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"Green" Transformation of the Common Agricultural Policy and Its Impact on Farm Income Disparities

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Abstract: Taking into account the evolution of the Common Agricultural Policy (CAP), it is wondered to what extent the "green" transformation of this policy and the accompanying change in the distribution of direct payments between farms contributed to the elimination of disproportions in agricultural income. The aim of the study was to investigate the changes in the proclaimed concepts related to the development of the EU agricultural sector in terms of their "green" transformation, and to assess the impact of "green" CAP payments on income inequalities between farms. The research was conducted based on the data representative for Polish commercial farms for the years 2004–2019, covering three financial perspectives of the agricultural policy. The methods of counterfactual modelling and assessment of income inequality were used in the study. The analyses showed that the evolution of the CAP priorities, and hence instruments, towards the pro-environmental (or, more broadly, towards sustainability) have so far had a rather negative impact on the income of Polish farms. In its current form, the support dedicated to environmental and climate protection did not fully compensate farmers for income losses resulting from the use of pro-environmental agricultural practices. Moreover, "green" CAP payments did not play a significant role in shaping income inequalities. Therefore, we can conclude that the CAP instruments do not contribute sufficiently to sustainable development (economic, social, and environmental), because they do not support/motivate farmers to change their production standards.

Keywords: agricultural policy; sustainable development; agri-environment-climate payments; farms

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1. Introduction

Along with its Cohesion Policy, the European Union's Common Agricultural Policy (CAP) still constitutes a major part (approximately 30%) of the EU budget [1]. Even though further CAP reforms are being implemented, whether under pressure from external factors (e.g., the World Trade Organization, the food crisis of 2007–2008) or internal factors (e.g., subsequent EU enlargements, the eurozone crisis in 2009–2011), only the instruments have changed. There are first-order changes related to minor policy changes or second-order changes, i.e., significant changes, e.g., replacing one instrument with another [2]. Relating to policy-change theory, it can be stated that the reforms introduced within the CAP are determined by a historical way of thinking dominant at the time with respect to the desired functions of agriculture, as well as the forms and objectives of support. There is a clear path dependency, where the choices made in the past determine the current ones in terms of the shape and financing of the EU agricultural policy [3]. Despite the inclusion of new actors in the decision-making process, the still powerful agricultural lobby has a decisive influence on decisions [4]. Thanks to this, the historically conditioned support for large, intensive farms continues (the historical model of direct payments). The regional model, postulated for years by the European Commission, encountering great reluctance from the member states, would contribute to a significant redistribution of funds from large to medium and small farms [5].

For many years, political discourse has been dominated by productivism, according to which the basic role of agriculture is food production, while the aim of the CAP is to stimulate agricultural production and increase the productivity of the agricultural sector. The neo-mercantilist tradition of the CAP dates to the early years of this policy, when Community preferences (import protection) and export subsidies were key elements in supporting the prices of agricultural products. According to the agricultural lobby, transferring public funds to farmers is fully justified by food production aimed at maintaining food security, improving agricultural productivity, and increasing agricultural income. Hence, they postulate protectionism and a state-assisted model, according to which the state should support agriculture as a sector that contributes to the implementation of important strategic goals [6]. Consequently, the CAP was transformed in the 1970s and 1980s into an instrument of sectoral protectionism, with many negative effects. High price support for agricultural products encouraged farmers to use intensive farming, favoring overproduction of food and environmental degradation [7].

Criticism of productivism influenced the domination of political discourse in Europe by multifunctionality, supported by most member states in 1997 and called the European Model of Agriculture [8]. In line with this concept, agriculture also requires special treatment, as it plays an important role in providing public goods, such as maintaining the rural landscape, the rural cultural heritage, and protecting the environment and biodiversity. As public goods are not properly regulated by market mechanisms, state intervention is needed both to correct negative externalities and to encourage farmers to deliver public goods [9]. EU agriculture began to move towards post-productivism, according to which agricultural activity should be based not on intensive production, but on more sustainable forms, economically and socially connected with rural communities. Given this trend, more and more "green" payments began to be incorporated into the CAP.

The last decade of the twentieth century saw a visible return of the concept of productivism in the form of so-called neo-productivism. Among the causes, Almas and Cambell [10] list the food crisis of 2007–2008, allocating part of food production to non-agricultural purposes (biofuels), the changing food preferences of consumers, food waste, climate change, less and less access to water, soil degradation, loss of biodiversity, and changing the functioning of global food systems. According to Burton and Wilson [11], the characteristic features of neo-productivism include: (a) a reduction of state intervention in markets and ideological promotion of environmentally friendly agriculture, (b) a reduction of agricultural intensification towards more environmentally sustainable agriculture and diversification of agricultural income sources, and (c) the promotion of environmental protection (for more on the interpretation and potential connections of productivism, post-productivism, multifunctionality, and neo-productivism, see the literature review by Wilson and Burton [12]).

Neo-productivism has been continued in the 21st century by referring to the principles of sustainable development in EU political discourse. In line with this approach, the CAP should focus on activities such as the provision of environmental services by farmers, which should be beneficial for the climate, energy, and the environment. Food security in this case is associated with strict adherence to sustainable agricultural practices. The issues were particularly emphasized in the "Farm to Fork" strategy within the European Green Deal framework [13].

The solutions adopted and applied within the framework of the abovementioned concepts indicate the existence of many shortcomings in the allocation of resources in the conditions of political choices. The benefits of selected interest groups are maximized, and a permanent loss of social welfare arises because of lobbying activities, party politics, the political interests of individual groups detached from economic rules, or the phenomenon of rent seeking [14]. The tendency to overprotect groups of farmers and agricultural sectors indicated by the member states, embedded in the CAP decision-making mechanisms, results in problems with the appropriate targeting of support for groups and sectors that are most in need. The shift from market price support to payments coupled with production has reduced the intensity of production, but has not lowered the negative impact on the production structure [15]. On the other hand, the introduction of full decoupling of payments from production along with the CAP reform in 2003 was supposed to favor the change in production directions and farmers' attitudes to market needs, and not to direct payments dedicated to specific types of production. However, the reform provided for many exceptions, allowing the free implementation of this principle. There was also no redistribution of direct payments according to the level of public goods produced by farmers.

The criteria for granting direct payments used under the CAP, from the very beginning of this policy, favor misallocation between large and medium-sized and small farms within the member states and between them. According to the data from the European Commission, approximately 80% of direct payments go to 20% of the beneficiaries, and this ratio has not changed for years [16]. However, it is worth recalling that the introduction of payments in the 1990s was to compensate farmers for the decrease in income due to the reduction in the prices of agricultural products. Hence, large farms that produced more than small farms were at greater risk of losing their income, and therefore were granted higher compensation. Nevertheless, this instrument was initially intended to be transitional. However, the long-term continuation of high support for certain types of production and large farms has significant regional consequences, limiting not only the development opportunities of the agricultural sector, but also the opportunities for the balanced territorial development of the entire EU [17]. In the case of Poland, research by Grochowska et al. [18] for commercial farms in 2006–2018 indicated deepening inequalities in farm income.

Considering the evolution of the CAP, the question arises of the extent to which the "green" transformation of this policy and the accompanying change in the distribution of direct payments between farms has contributed to reducing disproportions in agricultural income. In the literature on the subject, there are many works analyzing the impact of payments on agricultural income (e.g., [19–21]), but not so many considering the "green" instruments of the CAP. What is more, the results of the studies are ambiguous, as authors adopt different definitions of "green" payments. Some researchers analyzed the use of green box instruments, in line with the WTO nomenclature [22–24]. However, there can be doubts as to whether all green box instruments should be treated as pro-environmental (e.g., investment support). In other works, greening was considered as "green" instrument (i.e., crop diversification, maintenance of permanent pastures and creation of ecological focus areas) [25,26]. In the literature, however, there is no cross-sectional analysis of the impact of individual "green" instruments used in subsequent EU financial perspectives on the shaping of disproportions in the agricultural income between farms.

The novelty of this paper is, therefore, the assessment of farm profitability in the context of the evolution of priorities and instruments of agricultural policy, with particular emphasis on "green" payments, introduced in successive CAP reforms, as well as carrying out this assessment at the farm level. The aim of the study was to examine the changes taking place in the proclaimed concepts regarding the development of the agricultural sector in the EU in terms of "green" transformation and to estimate the impact of "green" payments on income inequalities between farms. The study undertook to verify the following research hypotheses:

Hypothesis 1 (H1). *The implementation of the instruments dedicated to environmental and climate protection in the CAP had no impact on the profitability of farms.*

Hypothesis 2 (H2). *The progressing "green" CAP transformation did not change the current disproportions in incomes between farms.*

Hypothesis 3 (H3). *CAP instruments aimed at supporting organic farming have the greatest potential to have a positive impact on income inequalities.*

2. Materials and Methods

2.1. Data and "Green" CAP Payments Definition

The study of the impact of "green" CAP instruments on the profitability of farms was based on unit data from the Polish Farm Accountancy Data Network (FADN) for 2004–2019, considering the three financial perspectives of agricultural policy in Poland. The FADN field of observation covers commercial farms, i.e., those producing more than 90% of Standard Output (SO) in total. The SO value is the five-year average value of plant or livestock production obtained from 1 ha or 1 animal per year, under average production conditions for a given region. For Poland, the FADN field of observation includes farms with an economic size of over EUR 4000 SO. According to the FADN methodology, stratified selection is used in sampling farms from the field of observation. This procedure aims to reflect the diversity of the farms due to three criteria: regional location, economic size, and type of farming. Farms for which it was not possible to determine the profitability level, due to zero utilized agricultural area (UAA), were excluded from the analysis. Ultimately, the research sample comprised 10,890 to 12,298 observations (see Table 1).

Table 1. Total number of farms and beneficiaries of "green" CAP payments in the research sample.

Number of Farms	2004	2005	2006	2007	2008	2009	2010	2011
Sample	11,104	11,774	11,823	12,038	12,298	12,258	11,004	10,890
Beneficiaries of "green" payments	61	204	2180	2161	2712	3058	3113	2794
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Sample	10,909	12,117	12,123	12,104	12,104	12,103	12,032	11,985
Beneficiaries of "green" payments	2591	3363	3027	1891	1868	1585	1535	1549

Source: own study based on Polish FADN data.

As shown in Table 1, the study assumed that in 2004–2019, support dedicated to environmental and climate protection was granted to between 61 and 3363 farms in Poland.

The scope of the "green" payments analyzed included instruments considered, inter alia, by Czyżewski et al. [27] and subsidies related to afforestation. The detailed scope of the "green" payments analyzed along with their modifications in subsequent financial perspectives can be seen in Figure 1.

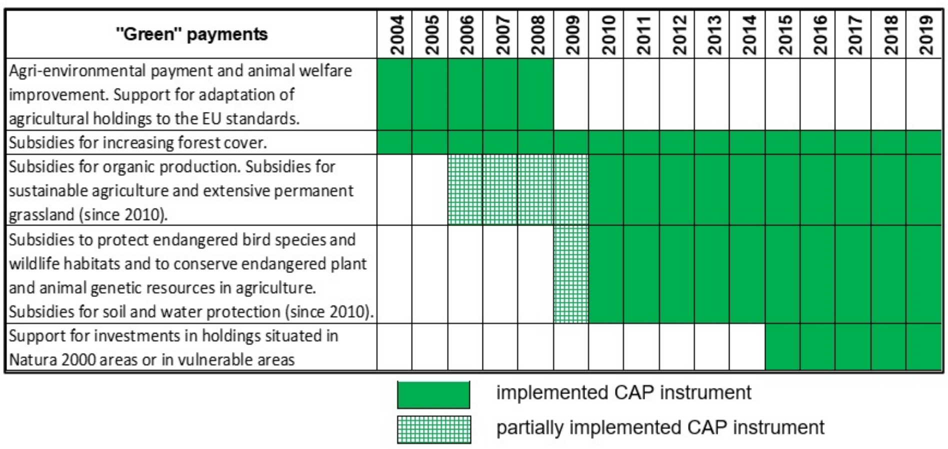

Figure 1. Scope of the "green" CAP payments analyzed. Source: own study.

As shown in Table 2, among the beneficiaries of "green" payments, the highest support was granted for organic farming. The average subsidy for organic farming (i.e., organic production, sustainable agriculture, and extensive permanent grassland) increased steadily from 2004 to 2013 (the first and second financial perspectives of the agricultural policy) and gradually decreased in subsequent years (during the third financial perspective).

Table 2. Descriptive statistics for "green" payments (EUR).

Agri-environmental payment and animal welfare improvement. Support for adaptation of agricultural holdings to the EU standards								
Statistics	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Min	0	0	0	0	0	-	-	-
Max	285	50,930	84,796	86,277	66,004	-	-	-
Mean	10	2509	4727	2972	2871	-	-	-
SD	47	5580	4999	4692	4542	-	-	-
Subsidies for increasing forest cover								
Statistics	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Min	0	0	0	0	0	0	0	0
Max	5253	14,020	41,872	57,407	120,943	31,526	63,333	31,262
Mean	1448	809	161	217	178	109	134	125
SD	1342	1836	1531	2132	2586	1029	1491	1045
Statistics	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Min	0	0	0	0	0	0	0	0
Max	50,513	37,883	38,064	38,067	36,495	18,838	18,838	18,663
Mean	140	103	96	131	128	122	130	111
SD	1423	1075	1032	1123	1048	781	820	746
Subsidies for organic production. Subsidies for sustainable agriculture and extensive permanent grassland (since 2010)								
Statistics	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Min	-	-	0	0	0	0	0	0
Max	-	-	15,820	26,893	108,636	127,383	77,814	86,383
Mean	-	-	149	263	345	482	1293	2094
SD	-	-	840	1434	2706	3346	3643	4385
Statistics	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Min	0	0	0	0	0	0	0	0
Max	37,896	76,938	47,466	37,973	39,576	39,449	27,852	31,416
Mean	2407	2796	2670	2540	2402	2273	2133	2040
SD	3774	4400	3797	3517	3272	3045	3101	3220
Subsidies to protect endangered bird species and wildlife habitats and to conserve endangered plant and animal genetic resources in agriculture. Subsidies for soil and water protection (since 2010)								
Statistics	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Min	-	-	-	-	-	0	0	0
Max	-	-	-	-	-	37,255	39,410	36,450
Mean	-	-	-	-	-	2275	1896	1389
SD	-	-	-	-	-	3466	3152	2348
Statistics	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Min	0	0	0	0	0	0	0	0
Max	39,429	34,026	87,043	35,084	32,969	45,962	31,033	37,973
Mean	1243	1363	1334	1249	1142	1185	1198	1587
SD	2300	2501	2887	2466	2565	2661	2626	3589
Support for investments in holdings situated in Natura 2000 areas or in vulnerable areas								
Statistics	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Min				0	0	0	0	0
Max				27,566	0	0	61,900	46,512
Mean				15	0	0	462	427
SD				634	0	0	4192	3797

Source: own study based on Polish FADN data.

2.2. Distribution of Farm Income in Polish Farms

Table 3 contains the basic descriptive statistics (minimum and maximum value, average, standard deviation) illustrating the distribution of profitability of farms in Poland in 2004–2019, as operationalized using income from a family farm per 1 ha of UAA.

Table 3. Descriptive statistics for family farm income per 1 ha of UAA (EUR/ha).

Statistics	2004	2005	2006	2007	2008	2009	2010	2011
Beneficiaries of "green" payments								
Min	−806	−415	−1318	−1711	−2848	−1827	−6705	−289
Max	1467	135,975	5422	8967	16,206	17,190	11,892	64,815
Mean	249	1222	485	513	483	379	575	680
SD	311	9797	409	518	570	534	578	1442
Other farms								
Min	−3248	−600	−52,363	−22,638	−453,935	−52,718	−64,288	−74,027
Max	234,572	725,526	1,065,228	1,325,726	248,737	678,210	206,445	303,140
Mean	779	1028	1424	1515	1175	1193	1221	1160
SD	6093	9293	13,505	15,851	922	11,015	6911	7105
Statistics	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Beneficiaries of "green" payments								
Min	−1578	−1113	−1326	−204	−2012	−73	−1935	−1717
Max	23,312	186	64,016	10,808	8064	9276	7725	10,448
Mean	641	593	517	473	660	630	511	587
SD	687	59	1241	540	593	631	591	650
Other farms								
Min	−77,518	−5844	−60,389	−53,573	−39,425	−12,976	−42,185	−3585
Max	389,146	338,504	415,912	506,266	287,930	245,411	253,070	139,654
Mean	1157	115	984	895	1024	990	926	996
SD	8516	8041	760	7346	5701	4628	5446	4502

Source: own study based on Polish FADN data.

Pursuant to the data from the Polish FADN sample, in the period analyzed, beneficiaries of "green" payments achieved lower average incomes compared to other farms. The profitability of the farms using CAP instruments dedicated to environmental and climate protection was usually half the profitability of farms not receiving "green" support. However, the differences may result from a much higher differentiation (variance) of income in the comparative group than among the beneficiaries of "green" payments. Hence, the verification of the research hypotheses requires the use of tools that consider the cause-and-effect nature of the relationship between "green" CAP payments and farms' profitability.

2.3. Measuring the Impact of "Green" CAP Payments on Farm Income

In the case of the verification of the first research hypothesis, an important part of the analysis was to determine the direct impact of "green" payments on farms' profitability. A randomized controlled experiment carried out on an experimental and control group is the ideal research method that makes it possible to isolate the effect of the selected factor on the resulting variable. The method ensures that there is no common causality between the state of the individual examined (whether affected or not influenced by the factor) and their observable and unobservable features. However, in social sciences, it is difficult to guarantee the conditions necessary to conduct experiments—usually only observational studies are possible. In this case, the tools used to reduce or eliminate common causality are methods based on the propensity score analysis, which allows the dataset from an observational study to be like the data collected during a randomized experiment. The key issue is the construction of an appropriate control group based on the analysis of the counterfactual state, understood as the hypothetical value of the result variable that the individual would achieve if they were in a different state [28]. Selecting observations for the control group, which is a counterfactual state for the experimental group, requires comparing both groups in terms of the set of their characteristics. The more features included in the comparison of the two groups, the more precisely the counterfactual state can be determined for the experimental group. However, matching the units from the experimental and control groups on the basis of many characteristics, especially those of a continuous nature, presents many technical difficulties. The literature, therefore, proposes to solve this problem by selecting the control group not on the basis of many features, but only on the basis of the propensity score, defined as the probability with which the individual is exposed to the factor. The similarity between the experimental and control groups in terms of the set of features included in the propensity score model is recognized on the basis of meeting assumptions jointly referred to as the condition of strong ignorability.

In our study, the direct impact of "green" CAP payments on farm profitability was estimated using the inverse probability of treatment weighting method, where the propensity score is used to weight the observations unaffected by the factor to form a control group. The greater the similarity of a farm in the control group to a farm receiving the "green" payment, the greater the weight assigned to it. The impact of "green" support on farm incomes was measured using the average treatment effect on the treated (ATT) [29,30]:

$$\mathrm{ATT} = \mathrm{E}(y_1 \mid d = 1) - \mathrm{E}(y_0 \mid d = 1) \quad (1)$$

where:

$\mathrm{E}(y_1 \mid d = 1)$—expected value of profitability after the introduction of "green" payments in the group of farms that received the support,

$\mathrm{E}(y_0 \mid d = 1)$—expected value of profitability in the absence of the introduction of "green" payments in the group of farms that received the support.

For each beneficiary of "green" payments, the value of the variable y_0 is unobservable and therefore must be estimated. In the case of the inverse probability of treatment weighting method, this value is estimated on the basis of the profitability of farms from the control group with the number C, using weights w_i determining the inverse of the probability of using "green" support in accordance with the formula [31]:

$$\hat{\mathrm{E}}(y_0 \mid d = 1) = \frac{\sum_{i \in C} w_i y_i}{\sum_{i \in C} w_i} \quad (2)$$

and

$$w_i = d_i + \frac{(1 - d_i)p(\mathbf{x}_i)}{1 - p(\mathbf{x}_i)} \quad (3)$$

where:

d_i—binary variable with the value 1 for a farm that received "green" payments, or the value 0 otherwise,

$p(\mathbf{x}_i)$—propensity score, i.e., the probability of receiving "green" payments as a function of farm characteristics: $p(x) = P(d = 1 \mid \mathbf{x})$,

$\mathbf{x}_i$—vector of observable farm characteristics constituting the basis for estimating the propensity score. The study used the basic features of farms extended by variables related to the economic and financial situation of the farm, such as: location (region at the NUTS 2 level), type of farming, economic size, total labor inputs, total UAA, rented UAA, UAA excluded from production, livestock units, value of crop and livestock production, intermediate consumption, depreciation, costs of external factors, net worth, and gross investment. To estimate the propensity score, a non-parametric generalized boosted models (GBM) method was used, proposed for observational studies by McCaffrey, Ridgeway and Morral [32].

2.4. Measuring Income Inequality Level under the "Green" CAP Transformation

The basis for the verification of the second and third research hypotheses was the estimation of the level of income inequality among farms using the Gini coefficient, and then decomposition of income inequalities based on the results of estimating the model of the form:

$$\ln Y_i = \alpha_0 + \beta_1 Y_i{}^{market} + \beta_2 S_i{}^{green} + \beta_3 S_i{}^{other} + \varepsilon_i \tag{4}$$

and for a more detailed breakdown of "green" payments:

$$\ln Y_i = \alpha_0 + \beta_1 Y_i{}^{market} + \beta_2 S_i{}^{EU\_standrds} + \beta_3 S_i{}^{forest} + \beta_4 S_i{}^{organic} + \beta_5 S_i{}^{protection} + \beta_6 S_i{}^{Natura2000} + \beta_7 S_i{}^{other} + \varepsilon_i \tag{5}$$

where:

$\ln Y_i$—natural logarithm of farm income per 1 ha of UAA,

$Y_i{}^{market}$—market income, being the difference between the revenues achieved and the costs incurred by a farm,

$S_i{}^{green}$—"green" CAP payments,

$S_i{}^{EU\_standrds}$, $S_i{}^{forest}$, $S_i{}^{organic}$, $S_i{}^{protection}$, $S_i{}^{Natura2000}$—respectively: payment related to the improvement of animal welfare and adjustment of farms to EU standards, subsidies for increasing forest cover, subsidies for organic farming, subsidies for the preservation of endangered genetic resources of plants and animals in agriculture and protection of soil and water, support for investments on farms located in Natura 2000 areas or in particularly endangered areas,

$S_i{}^{other}$—other subsidies,

α_0, $\beta_{1,\ldots,7}$, ε_i—respectively: intercept, structural parameters, and random error in the model.

The approach proposed by Fields [33], based on the theorem by Shorrocks [34], was used, making it possible to measure the extent to which income inequalities result from the basic components of farm income, which for the purposes of our study was decomposed into income obtained from the market, "green" payments, and other subsidies. The share of each j-th component of income was determined using the following equation:

$$p_j(\ln Y) \equiv \frac{s_j(\ln Y)}{R^2(\ln Y)} \tag{6}$$

where:

$$s_j(\ln Y) = \frac{\mathrm{cov}\left[\beta_j Z_j, \ln Y\right]}{\sigma^2(\ln Y)} \tag{7}$$

$$Z_j = \left\{ Y_i^{market}, S_i^{green}, S_i^{EU\_standards}, S_i^{forest}, S_i^{organic}, S_i^{protection}, S_i^{Natura2000}, S_i^{other} \right\} \tag{8}$$

The following conditions were also met:

$$\sum_{j=1}^{J+2} s_j(\ln Y) = 100\% \tag{9}$$

$$\sum_{j=1}^{J+1} s_j(\ln Y) = R^2(\ln Y) \tag{10}$$

Thus, the contribution of market income, "green" payments, and other subsidies to the emergence of income inequality was determined based on the share of covariance between a given component and income in the variability (variance) of farm profitability. This value was then related to the value of the coefficient of determination of the estimated linear model.

3. Results

The results of the research on the impact of CAP instruments dedicated to environmental and climate protection on the profitability of farms are presented in Table 4, which shows the value and standard error for the estimation of the average treatment effect on the treated (ATT), together with t-statistic and the corresponding *p*-value. In the period analyzed, the farms receiving "green" payments obtained, on average, significantly lower or similar (no statistical differences between the groups) income per 1 ha of UAA compared to other farms. In the following years, differences in the profitability of farms benefiting from "green" payments and the remaining ones gradually decreased. The greatest difference between the groups analyzed was recorded in 2004, the first year of Poland's EU membership. At that time, the profitability of farms that received "green" payments was, on average, approximately EUR 358 per 1 ha lower compared to the economic situation of other farms. At the end of the period analyzed, i.e., in 2019, both beneficiaries of "green" support and other farms achieved similar results in terms of income per 1 ha of UAA.

Table 4. Average effect of the impact of "green" CAP payments on profitability of farms (EUR/ha).

ATT Estimate	2004	2005	2006	2007	2008	2009	2010	2011
ATT	−358	383	−63	−128	−19	−79	−60	−5
SE(ATT)	102	425	19	47	25	48	21	42
t	−3.50	0.90	−3.38	−2.707	−0.763	−1.659	−2.805	−0.118
p-value	<0.01	0.368	<0.01	<0.01	0.445	0.097	<0.01	0.906
ATT Estimate	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
ATT	−41	−19	−55	−67	−26	−60	−66	5
SE(ATT)	23	27	39	35	39	35	44	42
t	−1.812	−0.731	−1.415	−1.908	−0.655	−1.697	−1.501	0.126
p-value	0.07	0.465	0.157	0.056	0.512	0.09	0.133	0.9

Source: own study based on Polish FADN data.

As mentioned above, significant differences in the profitability of both groups of farms were visible only in the first years of the new instruments dedicated to environmental and climate protection. The first clear difference between the groups analyzed appeared with the initiation of the CAP in Poland, when "green" instruments, such as agri-environmental support related to animal welfare improvement and the adjustment of farms to EU standards, or subsidies for afforestation, were introduced. Another significant difference in the profitability of both groups of farms was recorded in 2006 and 2007 with the introduction of subsidies for organic farming. A similar phenomenon could be seen in 2009, 2010, and 2012, when instruments related to the protection of endangered genetic resources of plants and animals, sustainable agriculture, extensive permanent grasslands, or the protection of soil and water were introduced. Clear differences in the profitability of both groups were also recorded in 2015 and 2017, when other "green" instruments, such as the agri-environment-climate measure and organic farming under the Rural Development Program, were implemented. The instruments dedicated to environmental and climate protection in the CAP had either no impact or a negative one on the profitability of farms.

The results of income inequality among farms are presented in Table 5. In 2004–2019, the value of the Gini coefficient ranged from 0.582 to 0.828, indicating a clearly uneven distribution of income among farms in Poland. Income inequalities between farms decreased slightly throughout the period analyzed. The smallest differences in the distribution of income per 1 ha of UAA between farms included in the research sample were recorded in 2010–2013, within the second financial perspective of the CAP.

Table 5. Income inequality decomposition for aggregated "green" CAP payments.

Income Decomposition	2004	2005	2006	2007	2008	2009	2010	2011
Gini coefficient	0.794	0.764	0.737	0.724	0.693	0.828	0.596	0.582
Market income	0.1499	0.1517	0.0777	0.0497	0.1215	0.0904	0.1423	0.1153
"Green" payments	0.0001	−0.0005	0.0006	0.0008	0.0024	0.0031	0.0015	0.0029
Other payments	0.0081	0.0158	0.0172	0.0064	0.0047	0.0022	0.0100	0.0216
Residuals	0.8420	0.8330	0.9046	0.9431	0.8715	0.9043	0.8463	0.8602
Income decomposition	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**
Gini coefficient	0.607	0.664	0.700	0.698	0.620	0.640	0.708	0.685
Market income	0.1293	0.0923	0.1263	0.1014	0.1697	0.1331	0.1493	0.1305
"Green" payments	0.0007	0.0027	0.0010	0	0.0005	0.0001	0	0.0016
Other payments	−0.005	0.0012	0.0121	0.0077	0.0519	0.0416	0.0184	0.0070
Residuals	0.8750	0.9039	0.8606	0.8910	0.7779	0.8252	0.8323	0.8609

Source: own study based on Polish FADN data.

Table 5 also shows the results of the income inequality decomposition, considering income components such as market income, "green" payments, and other subsidies. Due to the use of regression methods to decompose income variability, the results for the residuals in the model are also presented. The results of the estimated model show that in more than 70% of cases, the uneven distribution of income usually depended on factors other than those included in the model. This results from the selection of explanatory variables for the estimated model. However, the purpose of the analysis was not to identify the determinants of farm income variability, but to quantify the share of "green" payments in the formation of income inequalities. In approximately 2.5% of cases, farm income variance depended on subsidies, of which the share of "green" payments in the shaping of income inequality among farms was marginal and amounted to a maximum of 0.31%. The progressing "green" transformation of the CAP did not significantly change the existing disproportions in incomes between farms.

Table 6 presents a more detailed breakdown of income inequalities, considering various CAP instruments under the "green" payments analyzed. Payments related to organic farming had the largest share in shaping income variability. Thus, of all the "green" CAP instruments, subsidies to organic farming seem to have the greatest potential to influence income inequalities. They consisted of subsidies for organic production, and after 2010, also subsidies for sustainable agriculture and extensive permanent grassland.

Table 6. Decomposition of income inequalities for individual instruments under "green" CAP payments.

Income Decomposition	2004	2005	2006	2007	2008	2009	2010	2011
Market income	0.1499	0.1510	0.0776	0.0496	0.1208	0.0892	0.1416	0.1155
Adaptation to EU standards	0	0.0003	0.0001	0.0001	0.0003	X	X	X
Increasing forest cover	0	0	0	0	0.0002	0	0	0.0001
Organic production	X	X	0.0002	0	0.0001	0.0002	0.0003	0.0004
Conservation of plant and animal resources	X	X	X	X	X	0.0001	0	0.0002
Investments in Natura 2000/vulnerable areas	X	X	X	X	X	X	X	X
Other payments	0.0080	0.0158	0.0171	0.0064	0.0047	0.0031	0.0101	0.0217
Residuals	0.8421	0.8329	0.9050	0.9439	0.8738	0.9075	0.8480	0.8621

Table 6. *Cont.*

Income decomposition	2012	2013	2014	2015	2016	2017	2018	2019
Market income	0.12923	0.0918	0.1263	0.1013	0.1696	0.1332	0.1493	0.1303
Adaptation to EU standards	X	X	X	X	X	X	X	X
Increasing forest cover	0	0	0	0	0	0	0	0.0012
Organic production	0.0005	0.0006	0.0001	0.0003	0.0001	0.0002	0	0.0005
Conservation of plant and animal resources	0	0.0001	0.0002	0.0003	0	0	0	0
Investments in Natura 2000/vulnerable areas	X	X	X	0	X	X	0	0
Other payments	−0.0050	0.0012	0.0121	0.0077	0.0520	0.0415	0.0184	0.0071
Residuals	0.8752	0.9063	0.8613	0.8905	0.7783	0.8251	0.8323	0.8610

X—lack of a given CAP instrument, 0—parameter estimated value below 0.00001. Source: own study based on Polish FADN data.

4. Discussion and Conclusions

The results indicate a partially negative verification of the first research hypothesis. It was found that the implementation of instruments dedicated to environmental and climate protection in 2004–2019 usually resulted in a negative impact on the profitability of farms, and only in some cases were they neutral. Importantly, with the introduction of subsequent "green" instruments in the CAP, the average income of farms that used it was lower, but in the following years, the negative impact was gradually reduced. We could assume that the introduction of such "green" instruments as agri-environmental support for animal welfare improvement and the adjustment of farms to the EU standards required additional efforts and costs for Polish farmers, especially at the beginning of membership in the EU. It might have been particularly relevant to higher labor inputs and time consumption, which reduced the competitiveness of theses farms in the market. Ridier et al. [35] considered the labor force to be the main obstacle to agri-environmental practices. This is because the practices are labor intensive, and the marginal cost varies with the balance between labor demand and the resources available on a farm. Some other researchers have also found that participation in agri-environmental programs imposes costs on farmers: direct costs, such as increased labor and capital costs, and opportunity costs, such as reduced production (e.g., [36,37]).

The introduction of "green" payments in the EU was to compensate farmers for income losses incurred because of the use of instruments favoring the improvement of the natural environment, and as an economic incentive to change agricultural practices. Some research results suggest that the support provided through various "green" payments is not fully effective (e.g., [38,39]). However, the impact of "green" payments on agricultural income seems to be different due to the scheme features and individual farm factors. Scheme features relate to the overall design of the agri-environmental program, which varies between countries and over time. Farm factors are specific to the farmer in question. They are often sub-divided into factors that come primarily from the farm's physical qualities, e.g., size, soil quality, and farm system, and farmer characteristics, e.g., age, education, or family situation [40].

The behavioral factor, particularly farmers' preferences, has been underestimated in the approach to the "green" payments issue so far. It is therefore postulated (e.g., [41]) to include the perceptual constraints that explain the difference between optimal beliefs and choices and the beliefs and choices that people actually have in the concept of bounded rationality. The fact that most farmers did not change their agricultural practices, even though they confirmed the use of "greening" and the assumptions of the European Commission that the instrument would be implemented by nearly all farmers subject to "greening", partially show this blurred perception [42,43].

The second research hypothesis has been confirmed. Our research results indicate that the progressive "green" transformation of the CAP did not change the existing disproportions in incomes between farms, because the income inequalities between farms applying "green" payments and other farms only decreased slightly in the period analyzed.

The implementation of pro-environmental instruments under the CAP was supposed to have a positive impact on the environment, but it was not the main objective of this policy. For example, when set-aside (introduced in 1992 as a reaction to agricultural overproduction) was no longer needed due to changes in market conditions, it was reduced to zero in 2008 and then withdrawn in 2013. On the other hand, agri-environmental programs, also functioning within the CAP since 1992, although focused strictly on reducing the pressure of agriculture on the environment, were treated only as accompanying measures and were optional for farmers. Environmental rhetoric in the political discourse intensified, but it was difficult to put into practice due to the low priority for environmental protection and the closed agricultural policy network, considering mainly the interests of agricultural producers [44].

The reasons for no change in the income disparities between farms include the small share of "green" payments in the entire pool of payments received by farmers. According to Primdahla et al. [45], the percentage of expenditure on agri-environmental programs in Western European countries increased from 0.6% of the total funds in 1993 to 4.5% in 1997. However, the tendency was not continuous, and the 2013 CAP reform even resulted in a decrease in real expenditure. Linking cross-compliance and greening with direct payments, although disseminating the use of the "green" instruments in all farms, had little impact on environmental protection due to the watering down of their effects in policy formulation [46]. Low effectiveness of many "green" payments is mainly due to their environmental objectives being imprecise and there being no indication of baselines and time frames for measuring achievements, which makes it difficult to monitor and assess the environmental effects obtained [47–49]. Many of them are optional and, considering the small pool of funds allocated to the second pillar of the CAP, the impact of the "green" transformation of the CAP on the environment is small, and rather serves to support agricultural income.

Analyses by Scown et al. [17] showed that the main beneficiaries of CAP support were agricultural regions with incomes above the EU average (EU median net (i.e., disposable) income in 2015 was EUR 16,163), while regions that were less prosperous but provided a high level of public goods received lower payments. The regions friendly to climate and biodiversity, with low greenhouse gas (GHG) emissions and a high nature value of their agricultural areas, often generated low incomes and received the same or less CAP support, because decoupled direct payments are area-based. The authors concluded that CAP payments were 1.5 times higher in the agricultural regions with the most climate pollution than in the least polluting farms, with most of this support in regions with high GHG emissions going to high-income farms. The results suggest that the current distribution of CAP funds is inadequate in terms of needs in different regions of the EU and in supporting the environmental and social objectives of the EU's agricultural policy.

Our research results confirmed the marginal impact of "green" payments on the emergence of inequalities in farm incomes, i.e., a maximum of 0.3%, which is probably because of their very small share. Market income was the main source of the inequalities. Similar trends were observed in the studies by Severini and Tantani [50], in which the main source of inequality in farm income was market income (Gini coefficient 0.98), followed by income from direct payments (0.71) and income from outside the farm (0.66).

In the case of the third hypothesis, it was found that of the "green" payments, instruments aimed at supporting organic farming had the greatest impact on the shaping of farm incomes. However, the result should be treated with some reserve, as the share of payments for organic farming in the formation of income inequalities was only about 0.06%. Nevertheless, it could initially be assumed that it is in this type of CAP instrument that the greatest potential for reducing income disparities should be seen.

The result is particularly interesting in the context of the proposal of the European Commission [13] to increase the farmland used by organic farming in the EU to at least 25% by 2030. It is expected that the realization of environmental goals in organic farming will not only contribute to the preservation of soil fertility and plant and animal health, but will also induce positive external effects in biodiversity, energy, climate, and the environment [51]. In this context, it is worth citing the research by Sadowski et al. [52] on the farms benefiting from support for organic farming in Poland, which showed that the net value added was approximately 40% lower than for conventional farms. Importantly, the share of subsidies in the net value added in the years 2016–2018 was approximately 74%, which means that Polish organic farms are largely dependent on public aid. A similar dependence of organic farms on CAP support was observed by Łuczka et al. [53]. A question then arises as to what extent and how costly it would be to support organic farms in leveling disproportions in agricultural incomes (economic and social component), as well as reducing the pressure of agricultural production on the natural environment (environmental component) to ensure the sustainability of EU agriculture.

The results indicate that the progressive evolution of the priorities, and hence the CAP instruments, towards the pro-environmental (or, more broadly, towards sustainability) have so far had a rather negative impact on the income of Polish farms, with the provision that in subsequent years of operation the impact of a given "green" payment was gradually eliminated. At the level of the entire group of commercial farms in Poland, "green" CAP payments did not play a significant role in shaping income inequalities. Thus, in its current form, the support dedicated to environmental and climate protection did not fully compensate farmers for income losses resulting from the use of pro-environmental agricultural practices. This support may have a low motivational function and did not influence the creation of changes in farmers' decisions regarding the production standards applied. Thus, there is a need for continuing searches for CAP instruments that would be more effective in implementing the European Green Deal in terms of the sustainable (economic, social, and environmental) development of EU agriculture.

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