typology of the farm is defined by the share of output produced by crops (SE135) in the total agricultural output (SE131). The data is obtained from the FADN database.

A year lag of the debt-to-assets ratio is also included in the model since it determines debt servicing requirements, which, in turn, impacts the debt-to-assets ratio. The data on this variable is obtained from the FADN database.

Modeling results. The dynamic panel model is well specified, as the test for the first-order autocorrelation is significant, the test for the second-order autocorrelation is insignificant, the Sargan over-identification test is between 0.1 and 0.3 (Roodman, 2009), and the p-value of the Wald test is <0.001 (Table 3.12).

Table 3.12. Modeling results for the model "DPs Impact on Farm Debt-to-Assets Ratio"[3] in the EU-27

	Coefficient		Std. Error	p-value	Significance
Const	β_0	−21.39	20.97	0.308	
asin 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]					

The modeling results reveal a positive, however, insignificant DPs' impact on the farm debt-to-assets ratio. This result may seem unexpected since DPs directly increase the number of assets owned by the farm. Therefore, the debt-to-asset ratio should be expected to decrease, as documented by Skevas et al. (2017). Moreover, since DPs increase land prices, the assets of farmers owning land should also increase, decreasing the debt-to-assets ratio (Grzelak, 2022). It may also be the case that DPs stimulate the substitution of the DPs' income with farm income; thus, farmers become less motivated to replace or retool their fixed assets, and, therefore, their debt-to-assets ratio decreases. On the other hand, there is also evidence of the opposite impact (Ciaian et al., 2012; Soliwoda, 2016). The main reason for a positive relationship between DPs and the debt-to-assets ratio is, presumably, credit constraints. DPs improve access to credit (Vercammen 2007; Kropp & Katchova, 2011; O'Toole & Hennessy, 2013) because they provide a

[3] Time dummies were included in the primary model, but Wald joint test for time dummies suggested that none of them were significant; therefore, in the first version of the model, the time dummies were not included.

stable risk-free stream of cash flows for the duration of the financial programming period and increase the borrower's liquidity and, in turn, their repayment capacity, thus increasing the possibility of a borrower to obtain credit and/or get in on more favorable terms (Kropp & Katchova, 2011). Moreover, DPs influence the growth of land prices, which increases the value of potential collateral, which, in turn, supports borrowing capacity (Roe, Somwaru, & Diao, 2003, Vercammen, 2007). Increased access to credit may lead to greater use of the borrowed capital and, thus, increased debt-to-assets ratio. Since the DPs' effects may be twofold, the overall insignificant effect of DPs on the average farm solvency is not unexpected.

The insignificant impact is also obtained when analyzing the OMS and the NMS separately (Table 3.13).

Table 3.13. Modeling results of DPs impact on the debt-to-assets ratio in the OMS-15 and the NMS-12

	OMS				NMS		
	Coefficient	**Std. Error**	**Significance**		**Coefficient**	**Std. Error**	**Significance**
Const	2.66	1.91			1.52	2.85	
ln DPs	**−0.3**	0.30			**−0.33**	0.36	
asin Debt-to-assets ratio (-1)	0.99	0.01	***		0.97	0.02	***
ln UAA (-1)	−0.003	0.00			0.007	0.00	***
Crop share in output	−0.19	0.60			−1.06	2.07	
Net profit margin (-1)	−1.45	1.71			5.77	2.65	**
Test for AR(1) errors:	z = -5.95 [0.000]				z = -5.49 [0.000]		
Test for AR(2) errors:	z = 0.02 [0.986]				z = -0.37 [0.715]		
Sargan over-identification test:	χ^2 (103) = 113.43 [0.23]				χ^2 (103) = 115.38 [0.19]		
Wald (joint) test:	χ^2 (5) = 27146.4 [0.0000]				χ^2 (5) = 3874.2 [0.000]		

What concerns the control variables, the lag of the debt-to-assets ratio appears to be the main determinant of the debt-to-assets ratio, as expected. Other control variables, i.e., UAA and the net profit margin, appear to be significant for the NMS.

3.3.6. Direct Payments' Impact on Salaried Employment

This model aims to examine the DPs' impact on salaried employment in the agricultural sector. Fixed-effects model (FE) was used to determine the DPs' impact, specified as:

$$lnSE_{it} = \beta_0 + \beta_1 lnDP_{it} + \beta_2 lnUAA_{it} + \beta_3 lnPR_{it} + \beta_4 TYP_{it} + \beta_5 lnLC_{it} + \beta_6 CSTT_i + e_{it}. \quad (3.8)$$

Here, $lnSE_{it}$ represents salaried employment for the country i in the year t, measured as an index (2005 = 100%), log-transformed; β_j represents the parameter coefficients to be estimated; $lnDP_{it}$ is the log of DPs received per ha in the country i in time t; $lnUAA_{it}$ is the log of the farm utilized agricultural area in the country i in time t; $lnPR_{it}$ is the log of farm productivity, measured as the output per ha in the country i in time t; TYP_{it} is the farm crop output share in the total output in the country i in time t; $lnLC_{it}$ represents labor costs in the country i in time t; $CSTT_i$ are country-specific time trends ($i = 1,\ldots, 27$) and e_{it} is the idiosyncratic error.

Control variables include labor productivity, farm size, and farm typology. The changes in the hired farm labor force may be induced by changes in labor productivity, where increasing productivity should lead to decreasing demand for labor (Dupraz & Latruffe, 2010; Kaditi, 2013). Labor productivity is calculated as the total output (SE131) divided by the total labor input (SE010). The total labor input (hired and family) is considered because increasing (decreasing) family labor productivity may also impact hiring decisions. It also allows for avoiding the endogeneity issue.

Farm size may also impact the demand for hired labor (Dupraz, Latruffe & Mann, 2010). Larger farms may be more dependent on hired labor, while smaller farms may largely depend on the family labor force. A structural improvement on the farm, which implies higher productivity or a larger scale of production, is associated with a higher demand for (hired) labor (Kaditi, 2013; Mantino, 2017). Farm size is estimated via utilized agricultural area (ha).

Farm typology is important to control for since different types of farming require different levels of labor input. Animal farming is usually more labor-intensive than crop farming (with vegetable farming as a noticeable exception) (Tocco et al., 2013). Since the average country's farms typology is considered, the share of output produced by crops (SE135) in the total agricultural output (SE131) is considered an indicator of farm specialization. Although this indicator has its drawbacks (e.g., it does not account for higher labor demand in the vegetable sector), it does, however, reflect the major changes between animal and crop farming.

It is also important to control for labor costs (Kaditi, 2013). Labor costs are calculated as wages paid (SE370) divided by paid annual work units (SE020). The data is obtained from the FADN database.

Country-specific time trends were added to the model since salaried employment indices in different countries exhibit different long-term trends, indicating that a country-common time-varying variable is insufficient to account for the time series properties of the data.

Modeling results. The R^2 of the model is good ($R^2 = 0.64$). The observed impact of DPs on salaried employment in agriculture is negative (Table 3.14) and statistically significant, meaning that increasing DPs tend to decrease salaried employment. These findings confirm conclusions of earlier research: Chrastinová and Buriánová (2009), Dupraz, Latruffe, and Mann (2010), Kaditi (2013), and Mantino (2018) found that decoupled payments negatively affected hired labor (as well as family labor input). In the same line, Garrone et al. (2019a) argued that decoupled DPs have a strongly significant negative effect on the outflow of labor from agriculture in the EU-27, noting that the outflow of hired labor is higher than that of family labor.

Table 3.14. Modeling results for the model "DPs Impact on Salaried Employment" in the EU-27

	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	

Model: fixed-effects, using 374 observations; included 27 cross-sectional units; time-series length: minimum 12, maximum 14; robust (HAC) standard errors; within $R^2 = 0.64$.

Petrick and Zier (2012) argued that the introduction of the SFP in 2005 led to a decrease in agricultural employment since decoupling may have allowed the release of labor no longer necessary to maintain the production levels previously required to obtain crop- and livestock-related subsidies. It is documented that DPs decrease the incentives to produce for some farmers (Swinnen & Van Herck, 2010; Dupraz & Latruffe, 2015; Mantino, 2018); thus, the use of production factors (including hired labor) should also be decreasing. The decisions on production structure, such as moving from more labor-intensive (meat, milk, vegetables) to less labor-intensive production (grains), which is the case in at least several NMS (Valkanov, 2013; Ivanov, 2018; Mantino, 2018), could also be negatively impacting the demand for hired labor. Third, DPs influence farm investment capacity and decisions (Zhu & Oude Lansink, 2010). Due to the support, farms can change the combination of capital and labor by investing more in capital (Musliu,

2020) and, thus, decreasing their demand for labor. Fourth, the increase in land purchase and land rent prices (Michalek, Ciaian & Kancs, 2014; Feichtinger & Salhofer, 2013; Varacca et al., 2021) may lessen the farms' financial funds to hire workers. Finally, as Key and Roberts (2008) noted, farmers can derive nonpecuniary benefits from farming, and since DPs increase the farmers' liquidity, they may reduce their reliability on off-farm work (El-Osta, Mishra & Ahearn, 2004; Bhaskar & Beghin, 2007) providing more on-farm labor input and, thus, reducing demand for paid labor. Moreover, since DPs encourage marginal farms (which usually use only family labor) to stay in production, the opportunities to expand for medium- and large-sized farms are decreased (Balmann & Sahrbacher, 2014), thus reducing the opportunities to expand the demand for hired labor. In summary, although DPs may have a positive impact on salaried employment by increasing farm viability and improving farms' capacities to expand (Zhu & Oude Lansink, 2010), the overall effect seems to be negative.

Table 3.15. Modeling results of the DPs' impact on salaried employment in the OMS-15 and the NMS-12

	OMS				**NMS**		
	Coefficient	**Std. Error**	**Significance**		**Coefficient**	**Std. Error**	**Significance**
Const	4.92	1.51	***		5.78	0.58	***
ln DPs	**−0.17**	0.09	**		**−0.15**	0.07	**
ln UAA	−0.19	0.24			−0.01	0.10	
Crop share in output	0.33	0.25			−0.19	0.21	
ln labor productivity	−0.03	0.06			0.02	0.06	
ln Labor costs	0.17	0.05	***		−0.06	0.07	
Model: fixed-effects, robust (HAC) standard errors	225 observations Within $R^2 = 0.66$				164 observations Within $R^2 = 0.64$		

The results for the NMS and the OMS show similar results: DPs tend to stimulate a decrease in salaried employment in the agricultural sector in both country groups (Table 3.15). The negative impact for the OMS and the NMS is statistically significant and of similar strength.

These findings are in line with the earlier research. Garrone et al. (2019a), who investigated, namely, the DPs' impact on agricultural employment in the whole EU and the OMS and the NMS separately, concluded that decoupled DPs have a strongly significant negative effect on the outflow of labor from agriculture. Chrastinová and Buriánová (2009) also found a negative relationship between DPs and employment in the Slovak Republic (NMS). Dupraz, Latruffe, and Mann (2010) obtained the same results for France, and Mantino did so for France (OMS).

3.3.7. Direct Payments' Impact on Labor Productivity

The random-effects model (RE) was used to determine the impact of DPs on labor productivity in agriculture. Hausman test statistics (H = 7.44 with p-value = prob(chi-square(8) > 7.44) = 0.49 and Breusch-Pagan test statistics (LM = 1569.48 with p-value = prob(chi-square(1) > 1569.48) = 0) = 0) confirm this choice. FE model is also performed to compare the results.

The following model has been specified:

$$lnLP_{it} = \beta_0 + \beta_1 lnDP_{it} + \beta_2 lnSC_{it} + \beta_3 TYP_{it} + \beta_4 lnUAA_{it} + \beta_5 lnFC_{it} + \beta_6 lnAvFC_i + \beta_7 lnAvUAA_i + \beta_8 AvTYP_i + \beta_9 td_t + (v_i + e_{it}). \quad (3.9)$$

Here $lnLP_{it}$ represents the farm labor productivity for the country i in year t, log-transformed; β_j represents the parameter coefficients to be estimated; $lnDP_{it}$ is the log of DPs per ha in the country i in time t; $lnSC_{it}$ is the log of total specific costs of a farm in the country i in time t; TYP_{it} is the farm's crop output share in the total output in the country i in time t; $lnUAA_{it}$ is the log of farm utilized agricultural area in a country i in time t; $lnAvUAA_i$ is the log of average farm utilized agricultural area in the country i in the period 2005–2019; $lnFC_{it}$ is the log of fixed capital per worker in the country i in time t; $lnAvFC_i$ is the log of the average fixed capital per worker in the country i in the period 2005–2019; $AvTYP_i$ is the average farm's crop output share in the total output in the country i in the period 2005–2019; td_t is the time dummies ($t = 1,\dots, T - 1$; $T = 14$), v_i is the individual-specific error, and e_{it} is the idiosyncratic error.

The dependent variable, labor productivity, is measured as output per worker (the total agricultural output (the production value at a producer price, values at constant prices (2010 = 100%)) divided by the total labor force input (AWU)). Note that labor productivity is estimated per annual work unit to control for differences in the scale of farms whilst also efficiently measuring the productivity of the agricultural workforce. Data on this variable is obtained from the EUROSTAT database.

Time-variant control variables include farm size, farm typology, specific costs, and fixed capital per worker. Time-invariant control variables include average farm size, farm typology, and the average amount of fixed capital per worker.

Farm size and/or farm type are two variables that are controlled for in most studies researching farm productivity (Looga et al., 2018; Garrone et al., 2019a).

Different types of farming differ in labor intensity and, subsequently, labor productivity. Farm typology is measured as the crop output (SE135) in the total agricultural output (SE131). Both the average farm type (the average crop output in the total agricultural output in the period 2005–2019) and the farm type (the crop output in the total agricultural output in the specific year) are considered. The data on these variables are obtained from the FADN database.

Farm size must be controlled for as it influences farm capabilities to exploit economies of scale and access credit for investment, influencing production structure, etc. (Balezentis et al., 2019) and may also significantly influence farm labor productivity. Farm size is measured in farm UAA (SE025). Average farm size is estimated as an arithmetic average of farm UAA in the period 2005–2019, while UAA is the number of ha used in a certain year (data obtained from the FADN database).

The farm's capital and its investment are closely related to labor productivity, as documented by several studies (Aderajew et al., 2018; Onegina et al., 2020; Kryszak, Guth & Czyżewski, 2021). Fixed capital per worker is measured as total fixed assets (SE441) divided by the total labor input (SE010) in the period 2005–2019. Data is obtained from the FADN database.

Specific costs, comprising crop-specific inputs (seeds and seedlings, fertilizers, crop protection products, other specific crop costs) and livestock-specific inputs (feed for grazing stock and granivores, other specific livestock costs), reveal the quality (and quantity) of input used, which, in turn, determines the output and, thus, productivity (Bojnec & Fertő, 2013). Data on specific costs (SE281) is obtained from the FADN database.

Time dummies are included to remove the effects of time-specific variables common to all countries.

Auxiliary regression for the non-linearity test (squared terms) suggested a non-linear relationship between the dependent variable and independent variables: the log of DPs and the log of the average UAA; therefore, squares of these independent variables were included in the model.

Modeling results. The model fit is very good ($R^2 = 83\%$). The observed impact of DPs on labor productivity is positive and statistically significant (Table 3.16). The increase of DPs by 10% would stimulate an increase in labor productivity by 3.1%. Very similar results are obtained by both RE and FE models.

The FE model was used to determine the DPs impact on labor productivity for the OMS and the NMS (although the RE model was more efficient in analyzing DPs impact on labor productivity for the whole EU-27, it cannot be applied when analyzing the NMS and the OMS separately due to much lesser data volume). Both models show a very good fit (Table 3.17). The results for both country groups are quite similar: DPs tend to stimulate an increase in labor productivity in the agricultural sector in the old and the new MS, although, in the NMS, the impact tends to be stronger, whereas, in the OMS, the statistical significance of the relationship is marginal.

Table 3.16. Modeling results for the model "DPs Impact on Labor Productivity" in the EU-27

		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				
	$R^2 = 0.83$					$R^2 = 0.72$		

Model: using 401 observations; included 27 cross-sectional units; time-series length: minimum 13, maximum 15; robust (HAC) standard errors.

These findings are similar to the results obtained by other researchers. For example, Kazukauskas et al. (2014) found that decoupled payments had significant positive effects on farm productivity and behavioral changes related to farm specialization in Ireland, Denmark, and the Netherlands. Garrone et al. (2019) found a positive impact of decoupled DPs on labor productivity in both the OMS and the NMS. This positive effect is not unexpected since DPs enable farmers to overcome financial constraints and invest in better equipment, which, according to Baer-Nawrocka and Poczta (2018), have a strong positive effect on labor productivity growth. On the other hand, Mary (2013) found a negative link between the two. Similarly, Devadoss, Gibson, and Luckstead (2016), after performing simulations, concluded that the removal of DPs should augment productivity. Serenčéš, Strápeková, and Tóth (2018) argued that in Slovakia, the growth in labor productivity was mainly achieved by a decrease in the labor force input rather than the increase in real productivity. According to them, farmers are less motivated to produce when the support is increasing. The statement that subsidies undermine motivation to produce has received support from other authors as well (Ferjani, 2009; Minviel & De Witte, 2017; Patton, Olagunjuand & Feng, 2017). However, since the DPs can influence farmers' behavior in both ways, i.e., enhancing and inhibiting labor productivity growth, the net effect is of the main interest. The results of this study suggest that the net effect of DPs on labor productivity is positive.

Table 3.17. Modeling results of DPs impact on labor productivity in the OMS-15 and the NMS-12

	OMS				NMS		
	Coefficient	**Std. Error**	**Significance**		**Coefficient**	**Std. Error**	**Significance**
Const	2.37	0.83	***		−2.71	1.07	**
ln DPs	**0.22**	0.12	*		**0.3**	0.09	***
Total specific costs	−0.05	0.07			0.15	0.16	
Crop share in output	0.49	0.21	**		0.46	0.47	
ln UAA	−0.11	0.27			0.11	0.22	
ln fixed capital per worker	0.08	0.11			0.17	0.10	
Model: fixed-effects, robust (HAC) standard errors	225 observations Within $R^2 = 0.77$				176 observations Within $R^2 = 0.75$		

Concerning the control variables, the average and yearly fixed capital per worker tend to influence changes in labor productivity for the EU-27 significantly positively, as expected (Onegin et al., 2020), and both are statistically significant predictors of labor productivity. Increasing total specific costs also enables higher productivity, and this relationship is rather clear: although higher quality seeds, fertilizers, crop protection products, and/or feed for animals increase costs, they also add to the growth of output and, thus, the growth in labor productivity. Labor productivity seems to be higher where the average and yearly farm size is larger, although these positive relationships are not statistically significant. The average and yearly farm crop share in the total output is positive, which is likely, since the shift to less labor-intensive crop cultivation may reduce the needed labor and, thus, increase productivity. However, the statistical significance of these two variables differs, with the former being insignificant and the latter being significant.

Concerning the OMS and the NMS separately, only the crop share was documented as statistically significant and only for the OMS.

3.3.8. Direct Payments' Impact on Wages of Agricultural Employees

The goal of this model is to examine the DPs' impact on the wages of agricultural employees. The fixed-effects model (FE) was used to determine this impact, specified as:

$$lnW_{it} = \beta_0 + \beta_1 lnDP_{it} + \beta_2 lnNET_{it} + \beta_3 lnPR_{it} + \beta_4 UN_{it} + \beta_5 CSTT_i + e_{it}. \quad (3.10)$$

Here, lnW_{it} represents wages for agricultural employees in the country i in time t, log-transformed; β_j represents the parameter coefficients to be estimated; $lnDP_{it}$ is the log of DPs per ha in the country i in time t; $lnNET_{it}$ is the average of net earnings in all economic activities in the country i in time t, log-transformed; $lnPR_{it}$ is the log of farm productivity, measured as output per ha in the country i in time t, log-transformed; UN_{it} is the total unemployment in the country i in time t, log-transformed; $CSTT_i$ are country-specific time trends (i = 1,…,27) and e_{it} is the idiosyncratic error.

The dependent variable, wages of agricultural employees (EUR/AWU), is calculated as wages paid (SE370) divided by paid labor input (SE020). Data is obtained from the FADN database.

The control variables include net earnings in all economic activities in a country, labor productivity, and total unemployment.

Wages in agriculture are affected by the average wage rate in the country since increasing wages in other sectors attracts employees from agriculture by offering them an opportunity to earn higher salaries (Binswangerand & Singh, 2018; Charlton et al., 2019). To keep employees from leaving, agricultural employers also have to increase wages. This is confirmed by Kumar et al. (2020), who showed a significant and positive effect of non-farm wages on agricultural wages. Wages in all economic activities in a country are measured by the net earnings of a single person, earning 100% of the average earning, EUR. The data is obtained from the EUROSTAT database.

Labor productivity may also be a significant determinant of wage rate, as confirmed by various authors. For example, Venkatesh (2013) and Nikulin (2015) found a strong relationship between wages and productivity. Katovich & Maia (2018) confirmed these findings, concluding that productivity is significantly positively associated with wage levels for all economic sectors (also adding that such institutional factors as labor formalization and minimum wage exert equally significant impacts). Labor productivity is measured as the output (EUR) of one annual work unit (the total output (SE131) divided by the total labor input (SE010)) in the period 2005–2019. The data is obtained from the FADN database.

The total unemployment rate is also considered a potential determinant of wages in agriculture. Most theories of wage determination imply a negative relationship between the level of wages and unemployment (Blanchard & Katz, 1999). Increasing unemployment increases the supply of labor, which, in turn, may negatively affect the wage rate. The significant relationship between unemployment and wages is documented by Moretti et al. (2000), Blien et al. (2012), and Rosolia (2015). Unemployment is measured as a percentage of the active population (from 15 to 74 years). The data is obtained from the EUROSTAT database.

Although many authors emphasize that wages are strongly influenced by the institutional structure and minimum wages (Moretti et al., 2000; Layard et al., 2005; Katovich & Maia, 2018), the statistical data on these variables are very scarce; therefore, they are omitted in this study. Country-specific time trends were added to the model since wages for agricultural employees in different countries exhibit different long-term trends, indicating that a country-common time-varying variable is insufficient to account for the time series properties of the data.

Modeling results. The model fit is very good ($R^2 = 93\%$). The observed DPs' impact on the wages of agricultural employees is positive; however, it is statistically insignificant (Table 3.18).

Table 3.18. Modeling results for the model "DPs Impact on Wages of Agricultural Employees" in the EU-27

	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	

Model: fixed-effects, using 391 observations; included 27 cross-sectional units; time-series length: minimum 7, maximum 15; robust (HAC) standard errors; within $R^2 = 0.93$.

Similar results are obtained when analyzing the OMS and the NMS separately (Table 3.19). The results for both country groups show an insignificant impact of DPs on agricultural employees' wages.

The DPs' insignificant impact on wages is not unexpected since, in the general wages in all sectors, they mainly depend on labor productivity and the average earnings in a country (Venkatesh, 2013; Nikulin, 2015; Katovich & Maia, 2018;

Binswangerand & Singh, 2018; Charlton et al., 2019; Kumar et al., 2020), and even if subsidies could have an impact, it is expected to be either very small or insignificant. Farms, even getting higher cash inflows from DPs, should not, at least directly, be motivated to increase wages for their employees. The indirect effect may also be ambiguous due to the contradictory effects of DPs on farmers' behavior. For example, if DPs stimulate farm expansion and, thus, increase farm profitability, the wages for hired workers might rise. Whereas, if DPs systematically undermine farmers' incentives to maintain production levels, the "freed" labor supply may, in turn, influence reduction in wages. Moreover, increasing land and land rent prices may increase costs for farmers, preventing wage rises. However, in general, literature on the relationship between DPs and the wages of salaried agricultural employees is especially scarce. Most of it is concentrated on how DPs influence the income of self-employed persons (namely, farmers) (Severini, Tantari & Di Tommaso, 2016; Castañeda-Vera and Garrido, 2017; Hayden et al., 2019; Kryszak & Matuszczak, 2019). One of the scarce examples is a study on how CAP subsidies impact the wages of agricultural employees in Slovakia. It concludes that subsidies tend to slow down the growth of wages (Chrastinová and Buriánová, 2009). However, the overall empirical evidence is lacking on the DPs' impact on wages for both the NMS and the OMS.

Table 3.19. Modeling results of the direct payments' impact on the wages of agricultural employees in the OMS-15 and the NMS-12

	OMS			**NMS**		
	Coefficient	**Std. Error**	**Significance**	**Coefficient**	**Std. Error**	**Significance**
Const	3.49	1.02	***	2.5	0.96	**
ln DPs	**−0.09**	0.11		**0.05**	0.06	
ln Net earnings in a country (total NACE)	0.63	0.11	***	0.48	0.14	***
ln Labor productivity	0.04	0.08		0.17	0.08	**
ln Total unemployment	−0.01	0.02		−0.01	0.02	
Model: fixed-effects, robust (HAC) standard errors	225 observations Within $R^2 = 0.85$			166 observations Within $R^2 = 0.95$		

The control variables, the labor productivity and the net earnings in all economic activities in a country, are significant predictors of wages in the agricultural sector for the whole EU-27 and the NMS and the OMS separately (except for the labor productivity, which is statistically insignificant for OMS). As documented by earlier research, the growth in average wage rates in a country also stimulates the growth in the wages in the agricultural sector since different sectors are competing for the workforce (Binswangerand & Singh, 2018; Charlton et al., 2019; Kumar et al., 2020). The positive relationship between labor productivity and wages is also expected and well-documented (Venkatesh, 2013; Nikulin, 2015; Katovich & Maia, 2018). Total unemployment, on the other hand, is, as expected, inversely related to wages; however, it is insignificant.

3.4. Index Creation: Direct Payments' Impact on Agriculture's Economic Resilience

The assessment of actual resilience in this dissertation is based on the key functions of agriculture. Since each function is reflected by several indicators, first, the DPs' impact on the growth of separate indicators of agriculture's key economic functions had to be determined, then aggregating the estimates under sub-indices for the DPs' impact on the resilience of different functions and finally under one composite index, reflecting the DPs impact on agriculture's overall economic resilience. This way estimation (as compared to that of the DPs' impact on resilience by first computing the overall resilience of the sector and then estimating the DPs' impact on it) allows for a better understanding and a more detailed view of the DPs' impact on agriculture's resilience as the estimated DPs impact on individual indicators enables to detect the stimulated indicators/functions that are inhibited and not impacted significantly by DPs. Thus, a better policy response could be enabled.

Table 3.20 provides the summary of the results for the DPs' impact on the performances of separate indicators, reflecting key functions of agriculture obtained by using FE, RE, or GMM methods.

The results show that DPs had a statistically significant impact (at a $p = 0.1$ significance level) on six out of eight resilience indicators in EU-27: DPs do not seem to have exerted a significant influence on farm solvency and wages of hired employees in the agricultural sector. Considering the indicators with significant DPs impact and considering the CAP goals, only farm profitability, labor productivity, and food price ratio are influenced positively, i.e., growing DPs positively impact the growth of the farm net profit margin and labor productivity and determine slower growth of food prices in relation to prices of all consumer goods. In contrast, a positive DPs' statistical relationship with the expense-to-income ratio reflects a negative DPs' impact; in other words, increasing inefficiency. Increasing DPs also significantly negatively affect the total agricultural production and hired employment rates in the agricultural sector.

Table 3.20. Percentage change of indicators due to 10% change in DPs in the EU-27, the OMS-15, and the NMS-12

Indicator	**Benefit (+) /costs (−)**	**Change, %**		
		EU-27	**OMS-15**	**NMS-12**
Agricultural production	+	−1	0	−0.8
Food price ratio to prices of all consumer goods	−	−0.3	0	−0.2
Farm net profit margin	+	3.8[4]	4.3	4.2
Farm expense-to-output ratio	−	0.7	0	1
Farm debt-to-assets ratio	−	0	0	0
Salaried employment	+	−1.6	−1.7	−1.5
Labor productivity	+	3.1	2.2	3
Wages of agricultural employees	+	0	0	0

Results separately obtained for the OMS and the NMS show that the DPs' impact on agriculture's economic resilience is relatively similar in the OMS and the NMS; however, some differences are significant. For the OMS, DPs tended to have a significant impact[5] on three, and for the NMS, on six resilience indicators. In the OMS, the impact is negligible on agricultural production, food prices, farm efficiency, farm solvency, and wages, and in the NMS, although also insignificant, on farm solvency and wages, yet it is significantly negative on agricultural production and farm efficiency. For both country groups, a negative DPs' influence on salaried employment was detected. On the other hand, DPs have a positive impact on agriculture's economic resilience via farm profitability and labor productivity both in the OMS and the NMS.

The DPs regression coefficients for each indicator were aggregated into subindices to estimate the DPs' impact on each key function's performance of agriculture. These subindices were calculated as a weighted sum (more in Section 2.3.3). The weights for each indicator were determined by an expert survey using the method of indirect weight determination (more in Sections 2.3.2 and 2.3.3). DPIERA sub-indices and the DPIERA index reflect a percentage change in resilience due to a certain change in the DPs level. Here, DPIERA and its subindices are calculated as a percentage change, which would be induced by the increase in DPs by 10% (other variables staying constant) (Table 3.21).

[4] Since the data of this variable was not log-transformed, the percentage change of this indicator, due to a 10% change in DPs, is calculated according to formulas 2.35 and 2.36 (more in Section 2.3.3)

[5] The results are considered statistically significant at a p = 0.1 level.

Table 3.21. Subindices of the DPs' impact on the resilience of agriculture's key functions in the EU-27, the OMS-15, and the NMS-12

Sub-index	**Key function**	**Value**		
		EU-27	**OMS-15**	**NMS-12**
$DPIERA_{production}$	Production of affordable food and other agricultural goods	−0.344%	0.000%	−0.279%
$DPIERA_{farm\_viability}$	Assurance of farm viability	0.967%	1.376%	0.984%
$DPIERA_{jobs}$	Creation and maintenance of decent jobs	0.682%	0.336%	0.673%

The results (Table 3.21) show that for the EU-27, DPs tended to have a negative impact on the function "Production of affordable food and other agricultural goods," which is rated as the most important function in agriculture. This result was determined by a negative DPs' impact on agricultural production since the impact on food prices, although positive (i.e., the influence on the food price ratio is negative), is much smaller. It confirms the findings of other authors (Doucha & Foltýn, 2008; Mala et al., 2014; Opatrny, 2018) and points out that DPs, even when mostly decoupled from production, may still exert a significant systematic negative influence on farmers' production and management decisions, resulting in a decrease of the total output. It is important to emphasize that the negative effects of DPs may be transmitted by influencing several aspects of farmer behavior. First, the negative DPs' influence on farmers' motivation to produce efficiently and at maximum potential is empirically documented (Ferjani, 2009; Patton, Olagunjuand & Feng, 2017). Second, DPs may not encourage the shift to the production of higher value-added products (e.g., the shift to ecological production, participation in quality schemes, investment in storage and packaging, changes in the production structure, etc.) as some level of income is guaranteed without additional efforts. However, they may encourage farmers to shift to less labor-intensive activities, such as crop farming, creating relatively lower-value products, as compared to animal husbandry and production of vegetables, fruits and berries, and other cultures, which create relatively higher value-added products. The shift from animal husbandry to crop farming in the last decade has been observed in many NMS (Ivanov, 2018; Balezentis et al., 2019), revealing that DPs may tend to direct the farmers' attention in production decision-making from market-based factors to support-based factors, which, in turn, is related to many potentially negative consequences, such as allocative inefficiency, avoidance of investment (that need a long-term planning rather than short-term subsidy seeking), etc. Although this negative impact may be partly offset by the DPs' positive influence on increasing investment capacity and subsequent increase in productivity, it may be concluded that DPs are not the optimal strategy to encourage a market-orientated efficient production of higher-value agricultural goods. And although, in general, agricultural production in the whole EU is exhibiting a tendency of a slight increase, it could have probably been higher (Opatrny, 2018) if negative influences of DPs were not in effect.

The analysis of the separate results of the OMS and the NMS shows that the function "Production of affordable food and other agricultural goods" had a negligible DPs' impact on the OMS; however, it was negative on the NMS. The negative impact on the function is due to the negative effects on agricultural production. In 2005–2019, in NMS, DPs increased by more than 50%, and the agricultural output index exhibited only a very slight increase, which is mainly determined by the growth in productivity stimulated by technological progress. The negative DPs' impact on production is transferred, assumably, mainly via systematically changing farmer behavior in non-preferrable ways (as discussed above and in Section 1.3.2). One of the most notable differences between the DPs' impact on production in the OMS and the NMS may be due to a strong DPs impact on changing production structure (from animal husbandry to crop farming) in the NMS (Ivanov, 2018; Balezentis et al., 2019; Morkunas & Labukas, 2020; Némethová & Vilinová, 2022), while it is not emphasized in the literature in the case of the OMS. The other sorts of systematic non-preferrable behavior were observed both in the OMS and the NMS (Latruffe & Desjeux, 2016; Minviel & Latruffe, 2017; Marzec & Pisulewski, 2017). On the other hand, the ratio of food prices to prices of all consumer goods is negatively influenced only in the NMS, while in the OMS, its impact is insignificant. As an increasing ratio is considered a negative resilience tendency, the negative DPs' impact on it is a preferable result. However, it is significantly smaller than the DPs' effect on agricultural output; therefore, the overall DPs' impact on the resilience of the function "Production of affordable agricultural goods" in the NMS is negative.

The relatively strongest DPs' impact was observed on the function "Assurance of farm viability," as expected since DPs are paid at the micro level and directly influence farmers' financial assets, whereas such meso-level indicators as the total agricultural production or agricultural employment are primarily affected through the micro level. The results suggest that an increase in the DPs level per ha by 10% would increase a farm's viability by 0.967% in the EU-27. DPs tend to significantly increase the profitability of an average farm, thus having the potential to contribute to the farm's financial buffer in the face of various crises. However, the overall positive impact on the resilience of the function of assuring farm viability hides several important issues. First, while DPs do directly increase farms' profits in the short run, the efficiency of farms tends to decrease due to the DPs. This reduction in efficiency may trigger a decrease in farms' competitiveness and subsequently stimulate an increase in their dependency on subsidies. Thus, the vicious circle could be started: the more direct payments farmers get, the less motivation they have to perform effectively and efficiently; the less efficient activities lead to decreasing income, and thus, more subsidies are needed to stay in business and to keep producing agricultural goods. Moreover, as discussed above, since DPs guarantee some level of income, farmers are less motivated to optimize their business activities and to constantly adapt to various changes (Patton, Olagunjuand & Feng, 2017; Minviel & De Witte, 2017; Lazíková et al., 2019). Therefore, it may be assumed that motivation to cooperate, to innovate (create and absorb innovations), and to learn and regularly update knowledge, which is at the basis of business optimization and adaptation, is also affected negatively. Meanwhile, these behavioral patterns (learning, cooperation, and innovation) are widely acknowledged to have an important positive influence on the resilience (and especially its adaptation dimension) of any economic system (Boschma, 2015; Urruty, Tailliez-Lefebvre & Huyghe, 2016; Bristow & Healy, 2017; Wink et al., 2018; Sellberg et al., 2018). DPs, slowing down the need for such behavior, inhibit not only the potential growth of farm income and profitability but, even more importantly, undermine the development of the resilience capacities necessary for the resilience of agriculture in the long run.

The other problem related to DPs and concerned with farm efficiency is the distribution of payments. The largest share of DPs (around 80%) goes to the largest farms (usually constituting less than 20% of all farms) (Matthews, 2017). Larger farms are typically better managed, able to hire high-qualified employees, and usually enjoy economies of scale and high market power; therefore, in general, large farms are more efficient and productive, working profitably even without subsidies. Moreover, large farms are often located in the richer areas of the EU (Swinnen & van Herck, 2009). This means that the largest share of support via DPs goes to the farms that need it relatively the least. In the meanwhile, smaller farms get relatively small amounts of DPs, which subsequently raises several issues. First, small amounts of additional cash income have much less potential to encourage investment, both due to the longer time needed to accumulate necessary resources and due to the less improved access to credit. Moreover, smaller farms, according to the FADN data, balance on the edge of unprofitability (not including subsidies) and, therefore, often have to use part of the subsidies to cover losses, reducing the potential to invest in the development of the farm's economic capacity. In the meanwhile, most smaller farms are the least efficient and, therefore, are most in need of the growth of efficiency and productivity. Finally, smaller farms can be, presumably, more affected by the motivation crowding-out effect than large farms, which are in many cases owned and managed by different agents and, therefore, should be less inclined to the effect. Thus, it can be concluded that although the net effect of DPs on farm viability function is positive, the DPs' negative impact on farm efficiency raises questions if such farm viability is sustainable since this negative effect poses serious risks of weakening the actual farm viability and increasing the farm's reliance on subsidies.

Another issue related to DPs is that part of the payment leaks to landowners that are not necessarily farmers. They increase costs for farmers that rent or purchase land, which negatively influences the expense-to-income ratio and the overall profitability of those farms. Higher costs also make expansion more costly, slowing the growth of efficiency in the sector. Inflated land prices and the received DPs may also inhibit the restructuring of the sector by enabling small low-productive farms, usually in the disposal of land with ownership rights, to remain in the sector. Thus, DPs exert a negative influence on the sector's renewal, which is important for its long-term competitiveness and, in turn, its economic resilience. There is also evidence of DPs leakage not only via land prices but also input prices as well as lower purchase prices of agricultural produce (Ciliberti & Frascarelli, 2019), further negatively impacting the efficiency, profitability, and, in turn, resilience of the farms.

Finally, DPs may be providing buffer resources for farmers to stay in business and carry on with relatively low-profit business models. As farmers have less need to constantly adapt to changes in the environment (including the business environment), their abilities to adapt are declining, and, thus, they are more likely to get into the risk of unlearning adaptability (and transformability) in the long run (Candell et al., 2020), consequently, seriously weakening general resilience of individual farms and the entire sector. These considerations suggest a need for improvement of a DPs system, especially for farmer motivations and capabilities to work efficiently and better targeting.

Investigating the OMS and the NMS separately, it must be noted that DPs' positive impact on the function "Assurance of farm viability" is much stronger in the OMS than in the NMS. This disparity is mainly determined by a different effect of DPs on farm efficiency: in the NMS, it is significantly negative (positively influencing the expense-to-income ratio), while in the OMS, although also negative, it is statistically insignificant. In conclusion, although DPs overall had a positive impact on the function "Assurance of farm viability" in the NMS, the viability ensured by such payments may be less sustainable. Elevating the incomes of farmers only by direct income support, not encouraging the increase of their efficiency and other factors necessary for successful competition in the market, may end in farmers' higher dependency on subsidies, which signals declining viability and, in turn, resilience.

The resilience of the third key agricultural function, "Creation and maintenance of decent jobs," has been positively related to the level of DPs: an increase of DPs by 10% would stimulate the increase of resilience of this function by 0.68% in the EU-27. The positive impact is determined by the positive DPs relationship with agricultural labor productivity, which, according to the ratings of the experts, is significantly more important than maintaining hired employees in the sector, which is affected negatively. Increasing labor productivity is a very important positive factor in strengthening the agricultural sector and its further development. Productivity growth is mostly enabled by investment in farm modernization, better quality seeds and feeding stuffs, improved cultivation/feeding methods, etc., which are, at least partly, encouraged by DPs (mainly by providing financial assets and facilitating access to credit). At the same time, however, attention must be paid to the observed shift from labor-intensive sectors (especially dairy) to less labor-intensive sectors (crop farming) (Ivanov, 2018; Balezentis et al., 2019). The increase in labor productivity over the period may not be as high as documented. Moreover, the above-discussed negative influence of DPs on farmers' motivation to produce efficiently may also have been slowing down the growth of productivity.

A negative relationship with the salaried employment index reveals a negative trend in agriculture. Although the decreasing overall employment is a natural consequence of competition and technological progress and is observed across all the EU countries, this tendency is mostly determined by the exit of small subsistence and semi-subsistence farms, which usually employ only themselves (and, in some cases, family members). This tendency is not considered negative since it enables the restructuring of the sector into a more competitive one. However, this is not exactly the case for salaried employment. Most paid employees are hired by medium and large farms. The decrease in the demand for hired labor in agriculture could be partly explained by technological progress, enabling the same productivity with less labor input. However, negative processes could have been going on as well. First, the tendency may signal that medium farms, which employed hired labor, are exiting the market (Glowinkel, Mocan & Külkens, 2020), as the FADN data show that in 17 countries out of 27, the paid labor input in an average farm increased during 2005–2019. Second, farms may be shifting from more to less labor-intensive sectors, which, in turn, could produce various negative consequences. Finally, farmers may be overinvesting in the capital in relation to labor (Pawlowski et al., 2021) and, thus, exhibiting allocative inefficiency. All these processes reflect undesirable trends encouraged by DPs.

Employee wages, rated as the most important indicator of the function "Creation and maintenance of decent jobs," was not significantly influenced by DPs, meaning that DPs did not affect agriculture's resilience in terms of this indicator. This is not unexpected since farm business owners/managers do not have a direct incentive to increase wages unless DPs help to alleviate financial constraints preventing them from hiring/maintaining higher-qualified employees. However, usually, the highest incentive to increase wages comes from the market, i.e., growing wages in the agricultural and other sectors.

The function "Creation and maintenance of decent jobs" is the only area where DPs in the NMS had a stronger positive impact than in the OMS. This difference is due to a stronger DPs effect on labor productivity in the NMS, which is not unexpected since labor productivity in the NMS is almost three times lower than in the OMS. Productivity growth is one of the key factors for the sector's growth, sustainability, and resilience. Significant growth in labor productivity in 2005–2019 is observed in the OMS and the NMS and would allow assuming positive processes in the sector: increasing capital availability, improvements in technology, increasing education of farmers, etc. On the other hand, the efficiency of average commercial farms remained very similar all over the period, balancing on the edge of inputs exceeding output. The non-increasing efficiency warns that even with growing labor productivity, cost management remains a serious issue in agriculture. The DPs' impact on other indicators of the employment function in the OMS and the NMS is very similar: DPs do not have a significant influence on wages; however, they similarly negatively affect salaried employment in both country groups, thus lowering the resilience coefficients of this function.

The obtained subindices of the DPs' impact on the performance of key functions of the agricultural sector were aggregated under the composite DPIERA indices, reflecting the DPs' impact on the overall resilience of agriculture in the EU-27 and, separately, in the OMS and the NMS (Table 3.22).

Table 3.22. DPIERA indices of DPs impact on the economic resilience of agriculture

Indices	**Value**
DPIERA EU-27	0.368%
DPIERA OMS-15	0.540%
DPIERA NMS-12	0.396%

The results show that an increase in DPs by 10% would stimulate the increase of agriculture's economic resilience by 0.368% in the EU-27. These findings suggest two major conclusions. First, DPs have a positive impact on the economic resilience of agriculture. DPs are especially important in increasing farmers' income and, thus, contributing to their survival in the market, which is especially volatile as compared to other sectors. Second, although there is no standard for the optimal impact of government support measures on agriculture's economic resilience, the influence of DPs is relatively small. This conclusion is based on several arguments. First, some of the resilience indicators (agricultural output, farm efficiency, paid employment) were affected negatively, thus decreasing the overall resilience of the sector, meaning that if those indicators were affected positively, the overall positive impact on resilience could have been significantly larger. Moreover, as discussed in Section 1.3, DPs may have opposite directions of influence on the same variables due to different impacts on farmer behavior, thus leading to a conclusion that these effects may at least partially cancel out each other and, therefore, the overall positive impact of DPs on a separate resilience indicator could have been relatively larger. Moreover, this positive impact is not only small but presumably, it may also be not sustainable in the longer run. Several indicators, especially farm efficiency, are affected negatively. Negative effects on farm efficiency may signal that DPs tend to act like a buffer not only for various disturbances but also for constant changes in the market, at least partially allowing farms to stay in the market with relatively less-efficient business models, lowering the need for restructuring and renewal. Without constant adaptation to changes and challenges, the ability to adapt may be seriously inhibited. Thus, DPs may be contributing to the deterioration of adaptability skills essential for the adaptability dimension of general resilience in the longer run.

When analyzing the DPs' impact on agriculture's economic resilience separately in the OMS and the NMS, a relatively much higher positive impact is observed for the OMS than for the NMS, which suggests that the CAP DPs are better adjusted to the OMS than the NMS. This is not surprising and can be explained by their historical development. When the NMS joined the CAP, several decades' worth of DPs were already attributed to the OMS. The different DPs' impact on farmers' behavior (e.g., due to different management models, farm size, mentality, etc.) may be influencing these differences between the OMS and the NMS. However, despite the higher absolute measures, the significance of DPs impact on separate resilience variables for OMS was at least in several cases marginal, suggesting that among the OMS, the remarkable differences of the DPs' impact may exist; therefore, a higher degree of country division may be recommended for more precise results. That could be one of the further research directions.

Summarizing the above, the DPs' impact on the economic resilience of agriculture is positive; however, the support system could be amended to increase a positive impact and avoid negative side effects. Several amendments could be suggested. First, the negative effects of DPs on farm efficiency should be considered. The theoretical analysis suggests that a negative impact on farm efficiency may be transmitted via the DPs' impact on farmer behavior in non-preferrable directions. Therefore, although the DPs' aim to support the farmers' income is not bad in itself, it could be more beneficial if income was supported more indirectly, thus avoiding inhibiting both the farmers' motivation to optimize their business activities and inhibiting their responsibility for their business success. Income could be supported by encouraging and facilitating solving problems associated with low income and low viability. For example, the low income of small farms is often related to small produce purchase prices, which could be solved, at least partially, by cooperation. Low income is also associated with the production of low-value-added products, which could be solved by transferring to higher value-added production (ecological farming, participation in quality schemes, product transformation on farms, etc.). On the other hand, solving low-income problems should allow for achieving the goal of income support in a long-term sustainable way. Thus, payments should be tied to a specific behavior needed to achieve resilience (subsidizing its costs) rather than paying based on just being an agricultural subject (and declaring UAA). Subsidies tied to behavior should enable resilience to increase more efficiently and effectively. Moreover, such a subsidization system should not contribute to the rise of input costs and should not slow down the restructuration process, which is necessary for a creation of a more competitive and resilient agricultural sector. Such subsidies should also avoid many negative side-effects, including the overcrowded motivation to produce efficiently, the increased risk-seeking behavior, and the decreased responsibility for own farming business success. Several behaviors are confirmed as significantly positively contributing to the increase of resilience: learning, cooperation, collaboration, innovation, and participation. All these behaviors are also related to the potential to increase the farmers' income. Such support would not inhibit the development of the farmers' adaptation skills; on the contrary, it should stimulate them (Feindt et al., 2019). These considerations are in line with those of other authors, stating that a result-based CAP payment system and better monitoring of outcomes are necessary (Scown, Brady & Nicholas, 2020).

However, the limitations of this study should also be considered. These limitations can be summarized as follows. First, empirical evidence is based on the aggregate EU, OMS, and NMS levels, which could mask important differences among individual member states. Expanding this research to a state level could allow revealing the determined effects that prevail across different EU countries or significant differences. Second, the Common Agricultural Policy encompasses not only direct payments but also other forms of support that could have had significant mediating or moderating effects on the DPs' impact on agriculture's economic resilience. Moreover, EU regional and rural development policies could have had important regional impacts. Third, the system of direct payments has been changing over the research period: new models of payment disbursement have been suggested, and new requirements for the farmers to receive direct payments have been introduced. Although the changes have not been radical, their potential effect cannot be rejected. Forth, direct payments could be allocated in two main ways, i.e., through the Single Area Payment System (SAPS) and the Single Payment Scheme (SPS), depending on the state's choice. Although most of the NMS have chosen SAPS, Malta and Slovenia have opted for SPS (European Parliament, 2015), while OMS had a possibility to choose from among three SPS models: historical, static, and dynamic hybrid (ibid). These differences, although not very significant, could have affected the analyzed DPs-resilience relationship. Fifth, tests, other than those used in this study may lead to different results, though it must be emphasized that the chosen methods were used by a large number of researchers in this area. Finally, the weights of individual agricultural functions were determined based on a survey of Lithuanian experts. In other countries, the weighting factors of individual functions might be different, which would also affect the final result.

3.5. Conclusions of the Third Chapter

1. DPs tended to stimulate an increase in farm profitability and labor productivity and a decrease in the ratio of food prices to prices of all consumer goods in the EU-27 in 2005–2019. On the other hand, DPs led to an increase in the farm expense-to-output ratio and a decrease in salaried employment and agricultural production. No statistically significant effect of DPs on farm solvency and wages was found.
2. Therefore, the impact of direct payments on the resilience of individual functions of agriculture in the EU-27 was not uniform: the effect was positive for the functions "Assurance of farm viability" (an increase in DPs by 10% would stimulate an increase in the resilience of this function by 0.967%) and "Creation and maintenance of decent jobs" (accordingly by 0.682%), while negative for the relatively most important function of agriculture (as considered so by the experts) "Production of affordable food and other agricultural goods" (an increase in DPs by 10% would stimulate a decrease in the resilience of this function by 0.344%).
3. Overall, DPs tended to have a positive impact on the economic resilience of agriculture in the EU-27 in 2005–2019: an increase in DPs by 10% would encourage a rise in agriculture's economic resilience by 0.368%. The positive impact on agriculture's economic resilience in the EU-27 was mainly determined by a positive DPs' impact on the key agricultural function, "Assurance of farm viability," namely, by its farm profitability indicator. This is an expected result since DPs constitute a relatively stable source of cash inflows, supplementing the income obtained from agricultural activity. The overall positive DPs' influence on agriculture's economic resilience, however, masks several important issues, as DPs tended to negatively impact several resilience indicators, such as farm efficiency, total agricultural output, and salaried employment.
4. The DPs' impact on agriculture's economic resilience was relatively similar in the OMS and the NMS, 2005–2019. However, some differences were significant. The results revealed a stronger overall positive impact of DPs in the OMS, where a 10% increase in a DPs' level would encourage an increase in resilience by 0.54%, while in the NMS, only 0.396%.

In the OMS, the resilience of two functions of agriculture, "Assurance of farm viability" and "Creation and maintenance of decent jobs," was significantly influenced by DPs. In the NMS, the resilience of all three functions was significantly impacted by DPs; however, the resilience of the function "Production of affordable food and other agricultural goods" was affected negatively. These differences were mainly determined by different DPs' impact on two indicators. First, DPs negatively impacted the agricultural production output in the NMS, while in the OMS, although also negative, it was statistically insignificant. Second, in the NMS, DPs tended to increase farm inefficiency. In the OMS, although the direction of the impact was the same, it was not statistically significant. However, DPs had a stronger positive impact on labor productivity and a significant negative influence on the ratio of food prices to the prices of all consumer goods (considered as a positive result) in the NMS as compared to the OMS. The influence on other resilience indicators is similar for both country groups.

General Conclusions

1. There is no universally agreed definition of economic resilience yet. Two main approaches to the resilience phenomenon prevail, i.e., "equilibrium" and "complex systems," with the latter becoming more popular. According to the complex systems approach, the resilience concept encompasses two types and three dimensions, resulting in a wide variety of resilience measurement ways and methods. After systematizing and categorizing the resilience assessment ways and methods, a conclusion was achieved that they differ by the focus on resilience, either as resilience capacity or factual resilience; and that factual resilience assessment methods depend mainly on the type and dimension of resilience in focus. Subsequently, the growth of key functions was identified as an appropriate measure of the adaptability dimension of actual general economic resilience of an economic system. These insights were integrated into the agricultural context, where research on economic resilience, although growing, is still very limited.
2. To construct the theoretical transmission mechanism of the DPs' impact on agriculture's economic resilience, the analysis of studies on the evaluation of the DPs' impact on various agricultural indicators (including economic indicators of the farm business, the volume of agricultural production, labor productivity, land, and land rental prices, farmers' behavior,

etc.) has been performed. It revealed that DPs could be influencing these indicators directly as well as indirectly. Moreover, these effects have been proven to be both positive and negative, depending mainly on how the DPs influence the behavior of farmers (especially their production and management decisions). In turn, the overall DPs' impact on the appropriate agricultural indicators has been documented to be ambiguous.

3. A model for assessing the DPs' impact on agriculture's economic resilience has been developed. Based on the operationalization of the actual resilience concept, the main agricultural functions, the production of affordable food and other agricultural goods, the assurance of farm viability, and the creation and maintenance of decent jobs have been identified to substantiate the selection of indicators reflecting agriculture's economic resilience. Subsequently, a list of eight indicators based on these functions has been formed. A logical scheme for constructing an index of direct payments' impact on agriculture's resilience and its sub-indices has been created.
4. After empirically applying the model for assessing the impact of direct payments on the economic resilience of agriculture over EU-27 and calculating the index values, the overall effect of the DPs on agriculture's economic resilience in 2005–2019 was found to be positive: an increase in DPs by 10% would encourage a rise in economic resilience of agriculture by 0.368%. However, DPs were observed to have a preferred impact only on three (out of eight) resilience indicators: farm profitability, labor productivity, and the ratio of food prices to prices of consumer goods. The positive influence was reduced by a negative DPs' impact on salaried employment, agricultural production output, and farm efficiency. Results showed that DPs did not have a statistically significant effect on the farm's debt-to-assets ratio and wages of agricultural employees.
5. The application of the model over the old and new EU MS in 2005–2019 revealed several important differences in the DPs' impact on agriculture's economic resilience in these two country groups. The results revealed a stronger overall positive impact of DPs for the OMS, where a 10% increase in a DPs' level would encourage an increase in resilience by 0.54%, while in the NMS, only 0.396%. This difference was mainly determined by a different DPs' impact on two indicators: agricultural production and the farm's expense-to-output ratio. In both country groups, the direction of the impact was the same; however, the impact was statistically significant only for the NMS. On the other hand, DPs had a stronger positive impact on labor productivity and a significant negative influence on the food price ratio (considered a positive result) in the NMS as compared to the OMS. However, the difference in the strength of the impact was not

strong enough to outweigh the differences in the negative influence. The DPs' impact on other resilience indicators was similar for both country groups.

6. Based on the obtained results, suggestions were offered to improve the design of DPs' support schemes, especially focusing on avoiding the negative side-effect of overcrowding farmers' motivation to optimize their businesses and inhibiting their adaptation skills.
7. The index of the direct payments' influence on agriculture's economic resilience allows for easy comparison of the DPs' impact on resilience with that of the other support schemes, thus enabling objectively based prioritization of financial funds' allocation among different support measures. The methodical principles of index creation are universal and could be applied across other sectors and regions. The assessment model of the DPs' impact on agriculture's economic resilience could also be adapted in future studies to simulate the impact of various other support schemes, as well as in studies identifying ways and measures to strengthen resilience or avoid its erosion.

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Summary in Lithuanian

Įvadas

Problemos formulavimas

Pastaraisiais dešimtmečiais dėl didžiulio potencialo atsparumo koncepcijos populiarumas ekonomikos srityje labai išaugo. Atsparumas taip pat vis dažniau įtraukiamas į daugumą politinių diskusijų apie žemės ūkį, o jo augimas įvardijamas kaip vienas pagrindinių ES bendrosios žemės ūkio politikos prioritetų (ES Komisija, 2020). Tačiau, nepaisant didėjančio populiarumo, atsparumo koncepcija vis dar nėra išgryninta. Atsparumo reiškinio daugialypiškumas kartu su dinaminių sistemų sudėtingumu ir neapibrėžtumu apsunkina atsparumo koncepcijos operacionalizaciją bei šio fenomeno vertinimą (Herrera & Kopainsky, 2015). Todėl vis dar nėra visuotinai priimto apibrėžimo, kas tiksliai yra ekonominis atsparumas, ir ką jis apima (Martin & Sunley, 2020; Quendler & Morkūnas, 2020; Wang & Li, 2022). Taip pat nėra visuotinai priimtos atsparumo reiškinio empirinio vertinimo metodologijos (Martin et al., 2016). Galiausiai, nėra bendro sutarimo ir dėl to, kokią įtaką atsparumui daro įvairios paramos politikos priemonės (Sanderson, Capon & Hertzler, 2017).

Žemės ūkio ekonominio atsparumo reiškinio tyrimai pasižymi fragmentiškumu ir nepakankamumu. Žemės ūkio ekonominio atsparumo studijos, kurių yra, palyginti, labai nedaug, daugiausia apima konceptualius (Darnhofer, 2014; Tendall et al., 2015) arba kokybinius tyrimus (Doeksen & Symes, 2015; Darnhofer et al., 2016). Be to, pagrindinis dėmesys skiriamas analizei mikro lygmeniu (Abson et al., 2013; Peerlings et al., 2014; Hamerlinck et al., 2014; Vigani & Berry, 2018; Borychowski et al., 2020; Wilczyński &

Kołoszycz, 2021). Negausūs žemės ūkio atsparumo tyrimų pavyzdžiai mezo lygmeniu (Morkūnas, Volkov & Pazienza, 2018; Morkūnas et al., 2018) yra skirti labiau atsparumo potencialui, o ne faktiniam atsparumui įvertinti. Kadangi metodologiniai pagrindai, kaip įvertinti faktinį žemės ūkio sektoriaus atsparumą, yra labai riboti, galimybės sistemingai ir nuosekliai didinti atsparumą, taip pat yra ribotos.

Kita problema yra susijusi su tyrimų, nagrinėjančių, kaip ES paramos žemės ūkiui schemos sąveikauja su sektoriaus atsparumu, stoka. Nors yra nemažai tyrimų, skirtų įvertinti, kaip tiesioginės išmokos veikia įvairius žemės ūkio verslo rodiklius (Rizov et al., 2013; Severini et al., 2016; Vigani & Berry, 2018; Vozárová et al., 2020; Borychowski et al., 2020), jaučiamas aiškus tyrimų, kiekybiškai įvertinančių tiesioginių išmokų įtaką žemės ūkio atsparumui mezo lygmeniu, trūkumas (Meuwissen et al., 2019). Siekiant reikšmingiau prisidėti prie atsparumo žemės ūkio sektoriuje didinimo, išsamesnis supratimas apie tai, kaip BŽŪP, o ypač labiausiai finansuojama BŽŪP paramos priemonė − tiesioginės išmokos, − veikia sektoriaus ekonominį atsparumą, yra itin reikalingas.

Darbo aktualumas

Šiuolaikinės žemės ūkio ir maisto gamybos sistemos susiduria su vis didėjančiu įvairaus pobūdžio spaudimu. Neretai vienu metu iškyla kelių rūšių rizikos, sustiprinančios viena kitos neigiamą poveikį. Vis didėjantis vykstančių pokyčių greitis, nepalankių meteorologinių reiškinių dažnis ir mastas bei didėjantis neapibrėžtumas dėl ateities kelia didelių papildomų iššūkių ilgalaikiam žemės ūkio gyvybingumui. Todėl daugelis mokslininkų (Herrera & Kopainsky, 2015; Quendler & Morkūnas, 2020) pabrėžia, kad žemės ūkio vystymosi tvarumas vis labiau priklausys nuo nuo jo atsparumo. COVID-19 krizė dar kartą pabrėžė atsparumo žemės ūkyje svarbą (Darnhofer, 2020; Štreimikienė et al., 2021; Lioutas & Charatsari, 2021). Norint padidinti atsparumą, būtina gebėti įvertinti atsparumo reiškinį ir nustatyti pagrindinius jo augimą skatinančius (bei stabdančius) veiksnius.

Daugelis atsparumą nagrinėjančių autorių daro prielaidą, kad valstybės parama daro įtaką atsparumui (Martin et al., 2016; Di Caro & Fratesi, 2018; Ubago et al., 2019; Meuwissen *et al.,* 2019), tačiau klausimai, kokios įtakos turi įvairios paramos priemonės ir net kokia tų priemonių poveikio kryptis, vis dar neturi patikimų empiriškai pagrįstų atsakymų, taip užkertant kelią efektyvesnių paramos priemonių formavimui. Europos Sąjunga kasmet skiria didžiulę finansinę paramą žemės ūkio sektoriui: 2023–2027 m. finansiniam laikotarpiui parama žemės ūkiui sudarys daugiau nei 30 proc. viso ES biudžeto[1]. Tiesioginės išmokos sudaro apie du trečdalius šios dalies. Paramos schemų poveikio žemės ūkio atsparumui įvertinimas turi potencialo prisidėti prie dviejų tikslų – veiksmingiau didinti žemės ūkio atsparumą bei efektyviau paskirstyti finansines lėšas. Taigi tiesioginių poveikio žemės ūkio atsparumui vertinimo įrankio sukūrimas turėtų didelę mokslinę bei praktinę vertę.

Tyrimo objektas

Disertacinio tyrimo objektas yra tiesioginių išmokų įtaka žemės ūkio ekonominiam atsparumui.

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[1] Atsižvelgiama tik į ES daugiametę finansinę programą, o papildomas finansavimas Naujos kartos ES atsigavimo priemonei neįtrauktas.

Darbo tikslas

Disertacijos tikslas yra sukurti ir aprobuoti teorinį modelį, kuriuo būtų galima įvertinti tiesioginių išmokų įtaką žemės ūkio ekonominiam atsparumui.

Darbo uždaviniai

Darbo tikslui pasiekti buvo sprendžiami šie *uždaviniai*:

1. Ištirti ekonominio atsparumo koncepcijos prigimtį, plėtrą, matavimą bei panaudojimą ir pritaikyti ją vertinant žemės ūkio atsparumą.
2. Susisteminti ankstesnius tiesioginių išmokų įtakos atskiriems žemės ūkio rodikliams vertinimo tyrimus.
3. Suformuoti žemės ūkio ekonominio atsparumo rodiklių sąranką.
4. Sukurti tiesioginių išmokų poveikio žemės ūkio ekonominiam atsparumui vertinimo teorinį modelį.
5. Patikrinti sukurto modelio praktinį pritaikomumą ES mastu.

Tyrimų metodika

Nagrinėjant darbo objektą, taikyti šie metodai:

- Sisteminės mokslinės literatūros analizės ir dedukcijos metodai taikyti atsparumo sampratos operacionalizavimui bei atsparumo reiškinio matavimo metodams parinkti.
- Sisteminės ir lyginamosios mokslinės literatūros analizės metodai panaudoti sudarant žemės ūkio ekonominio atsparumo rodiklių sąrašą.
- Tiesioginių išmokų įtakai atskiriems žemės ūkio ekonominio atsparumo rodikliams įvertinti panaudoti Fiksuoto poveikio modeliai (angl. Fixed Effects models), Atsitiktinio poveikio klaidų komponentų modeliai (angl. Random Effects models) ir Apibendrintas momentų metodas (angl. Generalized Method of Moments).
- Atskirų žemės ūkio funkcijų ir jų rodiklių svoriams nustatyti taikyta ekspertinė apklausa ir Netiesioginis svorių nustatymo metodas.
- Tiesioginių išmokų įtakos atskiriems atsparumo rodikliams verčių integravimui į sudėtinį rodiklį, atspindintį tiesioginių išmokų įtaką visam ekonominiam žemės ūkio atsparumui, buvo taikoma svertinė suma.
- Empiriniame tyrime taip pat buvo taikomi statistinės analizės, palyginimo ir apibendrinimo metodai.

Darbo mokslinis naujumas

Gauti šie ekonomikos mokslui nauji rezultatai:

1. Ekonominio atsparumo tyrimai papildyti prisidedant prie atsparumo koncepcijos operacionalizavimo: išskirti faktinis atsparumas bei atsparumo potencialas, išryškinti jų skirtumai. Ekonominio atsparumo tyrimai buvo papildyti susisteminant atsparumo matavimo būdus ir pasiūlant inovatyvią jų grupavimo sistemą pagal atsparumo tipą ir dimensiją.
2. Suformuota ir pagrįsta originali rodiklių sąranka žemės ūkio ekonominiam atsparumui vertinti. Sąranka apima 3 rodiklių grupes: įperkamo maisto ir kitų žemės ūkio produktų gamybą, ūkių gyvybingumą bei kokybiškų darbo vietų kūrimą ir išlaikymą.
3. Pasiūlyta novatoriška tiesioginių išmokų poveikio žemės ūkio ekonominiam atsparumui vertinimo sistema, integruojanti skirtingus kiekybinius vertinimo metodus. Sukonstruotas ES BŽŪP tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui mezo lygmeniu indeksas ir išryškintas mažai tyrinėtas tiesioginių išmokų poveikis žemės ūkio ekonominiam atsparumui.

Darbo rezultatų praktinė reikšmė

Gauti rezultatai gali būti naudojami žemės ūkio politikos formuotojų nacionaliniame ar ES lygmenyje paramos schemų projektavimui, atrankai, taip pat lėšų paskirstymui tarp jų tobulinti, taip efektyviau ir veiksmingiau panaudojant finansinius išteklius, kadangi tiesioginių išmokų poveikis žemės ūkio ekonominiam atsparumui buvo nustatytas objektyvių kiekybinių metodų, tiesioginių išmokų poveikio žemės ūkiui tyrimų analizės bei atsparumo tyrimų teorinių įžvalgų pagrindu.

Informaciją apie subindeksus, atspindinčius tiesioginių išmokų paveiktus atsparumo pokyčius kiekvienos funkcijos atžvilgiu, paramos politikos formuotojai galėtų naudoti kaip perspėjimo informacinę sistemą, identifikuodami sritis, kuriose paramos sistema turi neigiamą arba nepakankamą įtaką.

Sukurtas tiesioginių išmokų poveikio žemės ūkio atsparumui modelis buvo empiriškai patikrintas pagal ES-27 valstybių narių, taip pat atskirai pagal 15 senųjų ir 12 naujųjų šalių narių duomenis. Tačiau metodiniai principai yra universalūs, todėl modelis būtų tinkamas taikyti ir kituose kontekstuose bei kituose regionuose.

Ginamieji teiginiai

1. Žemės ūkio faktinį ekonominį atsparumą tikslinga vertinti per pagrindines sektoriaus ekonomines funkcijas.
2. Bendrojo (angl. general) žemės ūkio ekonominio atsparumo prisitaikymo (angl. adaptability) dimensiją tikslinga vertinti per pagrindines žemės ūkio sektoriaus funkcijas atspindinčių rodiklių augimą.
3. BŽŪP tiesioginių išmokų įtaką atsparumui tikslinga vertinti per tiesioginių išmokų įtaką pagrindines žemės ūkio funkcijas atspindinčių rodiklių augimui, vėliau poveikio koeficientus integruojant į daugiakriterį indeksą.

Darbo rezultatų aprobavimas

Disertacijos tema yra publikuoti 6 moksliniai straipsniai straipsnių rinkiniuose, referuojamuose tarptautinėse duomenų bazėse Scopus ir Web of Science (Žičkienė et al., 2020; Volkov, Žičkienė et al., 2021; Baležentis, Žičkienė et al., 2021; Štreimikienė et al., 2021; Morkūnas, Žičkienė et al., 2021; Žičkienė et al., 2022).

Disertacijoje atliktų tyrimų rezultatai buvo paskelbti 4 mokslinėse konferencijose:

- 26^{th} tarptautinėje konferencijoje *"Research for Rural Development 2020"*, 2020 m. Jelgavoje, Latvijoje.
- 34^{th} EBRS konferencijoje 2021 m. Atėnuose, Graikijoje.

Disertacijoje atliktų tyrimų rezultatai pristatyti Vilniaus Gedimino technikos universiteto (Vilnius Tech) doktorantų moksliniame seminare ir moksliniame seminare Lodzės universitete (Lenkijoje) mokslinės stažuotės metu.

Disertacijos struktūra

Disertaciją sudaro trys pagrindiniai skyriai.

Pirmame skyriuje pateikta atsparumo reiškinio tyrimų ekonomikos srityje apžvalga. Išanalizuoti atsparumo sąvokos operacionalizavimo klausimai, susisteminti ir sugrupuoti atsparumo matavimo būdai ir metodai, pagrįstas atsparumo sampratos integravimas žemės ūkio kontekste. Taip pat pateikta tiesioginių išmokų įtakos žemės ūkio rodikliams tyrimų apžvalga. Skyrius baigiamas pagrindinių šio tyrimo uždavinių suformulavimu.

Antrame skyriuje pristatyta tiesioginių išmokų poveikio žemės ūkio sektoriaus ekonominiam atsparumui vertinimo metodologija, detaliai aprašyti jos elementai, veiksmų seka bei naudojami metodai.

Trečiame skyriuje pateikti tyrimo duomenys, tiesioginių išmokų poveikio atskiriems atsparumo rodikliams vertinimo rezultatai, ekspertinės apklausos rezultatai bei tiesioginių išmokų poveikio žemės ūkio ekonominiam atsparumui indekso ir jo subindeksų reikšmės ES-27, taip pat atskirai senųjų ir naujųjų šalių narių mastu 2005–2019 m.

Bendrosios išvados ir rekomendacijos apibendrina atliktą tyrimą. Po jų pateikiamas išsamus nuorodų sąrašas.

1. Tiesioginių išmokų poveikio žemės ūkio ekonominiam atsparumui vertinimas: literatūros apžvalga

Pirmajame disertacijos skyriuje atlikta literatūros šaltinių disertacijos tematika apžvalga. Šis skyrius sudarytas iš trijų dalių. Pirmojoje dalyje analizuojama atsparumo koncepcija. Analizė atskleidė, kad visuotinai priimto ekonominio atsparumo apibrėžimo kol kas nėra. Šiuo metu ekonominėje literatūroje galima rasti du pagrindinius požiūrius į atsparumo reiškinį: pusiausvyros požiūrius bei sudėtingų sistemų požiūrius, nors pastarųjų populiarumas vis labiau auga. Sudėtingų sistemų požiūriu atsparumo reiškinys yra daugialypis ir daugiatipis. Literatūros analizė atskleidė du pagrindinius atsparumo tipus: bendrąjį (įvairioms krizėms) ir specifinį (konkrečiai krizei) atsparumą. Taip pat literatūroje išskiriamos trys atsparumo reiškinio dimensijos: (1) gebėjimas atlaikyti krizes (tvirtumas; angl. *robustness/resistance*), (2) gebėjimas prisitaikyti prie pokyčių, nulemtų krizių (prisitaikymas; angl. *adaptability/adaptation*) ir (3) gebėjimas kokybiškai transformuotis po krizių (transformuojamumas; angl. *transformability*). Kadangi atsparumas yra įvairialypis konstruktas, kol kas nėra visuotinai priimtos metodologijos, kaip jį operacionalizuoti ir empiriškai išmatuoti. Atlikus išsamią literatūros analizę, išskirti du pagrindiniai atsparumo koncepcijos ekonomikoje operacionalizacijos būdai:

1) konstruojant indeksus, pagrįstus atitinkamos sistemos ir jos aplinkos charakteristikomis, galinčiomis turėti įtakos sistemos atsparumui, bei 2) konstruojant indeksus, pagrįstus pagrindinėmis tos sistemos funkcijomis. Atsparumui vertinti naudojamų rodiklių analizė leidžia daryti išvadą, kad tik pagrindinėmis tos sistemos funkcijomis pagrįsti indeksai įvertina faktinį atsparumą, o indeksai, pagrįsti atitinkamos sistemos charakteristikomis, labiau skirti atsparumo potencialui vertinti. Ekonomikos srities literatūroje taikoma labai daug įvairių atsparumo matavimo metodų (net ir apsiribojant faktinio atsparumo matavimais). Išsami daugelio literatūros šaltinių apie ekonominį atsparumą analizė leidžia daryti išvadą, kad ekonominio atsparumo matavimo būdai skiriasi priklausomai nuo dviejų pagrindinių faktorių: analizuojamo atsparumo tipo ir atsparumo dimensijos. Atsparumo matavimo metodai buvo susisteminti, pasiūlant skirstymą į keturias kategorijas: pagrindinių rodiklių nuosmukis (absoliutus arba santykinis) naudojamas specifinio atsparumo tvirtumo dimensijai išmatuoti, atsigavimo greitis ir mastas – specifinio atsparumo prisitaikymo dimensijai įvertinti, kintamumas – bendrojo atsparumo tvirtumo dimensijai, o augimas – bendrojo atsparumo prisitaikymo dimensijai išmatuoti.

Nors atsparumo reiškinys žemės ūkyje plačiai tyrinėjamas jau keletą dešimtmečių, tačiau dauguma šių tyrimų buvo skirti agroekosistemų atsparumui, o žemės ūkio ekonominio atsparumo tyrimai yra riboti ir fragmentiški. Pritaikius Martin ir Sunley (2015) ekonominio atsparumo apibrėžimą, žemės ūkio ekonominis atsparumas apibrėžiamas kaip šio sektoriaus gebėjimas atlaikyti įvairius sukrėtimus ar atsigauti po jų, prireikus adaptyviai keičiant ekonomines struktūras, įgyvendinant socialinius bei institucinius pokyčius, kad per tam tikrą laikotarpį būtų išlaikytos esminės sektoriaus funkcijos bei jų rezultatai. Siekiant apriboti tyrimo apimtį, darbe pasirinkta nagrinėti žemės ūkio sektoriaus faktinio bendrojo ekonominio atsparumo prisitaikymo dimensiją. Kadangi faktinio atsparumo vertinimas grindžiamas pagrindinių ekonominės sistemos funkcijų rezultatų pokyčiais, buvo išskirtos trys pagrindinės žemės ūkio ekonominės funkcijos: „Įperkamo maisto bei kitos žemės ūkio produkcijos gamyba“, „Ūkių gyvybingumo užtikrinimas“ bei „Kokybiškų darbo vietų kūrimas ir išlaikymas“, jos tapo pagrindu žemės ūkio ekonominio atsparumo rodiklių sąrankos sudarymui. Pagrindines funkcijas atspindinčių rodiklių augimas buvo pasirinktas kaip santykinai geriausias būdas įvertinti bendrojo ekonominio atsparumo prisitaikymo dimensiją.

Antrojoje dalyje pateikiama ES bendrosios žemės ūkio politikos raida, tiesioginių išmokų sistemos pokyčiai bei šioms išmokoms skirtų finansinių lėšų pokyčių apžvalga.

Trečiojoje dalyje pateikiama tyrimų tiesioginių išmokų poveikio įvairiems žemės ūkio rodikliams (ūkių pelningumui, mokumui, gyvybingumui, žemės kainoms, produkcijos gamybai, ūkininkų elgsenai ir t. t.) tematika analizė. Ši analizė atskleidė, kad tiesioginės išmokos turi ir tiesioginį, ir netiesioginį poveikį pagrindinių žemės ūkio ekonominių funkcijų rodikliams. Netiesioginė tiesioginių išmokų įtaka didele dalimi pasireiškia per šių išmokų poveikį ūkių valdytojų elgsenos, susijusios su gamybos, rizikos valdymo, investavimo bei kitais žemės ūkio verslo valdymo sprendimais, pokyčius. Dėl reikšmingo netiesioginio poveikio tiesioginių išmokų įtaka net tiems patiems kintamiesiems gali skirtis ne tik dydžiu, tačiau ir kryptimi. Parengtas tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui modelis (1.9 pav.).

2. Tiesioginių išmokų poveikio žemės ūkio atsparumui vertinimo metodologija

Antrajame darbo skyriuje pristatoma tiesioginių išmokų poveikio žemės ūkio ekonominiam atsparumui vertinimo teorinis modelis, apimantis 6 pagrindines fazes: konceptualaus tiesioginių išmokų poveikio žemės ūkio ekonominiam atsparumui vertinimo pagrindo sukūrimą, žemės ūkio ekonominių rodiklių sąrankos sudarymą, atskirų rodiklių svorių nustatymą, tiesioginių išmokų įtakos atskiriems žemės ūkio ekonominio atsparumo elementams įvertinimą, įtakos koeficientų sujungimą į 3 pagrindines žemės ūkio funkcijas atspindinčius subindeksus bei, galiausiai, šių sundeksų sujungimą į bendrą tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui indeksą. Pateikiamas detalus kiekvienos fazės ir joje taikomų metodų aprašymas.

Rodiklių sąrankos sudarymo dalyje pateikiamas atsparumo rodiklių atrankos procesas. Atsižvelgiant į įvairius tyrimus, kuriuose nagrinėjamas žemės ūkio funkcijų ir veiklos rezultatų vertinimas, taip pat į rodiklių parinkimo principus (rodiklių efektyvumą, reprezentatyvumų, prieinamumą, palyginamumą, dažnumą, ir atitikimą politikos tikslams), buvo atrinkti šie žemės ūkio ekonominio atsparumo rodikliai:

- Atspindintys funkciją „Įperkamo maisto bei kitos žemės ūkio produkcijos gamyba“:
    - žemės ūkio produkcijos indeksas;
    - bei maisto ir visų vartojimo prekių kainų santykis.
- Atspindintys funkciją „Ūkio gyvybingumo užtikrinimas“:
    - ūkių grynojo pelno marža (įskaitant subsidijas);
    - ūkių išlaidų ir produkcijos santykis;
    - ir ūkių skolos ir turto santykis.
- Atspindintys funkciją „Kokybiškų darbo vietų kūrimas ir išlaikymas“:
    - samdomų darbuotojų skaičius;
    - darbo produktyvumas;
    - ir darbo užmokestis.

Aprašytas rodiklių svorių nustatymo procesas. Tam pasirinktas ekspertinės apklausos metodas. Remiantis klasikine testo teorija, nustatytas anketinei apklausai reikalingas ekspertų skaičius. Aprašytas ekspertų nuomonių suderinamumo vertinimas remiantis Kendall konkordancijos koeficientu.

Toliau pateikiama kiekybinių metodų, skirtų įvertinti įvairių veiksnių poveikiui tiek atskiriems atsparumo komponentams, tiek bendram atsparumui, apžvalga. Ši apžvalga parodė, kad vieno metodo, kuris vienu ar kitu atveju būtų tinkamiausias, nėra. Vertinant tiesioginių išmokų įtaką atrinktiems atsparumo rodikliams, buvo nuspręsta panaudoti vienus iš dažniausiai taikomų metodų panelinių duomenų priežastinei analizei:

- Fiksuoto poveikio (angl. *Fixed Effects*) modeliai pasirinkti siekiant įvertinti tiesioginių išmokų įtaką maisto ir visų vartojimo prekių kainų santykiui, žemės ūkio produkcijos gamybai, ūkio pelningumui, samdomam užimtumui ir darbo užmokesčiui.
- Atsitiktinių efektų (angl. *Random Effects*) klaidų komponentų modeliai skirti įvertinti tiesioginių išmokų įtakai ūkių išlaidų ir produkcijos santykiui ir darbo našumui.

- Generalizuotas momentų metodas (angl. *Generalized method of moments*) skirtas įvertinti tiesioginių išmokų įtakai ūkių skolų ir turto santykiui.

Galiausiai aprašomas tiesioginių išmokų įtakos ekonominiam žemės ūkio atsparumui subindeksų ir sudėtinio indekso sudarymo procesas, kuriam panaudotas netiesioginis svorių nustatymo metodas bei svertinė suma.

3. Empirinis tiesioginių išmokų poveikio žemės ūkio ekonominiam atsparumui tyrimas

Trečiajame skyriuje pateikiami empirinio tyrimo rezultatai. Pirmiausia aprašomi tyrime naudojami duomenys, kurie apima ES valstybių narių vidutinius reprezentatyvių komercinių ūkių (ūkininkų ūkių ir žemės ūkio valdų) duomenis (iš ŪADT duomenų bazės) ir agreguotus žemės ūkio sektorių duomenis (iš EUROSTAT duomenų bazės) (S3.1 lentelė).

S3.1 lentelė. Žemės ūkio ekonominio atsparumo rodiklių duomenys

Funkcija	Rodiklis	Rodiklio aprašymas	Duomenų bazė	Duomenų trūkumas, proc.
Įperkamo maisto bei kitos žemės ūkio produkcijos gamyba	Maisto kainų ir visų vartojimo prekių kainų santykis	Vidutinis metinis maisto ir nealkoholinių gėrimų indekso ir vidutinio metinio visų suderinto vartotojų kainų indekso santykis, 2015 = 100	EUROSTAT	0
	Žemės ūkio produkcija	Produkcijos vertė gamintojo kainomis, realioji vertė, indeksas, 2005 = 100	EUROSTAT	0
Ūkių gyvybingumo užtikrinimas	Grynojo pelno marža	(Bendroji produkcija (SE131) – Išlaidos (SE270) + subsidijos$_{_be_inv}$ (SE605))/ (bendroji produkcija (SE131) + subsidijos$_{_be_inv}$ (SE605))	ŪADT	1
	Išlaidų ir produkcijos santykis	Išlaidos (SE270)/ Bendroji produkcija (SE131)	ŪADT	1
	Skolų ir turto santykis	Visos skolos (SE485)/Visas turtas(SE436)	ŪADT	1
Kokybiškų darbo vietų kūrimas ir išlaikymas	Samdomas užimtumas	Indeksas, 2005 = 100	EUROSTAT	0

S3.1 lentelės pabaiga

Funkcija	Rodiklis	Rodiklio aprašymas	Duomenų bazė	Duomenų trūkumas, proc.
Kokybiškų darbo vietų kūrimas ir išlaikymas	Darbo produktyvumas	Bendroji žemės ūkio produkcija (Produkcijos vertė gamintojo kainomis, palyginamosiosmis kainomis (2010 = 100)) / darbo jėgos sąnaudos (SD)	EUROSTAT	0
	Žemės ūkio darbuotojų darbo užmokestis	Samdomo darbo užmokestis (SE370)/samdomų darbuotojų darbo sąnaudos (SE020)	ŪADT	1

Tyrimo laikotarpis – 2005–2019 m. Skaičiavimai atlikti visos ES, apimančios 27 šalis (įskaitant Jungtinę Karalystę, bet neįskaitant Kroatijos), mastu. Skaičiavimai taip pat atlikti atskirai senųjų ir naujųjų ES šalių narių mastu, kadangi skirtingų ES valstybių narių žemės ūkio sektoriai labai skiriasi savo struktūra, našumu, kapitalizacija ir kitais faktoriais, todėl analizė pagal atskiras grupes įgalina išsamesnį ir gilesnį rezultatų interpretavimą ir palyginimą. Tyrimas pagrįstas paneliniais duomenimis.

Toliau pateikiami tiesioginių išmokų įtakos atskirų atsparumo rodiklių augimui, rezultatai. Jie rodo, kad ES lygmeniu tiesioginės išmokos reikšmingos teigiamos įtakos turėjo dviem atsparumo rodikliams: ūkių grynojo pelno maržai ir darbo produktyvumui (S3.2 lentelė). Taip pat reikšminga įtaka maisto ir visų vartojimo prekių kainų santykiui, nulemiant lėtesnį pirmųjų kilimą. Kita vertus tiesioginės išmokos turėjo neigiamos įtakos pagaminamos žemės ūkio produkcijos vertei, ūkių išlaidų bei produkcijos santykiui bei samdomam užimtumui. Ūkių skolų bei turto santykiui ir darbo užmokesčiui teisioginės išmokos, remiantis rezultatais, reikšmingos įtakos neturėjo. Šiek tiek kitokia situacija atsiskleidžia nagrinėjant tiesioginių išmokų įtaką atskirai senosioms ir naujosioms šalims narėms. Rezultatai rodo, kad senųjų šalių narių (įstojusių į ES iki 2004 m.) grupėje, tiesioginių išmokų įtaka reikšminga buvo tik trims iš aštuonių rodiklių. Iš jų tik 2 − ūkių grynojo pelno marža bei darbo produktyvumas, − buvo veikiami teigiamai. Tuo tarpu tiesioginių išmokų poveikis samdomam užimtumui nagrinėjamu laikotarpiu buvo neigiamas. Naujosiose šalyse narėse tiesioginės išmokos turėjo didesnį poveikį, kadangi fiksuota statistiškai reikšminga išmokų įtaka didesniam rodiklių skaičiui. Trys iš šešių rodiklių, kuriems fiksuota reikšminga išmokų įtaka, buvo veikiami pageidaujama linkme – didėjant tiesioginėms išmokoms mažėjo maisto ir visų vartojimo prekių kainų santykis bei didėjo vidutinė ūkių grynojo pelno marža bei darbo produktyvumas. Kita vertus, buvo fiksuotas nepageidaujamas tiesioginių išmokų poveikis naujųjų šalių narių žemės ūkio produkcijos vertei, išlaidų bei produkcijos santykiui bei samdomam užimtumui. Pateikiamas šių rezultatų palyginimas su kitų autorių gautais rezultatais atitinkamiems rodikliams.

S3.2 lentelė. Atsparumo rodiklių verčių pokytis, padidinus tiesiogines išmokas 10 proc., proc.

Rodiklis	**Nauda (+) /kaštai (−)**	**Pokytis, %**		
		ES-27	**SŠN*-15**	**NŠN*-12**
Žemės ūkio produkcijos vertė	+	–1	0	–0,8
Maisto ir visų vartojimo prekių kainų santykis	–	–0,3	0	–0,2
Ūkių grynojo pelno marža	+	3,8	4,3	4,2
Ūkių išlaidų ir pajamų santykis	–	0,7	0	1
Ūkių skolų ir turto santykis	–	0	0	0
Samdomas užimtumas	+	–1,6	–1,7	–1,5
Darbo produktyvumas	+	3,1	2,2	3
Žemės ūkio darbuotojų darbo užmokestis	+	0	0	0

*SŠN – Senosios šalys nares, NŠN – naujosios šalys narės

Trečiojoje dalyje pateikiami ekspertų apklausos rezultatai. Iš viso apklausta 15 ekspertų, atstovaujančių 3 svarbiausioms grupėms: mokslininkams, valdžios bei gamintojų atstovams. Ekspertai santykinai svarbiausia žemės ūkio funkcija išskyrė „Įperkamo maisto bei kitos žemės ūkio produkcijos gamyba“, o kaip santykinai mažiausios svarbos – „Kokybiškų darbo vietų kūrimas ir išlaikymas“ (S3.3 lentelė). Santykinai svarbiausias rodiklis – maisto ir visų vartojimo prekių kainų santykis, santykinai mažiausiai svarbus – samdomas užimtumas.

S3.3 lentelė. Ekonominio žemės ūkio atsparumo rodiklių svoriai (šaltinis: autorė)

Funkcija	**Rodiklis**	**Vidut. balas**	**St. nuokr.**	**Lokalūs svoriai**	**Globalūs svoriai**
Įperkamo maisto bei kitos žemės ūkio produkcijos gamyba	Žemės ūkio produkcijos vertė	4,44	0,53	0,49	0,19
	Maisto ir visų vartojimo prekių kainų santykis	4,67	0,50	0,51	0,20
Ūkių gyvybingumo užtikrinimas	Ūkių grynojo pelno marža	4,00	1,32	0,32	0,10
	Ūkių išlaidų ir produkcijos santykis	4,50	0,76	0,36	0,12
	Ūkių skolų ir turto santykis	4,00	0,50	0,32	0,10

S3.3 lentelės pabaiga

Funkcija	**Rodiklis**	**Vidut. balas**	**St. nuokr.**	**Lokalūs svoriai**	**Globalūs svoriai**
Kokybiškų darbo vietų kūrimas ir išlaikymas	Samdomas užimtumas	3,11	0,93	0,26	0,07
	Darbo produktyvumas	4,22	0,97	0,36	0,10
	Žemės ūkio darbuotojų darbo užmokestis	4,56	0,53	0,38	0,11

Ketvirtojoje dalyje pateikiami indekso ir subindeksų konstravimo rezultatai tiek bendrai ES-27, tiek atskirai senosioms ir naujosioms šalims narėms. Rezultatai rodo, kad tiesioginių išmokų įtaka atskirų ES-27 žemės ūkio funkcijų atsparumui nebuvo vienalytė: poveikis buvo teigiamas funkcijų „Ūkio gyvybingumo užtikrinimas“ (tiesioginių išmokų padidinimas 10 proc. paskatintų šios funkcijos atsparumo padidėjimą 0,967 proc.) bei „Kokybiškų darbo vietų kūrimas ir išlaikymas“ (atitinkamai 0,682 proc.) atsparumui, tuo tarpu santykinai svarbiausiai žemės ūkio funkcijai (ekspertų manymu) „Įperkamo maisto ir kitų žemės ūkio prekių gamyba“ fiksuotas neigiamas poveikis (tiesioginių išmokų padidėjimas 10 proc. paskatintų šios funkcijos atsparumo sumažėjimą 0,344 proc.) (S3.4 lentelė).

S3.4 lentelė. Tiesioginių išmokų įtakos pagrindinių žemės ūkio funkcijų atsparumui subindeksai ES-27, SŠN-15 ir NŠN-12, proc.

Subindeksas	**Funkcija**	**Vertė**		
		ES-27	**SŠN-15**	**NŠN-12**
$DPIERA_{gamyba}$	Įperkamos žemės ūkio produkcijos gamyba	–0,344 %	0,000 %	–0,279 %
$DPIERA_{gyvybingumas}$	Ūkių gyvybingumo užtikrinimas	0,967 %	1,376 %	0,984 %
$DPIERA_{darbai}$	Kokybiškų darbo vietų kūrimas ir išlaikymas	0,682 %	0,336 %	0,673 %

Senosiose ir naujosiose šalyse narėse išmokų poveikis buvo skirtingas. Rezultatai atskleidė stipresnį bendrą teigiamą tiesioginių išmokų poveikį senosioms šalims narėms, kur 10 % išmokų padidėjimas paskatintų atsparumo padidėjimą 0,54 %, o naujosiose šalyse narėse – tik 0,396 %. Senosiose šalyse narėse tiesioginės išmokos turėjo riekšmingos teigiamos įtakos fukcijų „Ūkio gyvybingumo užtikrinimas“ ir „Kokybiškų darbo vietų kūrimas ir išlaikymas“ atsparumui. Tuo tarpu naujosiose šalyse narėse fiksuotas neigiamas poveikis funkcijos „Įperkamo maisto ir kitos žemės ūkio produkcijos gamyba“ atsparumui, bei mažesnė teigiama įtaka funkcijos „Ūkių gyvybingumo užtikrinimas“. Kita vertus, naujosiose šalyse narėse didesnė teigiama įtaka nei senosiose atskleidžiama fukcijos „Kokybiškų darbo vietų kūrimas ir išlaikymas” atsparumui.

Agreguotas tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui indeksas rodo, kad, bendrai paėmus, tiesioginių išmokų įtaka tiek ES-27, tiek senųjų ir naujųjų šalių mastu buvo teigiama (S3.5 lentelė).

S3.5 lentelė. Tiesioginių išmokų įtakos žemės ūkio ekonominiams atsparumui indeksai (DPIERA – angl. Direct Payments' Impact on Economic Resilience of Agriculture), proc.

Indeksas	Vertė
DPIERA ES-27	0,368 %
DPIERA SŠN-15	0,540 %
DPIERA NŠN-12	0,396 %

Pateikiama su gautais rezultatais susijusi diskusija, išryškinant pagrindinius tiesioginių išmokų įtakos žemės ūkio atsparumui teigiamus ir neigiamus aspektus. Vienas iš problematiškiausių aspektų – fiksuotas reikšmingas neigiamas tiesioginių išmokų poveikis vidutiniam ūkių efektyvumui. Pateikiami pasiūlymai dėl tiesioginių išmokų paramos taikymo optimizavimo.

Siūlomas tiesioginių išmokų poveikio žemės ūkio ekonominiam atsparumui vertinimo modelis pasižymi daugiadimensiškumu, lankstumu, aktualumu ir pritaikomumu. Taikant šį modelį, vertinama tiesioginių išmokų įtaka tiek atskiroms žemės ūkio ekonominio atsparumo dimensijoms, tiek bendram ekonominiam atsparumui.

Bendrosios išvados

1. Visuotinai priimto ekonominio atsparumo apibrėžimo kol kas nėra. Vyrauja du pagrindiniai požiūriai į atsparumo reiškinį: „pusiausvyros" ir „sudėtingų sistemų", iš kurių pastarieji taikomi vis dažniau. Remiantis sudėtingų sistemų požiūriu, atsparumo kosntruktas apima du tipus ir tris dimensijas. Toks atsparumo reiškinio daugiamatiškumas ir daugialypiškumas lėmė jo matavimo būdų ir metodų gausą, dėl to šio fenomeno tyrimai yra gana chaotiški. Susisteminus ir sugrupavus atsparumo vertinimo būdus ir metodus, prieita prie išvados, kad atsparumo matavimo būdai skiriasi priklausomai nuo to, ar fokusuojamasi į faktinį atsparumą, ar atsparumo potencialą; o faktinio atsparumo vertinimo metodai priklauso nuo nagrinėjamo atsparumo tipo ir dimensijos. Atitinkamai nustatyta, kad pagrindinių funkcijų rodiklių augimas yra tinkamas bendrojo ekonominės sistemos ekonominio atsparumo prisitaikymo dimensijos matas. Šios įžvalgos buvo integruotos į žemės ūkio ekonomikos kontekstą, kur ekonominio atsparumo tyrimai, nors ir besiplečiantys, vis dar yra labai riboti.
2. Siekiant suformuluoti teorinį tiesioginių išmokų poveikio žemės ūkio ekonominiam atsparumui modelį, atlikta tiesioginių išmokų poveikio įvairiems žemės ūkio rodikliams (įskaitant žemės ūkio verslo ekonominius rodiklius, žemės ūkio produkcijos apimtis, darbo produktyvumą, žemės ir žemės nuomos kainas ir t. t.) vertinimo tyrimų analizė, atskleidusi, kad tiesioginės išmokos šiems rodikliams daro tiek tiesioginį, tiek netiesioginį poveikį. Ji taip pat parodė, kad šis poveikis

gali būti ir teigiamas, ir neigiamas, daugiausia priklausomai nuo to, kaip tiesioginės išmokos paveikia ūkininkų elgesį (ypač jų gamybos ir valdymo sprendimus). Todėl bendras tiesioginių išmokų poveikis atitinkamiems žemės ūkio rodikliams apibendrinamas kaip nevienareikšmis.

3. Sukurtas tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui vertinimo teorinis modelis. Remiantis faktinio atsparumo koncepto operacionalizavimu, išskirtos trys pagrindinės ekonominės žemės ūkio funkcijos – Įperkamo maisto bei kitos žemės ūkio produkcijos gamyba, Ūkių gyvybingumo užtikrinimas ir Kokybiškų darbo vietų kūrimas ir išlaikymas, – kuriomis remiantis buvo pagrįsta ekonominio žemės ūkio atsparumo rodiklių atranka. Sudaryta aštuonių žemės ūkio ekonominio atsparumo rodiklių sąranka. Parengta loginė tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui indekso ir jo subindeksų skaičiavimo schema.
4. Empiriškai pritaikius tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui vertinimo modelį ir apskaičiavus indekso reikšmes ES-27 šalių mastu 2005–2019 m., nustatyta, kad bendrai paėmus tiesioginių išmokų poveikis žemės ūkio ekonominiam atsparumui yra teigiamas: tiesioginių išmokų lygio padidinimas 10 proc. paskatintų žemės ūkio atsparumo padidėjimą 0,368 proc. Tačiau pastebėta, kad tiesioginės išmokos turėjo pageidaujamos įtakos tik trims (iš aštuonių) atsparumo rodikliams: ūkių grynojo pelno maržai, darbo produktyvumui bei maisto ir visų vartojimo kainų santykiui. Teigiamą įtaką mažino neigiama tiesioginių išmokų įtaka samdomam užimtumui, žemės ūkio produkcijos vertei ir ūkių išlaidų ir pajamų (neįskaičiuojant tiesioginių išmokų) santykiui. Rezultatai parodė, kad tiesioginės išmokos statistiškai reikšmingos įtakos ūkių skolų ir turto santykiui bei samdomų žemės ūkio darbuotojų darbo užmokesčiui neturėjo.
5. Modelio taikymas senosioms ir naujosioms ES valstybėms narėms atskleidė svarbius tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui skirtumus šiose dviejose šalių grupėse 2005–2019 m. periodu. Rezultatai atskleidė stipresnį bendrą teigiamą tiesioginių išmokų poveikį SŠN, kur 10% išmokų lygio padidinimas turėtų paskatinti bendro žemės ūkio ekonominio atsparumo padidėjimą 0,54%, o NŠN – tik 0,396 %. Šį skirtumą daugiausia lėmė tiesioginių išmokų įtakos skirtumai dviem rodikliams: žemės ūkio produkcijai ir ūkio išlaidų bei produkcijos santykiui. Abiejose šalių grupėse poveikio kryptis buvo ta pati, tačiau poveikis buvo statistiškai reikšmingas tik NŠN. Kita vertus, lyginant su SŠN, naujosiose šalyse narėse tiesioginės išmokos turėjo didesnės teigiamos įtakos darbo našumui ir reikšmingos neigiamos įtakos maisto kainų ir visų vartojimo prekių kainų santykiui (tai laikoma teigiamu rezultatu), tačiau poveikio stiprumo skirtumas nebuvo pakankamai didelis, kad nusvertų neigiamos įtakos skirtumus. Tiesioginių išmokų poveikis kitiems atsparumo rodikliams buvo panašus abiejose šalių grupėse.
6. Remiantis gautais rezultatais, buvo pateikti pasiūlymai tiesioginių išmokų paramos schemų dizainui tobulinti, ypač siekiant išvengti šalutinio poveikio – ūkininkų motyvacijos optimizuoti verslą mažinimo bei prisitaikymo įgūdžių slopinimo.

7. Tiesioginių išmokų įtakos žemės ūkio ekonominiam atsparumui indeksas leidžia santykinai lengvai palyginti tiesioginių išmokų poveikį atsparumui su kitų paramos schemų poveikiu, taip sukurdamas prielaidas objektyvesniam finansinių lėšų paskirstymo prioritetizavimui tarp skirtingų paramos priemonių. Metodologiniai šio indekso kūrimo principai yra universalūs ir gali būti pritaikyti kituose sektoriuose ir / ar regionuose. Tiesioginių išmokų poveikio žemės ūkio atsparumui vertinimo modelis galėtų būti taikomas tolesniuose tyrimuose, simuliuojant įvairių kitų paramos schemų poveikį, taip pat tyrimuose, kuriais siekiama nustatyti būdus ir priemones atsparumui didinti arba jo mažėjimui stabdyti.

Annexes

Annex A. Descriptive Statistics for Variables Used in Empirical Models

Annex B. Modeling results for Direct Payments' Impact on Resilience Indicators for EU-27

Annex C. Modeling results for Direct Payments' Impact on Resilience Indicators for OMS-15 and NMS-12

Annex D. The sample of a questionnaire used in an expert survey

Annex A. Descriptive Statistics of Variables Used in Empirical Models

Table A.1. Descriptive Statistics for the Variables Used in the Empirical Models for the EU-27

Variable	Unit of measure	Obs.	Mean	Std. dev.	Min	Max
Direct Payments	EUR/ha	401	310.46	224.08	61.58	2306.3
ln Direct payments		401	5.6	0.5	4.12	7.74
UAA	Ha	401	75.61	100.63	2.56	615.33
ln UAA		401	3.75	1.11	0.94	6.42
ln Average UAA		401	3.75	1.1	1.02	6.25
ln Total UAA in a country		403	7.9	1.73	2.33	10.47
Agricultural production index	%	405	107.75	14.72	76.08	150.92
ln Agricultural production index		405	4.67	0.13	4.33	5.02
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	15739
ln Output per ha		401	7.59	0.75	6.18	9.66
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
asin Debt-to-assets ratio		401	22.67	12	0.62	50.9
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
ln Expense-to-output ratio		401	−0.05	0.18	−0.52	0.56
Fixed capital per worker	EUR/AWU	401	2.6e+005	2.9e+005	9000.8	1.32e+006

End of Table A.1

Variable	Unit of measure	Obs.	Mean	Std. dev.	Min	Max
ln Fixed capital per worker		401	11.9	1.09	9.11	14.09
ln Average fixed capital per worker		401	11.93	1.05	10.07	13.98
Total labor input	AWU	401	2.35	2.58	1.02	20.73
ln Total labor input		401	0.64	0.52	0.02	3.03
Salaried employment index	%	405	100.41	24.54	49.65	198.57
ln Salaried employment index		405	4.58	0.22	3.91	5.29
Labor productivity	EUR/AWU	405	52.26	46.73	5.18	230.99
ln Labor productivity		401	10.7	0.84	8.65	12.52
Total specific costs	EUR	401	60199	65489	3453	3.3174 e+005
ln Total specific costs		401	10.45	1.08	8.15	12.71
Wages per AWU	EUR	401	16 301	10 060	1905	44 897
ln Wages per AWU		401	9.49	0.67	7.55	10.71
Net earnings in a country (total NACE)	EUR	391	18887	10764	2605.9	42584
ln Net earnings in a country (total NACE)		391	9.64	0.7	7.87	10.66
Labor costs (wages and salaries)	Index, %	405	91.66	17.3	32.2	170.6
ln Labor costs		405	4.5	0.21	3.47	5.14
Total unemployment	%	405	8.46	4.29	2	27.5
ln Total unemployment		405	2.03	0.44	0.6	3.3

Table A.2. Descriptive Statistics for the Variables Used in the Empirical Models for the OMS-15

Variable	Unit of measure	Obs.	Mean	Std. dev.	Min	Max
Direct Payments	EUR/ha	225	329.32	113.67	155.95	785.51
UAA	Ha	225	61.20	38.44	7.53	164.49
Agricultural production index	%	225	110.57	13.17	81.47	150.92
Crop output share in total output	%	225	0.48	0.15	0.11	0.74
Output per ha	EUR/ha	225	3019.3	2753.5	826.79	14887
Global food price	Index, %	225	100.14	11.24	76.80	118.80
Prices of means of production	Index, %	225	113.15	8.17	99.60	134.00
Food price HICP ratio	Index, %	225	0.99	0.03	0.92	1.11
Net profit margin	%	225	0.23	0.13	−0.12	0.5
Debt-to-assets ratio	%	225	19.22	16.37	0.01	60.23
Ratio of output sell price to the price of means of production	%	225	0.95	0.08	0.77	1.12
Expense-to-output ratio	%	225	0.94	0.18	0.59	1.46
Fixed capital per worker	EUR/AWU	225	4.05e+005	3.15e+005	41549	1.32e+006
Total labor input	AWU	225	1.71	0.44	1.02	2.96
Salaried employment index	%	225	107.35	27.13	57.41	198.57
Labor productivity	EUR/AWU	225	77.76	48.55	16.3	230.99
Total specific costs	EUR	225	68 638	58 231	5653	2.3e+005
Wages per AWU	EUR	225	22465	9143.5	6758.1	44897
Net earnings in a country (total NACE)	EUR	225	26584	7077.1	10983	42584
Labor costs (wages and salaries)	Index, %	225	94.79	10.39	72.8	132.2
Total unemployment	%	225	8.66	4.81	3.1	27.5

Table A.3. Descriptive Statistics for Variables Used in Empirical Models for the NMS-12

Variable	Unit of measure	Obs.	Mean	Std. dev.	Min	Max
Direct Payments	EUR/ha	176	286.34	311.76	61.58	2306.3
UAA	Ha	176	94.02	143.68	2.56	615.33
Agricultural production index	%	180	104.22	15.79	76.08	149.46
Crop output share in total output	%	176	0.57	0.09	0.29	0.75
Output per ha	EUR/ha	176	2508.1	3579	484.53	15739
Global food price	Index, %	180	100.14	11.24	76.8	118.8
Prices of means of production	Index, %	173	106.94	8.98	83.68	133.6
Food price HICP ratio	Index, %	180	0.99	0.05	0.83	1.16
Net profit margin	%	176	0.2	0.09	–0.09	0.41
Debt-to-assets ratio	%	176	15.93	11.97	1.13	45.46
Ratio of output sell price to the price of means of production	%	173	0.99	0.1	0.76	1.32
Expense-to-output ratio	%	176	0.99	0.17	0.66	1.75
Fixed capital per worker	EUR/AWU	176	74427	40629	9000.8	1.76e+005
Total labor input	AWU	176	3.17	3.71	1.05	20.73
Salaried employment index	%	180	91.73	17.39	49.65	132.31
Labor productivity	EUR/AWU	180	2.85	0.58	1.64	3.9
Total specific costs	EUR	176	49410	72486	3453	3.32e+005
Wages per AWU	EUR	176	8419.9	3602.6	1905	19555
Net earnings in a country (total NACE)	EUR	166	8452.7	3939.2	2605.9	21549
Labor costs (wages and salaries)	Index, %	180	87.74	22.64	32.2	170.6
Total unemployment	%	180	8.22	3.53	2	19.5

Annex B. Results of Modeling the Direct Payments' Impact on Resilience Indicators in the EU-27

Table B.1. Modeling results for the model "Direct Payments Impact on Agricultural Production"

	Coefficient	Std. Error	t-ratio	p-value
Const	1.535	1.61	0.96	0.3484
ln Direct Payments	−0.099	0.05	−2.17	0.0395
ln UAA	0.142	0.05	2.59	0.0154
ln Output per ha	0.507	0.06	8.99	<0.0001
Crop share in output	0.275	0.15	1.79	0.0844
ln Total UAA in a country	−0.098	0.19	−0.528	0.6021
CSTT1	−0.013	0.00	−6.98	<0.0001
CSTT2	−0.01	0.00	−4.46	0.0001
CSTT3	−0.001	0.00	−4.81	<0.0001
CSTT4	0.01	0.00	2.51	0.0186
CSTT5	0.003	0.00	1.59	0.1246
CSTT6	−0.007	0.00	−3.21	0.0035
CSTT7	−0.001	0.00	−0.32	0.7513
CSTT8	−0.009	0.00	−5.5	<0.0001
CSTT9	−0.004	0.00	−2.13	0.0431
CSTT10	−0.009	0.00	−3.99	0.0005
CSTT11	−0.016	0.00	−3.84	0.0007
CSTT12	−0.014	0.00	−4.45	0.0001
CSTT13	−0.026	0.00	−9.11	<0.0001
CSTT14	−0.008	0.00	−3	0.0059
CSTT15	0.009	0.00	5.19	<0.0001
CSTT16	−0.03	0.00	−6.12	<0.0001
CSTT17	0.001	0.00	0.17	0.8636
CSTT18	−0.002	0.00	−0.61	0.5476
CSTT19	−0.017	0.00	−4.7	<0.0001
CSTT20	−1.6e-05	0.00	−0.01	0.9963

End of Table B.1

	Coefficient	Std. Error	t-ratio	p-value
CSTT21	−0.001	0.00	−0.41	0.683
CSTT22	0.001	0.00	0.35	0.7259
CSTT23	−0.031	0.00	−7.94	<0.0001
CSTT24	0.022	0.00	12.86	<0.0001
CSTT25	−0.006	0.00	−2.13	0.043
CSTT26	−0.017	0.00	−4.02	0.0004
CSTT 27	−0.015	0.00	−4.78	<0.0001
Mean dependent var	4.671784	S.D. dependent var	0.135370	
Sum squared resid	0.981308	S.E. of regression	0.053645	
LSDV R-squared	0.865789	Within R-squared	0.677718	
Log-likelihood	634.4912	Akaike criterion	−1150.982	
Schwarz criterion	−915.4861	Hannan-Quinn	−1057.723	
rho	0.277237	Durbin-Watson	1.322294	
Fixed-effects, using 400 observations Included 27 cross-sectional units Time-series length: minimum 13, maximum 15 Dependent variable: ln Agricultural production index Robust (HAC) standard errors				

Table B.2. Modeling results for the model “Direct Payments Impact on the Ratio of Food Prices to Prices of Consumer Goods”

	Coefficient	Std. Error	t-ratio	p-value
const	−0.195	0.1403	−1.39	0.166
ln Direct Payments	−0.028	0.0152	−1.85	0.065
Global food price index	0.00018	0.0002	1.17	0.242
Price index of means of production	0.001	0.0003	3.33	0.001
ln Labor costs	0.043	0.0311	1.37	0.172
ln Total unemployment	0.002	0.0080	0.21	0.836
CSTT1	0.002	0.001	2.34	0.020
CSTT2	0.002	0.001	2.08	0.038
CSTT3	0.004	0.001	6.07	<0.0001

End of Table B.2

	Coefficient	Std. Error	t-ratio	p-value
CSTT4	−0.002	0.001	−2.25	0.025
CSTT5	−0.001	0.001	−0.80	0.424
CSTT6	−0.002	0.001	−2.31	0.021
CSTT7	−0.014	0.001	−21.01	<0.0001
CSTT8	8.8e-05	0.001	0.10	0.917
CSTT9	0.002	0.001	1.96	0.051
CSTT10	0.001	0.001	0.96	0.339
CSTT11	0.002	0.001	2.78	0.006
CSTT12	−0.005	0.001	−9.21	<0.0001
CSTT13	−0.001	0.001	−0.79	0.428
CSTT14	0.005	0.001	5.78	<0.0001
CSTT15	0.000	0.001	0.47	0.642
CSTT16	0.007	0.002	3.09	0.002
CSTT17	0.006	0.001	6.76	<0.0001
CSTT18	0.009	0.001	6.51	<0.0001
CSTT19	0.004	0.003	1.62	0.107
CSTT20	0.007	0.002	4.10	<0.0001
CSTT21	0.005	0.002	2.86	0.005
CSTT22	0.004	0.002	2.04	0.042
CSTT23	0.011	0.002	5.78	<0.0001
CSTT24	0.005	0.001	3.53	0.001
CSTT25	−0.013	0.003	−5.178	<0.0001
CSTT26	0.005	0.001	3.19	0.002
CSTT 27	0.008	0.001	8.11	<0.0001

Mean dependent var	−0.011620	S.D. dependent var	0.038872
Sum squared resid	0.089680	S.E. of regression	0.016362
LSDV R-squared	0.848979	Within R-squared	0.794580
Log-likelihood	1093.347	Akaike criterion	−2068.694
Schwarz criterion	−1834.089	Hannan-Quinn	−1975.732
rho	0.548289	Durbin-Watson	0.822016

Fixed-effects, using 394 observations
Included 27 cross-sectional units
Time-series length: minimum 8, maximum 15
Dependent variable: ln Food price HICP ratio
Robust (HAC) standard errors

Table B.3. Modeling results for the model "Direct Payments Impact on Farm Net Profit Margin"

	Coefficient	**Std. Error**	**t-ratio**	**p-value**
const	−0.696	0.198	−3.514	0.0016
ln Direct payments	0.084	0.033	2.553	0.0169
Ratio of output sell price to the price of means of production	0.385	0.061	6.345	<0.0001
ln UAA	0.004	0.037	0.1042	0.9178
Crop share in output	0.197	0.063	3.122	0.0044
asin Debt to assets ratio (lag 1)	−0.002	0.001	−1.269	0.2157
CSTT1	0.003	0.001	1.872	0.0725
CSTT2	0.014	0.001	9.317	<0.0001
CSTT3	0.004	0.001	3.629	0.0012
CSTT4	−0.008	0.002	−4.743	<0.0001
CSTT5	−0.006	0.001	−6.492	<0.0001
CSTT6	−0.003	0.001	−2.865	0.0081
CSTT7	−0.004	0.000	−9.112	<0.0001
CSTT8	0.002	0.001	1.846	0.0762
CSTT9	0.003	0.001	2.756	0.0105
CSTT10	0.005	0.001	5.918	<0.0001
CSTT11	−0.004	0.001	−8.514	<0.0001
CSTT12	0.007	0.001	5.746	<0.0001
CSTT13	−0.002	0.002	−1.076	0.2920
CSTT14	−0.005	0.001	−5.458	<0.0001
CSTT15	−0.006	0.000	−13.24	<0.0001
CSTT16	−0.006	0.003	−2.068	0.0487
CSTT17	−0.003	0.002	−1.610	0.1195
CSTT18	−0.002	0.002	−0.8173	0.4212
CSTT19	−0.008	0.002	−3.574	0.0014
CSTT20	0.004	0.002	1.545	0.1345
CSTT21	−0.014	0.001	−10.93	<0.0001
CSTT22	−0.004	0.001	−3.710	0.0010
CSTT23	0.006	0.003	1.984	0.0579
CSTT24	−0.007	0.001	−4.847	<0.0001
CSTT25	−0.008	0.002	−4.379	0.0002
CSTT26	0.013	0.004	3.610	0.0013
CSTT 27	−0.001	0.001	−1.606	0.1204

End of Table B.3

	Coefficient	Std. Error	t-ratio
Mean dependent var	0.212048	S.D. dependent var	0.118171
Sum squared resid	0.281523	S.E. of regression	0.030233
LSDV R-squared	0.944918	Within R-squared	0.555453
Log-likelihood	795.4772	Akaike criterion	−1472.954
Schwarz criterion	−1242.538	Hannan-Quinn	−1381.403
rho	0.041351	Durbin-Watson	1.777034
Fixed-effects, using 367 observations Included 27 cross-sectional units Time-series length: minimum 7, maximum 14 Dependent variable: Net profit margin Robust (HAC) standard errors			

Table B.4. Modeling results for the model "Direct Payments Impact on Farm Expense-to-Output Ratio"

	Coefficient	Std. Error	z	p-value
const	0.248079	0.236066	1.051	0.2933
Crop share in output	−0.356971	0.0970196	−3.679	0.0002
asin Debt-to-assets ratio	0.00292443	0.00300810	0.9722	0.3310
Ratio of output sell price to the price of means of production	−0.341025	0.0768744	−4.436	<0.0001
ln Direct Payments	0.0729433	0.0320709	2.274	0.0229
ln average UAA	0.102859	0.0341667	3.010	0.0026
ln Total labor input	−0.220988	0.100856	−2.191	0.0284
ln average fixed capital per worker	−0.0482190	0.0178225	−2.706	0.0068
squared ln Total labor input	0.0962445	0.0289337	3.326	0.0009
Time dummy_2	0.0137167	0.0120675	1.137	0.2557
Time dummy_3	−0.0200378	0.0171399	−1.169	0.2424
Time dummy_4	−0.0103103	0.0165818	−0.6218	0.5341
Time dummy_5	0.0646297	0.0149440	4.325	<0.0001
Time dummy_6	0.0168909	0.0171247	0.9863	0.3240
Time dummy_7	−0.0219791	0.0168565	−1.304	0.1923
Time dummy_8	−0.00743544	0.0175364	−0.4240	0.6716
Time dummy_9	0.00721956	0.0162093	0.4454	0.6560
Time dummy_10	−0.00617764	0.0156639	−0.3944	0.6933

End of Table B.4

	Coefficient	Std. Error	z	p-value
Time dummy_11	0.0123193	0.0194656	0.6329	0.5268
Time dummy_12	0.0127039	0.0178725	0.7108	0.4772
Time dummy_13	−0.0231986	0.0195950	−1.184	0.2365
Time dummy_14	−0.00307882	0.0205161	−0.1501	0.8807
Time dummy_15	−0.0299422	0.0209242	−1.431	0.1524

Mean dependent var	−0.058290	S.D. dependent var	0.180457
Sum squared resid	5.806096	S.E. of regression	0.124931
Log-likelihood	271.7744	Akaike criterion	−497.5488
Schwarz criterion	−406.0927	Hannan-Quinn	−461.3095
rho	0.433461	Durbin-Watson	0.987151

'Between' variance = 0.015025
'Within' variance = 0.00292524
mean theta = 0.884675
corr(y,yhat)^2 = 0.546696

Random-effects (GLS), using 394 observations
Included 27 cross-sectional units
Time-series length: minimum 8, maximum 15
Dependent variable: ln Expense-to-output ratio
Robust (HAC) standard errors

Joint test on named regressors − Asymptotic test statistic: Chi-square(22) = 1831.48 with p-value = 0
Breusch-Pagan test − Asymptotic test statistic: Chi-square(1) = 1510.9 with p-value = 0
Hausman test − Asymptotic test statistic: Chi-square(8) = 11.2092 with p-value = 0.190125

Table B.5. Modeling results for the model “Direct Payments Impact on Salaried Employment”

	Coefficient	Std. Error	t-ratio	p-value
const	5.50359	0.490397	11.22	<0.0001
ln Direct Payments	−0.163364	0.0559592	−2.919	0.0072
ln UAA	−0.0538213	0.0946435	−0.5687	0.5745
Crop share in output	0.00441894	0.179544	0.02461	0.9806
ln Labor productivity (lag 1)	−0.0188134	0.0452217	−0.4160	0.6808
Ln Labor costs	0.0401083	0.0496609	0.8076	0.4266
CSTT1	0.0232029	0.00178859	12.97	<0.0001

End of Table B.5

	Coefficient	Std. Error	t-ratio	p-value
CSTT2	0.0220521	0.00235416	9.367	<0.0001
CSTT3	0.00185906	0.00165457	1.124	0.2715
CSTT4	−0.0367492	0.00282455	−13.01	<0.0001
CSTT5	0.00842043	0.00189144	4.452	0.0001
CSTT6	−0.0020107	0.00147987	−1.359	0.1859
CSTT7	0.0150158	0.00207260	7.245	<0.0001
CSTT8	0.00756929	0.00211401	3.581	0.0014
CSTT9	0.0474324	0.00241047	19.68	<0.0001
CSTT10	−0.0014532	0.00157378	−0.9234	0.3643
CSTT11	0.0302141	0.00262257	11.52	<0.0001
CSTT12	0.00851143	0.00312303	2.725	0.0113
CSTT13	−0.0215607	0.00337560	−6.387	<0.0001
CSTT14	0.00237527	0.00203254	1.169	0.2532
CSTT15	−0.0037144	0.00123303	−3.012	0.0057
CSTT16	0.0105213	0.00661787	1.590	0.1240
CSTT17	−0.0131967	0.00237215	−5.563	<0.0001
CSTT18	−0.0223250	0.00558240	−3.999	0.0005
CSTT19	−0.0012013	0.00471676	−0.2547	0.8010
CSTT20	0.0182143	0.00448207	4.064	0.0004
CSTT21	0.00618623	0.00411171	1.505	0.1445
CSTT22	0.00238528	0.00479806	0.4971	0.6233
CSTT23	0.00231171	0.00543754	0.4251	0.6742
CSTT24	0.0251229	0.00314209	7.996	<0.0001
CSTT25	−0.0275972	0.00413103	−6.680	<0.0001
CSTT26	−0.0401707	0.00730605	−5.498	<0.0001
CSTT 27	−0.0158685	0.00353394	−4.490	0.0001

Mean dependent var	4.582768	S.D. dependent var	0.224752
Sum squared resid	1.788549	S.E. of regression	0.072317
LSDV R-squared	0.911482	Within R-squared	0.641252
Log-likelihood	516.2232	Akaike criterion	−914.4464
Schwarz criterion	−678.8027	Hannan-Quinn	−821.1376
rho	0.279115	Durbin-Watson	1.246164

Fixed-effects, using 401 observations
Included 27 cross-sectional units
Time-series length: minimum 13, maximum 15
Dependent variable: ln Salaried employment index
Robust (HAC) standard errors

Table B.6. Modeling results for the model “Direct Payments Impact on Labor Productivity”

	Coefficient	Std. Error	z	p-value
const	−7.27211	1.20867	−6.017	<0.0001
ln Direct Payments	0.309326	0.0618932	4.998	<0.0001
ln Total specific costs	0.131846	0.0580504	2.271	0.0231
Crop share in output	0.586837	0.288277	2.036	0.0418
ln UAA	0.0620427	0.147060	0.4219	0.6731
ln Average fixed capital per worker	0.368517	0.0787690	4.678	<0.0001
Average crop share in output	0.0460647	0.803562	0.05733	0.9543
ln Average UAA	0.117924	0.139058	0.8480	0.3964
ln Fixed capital per worker	0.202711	0.0707920	2.863	0.0042
Time dummy_2	−0.121884	0.0212882	−5.725	<0.0001
Time dummy_3	−0.150666	0.0247996	−6.075	<0.0001
Time dummy_4	−0.121442	0.0238934	−5.083	<0.0001
Time dummy_5	−0.0942156	0.0242024	−3.893	<0.0001
Time dummy_6	−0.101711	0.0211103	−4.818	<0.0001
Time dummy_7	−0.0750012	0.0217950	−3.441	0.0006
Time dummy_8	−0.117252	0.0249508	−4.699	<0.0001
Time dummy_9	−0.0710366	0.0215130	−3.302	0.0010
Time dummy_10	−0.0103089	0.0242992	−0.4243	0.6714
Time dummy_11	−0.00289143	0.0270010	−0.1071	0.9147
Time dummy_12	−0.00406491	0.0248635	−0.1635	0.8701
Time dummy_13	0.0212958	0.0259017	0.8222	0.4110
Time dummy_14	0.00659627	0.0300869	0.2192	0.8265

Mean dependent var	3.592363	S.D. dependent var	0.883535
Sum squared resid	52.54189	S.E. of regression	0.371844
Log-likelihood	−161.5080	Akaike criterion	367.0161
Schwarz criterion	454.8832	Hannan-Quinn	401.8092
rho	0.592488	Durbin-Watson	0.667304

'Between' variance = 0.116601
'Within' variance = 0.010336
mean theta = 0.922934
corr(y,yhat)^2 = 0.832154

End of Table B.6

Random-effects (GLS), using 401 observations Included 27 cross-sectional units Time-series length: minimum 13, maximum 15 Dependent variable: ln Labor productivity Robust (HAC) standard errors
Joint test on named regressors − Asymptotic test statistic: Chi-square(21) = 1419.23 with p-value = 7.1333e-288 Breusch-Pagan test statistic: LM = 2297.89 with p-value = prob (chi-square(1) > 2297.89) = 0 Hausman test statistic: H = 10.8177 with p-value = prob(chi-square(5) > 10.8177) = 0.0551171

Table B.7. Modeling results for the model "Direct Payments Impact on Wages of Agricultural Employees"

	Coefficient	**Std. Error**	**t-ratio**	**p-value**
const	2.85688	0.855125	3.341	0.0025
ln Direct Payments	0.0297222	0.0536013	0.5545	0.5840
ln Net earnings in a country (total NACE)	0.528365	0.105837	4.992	<0.0001
ln Total unemployment	−0.0124686	0.0169595	−0.7352	0.4688
ln Labor productivity	0.120759	0.0580767	2.079	0.0476
CSTT1	−0.0132435	0.00150821	−8.781	<0.0001
CSTT2	0.00332118	0.00144519	2.298	0.0299
CSTT3	0.00977329	0.00234027	4.176	0.0003
CSTT4	0.0146558	0.00379190	3.865	0.0007
CSTT5	0.0106562	0.00166726	6.391	<0.0001
CSTT6	0.00761219	0.00156031	4.879	<0.0001
CSTT7	0.00901988	0.00295464	3.053	0.0052
CSTT8	0.0149631	0.00144448	10.36	<0.0001
CSTT9	0.0201233	0.00174375	11.54	<0.0001
CSTT10	0.00185525	0.00152048	1.220	0.2334
CSTT11	0.0331243	0.00194541	17.03	<0.0001
CSTT12	0.0155916	0.00188593	8.267	<0.0001
CSTT13	0.0167206	0.00280385	5.963	<0.0001
CSTT14	0.00127265	0.00197994	0.6428	0.5260
CSTT15	0.00628112	0.00156006	4.026	0.0004
CSTT16	0.0326541	0.00728395	4.483	0.0001
CSTT17	−0.0227183	0.00408636	−5.560	<0.0001

End of Table B.7

	Coefficient	**Std. Error**	**t-ratio**	**p-value**
CSTT18	0.0268515	0.00540934	4.964	<0.0001
CSTT19	0.0391463	0.00587653	6.661	<0.0001
CSTT20	0.00138563	0.00518447	0.2673	0.7914
CSTT21	0.0381025	0.00603320	6.315	<0.0001
CSTT22	0.0333296	0.00676238	4.929	<0.0001
CSTT23	0.00602064	0.00421761	1.427	0.1653
CSTT24	0.0288245	0.00569972	5.057	<0.0001
CSTT25	0.0140213	0.00608686	2.304	0.0295
CSTT26	0.0389469	0.00495207	7.865	<0.0001
CSTT 27	0.0167951	0.00256866	6.538	<0.0001

Mean dependent var	9.510485	S.D. dependent var	0.665437
Sum squared resid	1.117472	S.E. of regression	0.057929
LSDV R-squared	0.993529	Within R-squared	0.928166
Log-likelihood	590.3633	Akaike criterion	−1064.727
Schwarz criterion	−834.5416	Hannan-Quinn	−973.4891
rho	0.288194	Durbin-Watson	1.254815

Fixed-effects, using 391 observations
Included 27 cross-sectional units
Time-series length: minimum 7, maximum 15
Dependent variable: ln Wages per AWU
Robust (HAC) standard errors

Annex C. Results of Modeling the Direct Payments' Impact on Resilience Indicators in the OMS-15 and the NMS-12

Table C.1.1. Modeling results for the model "Direct Payments Impact on Agricultural Production" in the OMS-15

	Coefficient	Std. Error	t-ratio	p-value
Const	3.66589	1.15931	3.162	0.0069
ln Direct Payments	−0.121029	0.0741352	−1.633	0.1248
ln UAA	0.276874	0.0871681	3.176	0.0067
ln output per ha	0.534745	0.0744636	7.181	<0.0001
Crop share in output	0.0100869	0.209801	0.04808	0.9623
Total UAA in a country	−0.409925	0.0851185	−4.816	0.0003
CSTT1	−0.0175700	0.00297532	−5.905	<0.0001
CSTT2	−0.0125191	0.00308476	−4.058	0.0012
CSTT3	−0.0108919	0.00257289	−4.233	0.0008
CSTT4	0.0129926	0.00257208	5.051	0.0002
CSTT5	−0.00213617	0.00367769	−0.5808	0.5706
CSTT6	−0.0103918	0.00237644	−4.373	0.0006
CSTT7	−0.00234184	0.00428625	−0.5464	0.5934
CSTT8	−0.0153071	0.00314259	−4.871	0.0002
CSTT9	−0.00872807	0.00332951	−2.621	0.0201
CSTT10	−0.0144904	0.00340912	−4.250	0.0008
CSTT11	−0.0231012	0.00336433	−6.866	<0.0001
CSTT12	−0.0125517	0.00420532	−2.985	0.0098
CSTT13	−0.0284515	0.00391365	−7.270	<0.0001
CSTT14	−0.00921032	0.00361100	−2.551	0.0231
CSTT15	0.00784426	0.00226018	3.471	0.0037

Mean dependent var	4.699518	S.D. dependent var	0.116118
Sum squared resid	0.412663	S.E. of regression	0.046727
LSDV R-squared	0.862756	Within R-squared	0.717663
Log-likelihood	387.3959	Akaike criterion	−704.7918
Schwarz criterion	−585.3842	Hannan-Quinn	−656.5931
Rho	0.220346	Durbin-Watson	1.449027

Fixed-effects, using 224 observations
Included 15 cross-sectional units
Time-series length: minimum 14, maximum 15
Dependent variable: ln Agricultural production index, Robust (HAC) standard errors

Table C.1.2. Modeling results for the model "Direct Payments Impact on Agricultural Production" in the NMS-12

	Coefficient	**Std. Error**	**t-ratio**	**p-value**
Const	−1.09039	0.844324	−1.291	0.1986
ln Direct Payments	−0.0786954	0.0471869	−1.668	0.0975
ln UAA	0.119231	0.0714916	1.668	0.0975
ln output per ha	0.494854	0.0811281	6.100	<0.0001
Crop share in output	0.361500	0.227955	1.586	0.1149
Total UAA in a country	0.268407	0.0871851	3.079	0.0025
CSTT1	−0.0299233	0.00538513	−5.557	<0.0001
CSTT2	0.00808305	0.00279580	2.891	0.0044
CSTT3	−0.00262977	0.00441391	−0.5958	0.5522
CSTT4	−0.0203742	0.00350834	−5.807	<0.0001
CSTT5	0.00162821	0.00455581	0.3574	0.7213
CSTT6	−0.00475430	0.00281008	−1.692	0.0928
CSTT7	−0.00197434	0.00447209	−0.4415	0.6595
CSTT8	−0.0331068	0.00546795	−6.055	<0.0001
CSTT9	0.0245418	0.00222560	11.03	<0.0001
CSTT10	−0.00621442	0.00364776	−1.704	0.0906
CSTT11	−0.0185977	0.00619381	−3.003	0.0031
CSTT12	−0.0140948	0.00442575	−3.185	0.0018

Mean dependent var	4.636486	S.D. dependent var	0.149538
Sum squared resid	0.510991	S.E. of regression	0.058959
LSDV R-squared	0.869422	Within R-squared	0.677258
Log-likelihood	264.3528	Akaike criterion	−470.7057
Schwarz criterion	−378.7617	Hannan-Quinn	−433.4136
rho	0.265141	Durbin-Watson	1.362888

Fixed-effects, using 176 observations
Included 12 cross-sectional units
Time-series length: minimum 13, maximum 15
Dependent variable: ln Agricultural production index
Robust (HAC) standard errors

Table C.2.1. Modeling results for the model "Direct Payments Impact on the Ratio of Food Prices to Prices of Consumer Goods" in the OMS-15

	Coefficient	Std. Error	t-ratio	p-value
const	0.305	0.286	1.065	0.288
ln Direct Payments	−0.072	0.052	−1.366	0.174
Global food price index	0.000	0.00014	0.9489	0.3439
Price index of means of production	0.001	0.0004	2.422	0.0164
ln Labor costs	−0.0081	0.061	−0.1328	0.895
ln Total unemployment	0.006	0.014	0.447	0.655
CSTT1	0.002	0.002	1.282	0.201
CSTT2	0.003	0.002	1.148	0.252
CSTT3	0.005	0.002	3.214	0.002
CSTT4	−0.005	0.003	−1.778	0.0769
CSTT5	0.000	0.00133	0.2619	0.7937
CSTT6	−0.002	0.002	−0.820	0.413
CSTT7	−0.013	0.001	−9.258	<0.0001
CSTT8	0.001	0.001	0.879	0.381
CSTT9	0.004	0.002	2.234	0.027
CSTT10	0.001	0.001	0.956	0.340
CSTT11	0.004	0.002	2.556	0.011
CSTT12	−0.003	0.0007	−4.6	<0.0001
CSTT13	−0.0005	0.0026	−0.211	0.833
CSTT14	0.006	0.002	3.743	0.000
CSTT15	0.001	0.002	0.579	0.563

Mean dependent var	−0.007157	S.D. dependent var	0.029655
Sum squared resid	0.049781	S.E. of regression	0.016187
LSDV R-squared	0.747287	Within R-squared	0.664563
Log-likelihood	627.5629	Akaike criterion	−1185.126
Schwarz criterion	−1065.562	Hannan-Quinn	−1136.869
rho	0.597298	Durbin-Watson	0.723647

Fixed-effects, using 225 observations
Included 15 cross-sectional units
Time-series length = 15
Dependent variable: ln Food price HICP ratio
Robust (HAC) standard errors

Table C.2.2. Modeling results for the model “Direct Payments Impact on the Ratio of Food Prices to Prices of Consumer Goods” in the NMS-12

	Coefficient	**Std. Error**	**t-ratio**	**p-value**
const	−0.27	0.155	−1.745	0.083
ln Direct Payments	−0.022	0.013	−1.668	0.098
Global food price index	0.0005	0.0003	1.615	0.109
Price index of means of production	0.001	0.0004	2.566	0.011
ln Labor costs	0.039	0.034	1.128	0.261
ln Total unemployment	−0.003	0.009	−0.3764	0.707
CSTT1	0.007	0.003	2.650	0.009
CSTT2	0.007	0.001	7.451	<0.0001
CSTT3	0.008	0.001	6.368	<0.0001
CSTT4	0.003	0.003	0.932	0.353
CSTT5	0.006	0.002	3.502	0.001
CSTT6	0.005	0.002	2.433	0.016
CSTT7	0.004	0.002	1.698	0.092
CSTT8	0.012	0.002	6.949	<0.0001
CSTT9	0.004	0.001	2.923	0.004
CSTT10	−0.0136298	0.003	−4.463	<0.0001
CSTT11	0.004	0.002	2.791	0.006
CSTT12	0.007	0.001	7.594	<0.0001

Mean dependent var	−0.017560	S.D. dependent var	0.047958
Sum squared resid	0.034587	S.E. of regression	0.015718
LSDV R-squared	0.910487	Within R-squared	0.879972
Log-likelihood	477.9568	Akaike criterion	−897.9135
Schwarz criterion	−807.1465	Hannan-Quinn	−861.0786
rho	0.416443	Durbin-Watson	1.015345

Fixed-effects, using 169 observations
Included 12 cross-sectional units
Time-series length: minimum 8, maximum 15
Dependent variable: ln Food price HICP ratio
Robust (HAC) standard errors

Table C.3.1. Modeling results for the model “Direct Payments Impact on Farm Net Profit Margin” in the OMS-15

	Coefficient	Std. Error	t-ratio	p-value
const	−0.708110	0.303653	−2.332	0.0352
ln Direct payments	0.106064	0.0556590	1.906	0.0774
Ratio of output sell price to the price of means of production	0.432567	0.0918581	4.709	0.0003
ln UAA	−0.0345633	0.0683422	−0.5057	0.6209
Crop share in output	0.116473	0.114351	1.019	0.3257
asin Debt to assets ratio (lag 1)	−0.000562201	0.00310406	−0.1811	0.8589
CSTT1	0.00445446	0.00265896	1.675	0.1161
CSTT2	0.0152921	0.00257160	5.947	<0.0001
CSTT3	0.00414023	0.00164249	2.521	0.0245
CSTT4	−0.00602584	0.00334684	−1.800	0.0934
CSTT5	−0.00517842	0.00182496	−2.838	0.0132
CSTT6	−0.00244599	0.00168182	−1.454	0.1679
CSTT7	−0.00348507	0.000634202	−5.495	<0.0001
CSTT8	0.00303826	0.00214184	1.419	0.1779
CSTT9	0.00216777	0.00220278	0.9841	0.3418
CSTT10	0.00556947	0.00139114	4.004	0.0013
CSTT11	−0.00462890	0.000831389	−5.568	<0.0001
CSTT12	0.00704576	0.00208845	3.374	0.0045
CSTT13	0.000472145	0.00344777	0.1369	0.8930
CSTT14	−0.00328484	0.00173713	−1.891	0.0795
CSTT15	−0.00560377	0.000803981	−6.970	<0.0001

Mean dependent var	0.224410	S.D. dependent var	0.125698
Sum squared resid	0.134795	S.E. of regression	0.027754
LSDV R-squared	0.959180	Within R-squared	0.549222
Log-likelihood	473.8891	Akaike criterion	−877.7781
Schwarz criterion	−760.6293	Hannan-Quinn	−830.4192
rho	0.168338	Durbin-Watson	1.509201

Fixed-effects, using 210 observations
Included 15 cross-sectional units
Time-series length = 14
Dependent variable: Net profit margin
Robust (HAC) standard errors

Table C.3.2. Modeling results for the model "Direct Payments Impact on Farm Net Profit Margin" in the NMS-12

	Coefficient	Std. Error	t-ratio	p-value
const	−0.664018	0.241288	−2.752	0.0068
ln Direct payments	0.0765939	0.0428068	1.789	0.0759
Ratio of output sell price to the price of means of production	0.347501	0.0679481	5.114	<0.0001
ln UAA	0.00885159	0.0457143	0.1936	0.8468
Crop share in output	0.234093	0.0855968	2.735	0.0071
asin Debt to assets ratio (lag 1)	−0.00241031	0.00136918	−1.760	0.0807
CSTT1	−0.00653028	0.00387417	−1.686	0.0943
CSTT2	−0.00159636	0.00180058	−0.8866	0.3770
CSTT3	−0.000925124	0.00235852	−0.3922	0.6955
CSTT4	−0.00844870	0.00257627	−3.279	0.0013
CSTT5	0.00327741	0.00274733	1.193	0.2351
CSTT6	−0.0140684	0.00157617	−8.926	<0.0001
CSTT7	−0.00460860	0.00148731	−3.099	0.0024
CSTT8	0.00566510	0.00410883	1.379	0.1704
CSTT9	−0.00662475	0.00169908	−3.899	0.0002
CSTT10	−0.00823281	0.00214231	−3.843	0.0002
CSTT11	0.0141304	0.00338677	4.172	<0.0001
CSTT12	−0.00145253	0.000958730	−1.515	0.1322

Mean dependent var	0.195512	S.D. dependent var	0.105423
Sum squared resid	0.143243	S.E. of regression	0.033453
LSDV R-squared	0.917381	Within R-squared	0.571455
Log-likelihood	326.6844	Akaike criterion	−595.3687
Schwarz criterion	−506.7376	Hannan-Quinn	−559.3725
rho	−0.066378	Durbin-Watson	1.990059

Fixed-effects, using 157 observations
Included 12 cross-sectional units
Time-series length: minimum 7, maximum 14
Dependent variable: Net profit margin
Robust (HAC) standard errors

Table C.4.1. Modeling results for the model "Direct Payments Impact on Farm Expense-to-Output ratio" in the OMS-15

	Coefficient	**Std. Error**	**t-ratio**	**p-value**
const	−0.515280	0.968160	−0.5322	0.5952
ln Direct payments	0.0205237	0.0971364	0.2113	0.8329
Ratio of output sell price to the price of means of production	−0.328343	0.115927	−2.832	0.0051
ln UAA	0.101634	0.111155	0.9143	0.3617
Crop share in output	−0.359999	0.141409	−2.546	0.0117
asin Debt to assets ratio	0.000161834	0.00402780	0.04018	0.9680
ln Total labor input	−0.614717	0.428061	−1.436	0.1526
squared ln Total labor input	0.466633	0.395094	1.181	0.2391
ln fixed capital per worker	0.0480595	0.0529672	0.9073	0.3654
Time dummy_2	−0.00133004	0.0168115	−0.07911	0.9370
Time dummy_3	−0.0440688	0.0166794	−2.642	0.0089
Time dummy_4	−0.0269473	0.0201173	−1.340	0.1820
Time dummy_5	0.0215116	0.0207508	1.037	0.3012
Time dummy_6	−0.0264964	0.0226425	−1.170	0.2434
Time dummy_7	−0.0575367	0.0292313	−1.968	0.0505
Time dummy_8	−0.0528848	0.0322429	−1.640	0.1026
Time dummy_9	−0.0425849	0.0349162	−1.220	0.2241
Time dummy_10	−0.0515828	0.0356051	−1.449	0.1491
Time dummy_11	−0.0441127	0.0409952	−1.076	0.2833
Time dummy_12	−0.0495469	0.0388845	−1.274	0.2042
Time dummy_13	−0.0857954	0.0419656	−2.044	0.0423
Time dummy_14	−0.0667756	0.0385775	−1.731	0.0851
Time dummy_15	−0.0939459	0.0427730	−2.196	0.0293

Mean dependent var	−0.080900	S.D. dependent var	0.187486
Sum squared resid	0.422424	S.E. of regression	0.047402
LSDV R-squared	0.946351	Within R-squared	0.411632
Log-likelihood	386.9966	Akaike criterion	−699.9931
Schwarz criterion	−573.5974	Hannan-Quinn	−648.9793
rho	0.536108	Durbin-Watson	0.831006

Fixed-effects, using 225 observations
Included 15 cross-sectional units
Time-series length = 15
Dependent variable: ln Expense-to-output ratio
Robust (HAC) standard errors

Table C.4.2. Modeling results for the model “Direct Payments Impact on Farm Expense-to-Output ratio” in the NMS-12

	Coefficient	Std. Error	t-ratio	p-value
const	0.608735	0.425523	1.431	0.1549
ln Direct payments	0.101304	0.0388041	2.611	0.0101
Ratio of output sell price to the price of means of production	−0.488064	0.111830	−4.364	<0.0001
ln UAA	0.139189	0.0625895	2.224	0.0278
Crop share in output	−0.472565	0.141504	−3.340	0.0011
asin Debt to assets ratio	0.00266047	0.00454816	0.5850	0.5595
ln Total labor input	−0.232694	0.0893936	−2.603	0.0103
squared ln Total labor input	0.0901562	0.0340025	2.651	0.0090
ln fixed capital per worker	−0.0839357	0.0326431	−2.571	0.0112
Time dummy_2	0.0249849	0.0206978	1.207	0.2295
Time dummy_3	0.00641979	0.0303938	0.2112	0.8330
Time dummy_4	−0.00654863	0.0328912	−0.1991	0.8425
Time dummy_5	0.0764263	0.0143364	5.331	<0.0001
Time dummy_6	0.0494496	0.0216980	2.279	0.0242
Time dummy_7	0.00311600	0.0234479	0.1329	0.8945
Time dummy_8	0.0301033	0.0192197	1.566	0.1196
Time dummy_9	0.0389617	0.0166517	2.340	0.0207
Time dummy_10	0.0129654	0.0198084	0.6545	0.5139
Time dummy_11	0.0565288	0.0175795	3.216	0.0016
Time dummy_12	0.0634388	0.0176029	3.604	0.0004
Time dummy_13	0.0310377	0.0156911	1.978	0.0499
Time dummy_14	0.0330181	0.0200824	1.644	0.1025

Mean dependent var	−0.028188	S.D. dependent var	0.166476
Sum squared resid	0.423812	S.E. of regression	0.055824
LSDV R-squared	0.908974	Within R-squared	0.527811
Log-likelihood	266.2161	Akaike criterion	−466.4322
Schwarz criterion	−363.1455	Hannan-Quinn	−424.5165
rho	0.163721	Durbin-Watson	1.529666

Fixed-effects, using 169 observations
Included 12 cross-sectional units
Time-series length: minimum 8, maximum 15
Dependent variable: ln Expense-to-output ratio
Robust (HAC) standard errors

Table C.5.1. Modeling results for the model "Direct Payments Impact on Salaried Employment" in the OMS-15

	Coefficient	**Std. Error**	**t-ratio**	**p-value**
const	4.91533	1.50575	3.264	0.0013
ln Direct Payments	−0.170001	0.0850450	−1.999	0.0470
ln UAA	−0.191783	0.243594	−0.7873	0.4321
Crop share in output	0.331638	0.251184	1.320	0.1883
ln labor productivity	−0.0346898	0.0573004	−0.6054	0.5456
ln Labor costs	0.165078	0.0524941	3.145	0.0019
CSTT1	0.0262720	0.00293949	8.938	<0.0001
CSTT2	0.0215707	0.00530936	4.063	<0.0001
CSTT3	0.000935291	0.00356858	0.2621	0.7935
CSTT4	−0.0355374	0.00403694	−8.803	<0.0001
CSTT5	0.00947656	0.00686063	1.381	0.1688
CSTT6	−0.00351115	0.00205976	−1.705	0.0899
CSTT7	0.0138593	0.00359282	3.858	0.0002
CSTT8	0.00906265	0.00777276	1.166	0.2451
CSTT9	0.0484194	0.00467233	10.36	<0.0001
CSTT10	−3.95257e-05	0.00347960	−0.0114	0.9909
CSTT11	0.0243242	0.00342166	7.109	<0.0001
CSTT12	0.00250414	0.00348484	0.7186	0.4733
CSTT13	−0.0249864	0.00640958	−3.898	0.0001
CSTT14	−0.000388022	0.00512695	−0.0757	0.9398
CSTT15	−0.00501656	0.00190801	−2.629	0.0093

Mean dependent var	4.649255	S.D. dependent var	0.224791
Sum squared resid	0.869157	S.E. of regression	0.067635
LSDV R-squared	0.923213	Within R-squared	0.664322
Log-likelihood	305.8262	Akaike criterion	−541.6524
Schwarz criterion	−422.0889	Hannan-Quinn	−493.3961
rho	0.179208	Durbin-Watson	1.317594

Fixed-effects, using 225 observations
Included 15 cross-sectional units
Time-series length = 15
Dependent variable: ln Salaried employment index
Robust (HAC) standard errors

Table C.5.2. Modeling results for the model "Direct Payments Impact on Salaried Employment" in the NMS-12

	Coefficient	Std. Error	t-ratio	p-value
const	5.77620	0.578196	9.990	<0.0001
ln Direct Payments	−0.154737	0.0740764	−2.089	0.0384
ln UAA	−0.00582624	0.0959389	−0.06073	0.9517
Crop share in output	−0.192152	0.212961	−0.9023	0.3684
ln Labor productivity	0.0190588	0.0631772	0.3017	0.7633
ln Labor costs	−0.0553057	0.0705885	−0.7835	0.4346
CSTT1	0.0124808	0.00571955	2.182	0.0307
CSTT2	−0.0152147	0.00289498	−5.256	<0.0001
CSTT3	−0.0180957	0.00692877	−2.612	0.0099
CSTT4	0.00343823	0.00604748	0.5685	0.5705
CSTT5	0.0205245	0.00573970	3.576	0.0005
CSTT6	0.0117169	0.00491829	2.382	0.0185
CSTT7	0.00816212	0.00594932	1.372	0.1722
CSTT8	0.00551332	0.00705382	0.7816	0.4357
CSTT9	0.0284333	0.00410011	6.935	<0.0001
CSTT10	−0.0241291	0.00460714	−5.237	<0.0001
CSTT11	−0.0347284	0.00902627	−3.847	0.0002
CSTT12	−0.0123568	0.00424991	−2.908	0.0042

Mean dependent var	4.497770	S.D. dependent var	0.194501
Sum squared resid	0.872116	S.E. of regression	0.077024
LSDV R-squared	0.868267	Within R-squared	0.636054
Log-likelihood	217.3107	Akaike criterion	−376.6214
Schwarz criterion	−284.6773	Hannan-Quinn	−339.3293
rho	0.351213	Durbin-Watson	1.237288

Fixed-effects, using 176 observations
Included 12 cross-sectional units
Time-series length: minimum 13, maximum 15
Dependent variable: ln Salaried employment index
Robust (HAC) standard errors

Table C.6.1. Modeling results for the model “Direct Payments Impact on Labor Productivity” in the OMS-15

	Coefficient	**Std. Error**	**t-ratio**	**p-value**
const	2.37340	0.832176	2.852	0.0048
ln Direct Payments	0.220768	0.118216	1.868	0.0634
Total specific costs	−0.0490669	0.0654424	−0.7498	0.4543
Crop share in output	0.493872	0.210357	2.348	0.0199
ln UAA	−0.114868	0.266210	−0.4315	0.6666
ln fixed capital per worker	0.0878498	0.107978	0.8136	0.4169
Time dummy_2	−0.0255986	0.00951779	−2.690	0.0078
Time dummy_3	0.00782116	0.0193959	0.4032	0.6872
Time dummy_4	0.0550460	0.0255914	2.151	0.0327
Time dummy_5	0.0971180	0.0300224	3.235	0.0014
Time dummy_6	0.0779946	0.0341629	2.283	0.0235
Time dummy_7	0.119833	0.0398742	3.005	0.0030
Time dummy_8	0.112383	0.0426147	2.637	0.0090
Time dummy_9	0.155239	0.0485760	3.196	0.0016
Time dummy_10	0.214908	0.0575186	3.736	0.0002
Time dummy_11	0.226348	0.0558282	4.054	<0.0001
Time dummy_12	0.242699	0.0586709	4.137	<0.0001
Time dummy_13	0.271200	0.0623269	4.351	<0.0001
Time dummy_14	0.262374	0.0672225	3.903	0.0001
Time dummy_15	0.323094	0.0703735	4.591	<0.0001

Mean dependent var	4.153640	S.D. dependent var	0.652427
Sum squared resid	0.707825	S.E. of regression	0.060876
LSDV R-squared	0.992576	Within R-squared	0.766334
Log-likelihood	328.9254	Akaike criterion	−589.8509
Schwarz criterion	−473.7034	Hannan-Quinn	−542.9733
rho	0.703564	Durbin-Watson	0.520433

Fixed-effects, using 225 observations
Included 15 cross-sectional units
Time-series length = 15
Dependent variable: ln Labor productivity
Robust (HAC) standard errors

Table C.6.2. Modeling results for the model “Direct Payments Impact on Labor Productivity” in the NMS-12

	Coefficient	**Std. Error**	**t-ratio**	**p-value**
const	−2.70644	1.06797	−2.534	0.0123
ln Direct Payments	0.301177	0.0929434	3.240	0.0015
Total specific costs	0.153390	0.157220	0.9756	0.3309
Crop share in output	0.458639	0.471935	0.9718	0.3327
ln UAA	0.105958	0.219468	0.4828	0.6300
ln fixed capital per worker	0.165075	0.104536	1.579	0.1165
Time dummy_2	−0.134242	0.0429570	−3.125	0.0021
Time dummy_3	−0.202906	0.0502396	−4.039	<0.0001
Time dummy_4	−0.159663	0.0424464	−3.762	0.0002
Time dummy_5	−0.145807	0.0422404	−3.452	0.0007
Time dummy_6	−0.119553	0.0434548	−2.751	0.0067
Time dummy_7	−0.0785251	0.0419396	−1.872	0.0632
Time dummy_8	−0.114424	0.0531129	−2.154	0.0329
Time dummy_9	−0.0648063	0.0412270	−1.572	0.1181
Time dummy_10	0.00852749	0.0444619	0.1918	0.8482
Time dummy_11	0.0265083	0.0574036	0.4618	0.6449
Time dummy_12	0.00761998	0.0500653	0.1522	0.8792
Time dummy_13	0.0306805	0.0512828	0.5983	0.5506
Time dummy_14	0.0226001	0.0556978	0.4058	0.6855

Mean dependent var	2.874823	S.D. dependent var	0.562686
Sum squared resid	2.588806	S.E. of regression	0.133160
LSDV R-squared	0.953277	Within R-squared	0.749383
Log-likelihood	121.5641	Akaike criterion	−183.1282
Schwarz criterion	−88.01364	Hannan-Quinn	−144.5502
rho	0.568402	Durbin-Watson	0.685616

Fixed-effects, using 176 observations
Included 12 cross-sectional units
Time-series length: minimum 13, maximum 15
Dependent variable: ln Labor productivity
Robust (HAC) standard errors

Table C.7.1. Modeling results for the model "Direct Payments Impact on Wages of Agricultural Employees" in the OMS-15

	Coefficient	Std. Error	t-ratio	p-value
const	3.48771	1.01758	3.427	0.0041
ln Direct Payments	−0.0932441	0.105453	−0.8842	0.3915
ln Net earnings in a country (total NACE)	0.636289	0.105893	6.009	<0.0001
ln Total unemployment	−0.00901114	0.0237866	−0.3788	0.7105
ln Labor productivity	0.0400800	0.0805604	0.4975	0.6265
CSTT1	−0.0151457	0.00269529	−5.619	<0.0001
CSTT2	0.00181808	0.00223685	0.8128	0.4299
CSTT3	0.00936854	0.00327394	2.862	0.0126
CSTT4	0.0138382	0.00409533	3.379	0.0045
CSTT5	0.0127262	0.00225626	5.640	<0.0001
CSTT6	0.00646932	0.00274355	2.358	0.0334
CSTT7	0.0124477	0.00422737	2.945	0.0107
CSTT8	0.0170333	0.00198496	8.581	<0.0001
CSTT9	0.0218208	0.00222510	9.807	<0.0001
CSTT10	0.00133890	0.00215726	0.6206	0.5448
CSTT11	0.0345842	0.00242717	14.25	<0.0001
CSTT12	0.0207611	0.00334360	6.209	<0.0001
CSTT13	0.0163083	0.00477983	3.412	0.0042
CSTT14	0.00208548	0.00246734	0.8452	0.4122
CSTT15	0.00622402	0.00278031	2.239	0.0419

Mean dependent var	9.923622	S.D. dependent var	0.465058
Sum squared resid	0.525086	S.E. of regression	0.052432
LSDV R-squared	0.989162	Within R-squared	0.847698
Log-likelihood	362.5218	Akaike criterion	−657.0436
Schwarz criterion	−540.8962	Hannan-Quinn	−610.1660
rho	0.300365	Durbin-Watson	1.292120

Fixed-effects, using 225 observations
Included 15 cross-sectional units
Time-series length = 15
Dependent variable: ln Wages per AWU
Robust (HAC) standard errors

Table C.7.2. Modeling results for the model "Direct Payments Impact on Wages of Agricultural Employees" in the NMS-15

	Coefficient	Std. Error	t-ratio	p-value
const	2.50564	0.958203	2.615	0.0099
ln Direct Payments	0.0525655	0.0647671	0.8116	0.4184
ln Net earnings in a country (total NACE)	0.478049	0.144312	3.313	0.0012
ln Total unemployment	−0.0132915	0.0245078	−0.5423	0.5885
ln Labor productivity	0.171294	0.0845960	2.025	0.0448
CSTT1	0.0302070	0.00910650	3.317	0.0012
CSTT2	−0.0205464	0.00497873	−4.127	<0.0001
CSTT3	0.0249693	0.00705222	3.541	0.0005
CSTT4	0.0365361	0.00713811	5.118	<0.0001
CSTT5	5.33611e-05	0.00679874	0.007849	0.9937
CSTT6	0.0368796	0.00757597	4.868	<0.0001
CSTT7	0.0321566	0.00856166	3.756	0.0003
CSTT8	0.00894393	0.00392746	2.277	0.0243
CSTT9	0.0282794	0.00781131	3.620	0.0004
CSTT10	0.0129866	0.00777287	1.671	0.0970
CSTT11	0.0355137	0.00600331	5.916	<0.0001
CSTT12	0.0146576	0.00324379	4.519	<0.0001

Mean dependent var	8.950510	S.D. dependent var	0.452544
Sum squared resid	0.567898	S.E. of regression	0.064150
LSDV R-squared	0.983194	Within R-squared	0.953100
Log-likelihood	235.7138	Akaike criterion	−415.4276
Schwarz criterion	−328.2919	Hannan-Quinn	−380.0586
rho	0.236399	Durbin-Watson	1.299782

Fixed-effects, using 166 observations
Included 12 cross-sectional units
Time-series length: minimum 7, maximum 15
Dependent variable: ln Wages per AWU
Robust (HAC) standard errors

Annex D. Sample of a Questionnaire Used in an Expert Survey

Gerbiamasis (-oji) eksperte,

Vis dažnėjančių ir intensyvėjančių krizių, nepalankių meteorologinių įvykių bei didėjančio netikrumo akivaizdoje žemės ūkio atsparumas yra vienas svarbiausių tiek kiekvienos šalies, tiek visos Europos Sąjungos žemės ūkio politikos prioritetų. Visgi žemės ūkio atsparumo fenomenas bei jį lemiantys veiksniai iš mokslinės pusės tyrinėtas mažai ir fragmentiškai.
Aš, Agnė Žičkienė, jungtinių Vilniaus Gedimino technikos universiteto bei Lietuvos socialinių mokslų centro doktorantūros studijų doktorantė, rašau disertaciją tema „Tiesioginių išmokų įtakos žemės ūkio atsparumui vertinimas“. Šiame tyrime žemės ūkio atsparumas traktuojamas kaip šios šakos gebėjimas absorbuoti įvairias krizes bei prisitaikyti prie jų, jei būtina, keičiant savo esamas ekonomines ar socialines struktūras ar institucinę sąrangą, išlaikant pagrindines savo funkcijas bei jų įvykdymo lygį tam tikru laikotarpiu. Pagrindinėmis žemės ūkio funkcijomis laikomi: gebėjimas gyventojus aprūpinti maistu prieinamomis kainomis; gebėjimas užtikrinti ūkių gyvybingumą; gebėjimas žemės ūkio sektoriuje išlaikyti kokybiškas darbo vietas ir jas kurti.
Šia apklausa siekiama nustatyti, kiekvienos iš paminėtų žemės ūkio sektoriaus funkcijų santykinę svarbą bei tiesioginių išmokų poveikį joms.
Jūsų nuomonė labai vertinama. Užpildyti anketą užtrunka apie 5 min.

Jei Jums kyla neaiškumų atsakinėjant į klausimus, prašome kreiptis į Agnę Žičkienę (tel. 865096748, agne.zickiene@laei.lt).

Iš anksto labai dėkoju Jums už bendradarbiavimą!

1. **Pateiktas žemės ūkio funkcijas įvertinkite pagal svarbą šaliai nuo 1 iki 5 balų. Jei kelios funkcijos, Jūsų nuomone, yra vienodai svarbios, skirkite joms vienodai balų.**

Mažiausiai svarbi Svarbiausia

1 2 3 4 5

Žemės ūkio funkcija	Funkcijos svarba, balais
Maisto ir kitos žemės ūkio produkcijos gamyba prieinamomis kainomis	
Ūkių gyvybingumo užtikrinimas	
Kokybiškų samdomo darbo vietų žemės ūkio sektoriuje išlaikymas ir kūrimas	

2. **Kiekviena žemės ūkio funkcija vertinama keletu rodiklių. Rodiklius įvertinkite pagal svarbą atitinkamos funkcijos vertinimui nuo 1 iki 5 balų. Jei keli rodikliai, Jūsų nuomone, yra vienodai svarbūs, skirkite jiems vienodai balų.**

Mažiausiai svarbus — Svarbiausias

1 — 2 — 3 — 4 — 5

Funkcija ir jos vertinimo rodikliai	Rodiklio svarba funkcijos įvertinimui, balais
Funkcijos „ Maisto ir kitos žemės ūkio produkcijos gamyba prieinamomis kainomis “ vertinimo rodikliai:	
Žemės ūkio produkcijos vertė	
Maisto produktų vidutinių mažmeninių kainų indekso santykis su visų vartojimo kainų indeksu	
Funkcijos „Ūkių gyvybingumo užtikrinimas“ vertinimo rodikliai:	
Ūkių grynojo pelno marža	
Ūkio kaštų ir produkcijos santykis	
Ūkių skolos ir turto santykis	
Funkcijos „Kokybiškų samdomo darbo vietų žemės ūkio sektoriuje išlaikymas ir kūrimas“ vertinimo rodikliai:	
Samdomų darbuotojų skaičius žemės ūkio sektoriuje	
Darbuotojų produktyvumas	
Vidutinis darbo užmokestis žemės ūkyje	

Agnė ŽIČKIENĖ

IMPACT ASSESSMENT OF DIRECT PAYMENTS OF EU COMMON AGRICULTURAL POLICY ON ECONOMIC RESILIENCE OF AGRICULTURE

Doctoral Dissertation

Social Sciences,
Economics (S 004)

ES BENDROSIOS ŽEMĖS ŪKIO POLITIKOS TIESIOGINIŲ IŠMOKŲ ĮTAKOS ŽEMĖS ŪKIO EKONOMINIAM ATSPARUMUI VERTINIMAS

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