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The role of CAP subsidies in all European Union member states: an analysis of technical inefficiency[1]

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Abstract

The purpose of this research was to assess the impact of CAP payments made to farms included in the European FADN dataset between 2004 and 2019 and, considering this financial aid as an environmental variable, identify patterns of inefficiency in EU farming. The study has adopted a twofold quantitative approach, applying both two-stage DEA and Multidirectional Efficiency Analysis. The results reveal significant imbalances between EU member states over the period of investigation, and underline the specific effect that total CAP disbursed subsidies and second pillar CAP support have on technical inefficiency.

Key words: Data Envelopment Analysis; two-stage DEA; second pillar; rural development; FADN

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Introduction

A literature review recently carried out by Minviel and Latruffe (2017) through meta-analysis identified a wealth of studies aimed at estimating the impact that financial subsidies allocated through the Common Agricultural Policy have on farmers in many different European Union (EU) countries. According to these authors, assessing what relationship subsidies allocated through the CAP have on the levels of technical efficiency in farming represents a critical issue in developing public policy. A systematic literature review has found that subsidies are negatively associated with farm technical efficiency, even if the effects are sensitive to the way subsidies are modelled in the empirical studies (Minviel and Latruffe, 2017). An estimation of technical efficiency in crop farms included in the FADN dataset for the period 1995–2004 located in Germany, the Netherlands, and Sweden shows that increasing the share of crop subsidies on total subsidies has mixed effects, with a negative impact on technical efficiency in Germany, a positive impact in Sweden, and an insignificant effect in the Netherlands. In contrast, increasing the share of total subsidies on total farm revenues has a negative impact on technical efficiency in all investigated countries (Zhu and Lansink, 2010). The reasons for this are unclear, although as investigations in other European countries have suggested, the effect is related to the size of the farm and its degree of specialisation, (Galluzzo, 2022; Zhu and Lansink, 2010; Koteva, 2019).

Turning our attention to other highly specialised farming sectors such as dairy, the findings underline that the effect of subsidies on technical efficiency may be positive, null, or negative, depending on the country and the form in which decoupled subsides are paid following the 2003

CAP reforms that reduced the impact that subsidies have on technical efficiency (Latruffe et al., 2017; Nikolov and Anastasova-Chopeva, 2017). In general, the lowest levels of technical efficiency can be found in farms which receive the highest proportion of their gross income from subsidies (Žáková Kroupová and Trnková, 2020).

Turning to the issue of land capital endowment, some studies have indicated that the dimension of farms as well as their specialisation has a positive impact on technical efficiency, particularly in the case of enterprises specialised in animal production (Rudinskaya et al., 2020). On the other side, the lowest levels of technical efficiency are typically found in farms situated in mountainous regions receiving Less Favoured Areas (LFAs) payments (Rudinskaya et al., 2020). Subsidies allocated through the CAP have some direct impact, both on the technical efficiency as well as the performance of farms in terms of total factor productivity (TFP). This underlines that LFA payments and agri-environmental (AE) subsidies had no impact on the different components of TFP and, consequently, on the technical efficiency (Barath et al., 2020). The effect of subsides is not the same in all European countries. In fact, a recent study on CAP subsidies has argued that financial supports have had a negative impact on agricultural productivity in almost all the EU member states with the exception of Bulgaria (Nikolov and Anastasova-Chopeva, 2017; Koteva et al., 2013), where subsidies have had a positive effect on small and medium-sized farms (Alexandri et al., 2021). The effect on productivity of other input variables such as land is positive in most investigated countries. Given this context, it is clear that EU policies on subsidies must be devised that pay due attention to specific characteristics and needs of divergent European Union members (Alexandri et al., 2021). In general, studies have investigated that subsidies for both LFA and non-LFA farms can reduce farm income risk, with a consequent effect on technical efficiency. In contrast, subsidies and the size of farms have an effect on income risk for farms receiving LFA support, with a non-linear relationship between farm size and income risk. Bojnec and Fertő, 2018). Other studies have found only a minor and statistically non-significant difference in technical efficiency between farms receiving LFA supports and farms not receiving LFA payments (Baráth et al., 2020). These authors have argued that the difference between these two groups of farms is highly significant in terms of heterogeneity and technology hence, farms receiving LFA payments are not more inefficient, they just follow a different production and use specific technologies.

Furthermore, focusing on the impact of subsidies allocated under the first pillar of CAP on technical efficiency, the main findings indicate that direct payments have a significant effect on technical efficiency in specialised farms receiving higher levels of support, even if the criterion of how subsidies are distributed is fundamental in determining their impact on technical efficiency (Bonfiglio et al., 2019).

Galluzzo argued (2021) that in several European nations such as Italy, France, Slovenia, Hungary, and Poland, the technical and allocative efficiency of farms has been influenced by the type of crop specialisation, agri-environmental policy, the typology of farm ownership, and the dimension of farms in terms of land capital endowment (Cisilino et al., 2021; Galluzzo, 2016; Latruffe et al., 2017; Gorton and Davidova, 2004; Latruffe and Nauges, 2014; Bojnec and Latruffe, 2013; Garrone et al., 2019; Koteva, 2019). In the literature, a review undertaken by Nowak et al. in 2015 estimated the technical efficiency in all EU countries, with the highest values being assessed in certain countries (Cyprus, Denmark, Greece, France, Spain, the Netherlands, Luxembourg, Italy, and Malta); nevertheless, the dimension of the farming enterprise was not found to have had an effect on its technical efficiency (Galluzzo, 2021).

On the other hand, few studies have investigated the pattern of inefficiency and the impact of CAP subsidies as environmental variables in all European countries hence, a literature review is not able to explain the real reasons that push farmers to adhere to certain policy actions supported through the CAP, and specific patterns of inefficiency correlated to those decisions (Uthes and Matzdorf, 2016). In fact, for many farms, participation in measures sponsored through the CAP such as agri-environmental policies have led to a reduction in technical efficiency, with this reduction being a direct consequence of the farmer following a specific rational choice explained by the hypothesis of rational inefficiency (Bogetoft and Hougaard, 2003).

A detailed literature review focused on estimating the impact of financial subsidies allocated through the Common Agricultural Policy to farmers using a two-stage methodology does not yield many results (Horvat et al., 2019; Gutiérrez et al., 2017; Forleo et al., 2021; Galluzzo, 2021). In particular, through a two-stage approach in the estimation of technical efficiency, as proposed as a theoretical framework by Simar and Wilson in 2011 and Daraio et al. in 2018, it is possible to assess the effect of some environmental variables, such as the financial subsidies allocated through the CAP, on the technical efficiency in farms. Some recent studies conducted in Italy and Romania have used a two-stage analysis of technical efficiency in estimating the role of CAP subsidies using a non-parametric approach (Romagnoli et al., 2021; Galluzzo, 2021). The results showed that the effect of the financial subsidies disbursed through the first and second pillars of the CAP can diverge in the countries investigated. Galluzzo argued that subsidies disbursed under only the second pillar of the CAP aimed to stimulate the rural development have not had any positive and clear effect on technical efficiency. On the contrary, Romagnoli et al. (2021) argue that EU subsidies paid to less-favoured areas are pivotal for farms located in mountainous zones, with their use consequently impacting the technical efficiency.

Purpose of the research

The purpose of this research was to assess the impact of CAP payments on all EU farms included in the Farm Accounting Data Network (FADN) dataset from 2004 to 2019, considering certain financial support allocated through the CAP as environmental variables in order to estimate the pattern of inefficiency in each input and output. In this research, a two-fold quantitative approach has been used: firstly, a two-stage Data Envelopment Analysis (DEA), followed by a Multidirectional Efficiency Analysis (MEA) aimed at investigating the impact that CAP subsidies have on technical inefficiency in farms. The novelty of this study lies in applying a quantitative approach in order to assess patterns of inefficiency in each input and output, and also to estimate the financial subsidies allocated through the Common Agricultural Policy as an environmental variable able to act on the technical efficiency in the outputs.

The impact of the financial subsides allocated under the CAP has been assessed considering the total support paid through the CAP (first and second pillars), the support disbursed through the Rural Development Programme (RDP), and direct aid to disadvantaged rural communities such as the Less Favoured Areas (LFA) payments. All these subsidies have been considered as environmental variables correlated to the technical efficiency previously estimated through the DEA analysis in the first stage of the investigation. The element of innovation in this approach is in introducing financial subsidies as a variable able to influence the level of technical efficiency, in order to understand the effect that subsidies have, as well as the pattern of inefficiency their use in farms can have as a consequence. The main policy implications are centred on analysing the impact of certain financial subsidies allocated under the second pillar of the CAP on the level of technical efficiency in farms, as well as on assessing which financial subsidies and inputs are more or less inefficient in farms.

Methodology

In general, two different methodologies can be used to assess technical efficiency; one is through parametric or stochastic modelling (SFA), while the other is through non-parametric modelling using the Data Envelopment Analysis (DEA) method (Coelli et al., 2005; Kumbhakar et al., 2015; Galluzzo, 2021). The DEA has the benefit that it allows the estimation of multiple inputs and multiple outputs without *a priori* defined functions of production and other specifications in the model (Coelli et al., 2005; Galluzzo, 2021).

In this paper, the DEA approach has been used in an input-oriented variable returns to scale (VRS) model with the aim of minimising inputs, using data from all farms included in the Farm Accountancy Data Network dataset during the period 2004 to 2019. In this research, by the estimation of the technical efficiency using the DEA it is possible to set a hypothetical frontier of production made by a combination of input able to produce a fixed quantity of output (Coelli et al., 2005; Galluzzo, 2021). This is the case of the DEA input oriented approach, which is a non-parametric method able to minimize this combination in input, that has been used in this research. The value of technical efficiency estimated by the DEA is in a range between 0, farms totally technical inefficient and located under and very far from the frontier of production, and 1 in farms technical efficient located on the frontier of production which is the optimal threshold that every farm can not exceed given a well defined level of technology (Coelli et al., 2005; Kumbhakar et al., 2015; Galluzzo, 2021). On the contrary values of technical efficiency estimated by the DEA greater than zero but less than one indicate intermediate situations of technical inefficiency.

With the purpose of assessing whether certain environmental variables such as financial subsidies allocated through the CAP have an impact on the technical efficiency of farms assessed through the DEA, the two-stage DEA approach proposed by Simar and Wilson has been used (Simar and Wilson, 2011; Daraio et al., 2018). In this research, three different impacts of environmental variables have been tested: in the first hypothesis, the impact of total financial subsidies allocated through the CAP has been estimated; in the second hypothesis, only the impact of RDP subsidies has been tested; finally, in the third hypothesis, the effect of LFA subsidies as an environmental variable has been tested.

One of the main drawbacks of the DEA is its inability to identify inefficiency or efficiency patterns in each input and output variable. This weakness is effectively overcome by Multi-Directional Efficiency Analysis or MEA (Bogetoft and Hougaard, 2003; Asmild et al., 2003; Hansson et al., 2020). According to these authors, MEA has the advantage of simultaneously estimating efficiency in multi-input and multi-output models and also assessing inefficiency in each of the individual inputs and outputs used in the production process (Manevska-Tasevska et al., 2021). The MEA approach makes it possible to identify those deviations from the production frontier, expressed in terms of productivity change, that are due to variables not incorporated in the analysis of technical efficiency (Bogetoft and Hougaard; 2003, Hansson et al., 2020).

Using data from the FADN dataset for the years 2004-2009, Baležentis and De Witte noted (2015) how the production efficiency of Lithuanian farms during the period was negatively correlated with the levels of production subsidies paid. MEA scores range between zero, for farms that are totally inefficient, and 1, for farms that are totally efficient without any excess inputs or outputs. Input efficiency scores of 1 indicate that there is no potential for improvement on the input/output variable in question, while a score of less than one (e.g. 0.8) indicate that the farm must reduce the input in question (in this case, by 20 percent) to be efficient. The estimation of the technical efficiency in the two-stage DEA and MEA approaches has been made using the RStudio deaR, rDEA, and Benchmarking software packages.

Results and discussion

The descriptive statistics for all investigated farms included in the FADN dataset from 2004 to 2019 show an average land capital of around 62 hectares with some significant fluctuations between different EU states and years of investigation, with lowest and highest values of 0.73 and over 1,200 hectares, respectively (Table 1). Taken as a whole, farms included in the FADN dataset received an average of almost 23 thousand Euros in subsidies and other financial payments allocated through the first and second pillars of CAP. RDP subsides represented some 26% of these total payments. In regards to LFA payments, these equalled just under 42% of the total subsidies paid through the RDP.

Using this data, the DEA has revealed an average technically efficiency value of 0.84, which is below the optimal value of the frontier of production equal to 1, meaning that all farms are technically inefficient. The highest value of technical efficiency estimated by the DEA (Fig. 1) has been found in European farms specialised in granivores and in horticulture, at 0.87 and 0.86, respec-

Table 1. Main descriptive statistics in all EU farms included in FADN dataset

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Land	2,901	61.57	117.69	0.73	1,221.81
Labour	2,901	5,737.25	6,958.15	944.07	95,876.34
Specific costs	2,901	77,487.51	124,066.60	500	1,070,131
Other costs	2901	38,649.80	50,881.02	894	459,223
Assets	2,901	604,418.70	725,872.60	16,242	6,289,760
Total Common Agricultural Policy support	2,901	22,918.32	37,586.39	105	383,780
LFA subsidies	2,901	2,516.34	8,273.80	0	112,186
RDP subsidies	2,901	6,005.41	13,351.08	0	185,049

Source: Author's own elaboration on data available at: https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/FADNPublicDatabase.html

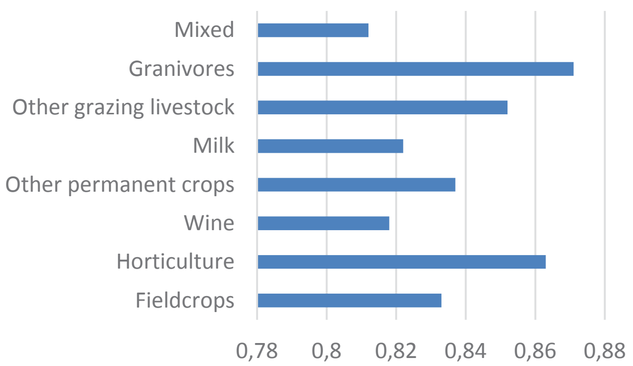

Fig. 1. Average value of DEA in all farms

Source: Author's own elaboration on data available at: https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/FADNPublicDatabase.html

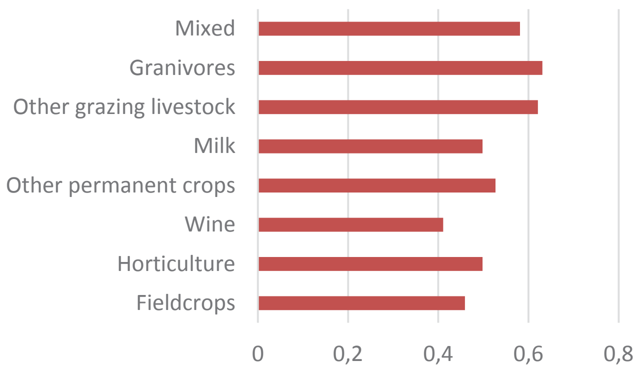

Fig. 2. Minimum value of technical efficiency estimated in all types of farms

Source: Author's own elaboration on data available at: https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/FADNPublicDatabase.html

tively. In contrast, the lowest value was found in mixed farms with a value of around 0.81, implying that these farms use more input compared to the optimal combination.

The fluctuations in technical efficiency between all investigated types of farming estimated using the DEA input-oriented approach show the highest range in farms specialised in wine, with the lowest in farms specialised in granivores and in other grazing livestock (Fig. 2). These differences in technical efficiency can be correlated to the specialisation and to size of farms, as studies in some EU countries have found (Zhu and Lansik, 2010; Garrone at al., 2019).

The average value of technical efficiency in all European farms included in the FADN dataset was found to be 0.83 (Table 2), albeit with significant differences between EU member states. In fact, Finland, France, Slovakia, and Romania were found to have had the highest levels of technical efficiency, while Poland and Slovenia had the lowest levels of technical efficiency. Interestingly, the results do not show an obvious divide between old and new EU member states, which might suggest that there are no significant differences in technology or the allocation of input between countries.

In order to assess whether there are significant differences due to the role of financial subsidies allocated through the second pillar of CAP (RDP), a t test has been used. The findings reveal a significant difference between the average value estimated using the DEA and that using the two-stage DEA. Consequently, it can be said, farms receiving financial subsidies through the second pillar of CAP have been less technically efficient compared to farms not receiving those financial supports (Table 3). The same difference has been found when comparing farms in disadvantaged rural areas that receive only LFA payments and those that do not, which corroborates the need of farmers located in mountainous areas or less favoured areas for specific support. These findings support those of numerous authors in different European countries who have underlined the positive role that specific financial support has on the technical efficiency of farms (Galluzzo, 2020). Other studies have also previously highlighted that, in general, LFA subsidies had a negative correlation to technical efficiency (Minviel and Latruffe, 2017), and similar results have been found in farms specialised in certain productions such as olives in Spain or in some new-comer EU states such as the Czech Republic (Lambarraa and Kallas, 2009; Rudinskaya et al., 2019).

Table 2. Main descriptive statistics of the technical efficiency estimated through the DEA approach in all EU countries

Member state	Average	St. dev.	Median
Austria	0.796	0.076	0.772
Belgium	0.861	0.081	0.854
Bulgaria	0.879	0.132	0.915
Cyprus	0.803	0.141	0.815
Czech Rep.	0.811	0.122	0.787
Germany	0.786	0.077	0.772
Denmark	0.894	0.069	0.907
Estonia	0.782	0.073	0.775
Greece	0.906	0.072	0.909
Spain	0.845	0.079	0.847
Finland	0.958	0.041	0.965
France	0.928	0.058	0.937
Croatia	0.812	0.100	0.825
Hungary	0.816	0.101	0.834
Ireland	0.859	0.070	0.856
Italy	0.873	0.064	0.869
Lithuania	0.815	0.099	0.788
Luxemburg	0.882	0.061	0.874
Latvia	0.835	0.078	0.833
Malta	0.812	0.094	0.799
Netherlands	0.859	0.076	0.855
Poland	0.678	0.072	0.874
Portugal	0.866	0.084	0.870
Romania	0.914	0.087	0.939
Sweden	0.789	0.090	0.768
Slovenia	0.749	0.096	0.739
Slovakia	0.920	0.101	0.953
United Kingdom	0.783	0.093	0.770
Average	***0.838***	***0.106***	***0.841***

Source: Author's own elaboration on data available at: https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/FADNPublicDatabase.html

In the MEA estimation, both the input and output variables used were the total financial subsidies allocated through the CAP (first and second pillars), the total subsidies disbursed through the second pillar only (RDP) minus subsidies to farms located in less favoured areas (RDP), and the financial support allocated to disadvantaged rural areas (LFA). Regarding the input variables, the MEA results reveal the highest level of input excess in the variable land, which implied the highest level of technical inefficiency, while the lowest excess was assessed in the input other costs (Table 4). The same results have been found when focusing on the median rather than the mean. Turning our attention to the output variables, the findings highlight an inefficient use of total output equal to 8%. Total financial subsidies allocated through the CAP on average show an excess of 20%, while the subsides allocated through the second pillar of the CAP (RDP without LFA subsidies) and payments made to disadvantaged rural areas (LFA) show an excess of

Table 3. Comparing TE estimated through the DEA two-stage and DEA input-oriented approach

Average DEA input oriented	Average DEA two stages RDP	T value	Significance
0.8389	0.7948	16.643	***
Average DEA input oriented	Average DEA two stages LFA	T value	Significance
0.8389	0.7949	16.647	***

Source: Author's own elaboration on data available at: https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/FADNPublicDatabase.html

**** P < 0.001*

Table 4. Patterns of inefficiency estimated in all EU farms included in FADN dataset

	Labour	**Land**	**Specific costs**	**Other costs**	**Assets**	**Output**	**Total CAP**	**RDP**	**LFA**
Mean	0.9147844	0.866632	0.907884	0.916756	0.900949	0.92856	0.803051	0.581137	0.444289
St. Dev.	0.0578017	0.080212	0.065403	0.054916	0.068446	0.067082	0.183652	0.298952	0.365059
Median	0.9138528	0.851147	0.909171	0.914886	0.899331	0.941994	0.848711	0.583447	0.396437

Source: Author's own elaboration on data available at: https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/FADNPublicDatabase.html

Table 5. Patterns of inefficiency estimated in all different types of farming

	Labour	**Land**	**Specific costs**	**Other costs**	**Assets**	**Output**	**Total CAP**	**RDP**	**LFA**
Field crops	0.917604	0.849367	0.897048	0.909401	0.891848	0.921387	0.869594	0.523753	0.344816
Horticulture	0.912332	0.896223	0.934763	0.922725	0.932604	0.954523	0.62708	0.446904	0.305201
Wine	0.912269	0.877907	0.913221	0.916692	0.894346	0.934968	0.728383	0.612288	0.383945
Other	0.918125	0.883702	0.914435	0.918488	0.900835	0.924084	0.773449	0.614885	0.416205
Milk	0.901644	0.855829	0.903071	0.908908	0.890704	0.931414	0.848945	0.594432	0.539192
Other grazing	0.928039	0.877234	0.899021	0.932233	0.896324	0.907893	0.900939	0.749962	0.652789
Granivores	0.919479	0.86245	0.930449	0.925268	0.926321	0.959238	0.743049	0.497512	0.359509
Mixed	0.907933	0.845232	0.884872	0.902894	0.882168	0.908099	0.842142	0.58748	0.466332
Average	**0.914784**	**0.866632**	**0.907884**	**0.916756**	**0.900949**	**0.92856**	**0.803051**	**0.581137**	**0.444289**

Source: Author's own elaboration on data available at: https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/FADNPublicDatabase.html

42% and 66%, respectively. Drawing some conclusions, it seems as some farms are not able to use efficiently LFA subsidies that could exceed the optimal threshold.

The investigation of patterns of inefficiency has shown that mixed farms have had the highest level of input excess in all used input (Table 5). In contrast, the highest level of output excess, and consequently the highest level of technical inefficiency, has been found in other grazing livestock farms and in mixed farms. While horticulture farms have shown the highest values of excess in respect to financial subsidies allocated through the CAP, Rural Development Programme, and LFA payments, European farms specialised in other grazing livestock have been more techni-

Table 6. Patterns of inefficiency estimated in all EU states

Country	Labour	Land	Specific costs	Other costs	Assets	Output	Total CAP	RDP	LFA
Austria	0.897743	0.888726	0.908132	0.914326	0.879579	0.920318	0.845863	0.836582	0.524149
Belgium	0.908131	0.857837	0.925682	0.928628	0.908456	0.953716	0.808009	0.437239	0.119623
Bulgaria	0.922809	0.905244	0.934141	0.931244	0.951003	0.955133	0.852066	0.661638	0.462087
Cyprus	0.911228	0.86968	0.878619	0.886963	0.879136	0.832078	0.772802	0.542892	0.614701
Czech Rep.	0.881664	0.860989	0.916823	0.897106	0.915291	0.931369	0.758347	0.584211	0.375339
Germany	0.872247	0.820753	0.898966	0.880342	0.861898	0.923254	0.707672	0.381999	0.182662
Denmark	0.951357	0.884718	0.931024	0.925206	0.861898	0.954048	0.870533	0.337213	0.051474
Estonia	0.874817	0.79734	0.857047	0.872637	0.912866	0.904386	0.728335	0.641941	0.21751
Greece	0.951766	0.920099	0.928661	0.944112	0.94833	0.948422	0.88126	0.629327	0.660156
Spain	0.920219	0.813594	0.907876	0.920702	0.874981	0.940311	0.766738	0.375699	0.315822
Finland	0.990907	0.996996	0.992856	0.993459	0.995899	0.994599	0.993922	0.989697	0.996271
France	0.960858	0.917243	0.956835	0.952493	0.970951	0.972667	0.9174	0.586376	0.571155
Croatia	0.907752	0.842021	0.845988	0.919571	0.85428	0.895854	0.72625	0.455063	0.497987
Hungary	0.899159	0.839241	0.881924	0.887178	0.923075	0.913454	0.799396	0.564335	0.112437
Ireland	0.918403	0.842601	0.892676	0.934259	0.809941	0.918467	0.901573	0.600805	0.410214
Italy	0.93383	0.854147	0.919816	0.937506	0.880022	0.957663	0.784219	0.538494	0.376747
Lithuania	0.901227	0.835924	0.87585	0.904703	0.923616	0.910821	0.795096	0.598733	0.618205
Luxembourg	0.924636	0.908372	0.945269	0.95017	0.888062	0.960851	0.925979	0.907882	0.851629
Latvia	0.9045	0.837595	0.883142	0.891421	0.937674	0.924483	0.832475	0.69622	0.628166
Malta	0.953815	0.958686	0.944751	0.94303	0.91735	0.950674	0.803199	0.729581	0.921424
Netherlands	0.928532	0.876378	0.927916	0.905598	0.863145	0.952858	0.716834	0.386659	0.013414
Poland	0.843505	0.772404	0.803452	0.849165	0.828212	0.81286	0.600438	0.342971	0.364716
Portugal	0.942511	0.882522	0.922595	0.943509	0.941882	0.946175	0.794289	0.74078	0.791508
Romania	0.939469	0.911015	0.935696	0.953722	0.947818	0.957464	0.81202	0.415945	0.323967
Sweden	0.891529	0.81875	0.886106	0.883482	0.859224	0.903145	0.802287	0.584391	0.312724
Slovenia	0.904877	0.878574	0.85294	0.902534	0.859934	0.851767	0.792707	0.785466	0.691326
Slovakia	0.948513	0.929028	0.96528	0.954901	0.961094	0.972255	0.94709	0.846908	0.865601
UK	0.850918	0.794199	0.890921	0.892346	0.841546	0.916855	0.696096	0.391243	0.102996
Average	**0.914784**	**0.866632**	**0.907884**	**0.916756**	**0.900949**	**0.92856**	**0.803051**	**0.581137**	**0.444289**

Source: Author's own elaboration on data available at: https://agridata.ec.europa.eu/extensions/FADNPublicDatabase/FADNPublicDatabase.html

cally efficient than other types of farm, with the lowest level of technical efficiency expressed in terms of excess in output.

Comparing the patterns of inefficiency, assessed by the MEA, instead of the technical efficiency estimated by the DEA, underling as the MEA and the analysis of the patterns of inefficiency in each input and output are the novelty points of this present research, carried out in all European countries, the results show that the highest level of technical inefficiency, due to excess in all input and total produced output in farms is found in Poland (Table 6). Poland also registered the highest level of technical inefficiency in financial subsidies allocated through the CAP under both the first and second pillars, LFA and RDP minus LFA payments respectively. In contrast, Finland has been the most technically efficient EU country in respect to total CAP subsidies allocated with no significant excess in used input or produced output. Turning our attention to second pillar subsidies, the results are mixed. In fact, while Denmark and Poland show the highest levels of technical inefficiency in relation to the variable RDP payments, the Netherlands, Hungary, the United Kingdom, and Belgium record the highest levels of inefficiency in regard to the variable LFA payments. Old and new member states of the EU, Finland and Malta, have seen the highest levels of technical efficiency, and consequently the lowest level of excess in this variable, in using LFA subsidies.

Conclusions

Drawing some closing remarks, the results reveal statistical differences in levels of technical inefficiency between different countries and between different types of farming, as other studies carried out in farms receiving LFA subsidies have previously found, arising from a heterogeneity in technology. LFA subsidies have been more inefficient in certain countries, such as Denmark and the Netherlands, where there is not a significant presence of disadvantaged rural areas, owing also to the application of different policy choices in respect to RDP programmes (Baráth et al., 2020). This has corroborated the theoretical hypothesis, according to which payments to less favoured areas do not have a significant impact on technical efficiency (Baráth et al., 2020). Furthermore, the patterns of technical inefficiency revealed have corroborated the hypothesis that the effect of some types of subsidy can be positive or negative depending on the production specialisation and orientation of the farm and its size in terms of land capital (Latruffe and Desjeux, 2016; Zhu and Lansick, 2010).

The role of specialisation is a fundamental driver in increasing technical efficiency due to the non-homogenous technologies used in farms, and this should be corroborated through other quantitative approaches. Furthermore, while this study has corroborated that differences in technical efficiency do exist, there are not significant differences between EU countries, and this is an important observation considering the homogenous use of technology, as Nowak et al. argued in 2015. The LFA subsidies are pivotal in certain countries due to their lower levels of technical efficiency, which implies a different allocation of subsidies between the first and second pillars of the CAP, even if the positive role of the CAP overall as a tool for improving the levels of technical efficiency in farms has been corroborated by this research.

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