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The Environmental and Climatic CAP Measures in Poland vs. Farmers' Expectations—Regional Analysis

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Abstract: The Common Agricultural Policy of the European Union remains at the top tier of the union's legacies with the aim of bequeathing a sustainable future for all. Series of actions geared towards reforming the environmental and climate goals of the CAP are constantly being taken. The objective of this paper is to verify if the environmental and climatic CAP measures proposed in Poland's Strategic Development Plan for Agriculture, for the years 2023–2027, reflect farmers' preferences regarding the structure of the CAP support. To achieve this goal, we model a hypothetical strategic game involving farmers from different regions. The outcomes of the game were derived from the ex-post analysis of EU funds, in the application for environmental and climatic CAP measures, in addition to the results of simulations of the partial equilibrium model for the agricultural sector (CAPRI). It was found out that farmers from regions with disadvantaged agrarian structures would find it more difficult to cope with new eco-schemes due to the fact that good agricultural practices are rather low in such regions. For the long-term development of Polish agriculture, the agrarian structures need to be improved, as this affects the emission of greenhouse gases. The varying preferences of farmers from different Polish regions in implementing eco-schemes can be balanced by increasing redistributive payments.

Keywords: rural development; CAP; environmental sustainability; regional diversification

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1. Introduction

Since its introduction in 1957, the EU Common Agricultural Policy has been undergoing a series of improvements and modifications aimed at promoting food security and, recently, suitable land use. The results of Sadowski and Baer-Nawrocka (2018) [1] suggest that EU agriculture is currently among the most sustainable in the world. In order to encourage environmentally sustainable farming, the 2013 CAP reform introduced a payment for a compulsory set of 'greening measures', accounting for 30% of the direct payments budget. Greening, or sustainable land use, is a process whereby farmers who adopt or maintain farming practices that help meet environmental and climate goals are rewarded with payments. In other words, greening is seen as a reward system for farmers for preserving natural resources and providing public goods (which are benefits to the public but not reflected in market prices).

The new CAP, starting in 2023, will also aim to enhance environmental sustainability of the agricultural sector. As part of measures to maintain the EU's climate objectives and protect the environment, the EU proposed the so-called eco-schemes for the future CAP. Eco-schemes refer to payment schemes for the care of the environment and climate, which will be funded from member states' first Pillar budgets of the CAP. The member states have to make one or more eco-schemes available, but farmers will have the freedom to participate or not. The condition for granting payment per hectare of the area covering the eco-scheme is the implementation of at least one practice on the farm. Many other types of payment will continue to be offered in CAP Pillar II, which can support care for the environment and climate, as well as support for rural areas.

It is worth adding that the above-mentioned CAP instruments, to strengthen efforts to reduce the negative impact of agricultural production on the environment and climate, are in line with the regulatory changes announced at the end of 2019 as part of the European Green Deal (EGD). The aim of the EGD is to minimize the scale of consumption of natural resources while maintaining the EU's international competitiveness. As a result of the implementation of the EGD, by 2050, Europe is to become the first climate-neutral continent, maintaining the sustainable development of the economy and improving the health and quality of life of citizens. Almost all elements of EGD relate directly and indirectly to agriculture. However, two strategies will have the greatest impact on the agricultural sector, (1) "from farm to fork", i.e., creating a fair, healthy and environmentally friendly food system, and (2) protection and restoration of ecosystems. The farm-to-fork strategy aims to provide all Europeans with fresh and safe food, produced using sustainable practices (such as precision farming, organic farming, agroecology, agro-forestry) and stricter animal welfare standards, while ensuring decent living conditions farmers and their families. In turn, the biodiversity strategy emphasizes the importance of protecting natural capital, including agricultural and forest ecosystems (Report on the Impact of the European Green Deal on Polish agriculture, Polityka Insight, Research, Warsaw, 2021).

For each financial perspective, member states prepare national or regional development programs for agriculture. Since her accession to the EU, Poland has introduced three RDPs (2004–2006, 2007–2013, and 2014–2022) and proposed a Strategic Development Plan for Agriculture for the years 2023–2027. All plans were set by the Ministry of Agriculture at a national level. For the year 2023, the planning of the structure of CAP measures, at a national level, is done for two pillars in one strategic development program for agriculture.

Due to a large regional differentiation of agricultural structures and centralized planning of EU funds distribution in Poland (in the form of one Strategic Development Plan for Agriculture), there is an open question of how to organize a national development plan and the allocation of funds in order to adjust to new policy requirements and, at the same time, satisfy diversified needs of farmers. Farmers might not be willing to apply for optional eco-schemes, as additional effort is required to apply, meet requirements, and get rewarded. Other policy measures, such as direct payments, redistribution payments, or second pillar programs are more easily accessible and more tempting, especially for owners of smaller farms. Moreover, as eco-schemes (which are to be introduced in 2023) are a new proposal, farmers' responses to them remain uncertain and might differ across Polish regions. Note that, with a limited budget, an increase in spending for one political program decreases the possible allocations for the other measures. Thus, satisfying the preferences of a regionally diversified group of farmers on a national level, within one strategic development program, without a regional approach remains a challenge. The objective of this paper is to verify if the environmental and climatic CAP measures, proposed in Poland's Strategic Development Plan for Agriculture for the years 2023–2027, reflect farmers' preferences regarding the structure of the CAP support. To achieve this goal, we model a hypothetical strategic game involving farmers from different regions. The game payoffs are based on the ex-post analysis of EU funds' application for measures aimed to enhance environmental sustainability of the agricultural sector, as well as the findings of simulations of the partial equilibrium model for the agricultural sector (CAPRI-Common Agricultural Policy Regionalized Impact model).

The layout of the paper begins with the presentation of the literature review and research method. This is followed by a description of the regional differences in agricultural structures in Poland and farmers responses to policy measures proposed until 2022, with a special emphasis on measures dedicated to enhance environmental sustainability of the agricultural sector (agri-environment-climate action and organic farming). Lastly, we present the results of the simulations and conclude with a discussion.

2. Literature Review

The CAP greening concept and other environmental policy tools of the CAP have, so far, generated mixed reactions in terms of the overall benefits, as well as economic and environmental impact. As previously mentioned, Sadowski and Baer-Nawrocka (2018) [1] showed that agricultural production in the EU is one of the most sustainable on a global scale. Their research proved that, in the last 50 years, the greatest progress in reducing the polygenicity of production, expressed in the amount of greenhouse gas emissions per 1 Kcal of the production, was noted in the EU. This process has been enforced both by the pro-ecological policy (with greater intensity carried out especially since the beginning of the 1990s as a result of the MacSharry reform) and by scientific and technical progress.

With the exception of Asia, the ecological "costs" of agricultural energy production, in many other parts of the world, are higher than in European agriculture. One of the highest in EU agriculture, compared to other regions, is polygenicity per 1 ha of UAA. However, it was emphasized that, firstly, it occurs in the conditions of a relatively small nutritional surface per capita and, secondly, it occurs in the EU, which is the only area of the world, in recent years, where there has been a reduction in greenhouse gas emissions from agriculture per unit area. In summary, it was found that, in the short term, the simultaneous implementation of the nutritional goal and full ecological goals does not occur in agriculture in any of the regions in the world. Nevertheless, in the global and long-term perspective, European Union agriculture largely corresponds to the postulate of durability and sustainability. Against the background of world agriculture, in the institutional conditions guaranteed by the CAP, it meets the postulates of economic and social balance to a relatively high degree, and its development occurs along with the negative impact on the environment.

The 2013 CAP reform introduced payment for a mandatory set of 'greening measures', which led to minor improvements in environmental protection and nature conservation [2]. While the number of important ecological areas increased slightly, there was very little change in the diversity of arable crops compared to the period before the introduction of greening. The national average of permanent grassland also increased modestly. However, this increase cannot be attributed exclusively to greening. The use of pesticides, on the other hand, did not significantly reduce the environmental risk because there was also virtually no change in land use. One reason for such minor changes is that farms were not required to adjust their production methods significantly in order to receive the full subsidy. It can, therefore, be concluded that the way in which the greening measures were designed was insufficiently ambitious to bring about significant positive effects for the environment. According to Dessart (2019) [3], greening is viewed in a relatively positive light, as it provides some significant benefits, mainly for wildlife (ecological focus areas), for soils (crop diversification and catch crops mean less need for chemicals), and, ultimately, for business, without too many constraints. On the other hand, Dessart (2019) [3] also stated three main areas of concern on greening, which include the lack of coherence of some requirements with the stated environmental goals, skepticism regarding the true goal of greening, and the lack of additivity. In their paper, Gocht et al. (2017) [4] also provided a qualitative assessment of the economic and environmental effects of CAP greening in the EU. According to them, CAP greening leads to a minor increase in the utilized agricultural area (around 0.6% in the EU-28), meaning that farmers partially reduce the impact of greening requirements by bringing new land into cultivation or by counting it as EFA. The results of their simulation also showed that CAP greening will lead to a small increase in prices in parallel with the decrease in production, with arable crop products mostly affected. In terms of the environment, the authors found out that greenhouse gas emissions decrease, on average, by −0.2% in EU-28. According to their study, Hristov et al. (2020) [5] implied that greening measures need to be tailored to local conditions and priorities in order to produce improvements in the environment. They further stated that the environmental performance of CAP can only be improved if member states are given the flexibility to devise spatially targeted environmental measures that are complemented by the power to

require evidence of environmental improvements as a basis of payments, such as a form of result-based scheme. In Poland, the total CAP funds distribution is planned, on the national level, in the form of one strategic development plan for agriculture. Due to the differences in agricultural structures, Polish farmers derive different levels of benefit from the CAP depending on the region [6–10]. As pointed out by Kiryluk-Dryjska and Baer-Nawrocka (2021) [11], based on CAPRI model calculations, regions with lesser potentials do not gain as many benefits from the CAP as the regions with greater potential (mostly including the territories with a larger average farm area). This is because the amount of support provided under pillar I is allocated according to the area of the farm's agricultural land. To reduce differences in the amount of aid granted between the farms in Poland, redistribution payments were used in the current policy and are planned for the years 2023–2027. Presently, the payment is available to all Polish farms with an area of 3–30 ha, and the criteria for disbursement is the area of land eligible for the single area payment (however, for no more than 27 ha per farm). The required number of hectares for the payment is limited on a per country basis (30 hectares or the average farm size in the country concerned, if over 30 hectares). The amount per hectare cannot exceed 65% of the average payment per hectare, as formulated by the EU [12]. In the coming 2023–2027 Strategic Development Plan for Agriculture in Poland, the support is granted from 1 ha to 30 ha for farms with the total area ranging from 3 to 50 ha.

Theoretically, the varying levels of benefits derived from the CAP were also to be reduced by measures of its second pillar, due to the fact that it is aimed at restructuring. In line with rural development programs set by each country, additional financial assistance necessary for activities aimed at rural and agricultural development can be obtained. Co-financing development projects, carried out by rural residents, receive support, and the application depends largely on how active the potential beneficiaries are. As opined by Smędzik-Ambroży et al. (2019) [13], the results of the previous programs also suggest that larger farms benefited more than smaller farms from pillar II, which also has the regional dimension [14–16]. The study by Matyka (2019) [17] disclosed that the implementation of the main environmental activities under the RDP 2014–2020 is largely differentiated on a regional level. He further stated that the intensity of implementation of the agri-environment climate and organic farming measures were correlated directly with average farm size. According to Biernat-Jarka and Trebska (2018) [18], organic farming in Poland shows quite large regional variations, resulting largely from natural conditions. Thus, it can be implied that applications for eco-schemes would also be affected by agricultural structures in regions.

3. Materials and Methods

We predict farmers' preferences regarding the structure of the CAP support in Poland after the implementation of eco-schemes with the use of the strategic game with ordinal preferences. Game theory is a division of science that aims to examine how people arrive at decisions in conflicting circumstances. It provides methods for logical analysis of conflicts and an integrating force of economics and political sciences. The primary goal of game theory is to help to understand situations in which decision-makers interact. Game theory is called a natural tool of social interaction analyses [19]. In addition, Osborne (2004) [20] underlines the understanding that game theoretic models are particularly relevant in social, political and economic arenas.

Studying game theoretic model may suggest ways in which an individual or group's behavior can be improved to actualize a better outcome. Thus, studying conflicts using game theory is often used to predict and enhance their results. By analyzing the incentives encountered by players involved in battle, we may also see the merits and demerits of various strategies.

Game theory assumes that a decision-maker chooses the best action according to his preferences, among all the actions available to him. The model captures the interaction between players by allowing each player to be affected by the actions of all players. Thus,

the result of the game is determined by the actions taken by all players. Game theory examines the way in which actors make choices when the outcomes following from that choice depend not only on their own choice but the choice made by others. Given the assumption of a common knowledge of rationality, actors choose the best possible strategy on the assumption that their opponent will play their best possible strategy. The resulting outcome, if there is one, is Nash's equilibrium.

Nash equilibrium of strategic game with ordinal preferences is the action profile a^* where for every player i and every action a_i of player i, a^* is at least as good according to player i's preferences as the action profile (a_i, a^*_{-i}) in which player i chooses a_i while every other player j choses a^*_j. Equivalently, for every player i, $u_i(a^*) \geq u_i(a_i, a^*_{-i})$ for every action a_i of player i, where u_i is a pay-off function that represents player i's preferences.

The description of a Nash equilibrium is set up to model a steady state among players. Game theory is especially useful in politics when all actions taken by decision-makers are interdependent. Game theoretic models have also been used to enhance understanding of the Common Agricultural Policy's decisions. On his part, Patterson (1997) [21] examines the conditions under which this important shift of the CAP occurred. The study concludes that the power and heterogeneity of interest groups at various levels of the game matter, that the real and perceived costs of no agreement affect the degree of substantive reform, and, finally, that a three-level interactive strategy is important in achieving an acceptable agreement at each level of the game. In their work, Coleman and Tangermann (1999) [22], drawing on the concept of linked games, conclude that the reform of the Common Agricultural Policy (CAP) showed to be significantly shaped by proposals and outcomes in the international negotiations on agriculture during the GATT Uruguay Round. The non-cooperative game theory was used by Kiryluk-Dryjska (2016) [23] and Kiryluk-Dryjska and Baer-Nawrocka (2019) [24] to demonstrate the rationale behind the CAP reforms. In this paper, we demonstrate how game theory models can be jointly used with the CAPRI model simulations to assess the policy changes.

The process of formulating and analyzing a strategic game model should improve the understanding of the situation we are considering. The strength of the game theory, model with ordinal preferences, is its simplicity; the premise upon which it rests should catch the core nature of the situation. In order to make predictions with the use of the strategic games, a credible assumption of a preference structure of the players is critical. In our approach, the game payoffs are based on the ex-post analysis of EU funds' application for measures of Polish Rural Development Program (PRDP) 2014–2020, aimed to enhance environmental sustainability of the agricultural sector, as well as the results of simulations of the partial equilibrium model for the agricultural sector—CAPRI (Common Agricultural Policy Regionalized Impact model).

The CAPRI model is widely used for the estimation of changes of the agricultural sector of the European Union. For instance, this model was applied for environmental changes estimation related to different agricultural policy reforms [25–28]. There were simulated changes in the production sphere, economic effects, and land utilization under the influence of improvements in the procedure of direct payments (decoupling) [29–32]. In their research, Schroeder et al. (2015) [33] extended the CAPRI model with a regional computational general equilibrium (CGE) model to estimate the effects of Pillar II of the Common Agricultural Policy. The database of the model is based on data gotten at the national and regional level from EUROSTAT, the Economic Accounts for Agriculture (EAA), as well as Farm Accountancy Data Network (FADN). Subsequently, trends functions are defined on the basis of: the above-mentioned database, various prognoses of the macroeconomic indicators and agricultural world market (by OECD, FAO, and DG-AGRI), as well as user-presumed scenario changes within the CAP. In this paper, CAPRI was used to give insights about farmers' responses to eco-schemes in Polish regions by simulating regional dependence on Polish farms on the CAP's greening measures, taking as a proxy the emissions of CO_2, CH_4, and N_2O. The simulation is performed with the use of CAPRI model with two extreme policy options. The first, assumes the continuation of the current

greening policy of the CAP. The second, in contrast assumes a total dismantling of the CAP. The comparison of the scenarios results shows not only the differences in the emissions on national but also on regional level.

To make reliable game pay-offs, apart from CAPRI results, we also use statistical data from Polish Agency of Modernization and Restructuration of Agriculture on the ex-post analysis of EU funds' application for measures aimed to enhance environmental sustainability of the agricultural sector. In the paper we also use recent Polish statistical office data on farms' structure and agricultural potential expressed by land, labor, and capital relations, as well as agricultural productivity in Polish regions.

4. Results

Table 1 presents the average farm area, the potential of farms expressed by the relations of land, labor, and capital, as well as agricultural productivity in Polish regions. Agricultural structures are widely regionally diversified in Poland. This results in diversified land use and its productivity. Average farm area in Poland oscillates between 3.9 ha and 27.6 ha, with the smallest in Southern regions of the country (Małopolskie, Podkarpackie, Świętokrzyskie and Śląskie). The research from Baer-Nawrocka and Poczta (2021) [10] shows that, in the above voivodeships, the share of the smallest farms (up to 5 ha), in the total population of holdings larger than 1 ha, is 65–85%, i.e., considerably above the average figure for Poland (52.4%). The agricultural structure problem consists in the concentration of agricultural land in different size groups. In these regions, small farms hold 30–50% of agricultural land. Conversely, a much more favorable structure of farms can be found in voivodeships where former state-owned agricultural holdings gave rise to the establishment of relatively large farms. These are the western and northern parts of Poland, including the Zachodniopomorskie, Warmińsko–Mazurskie, and Pomorskie voivodeships. In these regions, most agricultural land is concentrated in farms larger than 50 ha, and the average farm size is very much above the average Polish level of 10.5 ha of agricultural land. A very similar pattern can be observed regarding the area of utilized agricultural land and the value of capital per person fully employed in agriculture. A positive interdependence between land, labor, and capital result in agricultural productivity. As it can be seen from Table 1, the productivity in southern regions is the smallest among all regions. Global agricultural production per 1 AWU in Małopolskie, Podkarpackie, Świętokrzyskie, and Śląskie does not exceed national average. With regard to these regions, it can be concluded that the production potential of farms is low. In turn, farms located in the west and north are characterized by more favorable relations between production factors and, consequently, production results.

Table 1. Characteristics of agricultural potential and productivity in the Polish regions.

Region	Average Farm Area (ha)	UAA/1 AWU (ha)	Capital Value/1 AWU (EUR)	Global Agricultural Production/1 ha UAA (EUR)	Global Agricultural Production/1 AWU (EUR)
Dolnośląskie	15.0	12.3	19.9	969.5	11,687.8
Kujawsko-pomorskie	17.3	9.7	17.0	1423.8	13,868.4
Lubelskie	8.4	5.0	7.9	1193.1	5875.5
Lubuskie	18.6	16.3	21.2	961.2	14,666.3
Łódzkie	8.0	5.7	11.7	1586.2	8945.8
Małopolskie	3.9	2.9	6.2	1298.6	3534.9
Mazowieckie	9.1	6.6	12.7	1598.4	10,519.0
Opolskie	18.6	10.8	21.2	1257.7	13,518.4
Podkarpackie	4.3	3.4	6.2	848.2	2749.2
Podlaskie	14.1	8.4	14.2	1197.0	10,157.8
Pomorskie	18.7	12.7	19.6	1131.8	14,168.0

Table 1. *Cont.*

Region	Average Farm Area (ha)	UAA/1 AWU (ha)	Capital Value/1 AWU (EUR)	Global Agricultural Production/1 ha UAA (EUR)	Global Agricultural Production/1 AWU (EUR)
Śląskie	6.4	5.1	13.3	1421.2	6708.9
Świętokrzyskie	5.6	3.7	7.4	1369.4	4950.7
Warmińsko-mazurskie	22.4	16.3	24.8	1007.1	16,126.8
Wielkopolskie	14.0	8.5	18.6	1866.8	15,822.4
Zachodniopomorskie	27.6	22.0	31.2	796.5	17,075.0

Source: own elaboration based on Polish statistical office data.

To model the game predicting farmers' preferences, regarding the structure of the CAP support in Poland after eco-schemes' implementation, we use two components. The first consists of the ex-post analysis of the regional applications for the agri-environment-climate measure and organic farming in the years 2014–2020 (Table 2). The second, theoretical one involves a regionalized simulation of the emission of greenhouse gases in the agricultural sector in Poland (Table 3). The simulation is performed with the use of CAPRI model with two extreme policy options. The comparison of the scenario's results shows not only the differences in the emissions on national but also on regional level. We take the changes in the level of the emission between the two examined policy options as a proxy of farms' preparation for eco-requirements proposed by the CAP. Relatively small differences in the emissions level between two analyzed policy scenarios would suggest that farms' eco-practices are already more advanced, and initially, farmers are better prepared to engage in new CAP ecological restrictions, including the eco-schemes implementation. In contrast, large differences suggest that farms still need some longer adaptation process, as their structures are not yet advanced enough to engage in new eco-practices.

Table 2. Number of beneficiaries of agri-environmental, climate action, and organic farming in regions per 100 farms across Polish regions.

Region	Agri-Environment-Climate Action	Organic Farming
Dolnośląskie	8.42	1.93
Kujawsko-pomorskie	11.50	0.72
Lubelskie	7.62	1.52
Lubuskie	17.71	7.87
Łódzkie	2.72	0.54
Małopolskie	3.27	0.89
Mazowieckie	3.88	1.26
Opolskie	5.70	0.36
Podkarpackie	8.14	1.15
Podlaskie	12.85	5.64
Pomorskie	18.44	2.37
Śląskie	2.25	0.38
Świętokrzyskie	5.96	1.22
Warmińsko-mazurskie	18.61	12.63
Wielkopolskie	7.39	0.81
Zachodniopomorskie	18.36	13.00
Poland	9.55	3.27

Source: own calculation based on Report of the Agency for Restructuring and Modernization of Agriculture 2020.

Table 3. The changes in the emission level of carbon dioxide, methane, and nitrous oxide in Polish agriculture when deleting the CAP.

	Total CO_2eq-(kg CO_2eq/ha) (%)	CH4-(kg CO_2eq/ha) (%)	N_2O-(kg CO_2eq/ha) (%)
Poland	4.06	5.54	3.18
Łódzkie	3.08	4.21	2.33
Mazowieckie	3.65	4.66	2.77
Małopolskie	4.62	6.90	2.89
Śląskie	6.31	8.94	4.77
Lubelskie	2.87	5.09	1.90
Podkarpackie	6.75	7.39	6.40
Świętokrzyskie	4.54	6.14	3.57
Podlaskie	2.97	4.39	1.50
Wielkopolskie	3.72	5.19	2.91
Zachodniopomorskie	3.52	2.31	3.83
Lubuskie	3.98	7.52	2.58
Dolnośląskie	3.94	4.86	3.74
Opolskie	2.90	2.19	3.11
Kujawsko-Pomorskie	2.55	3.69	1.89
Warmińsko-Mazurskie	5.02	7.22	3.34
Pomorskie	4.61	5.76	4.14

Source: own calculations based on CAPRI model.

The total budget of the Polish Rural Development Program for years 2014–2020 amounted to EUR 13,513 million, and around 14% of this value was allocated to the agri-environment-climate measure (EUR 1184 million) and organic farming (EUR 699 million). Table 2 presents the number of beneficiaries of agri-environmental, climate action, and organic farming in regions in relation to the number of farms in regions.

The highest number of beneficiaries of agri-environmental, climate action, and organic farming is observed in Zachodniopomorskie and Warmińsko-mazurskie, with the lowest in Świętokrzyskie, Małopolskie, Śląskie, and Podkarpackie. Comparing the results with data on agricultural potential (Table 1), it can be concluded that regions with lower than average agricultural potential in Poland showed lower interest in PRDP 2014–2020 programs dedicated to enhance environmental sustainability of the agricultural sector.

Table 3 presents the changes in the emission level of carbon dioxide, methane, and nitrous oxide between two analyzed scenarios simulated with the use of CAPRI model, as explained in the methodological part of the paper. The difference demonstrates the changes of the emission, while dismantling the CAP, compared to the current state.

In investigating the repercussions of suspending the CAP, it can be deduced that doing so would increase the total emissions of greenhouse gases in Poland. Without the CAP's greening measures the total emissions of carbon dioxide, methane and nitrous oxide would be larger by 4.1%, 5.5%, and 3.2%, respectively. The results suggest that greening programs implemented, until 2022, were effective, with respect to the level of emissions. Moreover, the results demonstrate that this impact was the highest in regions predominated by small farms with weak agricultural structures (Małopolskie, Śląskie, Podkarpackie and Świętokrzyskie). This result might be surprising, but it can suggest that, without the CAP, regions predominated by the presence small farms in Poland would be more ecologically harmful than those by the larger farms. This can be explained by the low level of good agricultural practices implemented by the owners of small holdings. As reported by Sadowski (2012) [34], apart from the fact that entities with a small area are mostly ineffective and non-competitive, their activities are often not environmentally friendly. Application for direct payments forced farmers to meet certain EU standards, but still, their adaptation level to new requirements is not sufficient. Thus, we conclude that farmers from regions with less advantages in agrarian structures would have more

difficulties with coping with new eco-schemes, as the level of their good agricultural practices is still relatively low.

Due to strongly regionally diversified applications for programs enhancing ecological sustainability of the agricultural sector in the years 2014–2020 and presented results of the CAPRI simulation, we assumed that a hypothetical game is played between the farmers working in regions that have a smaller/greater production potential competing to structure expenditures from CAP, according to their preferences.

When anticipating the preferences versus the CAP measure structure in Poland, we suppose that expanding the redistributive payment for small farms as well as expenses of pillar II of the CAP would be the best strategic choice for farmers from areas having lower production potential. Since farmers from these zones, with smaller production capacity, are not yet prepared to cope with new eco-schemes, they clearly would not opt for it. A safer option would be to increase expenses for the pillar II programs, with which they are already familiar with. The alternative with the least benefit for them would comprise smaller support for redistributive payment for small farms and implementation of eco-schemes. This option would strongly decrease their competitiveness versus larger farms, which would not only gain more from direct payments but also more easily apply for eco-schemes.

With respect to farmers based in areas with greater production capabilities, the most valuable choice would be to decrease the redistributive payment for small farms, while concurrently implementing eco-schemes. As stated above large farms are better prepared to meet eco-schemes requirements, especially if they were supported by the high basic direct payment. The second-best alternative would be to reduce the redistributive payment for small farms but increase pillar II expenditures. The least profitable choice for them would include raising the funds offered for redistributive payment and the second pillar expenditures. Table 4 shows a pay-off matrix of the non-cooperative game centered on the choices addressed above. It allows for a rational examination of the stances embraced by farmers in the negotiation process. The matrix was formulated based on ordinal utilities, with 4 and 1 being equivalent to the largest and smallest utility, respectively. It can be seen that the two extreme options of the two groups of players are opposite. The best option for one group is the worst for the second. Farmers functioning in areas with a larger production capacity would eagerly approve a decrease in redistributive payment and implement eco-schemes, while this policy option would be the worst among that analyzed for the second group. Conversely, farmers working in zones with a smaller production capability would be willing to enlarge support for redistributive payment and the second pillar, which would be the least advantageous for their opponents.

Table 4. Pay-off matrix for the strategic game.

		Farmers Performing Operations in Areas with a Smaller Production Capacity	
		Lobby for larger support under redistributive payment (relatively smaller basic payment)	Accept smaller support under redistributive payment (relatively larger basic payment)
Farmers operating in regions with a greater production potential	Accept implementation of eco-schemes	2, 3 *	4, 1
	Lobby for an increase expenditure for the 2nd pillar measures	1, 4	3, 2

Source: own compilation. * Nash equilibrium.

Nash equilibrium is in the state (2, 3). It is the result of two dominant strategies: accept the implementation of eco-schemes (for farmers operating in areas with a greater production capacity) and lobby for larger support under redistributive payment (farmers performing

operations in areas with a smaller production capacity). Accepting to implement eco-schemes combined with the larger support under redistributive payment is a steady state among players. It can be considered a stable outcome satisfying the preferences of farmers from different Polish regions.

The achieved results can be confirmed by the alternative game theory concept introduced by Brams [35]—the theory of moves. The theory is dynamic and explains strategically the progression of players' states that lead to a new equilibrium. Based on possible pay-offs, the players can decide whether or not to change their strategy to attain a more advantageous state. A play of a game starts in an initial state, at which players accrue payoffs only if they remain in that state so that it becomes the final state, or outcome, of the game. If they do not remain in the initial state, they still know what payoffs they would have accrued had they stayed; hence, they can make a rational calculation of the advantages of staying or moving [35]. If the game starts (as in the analyzed case) in a state (2, 3), players remain in that state, and it becomes the outcome of the game.

5. Discussion

Our results demonstrate that environmental and climatic CAP measures result in a decrease in greenhouse gases emissions produced by the agricultural sector in Poland. The decreases are larger in regions with relatively disadvantageous agrarian structures. Eco-schemes, planned from 2023, offer a new possibility for spending part of the direct payments budget on care for the environment and climate, thus supporting the transition towards more sustainable farming. In their findings, Gotch et al. (2017) [4] estimate that CAP greening will lead to the further decrease in greenhouse gas emissions in EU-28. However, it will also lead to the decrease in production, which might affect the competitiveness of the EU agriculture. Concerns about implementation of the European Green Deal in agriculture are also raised by the authors of the Report on the Impact of the European Green Deal on Polish Agriculture [36], who calculate that agriculture in many regions of Poland, taking into account the unfavorable agrarian structure and, consequently, unfavorable relations between the land, labor, and capital, as well as their low productivity, is not yet prepared to implement the assumptions of the EGD. The actual production possibilities and competitive agriculture depend, to a large extent, on the agrarian structure. The agrarian structure largely determines the possibility of implementing modern technological solutions necessary for the implementation of the planned changes within the EGD. As larger farms (mostly operating in regions with more advantageous agrarian structures) are able to partly reduce the effect of greening requirements by scale of production and total direct support, smaller farms might not be able to cope with it. They are not only not sufficiently equipped in land and capital but also demonstrate a low level of eco-friendly practices. Thus, eco-schemes might, in fact, relatively decreased competitiveness of weaker regions. All this means that the assumed changes in the EU policy may aggravate the unfavorable situation in Polish agriculture.

The Nash equilibrium of the strategic game presented in the paper suggest that, in order to balance the diversified preferences of farmers from different regions in Poland, while implementing eco-schemes, redistributive payment needs to be increased. That is what actually took place in the Strategic Development Plan for Agriculture for the years 2023–2027, where the total number of beneficiaries of this program increased, with the support being granted for farms with the total area ranging from 3 to 50 ha, compared to from 3 to 30 ha in the current financial perspective. As most of the farms in Poland are low scale, we might conclude that the decision was rational in terms of satisfying the temporary farmers' preferences. However, many observers suggest that redistribution payment brakes the structural changes, as it artificially supports ineffective farms. The impact of agricultural subsidies on productivity was also stated, and it showed that excessive support slows down structural transformations in the agricultural sector [37–43].

In the paper, we compare the scenario assuming a total dismantling of the CAP to the continuation of the current policy. We are aware that the first scenario is rather hypothetical

and presents a radical approach, but our intention was to emphasize the CAP's impact on the emissions of greenhouse gases in Polish agriculture by regions.

To give an overview of the problem and define a game, we used two data sources: the CAPRI model and statistics on farmers' responses to eco-schemes in Polish regions. Examples of different environmental indicators that could be used in the further research are presented in [44].

6. Conclusions

To summarize, the environmental and climatic CAP measures, proposed in Poland's Strategic Development Plan for Agriculture for the years 2023–2027, reflect farmers' preferences regarding the structure of the CAP support. Moreover, it can also be seen, from our results, that agricultural potential affects the emissions of greenhouse gases. Thus, considering long-term development of the agricultural sector in Poland and environmental sustainability, one of the key challenges should be to improve agrarian structures. Only strong, competitive farms are able to compete on the market and meet further eco-requirements. Thus, all policy supports in forms of redistribution, if needed, shall only be temporary.

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