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Impact of Policy and Factor Intensity on Sustainable Value of European Agriculture: Exploring Trade-Offs of Environmental, Economic and Social Efficiency at the Regional Level

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Abstract: Although sustainable development is a topic broadly discussed in the literature in relation to existing policy stimulus, a holistic approach to the implementation of sustainability in agriculture—for which there are three dimensions (economic, social and environmental)—is still missing. A regional approach, which averages the entire EU region, could therefore be useful in the long term for recommending directional guidelines for the Common Agricultural Policy (CAP). The objective of this study is to investigate the impact of key groups of CAP instruments and factor intensity on the three above-mentioned aspects of sustainability in the 2004–2017 period, with the assumption that they are all reciprocally related. This goal was achieved by measuring sustainability using the modified sustainable value approach combined with frontier-based nonparametric assessment and applying structural equation modelling, including multilevel random intercept. This research highlights trade-offs between environmental, economic and social efficiency and checks the impact of the EU CAP schemes on the sustainability of environmental, economic, and social dimensions in agriculture. Despite common indications of trade-offs, particularly between economic performance and eco-efficiency, our study shows that in the long term, such feedback has not occurred in any EU regions. Moreover, there are positive interactions between all three dimensions of sustainability from a cross-sectional perspective. The analysis of the impact of CAP subsidies proves that the current system of agri-environmental, set-aside and rural development payments has been effective in the long term, although broader implementation of environmental schemes in regions with lower labour productivity may negatively affect social sustainability.

Keywords: sustainability; social efficiency; environmental efficiency; economic efficiency; CAP; subsidies; structural equation modelling; SEM; GSEM

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1. Introduction

Sustainable development is currently one of the main challenges of economic policy. From the perspective of the sustainability of agriculture in the European Union (EU), the key dilemma is the effectiveness of the Common Agricultural Policy (CAP). Even though a new CAP programming period is being negotiated, researchers and policy-makers question whether the support schemes performed well to ensure an adequate standard of life for agricultural producers combined with care for the natural environment and good economic conditions in the agricultural sector as a whole. As one of the main objectives of CAP, the Treaty on the Functioning of the European Union states that an increase in agricultural productivity is possible by ensuring technical progress, the rational development of agricultural production and the optimum use of production factors, especially labour [1]. 'Agenda 2000' introduced the EU's rural development policy, the overarching priorities of which included fostering agricultural competitiveness, ensuring the sustainable management of natural resources and promoting climate action. Since the 2003 Luxemburg reform, a new objective was to better meet new societal demands regarding environmental conservation and product quality. Sustainable development, which is currently one of the most important objectives of the EU's CAP, has been the subject of many scientific papers [2–6]. However, sustainable development may be implemented in many ways and the eco-efficiency concept is one of growing importance. Over the past decade, the frontier eco-efficiency (FEE) model has been developed as a tool of measuring the environmental performance. Instead of including environmental issues in conventional production function; it assesses eco-efficiency separately by considering the economic outcome as an output and the environmental impacts as an input [7,8]. In this article, we followed the above understanding of sustainable development. The CAP instruments are key factors in determining the eco-efficiency of agricultural activity. Agri-environmental subsidies contribute to the sustainable development of agriculture, while the increase in capital expenditure is conducive to higher economic efficiency in the European agricultural sector [9]. However, there is a concern that stimulating capital endowment under the CAP encourages industrial agriculture and may lead to excessive investment [10]. In this study, the authors attempt to verify the hypothesis that these fears are not fully justified and that, depending on the type of subsidy that is offered under CAP, the economic, social and environmental efficiency of farms may be affected in various ways. Unlike some previous studies [11–13], our study is conducted on a full European region population based on aggregated long-term European Union Farm Accountancy Data Network (EUFADN) data. Thus, we are able to provide more general and holistic insight into three frontier-based sustainability dimensions and the trade-offs thereof, providing an alternative for a microeconomic CES-type model [14] or a partial equilibrium models [15]. The results obtained should therefore constitute guidelines for decision-makers when shaping agricultural policy instruments that are conducive to environmental, social and economic efficiency in the member states of the EU and their respective regions.

Therefore, the aim of this study is to investigate the impact of particular groups of CAP instruments and factor intensity on three dimensions of long-term sustainability between 2004 and 2017 with the assumption that they are mutually correlated and the analysis will reveal the strength and direction of these relations. First, the authors measured the relative contribution to the sustainable development of the European agriculture at the regional scale using the modified sustainable value indicator (MSV) –see justification in the next paragraph; secondly, a structural equations model (SEM) and a multilevel generalised structural equation model (GSEM) with random intercept were built to test for four groups of hypotheses (depicted by the arrows in Figures 1–3, all hypotheses are presented in Table 1): The first group (H1–H5) concerns the impact of particular types of subsidies and factor endowments on economic sustainability; the second group (H6–H10) depicts the impact on environmental sustainability; the third group (H11–H15) illustrates the impact on social sustainability; and the fourth group (H16–H18) attempts to assess trade-offs between the three sustainability dimensions.

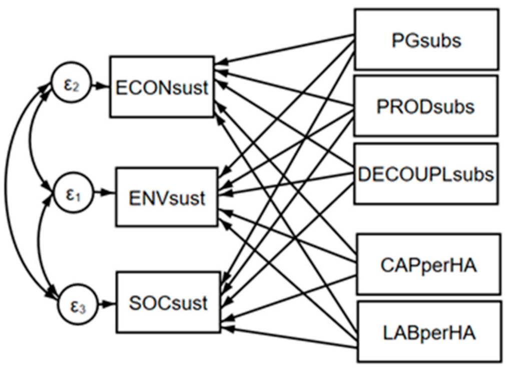

Figure 1. Structural equation model exploring the impact of the EU CAP schemes and factor endowments on the sustainability dimensions in agriculture and their mutual interactions in the years 2004–2017. Note: The single arrows indicate regression, and the double arrows indicate covariances.

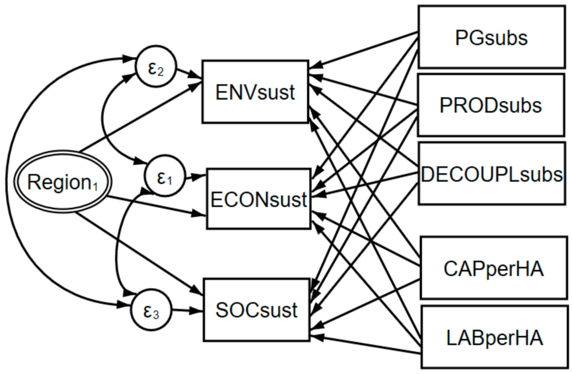

Figure 2. Multilevel GSEM with the random 'between' effect captured for the regions (125 regions ×14 years). Note: this is extended version of the model from Figure 1 with the random intercept at the region level based on the full panel of 1750 observation (125 regions × 14 years); it captures region-specific random effects and makes it possible to interpret the coefficients for time series.

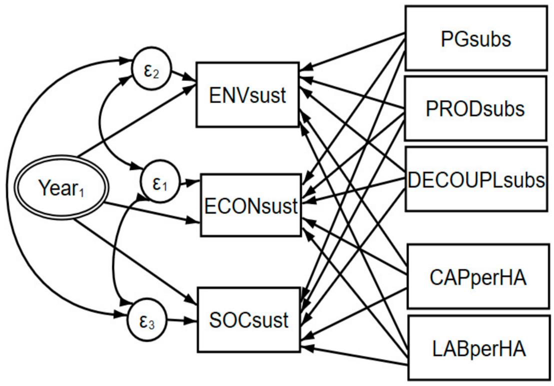

Figure 3. Multilevel GSEM with the random 'between' effect captured for the years (14 years × 125 regions). Note: this is the extended version of the model from Figure 1 with the random intercept at the year level based on the full panel of 1750 observation (125 regions × 14 years); it captures year-specific random effects and makes it possible to interpret the coefficients for cross-sectional data.

Table 1. Hypotheses tested by the SEM and GSEM with conclusions.

No.	Relation	Expected Sign	SEM/GSEM Results	Conclusions
H1	Subsidies for public goods have a negative impact on economic sustainability.	−	Significant negative (−)	H1 accepted
H2	Production subsidies have a positive impact on economic sustainability.	+	Significant negative (−)	H2 rejected
H3	Decoupled payments contribute positively to gaining economic sustainability.	+	Significant negative (−)	H3 rejected
H4	Bigger capital intensity fosters economic sustainability.	+	Significant positive (+)	H4 accepted
H5	Bigger labour intensity negatively affects the economic sustainability.	−	Insignificant negative	H5 inconclusive

Table 1. *Cont.*

No.	Relation	Expected Sign	SEM/GSEM Results	Conclusions
H6	Subsidies for public goods contributes positively to environmental sustainability.	+	Significant positive (+)	H6 accepted
H7	Production subsidies have a negative impact on environmental sustainability.	−	Significant negative (−)	H7 accepted
H8	Decoupled payments contribute positively to environmental sustainability.	+	Significant negative (−)	H8 rejected
H9	Bigger capital intensity lowers environmental sustainability.	−	Significant positive (+)	H9 rejected
H10	Bigger labour intensity affects positively environmental sustainability.	+	Significant negative (−)	H10 rejected
H11	Subsidies for public goods contributes positively to social sustainability.	+	Significant negative (−)	H11 rejected
H12	Production subsidies have positive impact on social sustainability.	+	Significant negative (−)	H12 rejected
H13	Decoupled payments contribute positively to social sustainability.	+	Significant (+) in cross-section, (−) for dynamics	H13 accepted in cross-sectional approach; rejected in dynamic aspect
H14	Bigger capital intensity fosters social sustainability.	+	Significant positive (+)	H14 accepted
H15	Bigger labour intensity affects positively the social sustainability.	+	Significant negative (−)	H15 rejected
H16	There is a significant negative two-side relation between economic and environmental sustainability.	−	Significant positive (+)	H16 rejected
H17	There is a significant negative two-side relation between environmental and social sustainability.	−	Significant (+) in cross-section, (−) for dynamics	H17 rejected in cross-sectional approach; accepted in dynamic analysis
H18	There is a positive two-side relation between economic and social sustainability.	+	Significant positive (+)	H18 accepted

Note: We perform the hypotheses tests by estimating SEM coefficients attributed to the arrows depicted in Figures 1–3 and assuming that the hypothesis is accepted if the coefficient is statistically significant at p-value level $p \leq 0.1$.

The sustainable value (SV) estimator including linear production function was originally advocated by Figge and Hahn [16], but has more recently been strongly criticized by Kuosmanen and Kuosmanen [17] with regard to its very unrealistic linearity assumption. On the other hand, adopting the non-linear production function for aggregated or average data has met criticism from Salois et al. [18] and Felipe and MCcombie [19,20]. Searching for a consensus, we attempted to combine the original SV approach with non-parametric frontier measurement (which does not imply any specific functional relation) and maintain linear (average) return to scale of using specific input as we dealt with region-aggregated data.

In summary, our original contribution is as follows: (1) applying the value-based measures of sustainability; (2) gaining a holistic (i.e., structural) perspective of the determinants; and (3) revealing the interactions between various dimensions of long-term sustainability in the EU agricultural sector, which, to the best of our knowledge, has not hitherto been examined. The rest of paper is organised as follows: in the next section we provide a background for the eco-efficiency approach adopted in this study, in the data and method section we explain the idea of the sustainable value advocating for the MSV and present the modelling procedure, in the results and discussion section the main findings are developed and summed up with conclusions for policy makers.

2. Literature Background

The efficiency-based approach is well-established in the literature, and the most-investigated dimension concerns eco-efficiency [21,22], measured by various models and discussed by Repar et al. [8] in their comprehensive review study. Many authors have also explored the eco-efficiency determinants using FEE model at the farm level, including the CAP schemes, by adopting double-bootstrapped truncated regression in which the data envelopment analysis (DEA) score stands for the dependent variable [23–28]. In this study, we extended the analysis by Czyżewski et al. [29] by adding several years to the analysis and two additional sustainability dimensions (the economic and social efficiency), which imply engaging structural equation modelling. In the cited article, the notion of "clean production" was adopted. In general, the underlying concept assumes that one compares a regional average ratio of agricultural output per unit of environmental impact with an average outcome of fully efficient technology for this kind of inputs derived from a frontier-based assessment. Both ratios are expressed in Euro per unit of polluting input; hence, the negative gap can be translated as the value of production that ought to be provided without additional environmental impact to catch up with the frontier technology, i.e., it would be the average 'clean' value or 'clean production' gap. Finally, this value is weighted by the average volume of the respective inputs involved in the region.

Economic efficiency is a complex concept that expresses the effectiveness of an economic activity most often related to the productivity of capital (i.e., assets) [30]. We follow this line of thought in our study. Of the three dimensions, social efficiency is the most ambiguous concept. Scientists have stressed the importance of increasing employment in rural areas that are supported by CAP, which may be a remedy for social exclusion, depopulation of these areas and the income gap [31–34]. The authors cited above implied that a simultaneous growth of revenues at least proportional to the increase in work units would be needed. The boundaries of a category as broad as social efficiency are vague, and many approaches have been considered in the literature. The scope of EUFADN data makes it possible to only follow the simplest one in which 'social efficiency is reflected by social factors that shape and maintain economic processes' [35] (i.e., various types of labour). In particular, we can distinguish the following factors in the EUFADN data: family labour (i.e., unpaid labour), external services (i.e., paid labour) and wages; each of these serves as a proxy for different regional market conditions that affect farms in the EU.

3. Materials and Methods

3.1. Stage 1—Measuring Sustainable Value Based on Regional Average

In the first stage, MSVs for average farms in European regions were computed. As was mentioned, we modified the SV methodology by Figge and Hahn [16,36] following Grzelak [37], Czyżewski [29] and Liesen et al. [38]. We accept that the criticism by Kuosmanen and Kuosmanen [17] (see footnote No 1) is fully justified with regard to a microeconomic production function. Obviously, the eco-efficiency gap between the object and benchmark technology $\left(\frac{y_i}{x_{ij}} - \frac{yb_i}{xb_{ij}}\right)$ is a function of x_{ij} inputs used (see Equation (1). Figge and Hahn assumed implicitly that it was a linear function, which is a very strong and restrictive assumption [17], as in the conventional production function, the output elasticities are not equal to the factor shares, and variable returns to scale are expected. This logic is not, however, suitable for aggregated or average data such as those in the EUFADN database. Felipe and MCcombie [19] argue that the production function is essentially a microeconomic concept. They say: "The best statistical fit given by estimating putative regional aggregate production functions must give estimates of constant returns to scale with the output elasticities equal to their factor shares . . . . Regressions that find increasing returns to scale and any differences between the values of the output elasticities and the factor shares do so by virtue of being misspecified". Coelli and Rao [39], as well as Salois et al. [18] shared this view, arguing that the variable return to scale typical of the microeconomic production function is not applicable for aggregated data. Therefore, we decided to maintain the idea of "eco-efficiency gap" from the SV method, abandoning, however, Figge and Hahn's concept of opportunity cost as the benchmark. As explained in the previous section, we simply computed weighted eco-efficiency gap between the specific region and the subsample of regions that had fully adopted efficient technology and were located on the eco-efficiency frontier. In other words, we attempted to express the distance of specific region to the eco-efficiency frontier in monetary units with regard to the specific input. Due to the regional aggregation of data assuming that the eco-efficiency gap is a linear function of the average input x_j seems to be only logical option. Although it would be possible to request data at farm level for some EU countries, in many cases, such access is highly restricted due to regulations on personal data protection. Thus, such research will necessarily be incomplete and miss its main goal. We defined MSV as follows:

$$MSV_i = \frac{1}{m}\sum_{j=1}^{m} x_{ij}\left(\frac{y_i}{x_{ij}} - \frac{yf_i}{xf_{ij}}\right) \quad (1)$$

where MSV_i is the sustainable value afferent of a region average farm i; x_{ij} and xf_{ij} represent, respectively, the inputs used of type-j and the farm i, and the frontier average input identified by the DEA with constant return-to-scale CRS; y_i and yf_i are the return of the resources (i.e., the agricultural output) of the analysed farm and the frontier unit; $i = 1 \ldots n$ is the region; and $j = 1 \ldots m$ is the type of analysed inputs.

The frontier unit subsample was determined by solving the following linear programming problem (i.e., the so-called CCR input-based multiplier model) [40]:

$$\max\theta = \sum_{i=1}^{m} \mu_r y_{ro} \quad (2)$$

subject to:

$$\sum_{i=1}^{m} v_i x_{io} = 1 \sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0 \mu_r, v_i \geq 0(\varepsilon)$$

where x_{io} is the input i used by object $o(i = 1 \ldots m)$; y_{ro} is the output r used by object $o(r = 1 \ldots s)$; ε is the infinitesimal constant; and v_i and μ_r are called multipliers.

Theoretically, MSV can take both positive and negative values in monetary terms. If the SV has a minus sign, it indicates a value of 'clean production' (i.e., zero-inputs) that ought to be provided by a farm to achieve a 'frontier' eco-efficiency level that is close to Pareto's optimum. It may happen that, even though the radial solution of Equation (2) is optimal ($\theta = 1$), some particular inputs or outputs are recognised as ineffective, which will result in output- or input-specific slacks. Such cases are known as weak efficiency, or Farrell's efficiency [41], and are not fully efficient in the Pareto sense. Although we did not perform a typical slack-based analysis, the positive MSV addresses this case, as our benchmark was calculated based on the means for a particular input of optimal regions in the Farrell sense.

To account for the size of average farms from various regions, the output to *MSV* (*OTV*) ratio indicator was calculated: $OTV_i = \frac{y_i}{y_i - MSV_i}$. An *OTV* score below 1 shows an output required to catch up with the frontier (i.e., with optimal efficiency in the Farrell sense); hence, we can identify scores that approach *OTV* = 1 as progress in the Pareto sense. A relatively rare situation of a score exceeding 1 can be perceived as a share of the 'clean' output, thus requiring no inputs, with reference to the frontier unit [37]. For example, a score of 0.80 means that a unit might replace 20% of its output with the 'clean' output to catch up with the benchmark, which is optimal in the Farrell sense. This reflects an average potential for environmental or socio-economic improvements that can be conducted in a sustainable way in different EU regions. The *OTV* ratios were employed in a further analysis as the dependent variables in the SEM; these are also presented in Table 2 as the descriptive statistics.

Table 2. Descriptive statistics of the variables used in the SEM and GSEM (OTV ratios).

Var.	Statistics	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	** Av. Growth
ENV Sust *	Mean	0.94 *	0.93	1.01	0.94	0.88	0.87	0.88	0.88	0.87	0.88	0.95	0.97	0.94	0.93	1.00
	Std. Dev.	0.28	0.26	0.27	0.32	0.28	0.30	0.27	0.26	0.26	0.27	0.26	0.26	0.26	0.25	
	Min	0.14	0.13	0.23	0.18	0.21	0.16	0.11	0.11	0.09	0.19	0.11	0.18	0.25	0.35	
	Max	1.66	1.53	1.66	2.57	1.59	1.81	1.56	1.46	1.51	1.52	1.56	1.65	1.61	1.58	
ECON sust	Mean	0.86	0.84	0.82	0.80	0.77	0.83	0.78	0.78	0.71	0.70	0.74	0.78	0.61	0.70	0.98
	Std. Dev.	0.30	0.31	0.29	0.25	0.26	0.29	0.26	0.25	0.24	0.24	0.23	0.26	0.25	0.26	
	Min	0.31	0.31	0.32	0.29	0.31	0.35	0.29	0.29	0.26	0.17	0.28	0.30	0.19	0.26	
	Max	1.72	1.89	1.75	1.44	1.82	1.83	1.73	1.52	1.45	1.45	1.39	1.79	1.44	1.80	
SOC sust	Mean	0.70	0.62	0.56	0.49	0.54	0.60	0.61	0.59	0.53	0.51	0.56	0.65	0.68	0.64	0.99
	Std. Dev.	0.35	0.33	0.31	0.32	0.35	0.37	0.39	0.38	0.36	0.35	0.34	0.39	0.38	0.37	
	Min	0.14	0.11	0.09	0.02	0.04	0.07	0.08	0.08	0.06	0.06	0.08	0.09	0.09	0.08	
	Max	1.41	1.65	1.64	1.53	1.68	1.67	1.76	1.83	1.72	1.66	1.39	1.70	1.63	1.71	
PG subs	Mean	0.05	0.05	0.05	0.04	0.04	0.05	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.98
	Std. Dev.	0.06	0.07	0.06	0.06	0.06	0.07	0.06	0.06	0.05	0.05	0.05	0.06	0.05	0.05	
	Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Max	0.33	0.38	0.29	0.29	0.30	0.35	0.33	0.32	0.27	0.27	0.26	0.39	0.26	0.25	
PROD subs	Mean	0.17	0.11	0.06	0.05	0.05	0.06	0.05	0.04	0.03	0.03	0.03	0.04	0.03	0.03	0.88
	Std. Dev.	0.10	0.12	0.06	0.05	0.05	0.06	0.06	0.05	0.05	0.05	0.05	0.07	0.04	0.05	
	Min	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	−0.01	0.00	0.00	0.00	
	Max	0.62	0.59	0.40	0.34	0.33	0.33	0.38	0.30	0.34	0.33	0.40	0.57	0.25	0.26	
DECOUPL subs	Mean	0.07	0.10	0.13	0.11	0.12	0.13	0.12	0.12	0.11	0.12	0.12	0.08	0.07	0.07	1.00
	Std. Dev.	0.05	0.08	0.08	0.07	0.07	0.07	0.06	0.06	0.05	0.05	0.05	0.06	0.03	0.03	
	Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Max	0.25	0.35	0.36	0.32	0.33	0.36	0.30	0.26	0.27	0.28	0.27	0.68	0.16	0.15	
CAP perHa	Mean	3224.7	2969.7	3024.93	2902.50	3397.05	3569.88	3116.50	2632.75	2909.01	3252.92	3255.61	3144.99	2856.30	2844.39	0.99
	Std. Dev.	3174.97	2607.2	2265.17	2677.71	4102.09	3985.24	2718.54	2435.64	2991.27	3668.07	3734.03	3179.98	2900.90	2992.16	
	Min	487.20	503.12	469.19	333.03	481.38	518.84	501.26	494.18	493.37	499.96	398.72	501.86	527.22	559.84	
	Max	18,849.6	23,701	12,674.9	14,008.9	27,010.4	26,207.1	20,892.4	16,848.5	20,058.8	28,809.9	28,567.7	20,248.3	20,966.0	23,916.7	
LAB perHa	Mean	147.26	132.74	131.02	137.64	154.15	167.80	158.64	129.53	135.48	153.53	152.95	141.52	121.95	123.24	0.99
	Std. Dev.	160.13	230.86	119.51	147.75	232.82	288.18	238.64	148.58	138.43	233.89	290.81	150.59	189.80	198.83	
	Min	14.35	25.01	18.40	14.45	22.88	22.98	14.51	12.73	22.57	20.79	19.44	12.85	14.02	14.59	
	Max	931.83	2316.5	545.38	808.73	1877.01	2349.57	2002.79	1021.28	669.24	1809.84	2648.42	849.84	1927.28	2034.19	

* For example 0.94 score means that average farm might replace 6% of output by the input-less output to catch up with its optimal level in Farrell sense; ** Compound annual rate of change.

We use EUFADN region-average farm data from 125 regions and 25 EU member countries [42], excluding Cyprus and Malta, as they were outliers. The research covers the time range from 2004–2017. Provided that the agricultural output (SE131, which excludes subsidies) stands for the effect *(y)*, the following inputs *(x)* were used for the respective dimensions of SV (FADN database codes in brackets; Table 3):

Table 3. The inputs used in various dimensions of sustainability.

Environmental Efficiency ENVsust:
Stock density per ha (SE120) Mineral fertilisers used (SE295) plant-protection products (SE300) Total use of energy (SE345) UAA minus woodland area * (SE075)
Social efficiency SOCsust:
Unpaid labour input (SE015) Paid labour input (SE020) Wages paid (SE370)
Economic efficiency ECONsust:
Total used agricultural area (SE025) Buildings (SE450) Machinery (SE455) Breeding Livestock (SE460) Total current assets (SE465)

* As assumed in the eco-efficiency concept, the inputs should reflect environmental pressure; hence, we included the used agricultural area that was not compensated by woodland area cultivated on farms.

The above data can be directly downloaded in various cross-sections from the website https://ec.europa.eu/agriculture/rica/database/database_en.cfm [42] using the provided codes. The EUFADN methodology, especially sampling and weighting procedure, is also described there. The farm accountancy data network is the only source of microeconomic data that have been describing European farming based on harmonised bookkeeping principles since the 60s (online data is available since 1989). It monitors European farms' business activities and the impact of the measures taken under the CAP. This is based on national representative surveys and covers agricultural holdings that, according to their size, can be considered to be commercial. Agricultural holdings have been selected to take part in the survey on the basis of sampling established at the level of each EU region. As a result, more than 5 million farms are represented in total, covering about 90% of the agricultural area and agricultural production of the EU.

The above set of variables addresses the discussion on the environmental sustainability of agriculture and is well-grounded for environmental efficiency [43]. For the other two other dimensions, we attempted to reflect all possible factors that could contribute to agricultural output in terms of labour and capital (i.e., assets) endowment, including the market value of labour (i.e., wages). We followed the sustainable intensification concept as defined by Staniszewski [21], who advocated that a greater emphasis should be placed on saving resources of capital, labour and environmental inputs in the agricultural sector of the EU, than on increasing food production. Therefore, we decided to insert factor intensity as an explanatory variable into the SEM.

3.2. Stage 2—Structural Equation Modelling

The term structural equation modelling does not describe a single statistical technique, but refers instead to a family of related econometric tools; there are other terms used to identify this approach, such as covariance structure modelling and analysis of covariance structures [44,45]. Compared to multiple regression, advantages of SEM include more flexible assumptions, thereby allowing interpretation even in the face of multicollinearity, and the ability to estimate models with multiple dependent variables, latent variables and endogenous relations that are difficult to capture using other approaches. SEM, particularly, makes it possible to verify whether the pattern of covariances in data and regression between variables is consistent with the specified theoretical model [46]. Therefore, we used SEM and GSEM to test the set of hypotheses justified by literature (Table 1). We carried out a three-fold analysis aiming at revealing regression coefficients and covariances, as depicted in Figures 1 and 2. The *OTVs* indicators acted as the dependent variables. We conducted the following procedure:

1. We performed tests for the invariance of parameters among the groups, then we fitted 14 separate cross-sectional SEM models for the respective years within the 2004–2017 period, following the procedure applied by Hadrich and Olson [47]. We ran SEM group analyses using the maximum-likelihood method with bootstrapped standard errors (1000 replications) to limit estimation biases resulting, i.a., from heteroscedasticity. The samples in each year within the 2004–2017 period were treated as separate groups of observations. To test the null hypothesis that structural coefficients, structural intercepts and covariances of structural errors were equal across the groups, we performed tests for group invariance of parameters and joint tests for each parameter class. We also tested for the collinearity of the variables in the model and obtained VIF results below 2 in all cases. The above tests suggested that we could not impose constraints on any parameters, which means it was not possible to assume that they were equal across the groups, so we performed 14 separate SEM estimations. It is worth noting that the PGsubs coefficients and both of the covariances for ECONsust (with ENVsust and SOCsust) were the only invariant parameters. Table 4 depicts the SEM results with bootstrapped standard errors (1000 replications). We tested goodness-of-fit and analysed the modification indices. Our SEM models (Table 4) were saturated and full rank (i.e., it had the best possible fit), so the Chi-square measure (the model vs. the saturated model) was close to 0, and the fit indicators from Table 5 (TLI, CFI, RMSEA and SRMR) also achieved the best possible values.
2. We estimated multilevel GSEM with a random intercept [49] at the region level using a full panel of 1750 observation (125 regions $\times$ 14 years) to capture region-specific random effects. This approach can be described as a kind of variance component model [49], and brings an outcome comparable to a panel regression with random effects (Figure 2); hence, it allows us to interpret the coefficients for a time series.
3. Finally, we again estimated the GSEM with a random intercept, but this time at the year level, also using the full panel. This is an approach that can be employed for cross-sectional interpretation. We added a random effect measurement (i.e., a multilevel latent variable; see Figure 3) to the model that is constant within a year and varies across years. This is akin to introducing the average level of variables from each year into the model in order to capture the time effect and allow for a cross-sectional interpretation of the panel data.

Table 4. Coefficients with bootstrapped standard errors (1000 replications) in the SEM of the effects of policy and factor intensity on sustainability.

VARIABLES	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
ENVsust														
PGsubs	0.519	−0.077	−0.315	0.755	1.468 ***	0.806 **	0.908 **	1.176 ***	1.117 ***	0.702 *	0.683 *	1.049 *	0.745	0.311
	[0.544]	[0.307]	[0.395]	[0.595]	[0.4867]	[0.393]	[0.358]	[0.342]	[0.397]	[0.423]	[0.399]	[0.572]	[0.460]	[0.571]
PRODsubs	−1.061 ***	−0.632 ***	−0.876 **	−1.693 **	−2.758 ***	−2.527 ***	−2.370 ***	−2.576 ***	−2.622 ***	−2.146 ***	−2.094 ***	−1.485	−2.340 ***	−1.758 ***
	[0.397]	[0.215]	[0.415]	[0.596]	[0.527]	[0.399]	[0.428]	[0.485]	[0.421]	[0.473]	[0.377]	[0.923]	[0.579]	[0.664]
DECOUPLsubs	−0.213	−0.733 **	−1.418 ***	−1.087 ***	−1.226 ***	−1.464 ***	−1.218 ***	−1.149 ***	−1.650 ***	−1.997 ***	−2.748 ***	−1.015	−3.683 ***	−3.781 ***
	[0.491]	[0.294]	[0.387]	[0.422]	[0.362]	[0.324]	[0.380]	[0.414]	[0.379]	[0.393]	[0.391]	[1.406]	[0.577]	[0.688]
CAPperHA′000	0.008	0.029 **	0.016	−0.009	0.003	0.015	0.016	0.022 **	0.006	−0.002	−0.007	−0.017	0.033 ***	0.034 ***
	[0.010]	[0.012]	[0.013]	[0.013]	[0.008]	[0.010]	[0.012]	[0.010]	[0.006]	[0.007]	[0.011]	[0.010]	[0.008]	[0.012]
LABperHA′000	0.126	−0.246	−0.174	0.205	0.056	−0.012	−0.217	−0.173	−0.063	0.173	0.073	0.213	−0.530 **	−0.680 **
	[0.194]	[0.157]	[0.237]	[0.235]	[0.144]	[0.014]	[0.183]	[0.191]	[0.160]	[0.128]	[0.140]	[0.173]	[0.140]	[0.305]
Constant	1.065 ***	1.026 ***	1.236 ***	1.094 ***	1.077 ***	1.131 ***	1.085 ***	1.034 ***	1.093 ***	1.129 ***	1.316 ***	1.079 ***	1.227 ***	1.229 ***
	[0.066]	[0.068]	[0.085]	[0.066]	[0.054]	[0.056]	[0.070]	[0.072]	[0.066]	[0.067]	[0.059]	[0.126]	[0.056]	[0.080]
ECONsust														
Pgsubs	−1.463 **	−1.502 ***	−1.494 ***	−0.916 **	−1.021 **	−0.888 **	−1.011 **	−1.198 **	−1.375 **	−1.474 ***	−1.543 ***	−2.063 ***	−0.243	−0.566
	[0.577]	[0.466]	[0.457]	[0.431]	[0.44]	[0.379]	[0.405]	[0.508]	[0.558]	[0.501]	[0.505]	[0.617]	[0.489]	[0.656]
PRODsubs	−0.652 *	−0.359	−0.840 *	−1.405 ***	−1.280 ***	−1.443 ***	−1.136 **	−0.980 *	−0.897 *	−0.288	−0.403	1.170	−1.795 **	−1.450 *
	[0.426]	[0.233]	[0.484]	[0.437]	[0.48]	[0.384]	[0.442]	[0.577]	[0.483]	[0.465]	[0.521]	[0.849]	[0.617]	[0.840]
DECOUPLsubs	−0.261	−1.097 ***	−0.551 *	−0.793 **	−0.508	−1.327 ***	−1.156 ***	−1.349 ***	−1.425 ***	−1.445 ***	−1.691 ***	−0.953	−4.218 ***	−4.808 ***
	[0.604]	[0.334]	[0.310]	[3.10E−01]	[0.329]	[0.312]	[0.368]	[0.369]	[0.365]	[0.404]	[0.442]	[1.040]	[0.614]	[1.014]
CAPpeHA′000	0.004	0.024 *	0.038 ***	0.017 *	0.009	0.017 *	0.017 *	0.021 *	0.011	0.001	0.012	0.006	−0.027 ***	−0.030 **
	[0.008]	[0.014]	[0.012]	[0.001]	[0.007]	[0.009]	[0.011]	[0.012]	[0.010]	[0.009]	[0.010]	[0.008]	[0.009]	[0.015]
LABperHA′000	0.135	−0.373 **	−0.411 *	−0.169	−0.178	−0.091	−0.150	−0.314 *	−0.063	−0.010	−0.183	0.083	0.570 ***	0.514
	[0.161]	[0.175]	[0.227]	[0.173]	[0.132]	[0.131]	[0.114]	[0.178]	[0.187]	[0.144]	[0.144]	[0.182]	[0.149]	[0.313]
Constant	1.034 ***	1.053 ***	0.948 ***	0962 ***	0.933 ***	1.091 ***	0.989 ***	1.011 ***	0.935 ***	0.944 ***	0.999 ***	0.873 ***	0.998 ***	1.130 ***
	[0.068]	[0.066]	[0.071]	[0.0049]	[0.049]	[0.054]	[0.064]	[0.061]	[0.063]	[0.065]	[0.060]	[0.096]	[0.060]	[0.106]

Table 4. *Cont.*

VARIABLES	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
							SOCsust							
Pgsubs	−0.482	−0.953 **	−0.485	−0.025	0.333	−0.050	0.494	0.644	0.388	0.048	0.260	0.692	−0.905	−1.490
	[0.619]	[0.404]	[0.540]	[0.556]	[0.608]	[0.538]	[0.657]	[0.681]	[0.740]	[0.636]	[0.751]	[0.818]	[0.766]	[1.187]
PRODsubs	−0.037	0.093	−1.138 *	−1.570 ***	−1.913 ***	−1.637 ***	−2.327 **	−2.411 **	−2.151 **	−1.859 ***	−1.633 **	−1.749 **	−0.072	0.235
	[0.461]	[0.261]	[0.604]	[0.564]	[0.658]	[0.55]	[0.955]	[1.003]	[0.882]	[0.621]	[0.731]	[0.883]	[0.965]	[1.456]
DECOUPLsubs	2.045 ***	1.677 ***	1.116 ***	1.696 ***	1.451 ***	1.065 **	0.507	0.411	−0.215	−0.713	−1.153 **	−0.214	−1.839 **	−2.112 *
	[0.614]	[0.382]	[0.409]	[0.40]	[0.452]	[0.442]	[0.536]	[0.582]	[0.545]	[0.511]	[0.483]	[1.110]	[0.961]	[1.172]
CAPpeHA’000	−0.004	0.016	−0.003	−0.010	−0.001	0.0003	0.014	0.036*	0.011	−0.001	0.000	−0.004	0.060 ***	0.051
	[0.010]	[0.017]	[0.018]	[0.012]	[0.010]	[0.014]	[0.016]	[0.019]	[0.012]	[0.013]	[0.017]	[0.014]	[0.014]	[0.042]
LABperHA’000	−0.192	−0.082	0.383	0.153	0.139	−0.071	−0.287	−0.658 **	−0.113	0.208	−0.025	0.143	−1.394 ***	−1.261
	[0.216]	[0.316]	[0.394]	[0.223]	[0.180]	[0.187]	[0.180]	[0.313]	[0.236]	[0.221]	[0.215]	[0.265]	[0.233]	[0.853]
Constant	0.626 ***	0.456 ***	0.457 ***	0.387 ***	0.435 ***	0.569 ***	0.639 ***	0.604 ***	0.596 ***	0.628 ***	0.736 ***	0.694 ***	0.838 ***	0.853 ***
	[0.079]	[0.077]	[0.080]	[0.063]	[0.067]	[0.076]	[0.095]	[0.093]	[0.090]	[0.084]	[0.085]	[0.111]	[0.094]	[0.185]
cov(ENVsust, ECONsust)	0.013 *	0.008	0.005	0.004	0.011 ***	0.011 ***	0.009 *	0.014 ***	0.013 ***	0.010*	0.007	0.019 ***	0.009 *	0.007
	[0.008]	[0.007]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.005]	[0.006]	[0.005]	[0.006]	[0.003]	[0.005]
cov(ENVsust, SOCsust)	0.046 ***	0.042 ***	0.033 ***	0.048 ***	0.048 ***	0.052 ***	0.053 ***	0.053 ***	0.050 ***	0.047 ***	0.035 ***	0.041 ***	0.008 *	0.018 ***
	[0.008]	[0.007]	[0.006]	[0.009]	[0.008]	[0.009]	[0.008]	[0.008]	[0.007]	[0.007]	[0.006]	[0.008]	[0.005]	[0.007]
cov(ECONsust, SOCsust)	0.008	0.020 ***	0.015 **	0.018 ***	0.021 ***	0.019 ***	0.023 ***	0.028 ***	0.027 ***	0.026 ***	0.014 **	0.026 ***	0.012 **	0.019 ***
	[0.008]	[0.007]	[0.007]	[0.006]	[0.007]	[0.008]	[0.007]	[0.006]	[0.006]	[0.006]	[0.005]	[0.007]	[0.005]	[0.007]
CD	0.512	0.599	0.643	0.594	0.543	0.607	0.51	0.496	0.506	0.46	0.535	0.385	0.785	0.804
Observations	111	111	111	124	124	125	125	125	125	125	124	125	124	124

Significant bolded; Standard errors in brackets. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5. Selected fit statistics reported for assessing a goodness-of-fit in SEM.

Measure	Name	Description	Cut-off for Good Fit
Chi-Square	Model Chi-Square	Tests the null hypothesis that the estimated model is equal to the saturated model, which perfectly reproduces all of the variances, covariances and means of the observed variables.	p-value > 0.05
NFI (TLI)	(Non) Normed-Fit Index Tucker Lewis Index	An NFI of 0.95 indicates the estimate improves the fit by 95% relative to the null model; NNFI is preferable for smaller samples. Sometimes the NNFI is called the Tucker Lewis index (TLI)	NFI $\geq$ 0.95 NNFI $\geq$ 0.95
CFI	Comparative Fit Index	A revised form of NFI that is less sensitive to sample size.	CFI $\geq$ 0.90
RMSEA	Root Mean Square Error of Approximation	A parsimony-adjusted index. Values less than 0.03 represent excellent fit.	RMSEA < 0.08
SRMR	(Standardised) Root Mean Square Residual	The square-root of the difference between the residuals of the sample covariance matrix and the hypothesised model. SRMR is standardised in nature, so it is easier to interpret than RMR.	SRMR < 0.08
CD	Coefficient of Determination	Interpretation is similar to R-square.	Higher is better
AIC	*Akaike Information Criterion*	Assesses the relative quality of statistical models.	Lower is better
BIC	Bayesian Information Criterion	Assesses the relative quality of statistical models.	Lower is better

Source: [48].

GSEM models were estimated to confirm the correctness of SEM modelling and to capture changes in time in addition to cross-sectional analysis. These are depicted in Figures 2 and 3. The results are compared in Table 6. Even though the model with a random intercept for the regions (125 regions × 14 years) provided an output comparable to a panel regression with random effects, there was no option to assess the correctness of being in line with the panel-regression assumptions. GSEM doesn't offer any goodness-of-fit tests, so we could only base our post-estimation check on the positive evaluation for the SEM models.

Table 6. Multilevel GSEM with the random 'between' effect captured for the regions and years (125 regions × 14 years, 2004–2017).

	Year Random Intercept (1)			Region Random Intercept (2)		
Parameters	Coef.	Std. Err.	P > z	Coef.	Std. Err.	P > z
ENVsust						
PGsubs	0.496	0.122	0.000	0.388	0.110	0.000
PRODsubs	−1.299	0.104	0.000	−0.898	0.078	0.000
DECOUPLsubs	−1.397	0.099	0.000	−1.743	0.082	0.000
CAPperHA'000	0.011	0.003	0.000	0.007	0.002	0.002
LABperHA'000	−0.107	0.040	0.007	−0.028	0.033	0.388
M1[Year/Region]	0.580	0.095	0.000	2.530	0.269	0.000
_cons	1.097	0.019	0.000	1.111	0.018	0.000

Table 6. *Cont.*

Parameters	Year Random Intercept (1) Coef.	Std. Err.	P > z	Region Random Intercept (2) Coef.	Std. Err.	P > z
ECONsust						
PGsubs	−1.449	0.117	0.000	−1.647	0.117	0.000
PRODsubs	−0.345	0.106	0.001	0.045	0.091	0.619
DECOUPLsubs	−1.061	0.095	0.000	−0.989	0.095	0.000
CAPperHA'000	0.008	0.002	0.001	0.007	0.003	0.003
LABperHA'000	−0.054	0.038	0.152	−0.029	0.039	0.454
M1[Year/Region]	1.000	(constrained)		1.000	(constrained)	
_cons	0.944	0.025	0.000	0.919	0.015	0.000
SOCsust						
PGsubs	−0.380	0.173	0.028	−0.310	0.126	0.014
PRODsubs	−0.458	0.140	0.001	−0.031	0.045	0.491
DECOUPLsubs	0.515	0.144	0.000	−0.693	0.067	0.000
CAPperHA'000	0.012	0.004	0.001	0.002	0.001	0.127
LABperHA'000	−0.204	0.057	0.000	−0.022	0.017	0.195
M1[Region/Year]	−0.247	0.156	0.113	5.696	0.600	0.000
_cons	0.569	0.021	0.000	0.665	0.033	0.000
var(M1[Year/Region])	0.006	0.002	0.013	0.004	0.001	0.006
var(e.ECONsust)	0.055	0.002	0.059	0.056	0.002	0.060
var(e.ENVsust)	0.061	0.002	0.066	0.040	0.002	0.043
var(e.SOCsust)	0.125	0.004	0.134	0.008	0.000	0.009
cov(e.ECONsust_e.ENVsust)	0.012	0.001	0.000	0.006	0.001	0.000
cov(e.ECONsust_e.SOCsust)	0.022	0.002	0.000	0.001	0.001	0.478
cov(e.ENVsust_e.SOCsust)	0.051	0.002	0.000	−0.002	0.001	0.016

The model from Figure 1 employs the following variables (with the respective EU-FADN SE codes, Table 7):

Table 7. Building exogenous and endogenous variables in SEM.

Exogenous Variables:
PGsubs: subsidies for public goods share: (LFA_SE622 + OtherRD_SE623 + EnvSub_SE621 + Set aside premiums_SE612)/Total output_SE131
PRODsubs: production subsidies share: (Total subsidies on crops_SE610 + Other crops subsidies_SE613 + Subsidies dairying_SE616 + Subsidies sheep & goats_SE618 + Subsidies on intermediate consumption_SE625)/Total output_SE131
DECOUPLsubs: decoupled subsidies share: (Decoupled payments_SE630 + Compensatory payments/area payments_SE611)/Total output_SE131
LABperHa: labour intensity: Labour input_SE011/Total Used Agricultural Area_SE025
CAPperHa: capital intensity: (Total fixed assets – land value/Total Used Agricultural Area_SE025
Endogenous Variables:
ENVsust: environment sustainable value, expressed by OTV_{env}
ECONsust: economic sustainable value, expressed by OTV_{econ}
SOCsust: social sustainable value, expressed by OTV_{soc}

A key part of SEM involves testing the goodness-of-fit of the model, as described above, which uses multiple measures presented in Table 5 [50].

4. Results

4.1. Descriptive Statistics

The descriptive statistics are presented in Table 2. In the examined period, a moderate OTV downward trend was noted in the case of social and economic efficiency, and a constant situation was observed for the eco-efficiency dimension (Table 2). It can be concluded that there are still significant reserves of each OTV-type improvement, which means there is the possibility of achieving higher production without increasing environmental, economic or social inputs. The worst situation appeared in terms of social efficiency (i.e., compensation of labour), and eco-efficiency was the best. Negative tendencies were also observed in the case of some groups of subsidies, namely subsidies for public goods and for production. For the latter, this tendency is fully justified by the change of CAP objectives in favour of decoupled payments. We also noticed a moderate negative tendency for the factor intensity.

4.2. Cross-Sectional SEM Results for Respective Years within 2004–2017

In Table 4, we can see significant and stable cross-sectional effects, which repeatedly occur in a majority of the period being studied. The most striking observation concerns the trade-offs between the three sustainability dimensions: in fact, no trade-offs were noticed, although there were positive mutual feedbacks. When it comes to the effects of CAP, production subsidies negatively impacted all of the sustainability aspects; public goods subsidies had a positive influence on environmental efficiency, but negatively influenced economic efficiency and were insignificant on the social dimension; decoupled subsidies had a negative effect on economic and eco-efficiency, and since 2014, also had a negative impact on social efficiency. According to AIC, BIC and CD, the model fit simultaneously improved, reaching the highest level in 2006 and 2017 (e.g., CD grew from 0.51 in 2004 to 0.80 in 2017).

4.3. Multilevel GSEM with Random Region and Year Effect

The GSEM results in Table 6 include an interesting comparison of the static and dynamic aspects of the policy impact on the sustainability dimensions and the interactions thereof.

The regional random intercept appears to be significant (see var_Region in Model 2); hence, the rest of the e variance in this model is attributed to changes in time. We can only see one important difference, compared to the previous cross-sectional analysis: the covariance between environmental and social efficiency is negative, which means that an increase in eco-efficiency might negatively affect social efficiency, even though in the regions that reported the higher eco-efficiency, the social efficiency was still higher. The model with year random intercept basically confirms the results for the previous cross-sectional analyses in separate years, although it proves almost all effects to be significant. The hypotheses sated in the introduction are answered in Table 1.

5. Discussion

As mentioned earlier, the question of what effect CAP subsidies have on the productivity or efficiency of farms in the European Union has been studied by many researchers, but it has not yet been definitively answered [51–54]. Subsidies that change competition conditions and morph into a support of income, rather than of production, are generally expected to cause a decrease in productivity. The cited studies show that before the decoupling reform (in 2003), subsidies had a positive impact on production, but a negative impact on productivity. The reform of CAP and decoupling also had an overall negative impact on employment within the agricultural sector, and therefore affected social sustainability.

The evidence suggests that in general, Pillar I (consisting of the instruments for direct support) prevents out-migration of small and family farms from the agricultural sector and, at best, maintained jobs in the agricultural sector, but did not create new jobs. Furthermore, Pillar I initiated higher, more intensive productivity, which gradually reduced the size of the agricultural workforce [55]. On the other hand, Pillar II (consisting of the instruments for public goods provision and environmental schemes) might successfully create new jobs in other areas, such as tourism, food processing and associated sectors, but implementation is highly dependent on member state and regional implementation approaches. A negative influence of subsidies on total factor productivity (TFP) or average productivity was found less often [10]. This result remains in opposition to our findings, which revealed a mostly negative impact of decoupled payments on all dimensions of sustainability. Many studies show that without direct CAP support, farm incomes would be significantly lower, possibly even in the negative [56–60], thus suggesting that this support does not affect market prices. The average incomes of agricultural holdings in individual EU states have almost reached average income levels in national economies, which in turn contributes to the socio-economic sustainability of agriculture in the EU [61]. This observation was also confirmed by other studies (e.g., [62]), which asserted that providing CAP instruments for agriculture had a decisive influence on the increase in income in EU-12 countries and on a decrease in the disparities between the income of farmers and remuneration obtained in other occupations. Hence, agricultural policy is of key importance for reducing agricultural deprivation [63–66]. When it comes to the eco-efficiency thread, Grovermann et al. [67] argued that innovative systems enabled by institutional help connected with production in agriculture increase overall efficiency. This is in line with our findings, which basically contradict the conventional perception regarding the negative correlation between environmental sustainability and economic performance. More stringent environmental policies can stimulate innovations that may over-compensate for the costs of complying with these policies [68]. This point of view, which says that the gradual strategic reorientation of environmental policies in the EU in favour of economic incentives has been more effective in stimulating productivity and innovation than in setting explicit directives about pollution control levels, was also advocated by De Santis and Lasinio [69]. Moreover, our findings confirmed the view presented in the literature that subsidies for public goods positively contribute to the goal of gaining environmental sustainability [70]. This conclusion may be derived from the fact that in mountain regions and in regions with a predominance of extensive production, especially in the new member states, the environmental criteria have already been reached, so subsidies for public goods make it possible to acquire new funds for development without bearing additional costs.

Although there is evidence of a negative general impact of CAP subsidies on productivity, it should be noted that the role of subsidies—especially green-box subsidies—in social sustainability, which is related to social capital, social inclusion, social exclusion and social cohesion in rural economies, cannot be forgotten. Nikolov et al. [71] pointed out that there is limited literature that focuses on social sustainability, and a comprehensive study of this concept is still needed. A study by the OECD [46] on sustainable development indicated that social sustainability is dealt with as it relates to the social implications of environmental politics, rather than as an equally constitutive component of sustainable development. Due to this fact, according to the cited authors, there have been few attempts to define social sustainability as an independent dimension of sustainable development; this shortcoming also concerns our study.

Omann and Spangenberg [72] contended that social sustainability focuses on personal assets like education, skills, experience, consumption, income and employment and comprises every citizen's right to actively participate in their society as an essential element. According to their analysis, therefore, access to societal resources is a key element of social sustainability; this is also the case in rural areas. In this way, environmental subsidies enhance valued landscapes and habitats and improve the public's enjoyment of the countryside. According to the Research for AGRI Committee, environmental subsidies might have a positive impact on the promotion of agritourism and therefore create new job opportunities in agricultural areas [73]. Pawłowska-Tyszko [74] claimed that environmental payments bring about positive effects in the social dimension, because as a basis of remuneration for green services, they also play a profit-making role, which is particularly important in small, extensive holdings, which are the main beneficiaries of these programmes. However, we recall Chabé-Ferret and Subervie [75], who stated that 'as a result of support for agri-environmental activities, two effects emerged: "additional"—value added generated by the implementation of an obligation and "windfall"—extraordinary, unexpected income. Thus, subsidies are cost-ineffective, and hence, producers do not incur full social costs of their activities.'

In the studies on the impact of factor intensity on sustainability and efficiency, we found the widespread view that an increase in capital expenditure is conducive to high economic efficiency [76]. In contrast, there is a concern that stimulating capital endowment under the CAP fosters industrial agriculture and may lead to excessive investment [10]. In the literature, there is generally a positive correlation between capital and economic stabilisation. However, there is evidence for the over-investment in equipment [10,77] in new member states as farms buy new assets regardless of profitability analysis.

When analysing the relationship between the three dimensions of sustainability, we found a significant positive impact in all three cases in the cross-sectional approach, which is surprising considering the common view that the goals of the CAP conflict and evidence from the research of only two old member countries Spain and Italy [78]. Staniszewski [21] explained that for older member states, the concept of sustainable intensification primarily means an increase in environmental agricultural productivity without diminishing economic productivity. In contrast, the sustainable intensification in new member states is more focused on improving economic productivity without depleting natural resources. Changes that were not in line with the sustainable intensification concept were reported in the Benelux countries and in the United Kingdom, where environmental productivity improved, but economic productivity diminished at the same time [11]. We should stress, however, that our analysis reveals long-term regional tendencies and interactions throughout the EU in a holistic approach that includes the main groups of CAP subsidies and all sustainability aspects, whereas the cited studies generally focused on particular farm-level schemes in short-term analysis.

6. Conclusions

Most of the research considering the impact of agricultural policy on sustainable agriculture has only focused on one aspect of sustainability (i.e., environmental impact, productivity, etc.) and on the chosen CAP tools. In this study, we attempted to determine the simultaneous relationships among the main groups of subsidies (subsidies for public goods, production subsidies and decoupled payments) and the three dimensions of sustainability in agriculture in a holistic way; such an approach may be useful for indicating directional guidelines for CAP in subsequent programming periods. This research sheds light on the trade-offs between environmental, economic and labour remuneration aspects. Although farm-level studies in the literature have indicated such trade-offs, particularly between economic performance and eco-efficiency, our study showed that in the long-term, such feedback has not occurred in EU regions. Moreover, there are positive interactions between all three dimensions of sustainability from a cross-sectional perspective.

Regarding recommendations for EU policy-makers: The level of eco-efficiency is fairly even in all of the EU regions. The current system of agri-environmental, set-aside and rural-development payments has been effective and should be consistently continued as they are now. However, a greater emphasis on environmental objectives in countries where the productivity of labour is far from optimal may have a negative impact on social sustainability. The long-term positive impact of capital intensity on all aspects of sustainability suggests that investment support should be strengthened, particularly in Central and Eastern European countries. Production support is inefficient in all aspects of sustainability and should be gradually replaced by other solutions. Redirection of the impact of direct payments on social sustainability from positive to negative is concerning. Consideration should be given as to whether or not decoupled payments should be linked to farm practices that might improve labour productivity or strengthen pro-ecological attitudes.

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